DEPARTMENT OF THE ARMY TECHNICAL MANUAL *TM 5-6115-593-34
DEPARTMENT OF THE NAVY PUBLICATION NAVFAC P-8-631-34
DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER TO-35C2-3-463-2

TECHNICAL MANUAL

Intermediate (Field) (Direct and General Support) and Depot Level Maintenance Manual

GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL SKID MTD., 500 KW, 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

DOD MODEL	CLASS	HERTZ	NSN
MEP-029A	UTILITY	50/60	6115-01-030-6085
MEP-029B	UTILITY	50/60	6115-01-318-6302

INCLUDING OPTIONAL KITS

DOD MODELS	NOMENCLATURE	NSN
MEP-029AHK	HOUSING KIT	6115-01-070-7550
MEP-029ACM	AUTOMATIC CONTROL MODULE	6115-01-275-7912
MEP-029ARC	REMOTE CONTROL MODULE	6110-01-070-7553
MEP-029ACC	REMOTE CONTROL CABLE	6110-01-087-4127

***This manual supersedes TM 5-6115-593-34/NAVFAC P-8-631-34/TO-35C2-3-463-2, dated 21 September 1981, including all changes.**

HEADQUARTERS DEPARTMENTS OF THE ARMY, AIR FORCE AND NAVY
23 JULY 1991

WARNING

**HIGH VOLTAGES PRESENT
DURING TEST.
DEATH
OR SEVERE BURNS MAY RESULT
IF PERSONNEL FAIL
TO OBSERVE SAFETY PRECAUTIONS.**

WARNING

**THE USE OF ACID IS
EXTREMELY DANGEROUS TO WORKMEN
AND
INJURIOUS TO MACHINER.
ALWAYS PROVIDE A TANK OF STRONG SODA
WATER AS A NEUTRALIZING AGENT.**

WARNING

**AVOID BREATHING FUMES
GENERATED BY SOLDERING.
REMOVE RINGS AND WATCHES.
EYE PROTECTION IS REQUIRED
TO AVOID INJURY TO PERSONNEL.**

WARNING

**USE EXTREME CARE WHEN REMOVING ROTOR
TO PREVENT INJURY TO HANDS
DUE TO MAGNETIC ATTRACTION BETWEEN
THE PERMANENT MAGNET GENERATOR ROTOR
AND THE PERMANENT MAGNET GENERATOR
STATOR OR GENERATOR SHAFT.**

WARNING

**NEVER ATTEMPT TO "DRILL OUT"
HOLES IN DRIVE DISCS.
IF DRIVE DISCS DO NOT FIT PROPERLY,
REPLACE DRIVE DISCS.**

WARNING

**BEFORE TURNING OFF
GENERATOR SET,
ENGAGE MAINTENANCE LOCKOUT SWITCH.
DISCONNECT AND ISOLATE
ELECTRICAL LEADS.**

WARNING

**SECONDARY TERMINALS
SHOULD NOT
BE LEFT OPEN
WHEN AC CURRENT IS APPLIED.**

WARNING

**SET MAINTENANCE LOCKOUT SWITCH
TO LOCKOUT.
DISCONNECT NEGATIVE CABLE
FROM BATTERIES.
REMOVE EXTERNAL POWER BY OPENING
CB101 (120V RECEPTACLE BREAKER).**

WARNING

**WHENEVER
GENERATOR SET
HAS JUST BEEN SHUT DOWN,
REMOVE RADIATOR CAP SLOWLY
TO ALLOW PRESSURE
TO ESCAPE
BEFORE REMOVING CAP.**

WARNING

**CLEAR AREA OF
PERSONNEL
AND
OTHER EQUIPMENT
WHEN ATTEMPTING
TO LIFT THE ENGINE**

WARNING

**OVERHEAD OPERATIONS
HAVE INHERENT HAZARDS THAT CANNOT
BE MECHANICALLY SAFEGUARDED.
HARD HATS AND SAFETY SHOES
ARE REQUIRED.**

WARNING

**SILENCER FRAME ASSEMBLY
IS HEAVY.
BE SURE TO PROVIDE
ADEQUATE SUPPORT.**

WARNING

**MAINTENANCE PERSONNEL
SHOULD EXERCISE EXTREME CARE
WHEN TESTING EQUIPMENT
WITH POWER ON.**

WARNING

**LIFTING DEVICES, CABLES,
AND/OR CHAINS SHOULD BE INSPECTED
FOR DETERIORATION OR DAMAGE
BEFORE USE.
A STABILIZING TETHER
SHOULD BE ATTACHED BETWEEN
THE ENGINE AND LIFTING HOOK FOR
ADDED SAFETY AND STABILIZTION
WHEN LIFTING THE UNIT.**

WARNING

**HIGH VOLTAGES PRESENT DURING TEST.
DEATH
OR
SEVERE BURNS
MAY RESULT IF PERSONNEL
FAIL PRECAUTIONS.**

WARNING

**BEFORE STARTING
ANY MAINTENANCE PROCEDURE,
SET MAINTENANCE LOCKOUT SWITCH
TO LOCKOUT.
DISCONNECT NEGATIVE CABLE
FROM BATTERIES.
REMOVE EXTERNAL POWER BY
OPENING CB101 (EXTERNAL POWER
CIRCUIT BREAKER) AND
DISCONNECTING POWER CABLE
FROM RECEPTACLE J101
(120V RECEPTACLE).**

WARNING

**COMPRESSED AIR
USED FOR
CLEANING AND DRYING PURPOSES
CAN CREATE AIRBORNE PARTICLES
THAT MAY ENTER THE EYES.
PRESSURE
SHALL NOT EXCEED 30 PSIG
AND
USE ONLY WITH ADEQUATE CHIP
GUARDS AND CHIPPING GOGGLES.**

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WASHINGTON, D.C., 23 JULY 1991

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REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual directly to: US Army Troop Support Command, ATTN: AMSTR-MMTS, 4300 Goodfellow Blvd. , St. Louis, MO 63120-1798. A reply will be furnished directly to you.

Approved for public release; distribution Is unlimited.

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1**. SCOPE.** This manual contains instructions for intermediate (field) (direct support and general support) and depot maintenance personnel maintaining the 500 KW Diesel Engine Driven Generator Set. The unit is a 50/60 Hertz, (Mode I) Tactical Utility (Type I, Class 2A) Set and maintained as authorized by the Maintenance Allocation Chart (MAC). It provides information on the maintenance of the equipment which is beyond the scope of the tools, equipment, personnel, or supplies normally available to the operator/crew and organizational levels. Where the contents of referenced documents conflict with the contents of this manual, the contents of this manual will be followed.

1-2. LIMITED APPLICABILITY. Some portions of this publication are not applicable to all services. These portions are prefixed to indicate the services to which they pertain: (A) for Army, (F) for Air Force, and (N) for Navy. Portions not prefixed are applicable to all services.

1-3. MAINTENANCE FORMS AND RECORDS. The forms and records used for maintenance purposes by the various services are specified as follows:

a. (A) Maintenance forms and records used by Army personnel are prescribed by DA PAM 738-750.

b. (F) Maintenance forms and records used by Air Force personnel are prescribed in AFM-66-1 and the applicable 00-20 Series Technical Orders.

c. (N) Navy users should refer to their service peculiar directives to determine applicable maintenance forms and records to be used.

1-4. REPORTING OF ERRORS. Report of errors, omissions, and recommendations for improvement of this publication by the individual user is encouraged. Reports should be submitted as follows:

a. (A) Army DA Form 2028 directly to: Commander, U. S. Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798.

b. (F) Air force AFTO Form 22 directly to: Commander, Sacramento Air Logistics Center, ATTN: SM-ALC-MMEDTA, McClellan Air Force Base, CA 95652-5609, in accordance with tO-00-5-1.

c. (N) Navy by letter directly to: Commanding Officer, Naval Construction Battalion Center, ATTN: Code 15741, Port Hueneme, CA 93043-5000.

1-5. LEVELS OF MAINTENANCE ACCOMPLISHMENT. The authorized maintenance and repair functions will be accomplished as follows:

a. (A, MC) Army and Marine Corps users shall refer to the maintenance Allocation Chart (MAC) for tasks and levels of maintenance to be performed.

b. (F) Air Force users shall accomplish maintenance at the user level consistent with their capability in accordance with policies established in AFM-66-1.

c. (N) Navy users shall determine their maintenance levels in accordance with their service directives.

Section II. DESCRIPTION AND TABULATED DATA

1-6. DESCRIPTION. A general description of the generator set and the auxiliary equipment used in conjunction with 'it is contained in the Operator/ Crew and Organizational Maintenance manual. Detailed descriptions of the components of the generator set are provided in the applicable maintenance paragraphs of this manual.

1-7. TABULATED DATA. This paragraph contains all maintenance data pertinent to intermediate (field) (direct and general support) and depot maintenance personnel. The generator set has identification and instructional plates located throughout the set. The information pertaining to these plates is contained in the Operator/Crew and Organizational Maintenance manual.

a. Generator Set.

Manufacturer .... Fermont Division, Dynamics Corporation of America
DOD Drawing Number... 76-029
Model MEP-029B
Mode .... 50/60 Hertz 3 phase, 4 wire
Class .... Utility

b. External Power Box Assembly.

Starter Motor Contactor
DOD Drawing Number 76-11254
Contact Rating
Volt .... hp
200 10
230 15
380-575 25
Overload trip .... 35.5 to 38.2 amps
Nominal operating. .... .120V AC, 50/60 Hz
Required operating ranges .... 50 Hz nominal from 110 to 123V AC and from 47.5 to 52.5 Hz
60 Hz nominal from 114 to 144V AC and from 57.5 to 62.5 Hz

c. AC-DC Control Box Assembly.

Battery Charger
DOD Drawing Number.. 76-11207
AC Input .... 120V AC, 50/60 Hz
DC Output .... 24V DC, 20 amps
Fuse protection .... AC input and DC output
Diodes, zener (measured with associated resistor)
CR1 (TD1) .... .6.8 volts
CR4 (TD3) .... 15 volts
Resistors
R116 .... 5 ohms, 14 watts, $\pm$5 percent
R4 (TD1) .... 820 ohms, 25 watts $\pm$5 percent
R1 (TD1) 2 k, 1 watt, $\pm$5 percent
R2 (TD1) .... 2.7 megohms, 25 watts, $\pm$5 percent
R1 (TD3) .... 2 k, 1 watt, $\pm$5 percent
R2 (TD3) .... 2 k, 1 watt, $\pm$5 percent
R4 (TD3) .... 2 k, 0.25 watt, $\pm$5 percent
R7 (TD3) .... 20 k, 0.25 watt, $\pm$5 percent
R6 (TD3)................................. 200 ohms, 1 watt, $\pm$5 percent
R5 (TD3) .... 68 k, 0.25 watt, $\pm$5 percent
R3 (TD3) .... .6 k, 0.25 watt, $\pm$5 percent
Capacitors
C1 (TD1) .... 10 microfarads, 25 volts, $\pm$5 per-cent
C2 (TD1) .... 47 microfarads, 50 volts, $\pm$5 per-cent
C1 (TD3) .... 300 microfarads, 30 volts, ±5 per-cent
Governor Controller
DOD Drawing Number... 76-11208
Inputs .... 90 to 240V AC, 3 phase load sensing
24V DC supply, 10 watts consumption
900 to 2700 rpm speed range
Output .... Voltage to actuator 0 to 8V DC
Operating range .... 40 to 160°F (-40 to 71°C)
Voltage Regulator
DOD Drawing Number 76-11209
Power input.............................. 120V AC, 50/60 Hz 840VA
Output rating............................ 62.5V DC, 7 amps mas continuous;
90V DC, 10 amps 1 minute forcing
Sensing................................... 208V AC, 3 phase, 50/60 Hz
Voltage regulation..................... $\pm$1/2 percent
Response time .... T6 milliseconds

d. Control Cubicle Assembly.

Alarm Horn
DOD Drawing Number... 76-11225
Input .... 24V DC
Output .... 370 cycles per second, audible

Annunciator Control Assembly
DOD Drawing Number. 76-11272
Diodes (20) JANIN4383
1 amp, 200 volt
Relays (13) M5757/23-003
10 amp, DPDT,
MIL-R-5757
Diodes, Silicone
DOD Drawing Number. 76-11244
Five diodes .... 400 prv, 3 amps
Resistor
Type RWR74S3920RFR,
39,000 ohms,
±5 percent,
MIL-R-22
Resistor Assembly TB107
DOD Drawing Number.. 70-1131
Two resistors .... 7.5 ohms, ±5
percent
Resistors
R4 (TD2) .... 820 ohms, 25
watts
±5 percent
R1 (TD2) .... 2 k, 1 watt,
±5 percent
R2 (TD2).................................. 2.7 megohms,
25 watts,
±5 percent
R3 (TD2).................................. 390 k, 0.25 watt,
±5 percent
Capacitors
C1 (TD2) .... 10 microfarads,
25 volts,
±5 per-cent
C2 (TD2).................................. 47 microfarads,
50 volts,
±5 per-cent
Flashing Circuit (FC1)
Flasher
DOD Drawing Number... 76-11396
24V DC, No.
313 lamp
Terminal
DOD Drawing Number... 76-11241
Digital Clock
DOD Drawing Number... 76-11221
Input .... 120V AC, 50/60 Hz
Features .... 50 to 60 Hz
select; fast
and slow set,
and hold
Synchroscope Meter
DOD Drawing Number.. 76-11219
Voltage .... 120V AC, 50/60 Hz
Accuracy.. .2 degrees
Pull-in frequency .... 48 Hz
Dropout frequency........................... 47 Hz
Underfrequency Relay
DOD Drawing Number 77-11002
Input .... 1 20V AC 50 or
60 Hz
Trip Characteristic...................... .50 or 60 Hz - 3%
(adjustable)
Overfrequency Relay
DOD Drawing Number... 77-11001
Input .... 120V AC 50
or 60 Hz
Trip Characteristic..................... 50 or 60 Hz - 3%
(adjustable)
Over/Under Voltage Relay
DOD Drawing Number 77-11003
Input .... 120V AC 50
or 60 Hz
Trip Characteristic.. .... 50 or 60 Hz - 3%
120V AC ±10%
(adjustable)
Synchronizer Relay
DOD Drawing Number 77-11006
Input .... 120V AC 50 or
60 Hz
Output .... Will allow breaker
closing when
buss and
generator
voltages are
matched to
within
±.5%
frequency,
±10% voltage.

e. Fuel Transfer Pump.

Solenoid Valve
DOD Drawing Number... 69-787-1
24V DC, 2-way
normally closed
Rated .... 25 psi

f. Generator and Reconnection Assembly.

Limit Switch
DOD Drawing Number.. 76-11295
Type .... .Roller Plunger
Contacts .... DPST - 1 NO - 1
NC
600 volts max
6 amps at 600V
AC, 15 amps at
-30V AC
Current Transformer
DOD Drawing Number... 76-11259
Ratio .... 1155/1 - 12.5VA
Max current through ... . .1.5 amp
winding
Continuous at 68°F .... 1.5 amp
(20°C)
Insulation class .... .600V AC

g. Engine and Controls.

Oil Pre-Alarm Pressure Switch

DOD Drawing Number	.76-11310
Switch code	1 NO contact, 1 NC contact
Contact rating	NO contact: 10 amp, 280V DC resistive. NC contact: 10 amp, 125V DC resistive
Pressure range	500 psi (35.2 kg/cm^2) max
Pressure setting	NO circuit trip: 19 to 23 psi (1.33 to 1.6 kg/cm^2) decreasing; NC circuit trip: 19 to 23 psi (1.33 to 1.6 kg/cm^2) decreasing
Temperature range	-65 to 160°F (-54 to 71°C)
Connector	MS3102R-14S-2P

Oil Shut Down Pressure.Switch

DOD Drawing Number	76-11311
Switch code	1 NO contact; 1 NC contact
Contact rating	10 amp, 28V DC resistive; 10 amp, 125V AC
Pressure range	500 psi (35.2 kg/cm^2) max
Pressure setting	NC circuit trip: 11 to 15 psi (0.8 to 1 kg/cm^2) decreasing; NC circuit trip: 11 to 15 psi (0.8 to 1 kg/cm^2) decreasing
Temperature range	.65 to 160°F (-54 to 71°C)
Connector	MS3102R-14S-2P

Lubricant Temperature Switch

DOD Drawing Number	76-11309
Rating	.10 amp, 28V DC
Connector	MS3102E-14S-2P
Circuit	Two independent double-break circuits, one NO and one NC
Operation	The NC circuit opens at 265 ±3° F (129 ±1° C) and the circuit closes at 255 ±3°F (124 ±1°C)

Overspeed Switch

DOD Drawing Number	70-1105-5
Type	Centrifugal or electronic element; 2 auto reset, 1 manual reset
Operating temperature range	-65 to 150°F (-54 to 66°C)
Element No. 1	Transfer at 290 to 310 rpm rising speed, auto reset 100 rpm max below trip speed
Element No. 2	Transfer at 590 to 610 rpm rising speed, auto reset 100 rpm max below trip speed
Element No. 3	Transfer at 1100 to to 1150 rpm rising speed, manual reset

Oil Temperature Sender

DOD Drawing Number	76-11249-2
Maximum operating temperature	325°F (163°C)
Temperature	230°F (110°C) 341.3 ohms, ±31 ohms

Magnetic Pickup

DOD Drawing Number	76-11250
Coil resistance	170-210 ohms
Output	70V P-P min

h. Remote Control Module.

Alarm Horn

DOD Drawing Number	76-11225
Input	24V DC
Output	370 cycles per second, audible

Annunciator Control Assembly

DOD Drawing Number	76-11272
Diodes (20)	JANIN4383 1 amp, 200 volt
Relays (13)	.M5757/23-003 10 amp, DPDT MIL-R-5757

Flashing Circuit (FCI)
Flasher
DOD Drawing Number.. .... 76-11396 24V DC, No. 313 lamp
Terminal
DOD Drawing Number.. 76-11241
Synchroscope Meter
DOD Drawing Number..7 6-11219
Voltage .... 120V AC, 50/60 Hz
Accuracy .... 2 degrees
Pull-in frequency....................... 48 Hz
Dropout frequency... .... 47 Hz

i. Parallel Cable Assemblies.

DOD Drawing Number.. .... 76-11320 and 76-11321
76-11320 1200 ft (365 m) 76-11253 cable
76-11321 1200 ft (365 m) 76-11253 cable

j. Housing Kit.

Actuator
DOD Drawing Number.. 76-11475
Voltage .... 24V DC
Load .... 250 pounds (113.5 kilograms)
Speed .... 1.0 in/sec (25.4 mm/sec)
Current .... 7 amps
26.5V DC Relay
DOD Drawing Number.. 76-11444
Coil resistance .... 300 ohms
.... ±10 percent
Contact type .... DPDT with arc chamfer
Contact rating .... .10 amp resistance at 26.5V DC/ 115V AC 400 Hz with enclosure grounded
Max pull-in volts....................... 18V DC
Min holding volts.. .... .10V DC
Min dropout volt .... 1V DC
Operating time at... .... 15MS max 26.5V DC
Release time at .... 15MS max 26.5V DC

NOTE

Throughout this technical manual MEP-029A is referrd to as code A and MEP-029B is referred to as code B.

1-8. INSTRUCTION PLATES. Refer to the Operator/Crew and Organizational .Maintenance manual for location of instruction plates in the generator set.

1-9. TORQUE DATA. Table 1-1 lists components that require special torques.

1-10. SCHEMATICS AND WIRING DIAGRAMS. FO-1 through FO-16 of the Operator/Crew and Organizational Maintenance manual are the schematic and wiring diagrams for the generator set and auxiliary equipment.

1-11. SERIAL NUMBER EFFECTIVITY.
Refer to TM5-6115-593-24P, Usable on Code data.

Table 1-1. Special Torque Data

COMPONENTS	TORQUE VALUE FT/LBS	TORQUE VALUE JOULES
GENERATOR		
Generator mount to skid base screws	202	274
Flexible coupling to flywheel screws	112	152
ENGINE		
Front trunnion mounting bolts	202	274
Bell housing mounting bolts	296	401
Main bearing capscrew		
Tighten to	200 min/210 max	271min/285 max
Advance to	410 min/420 max	555 min/570 max
Loosen	all	
Tighten to	200 min/210 max	271 min/285 max
Advance	420 min/460 max	570 min/624 max

* Applicable to Generator Set serial numbers FZ00001-FZ00064 only
* Cap screw should be coated with 30 weight oil

Table 1-1. Special Torque Data - Continued

COMPONENT	TORQUE VALUE FT/LBS	JOULES
Main bearing side capscrew		
All right side	70 min/75 max	95 min/102 max
All left side	70 min/75 max	95 min/102 max
All right side	135 min/145 max	145 min/197 max
All left side	135 min/145 max	145 min/197 max
Connecting rods nut		
Tighten to	70 min/80 max	95 min/108 max
Advance to	140 min/150 max	190 min/203 max
Loosen	all completely	
Tighten to	70 min/80 max	95 min/108 max
Advance to	140 min/150 max	190 min/203 max
Rear cover capscrews	29 to 31	39 to 42
Tappet guide screws *	95 to 115 (in/lbs)	11 to 13
Cylinder head capscrews		
Tighten to	25 to 40	34 to 54
Advance to	150 to 200	203 to 270
Continue to advance	275 to 305	373 to 414
Breakaway	275 to 340	373 to 461
Injector hold down capscrews	11 to 12 increments alternately of 4 ft/lbs (5 joules)	15 to 16
Damper flange capscrews	300 to 320	408 to 435 **
Damper capscrews		
Conical head	70 to 80	95 to 108
Hexagon head	100 to 120	136 to 163
Flywheel capscrews	350 to 390	475 to 529
Breakaway	350 to 420	475 to 570
STARTER MOTOR		
Nose housing bolts	11 min/15 max	15 min/20 max
TURBOCHARGER		
V-Band clamp tension	32 to 36 *	3.6 to 4.1
Rotor assembly locknut tension	20 to 24	27 to 33
Lubricating oil drain fitting		50 68
Diffuser plate capscrew	5 to 7	7 to 10
PIPE PLUG SIZE WITH TEFLON TAPE		
1/8	10 min/12 max	14 min/16 max
1/4	20 min/25 max	27 min/34 max
3/8	30 min/40 max	41 min/54 max
1/2	30 min/35 max	41 min/47 max
3/4	40 min/50 max	54 min/63 max
1	60 min/70 max	81 min/95 max
1-1/4	75 min/85 max	102 min/115 max
1-1/2	90 min/100 max	122 min/136 max

* In-lbs.

Table 1-2. Repair and Replacement Standards

PART OR LOCATION	WORN LIMIT	NEW MINIMUM INCH (mm)	NEW MAXIMUM INCH (mm)
CYLINDER BLOCK			
Camshaft bushing			
Inside diameter	2.1295 (54.089)	2.1245 (53.962)	2.1283 (54.059)
Camshaft bushing bore			
Inside diameter	2.2555 (57.290)	2.2535 (57.239)	2.2545 (57.264)
Cylinder liner counterbore			
Inside diameter		6.5616 (166.662)	6.5635 (166.713)
Depth	0.411 (10.44)	0.350 (8.89)	0.351 (8.91)
Liner-to-block clearance			
Lower bore		0.000 (0.00)	0.008 (0.20)
Lower liner bore		6.124 (155.55)	6.126 (155.60)
Main bearing bore			
Inside diameter	6.0965 (154.851)	6.095 (154.813)	6.096 (154.838)
Tappet bore			
Injector	1.627 (41.33)	1.6245 (41.262)	0.6255 (41.288)
Valve	1.190 (30.213)	1.187 (30.150)	1.188 (30.175)
Idler gearshaft	1.997 (50.72)	1.9975 (50.737)	1.998 (50.75)
Block			
Height from main bearing centerline	18.994 (482.45)	19.004 (482.70)	19.006 (482.75)
Height from installed alignment bar	15.9457 (405.02)	15.9565 (405.27)	15.958 (405.33)
Cylinder liner			
Inside diameter	5.505 (139.83)	5.4995 (139.687)	5.501 (139.73)
Protrusion (Installed)		0.004 (0.10)	0.006 (0.15)

NOTE

New cylinder liner dimensions at 60 to 70°F (16 to 21°C); may be 0.0002 to 0.0006 inch (0.005 to 0.015 mm) smaller than indicated due to lubrite coating.

Table 1-2. Repair and Replacement Standards - Continued

PART OR LOCATION	WORN LIMIT	NEW MINIMUM INCH (mm)	NEW MAXIMUM INCH (mm)
Cylinder liner counterbore			
Shim part number			
143938		0.0063 (0.160)	0.007 (0.196)
143939		0.0072 (0.183)	0.0088 (0.224)
143946		0.0081 (0.206)	0.0099 (0.251)
143947		0.018 (0.457)	0.022 (0.56)
143948		0.028 (0.71)	0.034 (0.86)
143949		0.056 (1.42)	0.068 (1.73)
Main bearing cap interference			
Fit in block		0.002 (0.05)	0.004 (0.10)
Idler Gear			
Bushing inside diameter	2.002 (50.85)	2.000 (50.80)	2.001 (50.83)
Idler gear hub	1.9965 (50.711)	1.9975 (50.77)	1.998 (50.75)
Thrust washer	0.090 (2.29)	0.093 (2.36)	0.098 (2.49)
Crankshaft			
Connecting rod journal Outside diameter	3.747 (95.17)	3.7485 (95.212)	3.750 (95.25)
Main bearing journal Outside diameter	5.7465 (145.961)	5.7485 (146.011)	5.750 (146.500)
Main and rod journals Out-of-round (total indicated runout)	0.002 (0.05)		
Bearings			
Main bearings			
Shell thickness	0.1692 (4.298)	0.1705 (4.331)	0.1712 (4.348)
Journal oil clearance (main	0.010 (0.254)	0.0026 (0.066)	0.0065 (0.165)
Rod bearings			
Shell thickness	0.1232 (3.129)	0.1245 (3.162)	0.1250 (2.175)
Journal oil clearance (connecting rod)	0.0085 (0.216)	0.0018 (0.046)	0.0053 (0.135)

Table 1-2. Repair and Replacement Standards - Continued

PART OR LOCATION	WORN LIMIT	NEW MINIMUM INCH (mm)	NEW MAXIMUM INCH (mm)
Crankshaft thrust ring			
Thickness	*	0.307 (7.80)	0.317 (8.05)
Crankshaft end clearance (Installed)	0.026 (0.66)	0.006 (0.15)	0.013 (0.33)
Connecting Rod			
Crankpin bore Inside diameter		4.0018)101.646)	4.0028 (101.671)
Out-of-round			0.001 (0.02)
Center-to-center-length		11.998 (304.75)	12.050 (304.80)

NOTE

***Add 0.003 inch (0.08 mm) ring gap to new maximum limit for 0.001 inch (0.03 mm) wear in cylinder liner wall.**

PART OR LOCATION	WORN LIMIT	NEW MINIMUM INCH (mm)	NEW MAXIMUM INCH (mm)
Piston pin bushing			
Inside diameter	2.0025 (50.863)	2.001 (50.82)	2.0015 (50.838)
Connecting rod			
Alignment without bushing			0.008 (0.20)
Alignment with bushing			0.004 (0.10)
Twist without bushing			0.020 (0.51)
Twist with bushing			0.010 (0.25)
Bolt pilot	0.6242 (15.855)	0.6245 (15.862)	0.625 (15.87)
Rod bolt hole	0.6249 (15.872)	0.6243 (15.857)	0.6248 (15.867)
Connecting rod bolt			
Outside diameter	0.540 (13.72)	0.541 (13.74)	0.545 (13.84)
Piston and Piston Rings			
Skirt diameter at 70xF (21xC)	5.483 139.27)	5.487 (139.37)	5.488 (139.39)

Table 1-2. Repair and Replacement Standards - Continued

PART OR LOCATION	WORN LIMIT	NEW MINIMUM INCH (mm)	NEW MAXIMUM INCH (mm)
Piston pin bore			
Inside diameter at 70xF (21xC)	2.000 (50.80)	1.9985 (50.762)	1.9989 (50.772)
Piston pin			
Outside diameter	1.9978 (50.744)	1.9988 (50.770)	1.990 (50.775)
Piston ring gap			
147670	*	0.017 (0.43)	0.027 (0.69)
132880	*	0.013 (0.33)	0.023 (0.58)
214730	0.029 (0.736)	0.019 (0.483)	0.029 (0.736)
218732	0.025 (0.635)	0.010 (0.254)	0.025 (0.635)

NOTE

***Add 0.003 inch (0.08 mm) ring gap to new maximum limit for 0.001 inch (0.03 mm) wear in cylinder liner wall.**

PART OR LOCATION	WORN LIMIT	NEW MINIMUM INCH (mm)	NEW MAXIMUM INCH (mm)
Vibration Damper			
Misalignment of index marker	1/16 (1.59)		1/16 (1.59)
Wobble	0.055 (1.40)		0.055 (1.40)
Eccentricity	0.030 (0.76)		0.030 (0.76)
Journal Camshaft			
Outside diameter	2.120 (58.85)	2.122 (53.90)	2.123 (53.92)
Lobe lift			
Valve			0.2835 (7.201)
Injector			0.117 (2.97)
Thrust washer			
Thickness		0.093 (2.36)	0.098 (2.49)
Valve Crossheads			
Inside diameter	0.440 (11.18)	0.434 (11.02)	0.436 (11.07)
Guide outside diameter	0.432 (10.97)	0.433 (11.00)	0.4335 11.011)
Guide assembled height (protrusion)		1.860 (47.24)	1.880 (47.75)
Bore depth		1.000 (25.40)	

Table 1-2. Repair and Replacement Standards - Continued

PART OR LOCATION	WORN LIMIT	NEW MINIMUM INCH (mm)	NEW MAXIMUM INCH (mm)
Valve Crossheads (Cont.)			
Crosshead to spring retainer clearance		0.025 (0.64)	
Valves, Guides and Springs			
Valve stem outside diameter	0.449 11.40)	0.450 (11.43)	0.451 (11.46)
Valve guide inside diameter	0.4545 11.544)	0.4525 (11.494)	0.4532 (11.511)
Valve guide height		1.315 (33.40)	1.325 (33.65)
Head height	5.460 (138.68)	5.490 (139.45)	5.510 (139.95)
Runout			0.002 (0.05)
Gear Cover			
Fuel pump drive bushing	1.5705 (39.891)	1.565 (39.75)	1.569 (39.85)
Generator drive bushing	1.3205 (33.541)	1.316 (33.43)	1.319 (33.50)
Camshaft support	1.757 (44.63)	1.751 (44.48)	1.754 (44.55)
Rear Cover			
Piston ring type	8.504 (216.00)	8.500 (215.90)	8.502 (215.95)

VALVE SEAT INSERT SPECIFICATION - INCH (mm)

INSERT PART NO.	CUTTER	DIAMETER	OVERSIZE DEPTH	INSERT OD	CYLINDER HEAD ID	INSERT THICKNESS
127930	ST-662	Std.	Std.	2.0025/2.0035 (50.864/50.889)	1.9995/2.005 (50.787/50.813)	0.278/0.282 (7.06/7.16)
127935	ST-662	0.005 (0.13)	Std.	2.0075/2.0085 (50.991/51.016)	2.0045/2.0055 (50.914/50.940)	0.278/0.282 (7.06/7.16)
127931	ST-662-1	0.010 (0.25)	Std.	2.0125/2.0135 (51.118/51.143)	2.0095/2.0105 (51.041/51.067)	0.278/0.282 (7.06/7.16)
127932	ST-662-2	0.020 (0.51)	0.005 (0.1270)	2.0225/2.0235 (51.372/51.397)	2.0195/2.0205 (51.295/51.321)	0.283/0.287 (7.06/7.29)
127933	ST-662-3	0.030 (0.76)	0.010 (0.2540)	2.0325/2.0335 (51.626/51.651)	2.0295/2.0305 (51.549/51.575)	0.288/0.292 (7.32/7.42)
127934	ST-662-4	0.040 (1.02)	0.015 (0.3810)	2.0425/2.0435 (51.880/51.905)	2.0395/2.0405 (51.803/51.829)	0.293/0.297 (7.44/7.54)

CAUTION

Be sure to measure insert before machining head or installing insert in head.

Table 1-2. Repair and Replacement Standards - Continued

PART OR LOCATION	WORN LIMIT	NEW MINIMUM INCH (mm)	NEW MAXIMUM INCH (mm)
CYLINDER HEAD			
Head Height	5.460 (138.68)	5.490 (139.45)	5.510 (139.95)
Injector Sleeve			
Top inside diameter		1.145 (29.08)	1.155 (29.34)
Injector cup protrusion	0.065 (1.65)	0.045 (1.14)	0.055 (1.40)
ROCKER LEVERS			
Bushing Inside Diameter	1.1285 (28.664)	1.1245 (28.562)	1.1275 (28.639)
Shaft Outside Diameter	1.122 (28.50)	1.123 (28.52)	1.124 (28.55)
Push Tubes			
Valve (ball end radius)		0.623 (15.82)	0.625 (15.88)
Socket (spherical inside diameter)		0.505 (12.83)	0.520 (13.21)
Injector (ball end radius)		0.623 (15.82)	0.625 (15.88)
Socket (spherical: inside diameter)		0.505 (12.83)	0.520 (13.21)
TAPPETS			
Injector			
Body inside diameter		0.998 (25.36)	1.007 (25.58)
Body outside diameter	1.6215 (41.186)	1.6225 (41.212)	1.6235 (41.237)
Injector			
Roller outside diameter	1.196 (30.38)	1.198 (30.43)	1.200 (30.48)
Roller inside diameter	0.630 (16.00)	0.628 (15.95)	0.629 (15.98)
Roller pin outside diameter	0.6233 (15.832)	0.6243 (15.857)	0.6247 (15.867)
Roller side diameter	0.025 (0.64)	0.008 (0.20)	0.020 (0.51)
Roller concentrating			.001 (0.03)
Roller squareness			0.004 (0.10)
Valve			
Body inside diameter		0.968 (24.59)	0.978 (24.84)
Body outside diameter	1.184 (30.08)	1.185 (30.10)	1.186 (30.12)
Roller outside diameter	1.059 (26.90)	1.061 (26.95)	1.063 (27.00)

Table 1-2. Repair and Replacement Standards - Continued

PART OR LOCATION	WORN LIMIT	NEW MINIMUM INCH (mm)	NEW MAXIMUM INCH (mm)
TAPPETS (Cont'd)			
Roller inside diameter	0.505 (12.83)	0.503 (12.78)	0.504 (12.80)
Roller pin outside diameter	0.4985 (12.662)	0.4995 (12.69)	0.500 (12.70)
Roller side clearance	0.027 (0.69)	0.008 (0.20)	0.022 (0.56)
Roller concentricity			.002 (0.05)
Roller squareness			.004 (0.10)
FAN HUB			
End Clearance		0.001 (0.03)	0.007 (0.18)
DRIVE UNITS			
Fuel Pump, Compressor Bushings	1.3205 (33.541)	1.316 33.43)	1.319 (33.50)
Generator Bushing	1.3205 (33.541)	1.316 (33.43)	1.319 (33.50)
WATER PUMP WITHOUT IDLER			
Impeller to shaft press fit	.0012 (0.031)	0.0012 (0.031)	0.0026 (0.066)
Pulley to shaft press fit	0.007 (0.018)	0.007 (0.018)	0.0021 (0.53)
Impeller to body		0.020 (0.51)	0.031 (0.79)
Impeller to cover		(0.51)	(1.02)
WATER PUMP WITH IDLER			
Impeller to shaft press fit	0.0012 (0.031)	0.0012 (0.031)	0.0026 (0.066)
Pulley to shaft press fit	0.001 (0.025)	0.001 (0.025	0.0025 (0.064)
Impeller to body clearance		(0.020 (0.58)	(0.031 (0.79)
Bearing bore on body	1.810 (45.97)	1.8085 (45.94)	1.8095 (45.96)
Seal bushing bore on body	1.8755 (47.64)	1.8735 (47.59)	1.8745 (47.61)
Bearing bore on idler pulley	1.810 (45.97)	1.8085 (45.94)	1.8095 (45.96)

Table 1-2. Repair and Replacement Standards - Continued

NEW MINIMUM PART OR LOCATION	WORN LIMIT	NEW MAXIMUM INCH (mm)	INCH (mm)
Idler shaft outside diameter	0.864 (21.95)	0.8646 (21.96)	0.8651 (21.97)
Pivot shaft outside diameter	0.870 (22.098)	0.8745 (22.21)	0.8750 (22.23)
Idler shaft bore (idler arm)	1.248 (31.70)	1.247 (31.67)	1.248 (31.70)
Pivot shaft bore (idler pulley hacket)	0.873 (22.17)	0.872 (22.15)	0.873 (22.17)

Table 1-3. Parameters AC-0% Droop

CHARACTERISTIC PARAMETER	VALUE	TEST METHOD MIL-STUD-705
Voltage Characteristics		
Regulation (%)	2%	608.1
Steady-state-stability (variation) (bandwith %)		
Short term (30 seconds)	1%	608.1
Long term (4 hours)	2%	608.2
Transient performance		
Application of 50% of rated load		
Dip (%) - 60 Hz	20%	619.2
Recovery (seconds)	3 sec	619.2
Rejection of rated load		
Rise (%) - 60 Hz	30%	619.2
Recovery (seconds)	no spec	619.2
Waveform		
Maximum deviation factor (%)	5%	601.1
Maximum individual harmonic (%)	2%	601.4
Voltage unbalance with unbalance load (%) (Note 1)	5%	620.2
Phase balance voltage (%)	1%	508.1
Voltage adjustment range		
50 Hz (120/208 volts)	190 to 213V	
50 Hz (240/416 volts)	380 to 426V	511.1
60 Hz (120/208 volts)	197 to 250V	
60 Hz (240/416 volts)	395 to 500V	511.1
Frequency Characteristics		
Regulation (%)	0.25%	608.1
Steady-state-stability (variation) (bandwith %)		
Short term (30 seconds)	0.5%	608.1
Long term (4 hours)	1%	608.2
Transient performance		
Application of 50% of rated load		
Undershoot (%)	4%	608.1
Recovery (seconds)	4 sec	608.1
Rejection of 50% of rated load		
Overshoot (%)	4%	608.1
Recovery (seconds)	4 sec	608.1
Frequency adjustment range (Hz)		
50 Hz	±5%	511.2
60 Hz	±4%	511.2

NOTE

1. The generator set connected for three phase output and supplying a single phase, unity power factor load connected line-to-line, with no other load on the set. The load current to be 25 percent of the rated full load current of the set.

Table 1-4. Electrical Performance Characteristic Parameters AC-3% Droop

CHARACTERISTIC PARAMETER	VALUE	TEST METHOD MIL-STUD-705
Voltage Characteristics		
Regulation (%)	2%	608.1
Steady-state-stability (variation)		
Short term (30 seconds)	1%	608.1
Long term (4 hours)	2%	608.2
Transient performance		
Application of rated load		
Dip (%)	20%	619.2
Recovery (seconds)	3 sec	619.2
Rejection of rated load		
Rise (%)	30%	619.2
Recovery (seconds)	no spec	619.2
Waveform		
Maximum deviation factor (%)	5%	601.1
Maximum individual harmonic (%)	2%	601.4
Voltage unbalance with unbalance load (%) (Note 1)	5%	620.2
Phase balance voltage (%)	1%	508.1
Voltage adjustment range		
50 Hz (120/208 volts)	190 to 213 V	
50 Hz (240/416 volts)	380 to 426 V	511.1
60 Hz (120/208 volts)	197 to 250 V	
60 Hz (240/416 volts)	395 to 500 V	511.1
Frequency Characteristics		
Regulation (%)	3	608.1
Steady-state-stability (variation) (bandwith %)		
Short term (30 seconds)	.5%	608.1
Long term (4 hours)	1%	608.2
Transient performance		
Application of 50% of rated load		
Undershoot (%)	4%	608.1
Recovery (seconds)	4 sec	608.1
Rejection of 50% of rated load		
Overshoot (%)	4%	608.1
Recovery (seconds)	4 sec	608.1
Frequency adjustment range (Hz)		
50 Hz	±5%	511.2
60 Hz	±4%	511.2

NOTE

1. The generator set connected for three phase output and supplying a single phase, unity power load connected line-to-line with no other load on the set. The load current to be 25 percent of the rated full load current of the set.

CHAPTER 2

GENERAL MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS, TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TDME) AND SUPPORT EQUIPMENT

2-1. REPAIR PARTS. Repair parts and equipment are listed and illustrated in the Repair Parts and Special Tools List manual covering the intermediate, direct, general support and depot maintenance for the generator set.

2-2. TOOLS AND EQUIPMENT. Tools and equipment are listed in the Repair Parts and Special Tools List manual covering the intermediate, direct, general support, and depot maintenance for the generator set.

2-3. SPECIAL TOOLS, TEST, AND SUPPORT EQUIPMENT. Special tools, test, and support equipment are listed in Table 2-1.

Section II. TROUBLESHOOTING

2-4. This section contains troubleshooting information for locating and correcting operating troubles which may develop in the generator set. Each malfunction for an individual component unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. You should perform the tests/inspections and corrective actions in the order listed.

2-5. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or cannot be corrected by listed corrective action, notify your supervisor.

2-6. Indicated malfunctions are those beyond the capacity of the generator set fault indicator panel. Generator set fault indicators should always be checked prior to troubleshooting.

SECTION III. GENERAL MAINTENANCE

2-7. GENERAL. This section contains general instructions on repair practices such as cleaning, connecting and disconnecting wires, soldering, and welding.

WARNING

COMPRESSED AIR USED FOR CLEANING AND DRYING PURPOSES CAN CREATE AIRBORNE PARTICLES THAT MAY ENTER THE EYES. PRESSURE SHALL NOT EXCEED 30 PSIG AND USE ONLY WITH ADEQUATE CHIP GUARDS AND CHIPPING GOGGLES.

2-8. CLEANING. Components may be cleaned with low pressure compressed air, then wiped clean with a dry, lint-free cloth. Components may also be cleaned with a cloth dampened in cleaning solvent, Federal Specification P-D-680.

2-9. WIRING. Tag all wires and cables during removal procedure for correct identification during replacement procedures. Before a part is unsoldered, note the position of the leads. If the part has several leads, tag each of the leads before unsoldering any of them. If wiring must be replaced, use leads of the same length and gauge. Never use replacement wire with a higher gauge number (smaller diameter).

2-10. SOLDERING. On printed circuit boards, use a pencil-type soldering iron with a 25-watt maximum heating capacity. Make well-soldered connections, using no more solder than is necessary. Do not allow drops of solder to fall into the unit. Do not allow a soldering iron to come into contact with insulation or other parts that may be damaged by excessive heat. Do not disturb the setting of any uncalibrated control without pre-determining its proper setting prior to reengergizing the equipment.

2-11. WELDING. Proper preparation is an important factor in welding, reference TM9-237. Edges to be joined must be clean. Necessary arrangements for holding parts in proper alignment during welding should be made. Oil, grease, paint, or foreign matter of any kind must be removed. With edges properly prepared for welding, the steps should be taken to make certain that the finished job will be in correct alignment.

Table 2-1. Special Tools, Test, and Support Equipment

ITEM	NSN or REFERENCE NO.	REFERENCE FIG NO.	REFERENCE PARA NO.	USE
Test stand, injector leakage	ST-990	13-17	13-13	Test injectors
Plunger extension	ST-1089	-	13-13	Disassemble injectors
Spray angle tester	ST-668	13-18	13-13	Test injectors
Test stand, injector	ST-790	13-19	13-13	Test injectors
Holding fixture	ST-1298	-	13-13	Disassemble injectors
Retainer wrench	ST-995	-	13-13	Disassemble injectors
Crowfoot wrench	ST-1072	-	13-13	Disassemble injectors
Injector sleeve cutter	ST-884	-	13-27	Rebuilding of cylinder head
Adapter wrench	ST-890	-	13-27	Rebuilding of cylinder head
Hydrostatic tester	ST-1012	-	13-27	Hydrostatic test test of cylinder head
Rod checking fixture	ST-561	-	13-33	Check piston rod alignment
Puller	ST-647	-	13-17	Pull water pump impeller
Ream Fixture	ST-490	-	13-14	Overhaul fuel pump
Injector sleeve holding	ST-1179	-	13-27	Hydrostatic test of cylinder head
Valve seat insert cutter set	ST-662	-	13-27	Rebuilding of cylinder head
Fuel pump spring pack adjusting tool	ST-984	-	13-14	Adjust governor spring pack
Oil seal assembly tool	ST-419	-	13-8 and 13-10	Assemble tachometer drive

Table 2-1. Special Tools, Test, and Support Equipment (Cont'd)

ITEM	NSN or REFERENCE NO.	REFERENCE FIG NO.	REFERENCE PARA NO.	USE
Test stand, fuel pump	ST-848	13-26	13-14	Test fuel pump
Gear pump block plate	ST-884	-	13-14	Test gear pump
Test stand, governor	8909-032	-	12-2	Test and repair of electric hydraulic actuator
Centering box	8909-038	-	12-5	Test and repair of electric hydraulic actuator
Electronic counter	8959-028	-	12-5	Test and repair of electric hydraulic actuator
Magnetic pickup	8959-031	-	12-5	Test and repair of electric hydraulic actuator
Pilot valve wrench	370109	12-5	12-5	Test and repair of electric hydraulic actuator
Gauss meter, bell	110-A	-	12-6	Test and repair of electric hydraulic actuator

Table 2-2. Generator Set, Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. ENGINE FAILS TO CRANK WHEN MASTER SWITCH IS MOVED TO START.

Move MASTER SWITCH to start. If the starter motor cranks and the engine does not turn over, the starter motor gear is not engaging the engine's ring gear (flywheel).

Remove starter motor and test in accordance with paragraph 13-5/13-6

Inspect teeth of the ring gear (at the point where the starter motor was mounted). If the teeth have broken off, replace the ring gear (refer to paragraph 13-22).

2. ENGINE CRANKS AT NORMAL SPEED BUT WILL NOT START

As engine is being cranked check position of the throttle arm on fuel injection pump.

If throttle arm is in no fuel position (toward the right), stop cranking. Disconnect electrical connector from top of hydraulic governor. (This will allow the hydraulic governor to operate in its mechanical mode, free of any control from governor controller A106.) Recrank engine. If engine starts, then A106 should be tested and repaired as required (see paragraph 4-11).

If engine still does not start, disconnect one end of linkage between throttle arm and hydraulic governor. Recrank engine as throttle arm is manually (and slowly) brought toward full fuel position (toward left). If engine starts, hydraulic governor is probably at fault and should be checked and repaired as required (see paragraph 12-2). If engine does not start, the fuel injection pump should be tested and repaired as required (see paragraph 13-14).

3. ENGINE SHUTS DOWN SOON AFTER STARTING

Crank engine. As engine is being cranked check position of throttle arm on fuel injection pump.

If throttle arm is in no fuel position (toward the right), stop cranking. Disconnect electrical connector from top of hydraulic governor. (This will allow the hydraulic governor to operate in its mechanical mode, free of any control from governor controller A106.) Recrank engine. If engine starts, then A106 should be tested and repaired as required (see paragraph 4-11).

If engine still does not start, disconnect one end of linkage between throttle arm and hydraulic governor. Recrank engine as throttle arm is manually (and slowly) brought toward full fuel position (toward left). If engine starts hydraulic governor is probably at fault and should be checked and repaired as required (refer to paragraph 12-2). If engine does not start, the fuel injection pump should be tested and repaired as required. Adjust in accordance with paragraph 12-3.

Table 2-2. Generator Set, Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

4. ENGINE RUNS ERRATICALLY OR MISFIRES

Step 1. Check fuel lines into and out of the fuel injection pump for damage, blockage, or air leaks.

Air leaks occurring at any point prior to the fuel injection pump will cause erratic engine operation. Air leaks are difficult to detect and a trial-and-error approach may be necessary. Check for loose fittings and defective fuel filter gaskets. Placing a fairly heavy oil around a suspected fitting may reveal the presence of air leaks. The oil would be sucked, quite noticeably, into the fuel line if air leaks are present.

Step 2. Check the engine's exhaust ports for presence of blackish smoke (unburnt fuel).

If present, note if smoke is coming from left or right exhaust port. If the left port is the source, it may be assumed that one of the fuel injectors or cylinders on the left side of the engine is malfunctioning.

Stop engine and remove the valve cover associated with suspected side of engine (see Chapter 13). Restart engine. Visually inspect valves, rocker arms, and push rods for improper or misadjusted operation.

If, for example, one push rod appears bent, the associated rocker arm will not travel as far as adjacent rocker arms and the corresponding valve not fully open. Thus, by comparing the motion of one rocker arm to other rocker arms, a faulty rocker arm or push rod would be immediately apparent.

Step 3. Check KW and KVAR readings on Generator Control Panel.

If readings indicate excessive power draw, rearrange load distribution to restore normal power consumption.

If readings indicate excessive power draw, rearrange load distribution to restore normal power consumption.

If KW and KVAR readings are normal, refer to Chapter 13 on engine assembly testing.

5. GENERATOR OUTPUT FREQUENCY INCORRECT

Step 1. Inspect motor-operated potentiometer B4 (2, figure 4-10) according to paragraph 4-21 and refer to paragraph 4-23 for testing and replacement procedures.

Step 2. Stop engine. Unplug electrical connector from top of hydraulic governor, disconnecting output of A106. Start engine.

If generator output is at correct frequency, governor controller A106 should be tested and repaired as required (see paragraph 4-11).

Table 2-2. Generator Set, Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

Step 3. Disconnect linkage between throttle arm (of fuel injection pump) and hydraulic governor. Set throttle arm to mid-position and start engine. Adjust the throttle arm for correct generator output frequency.

If it is possible to adjust throttle for correct frequency, hydraulic governor should be tested and repaired as required.

6. GENERATOR OUTPUT VOLTAGE INCORRECT OR FLUCTUATING.

Step 1. Inspect motor-operated potentiometer B5 (4, figure 4-10) according to paragraph 4-21 and refer to paragraph 4-23 for testing and replacement procedures.

Step 2. Shut down engine. Disconnect and tag exciter field leads from F- and F+ terminals of voltage regulator VR101. Observing polarity, connect exciter field leads to DC power supply (adjustable from 0 to 20 volts and capable of delivering 2 amperes). Start engine. Adjust power supply for required generator output voltage (as indicated on generator control panel).

If it is possible to obtain correct generator output voltage, proceed to next step.

If generator output voltage is still incorrect, generator should be tested and repaired as required. (see Chapter 11).

Step 3. Check PM generator output terminals 3 and 4 of VR1; voltage should be 135V AC + 15 percent.

If voltage is out of tolerance, disconnect leads from terminals 3 and 4 and recheck voltage at open leads coming from generator.

If voltage is within tolerance, voltage regulator VR101 should be tested and repaired as required (see Chapter 4, Section V).

If voltage is still out of tolerance, PM generator (part of main generator G1) should be tested and repaired as required (see Chapter 11).

Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS

2-12. GENERAL. This section contains procedures for the removal and installation of major components. Major components include the control cubicle, AC-DC control box assembly, external power box assembly, radiator assembly, generator, and the engine.

2-13. CONTROL CUBICLE. The control cubicle, figure 2-1, is mounted on four brackets attached on one side to the AC-DC control box assembly, and on the other side, to the external power box assembly.

a. Removal

(1) If generator set has a housing, remove left and right access doors in accordance with Chapter 15.

(2) Disconnect electric connectors J1 through J6 at rear of control cubicle.

(3) Remove screws, nuts, and lockwashers, between brackets and control cubicle. Do not remove bottom brackets from AC-DC control box assembly and external power box assembly.

(4) Using a hoist, remove control cubicle by sliding out over bottom brackets.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

b. Installation

(1) Using a suitable hoist, line up unit on brackets (two on each side) and slide unit in.

(2) Attach screws, nuts, and washers from control cubicle to each of the four angle brackets.

(3) Connect electrical connectors to J1 through J6 at rear of control cubicle.

(4) If generator set had a housing, replace left and right access doors in accordance with Chapter 15.

2-14. AC-DC CONTROL BOX ASSEMBLY. The AC-DC control box assembly, figure 2-2, is mounted on the left side of the control cubicle

a. Removal

(1) If generator set has a housing, remove left rear panel in accordance with Chapter 15.

(2) Disconnect electrical connectors J5, J6, J26, J27, and J31 on enclosure assembly. Tag and disconnect terminals of the shielded cable assembly, loosen adapter then remove shielded cable from AC-DC control box.

(3) Remove screws, washers, and nuts attaching AC-DC control box assembly to the support frame upright.

(4) Remove screws, washers, and nuts attaching AC-DC control box assembly base to the brackets on skid base.

(5) Remove control cubicle per paragraph 2-13.a.

(6) Using a hoist, remove AC-DC control box assembly.

b. Installation

(1) Secure all generator set wiring and cables in vicinity of AC-DC control box assembly location.

(2) Using a suitable hoist, locate unit on skid and attach to skid with screws, washers, and nuts (see figure 2-2)

(3) Similarly, attach screws, washers, and nuts from unit to frame support upright.

(4) Install control cubicle per paragraph 2-13 b.

(5) Connect electrical connectors to J5, J6, J26, J27, and J31 on enclosure assembly. Connect terminals of shielded cable assembly, remove tags, and tighten adapter.

(6) If generator set has a housing, replace left rear panel in accordance with Chapter 15.

2-15. EXTERNAL POWER BOX ASSEMBLY.

The external power box assembly, figure 2-3, is mounted at the right of the control cubicle.

a. Removal

(1) If generator set has a housing, remove left rear

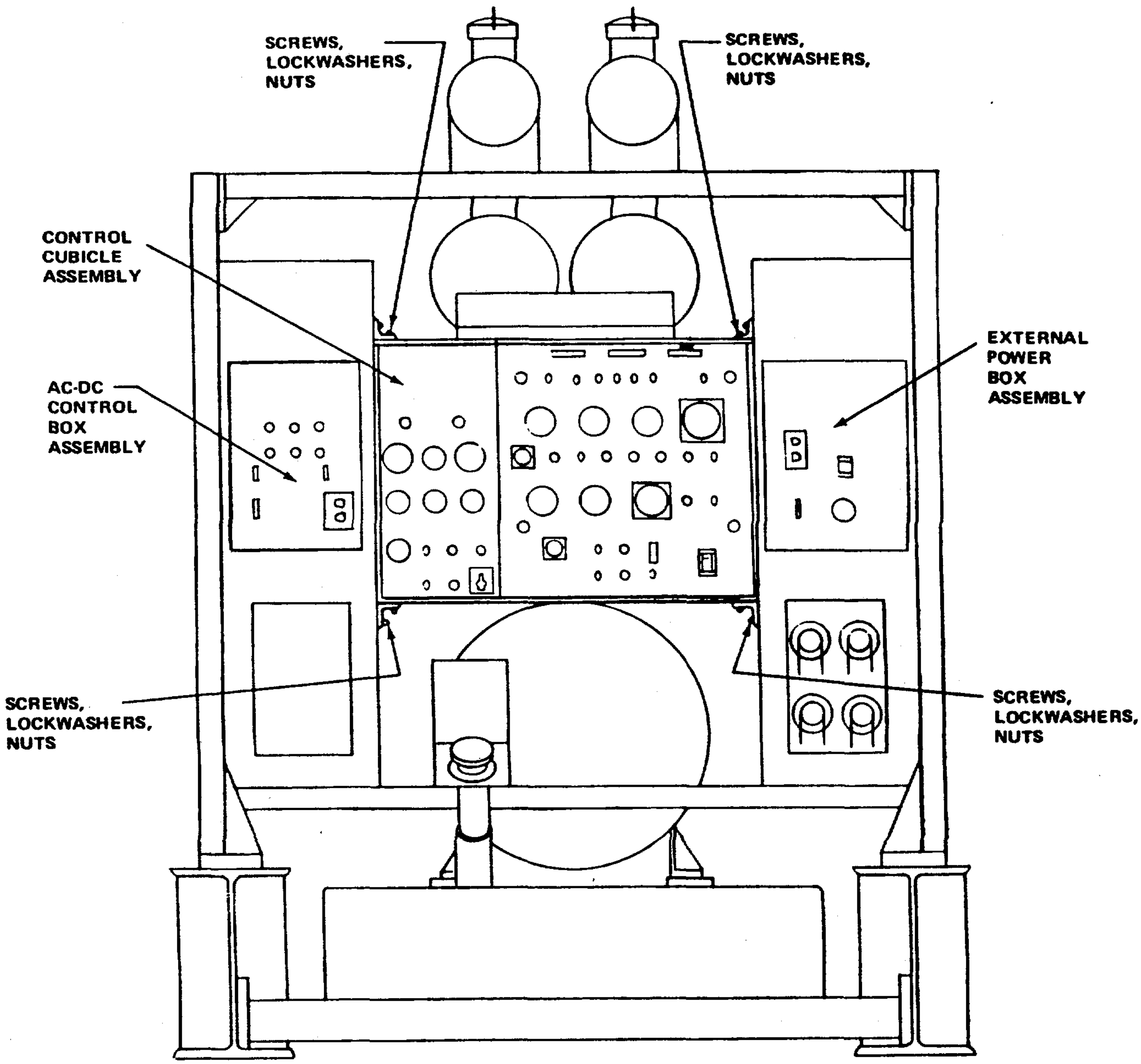


Figure 2-1. Location of Major Components

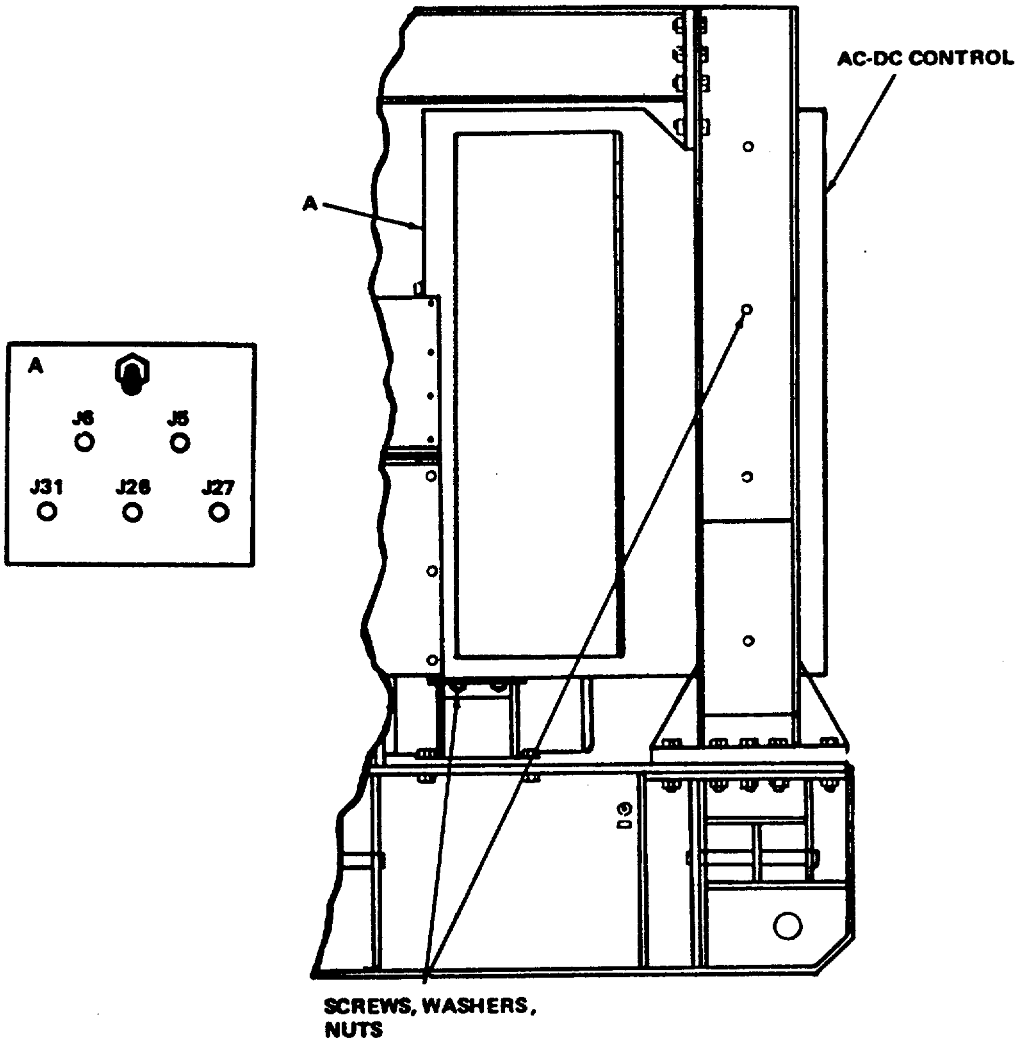


Figure 2-2. AC-DC Control Box Assembly, Removal and Installation

<u>WARNING</u>

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

panel in accordance with Chapter 15.

(2) Referring to figure 2-3, remove all screws, washers, and nuts attaching reconnection box and enclosure to the external power box assembly.

(3) Disconnect and tag all cables from reconnection box, circuit breaker, and cable tiedown at base of external power box assembly.

(4) Remove cables through sleeves and at front of generator set.

(5) Disconnect electrical connectors J27 through J31 (and J32, if generator set is equipped with housing).

(6) Disconnect buss bars (39, 42, and 45, figure 11-1) from the circuit breaker by removing screws, washers, and nuts that attach bars to

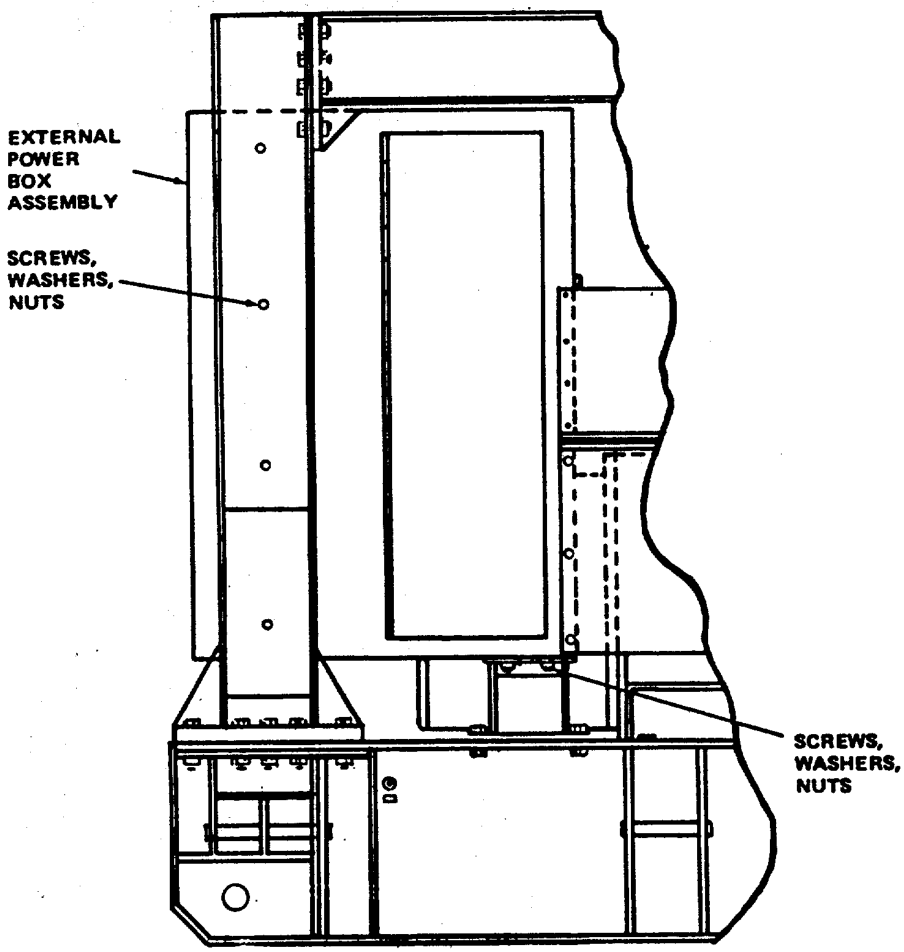


Figure 2-3. External Power Box Assembly, Removal and Installation (Sheet 1 of 2)

NOTE

Be careful not to tear off cable tags in process.

circuit breaker. Also, remove bolts, washers and nuts that secure buss bars to vertical buss bars in reconnection box. Remove bars through slot in external power box.

(7) Referring to figure 2-3, remove screws, washers, and nuts attaching external power box assembly to the frame support upright.

(8) Remove screws, washers, and nuts attaching bottom of the external power box assembly to skid base.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

(9) Remove control cable per paragraph 2-13.

(10) Using hoist, remove external power box assembly.

b. Installation

(1) Attach suitable hoist to the external power box assembly.

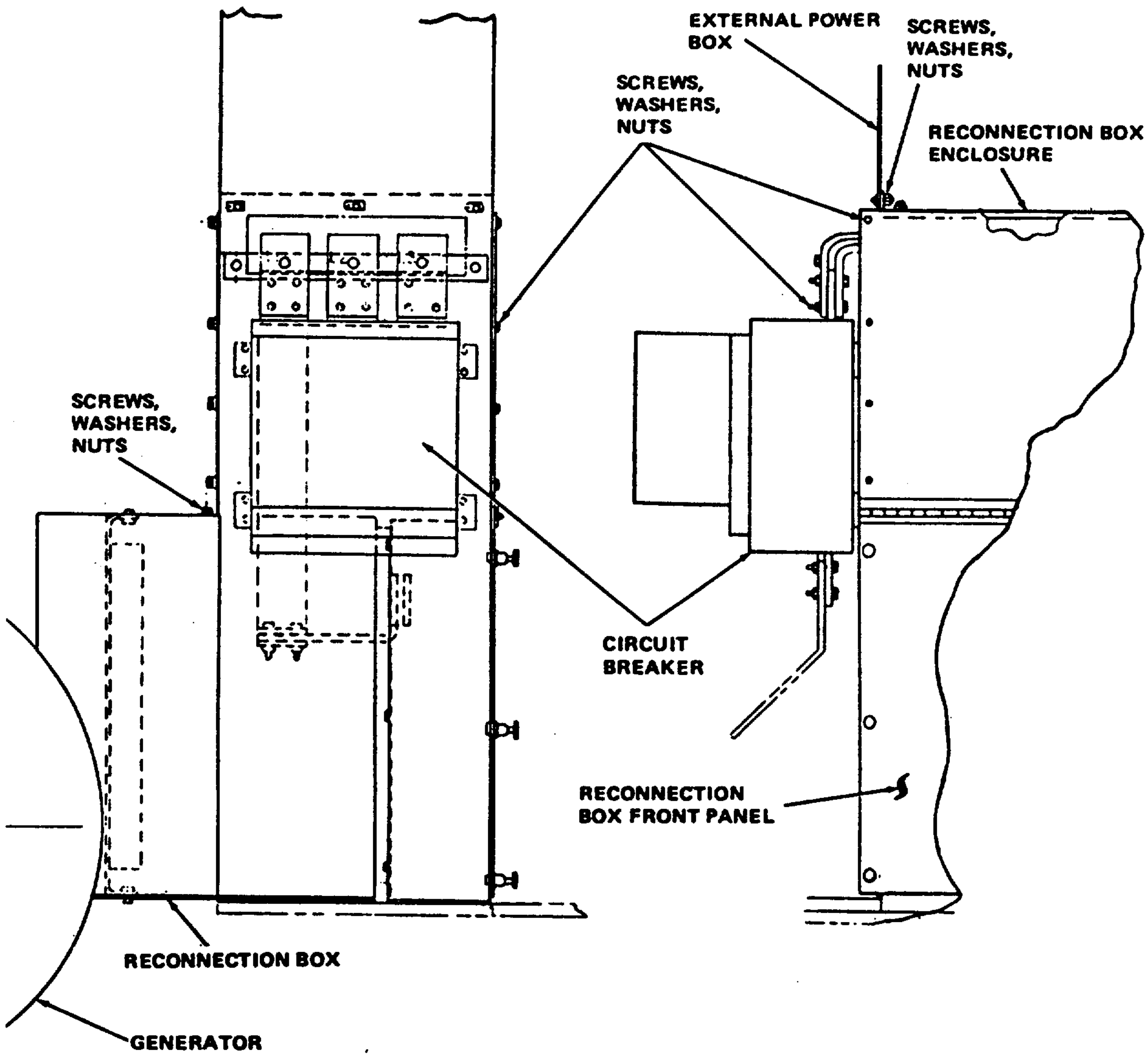


Figure 2-3. External Power Box Assembly, Removal and Installation (Sheet 2 of 2)

(2) Secure all generator set electrical cables in vicinity of installation.

(3) Locate external power box assembly and attach screws, washers, and nuts at bottom of unit to the skid base (see figure 2-3).

(4) Attach screws, washers, and nuts securing unit to frame support upright (see figure 2-3).

(5) Install control cable per paragraph 2-13 b.

(6) Connect electrical connectors J27 through J31 (and J32, if equipped with a housing).

(7) Thread heavy electrical cables through sleeves (on front) through unit, and connect to the reconnection box and circuit breaker. Secure cable tiedowns, as required.

(8) Attach screws, washers, and nuts securing unit to reconnection box and enclosure (see figure 2-3).

(9) Attach buss bars (39, 42, and 45, figure 11-1) to circuit breaker using screws, washers, and nuts. Secure opposite ends of buss bars to vertical buss bars in reconnection box.

(10) If generator set has a housing, replace right side panel in accordance with Chapter 15.

2-16. RADIATOR ASSEMBLY.

a. Removal. The complete radiator assembly is removed from generator set in accordance with paragraph 7-3 a or 7-7 a.

b. Installation. Install radiator assembly in accordance with paragraph 7-3 b or 7-7 b and torque screws as shown in figure 2-4.

2-17. GENERATOR.

a. Removal. Remove generator in accordance with paragraph 11-5 b(1).

b. Installation. Install generator in accordance with paragraph 11-5 b(2).

2-18. ENGINE.

a. Removal.

(1) Drain the engine cooling and lube systems and hydraulic sump as instructed in the Operator/Crew and Organizational Maintenance Manual.

(2) Disconnect the batteries.

(3) Disconnect the exhaust breather pipes from engine.

(4) Disconnect and remove air cleaner assembly hoses from two air shutdown valves.

(5) Disconnect and remove two hoses between air shutdown valves and turbochargers.

(6) Disconnect and remove two exhaust hoses from the turbochargers.

(7) Disconnect all cooling system hoses.

(8) Disconnect interconnecting wiring harnesses. Be sure to tag all wires.

(9) Tag and disconnect fuel lines.

(10) Uncouple generator from engine in accordance with paragraph 11-5 b. Disengage coupling from engine by backing off the generator.

(11) Remove engine mounting bolts (see figure 2-5).

WARNING

CLEAR AREA OF PERSONNEL AND OTHER EQUIPMENT WHEN ATTEMPTING TO LIFT THE ENGINE.

(12) If the engine is to be removed with an overhead hoist or crane, proceed as follows:

(a) Remove roof panels in accordance with Chapter 15.

(b) Remove silencer frame tie bar and frame support bar (5 and 13, figure 6-1) in accordance with paragraph 6-2.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

(c) Attach a suitable lifting device of at least 10-ton capacity to the engine hoist brackets.

(d) Hoist engine up forward to clear generator and lift off skid base. Place engine on a suitable engine support stand.

(13) If engine is to be removed with a forklift, proceed as follows:

WARNING

LIFTING DEVICES, CABLES, AND/OR CHAINS SHOULD BE INSPECTED FOE DETERIORATION OR DAMAGE BEFORE USE. A STABILIZING TETHER SHOULD BE ATTACHED BETWEEN THE ENGINE AND LIFTING HOOK FOR ADDED SAFETY AND STA"ILIZATION WHEN LIFTING THE UNIT.

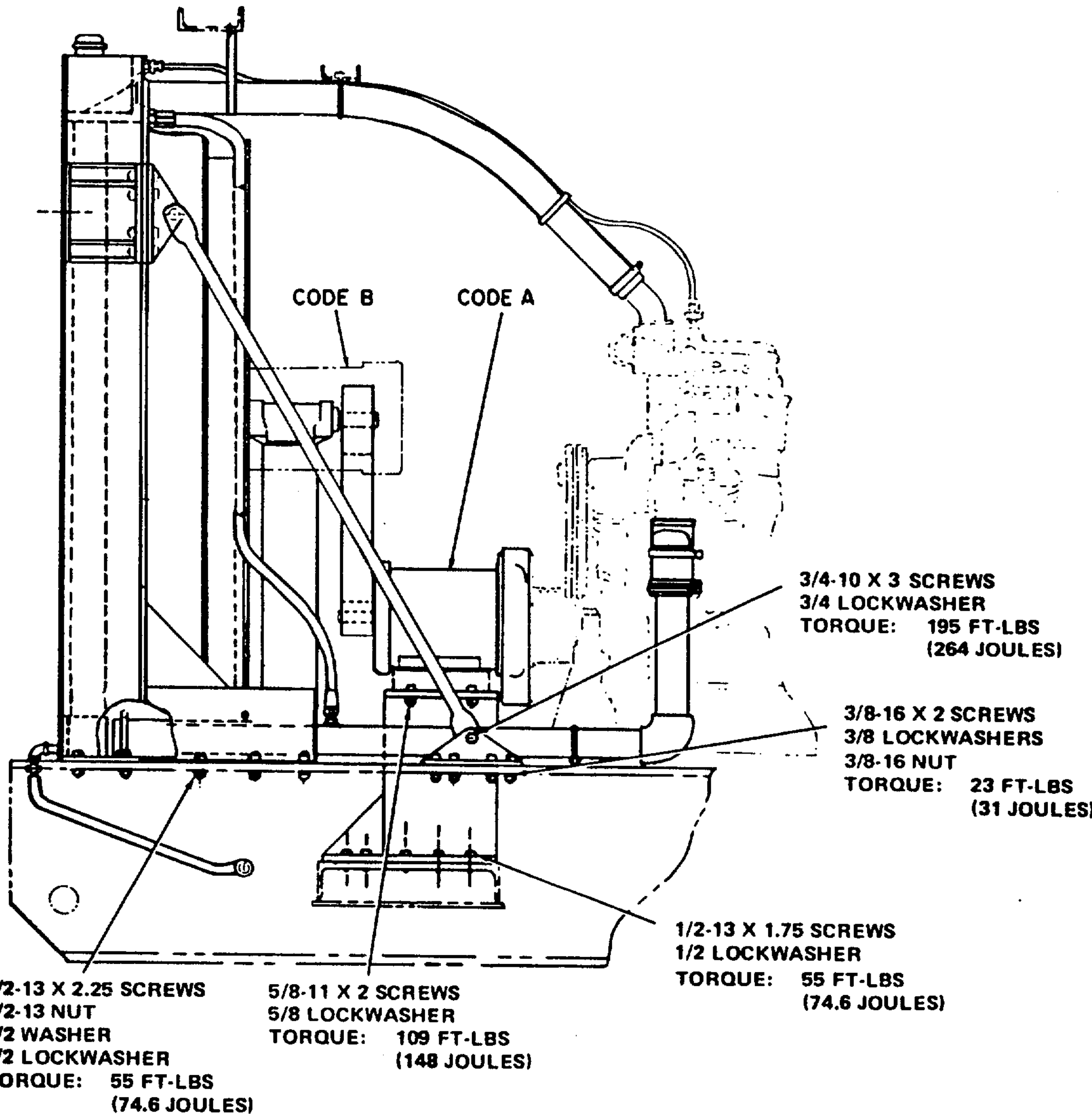


Figure 2-4. Radiator Assembly, Removal and Installation

(a) Remove the roof panels in accordance with Chapter 15.

(b) Depending on the side from which the engine will be removed, remove the left or right side housing panels and doors in accordance with Chapter 15.

(c) Remove either vertical support frames (26 or 27), figure 6-1).

(d) If necessary, remove the radiator fan belt (code A only) and radiator fan motor (paragraph 7-3), if the engine will be removed from the right side.

(e) Using a forklift of at least 10-ton capacity, lift engine off skid base and place engine on a suitable engine stand.

b. Installation.

WARNING

CLEAR AREA OF PERSONNEL AND OTHER EQUIPMENT WHEN ATTEMPTING TO LIFT THE ENGINE.

(1) If engine will be installed with an overhead crane or hoist, proceed as follows:

(a) Remove housing roof panels and silencer frame tie bar and support tie bar and support if these components were installed after engine removal.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

(b) Attach a suitable lifting device of at least 10-ton capacity to the engine hoist brackets.

WARNING

LIFTING DEVICES, CABLES, AND/OR CHAINS SHOULD BE INSPECTED FOR DETERIORATION OR DAMAGE BEFORE USE. A STABILIZING TETHER SHOULD BE ATTACHED BETWEEN THE ENGINE AND LIFTING HOOK FOR ADDED SAFETY AND STABILIZATION WHEN LIFTING THE UNIT.

(c) Position engine on skid base and couple engine to generator. Align in accordance with paragraph 11-5 b(2).

(d) Reinstall housing roof panels and silencer frame tie bar.

(2) If engine will be installed with a forklift proceed as follows:

(a) Remove housing roof panels, side panels and doors, and vertical support frames if these components were reinstalled after engine removal.

(b) Using a forklift of at least 10-ton capacity, mount engine on skid base and align with generator in accordance with paragraph 11-5 b(2).

(c) Reinstall housing roof panels, side panels and doors, and vertical support frames.

(3) Secure engine with engine mounting bolts.

(4) Install radiator fan motor and fan belts as required.

(5) Reconnect fuel lines, coolant hoses, and all electrical wiring harness connections. Remove wire tags after making connections.

(6) Connect hoses to air cleaners, air shutoff valves, and turbochargers.

(7) Connect exhaust breather pipes.

(8) Replace coolant and fill to proper level check for leaks

(9) Fill engine crankcase with proper lubricant. Check dipstick level at crankcase and governor pump.

(10) Reconnect batteries.

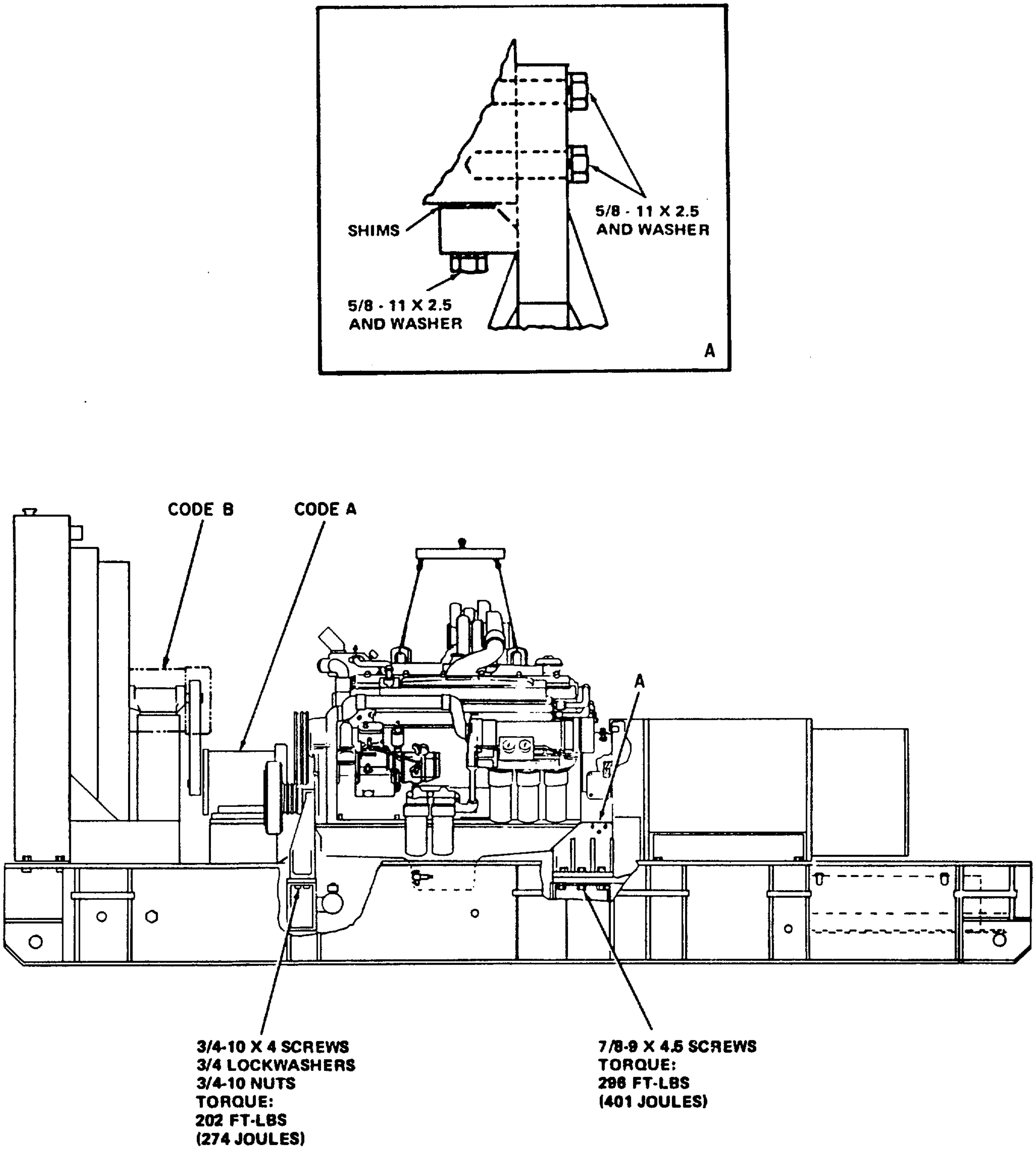


Figure 2-5. Engine, Removal and Installation.

CHAPTER 3

MAINTENANCE OF EXTERNAL POWER ASSEMBLY

3-1. PREHEAT SYSTEMS CONTACTOR K107 AND HEATER CONTACTOR K109

a. Removal. Refer to Operator/Crew and Organizational Maintenance manual for removal of preheat system contactor K107 (54, figure 3-1) and heater contactor K109 (54, figure 3-1).

b. Repair. (See figure 3-2.) Repair preheat system contactor K107 (54, figure 3-1) by replacing contacts, armature, and coil, as follows:

(1) Remove screws (1, figure 3-2) and cover (2). Disconnect wires from coil terminals. Remove coil (4) and magnet assembly (3).

(2) Separate the coil (4) from the magnet assembly (3).

NOTE

Contacts are not harmed by slight discoloration and pitting. Do not file them. Replacement is necessary only when the contact has worn thin.

(4) To replace movable contacts (6), place contactor (nameplate down) on a flat surface and insert a replacement movable contact finger.

3-2. CONTACTOR K108

a. Removal. Refer to Operator/Crew and Organizational Maintenance manual for removal of preheat system transfer contactor K108 (51, figure 3-1).

b. Repair. (See figure 3-3.) Repair transfer contactor K108 (51, figure 3-1) by replacing contacts, armature and coil in each contactor, as follows:

(1) Remove screws (3, figure 3-3) and cover (4). Disconnect wires from coil terminals. Remove coil (6) from the magnet assembly (5).

(2) Separate the coil (6) from the magnet assembly (5).

NOTE

Recommended driving torques for items 3 and 7 are 18 to 21 inch-pounds (2 to 2.4 joules).

(3) When replacing coil (6) the magnet must be installed with the word FRONT appearing as shown in figure 3-3.

NOTE

Contacts are not harmed by slight discoloration and slight pitting. Do not file them. Replacement is necessary when the contact is worn thin.

(4) Remove screws (7) on power plant. Replace movable contacts (8) by placing contactor (nameplate down) on a flat surface and inserting replacement movable contact fingers.

3-3. CONTACTOR K120

a. Removal. Refer to Operator/Crew and Organizational Maintenance manual for removal of motor contactor (57, figure 3-1).

b. Test. Make test connections to motor contactor K120 as shown in figure 3-4.

(1) Set switch to on and adjust variable load to provide 1000 watt load. Ammeter should read approximately 8.3 amps.

(2) Set switch to off.

(3) Connect jumper across L1 and L2 terminals.

(4) Remove and reconnect load to terminals X2 and T2.

(5) Set switch to on. Ammeter

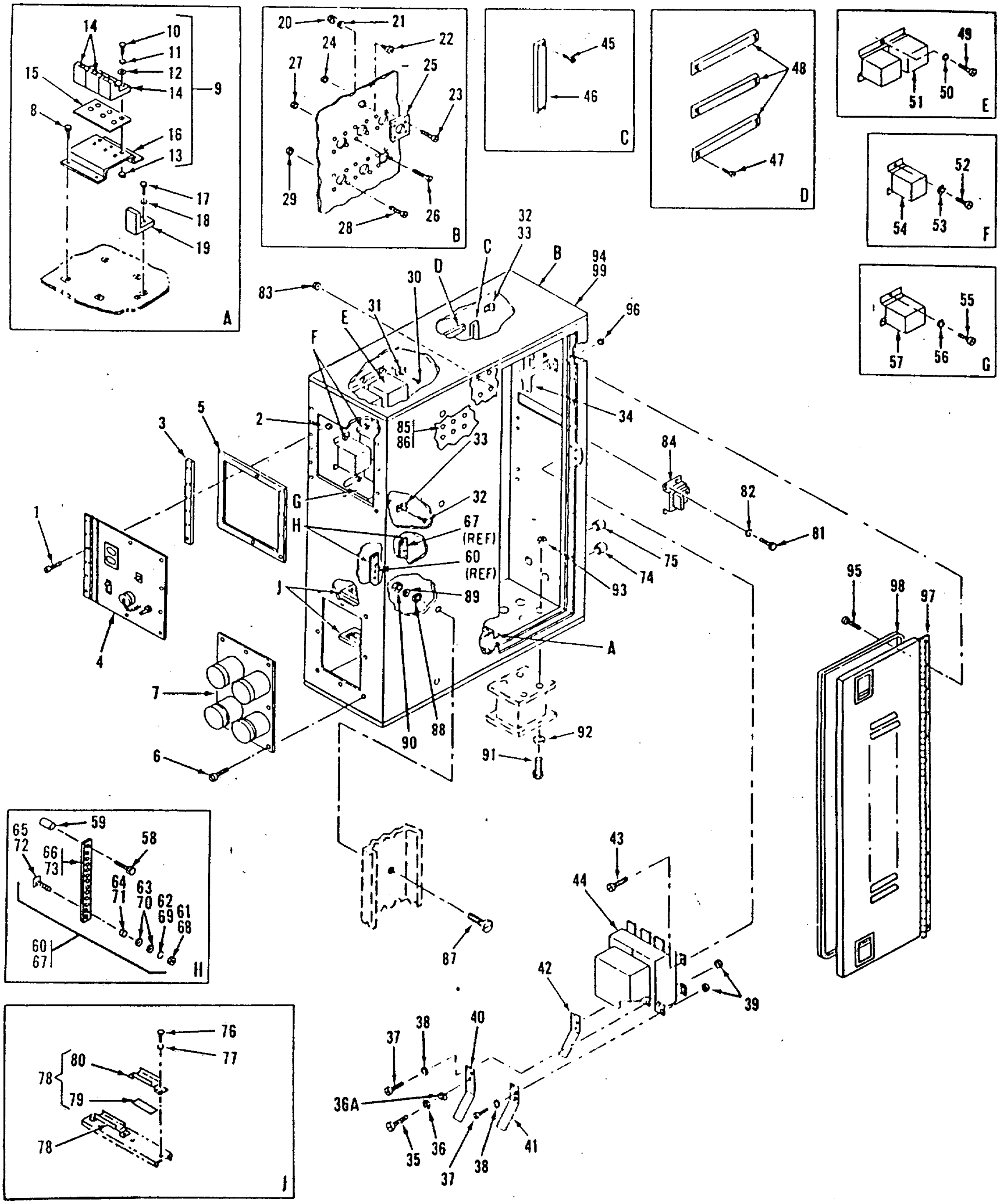


Figure 3-1. External Power Box Assembly, Exploded View

LEGEND FOR FIGURE 3-1

1. Screw
2. Nut
3. Space bar
4. Panel control assy
5. Weather stripping
6. Screw
7. Plate and sleeve assy
8. Screw
9. Neutral bar assy
10. Screw
11. Nut
12. Lockwasher
13 Washer
14. Compression lug
15. Plate
16 Bracket
17. Screw
18. Lockwasher
19. Compression lug
20. Locknut
21. Washer
22. Connector
23. Screw
24. Nut
25. Cover
26. Screw
27. Nut
28. Screw
29. Nut
30. Screw
31. Clamp
32. Screw
33. Clamp
34. Harness Assy
35. Screw
36. 36A. Washer
37. Bolt
38. Lockwasher
39. Nut
40. Buss bar
41. Buss bar
42. Buss bar
43. Screw
44. Circuit breaker
45. Screw
46. Terminal board
47. Screw
48. Terminal board
49. Screw
50. Lockwasher
51. Transfer contactor K108
52. Screw
53. Lockwasher
54. Heater contactor K107 & K109
55 Screw
56. Lockwasher
57. Motor starter K120
58. Screw
59. Spacer
60. Terminal block assy
61. Nut
62. Lockwasher
63. Washer
64. Nut
65. Bolt
66 Terminal block
67. Terminal block assy
68. Nut
69. Lockwasher
70. Washer
71 Jam nut
72. Bolt
73. Terminal block
74. Bushing
75. Bushing
76. Screw
77. Lockwasher
78. Clamp assy
79. Cushion
80. Clamp
81. Screw
82. Washer
83. Nut
84. Relay board assy
85. Screw
86. Lockwasher
87. Screw
88. Washer
89. Lockwasher
90. Nut
91. Screw
92. Lockwasher
93. Nut
94. Box and door assy
95. Screw
96. Nut
97. Door assy
98. Seal
99. Enclosure

should read approximately 8.3 amps.

(6) Set switch to off.

(7) Remove and reconnect jumper across L1 and L3.

(8) Remove and reconnect load to X2 and T3 terminals.

(9) Set switch to on. Ammeter should read approximately 8.3 amps.

(10) Slowly increase load to 4260 watts. Ammeter should read 35.5 amps and relay should trip between 4260 watts (35.5 amps) to 4584 watts (38.2 amps)

(11) Set switch to off and reset overload handle.

(12) Adjust variable load to zero load.

(13) Set switch to on.

(14) Adjust variable load for 1000 watt load. Ammeter should read 8.3 amps.

(15) If ammeter readings are erratic, contacts are worn or badly pitted and should be replaced. If there is no reading, armature, coil, or contacts may be defective and should be replaced. If overload relay does not trip at specified load, replace overload assembly.

c. Repair. (See figure 3-4.) Repair motor contactor K120 (57, figure 3-1) by replacing contacts, armature, overload assembly, and coil, as follows:

(1) Remove screws (1, figure 3-4) and cover (2). Disconnect wires and magnet assembly (3).

(2) Separate the coil (4) from the magnet assembly (3).

(3) When replacing coil (4) the magnet must be installed with the word FRONT appearing as shown in figure 3-4.

NOTE

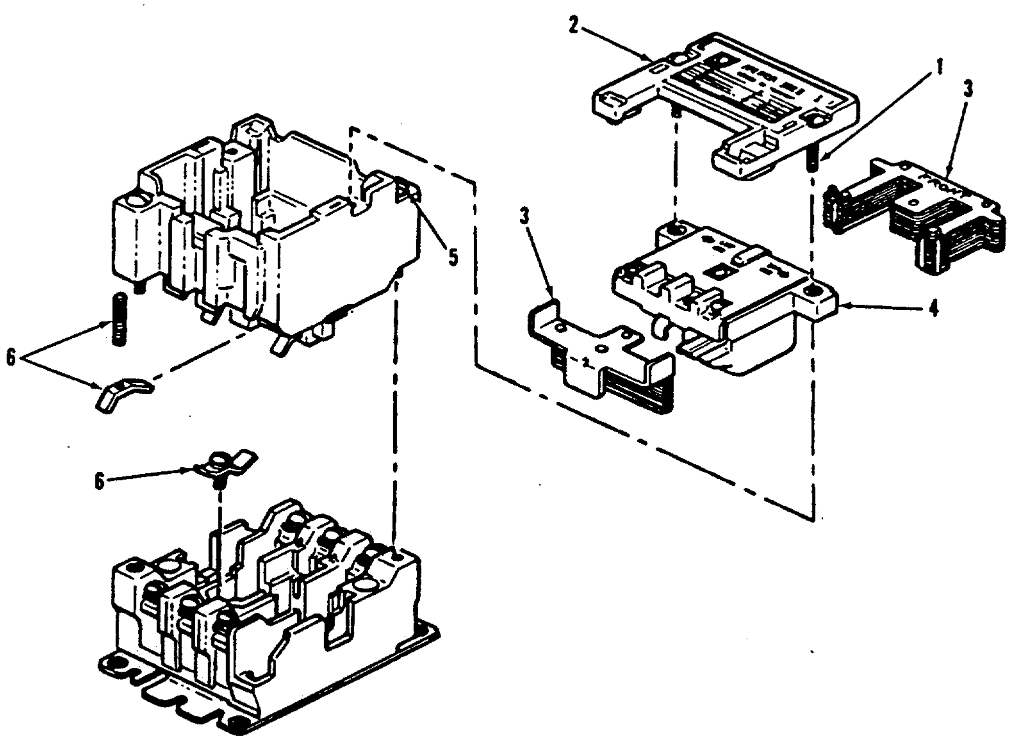
Recommended driving torques for items 1, 5, and 7 are 18 to 21 inch-pounds (2 to 2.4 joules), and item 6 is 6 to 9 inch-pounds (0.7 to 1 joules).

(4) Remove and replace overload assembly (8) by removing screws (7).

NOTE

Contacts are not harmed by light discoloration and slight pitting. Do not file them. Replacement is necessary only when the contact has worn thin.

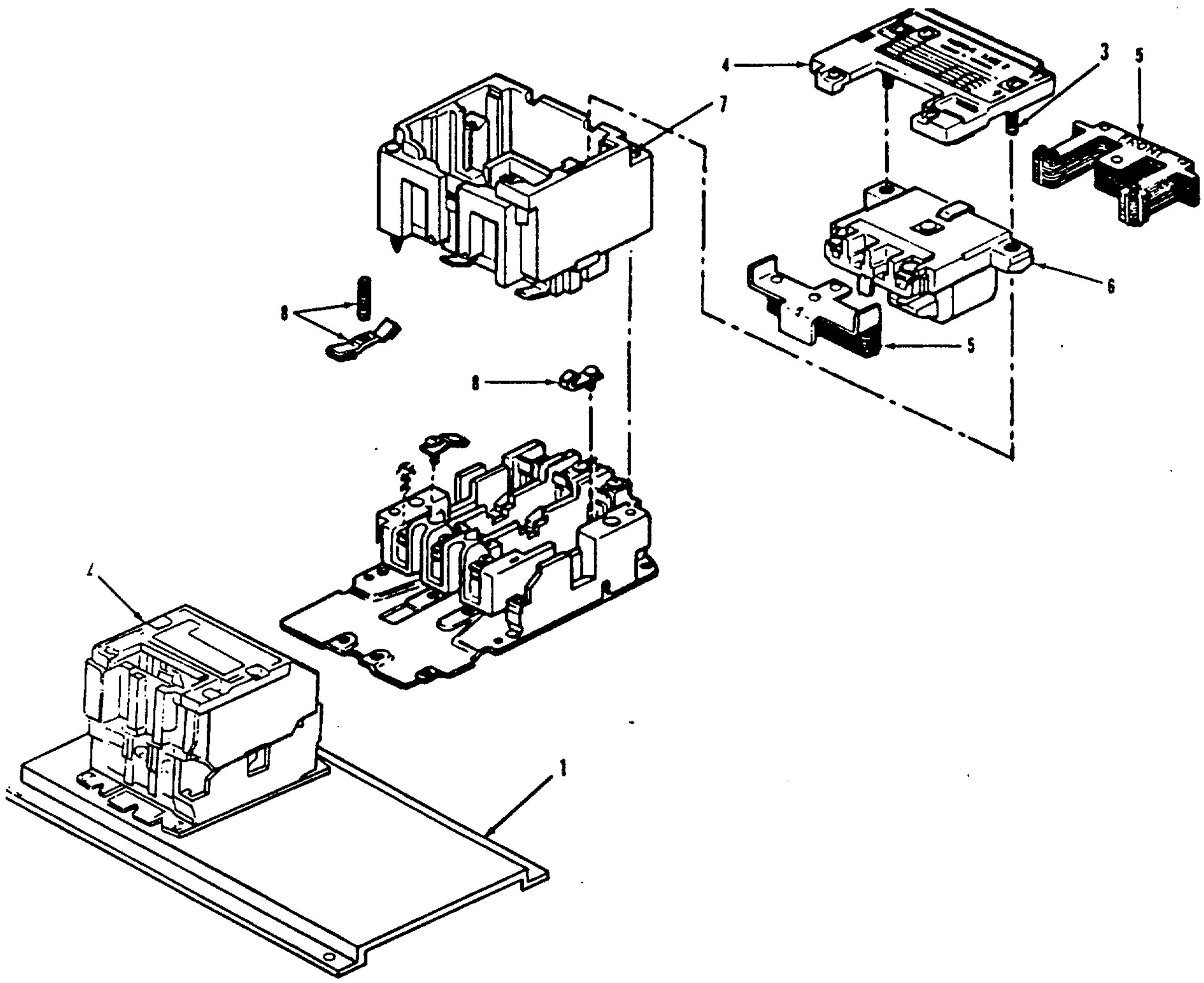
(5) To replace movable contacts (6), place contactor (nameplate down) on a flat surface and insert a replacement movable contact finger.



LEGEND

1. Screw
2. Cover
3. Magnet assy
4. Coil
5. Body
6. Contacts

Figure 3-2. Preheat System Contactor K107 and Heater Contactor K109, Exploded View



LEGEND

1. Mechanical interlock assy
2. Contactor
3. Screw
4. Cover
5. Magnet assy
6. Coil
7. Screw
8. Contact kit

Figure 3-3. Transfer Contactor K108, Exploded View

LEGEND FOR FIGURE 3-4

1. Screw
2. Cover
3. Magnet assy
4. Coil
5. Screw
6. Contact kit
7. Screw
8. Overload assy
9. Reset Bar

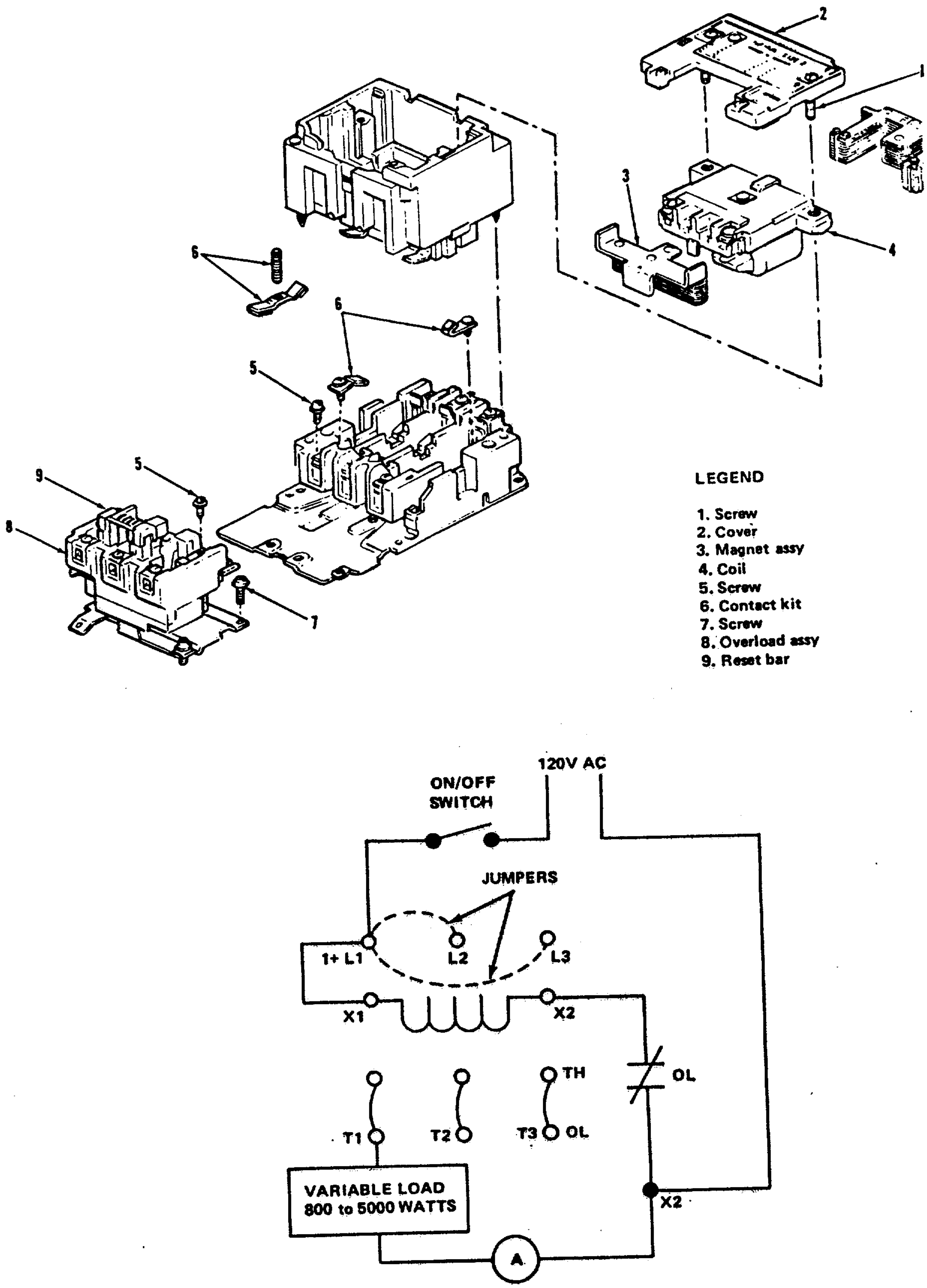


Figure 3-4. Contactor K120 Exploded View and Test Setup

CHAPTER 4

MAINTENANCE OF AC-DC CONTROL BOX ASSEMBLY

Section I. ENCLOSURE COMPONENTS

4-1. FUEL TRANSFER PUMP RELAY K20.

a. Replacement. (See figure 4-1.) The fuel transfer pump relay K20, (33, figure 4-1) is mounted on the right side wall of the AC-DC control box assembly. It is removed as follows:

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER CIRCUIT BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTABLE).

(1) Open door of AC-DC control box assembly to gain access.

(2) Remove and tag wires connected to the relay.

(3) Remove two screws (31) and nuts (32). Remove relay (33).

(4) Install relay (33) by mounting it to the side wall of the enclosure with two screws (31) and nuts (32).

(5) Connect wires and remove tags.

a. Testing

(1) Connect 24V DC to the small terminals on the contactor in series with a SPST switch as shown in figure 4-2.

(2) Connect ohmmeter (Rx1) scale to the larger terminals of the contactor.

(3) Close the SPST switch. Ohmmeter should show continuity.

(4) Open the SPST switch. Connect ohmmeter to the smaller terminals. Meter should read approximately 60 ohms.

4-2. TERMINAL BOARD.

4-3. REPLACEMENET. The six terminal boards (26 and 30, figure 4-1) are mounted on the right side wall of the enclosure (75). Replace as follows:

a. Removal. Tag and remove leads. Remove each terminal board (26 and 30) by removing two screws (24 or 28) and nuts (25 or 29).

NOTE

Diode (28) may also be tagged and disconnected from terminal board (30) at this time.

b. Replacement. Replace terminal board (26 or 30) on the enclosure side wall by attaching two screws (24) and nuts (25). Install diode (28) on terminal board (30) and remove tags.

4-4. RESISTOR R116. Resistor R116 (38, figure 4-1) is located on the right side wall of the enclosure (75).

a. Test. Disconnect either lead from resistor (38). With an ohmmeter (set Rx1 scale) measure resistance. It should be 5 ohms ±1 ohm. If not, replace.

b. Replacement.

(1) Remove two nuts (35, figure 4-1) which secure resistor lugs (36) to the standoff (37). Then remove resistor (38) from clip (41) and separate lugs (36) from lead

wire.

(2) Crimp lugs on lead wires, then install resistor (38) into clip (41). Secure lugs (36) to standoff (37) with nuts (35).

Section II. BATTERY CHARGER

4-5. GENERAL. This section covers inspection, replacement, testing, and repair of the battery charger.

4-6. DESCRIPTION. The battery charger transforms 120V AC to 24V DC at 20 amperes to charge the generator set batteries. It automatically senses the condition of the batteries and delivers the amount of current required to keep the batteries fully charged. The battery charger has a built-in cut out relay to prevent battery drain in the event of an AC power failure. Figure 4-3 is the battery charger schematic.

4-7. INSPECTION. Check battery charger input and output cable connections for looseness or corrosion. Check all components for loose mounting, poor solder connections, broken wires, overheated resistors, or any other signs of damage.

4-8. REMOVAL AND REPLACEMENT.

a. Removal. (See figure 4-1.) The battery charger (45, figure 4-1) is mounted to the right side wall of the AC-DC control box assembly enclosure. Open door (73) and remove as follows:

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCK-OUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER CIRCUIT BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTACLE).

(1) Open battery charger door.

Legend For Figure 4-1

1. Screw
2. Nut/washer
3. Ac-dc panel
4. Spacer bar
5. Stripping
6. Screw
7. Cover
8. Connector
9. Washer
10. Nut
11. Screw/washer
12. Nut
13. Screw, washer
14. Nut
15. Screw
16. Nut/washer
17. Clamp
18. Clamp
19. Clamp
20. Clamp
21. Screw/washer
22. Clamp
23 Harness
24. Screw
25. Nut/washer
26. Terminal block
26A. Jumper
27. Diode
27A. Lug
28. Screw
29. Nut/washer
30. Terminal block
31. Screw
32. Nut
33. Relay K20
34. Screw
35. Nut
36. Lug
37. Standoff
38. Resistor
39. Screw
40. Nut
41. Clip
42. Screw
43. Panel
44. Screw/washer
45. Battery charger
46. Screw
47. Washer
48. Voltage Regulator
49. Screw
50. Nut
51. Clamp
52. Screw
53. Nut
53A. Resistor assembly
54. Potentiometer
55. Lock
56. Governor
57. Sleeve
57A. Lug
58A. Washer
59. Screw
60. Clip
61. Screw/washer
62. Bracket
63. Screw
64. Washer
65. Washer
66. Nut
67. Screw
67A. Washer
68. Washer
69. Nut
70. Ac-dc box
71. Screw
72. Nut
73. Door assembly
74. Seal
75. Enclosure assembly

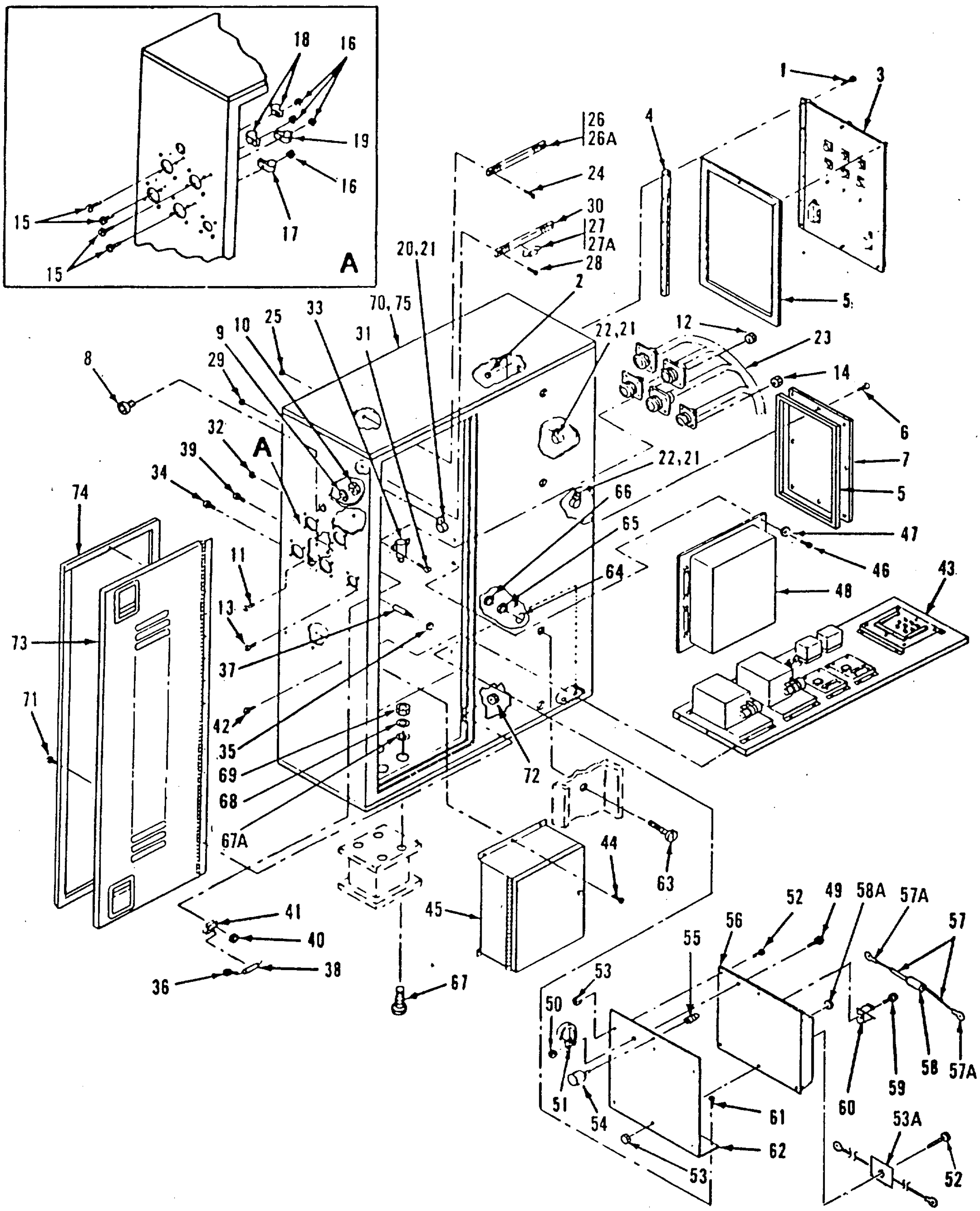


Figure 4-1. AC-DC Control Box Assembly, Exploded View

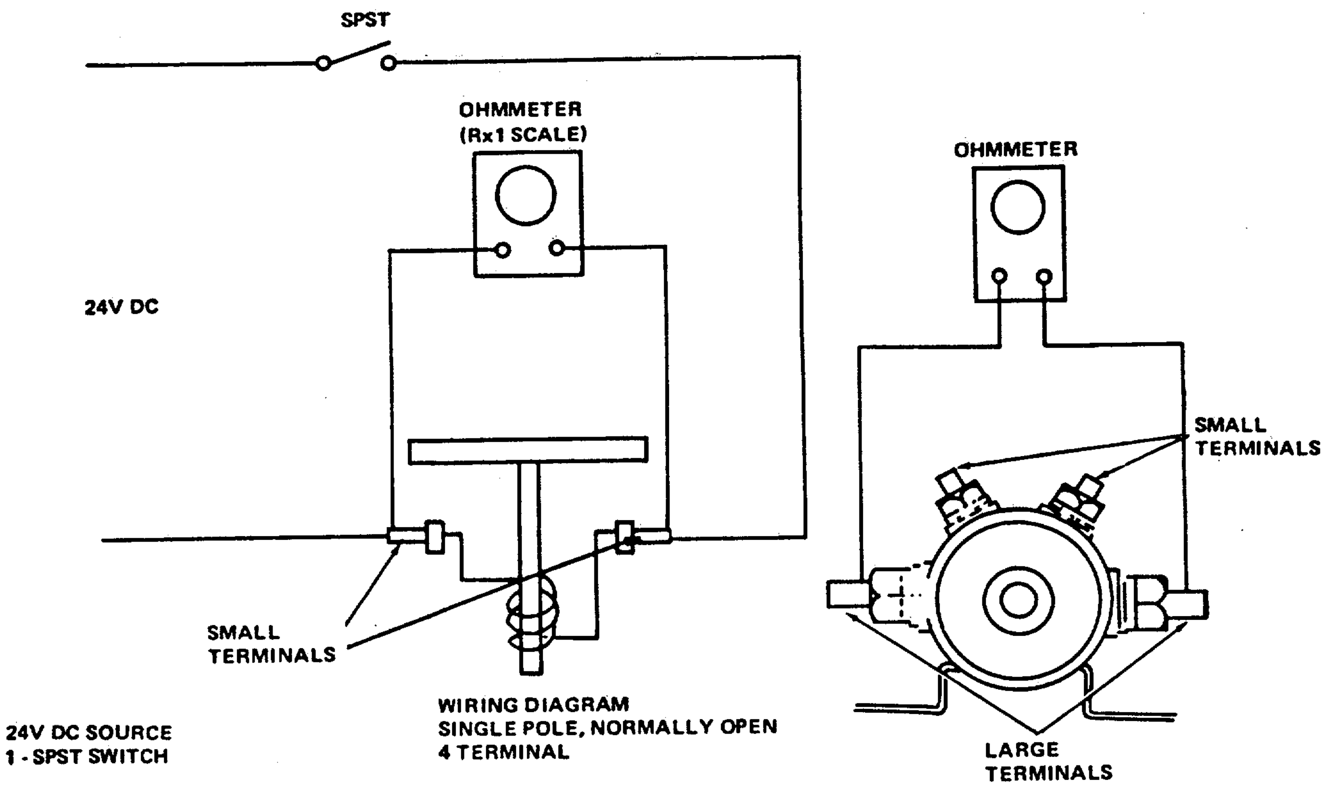


Figure 4-2. Fuel Transfer Pump Relay K20, Test Setup

and tag and disconnect input and output cables on terminal boards.

(2) Remove six screws (44) supporting battery charger to wall. Remove battery charger.

b. Replacement.

(1) Install battery charger (45, figure 4-1), to the enclosure with six screws.

(2) Connect cables to terminals inside the battery charger. Be sure to observe polarity, POS and NEG on OUTPUT connections. Remove tags.

4-9. TESTING. (See figure 4-3) The ground test may be performed without removing the battery charger from the set. Other tests are bench test procedures.

a. Ground or Short Circuit. Using an ohmmeter, check for a short to ground, primary to secondary breakdown, AC-DC short, or DC ground as follows:

NOTE

Check fuses F1, F2, F3, and F4 for continuity.

(1) With all power off, disconnect AC input power to INPUT connections on the unit. Disconnect the generator set negative battery cable.

(2) Set ohmmeter scale on ohms Rx100.

(3) Measure from either INPUT terminal to either terminal of the OUTPUT. Meter should not indicate a reading. If the meter reads full scale deflection, this indicates a

possible AC-DC short.

(4) Carefully inspect the wiring to make certain the AC wires are not touching the DC wires. If no wires are touching, the primary and secondary of transformer T1 or reactor T2 may be shorted. Disconnect the secondary of transformer T1 from the diodes CR1 and CR2. Measure with ohmmeter from INPUT terminal to one of the transformer T1 secondary leads. If there is an ohm-meter indication, there is an insulation breakdown between primary and secondary windings. The transformer should be replaced.

(5) Check both INPUT terminals to ground (chassis), and check both OUTPUT terminals to ground. If the meter indicates full-scale deflection, a wire is touching ground.

b. Diodes.

(1) Test silicon diodes (CR1 and CR2) as follows:

(a) Disconnect one end of the diode.

(b) Connect an ohmmeter (scale set Rx100) across the diode, note the reading. Now reverse ohmmeter leads to the diode, and again note reading. A good diode will read high resistance one way and low resistance the other way. A shorted diode will read full scale both ways. An open diode will read infinity (no reading) in either direction. Check all diodes and replace disconnected leads.

(2) Test zener diode (CR4) as follows (see figure 4-3):

(a) Connect a 20-40V DC variable power source to the battery charger.

(b) Connect a voltmeter across the zener diode (CR4) and resistor R1.

(c) Voltmeter must read only 22 volts while input voltage is varied from 20 to 30 volts DC.

c. Cutout Relay. Test the cutout relay (54, figure 4-4) as follows. See detail in figure 4-3.

(1) Connect a 120V AC source with a SPST switch (S1) as shown.

(2) With S1 closed, using an ohmmeter, check for continuity between contacts 3 and 6.

(3) Open switch and disconnect 120V AC.

d. Transistor Control Circuit. (See figures 4-3 and 4-4.)

(1) With power disconnect from battery charger, remove fuse F3. Connect a DC ammeter (0 to 50 amps) across fuse holder.

(2) Connect 120V AC input power to battery charger and record ammeter reading. Remove input power.

(3) Remove two wires from T2 (46, figure 4-4) and Q1 (68) connected to terminal 1 of TB1 (65).

(4) Temporarily connect these two wires together using a jumper.

(5) Connect 120V AC input power to battery charger.

(6) Record ammeter reading. If the reading is higher than reading recorded in step (2), the transistor control circuit may be defective. Check CR4 (69), (paragraph b(2), above) and check for open resistor R1 (74). If CR4 and R1 are not defective, replace transistor Q1 (68).

(7) Remove ammeter from fuse

holder. Remove jumpers on relay K1. Replace wires from T2 and Q1 on terminal a and TB1. Replace fuse F3.

e. Dummy Load Test for Battery Charger.

(1) Connect input of battery charger to 120V AC and output to two capacitors (1 and 2) and one resistor (3) in parallel (see figure 4-3).

(2) Connect an ammeter as shown. Ammeter reading must be 24 amps.

(3) Connect a second resistor (4) in parallel.

(4) Connect ammeter as shown. Ammeter reading must be 24 amps.

(5) If battery charger does not provide correct amperage, it is defective and must be repaired or replaced.

4-10. REPAIR. Repair of the battery charger involves the replacement of parts and the soldering of wire leads.

a. Adjustment of Variable Resistors. (See figure 4-3.) In the event that R1, R2, or R4 variable resistors are found to be defective, and are replaced, readjust resistors in accordance with the following procedure:

(1) Variable resistor R2 (9, figure 4-4).

(a) Connect 120V AC to INPUT terminals of battery charger.

(b) Connect a fully discharged 24V DC battery to OUTPUT POS and NEG terminals in battery charger.

(c) Remove fuse F3. Connect an ammeter (0 to 50 amps) across fuse F3 fuseholder terminals.

(d) Adjust R2 so that the battery charger current does not exceed 24 amps.

(2) Variable resistor R4 (17, figure 4-4).

(a) Connect 120V AC to INPUT terminals of battery charger.

(b) Connect OUTPUT POS and NEG terminals of battery charger to 24V DC battery.

(c) Adjust R4 so that the battery charger output does not exceed 2.33 volts per cell.

(3) Variable resistor R1 (74, figure 4-4).

(a) Connect 120V AC to INPUT terminals of battery charger.

(b) Connect OUTPUT POS and NEG terminals of battery charger to 24V DC battery.

(c) Adjust R1 so that the battery charger total output voltage (28 volts) does not vary more than 5 percent under "no load" to "full" condition.

b. Disassembly. Disassemble the battery charger as follows (see figure 4-4):

NOTE

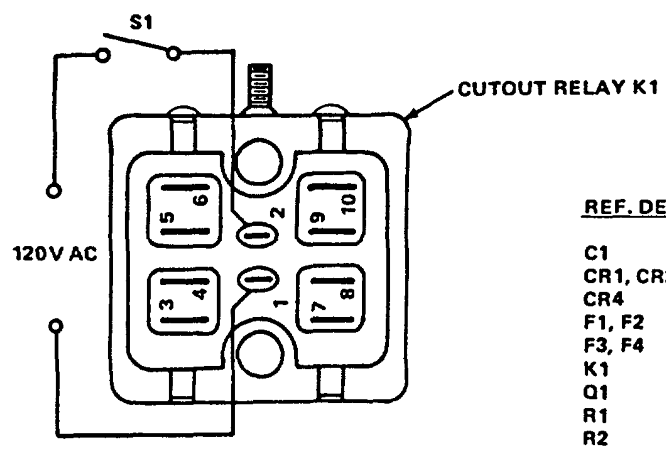
All components, except resistors (9 and 17), are mounted on plate at rear of battery charger.

(1) Resistors (9) and (17) are removed by unsoldering and tagging leads, and removing nut (3), washers (4 and 7) and stud (8) from brackets (5 and 6).

(2) Fuse clips (32 and 35) are mounted on a board attached to transformer (41).

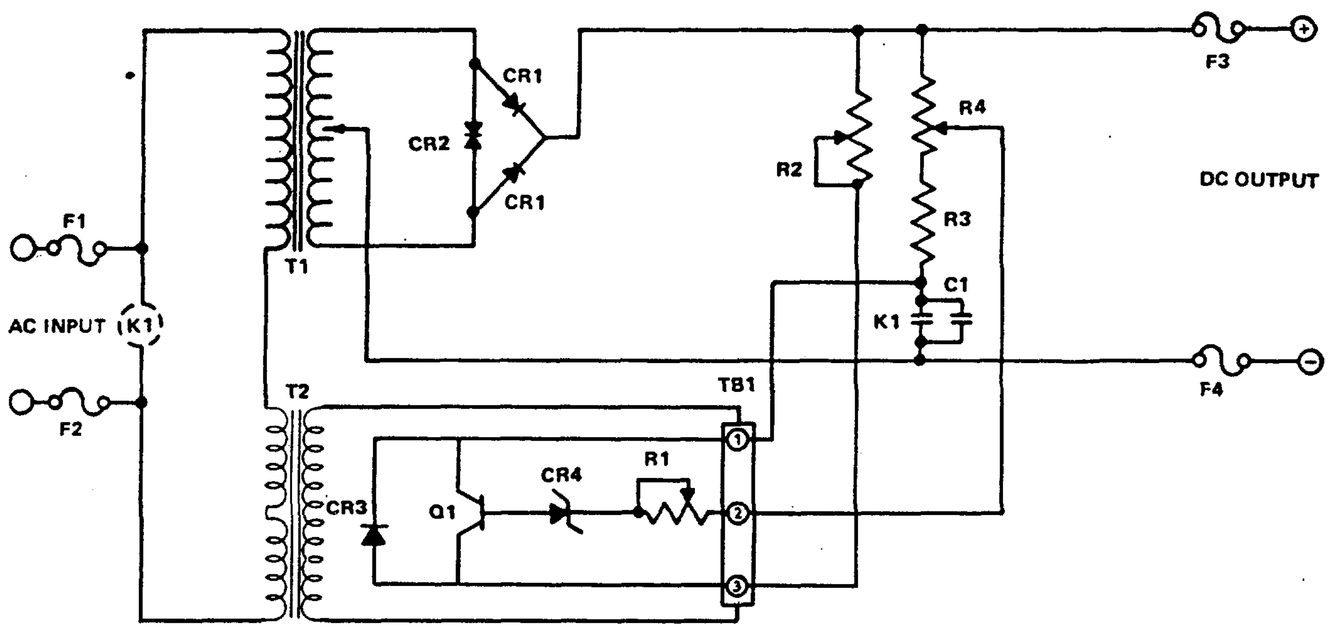
(3) Control circuit components are mounted on a separate board attached to the mounting plate (78).

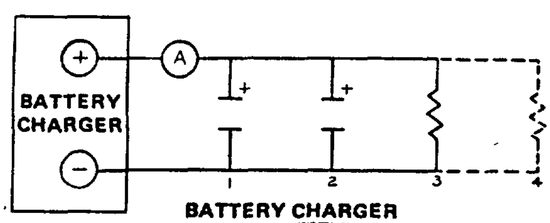
(4) Relay (54) and capacitor



CONTACTS	CONTINUITY
3-6	WITH S1 CLOSED

REF. DES.	UNIT DES.	ITEM
C1	C1	CAPACITOR
CR1, CR2	SD1, SP	DIODE
CR4	ZD	ZENER DIODE
F1, F2	ACF	FUSE
F3, F4	DCF	FUSE
K1	CO	RELAY
Q1	T1	TRANSISTOR
R1	RZ1	VARIABLE RESISTOR
R2	RC	RESISTOR, VAR.
R3	RV2	RESISTOR
R4	RV1	VARIABLE RESISTOR
T1	PT	TRANSFORMER
T2	SR	REACTOR
TB1	–	TERMINAL BOARD





BATTERY CHARGER
DUMMY LOAD TEST SETUP

1, 2	9,800 MICROFARAD, 50 WVDC ELECTROLYTIC CAPACITORS
3, 4	1,000 W, 1 OHM RESISTORS
A	AMMETER

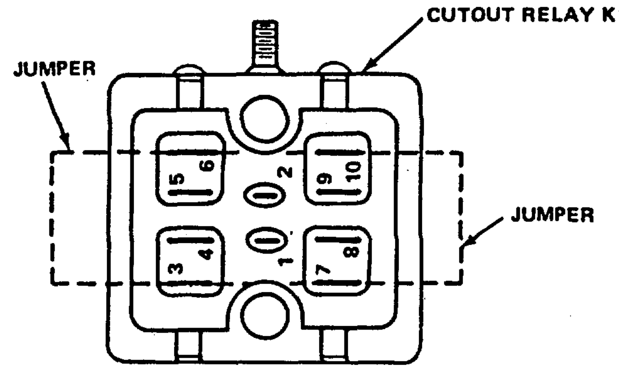


Figure 4-3. Battery Charger Schematic

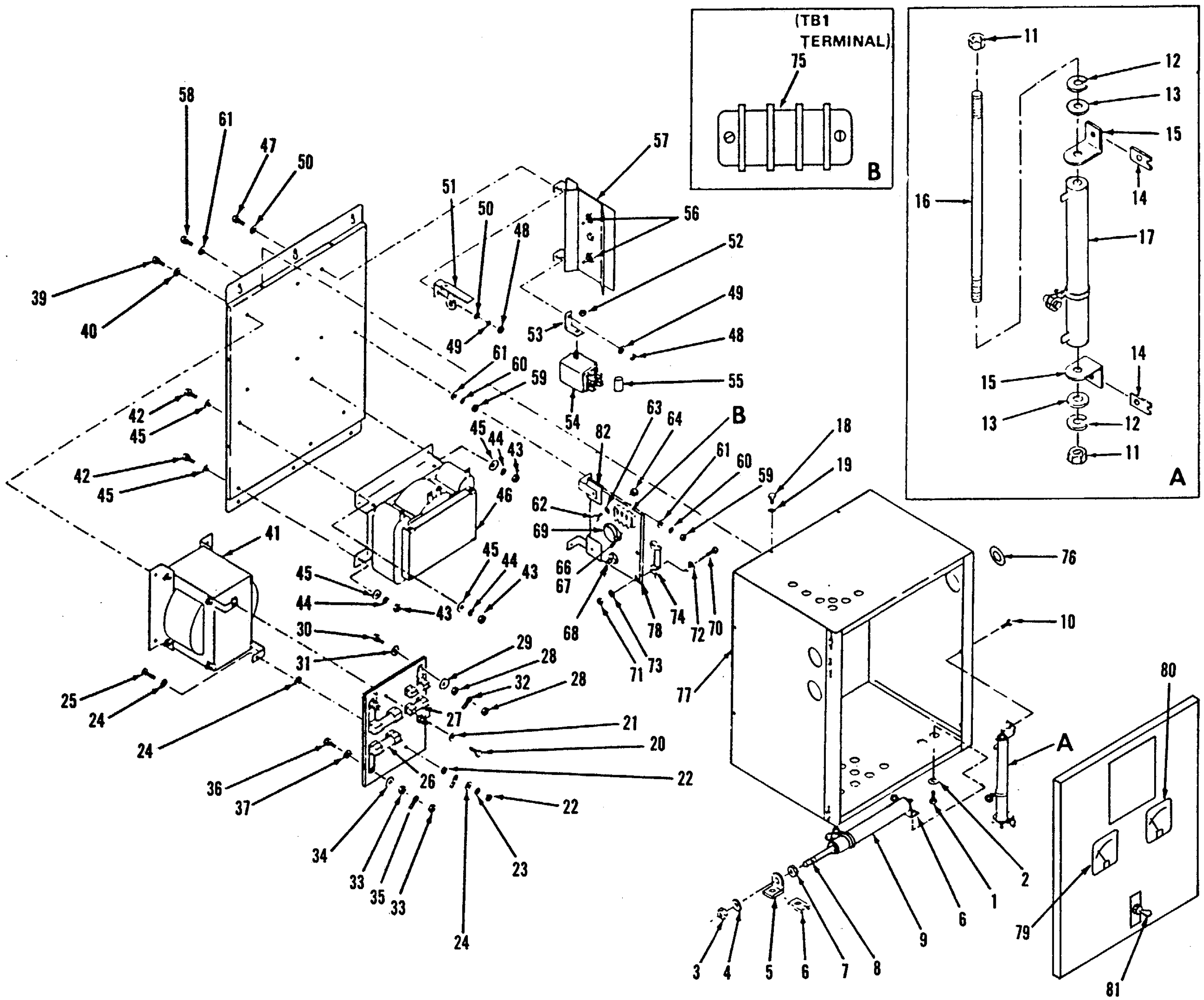


Figure 4-4. Battery Charger, Exploded View

Legend for Fig. 4-4

1.	Screw	22.	Nut	43.	Nut	62.	Screw
2.	Washer	23.	Washer	44.	Washer	63.	Washer
3.	Nut	24.	Washer	45.	Washer	64.	Nut
4.	Washer	25.	Screw	46.	Reactor Assy	65.	Not Used
5.	Clip	26.	Fuse	47.	Screw	66.	Screw
6.	Bracket	27.	Fuse	48.	Screw	67.	Washer
7.	Washer	28.	Nut	49.	Washer	68.	Transistor
8.	Stud	29.	Washer	50.	Washer	69.	Diode
9.	Resistor	30.	Screw	51.	Surge Protector	70.	Screw
10.	Screw	31.	Washer			71.	Nut
11.	Nut	32.	Clip	52.	Nut	72.	Washer
12.	Washer	33.	Nut	53.	Bracket	73.	Washer
13.	Washer	34.	Washer	54.	Relay, cut-out	74.	Resistor
14.	Clip	35.	Clip			75.	Terminal board
15.	Bracket	36.	Screw	55.	Capacitor	76.	Grommet
16.	Rod	37.	Washer	56.	Diode	77.	Enclosure
17.	Resistor	38.	Not Used	57.	Heatsink	78.	Baseplate
18.	Screw	39.	Screw	58.	Screw	79.	Voltmeter
19.	Washer	40.	Washer	59.	Nut	80.	Ammeter
20.	Screw	41.	Transformer	60.	Washer	81.	Switch
21.	Washer	42.	Screw	61.	Washer	82.	Control unit assy

assembly (55) are mounted with brackets attached with heat sink (57) onto mounting plate (78).

(5) Reactor assembly (46) is mounted directly to mounting plate (78).

Section III. GOVERNOR CONTROLLER

4-11. GENERAL. The governor controller A106 (56, figure 4-1) is the electronic portion of the load sharing and speed control unit which is part of the electric hydraulic governing system. The governor controller has two major functions, speed control and load sharing. It measures engine speed via a magnetic pickup and compares it to a speed reference. It then feeds corrections to the hydraulic actuator governor on the engine. It also has a speed sensing fail safe circuit, and a time ramp circuit (deceleration to idle speed - acceleration to rated speed).

4-12. INSPECTION. Inspect the governor controller front panel by removing the access cover (7, figure 4-1), paragraph 4-2. Inspect the connections on terminal boards for loose wires, inspect the potentiometers for signs of damage, and the control panel for scratches, dents or other damage.

4-13. ADJUSTMENTS. The controller has eight adjustment controls located on the front cover. Perform the following adjustments whenever the unit is replaced.

NOTE

Do not adjust the DE-DROOP, RAMP TIME, and LOW IDLE SPEED adjustments on the unit. These pots are factory set on each controller.

a. Disconnect F- and F+ leads on voltage regulator.

b. Set RATED SPEED (10T) potentiometer fully counterclockwise, then rotate 4 turns clockwise.

c. Set the STABILITY, GAIN, LOAD GAIN, and DROOP potentiometer to mid-range positions.

d. Toggle the FREQUENCY SELECTOR switch on the AC-DC Control Panel to the 50 Hz position.

e. Start the generator set.

f. Adjust the RATED SPEED (10T) potentiometer to obtain 50 Hz. Monitor the FREQUENCY meter on the Control Cubicle.

g. Toggle the FREQUENCY SELECTOR

switch to the 60 Hz position.

h. Loosen locknut and adjust R103 (54, figure 4-1) for 60 Hz operation. Monitor the FREQUENCY meter on the Control Cubicle. Tighten locknut (55).

i. Proceed to normal operation of the set and toggle the FREQUENCY SELECTOR switch to the 50 or 60 Hz position depending on the load requirement.

j. Run the engine until the coolant temperature has stabilized and is normal.

k. Turn the GAIN potentiometer clockwise until the generator set becomes unstable. Then back off this adjustment until generator set just becomes stable.

l. Rotate the STABILITY potentiometer 1/4 turn counterclockwise.

NOTE

The governor controller in the master unit may have to be readjusted to obtain a balanced load condition between the master set and other units in parallel operation. KW meters must be monitored for equal readings (proper load sharing).

4-14. REMOVAL AND REPLACEMENT. To gain access to the governor controller, access panel must be removed first, see paragraph 4-2.

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTACLE).

a. REMOVAL.

(1) Disconnect and tag all wires connected to the two terminal boards. Remove warning plate to gain access to terminals 1, 2 and 3 connections.

(2) Referring to figure 4-1, remove the six screws (52) and nuts (53) attaching the governor controller (56) to mounting bracket (62).

(3) Remove potentiometer R103 (54) from mounting bracket (62) by removing shaftlock (55). Mounting bracket (62) may be removed by removing six screws (61).

b. Replacement.

(1) Attach potentiometer (54) onto mounting bracket (62) with shaftlock (55).

(2) Replace mounting bracket (62) with six screws (61).

(3) Attach governor controller (56) to mounting bracket (62) with six screws (52) and nuts (53).

(4) Connect wires to terminal boards. Be sure to connect potentiometer (54) leads to terminals 16 and 20. Remove tags from wires. Replace warning plate.

(5) Perform adjustment procedures in accordance with paragraph 4-13.

4-15. TESTING. Bench testing is accomplished by simulating various parameters connected to the unit. The following items are required for the test setup: 20 to 40V DC source; 2 SPST switches; 35-ohm 10-watt resistor; AC signal generator, capable of producing 60 Hz with 10 rms volts output; and a DC voltmeter to 25 volts.

NOTE

Before performing test, visually check for damage to the chassis, terminal block, or printed circuit board.

a. Make the following connections to the governor A106 terminal boards (see figure 4-5).

(1) Connect 20 to 40V DC source to 12(+) and 13(-)

.

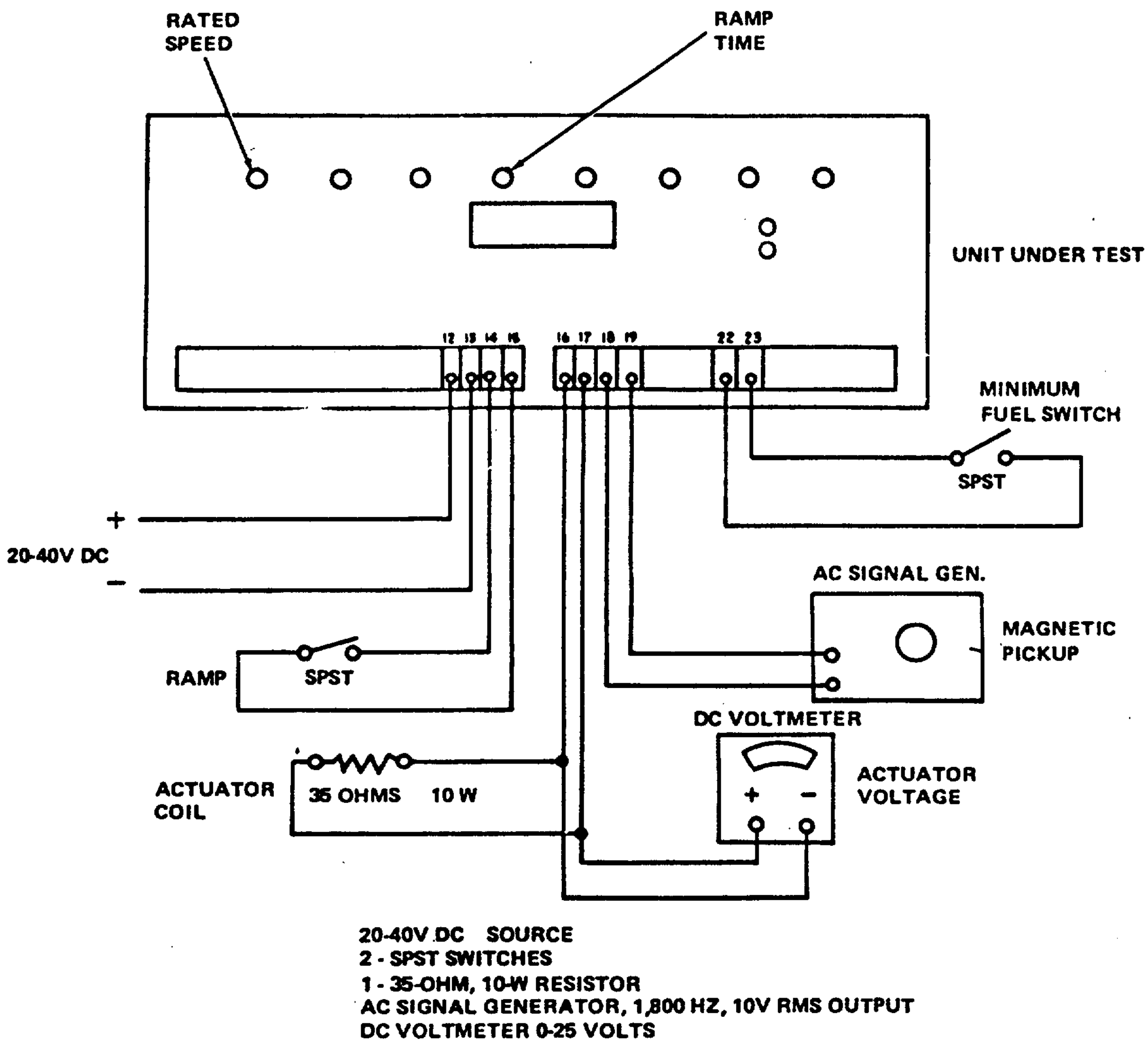


Figure 4-5. Governor A106, Test Setup

(2) Connect a closed SPST switch between 14 and 15.

(3) Connect a 35-ohm, 10-watt resistor between 16 and 17. This simulates the actuator coil.

(4) Connect AC signal generator to 18 and 19. This simulates the magnetic pickup.

(5) Connect an open SPST switch between 22 and 23. This simulates the minimum fuel switch.

(6) Turn RATED SPEED control fully clockwise.

(7) Connect DC voltmeter between 16(-) and 17 (+) to monitor actuator voltage.

(8) Check that jumper between 29 and 30 is installed.

b. Test as follows:

(1) Turn RATED SPEED control fully counterclockwise.

(2) Turn on power supply.

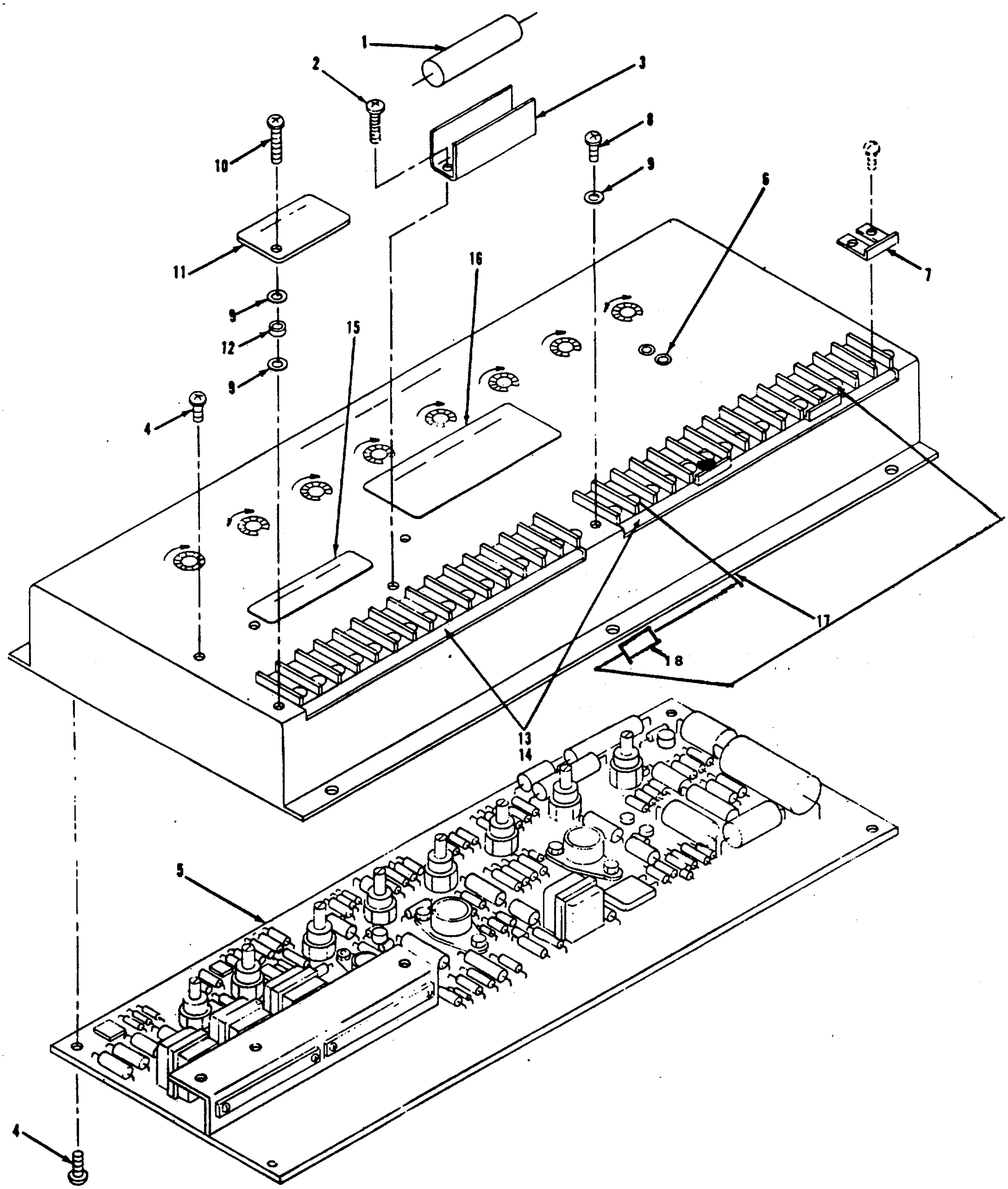


Figure 4-6. Governor Controller, Exploded View

Legend for Figure 4-6.

1.	Capacitor	7.	Jumper	13.	Terminal Board
2.	Screw	8.	Screw	14.	Terminal Board
3.	Clip	9.	Washer	15.	Decal
4.	Screw	10.	Screw	16.	Warning
5.	Printed Circuit Board	11.	Plate	17.	Chassis
6.	Jack	12.	Spacer	18.	Resistor

(3) Turn on AC signal generator. Set generator to 1,800 Hz at 2 to 6 volts rms.

(4) Voltage measured on DC voltmeter should approximate OV DC.

(5) Slowly turn the speed pot counterclockwise until the actuator voltage slowly starts to increase toward 8V DC. This means the speed setting has just crossed below the speed (frequency) signal.

(6) Decrease the frequency until the actuator voltage starts to decrease. This simulates a decrease in speed and normal control response.

(7) Open the RAMP SPST switch connected to terminals 14 and 15. Increase the signal generator frequency until the actuator voltage decreases. The actuator voltage will increase to 8V DC, and drop when the frequency reaches idle speed.

(8) Close the RAMP switch. The actuator voltage will fluctuate, and then settle at minimum voltage.

(9) Turn off the signal generator. The actuator voltage will go to 8V DC, verifying the fail safe circuit is working.

(10) Turn on the signal generator and move signal general frequency from below to above rated frequency to simulate a speed increase. The actuator voltage should increase towards 8V DC. Move frequency below rated speed. Actuator voltage will decrease.

(11) Close the MINIMUM FUEL switch between 22 and 23. DC voltage should go to 8 volts.

4-16. REPAIR. Repair the governor controller as follows:

a. <u>Disassembly of Chassis</u>

(1) Remove terminal boards (13 and 14, figure 4-6), by removing screws (8 and 10), washers (9) warning plate (11), washer (9), spacer (12), and washer (9).

(2) The printed circuit board assembly (5) is accessible by removing four screws (4) and unsoldering connections to terminal boards.

b. Repair of Printed Circuit Board Components.

NOTE

For repairs use a pencil-type low wattage soldering iron.

(1) When replacing 3-watt or 5-watt resistors, mount them at least 1/16 inch (1.6 mm) above printed circuit board.

(2) When replacing transistors Q2, Q4, or Q5, mount washer between the printed circuit board and the transistor.

Section IV. VOLTAGE REGULATOR

4-17. GENERAL. The voltage regulator assembly consists of the voltage regulator mounted with the electromagnetic interference (EMI) filter pack as a complete unit. The voltage regulator assembly senses generator voltage, compares the voltage with a reference voltage, and supplies field (stator) current to the generator to maintain voltage regulation. The EMI filter pack, associated with the voltage regulator, provides EMI suppression. The voltage regulator assembly is a separate unit mounted in the AC-DC control box assembly.

4-18. INSPECTION. Remove cover to facilitate inspection. Check voltage regulator wire connections on the terminal board. Check grounding straps for looseness. Check all components for loose mounting, poor connections, broken wires, or any other signs of damage.

4-19. TEST. The voltage regulator is tested to determine operational capability, as follows (see figures 4-7 and 4-8).

a. Operational Test.

(1) Connect voltage regulator as shown in test setup, figure 4-7.

(2) Disconnect leads from transformer T1 primary, and connect to the 120 volt input tap.

(3) Mark position of potentiometer R4 on voltage regulator.

NOTE

R1 in test setup substitutes for the motor-operated potentiometer in the AC-DC control box assembly. This adjustment is provided to control the generator voltage. When adjusted to its maximum resistance position (CCW), minimum generator voltage is obtained. Maximum generator voltage is obtained with minimum resistance (cw).

(4) Set potentiometer R4 on voltage regulator fully counterclockwise.

(5) Adjust potentiometer R1 (in figure 4-7), for maximum resistance.

(6) Slowly adjust R1 toward minimum resistance. Before reaching minimum resistance, light bulb should come on to near full

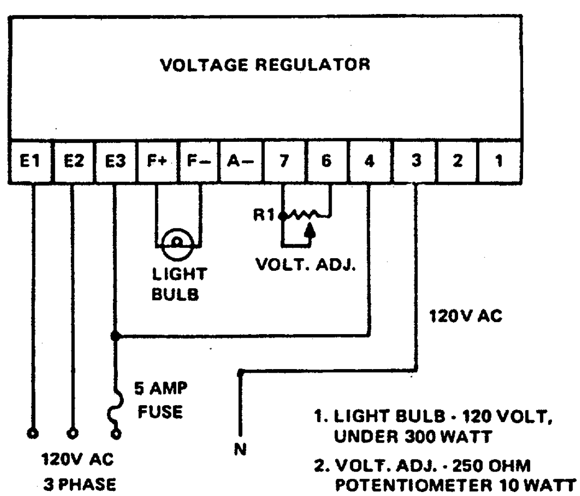


Figure 4-7. Voltage Regulator, Test Setup

brilliance. If light does not come on, adjust R3 on voltage regulator. Normally, R3 is set to provide R1 with an adjustment of ±10 percent of rated range.

(7) When R3 and R1 are correctly adjusted, a small change in R1 will turn the light bulb on and off. If light stays either "full on", or does not come on at all, the voltage regulator is defective.

NOTE

R4 on voltage regulator affects speed with which light turns on and off. Normally it is factory set in the extreme clockwise position. This setting normally assures good stability, but tends to slow the response time to the generator. If rotated counterclockwise, the system response time becomes faster. However, if rotated too far counterclockwise, the generator voltage may oscillate (hunt). It should then be rotated clockwise well above the point where oscillating occurs. The system voltage stability is very critical at no load.

(8) Reconnect leads to T1 primary as they were originally connected.

(9) Reset potentiometer R4 to its original position.

(10) Disconnect test setup and reinstall cover.

WARNING

MAINTENANCE PERSONNEL SHOULD EXERCISE EXTREME CARE WHEN TESTING EQUIPMENT WITH POWER ON.

b. On-Equipment Power Output Test. Use a multimeter to check for the following outputs at the F+ and F- terminals at the loads specified below:

No load	- 12V DC at 1.1 amps
250 KW load	- 22 V DC at 1.9 amps
500 KW load	- 32V DC at 2.8 amps

c. Testing of Replaceable Components. Refer to figures 4-8 and 4-9 and check the following components as indicated.

(1) Check diodes CR8 (29), CR9 (26), CR13 (30), CR14 (25), CR15 (33), and CR16 (34) by disconnecting one end of each diode and connecting an ohmmeter (set at Rx100) across the diode. Note reading. Reverse ohmmeter leads to the diode and not reading again. A good diode will read high resistance one way and low resistance the other way. A shorted diode will read full scale both ways and an open diode will read infinity (no reading) in either direction. Replace shorted or open diodes. Reconnect leads to good diodes.

(2) Check sensing transformers T1 and T2 (24) by applying inputs of 120 volts, 208 volts, 240 volts, 416 volts, 80 volts, and 600 volts. Check with a multimeter for 31 volts across diodes CR5 and CR2. Check for 31 volts across diodes CR6 and CR3. Check for 31 volts across diodes CR4 and CR1. If these voltages are not present for all inputs, the sensing transformers may be defective and must be replaced.

(3) After checking transformers T1 and T3, apply voltage to transformer inputs and verify opening and closing of relay K1 (23) contacts as indicated in schematic (figure 4-9). Remove voltage and monitor contacts for closing and opening as indicated.

(4) Use an ohmmeter to check for 1.0 ohms across resistor R25 (21) and 150 ohms across resistor R1 (9).

4-20. REPLACEMENT.

a. Repair by Replacement of Components. If any of the diodes, transformers, relays, or resistors are defective, the voltage regulator is repairable by replacing the defective component. Components are replaced by carefully unsoldering them from the printed circuit board, and carefully soldering new component into place.

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER CIRCUIT BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTACLE).

CAUTION

Do not apply excessive heat when soldering or unsoldering components.

b. Replacement.

(1) Removal. The voltage regulator (48, figure 4-1), is mounted in the AC-DC Control Box Assembly enclosure. Open AC-DC control box door, and remove voltage regulator as follows:

(a) Disconnect and tag all wires from voltage regulator terminal board, including grounds for shielded cables.

(b) Remove four screws (46) and washers (47) securing voltage regulator. Remove voltage regulator assembly.

(2) Installation.

(a) Install voltage regulator assembly (48, figure 4-1), to the AC-DC control box enclosure with four screws (46) and washers (47).

(b) Connect wires and shielded cable grounds to the voltage regulator assembly terminal board and chassis. Remove tags from wires

.

Section V. PANEL COMPONENT BASE ASSEMBLY

4-21. GENERAL. The panel component base assembly (43, figure 4-1) is located in the AC-DC control box assembly enclosure. It contains the motor-operated potentiometers P4 and P5, a shunt, two 24V DC relays K1 and K50, an AC-DC control relay TB9, and time delay modules TD1 and TD3. All components are directly mounted to the shelf and interconnected with a wiring harness. Relays K1 and K50 are plug-in type relays.

4-22. SHUNT. The shunt (6, figure 4-10), is repaired by replacing the entire assembly which is attached to the shelf with two screws (5).

4-23. RELAYS K1 AND K50. Relay K1 is the run-stop relay, and relay K50 is the battle short relay. Both relays (7, figure 4-10), are six-pole, double-throw type relays with four poles normally open and two poles normally closed. Test and replace as follows:

a. Test. To test relays K1 and K50, connect a 24V DC power source and a SPST switch as shown in figure 4-11.

(1) Close SPST switch. With an ohmmeter, check for an open circuit between terminals 1 and 2 and terminals 13 and 14. Meter should indicate continuity between terminals 3 and 4, terminals 5 and 6, and terminals 11 and 12.

(2) Open SPST switch, With an ohmmeter, check for continuity between terminals 1 and 2 and terminals 13 and 14. Meter should indicate an open circuit between terminals 3 and 4, terminals 5 and 6, and terminals 11 and 12. If relays fail this check, repair or replace the defective relay.

b. Replacement. Relays K1 and K50 are plug-in type relays mounted on the component assembly panel

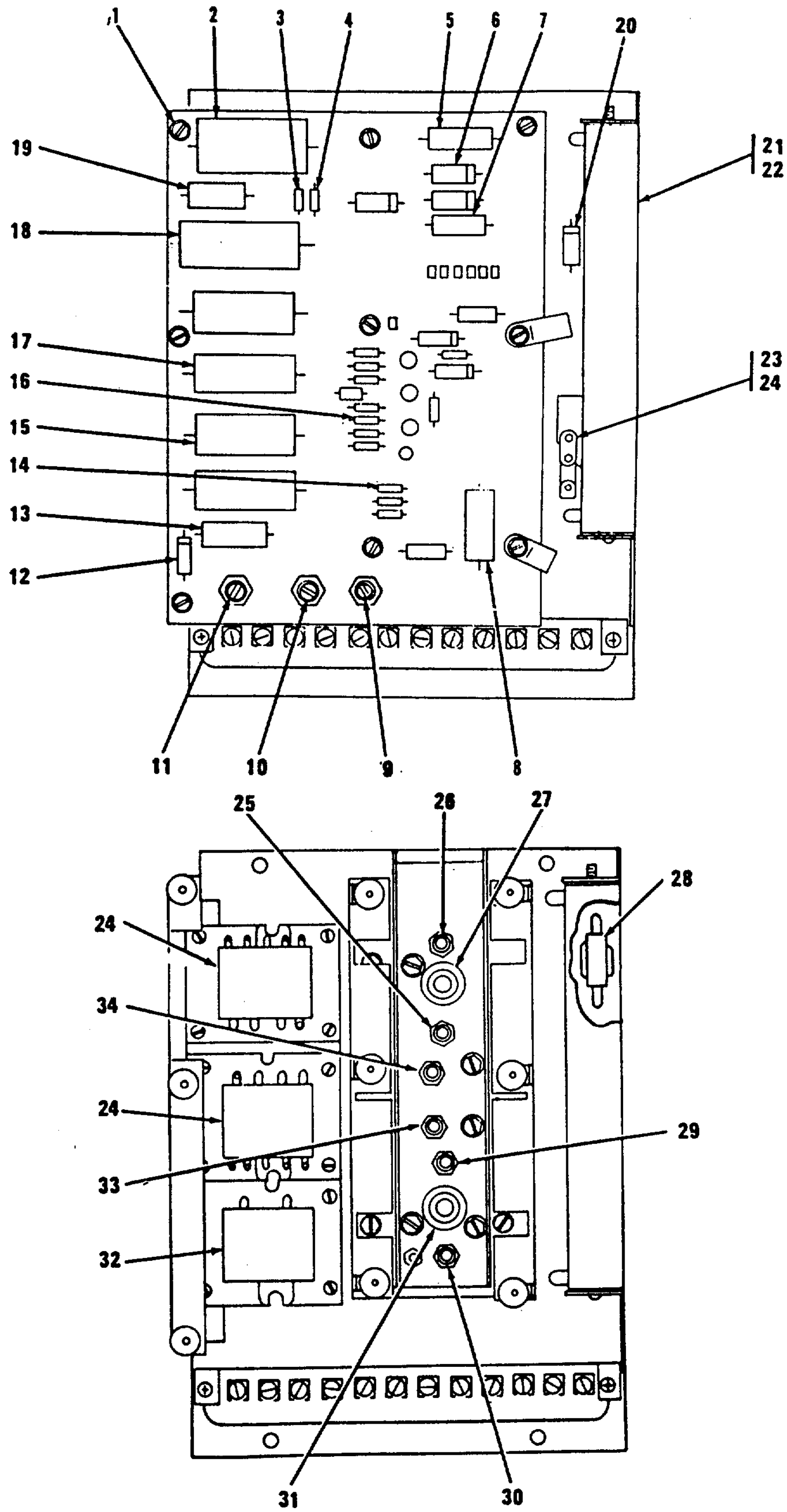


Figure 4-8. Voltage Regulator

LEGEND FOR FIGURE 4-8

1.	Circuit board assy	18.	Capacitor
2.	Capacitor	19.	Capacitor
3.	Resistor	20.	Resistor
4.	Resistor	21.	Resistor R25
5.	Resistor	22.	Bracket
6.	Resistor	23.	Relay K1
7.	Resistor	24.	Sensing transformer
8.	Capacitor	25.	Diode CR14
9.	Resistor R1	26.	Diode CR9
10.	Resistor R3	27.	Rectifier CR12
11.	Resistor R4	28.	Paralleling transformer T3
12.	Resistor	29.	Diode CR8
13.	Capacitor	30.	Diode CR13
14.	Resistor	31.	Rectifier CR11
15.	Capacitor	32.	Filter choke L1
16.	Resistor	33.	Diode CR15
17.	Capacitor	34.	Diode CR16

(shelf) of the AC-DC control box assembly. To remove relay, close locking device (under relay socket) and lift relay out of socket. To replace plug relay in snugly, until locking device is firmly in place.

c. Repair. Repair relays K1 and K50 by replacement in accordance with paragraph 4-23b.

4-24. AC-DC CONTROL RELAY ASSEMBLY TB9. The AC-DC control relay assembly (18, figure 4-10) contains three terminal boards, two diodes (CR1 and CR23), and eight relays:

REF. DES.	FUNCTION
K6	Crank disconnect
K8	Low fuel shutdown
K19	Overcrank shutdown
K20	Emergency stop
K22	Main CB control
K24	Ether control
K40	Frequency selector
K54	DC voltage slave

a. Test.

(1) Check each relay using test circuits shown in figure 4-12. Energize each set of relay contacts individually by applying 24V DC directly to leads. Check for open or closed contacts (no continuity or continuity) as indicated in figure 4-12. Check that each set of contacts revert (to either closed or open position) when deenergized. If any relay fails to either open or close as indicated, it is defective and must be replaced.

(2) Check diodes CR1 and CR23 for polarity. A good diode will read high resistance on way and low resistance the other way. A defective diode will read full scale both ways, or will read infinity (no reading) in either direction.

(3) Check terminal boards and printed circuit wiring by repeating steps (1) and (2), but apply 24V DC to TB9 terminals.

b. Repair. If any of the relays or diodes are defective, AC-DC Control Relay Assembly TB9 is repairable by replacing the defective component. If the printed circuit wiring, a terminal board, or a non-replaceable component proves defective, the entire assembly must be replaced.

c. Replacement.

(1) Remove relay assembly (18, figure 4-10) as follows:

(a) Tag and ten disconnect wires from terminal boards.

(b) Remove screws (19) to

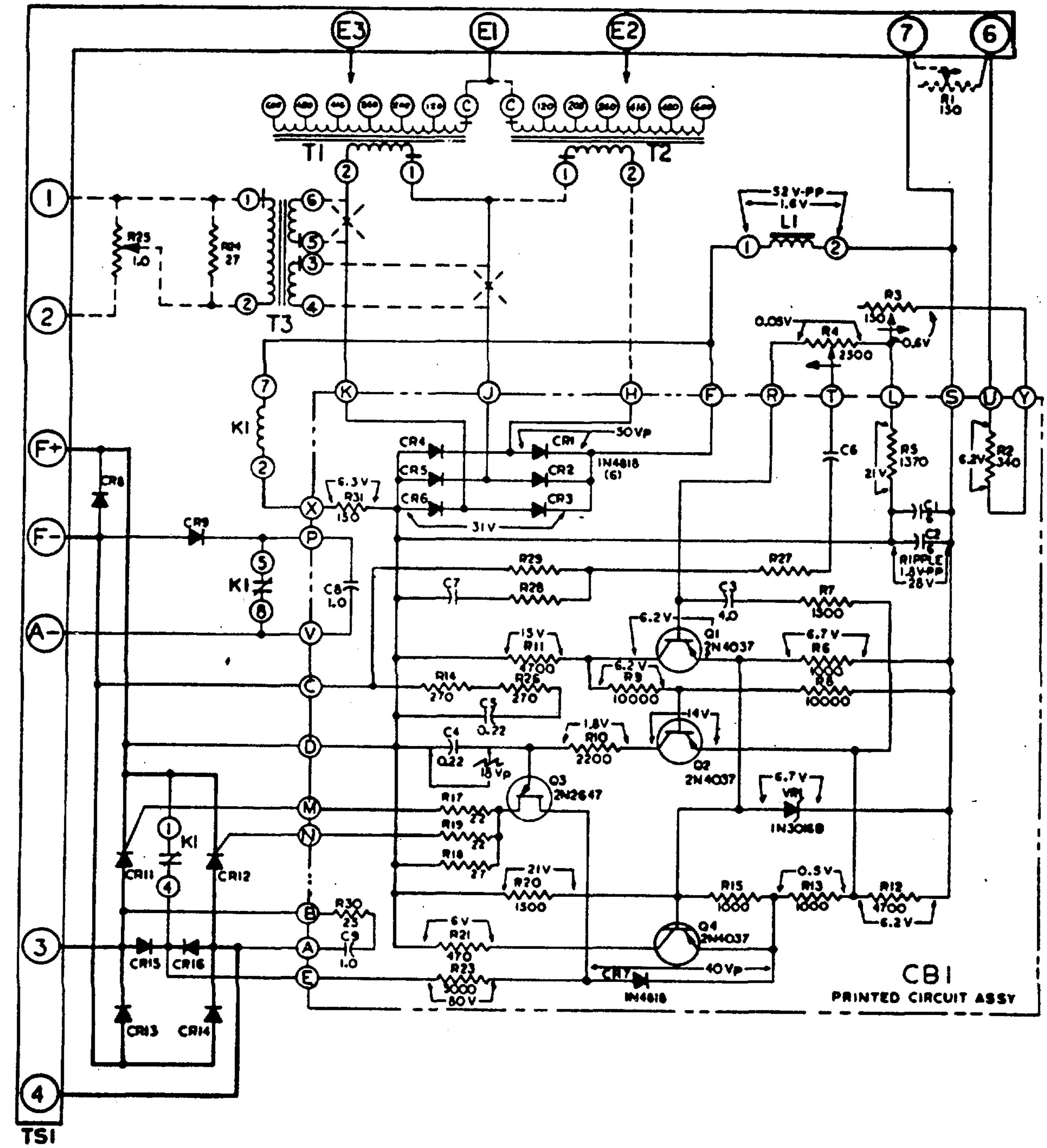
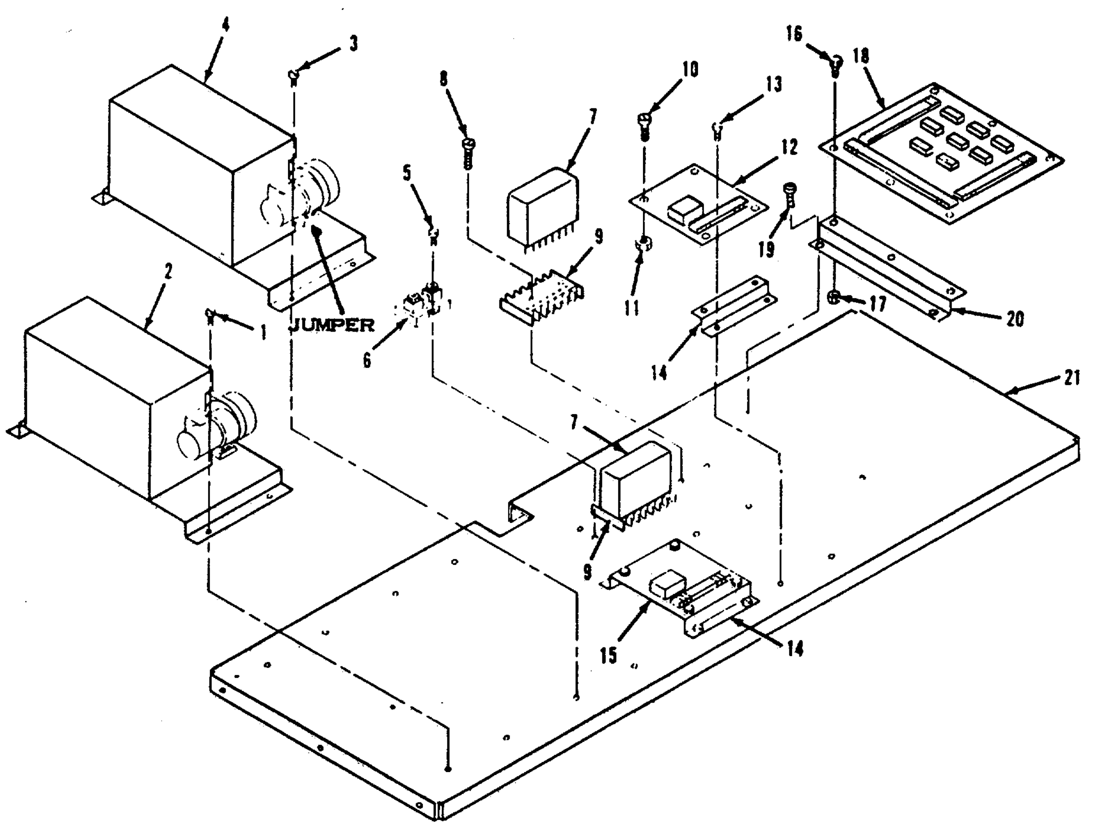


Figure 4-9. Voltage Regulator Schematic



LEGEND

1. Screw	9. Socket	16. Screw
2. Potentiometer	10. Screw	17. Nut
3. Screw	11. Nut	18. AC-DC control relay assy
4. Potentiometer	12. Time delay module TD3	19. Screw
5. Screw	13. Screw	20. Bracket
6. Shunt	14. Bracket	21. Shelf
7. Relay	15. Integrated time delay module TD1	
8. Screw		

Figure 4-10. Component Base Assembly, Exploded View

remove relay assembly (18) and brackets (20).

(c) Components are replaced by carefully unsoldering them from the printed circuit board.

CAUTION

Do not apply excessive heat when soldering or unsoldering components. It may damage the printed circuit wiring.

(d) If AC-DC Control Relay Assembly is to be replaced, remove screws (16) and nuts (17) to release relay assembly (18) from brackets (20).

(e) Prepare relay assembly (18) for installation by attaching brackets (20) using screws (16) and nuts (17).

(f) If components are being

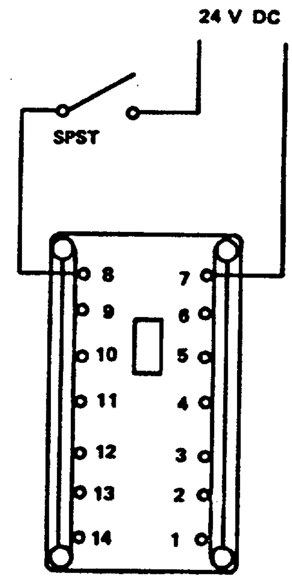


Figure 4-11. Component Assembly Panel, Relay K1 and K50, Test Setup

replaced, carefully solder new component into place.

(g) Install relay assembly (18) by securing brackets (20) to shelf (21) using screws (19).

(h) Connect wires to terminal boards, then remove wire tags.

4-25. TIME DELAY MODULES TD1 AND TD3. Time delay module TD1 (15, figure 4-10) delays crank limit relay K19 turn on by 30 seconds. Time delay TD3 (12) times on and off periods averaging 5-second delays and controls recrank inhibit relay K6.

a. Tests for Replaceable Components. Check the following components on TD1 and TD3:

(1) Check transistor Q1 (10, figure 4-13 and 16, figure 4-14) by connecting a transistor tester for current gain of 100 minimum, leakage, or short.

(2) Check transistors Q2 and Q3 (5 and 4, figure 4-14) by connecting each to a transistor tester and testing for current gain of 40 minimum, leakage, or short.

(3) Check capacitors (C1 and C2 (6 and 7, figure 4-13) by connecting each to a capacitor tester and checking for leakage and capacitance. C1 must read 10 microfarads, 25 volts ±5 percent. CR2 must read 47 microfarads, 50 volts ±10 percent.

(4) Check capacitor C1 (10, figure 4-14) by connecting to a capacitor tester and checking for leakage and capacitance. Cl must read 300 microfarads, 30 volts, ±5 percent.

(5) Check resistors using an ohmmeter for the following resistance's:

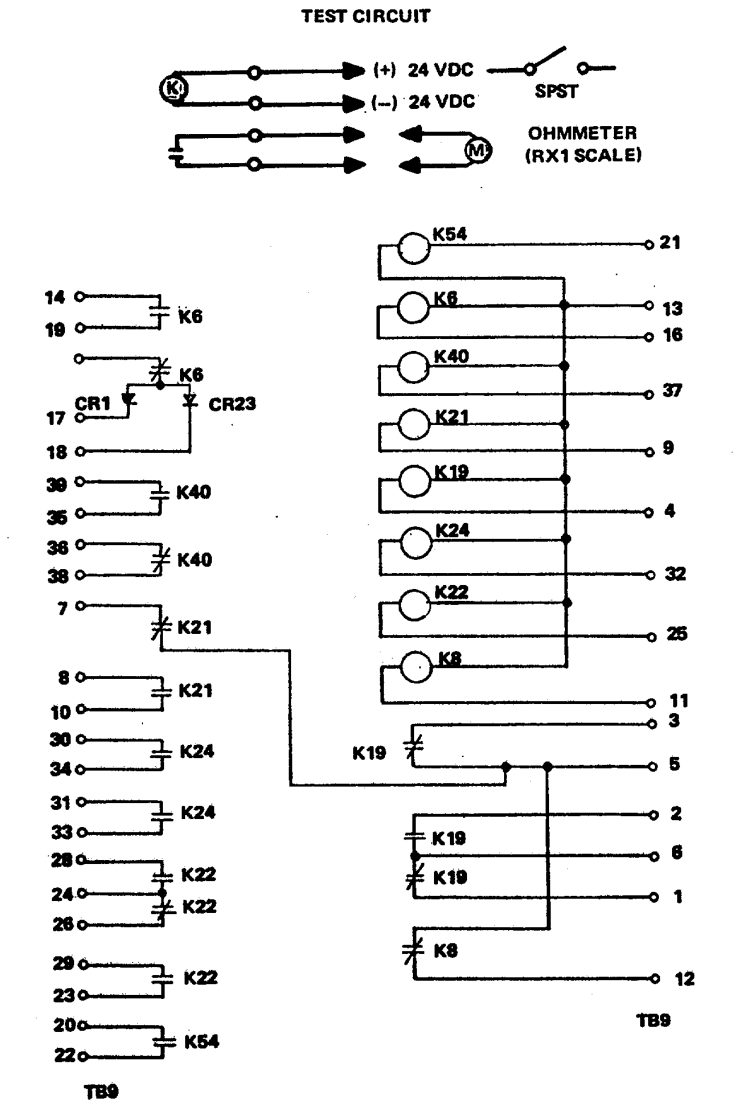


Figure 4-12. AC-DC Control Relay Assembly, Test Setup

<u>TD1</u>	
R4 (1)	820 ohms, 25 watts, ±5 percent
R1 (2)	2 k, 1 watt, ±5 percent
R2 (3)	2.7 megohms, 25 watts, ±5 percent
<u>TD3</u>	
R1 (1)	2 k, 1 watt, ±5 percent
R2 (3)	2 k, 1 watt, ±5 percent
R4 (6)	20 k, 0.25 watts, ±5 percent
R7 (8)	20 k, 0.25 watts, ±5 percent
R6 (9)	200 ohms, 1 watt, ±5 percent
R5 (12)	68 k, 0.25 watts, ±5 percent
R3 (13)	6 k, 0.25 watts, ±5 percent

(6) Check diodes CR1 (TD1), CR5, CR3 (TD3) as follows:

(a) Disconnect one end of the diode.

(b) Connect an ohmmeter (scale set Rx100) across the diode, note the reading. Now reverse ohmmeter leads to the diode, and again note reading. A good diode will read high resistance one way and low resistance the other way. A shorted diode will read full scale both ways. An open diode will read infinity (no reading) in either direction. Check all diodes and replace disconnected leads.

(7) Check zener diodes CR1 and CR4 by connecting a voltmeter across each zener and its associated resistor. CR1 must show reading of 6.8 volts across input range-of 20 to 40V DC. CR4 must show reading of 15 volts across input range of 20 to 40V DC.

b. Test of TD1.

(1) Connect time delay module TD1 as shown in figure 4-13.

(2) Close switch S1. Time the period it takes before lamp DS1 lights. The lamp must light in 25 to 35 seconds, or TD1 is defective and must be replaced.

c. Test of TD3

(1) Connect time delay module TD3 as shown in figure 4-14.

(2) Close switch S1 and time the period it takes before lamp DS1 lights. The lamp must light in 4.5 to 6 seconds, or TD3 is defective and must be replaced.

NOTE

Wait at least 15 seconds before proceeding.

d. Repair. If any of the replaceable components tested in a (above) are defective, TD1 and TD3 are repairable by replacing the defective component. If the printed circuit wiring or a terminal board, or a non-replaceable component, proves defective (test b or c, above), the entire assembly must be replaced.

e. Replacement.

(1) Tag and disconnect wires to TD1 or TD3 (12 or 15, figure 4-10).

(2) Remove screws (13) to remove time delay assemblies (12 or 15) with brackets (14).

(3) Components are replaced by carefully unsoldering them from the printed circuit board.

CAUTION

Do not apply excessive heat when soldering or unsoldering components. It may damage the printed circuit wiring.

(4) If either TD1 or TD3 are to be replaced as an assembly, remove screws (10) and nuts (11) to release time delay assembly (12 or 15) from brackets (14).

(5) Prepare time delay assembly (12 or 15) for installation by attaching brackets (14) using screws (10) and nuts (11).

(6) If components are to be replaced, carefully solder new component into place.

CAUTION

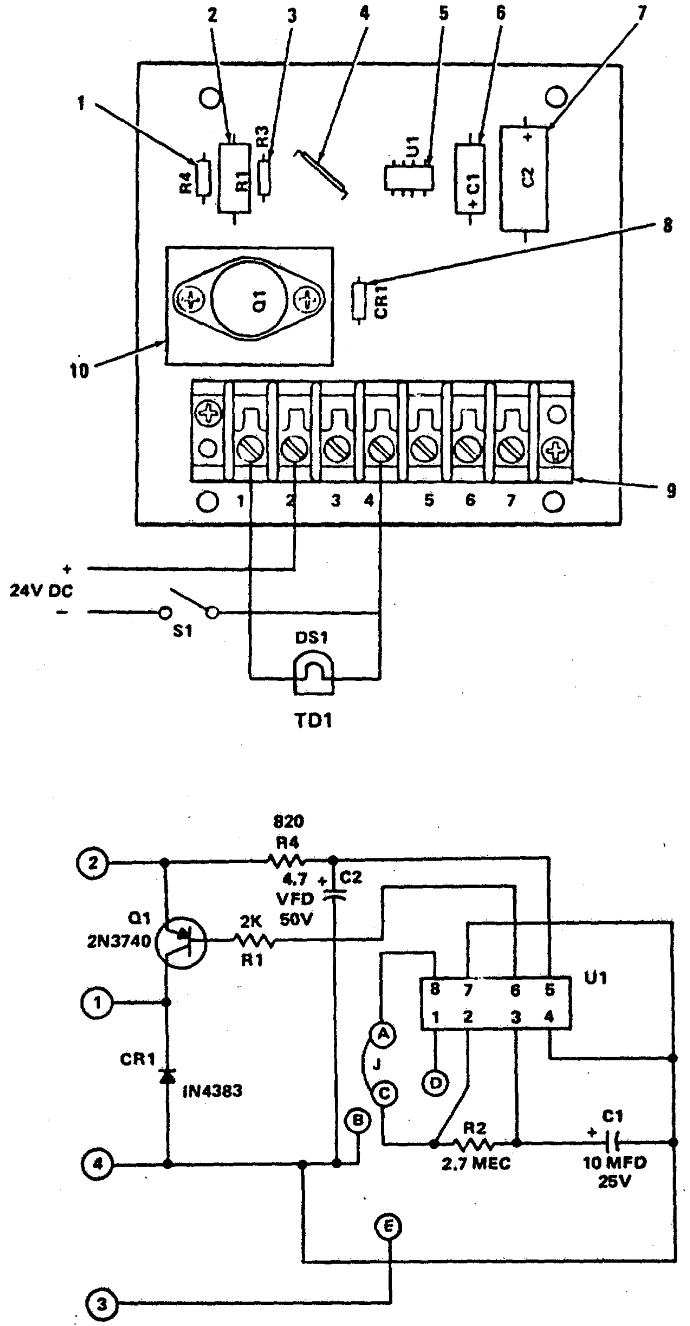
Do not apply excessive heat when soldering or unsoldering components. It may damage the printed circuit wiring.

(7) Install time delay assembly (12 or 15) by securing brackets (14) to shelf (21) using screws (13).

(8) Connect wires to terminal boards, then remove wire tags.

4-26. MOTOR-OPERATED POTENTIOMETERS P4 AND P5.

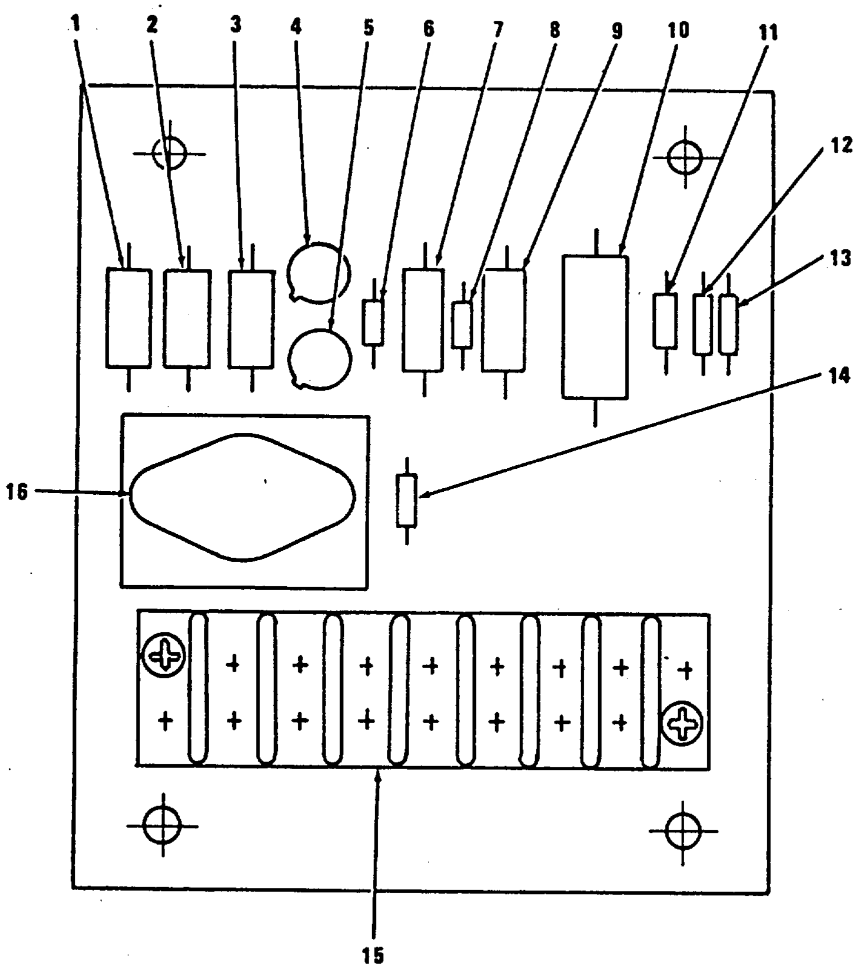
a. Replacement. The two motor operated potentiometers P4 and P5 (2 and 4, figure 4-10), are mounted on the component panel assembly (shelf) (43, figure 4-1) in the AC-DC control box assembly enclosure. Removal for either unit (P4 or P5) (figure 4-15), is as follows:



LEGEND

1. Resistor R4
2. Resistor R1
3. Resistor R2
4. Jumper
5. Timer U1
6. Capacitor C1
7. Capacitor C2
8. Diode CR1
9. Terminal board
10. Transistor Q1

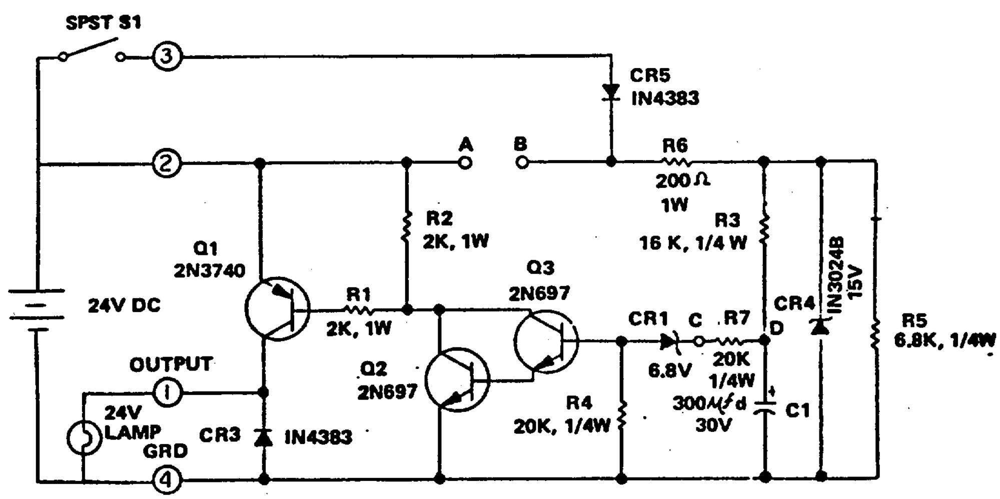
Figure 4-13. Time Delay Module TD1



TD3

LEGEND

1. Resistor R1
2. Diode CR5
3. Resistor R2
4. Transistor Q3
5. Transistor Q2
6. Resistor R4
7. Diode CR1
8. Resistor R7
9. Resistor R6
10. Capacitor C1
11. Zener Diode CR4
12. Resistor R5
13. Resistor R3
14. Diode CR3
15. Terminal Board TB1
16. Transistor Q1



SCHEMATIC

Figure 4-14. Time Delay Module TD3

(1) Remove and tag wires to terminals 1 through 6 on the terminal board.

(2) Remove four screws (1 and 3, figure 4-10) from each unit.

(3) Replace motor-operated potentiometer P4 or P5 on shelf by attaching four screws (1 and 3, figure 4-10).

(4) Connect wires to terminals 1 through 6 on terminal board. Remove tags.

b. Test. The following testing procedure applies to both motor operated potentiometers P4 and P5, unless otherwise indicated.

(1) Test chassis isolation with an ohmmeter (set on high scale) by measuring between chassis and terminals 1 through 6 on the terminal board. Meter reading should be no continuity.

(2) Referring to figure 4-16, provide a test setup as follows:

(a) Connect the (-) of a 24V DC source to terminal 6. The (+) side of the center terminal of SPST switch as shown.

(b) Label switch RAISE and LOWER. Connect the RAISE terminal of SPDT switch to terminal 5 and the LOWER terminal of SPDT switch to terminal 4.

(c) Connect an ohmmeter between terminals 2 and 3.

(d) Turn 24V DC power on. Set SPDT switch to RAISE. Meter shall read 230 ±5 ohms connected between terminals 2 and 3.

(e) Set SPDT switch to LOWER. Meter shall read 8 ±5 ohms connected between terminals 2 and 3.

NOTE

If ohmmeter readings at steps (d) and (e) are incorrect, cams need adjustment.

(f) The 230 ±5 ohm reading in step (d) is adjusted with cam B. This cam should be adjusted to stop the motor at 230 ±5 ohms, see figure 4-17.

(g) The 8 ±5 ohm reading in step (e) is adjusted with cam A. This cam should be adjusted to stop the motor at 8 ±5 ohms, see figure 4-17.

NOTE

Potentiometer reading adjustments in steps (f) and (g) are for motor-operated potentiometer P5. For P4, readings are 500 ±5 ohms in step (f), and 1 ±5 ohms in step (g).

(h) Verify that the motor can be run at 1 rpm to 3 rpm as R3 is rotated from clockwise to counterclockwise. Leave R3 set for 3 rpm operation.

c. Repair. Components within the motor-operated potentiometers that may be repaired are: brush replacement in motor M1, tightening of set screws on gears, cam adjustments and clutch torque.

(1) When motor M1 (9, figure 4-15) brushes are worn under 0.25 inch (6.4 mm) long, they must be replaced.

(2) Remove cover (3) by moving three screws (1) and washers (2). Tighten setscrews (19) on gear assembly (20) and setscrews (28) on gear (29).

(3) Adjust cams A and B in accordance with procedure in paragraph 4-26b (f) and (g).

(a) With cover (3) removed, remove motor mounting plate (17) and motor (9) by removing two screws (8).

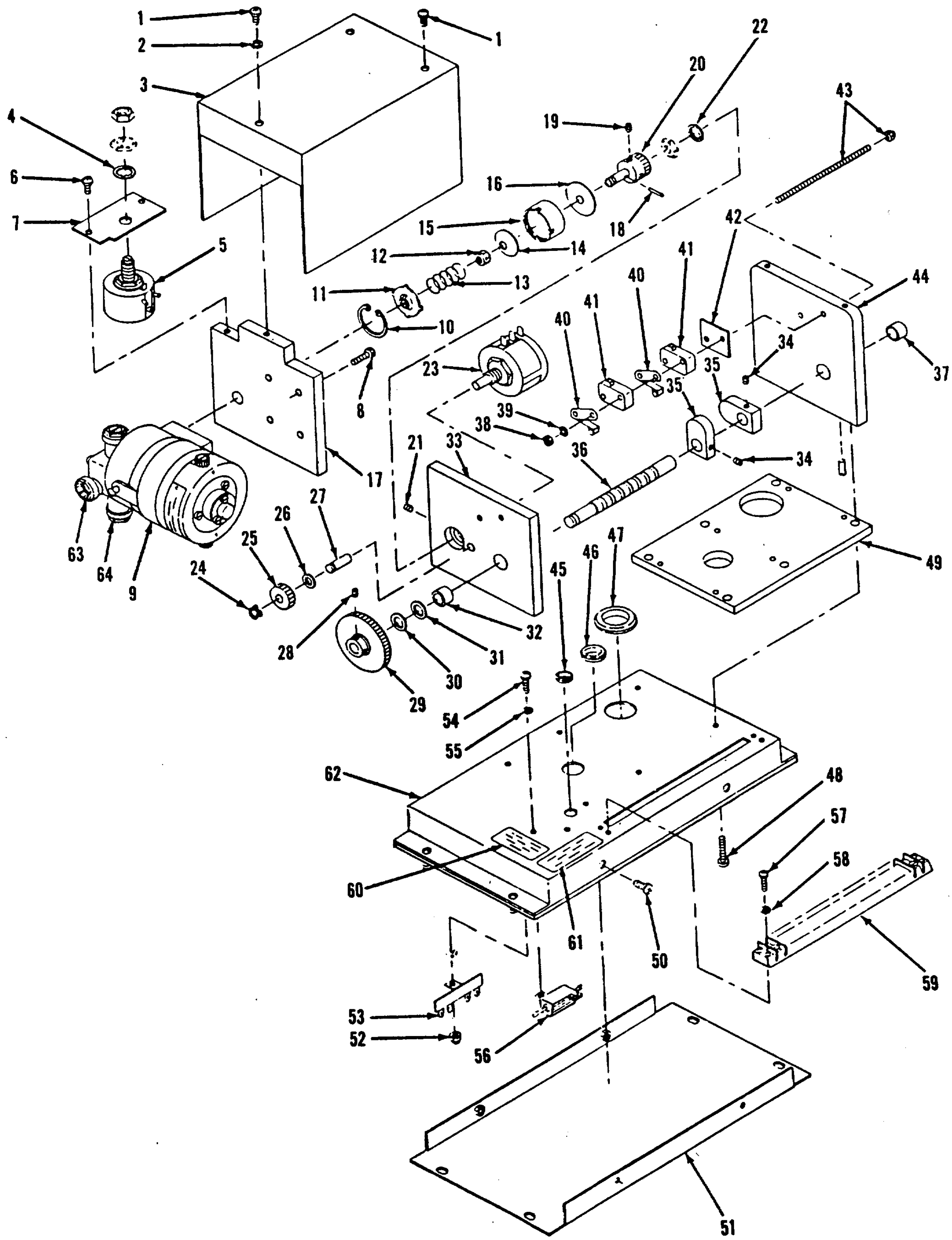


Figure 4-15. Motor Operated Potentiometer, Exploded View

LEGEND FOR FIGURE 4-15

1. Screw
2. Lockwasher
3. Cover
4. Washer
5. Potentiometer R3
6. Screw
7. Plate
8. Screw
9. Motor M1
10. Ring
11. Cover
12. Nut
13. Spring
14. Spring
15. Case
16. Clutch plate
17. Plate
18. Pin
19. Setscrew
20. Gear Assy
21. Setscrew
22. Lockwasher
23. Potentiometer R1
24. Ring
25. Gear
26. Spacer
27. Stud
28. Setscrew
29. Gear
30. Spacer
31. Spacer
32. Bushing
33. Plate
34. Setscrew
35. Cam
36. Shaft
37. Bushing
38. Nut
39. Washer
40. Lever
41. Switch
42. Plate
43. Nut-stud assy
44. Plate
45. Grommet
46. Grommet
47. Grommet
48. Screw
49. Plate
50. Screw
51. Base Plate Assy
52. Nut
53. Terminal strip TB2
54. Screw
55. Washer
56. Resistor R4
57. Screw
58. Washer
59. Terminal strip TB1
60. Instruction plate
61. ID plate
62. Chassis assy
63. Friction kit
64. Oil cup

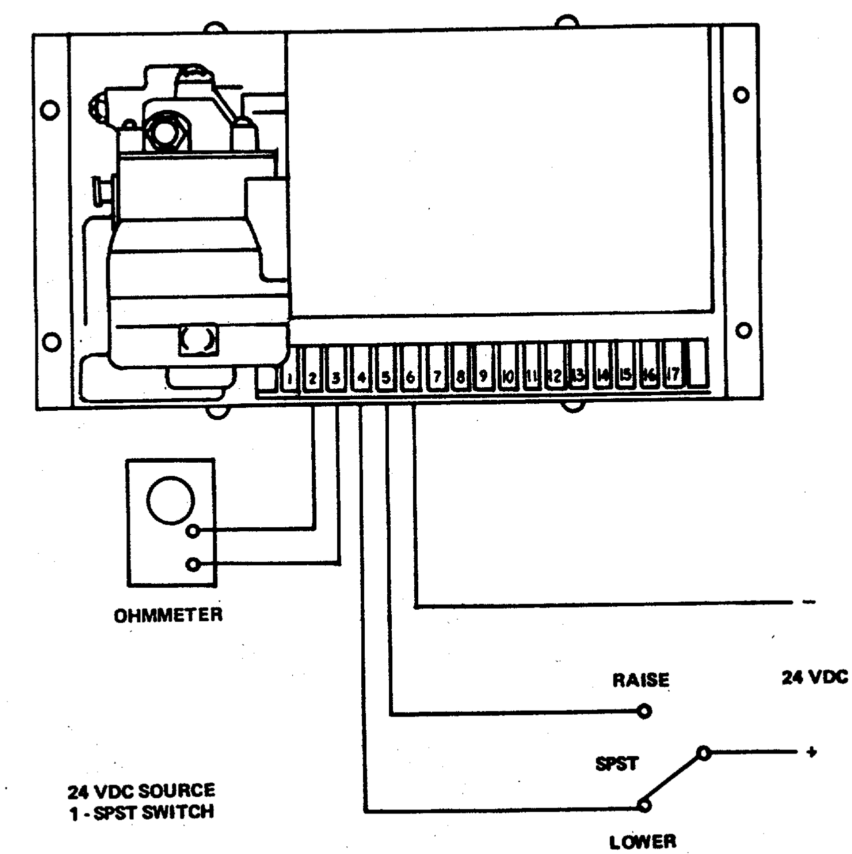


Figure 4-16. Motor-Operated Potentiometer, Test Setup

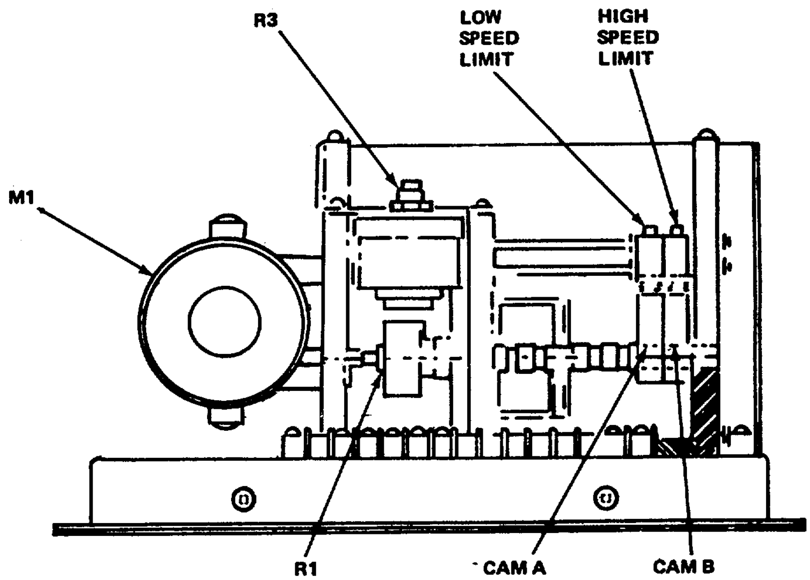


Figure 4-17. Motor-Operated Potentiometers, Cam Adjustment

(b) Remove retaining ring (10) friction cover (11) and spring (13). Elastic stop nut (12) is accessible for torque increase or decrease. Clutch assembly may be removed for torque adjustment by removing set screws (10).

(4) Adjust clutch (16, figure 4-15) to 20 ±5 inch-ounce (0.15 ±0.15 ±0.04 joules). Add shims if necessary to reduce looseness between motor shaft and clutch. Adjust torque with nut as shown in figure 4-18. Clutch assembly must be disassembled in accordance with figure 4-15 as follows:

(a) With cover (3) removed, remove motor mounting plate (17) and motor (9) by removing two screws (8).

(b) Remove retaining ring (10) friction cover (11) and spring (13). Elastic stop nut (12) is accessible for torque increase or decrease. Clutch assembly may be removed for torque adjustment by removing set screws (19).

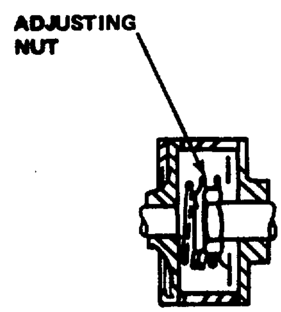


Figure 4-18. Motor-Operated Potentiometers, Clutch Adjustment Nut

Section VI. CAPACITOR, DIODE, AND CIRCUIT CARDS

4-27. CAPACITOR.

a. Testing.

(1) Disconnect capacitor (58, figure 4-1) leads and remove capacitor from clip (60).

(2) With capacitor tester, check capacitor (58) for 40 microfarad capacitance. Replace capacitor if it does not meet specified capacitance.

b. Replacement.

(1) Install new capacitor (58) in clip (60).

(2) Solder capacitor leads.

4-28. DIODE.

a. Testing.

(1) Disconnect one lead of diode (27, figure 4-1) from terminal board (30).

(2) Connect ohmmeter (Rx100) across diode and note reading.

(3) Reverse ohmmeter leads to diode and note reading.

(4) A good diode will read high resistance in one direction and low resistance in the other direction. A shorted diode will read full scale both ways. An open diode will read infinity (no reading) in both directions. Replace diode as required.

b. Replacement. Reconnect leads of new diode (27) on terminal board (30).

4-29. CIRCUIT CARDS.

a. Testing. Test individual circuit cards for obvious points of continuity using an ohmmeter.

b. Repair. If breaks on circuit card are minor or few, repair by soldering an insulated piece of wire between broken points of continuity. If circuit card is badly burnt or breaks are irreparable, repair card by replacement.

CHAPTER 5

MAINTENANCE OF CONTROL CUBICLE

5-1. GENERAL. The control cubicle is located at the rear (generator end) of the generator set. It contains two control panels, the engine control panel, and the generator control panel. These instruments, and other equipment necessary to start, operate, and monitor the generator set. The control cubicle is removable from the generator set as a single unit.

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER CIRCUIT BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTACLE).

5-2. TRANSDUCERS A103, A107, AND A108. Transducer A103 is mounted on the rear panel of the control cubicle enclosure (31, figure 5-1, sheet 1). Transducers A107 and A108 (thermal watt converters, 82, figure 5-1, sheet 2) are mounted at the base of the control cubicle.

a. Testing.

(1) Remove transducers A107 and A108 according to paragraph 5-2 b and test as follows:

WARNING

HIGH VOLTAGES PRESENT DURING TEST. DEATH OR SEVERE BURNS MAY RESULT IF PERSONNEL FAIL PRECAUTIONS

(a) Connect transducer (either A107 or A108) as shown in figure 5-2, using test equipment as shown.

(b) Adjust T1, T2, and T3 to their minimum position, fully counter-clockwise.

(c) Close S1 and open S2 and S3.

(d) Energize 120/208V AC. 3-phase, 4 wire, 60 Hz power source.

(e) Adjust T1 until 0.7 ampere is indicated on ammeter A1. At this point, the percentage of RATING METER shall indicate 33 percent.

(f) With S1 closed, close switch S2, and adjust T2 until 0.7 ampere is indicated on ammeter A2. The percentage of RATING METER shall indicate 66 percent.

(g) With S1 and S2 closed, close S3. Adjust T3 until 0.7 ampere is indicated on ammeter A3. The percentage of RATING METER shall indicate 100 percent.

(h) If requirements of steps (e), (f), and (g) are not met, replace the transducers.

(2) Transducers A103. This transducer and generator set frequency meter are a matched set, and must be tested as a set. Refer to the Operator/Crew and Organizational level Maintenance manual and remove frequency meter from the generator panel of the control cubicle.

(a) Connect a test setup as shown in figure 5-3.

(b) Vary the frequency from lowest scale reading to full scale reading at 120 volts and at frequencies between 48 and 53 Hz, the generator set meter shall read within 1 percent of the generated frequency (to the left); at 120 volts and at frequencies

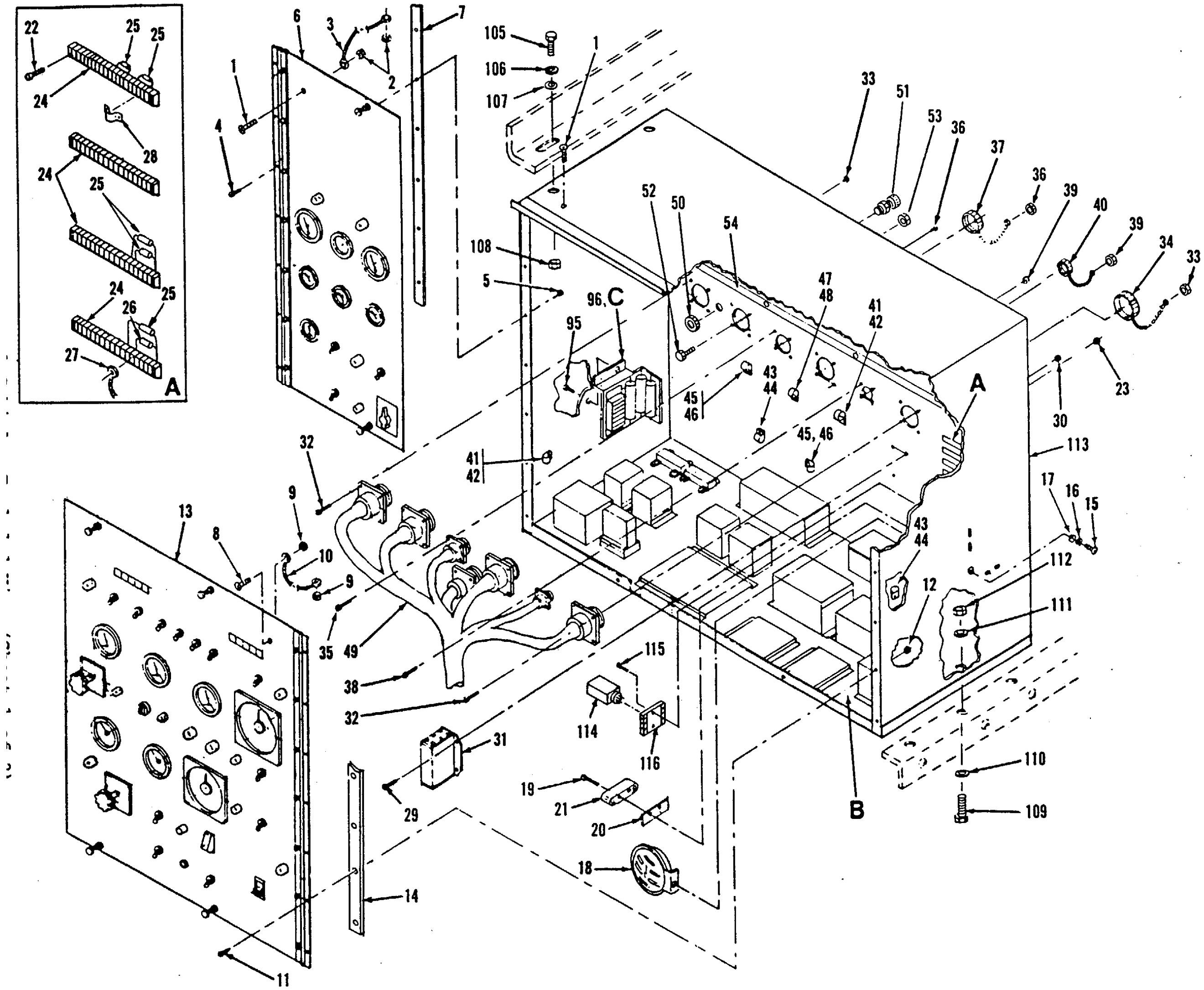


Figure 5-1. Control Cubicle, Exploded View (Sheet 1 of 2)

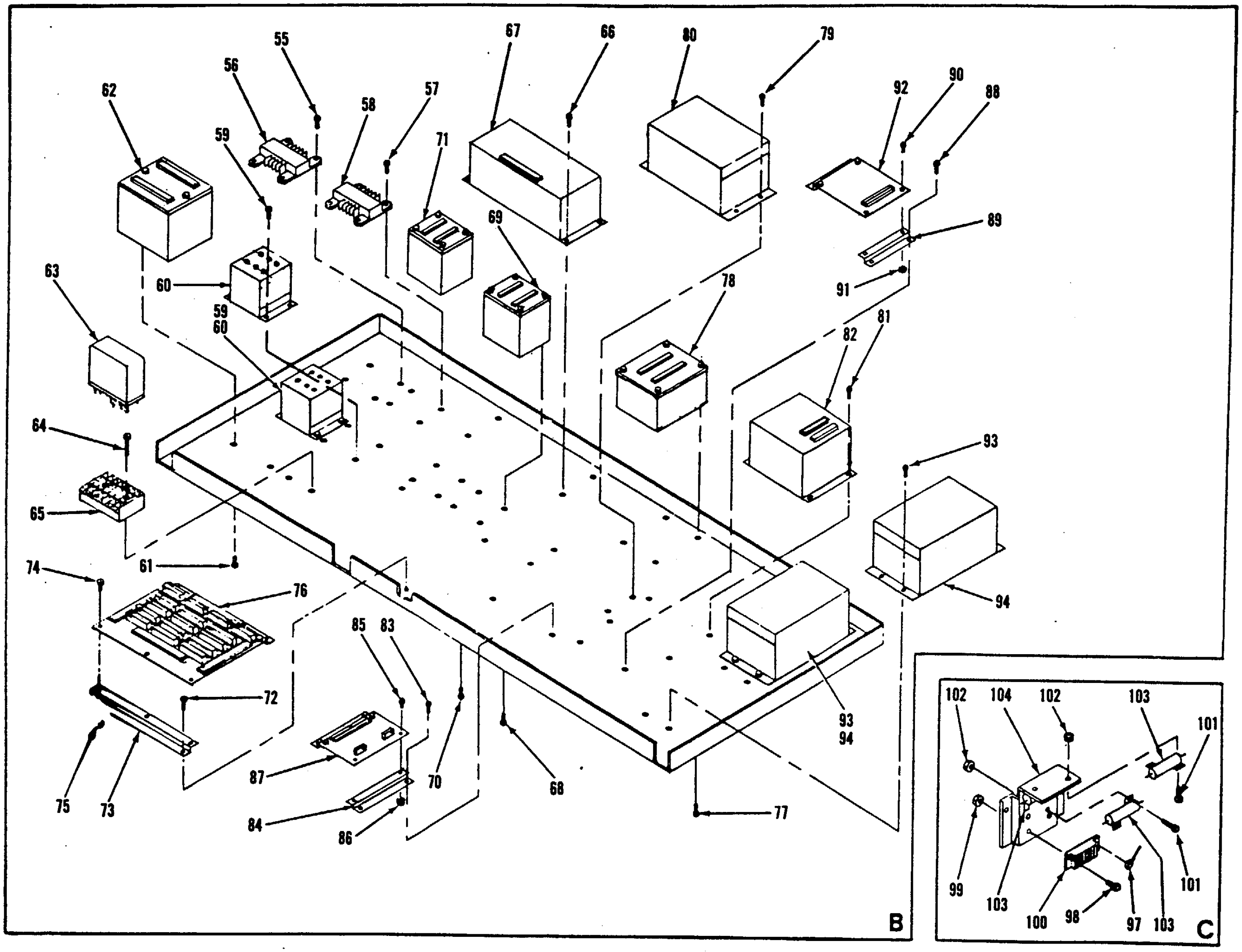


Figure 5-1. Control Cubicle, Exploded View (Sheet 2 of 2)

LEGEND FOR FIG. 5-1

Sheet 1
1. Screw
2. Nut
3. Door holder
4. Screw
5. Nut
6. Engine panel
7. Spacer
8. Screw
9. Nut
10. Door holder
11. Screw
12. Nut
13. Generator panel
14. Spacer
15. Screw
16. Lockwasher
17. Washer
18. Horn
19. Screw
20. Flasher
21. Terminal block
22. Screw
23. Nut
24. Terminal board
25. Diode
26. Resistor
27. Lug
28. Jumper
29. Screw
30. Nut
31. Transducer
32. Screw
33. Nut
34. Receptacle cover
35. Screw
36. Nut
37. Receptacle cover
38. Screw
39. Nut
40. Receptacle cover

Sheet 1 (Cont.)
41. Screw
42. Clamp
43. Screw
44. Clamp
45. Screw
46. Clamp
47. Screw
48. Clamp
49. Harness assy
50. Locknut
51. Connector
52. Screw
53. Nut
54. Relay assy

Sheet 2

55. Screw
56. Transformer
57. Screw
58. Transformer
59. Screw
60. Phase sequence relay
61. Screw
62. Overload device
63. Relay
64. Screw
65. Relay socket
66. Screw
67. Reverse power relay
68. Screw
69. Overvoltage relay
70. Screw
71. Short circuit relay
72. Screw
73. Bracket
74. Screw
75. Nut
76. Annuncitor control assy

Sheet 2 (Cont.)
77. Screw
78. Undervoltage relay
79. Screw
80. Transformer
81. Screw
82. Sync check relay
83. Screw
84. Bracket
85. Screw
86. Nut
87. Integrated time delay module
88. Screw
89. Bracket
90. Screw
91. Nut
92. Control relay assy
93. Screw
94. Transducer
95. Screw
96. Resistor assy
97. Terminal lug
98. Screw
99. Nut
100. Terminal board
101. Screw
102. Nut
103. Rectifier
104. Bracket
105. Screw
106. Lockwasher
107. Washer
108. Nut
109. Screw
110. Washer
111. Lockwasher
112. Nut
113. Control box
114. Flasher
115. Screw
116. Socket

between 57 and 62 Hz, generator set meter shall read within 1 percent of the generated frequency (to the right). The error at any point on frequency meter shall not be greater than 1 percent.

(c) If the above requirements are not satisfied, replace both the frequency meter and transducer as a matched set.

b. Replacement.

(1) Replace thermal watt converters (transducers) A107 and A108 (94, figure 5-1) as follows:

(a) Tag and disconnect lead wires.

(b) Remove screws (93) to remove transducers (94).

(c) Secure replacement transducer (94) using screws (93).

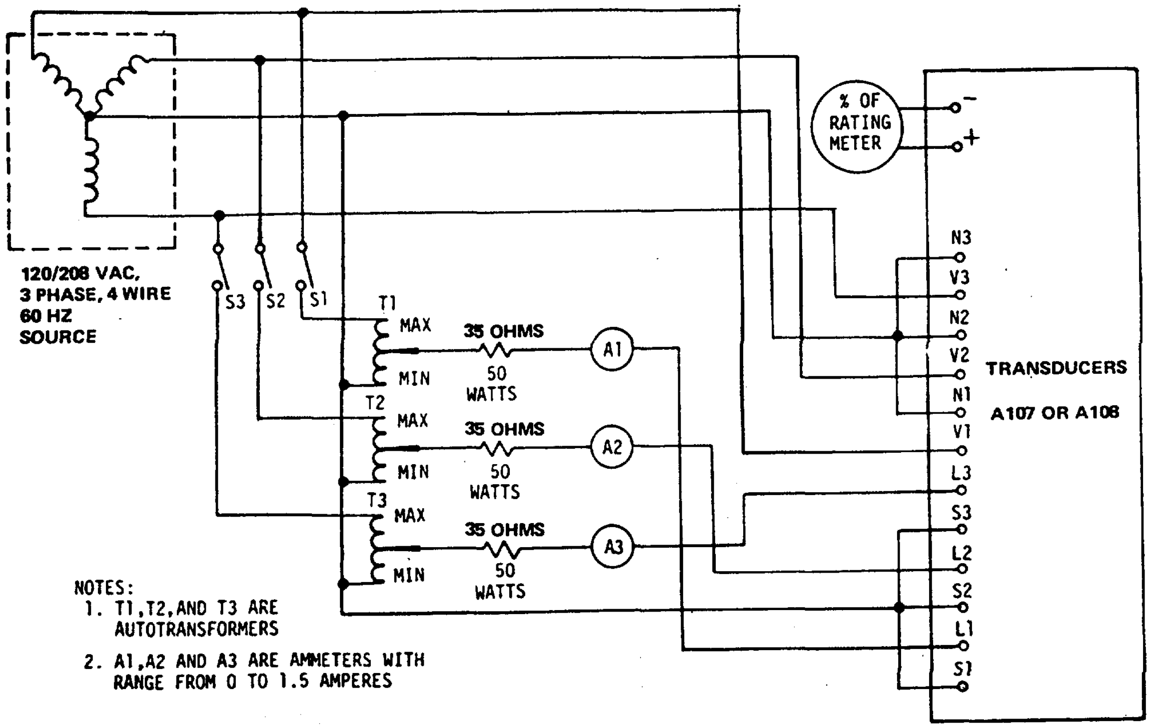


Figure 5-2. Transducers A107 and A108, Test Setup

(d) Connect lead wires, then remove tags.

(2) Replace transducer A103 (31, figure 5-1) as follows:

NOTE

Transducer A103 and the generator set frequency meter must be replaced as a matched set.

(a) Replacement of the frequency meter is within the scope of Organizational Maintenance, and is performed in accordance with Operator and Organizational Maintenance Manual.

(b) Tag and disconnect lead wires to A103.

(c) Remove screws (29) and nuts (30) to remove transducer (31).

(d) Secure replacement transducer (31) using screws (29) and nuts (30)

(e) Connect wires to A103 and then remove tags.

5-3. TRANSFORMERS.

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER CIRCUIT BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTACLE)

a. Transformers T101 and T102, Testing (56 and 58, figure 5-1). Remove transformers according to paragraph 5-3 c and test as follows:

(1) Referring to figure 5-4, use an ohmmeter and check for continuity between terminals H1 and H2, terminals H2 and H4, and terminals X2 and X1.

(2) With ohmmeter set on high scale, check for no continuity between terminals H1 and H3, and terminals H2 and X2.

(3) Connect a 240 volt input with the coils in parallel and check for 120 volt output.

(4) Connect a 480 volt input with the coils in series and check for 120 volt output.

(5) If transformers do not meet above check, replace them.

b. Transformer T103 (80, figure 5-1). Remove T103 according to paragraph 5-3 c and test as follows:

(1) Refer to figure 5-5 and apply 120V AC between terminals 1 and 2. Use a voltmeter to check for indicated voltages (within 3 percent) at test points shown.

(2) Repeat procedure with inputs at terminals 1 and 3, and at terminals 1 and 4.

(3) If transformer T103 fails to provide any of the indicated voltages, it is defective and must be replaced.

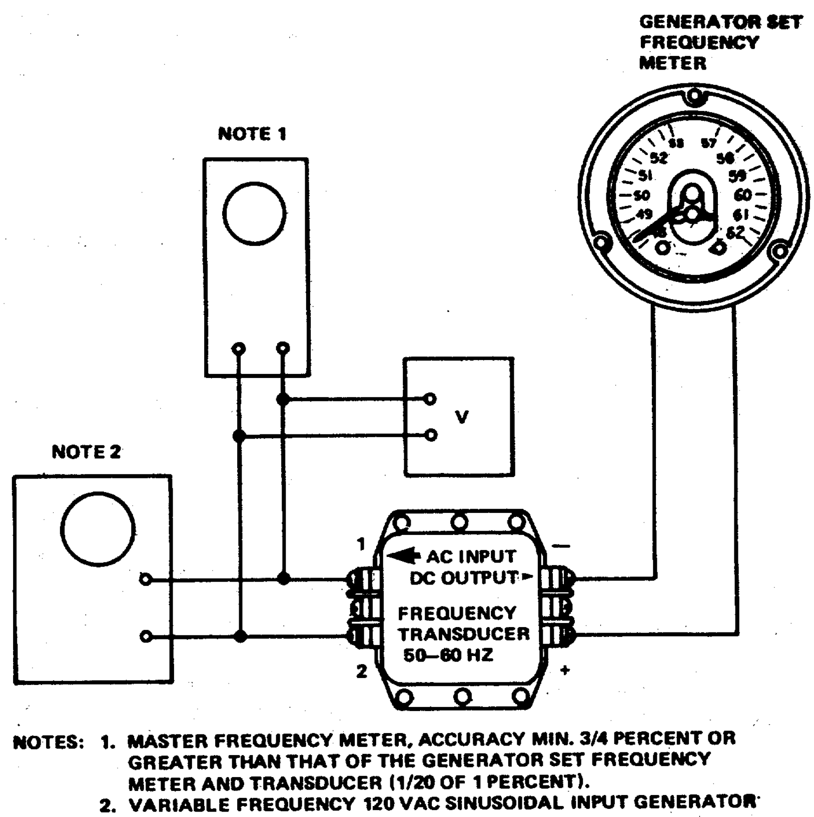


Figure 5-3. Transducer A103, Test Setup

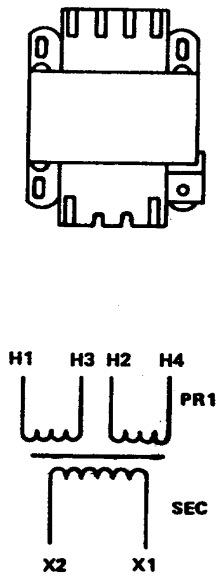


Figure 5-4. Transformers T101 and T102, Schematic

c. Replacement.
Transformers T101, T102, and T103 (56, 58 and 80 figure 5-1, sheet 2) are removed from the control cubicle base assembly by disconnecting and tagging wires, and removing four screws (66) on transformer (79).

5-4. RELAYS. Relays K23, K102, K103, K106, K111, K112, K113, and K114 are mounted at the base of the control cubicle. Refer to figure 5-1, sheet 2.

RELAY	ITEM NO.	FUNCTION
K23	63	24V DC
K102	69	Overvoltage
K103	60	Phase Sequence
K106	82	Synch Check
K111	78	Undervoltage
K112	67	Reverse Power
K113	71	Short Circuit
K114	62	Overload

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER CIRCUIT BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTACLE).

a. 24V DC Relay K23 (63, figure 5-1).

(1) Test relay K23 by connecting 24V DC and a single-pole single-throw switch as shown in figure 5-6.

(a) Close SPST switch. With an ohmmeter, check for an open circuit between terminals 1 and 2 and terminals 13 and 14. Meter should indicate continuity between terminals 3 and 4, terminals 5 and 6, and terminals 11 and 12.

(b) Open SPST switch. With the ohmmeter, check for continuity between terminals 1 and 2 and terminals 13 and 14. Meter should indicate an open circuit between terminals 3 and 4, terminals 5 and 6, and terminals 11 and 12. If relays fail this check, replace in accordance with (2), below.

(2) Replacement. Relay K23 is a plug-in type relay mounted in a socket on the box assembly panel at the base of the control cubicle. To remove,

close locking device (under relay socket) and lift relay out of socket. To replace, plug in snugly, until locking device is firmly in place.

b. Overvoltage Relay K102 (69, figure 5-1).

(1) Test. To test relay K102, connect relay as shown in test setup figure 5-7.

(a) Connect a variable 0 to 160V AC source and variable frequency (50 to 60 Hz) source to! terminals 1 and 2 with switch S1 in series.

(b) Connect lamps DS1 and DS2, switch S2, and a 24V DC supply as shown in figure 5-7.

(c) Close S1 and S2. Set voltage to 120 volts on terminals 1 and 2 and vary the frequency from 50 to 60 Hz. DS1 shall stay lit and DS2 shall remain extinguished.

(d) Slowly increase the voltage to 140 volts. Vary the frequency from 50 to 60 Hz. DS1 shall stay lit and DS2 shall remain extinguished.

(e) Slowly increase the voltage to 154 volts. Vary the frequency from 50 to 60 Hz. DS1 shall stay lit and DS2 shall remain extinguished.

(f) After each light transfer, remove AC power to clear the

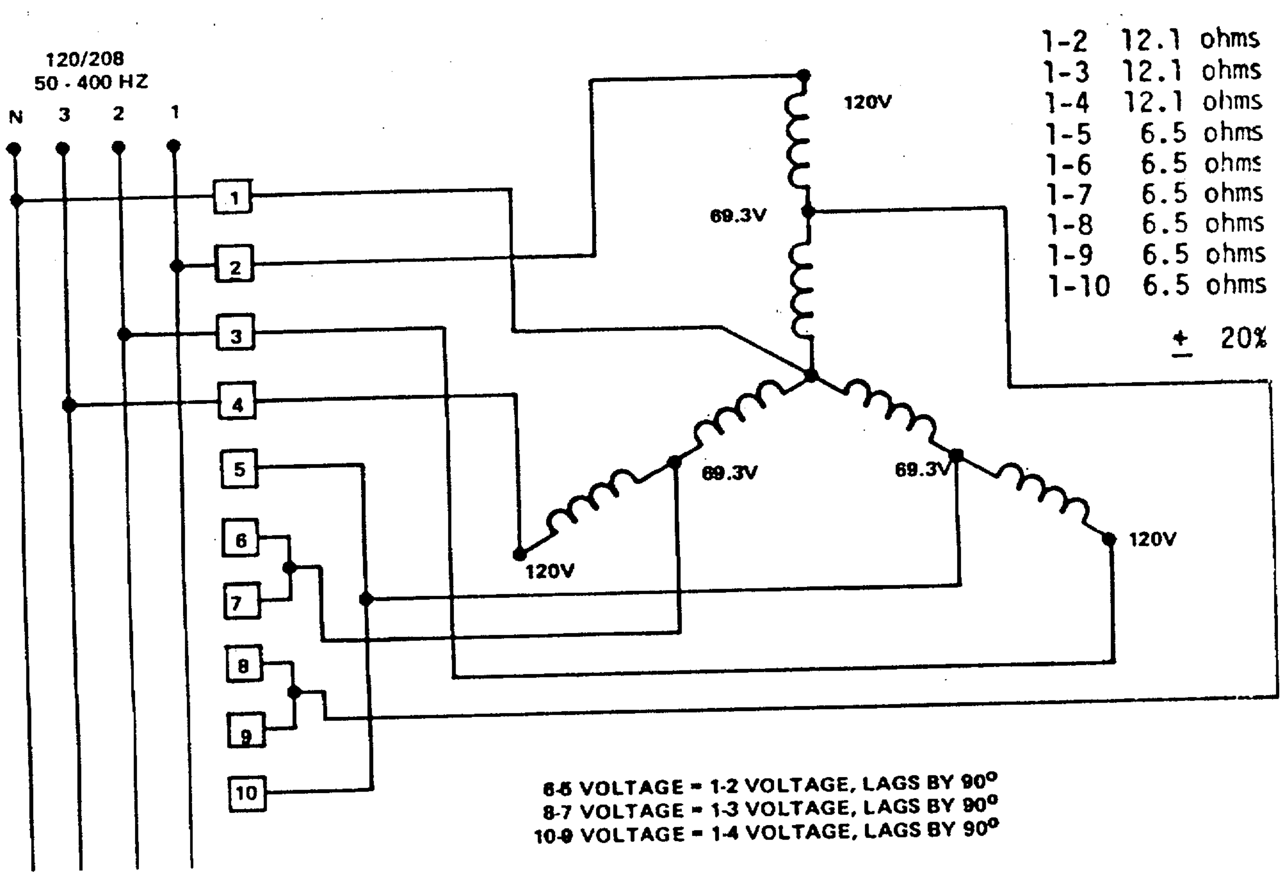


Figure 5-5. Transformer T103, Schematic

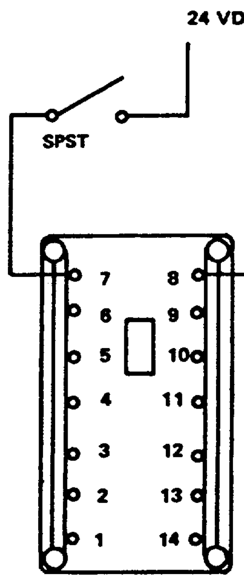


Figure 5-6. Relay K23, Test Setup

relay. Set the frequency at 50 Hz and increase the voltage to 156 volts. DS1 shall extinguish and DS2 shall light. Repeat for the same voltage.

NOTE

Disconnect relay from test setup.

(g) Using an ohmmeter, set on high scale, connect one lead to the relay case and the other lead to relay terminals one at a time. Meter should read no continuity. Similarly, connect ohmmeter between terminal 1 and 3, 4, 5, and terminal 1 and 6, 7, 8. There should be no meter reading.

(2) Replacement. Remove (69, figure 5-1, sheet 2) by disconnecting and tagging wires and removing four screws (68)

c. Phase Sequence Relays K103 (60, Figure 5-1).

(1) Test. To test relays K103, connect as shown in test setup, figure 5-8. This relay operates on 190-520 volt, 3-phase, 60 Hz. When incorrect phase sequence A, C, B (figure 5-8), is applied the relay will energize until power is removed. Ohmmeter connected to terminals 4 and 5 will indicate continuity at this point until the correct phase sequence is applied, then an open circuit will appear at terminals 4 and 5.

(2) Replacement. Remove relay (60, figure 5-1, sheet 2) by disconnecting and tagging wires and removing four screws (59).

d. Sync Check Relay K106 (82 Figure 5-1).

(1) Test. To test relay K106, connect as shown in test setup, figure 5-9. Two separate 115V AC sources are required: (1) a fixed frequency 115V AC 50/60 HZ source, and (2) a variable frequency 115V AC source. Two lamps connected in parallel across the two sources are also required. When the lamps turn off together, the 115V AC sources are synchronized. The ohmmeter must show continuity, indicating that the relay contacts are closed. Perform this test at both 50 and 60 HZ frequencies. If lights fail to turn off together while variable frequency source is within tolerance (47.5 to 52.5 Hz for 50 Hz test, 57.5 to 62.5 Hz for 60 Hz test), K106 is defective and must be replaced.

(2) Replacement. Remove relay (82 figure 5-1, sheet 2) by disconnecting and tagging wires and removing four screws (81).

e. Undervoltage Relay K111 (78, figure 5-1).

(1) Test. To test undervoltage relay K111, connect relay as shown in test setup figure 5-10.

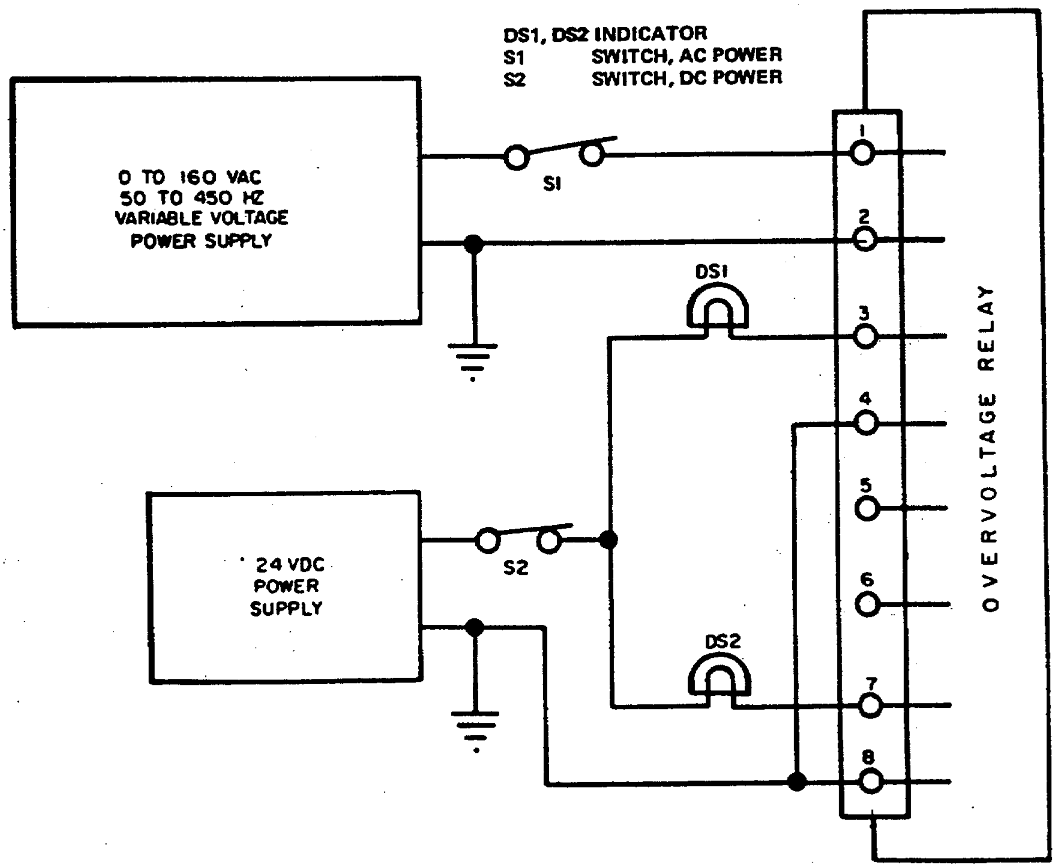


Figure 5-7. Overvoltage Relay K102, Test Setup

(a) Connect a variable 0 to 160V AC source and variable frequency (50 to 60 Hz) source to terminals 1 and 2 with switch S1 in series.

(b) Connect lamp DS1 and 24V DC power supply in series with switch S2 to terminals 3 and 4, also with terminals 7 and 8 (DS2).

(c) Adjust AC power supply to 120 volts, 60 Hz. With S1 and S2 closed, lamp DS1 shall extinguish and DS2 shall light.

(d) Reduce voltage slowly to 104 volts and hold for 2 minutes. Lamp DS1 and DS2 shall maintain states.

(e) Reduce voltage to 99 volts. DS1 and DS2 shall transfer states within 4 to 8 seconds.

(f) Increase voltage slowly to 113 volts. Lamps DS1 and DS2 shall transfer states.

(g) Reduce voltage to 48 volts. Transfer of states of DS1 and DS2 shall be instantaneous.

(h) Reduce frequency to 50 Hz and repeat the procedures in steps (c) through (h) with the same results.

(2) Replacement. Remove relay (78, figure 5-1, sheet 2) by disconnecting and tagging wires and removing four screws (77).

f. Reverse Power Sensing Relay K112 (67, figure 5-1).

NOTE

Check relay K112 fuse prior to performing the following tests.

(1) Polarity and Reverse Power Circuit Test.

NOTE

Ensure that the adjusting potentiometer is set fully clockwise before starting this test.

(a) Connect a 0 to 1.2 amp, 0.05V AC maximum, power source to terminals 1 and 2 (see figure 5-11). Connect a 115V AC, 60 Hz source to terminals 6 and 7. Connect an ohmmeter to terminals 4 and 5.

(b) Adjust the 0.05V AC power source (terminals 1 and 2) to 1 amp.

(c) Turn the adjusting potentiometer fully counterclockwise.

(d) If the contact between terminals 3 and 5 closes, then the polarity is incorrect and the wires on terminals 6 and 7 must be reversed, and the test must be started over.

(e) Push the Press-to-test Button. The contact between terminals 3 and 5 must close at this time.

(2) Inverse Time Trip Curves Test.

(a) Set the current source

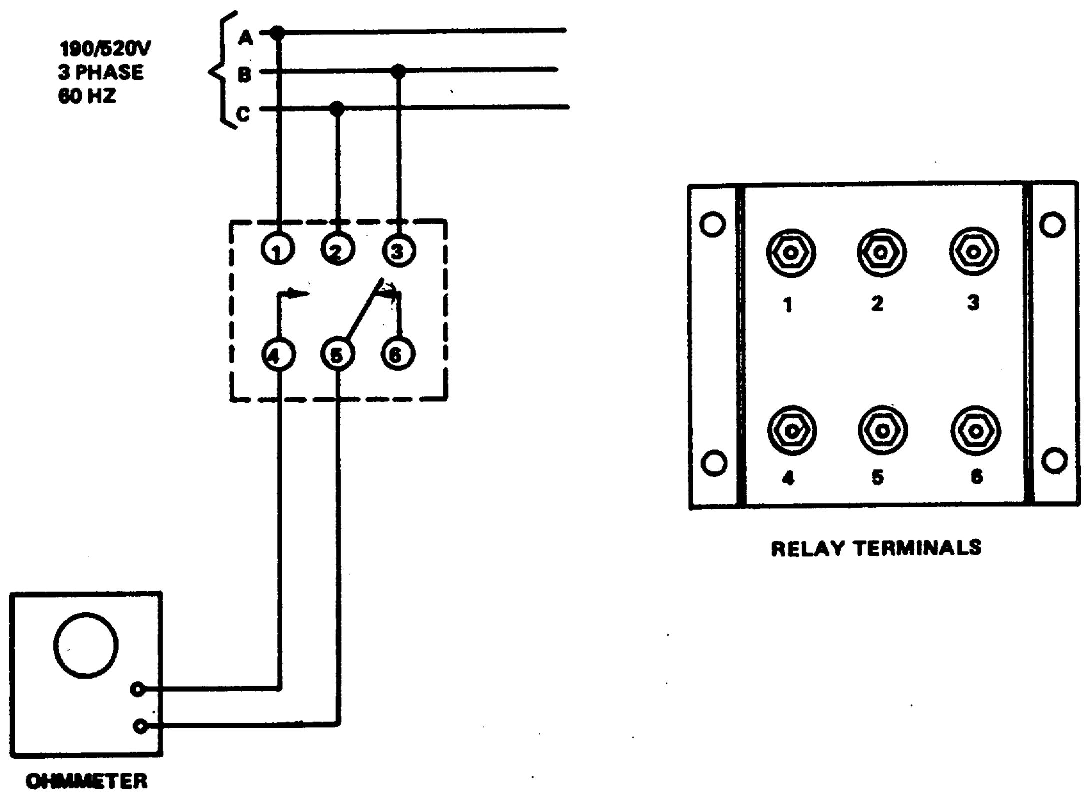


Figure 5-8. Phase Sequence Relay K103, Test Setup

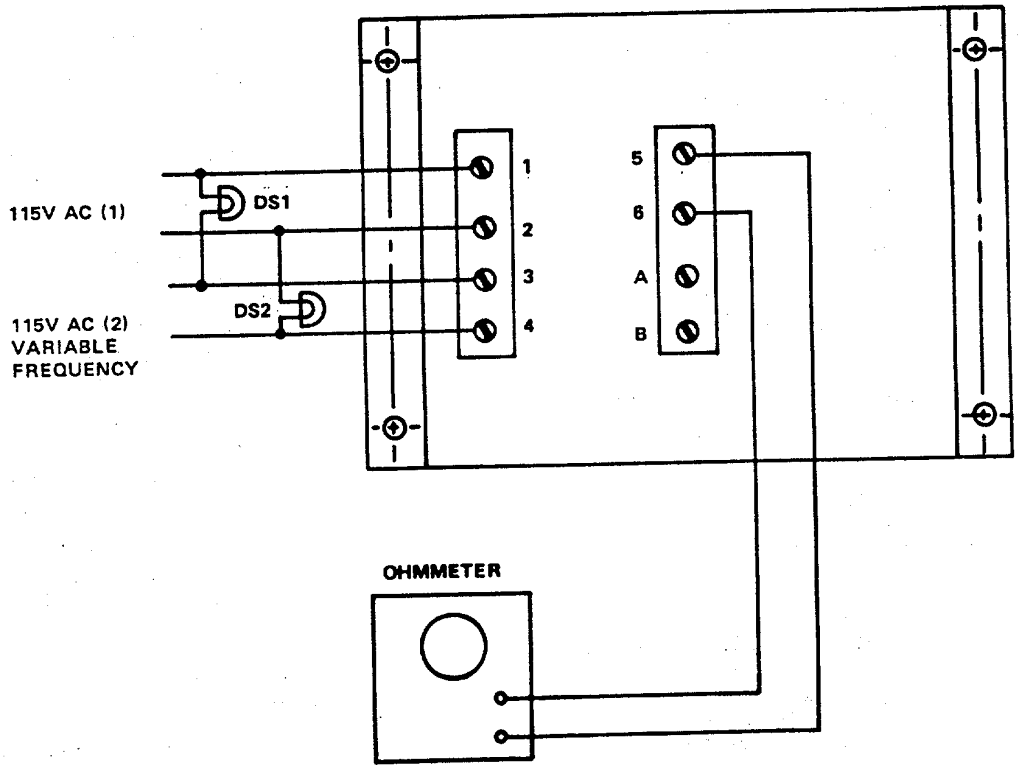


Figure 5-9. Sync Check Relay K106, Test Setup

on terminals 1 and 2 to 0.05 amp.

(b) Turn the adjusting potentiometer fully clockwise.

(c) Push the Press-to-test Button.

(d) Turn the adjusting potentiometer slowly counterclockwise until the contact between terminals 3 and 5 closes. Stop at that point and release the Press-to-test Button.

(e) Wait 15 seconds and push the Press-to-test Button. The contact between terminals 3 and 5 must close after an interval of approximately 4 to 5 seconds.

(3) Replacement. Remove relay (67, figure 5-1, sheet 2) by disconnecting and tagging wires and removing four screws (66).

g. <u>Short Circuit Relay K113 (71, figure 5-1).</u>

(1) <u>Test</u>.

(a) Connect the relay in the test setup shown in figure 5-12.

(b) Connect a lamp and a 24V DC power supply in series with terminals 5 and 6 (DS1), also with terminals 7 and 8 (DS2) and switch S3. Relay trip will be indicated by the two lamps: DS1 shall extinguish; DS2 shall light.

(c) Connect a variable 0 to 120V AC source (50 to 60 Hz) between terminals 1 and 4 and slowly increase the voltage. The relay shall transfer lights when voltage equals 24 volts ± volt.

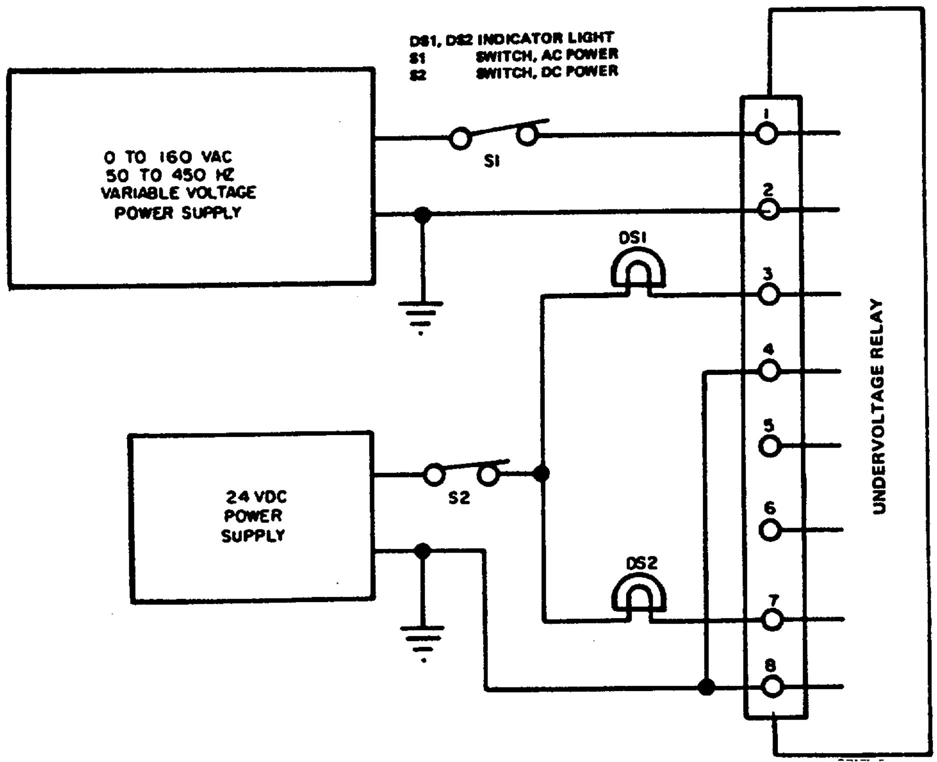


Figure 5-10. Undervoltage Relay K111, Test Setup.

Repeat the test with the input connected to 2 and 4, and then again, between 3 and 4 by rotating switch S2. The trip points should be within 1 volt of each other.

NOTE

Disconnect relay from test setup.

(d) With an ohmmeter, check that terminals 5, 6, 7, and 8, and terminals 1, 2, 3, and 4 are electrically isolated with the relay in either position.

(2) Replacement. Remove relay (71, figure 5-1, sheet 2) by disconnecting and tagging wires, and removing four screws (70).

h. Overload Relay K114 (62, figure 5-1)

(1) Test

(a) Connect the relay in the test setup shown in figure 5-13.

(b) With the 120/208V AC power source energized, turn on the 24V DC power and close switch S1. Lamp DS1 shall light and DS2 shall be extinguished.

(c) Adjust autotransformer T1, T2, and T3 until ammeters A1, A2, and A3 indicate 0.75 ampere. DS1 and DS2 shall not change states.

(d) Adjust autotransformer T1 until ammeter A1 indicates 0.975 ampere. After 8 ± 2 minutes, DS1 and DS2 must transfer states, if not, replace.

(e) Repeat step (d) for auto-transformers T2 and T3. The test shall be the same as for T1.

(2) Replacement. Remove relay (62, figure 5-1, sheet 2) by disconnecting and tagging wires and removing two screws (61).

i. Time delay TD2 (87, figure 5-1).

(1) Tests for Replacement Components. Check the following components on TD 2, figure 5-14.

(a) Check transistor Q1 by connecting to transistor tester and testing for current gain or 100 min, leakage, or short.

(b) Check capacitors C1 and C2 by connecting each to a capacitor tester and checking for leakage and capacitance. C1 must read 10 microfarads, 25 volts, ±5 percent. C2 must read 47 microfarads, 50 volts, ±10 percent.

(c) Check resistors, using an ohmmeter, for the following resistances.

R4 820 ohms, 25 watts, ±5 percent
R1 2 k megohms, 1 watt, ±5 percent
R2 2.7 megohms, 25 watts, ±5 percent
R3 390 k, 0.25 watt, ±5 percent

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER CIRCUIT BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTACLE).

(2) Test of TD2.

(a) Connect time delay circuit as shown in figure 5-14.

(b) Close switch S1. Time the period it takes before lamp DS1 lights. It must be 3.5 to 4.5 seconds or TD is defective.

(3) Repair. If any of the replaceable components tested in 1 (above) are defective, TD2 is repairable by replacing the defective component. If the printed circuit wiring or a terminal

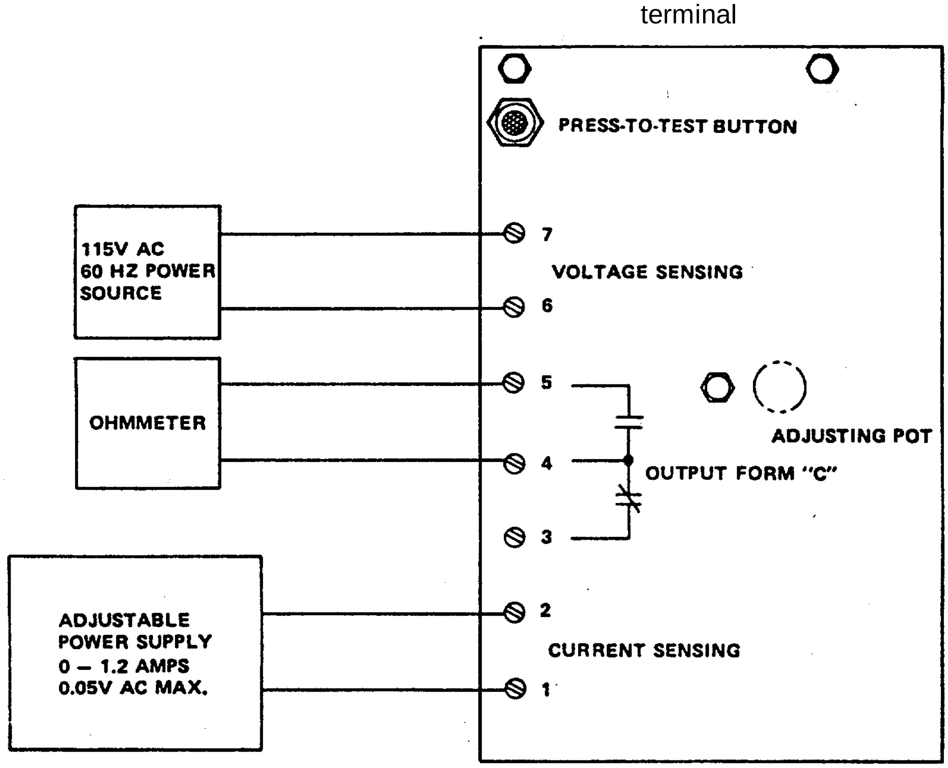


Figure 5-11. Reverse Power Relay K112, Test Setup

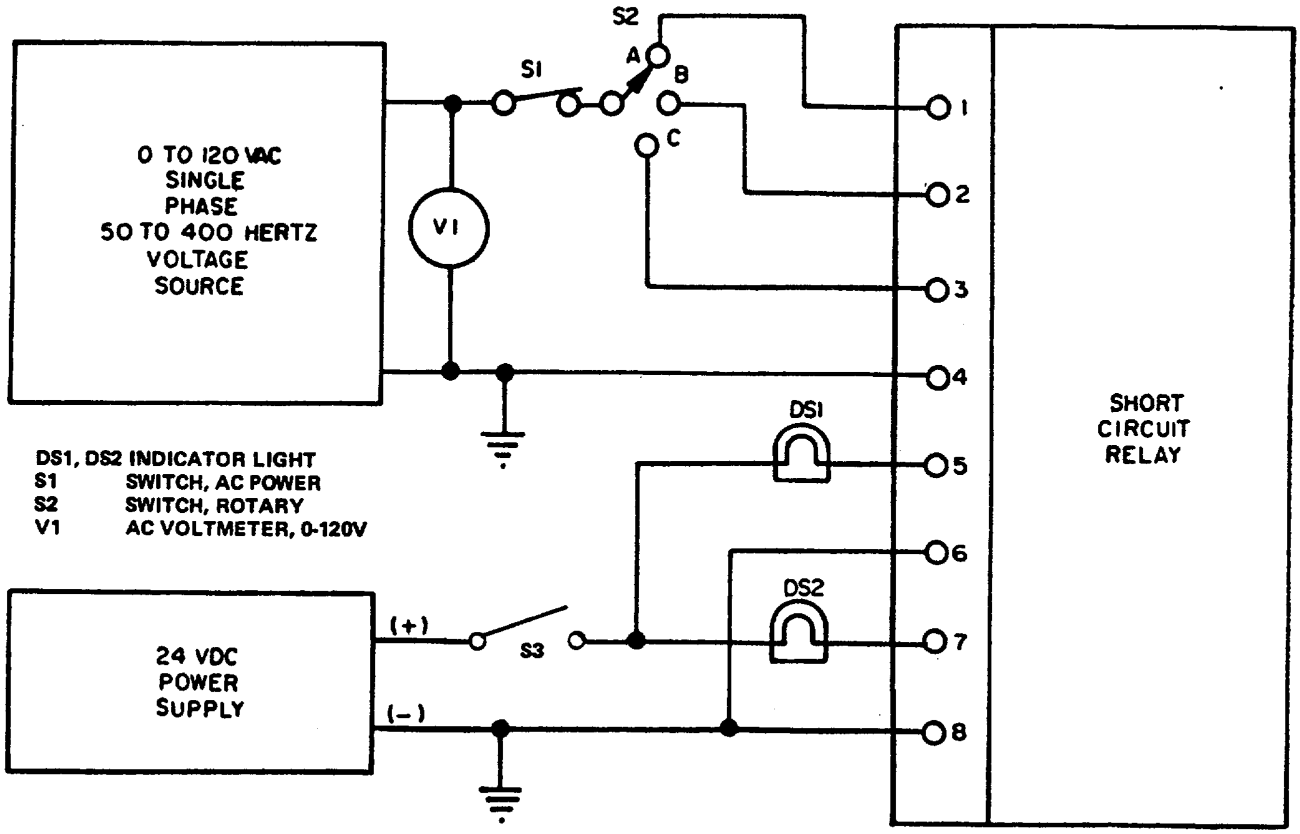


Figure 5-12. Short Circuit Relay K113, Test Setup

board, or a non-replaceable component, proves defective (test 2, above), the entire assembly must be replaced.

(4) Replacement.

(a) Tag and disconnect wires to TD2 (87, figure 5-1).

(b) Remove screws (83) to remove assembly (87) with brackets (84).

(c) Individual components are replaced by carefully unsoldering them from the printed circuit board.

(2) Test of TD2.

(a) Connect time delay circuit as shown in figure 5-14.

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER CIRCUIT BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTACLE).

(b) Close switch S1. Time the period it takes before lamp DS1 lights. It must be 3.5 to 4.5 seconds or TD is defective.

(3) Repair. If any of the replaceable components tested in 1 (above) are defective, TD2 is repairable by replacing the defective component. If the printed circuit wiring or a terminal board, or

a non-replaceable component, proves defective (test 2, above), the entire assembly must be replaced.

(4) Replacement.

(a) Tag and disconnect wires to TD2 (87, figure 5-1).

(b) Remove screws (83) to remove assembly (87) with brackets (84).

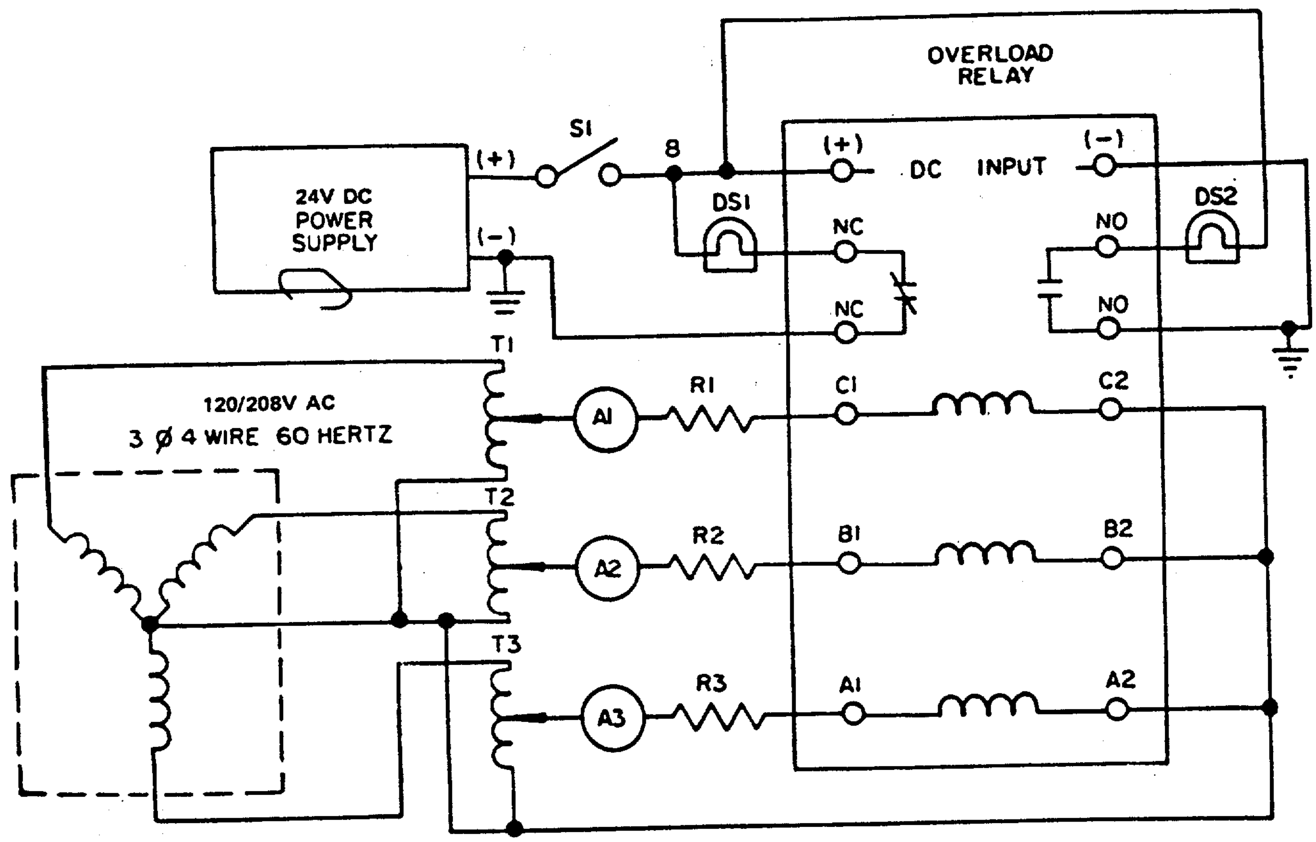
(c) Individual components are replaced by carefully unsoldering them from the printed circuit board.

CAUTION

Do not apply excessive heat when soldering or unsoldering components. It may damage the printed circuit wiring.

(d) If TD2 is to be replaced as an assembly, remove screws (85) and nuts (86) to release time delay assembly (87) from brackets (84).

(e) Prepare TD2 assembly (87) for installation by attaching brackets (84) using screws (85) and nuts (86).



DS1, DS2	INDICATOR LIGHT
R1, R2, R3	RESISTOR, FIXED, 7.5 OHMS
S1	SWITCH, DC POWER
T1, T2, T3	3 PHASE VARIAC
A1, A2, A3	AMMETERS

Figure 5-13. Overload Relay K114, Test Setup

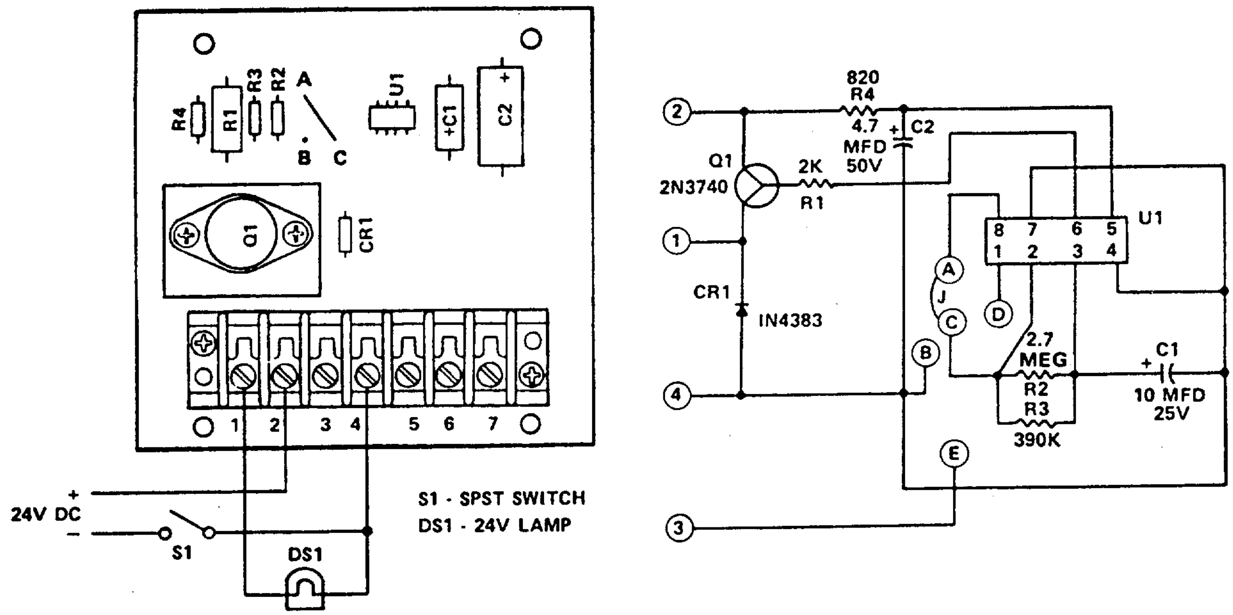


Figure 5-14. Time Delay TD2, Test Setup

(f) If components are to be replaced, carefully solder new component into place.

(g) Install time delay assembly (87) by securing brackets (84) using screws (83).

(h) Connect wires to terminal boards, then remove wire tags.

j. Control Relay Assembly TB10 (92 figure 5-1)

(1) Test.

(a) Connect control relay assembly as shown in figure 5-15.

(b) Close switch S1. With ohmmeter (Rx1 scale) check for continuity between terminals 1 and 5, and terminals 2 and 4. If ohmmeter shows no continuity, TB10 is defective and must be replaced.

(c) Open switch S1, close switch S2. With the ohmmeter, check for continuity between terminals 7 and 9. If ohm meter shows no continuity, TB10 is defective and must be replaced.

(2) Replacement.

(a) Tag and disconnect lead wires to TB10 (92, figure 5-1).

(b) Remove assembly (92) by removing screws (88).

(c) Release assembly (92) from brackets (89) by removing screws (90) and nuts (91).

(d) Prepare new TB10 assembly for installation by attaching brackets (89) using screws (90) and nuts (91).

(e) Install TB10 (92) using screws (88).

(f) Connect lead wires and remove wire tags.

5-5. RESISTOR ASSEMBLY TB 107. The resistor assembly TB107 (detail C, figure 5-1, sheet 2) is mounted to the left inside wall of the enclosure.

a. Test. Test by disconnecting one lead from each resistor. With an ohmmeter, check each resistor for 7.5 ohms ± 0.5 percent.

b. Replacement. Remove resistors by unsoldering leads and removing from clips.

5-6. ANNUNCIATOR CONTROL ASSEMBLY TB6 (76, figure 5-1). The annunciator control relay assembly contains four terminal boards, 20 diodes, and 13 relays:

REF DES	FUNCTION
K25A	Alarm Silence
K25B	Alarm Silence
K26	Alarm Arming
K27	High Coolant Temperature
K28	High Oil Temperature
K29	Low Oil Pressure
K30	Low Fuel Level
K31	Overspeed
K32	Overvoltage
K33	Undervoltage
K34	Reverse Power
K35	Overload
K36	Short Circuit

a. Test.

(1) Check each relay using test circuits shown in figure 5-16. Energize each set of relay contacts individually by applying 24V DC directly to leads. Check for open or closed contacts (no continuity or continuity) as indicated in figure 5-16. Check that each set of contacts revert (to either closed or open position) when deenergized. If only relay fails to either open or close as indicated, it is defective and must be replaced.

(2) Check diodes for polarity. A good diode will read high resistance one way and low resistance the other way. A defective diode will read full scale both ways, or will read infinity (no reading) in either direction.

(3) Check terminal boards and printed circuit wiring by repeating steps (1) and (2), but apply 24V DC to TB6 terminals.

b. Repair. If any of the relays or diodes are defective, Annunciator Control Relay Assembly TB6 is repairable by replacing the defective

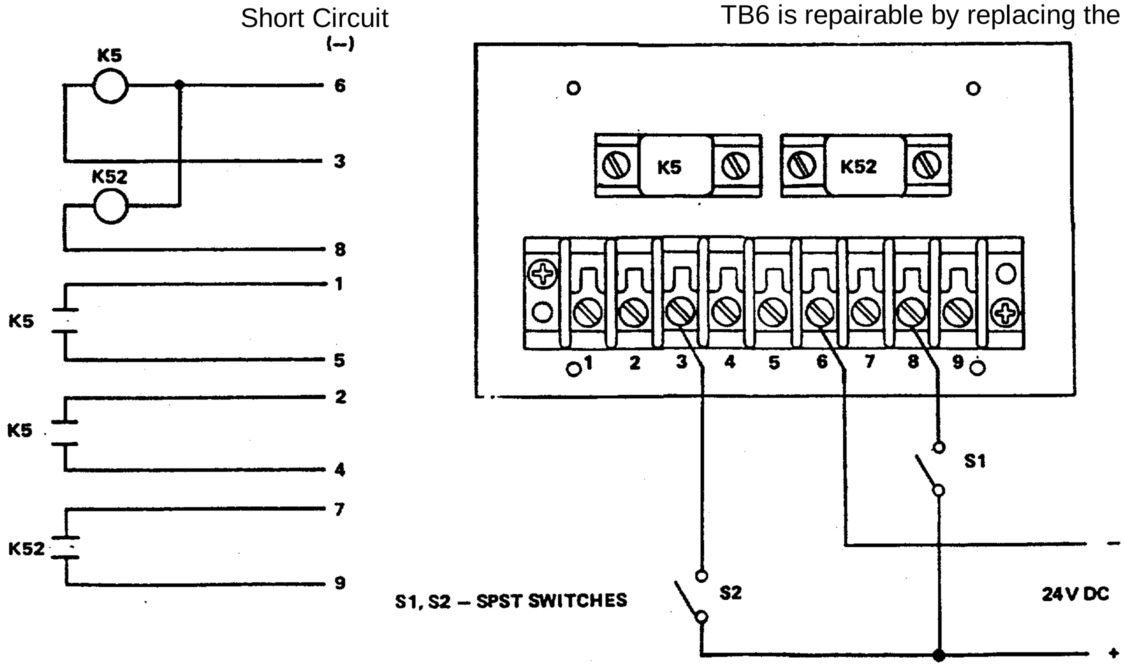
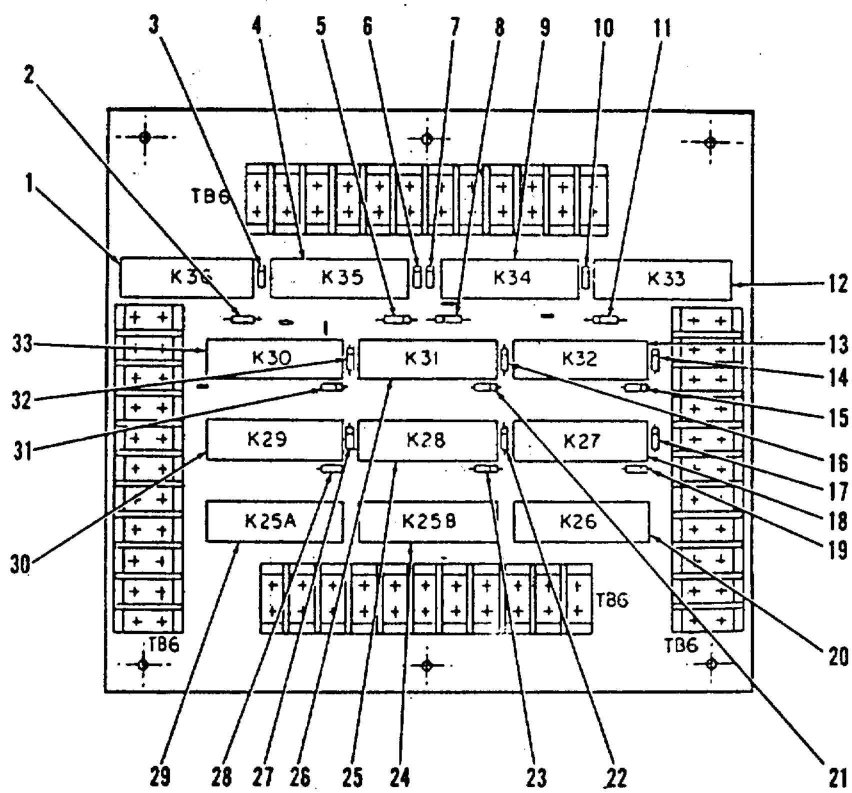


Figure 5-15. Control Relay Assembly TB10, Test Setup



LEGEND FOR 5-16

1. Relay K36
2. Diode CR21
3. Diode CR22
4. Relay K35
5. Diode CR19
6. Diode CR20
7. Diode CR18
8. Diode CR17
9. Relay K34
10. Diode CR16
11. Diode CR15
12. Relay K33
13. Relay K32
14. Diode CR14
15. Diode CR13
16. Diode CR12
17. Diode CR4
18. Relay K27
19. Diode CR3
20. Relay K26
21. Diode CR11
22. Diode CR6
23. Diode CR5
24. Relay K25B
25. Relay K28
26. Relay K31
27. Diode CR8
28. Diode CR7
29. Relay K25A
30. Relay K29
31. Diode CR9
32. Diode CR10
33. Relay K30

TYPICAL TEST CIRCUIT

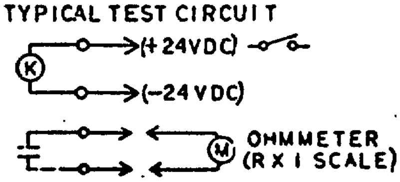
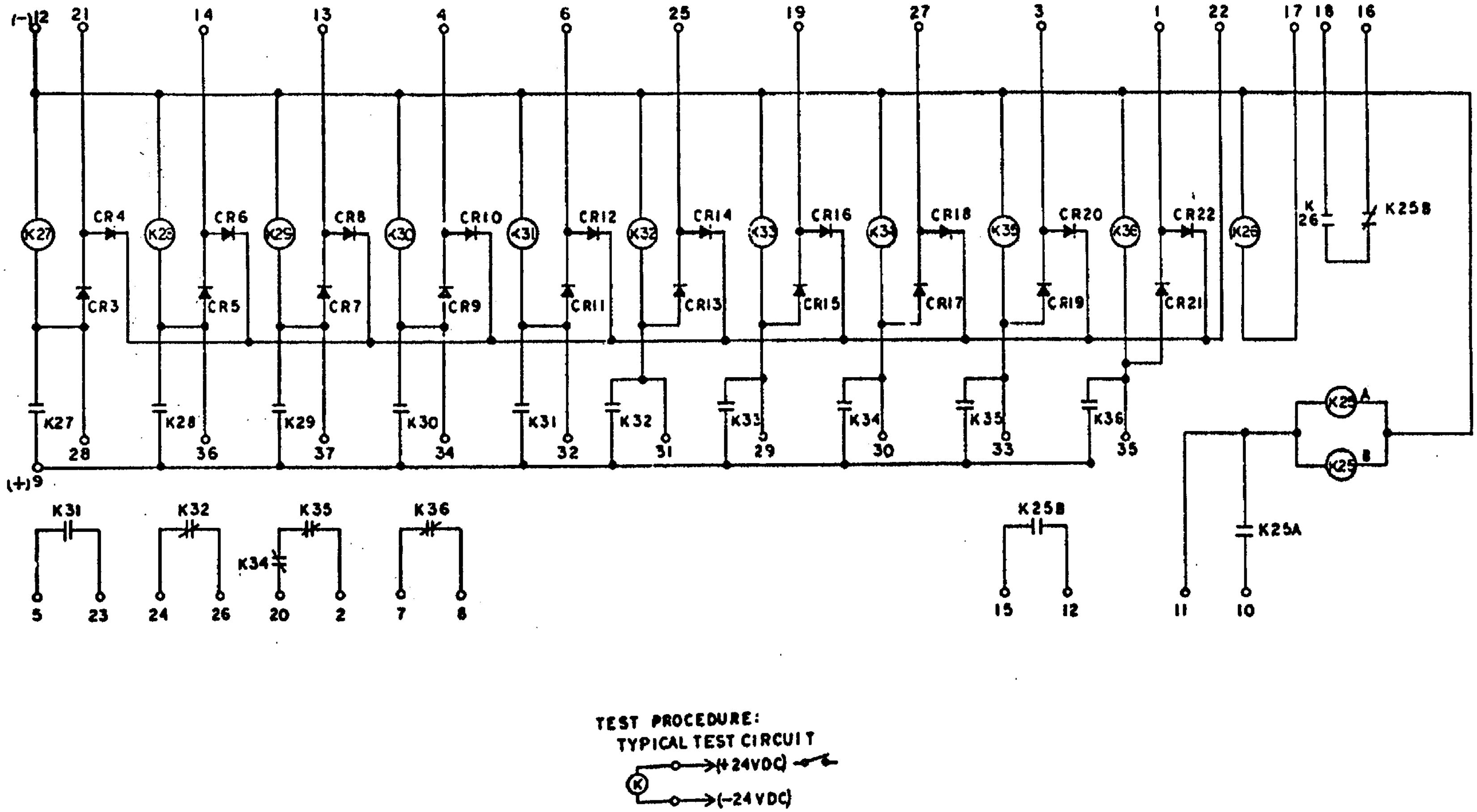


Figure 5-16. Annunciator Control Assembly, TB6 (Sheet 1 of 2)



5-16. Annunciator Control Assembly, TB6 (Sheet 2 of 2)

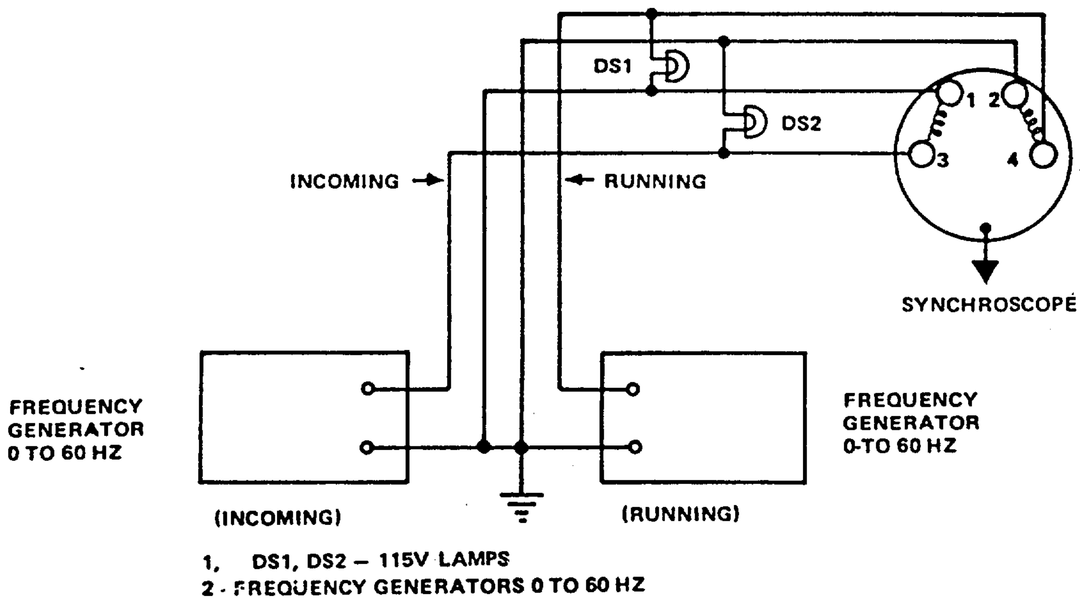


Figure 5-17. Synchroscope, Test Setup

component. If the printed circuit wiring or a terminal board proves defective, or a nonreplaceable component is defective, the entire assembly must be replaced.

c. Replacement.

(1) Remove relay assembly (76, figure 5-1) as follows:

(a) Tag and then disconnect wires from terminal boards.

(b) Remove screws (72) to remove relay assembly (76) and brackets (73).

(c) Components are replaced by carefully unsoldering them from the printed circuit board.

CAUTION

Do not apply excessive heat when soldering or unsoldering components. It may damage the printed circuit wiring.

(d) If Annunciator Control Relay Assembly is to be replaced; remove screws (74) and nuts (75) to release relay assembly (76) from brackets (73).

(e) Prepare relay assembly (76) for installation by attaching brackets (73) using screws (74) and nuts (75).

(f) If components are being replaced, carefully solder new component into place.

(g) Install relay assembly (76) by securing brackets (73) using screws (72).

(h) Connect wires to terminal boards, then remove wire tags.

5-7. FLASHING CIRCUIT FC1. The flasher (20, figure 5-1, sheet 1) is mounted on the inside right wall of the enclosure and plugs into a terminal block assembly (21). Remove flasher and check by connecting it in series with a 24V DC power source and test lamp. If the flasher is good, the test lamp should flash. If not, replace by plugging new flasher into place.

5-8. SYNCHROSCOPE.

a. Inspection. Inspect the synchroscope (114, figure 5-1) for loose electrical connections and damaged or scratched glass.

b. Testing.

(1) Connect the synchroscope as shown in figure 5-17 test setup. Frequency generators used should be capable of providing minimum 50 volts, maximum 240 volts. Frequency 0 to 60 Hz. For testing the pull-in frequency is 48 Hz, the drop-out frequency is 47 Hz.

(2) The synchroscope axial polarizing coils are energized from the 'incoming' frequency, while the radial field coils are connected to the 'running' circuit. If there is no difference between the two circuits either in phase angle or frequency, the pointer will remain motionless at the 12 o'clock position on the dial. With no frequency difference, any phase angle difference will cause the pointer to take up a position away from this point. If, however, there is a difference in frequency, this phase relationship will be constantly changing and the pointer will consequently rotate continuously in one direction or the other at a speed corresponding to the difference in frequency. If incoming' is at a higher speed than the 'running', the pointer rotates clockwise, and counterclockwise if its speed is lower.

(3) When the lamps turn off together, the two sources are synchronized. When the 'incoming' frequency has been adjusted to equal that of the 'running' frequency, the pointer will come to rest at a point on the scale depending on the phase displacement of the two voltages. The speed of the 'incoming' must then be inched up or down until the pointer takes a steady position at 12 o'clock.

c. Replacement. To remove the synchroscope from the generator panel, tag and disconnect wires, and remove attaching hardware. Replace in generator panel with attaching hardware and reconnect wires. Remove tags from wires.

5-9. RESISTOR AND DIODES. Resistor (26, figure 5-1, sheet 1) and diodes (25) are all mounted on terminal boards (24) on the rear wall of the enclosure. They are removed by unscrewing them from their terminals on terminal boards.

a. Test resistor (26) by measuring with an ohmmeter. It should be 39,000 ohms ±5 percent.

b. Test diodes as follows:

(1) Disconnect one end of the diode.

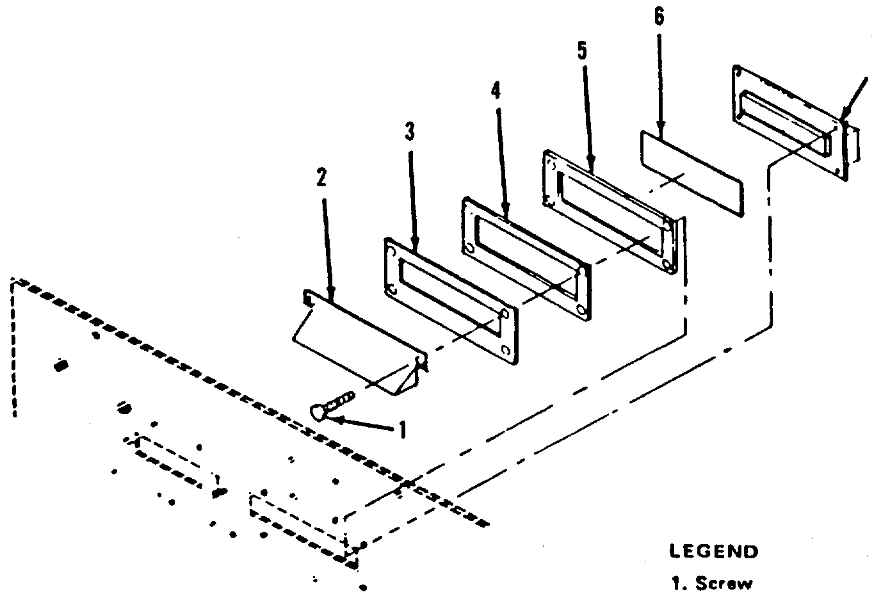
(2) Connect an ohmmeter (scale. set Rx100) across the diode, note the reading. Now reverse ohmmeter leads to the diode, and again note reading. A good diode will read high resistance one way and low resistance the other way. A shorted diode will read full scale both ways. An open diode will read infinity (no reading) in either direction. Check all diodes and replace disconnected leads.

5-10. DIGITAL CLOCK.

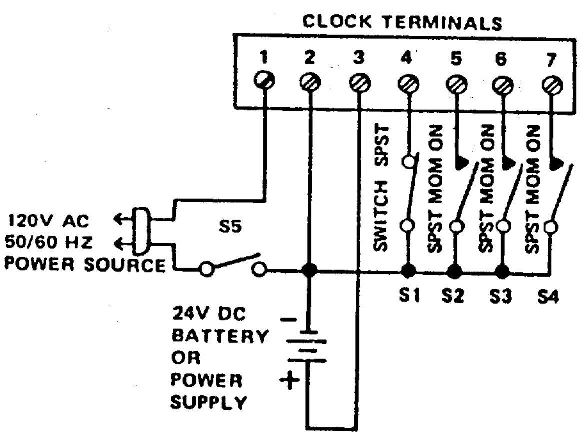
a. Testing.

(1) Connect clock in test setup shown in figure 5-18.

(2) Close switch S1 to test 60



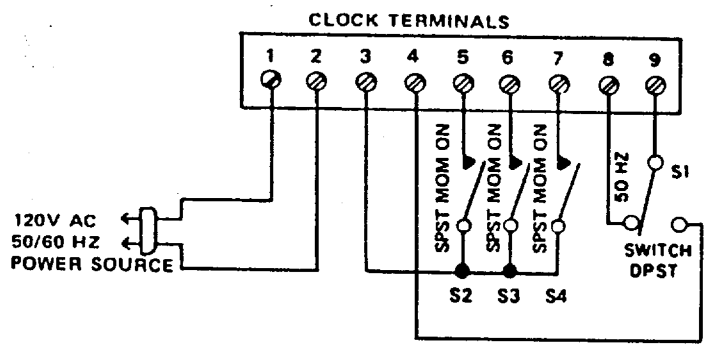
LEGEND
1. Screw
2. Shield
3. Plate
4. Plate
5. Gasket
6. Light control film
7. Digital clock



S1 SELECT 50/60 HZ CLOSE FOR 60 HZ
S2 ADVANCE HOURS @ 1/SECOND
S3 ADVANCE MINUTES @ 1/SECOND
S4 HOLD TIME/SECONDS ADJUST
S5 SPST SWITCH

TEST SETUP

CODE A



S1 SELECT 50/60 HZ
S2 ADVANCE HOURS @ 1/SECOND
S3 ADVANCE MINUTES @ 1/SECOND
S4 HOLD TIME/SECONDS ADJUST

TEST SETUP

CODE B

Figure 5-18. Digital Clock, M111

Hz operation.

(3) Close switch S5 (Code "A" only).

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER CIRCUIT BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTACLE).

(4) Observe display. Numerals must be illuminated and clock seconds must advance or clock M111 is defective and must be replaced. Open switch S5 (Code "A" only).

(5) Open switch S1 to test 50 Hz operation (Code "A" only) Place S1 to 60 cycle operation for Code "B".

(6) Close switch S5 (Code "A" only).

(7) Observe display. Numerals must be illuminated and clock seconds must advance or clock M111 is defective and must be replaced. Open switch S5 (Code "A" only).

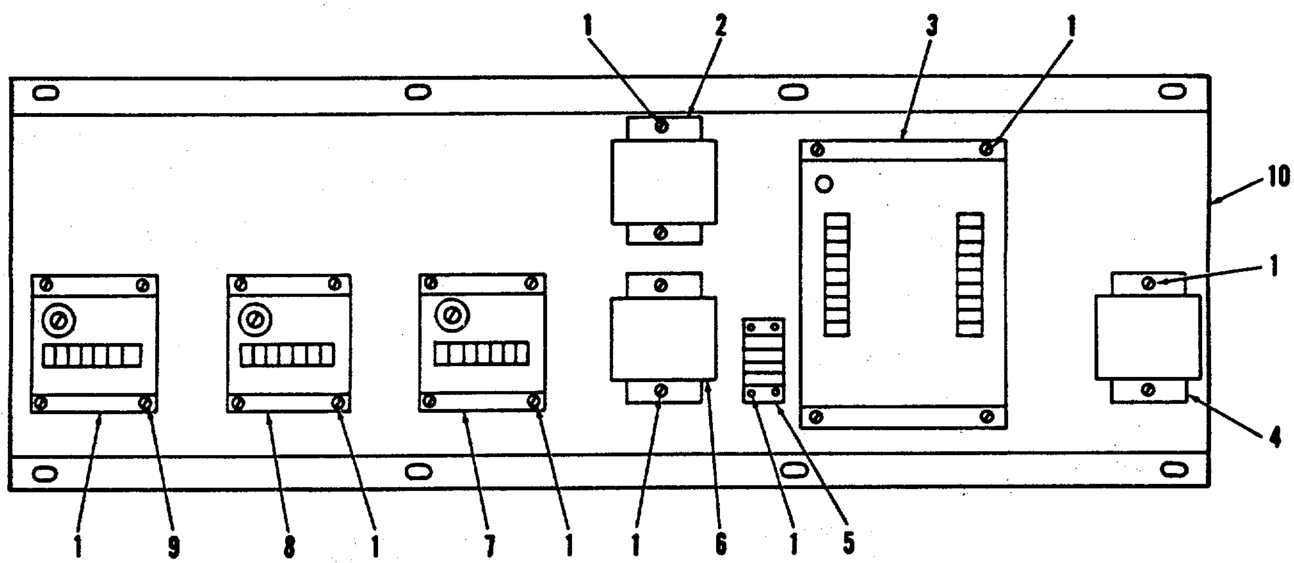
b. Replacement.

(1) Tag and disconnect all wires to the digital clock.

(2) Loosen screw (1) and carefully remove the clock (7) from the rear of the generator panel.

(3) Remove screw (1) to remove the shield (2), plates (3 and 4), gasket (5), and light control film (6) from the front of the generator panel.

(4) Position shield (2), plates (3 and 4), gasket (5), and



LEGEND

1. Screw
2. BCR relay
3. Synch relay
4. BTR relay
5. Terminal block
6. CR relay
7. Over/under voltage relay
8. Overfrequency relay
9. Underfrequency relay
10. Mounting plate

Figure 5-19. Control Cubicle, Relay Panel

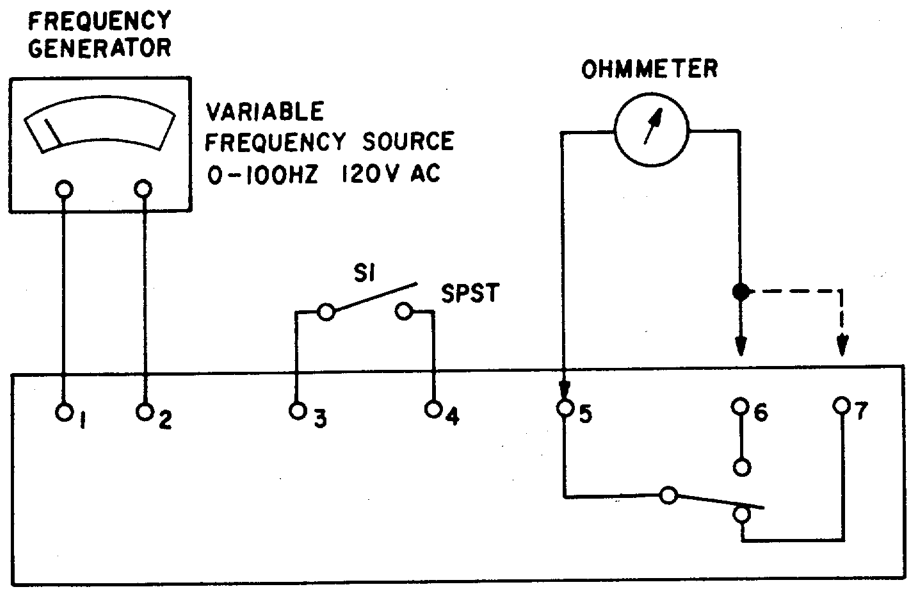


Figure 5-20. Under and Overfrequency Devices, Test Setup

light control film (6) on the front of the panel using screws (1).

(5) Mount the digital clock (7) using screws (1).

(6) Connect lead wires and remove tags.

5-11. ALARM HORN.

a. Removal. Remove alarm horn (18, figure 5-1) as follows:

WARNING

BEFORE STARTING ANY MAINTENANCE PROCEDURE, SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (EXTERNAL POWER CIRCUIT BREAKER) AND DISCONNECTING POWER CABLE FROM RECEPTACLE J101 (120V RECEPTACLE).

(1) Tag and disconnect wires to alarm horn.

(2) Remove horn (18) by removing screw (15), washer (16), and lockwasher (17).

b. Test. Connect 24V DC across terminals 1 and 2 of alarm horn. If horn does not sound, it is defective and should be replaced.

c. Installation.

(1) Install horn (18) using screw (15), washer (16), and lockwasher (17).

(2) Connect wires and remove tags.

5-12. RELAYS MOUNTED ON REAR PANEL OF CONTROL CUBICLE (54, figure 5-1).

a. Underfrequency relay 81GU (9, figure 5-19).

(1) Test the underfrequency relay by connecting as shown in figure 5-20.

(a) Switch S1 closed.

(b) Adjust variable frequency generator for 50 Hz output.

(c) With ohmmeter connected between terminals 5 and 7, adjust frequency generator to 48.5 Hz. Relay should trip as frequency is decreased. Ohmmeter will no longer show continuity.

(d) Open switch S1. Adjust frequency generator for 60 Hz output.

(e) Decrease frequency generator frequency to 58.2 Hz. With ohmmeter connected between terminals 5 and 6, relay should trip at 58.2 Hz (57.7 to 58.7 Hz), at which time ohmmeter will no longer show continuity.

(f) Turn adjustment screw clockwise to raise trip point.

(2) REPLACEMENT. Remove relay (9, figure 5-19) by disconnecting and tagging wires and removing four screws (1).

b. Overfrequency relay 81GO (8, figure 5-19).

(1) Test the overfrequency relay by connecting as shown in figure 5-20.

(a) Close switch S1.

(b) Adjust variable frequency generator for 50.0 Hz output.

(c) With ohmmeter connected between terminals 5 and 7, adjust frequency generator to 51.5 Hz (51 to 52). At this point, relay should trip. Ohmmeter will no longer show continuity.

(d) Open switch S1.

(e) Set frequency generator output to 60.0 Hz and connect ohmmeter between terminals 5 and 6. Ohmmeter should indicate continuity. Increase frequency generator output to 61.8 Hz: relay should trip at 61.8 Hz (61.3 to 62.3) and ohmmeter should indicate infinite ohms.

(f) Turn adjustment screw clockwise to raise trip point.

(2) REPLACEMENT. Remove relay (8, figure 5-19) by disconnecting and tagging wires and removing four screws (1).

c. Over/under voltage relay 27/59G (7, figure 5-19).

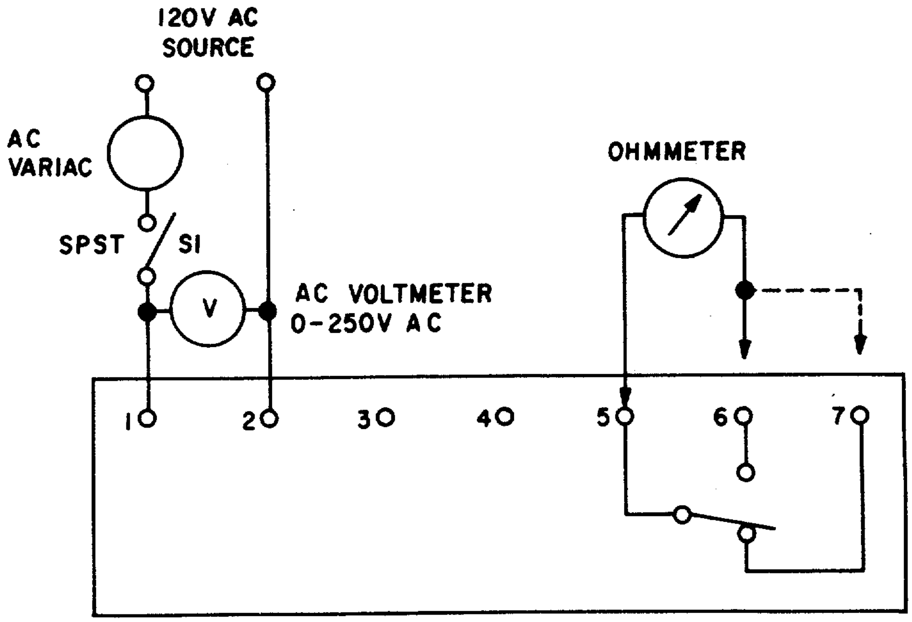


Figure 5-21. Over/under Voltage Device, Test Setup

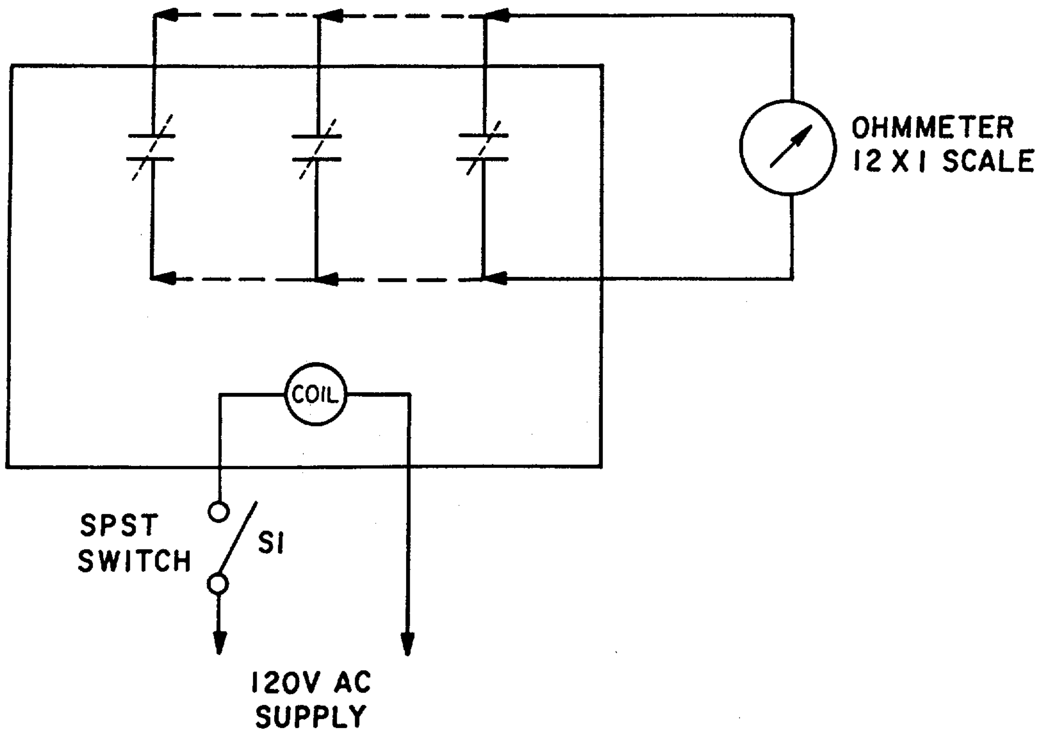


Figure 5-22. Relay Test Setup

(1) Test the relay by connecting as shown in figure 5-21.

(a) Close S1 and adjust variac for 110V AC as indicated by A.C. voltmeter.

(b) With ohmmeter connected between terminals 5 and 7, reduce AC voltage. Relay should trip at 108V AC. At this point, ohmmeter will no longer show continuity.

(c) With ohmmeter connected between terminals 5 and 6 adjust AC voltage source to read 130V AC on voltmeter.

(d) Increase voltage to 133V AC, relay should trip at 132V AC. Ohmmeter will no longer show continuity.

(2) REPLACEMENT. Remove relay (7, figure 5-19) by disconnecting and tagging wires and removing four screws (1).

d. RELAYS, BCR, CR AND BTR (2, 6, and 4, figure 5-19).

(1) Test any of the three relays by connecting as shown in figure 5-22.

(a) Close switch S1.

(b) Using the ohmmeter, verify that all normally open contacts have closed (zero resistance on meter) and all normally closed contacts have opened (infinite resistance on meter).

(2) REPLACEMENT. Remove relays (2, 6 or 4, figure 5-19) by disconnecting and tagging wires and removing two screws (1).

e. SRM, SYNCHRONIZING RELAY (3, figure 5-19)

(1) Test the SRM relay by connecting as shown in figure 5-23, synchronizing test.

(a) With 115V AC supplied, contacts 9 and 10 shall close causing ohmmeter to read zero ohms resistance.

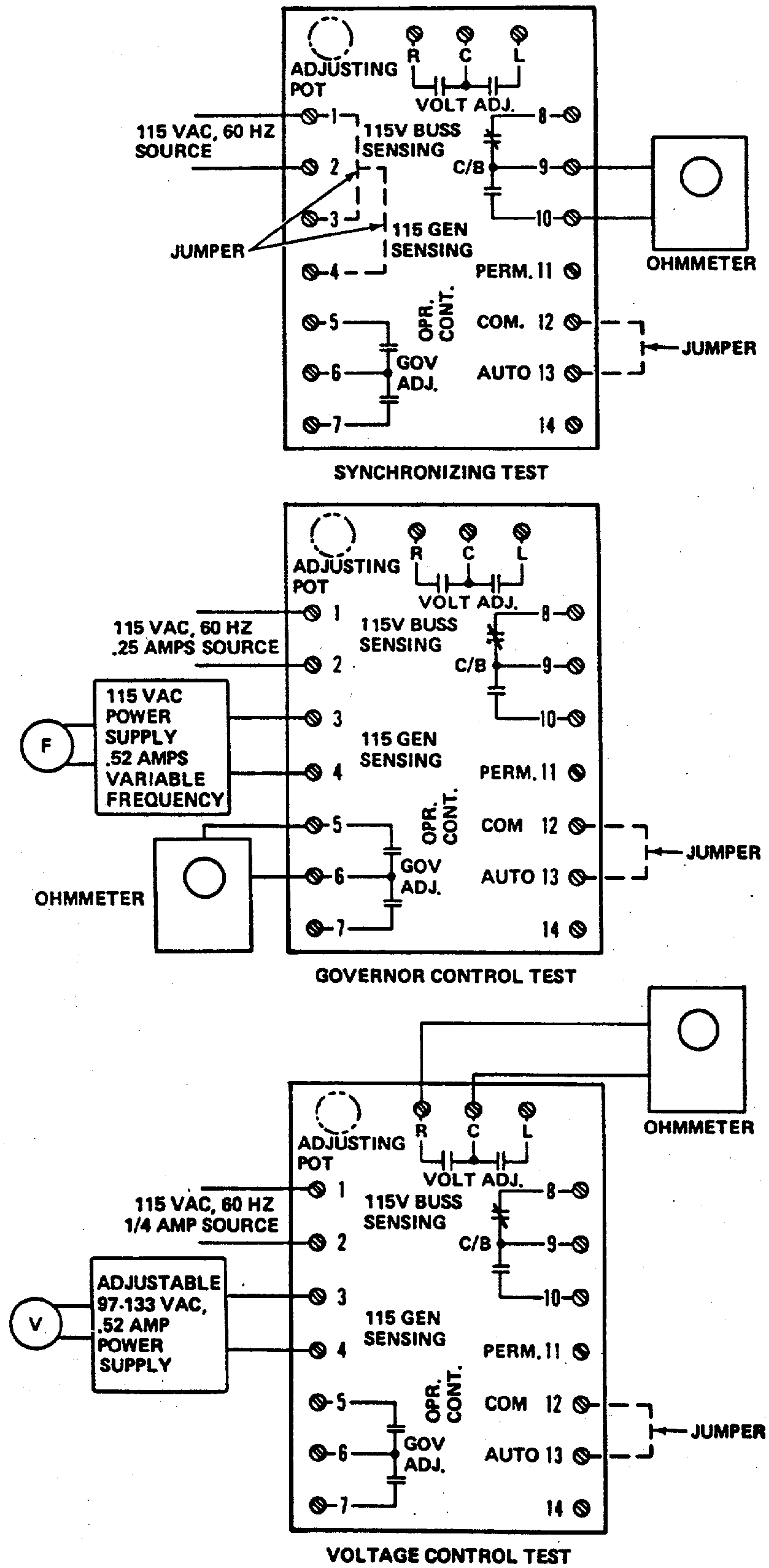


Figure 5-23. Synchronizer, Test Setup

(2) Test the SRM relay by connecting as shown in figure 5-23, "Governor Control Test."

(a) With 115V AC, 60 Hz supplied to terminals 1 and 2 adjust the frequency to terminals 3 and 4 to 59.7 Hz. The ohmmeter shall indicate zero ohms resistance across contacts 5 and 6.

(b) Connect ohmmeter across terminals 6 and 7 and adjust the variable frequency source to 60.3 Hz. The ohmmeter shall now show zero ohms resistance across contacts 6 and 7.

(3) Test the SRM relay by connecting as shown in figure 5-23, "Voltage Control Test".

(a) With 115 V AC connected to terminals 1 and 2 adjust the voltage to terminals 3 and 4 to 100 V AC. The ohmmeter shall indicate zero ohms resistance across terminals R and C.

(b) Connect the ohmmeter across terminals L and C and adjust the variable voltage source to 130V AC. The ohmmeter shall now show zero ohms resistance across terminals L and C.

(4) REPLACEMENT. Remove relay (3, figure 5-19) by disconnecting and tagging wires and removing four screws (1).

CHAPTER 6

MAINTENANCE OF THE SUPPORT FRAME ASSEMBLY

6-1. GENERAL. The support frame assembly (figure 6-1) is mounted directly on the generator set base assembly. It provides support for major components of the generator set, as well as providing a support for the optional housing kit. It is comprised of front, center, and rear support frames held together by tie bars.

6-2. REPLACEMENT. Removal and replacement of support frame assembly members, are as follows:

NOTE

If generator set had a housing kit, mufflers would be partially removed prior to removing the housing kit.

a. Remove housing kit, refer to Chapter 15.

b. Remove the AC-DC control box, external power box, control cubicle and reconnection box (see Chapter 2).

c. Partially disassemble the air-cleaner and muffler assemblies in order to dismantle the support frame. The air-cleaner bracket bolts mounted on the top center support frame (5, figure 6-1) must be removed. Also, remove bolts supporting the mufflers to the silencer frame tie bar assembly (13), and remove mufflers.

d. Frame supports (4, 5, 6 11, and 12) are removed by removing screws (1), nuts (3), and washers (2).

e. Remove silencer frame tie bar assembly (13) as a complete unit.

WARNING

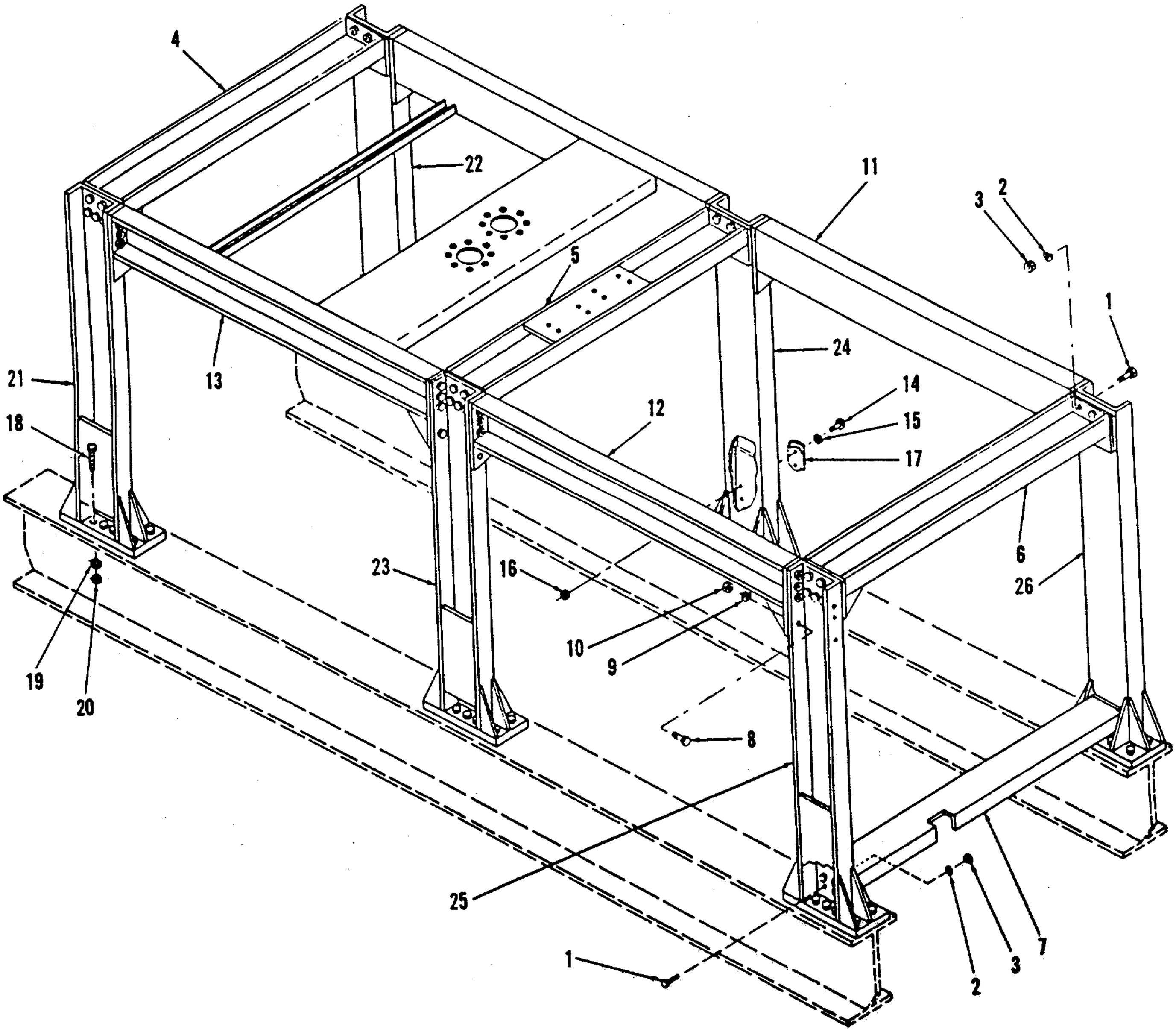
SILENCER FRAME ASSEMBLY IS HEAVY. BE SURE TO PROVIDE ADEQUATE SUPPORT.

f. Support frames (uprights) (21, 22, 23, 24, 25, and 26) are mounted to base assembly with screws (18), nuts (20) and washers (19).

NOTE

The bar assembly (7) must be removed before removing rear support frames (25 and 26).

g. Remove folding step (17) from center right hand support frame (24) by removing screw (14), nuts (16), and washers (15).



LEGEND

1. Screw
2. Lockwasher
3. Nut
4. Support frame
5. Support frame
6. Support frame
7. Tie bar
8. Screw
9. Lockwasher
10. Nut
11. Tie bar
12. Tie bar
13. Tie bar
14. Screw
15. Lockwasher
16. Nut
17. Step
18. Screw
19. Washer
20. Nut
21. Support frame
22. Support frame
23. Support frame
24. Support frame
25. Support frame
26. Support frame

Figure 6-1. Support Frame Assembly

CHAPTER 7

MAINTENANCE OF RADIATOR ASSEMBLY

7-1. GENERAL. The radiator assembly consists of a radiator core with removable tanks, fan, and fan motor. The fan is enclosed by a guard and located in a shroud attached to the radiator. An electric motor drives the fan via belts and sheaves (Code. A) or directly (Code B); see note below for explanation of codes. The radiator system cools the engine, lubricating oil cooler, and the intercooler. It reduces engine temperature and maintains coolant temperature at 125°F (52°C) when generator set is operated at continuous loads. When the housing kit is installed, a thermostatically controlled shutter assembly controls airflow to radiator by means of movable shutters.

NOTE

The radiator installation on earlier units (serial numbers FZ00001 thru FZ00064) differs from later units (serial numbers FZ09100 thru FZ09150), therefore the former in the following discussion is referred to as Code A and the latter as Code B.

7-2. TEST.

a. Preliminary. Preliminary inspections consist of checking for leaks (especially at hose connections), and coolant level may be checked at the sight glass. If coolant level is below sight glass, remove radiator cap and check level in upper tank.

WARNING

WHENEVER GENERATOR SET HAS JUST BEEN SHUT DOWN, REMOVE RADIATOR CAP SLOWLY TO ALLOW PRESSURE TO ESCAPE BEFORE REMOVING CAP.

Refill radiator with proper coolant to approximately 2 inches (50 mm) below filler neck level. Using a hydrometer, verify that antifreeze is in accordance with table 3-1 in the Operator/Crew and Organizational Maintenance manual, TM5-615-593-12.

b. Radiator Core Test. Remove radiator in accordance with instructions in paragraph 7-3 or 7-7.

Test the radiator for leaks by placing the radiator, with all outlet connections sealed, in a tank of water. Apply compressed air at 10 to 15 psi (0.7 to 1 kg/cm^2) at filler opening and observe for leakage indicated by air bubbles in the water. Repair if necessary.

7-3. RADIATOR REPLACEMENT, CODE A. Remove and replace radiator assembly as follows:

a. Removal.

(1) If generator set has a housing kit installed, remove panels and shutter assembly in accordance with Chapter 15. (See figure 7-1)

(2) Drain coolant from radiator, remove clamps (26, 22, 29, 32, 6, 7 and 13) and disconnect hoses (27, 25, 33, 16, 8, and 12).

(3) Tag and disconnect electrical leads to fan motor (64).

(4) Remove belt guard (58) by removing screws (55), nuts (57), and washers (56).

(5) Loosen adjusting screw on motor mount base (65) and slide base slightly together with fan motor (64) to loosen belts (59).

(6) Remove belts (59).

(7) Remove screws (47), washers (48 and 49) and nuts (50), that secure radiator assembly to skid base.

(8) Remove both support tubes (41).

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED. DO NOT STAND UNDER HOISTED LOADS.

(9) With a hoist, carefully lift radiator assembly off skid base.

b. Replacement.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED. DO NOT STAND UNDER HOISTED LOADS.

(1) Using a hoist, carefully set radiator assembly in place on skid base.

(2) Attach both support tubes (41). Install supports (46), if not previously installed.

(3) Attach radiator assembly to the skid base with screws (47), washers (48 and 49) and nuts (50).

(4) Install fan motor (64) on slide base (65), if not previously installed.

(5) Turn fan motor base adjusting screw (62), so that fan motor moves toward center of generator set.

(6) Install three belts (59) on sheave (60) and pulley (61).

(7) Adjust belt tension to allow 1/2 inch (13 mm) maximum play for each belt.

(8) Install belt guard (58) with screws (55), washers (56), and nuts (57).

(9) Connect electrical leads on fan motor (64).

(10) Replace housing kit (if installed) panels and shutter assembly in accordance with Chapter 15.

(11) Connect hoses (27, 25, 33, 16, 8, and 12) and secure with clamps (26, 22, 33, 6, 7, and 13).

(12) Fill radiator with coolant.

(13) Check for leaks.

7-4. RADIATOR REPAIR, CODE A.

a. Radiator. Clean and repair radiator core as follows:

(1) Remove radiator in accordance with paragraph 7-3.

(2) Remove top tank (82) and bottom tank (85).

(3) Inspect tubes. Clean tubes with radiator core brush, if necessary.

(4) Replace top tank (82) and bottom tank (85).

(5) Test the radiator for leaks by placing the radiator with all outlet connections sealed in a tank of water. Apply compressed air at 10 to 15 psi (0.7 to 1 kg/cm^2) at filler opening and observe for leakage, indicated by air bubbles in the water.

(6) Mark off any leaks in the radiator assembly.

(7) Dry out and clean the radiator thoroughly.

(8) Solder the leaks in the radiator with acid core solder.

(9) Straighten bent radiator fins.

(10) Replace radiator in accordance with paragraph 7-3.

7-5. MOTOR REPLACEMENT, CODE A.

Remove and replace fan motor, referring to figure 7-1 as follows:

a. Removal.

(1) Turn off all power. Disconnect electrical leads on fan motor (64).

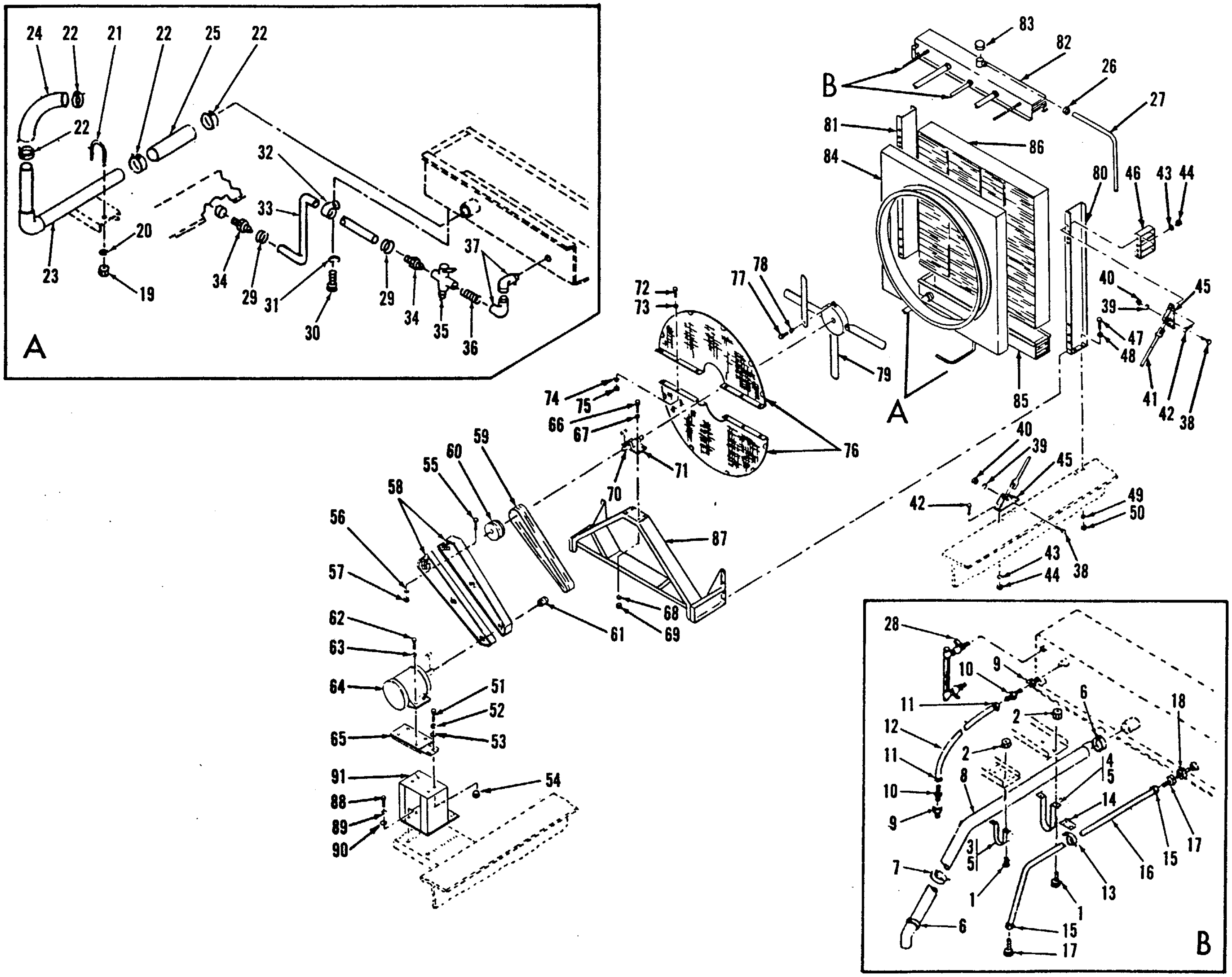


Figure 7-1. Radiator Assembly, Code A, Exploded View

LEGEND FOR FIGURE 7-1

1.	Screw	32.	Clamp	62.	Bolt
2.	Nut/washer	33.	Hose	63.	Washer
3.	Clamp	34.	Fitting	64.	Motor
4.	Clamp	35.	Drain cock	65.	Base
5.	Extrusion	36.	Nipple	66.	Bolt
6.	Clamp	37.	Elbow	67.	Washer
7.	Clamp	38.	Screw	68.	Washer
8.	Hose	39.	Washer	69.	Nut
9.	Reducer	40.	Nut	70.	Shaft
10.	Nipple	41	Support tube	71.	Bearing
11.	Fitting	42.	Screw	72.	Bolt
12.	Hose	43.	Washer	73.	Washer
13.	Clamp	44.	Nut	74.	Washer
14.	Bracket	45.	Bracket	75.	Nut
15.	Fitting	46.	Support	76.	Fan guard
16.	Hose	47.	Screw	77.	Bolt
17.	Nipple	48.	Washer	78.	Washer
18.	Reducer	49.	Washer	79.	Fan
19.	Nut	50.	Nut	80.	Plate
20.	Washer	51.	Screw	81	Plate
21.	U-bolt	52.	Washer	82.	Top tank
22.	Clamp	53.	Washer	83.	Cap
23.	Pipe	54.	Nut	84.	Shroud
24.	Hose	55.	Screw	85.	Bottom tank
25.	Hose	56.	Washer	86.	Core
26.	Clamp	57.	Nut	87.	Frame
27.	Hose	58.	Belt guard	88.	Screw
28.	Valve	59.	Belt	89.	Washer
29.	Clamp	60.	Sheave	90.	Washer
30.	Screw	61	Pulley	91.	Support
31.	Washer				

(2) Move fan motor mount (65) adjusting screw and slide motor mount together with fan motor to release belt tension.

(3) Remove belt guard (58) by removing screws (55), nuts (57), and washers (56).

(4) Remove belts (59).

(5) Remove screws (62) and washers (63) that secure fan motor (64) to base (65).

b. Disassembly. Disassemble fan motor as follows (see figure 7-2).

(1) Remove fan cover (2) by removing bolts (1).

(2) Remove snap ring (3) and washer (4).

(3) Remove fan (5) and key (6).

(4) Remove nuts (7) and remove oppositve drive end bracket (9).

(5) Remove spring (10) and bearing (11).

(6) Remove collar shield (13).

(7) Remove nuts (7) and studs (8) and separate drive end bracket (14) from stator frame (19).

(8) Remove drive end bearing (15).

(9) Remove shaft (18) and rotor assembly (17)..

(10) Remove stator core (20) and stator winding (21).

c. Inspection.

(1) Inspect for burnt or broken insulation.

(2) Inspect if insulation is dry, brittle or faded. Revarnish as necessary.

(3) Check bearings for visible signs of damage, excessive wear, or discoloration. Replace as necessary.

d. Repair. Repair of the fan motor consists of replacing broken, worn or defective components found during inspection and drying or revarnishing of windings if required as a result of the megger test.

e. Reassembly. Reassemble motor as follows (see figure 7-2).

(1) Install stator winding (21) and core (20) inside stator frame (19).

(2) Install shaft (18) and motor assembly (17).

(3) Install drive end bearing (15).

(4) Install drive end bracket (14) and secure to stator frame with studs (8) and nuts (7).

(5) Install collar shield (13).

(6) Install rear bearing (11) and spring (10).

(7) Install opposite drive end bracket (9) and secure with nuts (7).

(8) Slide fan (5) and washer (4) onto shaft (18). Secure with snap ring (3).

(9) Install fan cover (2) using nuts (1).

f. Replacement.

(1) Install fan motor (64, figure 7-1) on motor mount (65). Attach with bolts (62) and washers (63).

(2) Install pulley (61).

(3) Install belts (59) on sheaves (60) and pulley (61).

(4) Install belt guard (58) with screws (55), nuts (57 and washers (56).

(5) Adjust belt tension, with motor mount (65) adjusting screw, allowing 1/2 inch (13 mm) maximum play of each belt.

(6) Connect electrical leads on fan motor. Remove tags.

7-6. FAN AND BEARING REPLACEMENT, CODE A.

a. Inspection.

(1) Inspect fan (79) for bent or deformed blades.

(2) Inspect tightness of attaching bolt and washer for each fan blade.

(3) Inspect fan bearing (71) for visible signs of damage, wear or deterioration.

b. Removal. Remove fan and bearing as follows:

(1) Turn off all power. Disconnect electrical leads on fan motor (64).

(2) Remove fan motor mount (65) adjusting screw and slide mount with motor to release belt tension.

(3) Remove belt guard (58) by removing screws (55), nuts (57), and washers (56).

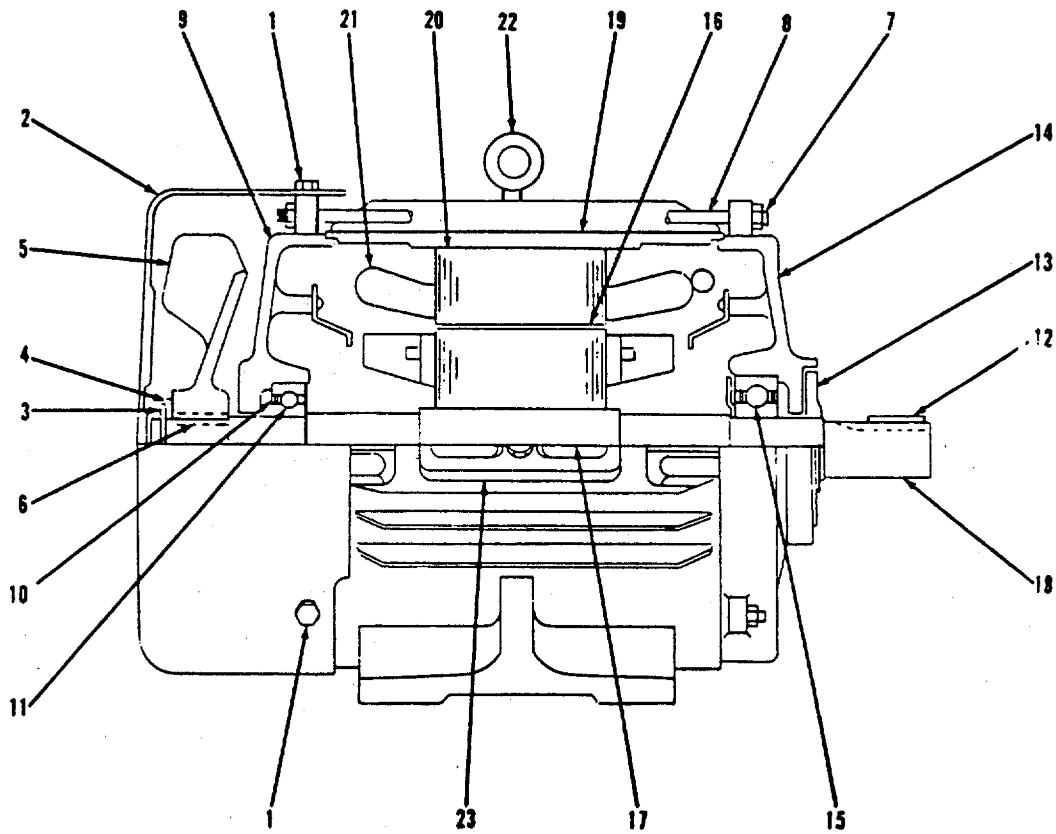
(4) Remove belt guards (58).

(5) Slide fan sheave (60) off bearing shaft (71). Remove key from shaft.

(6) Remove bolts (72), washers (73 and 74), and nuts (75) and remove fan guard (76).

(7) Remove bolts (77) and washers (78) and remove fan blades from fan (79).

(8) Remove bolts (66), washers



LEGEND

1. Bolt
2. Fan cover
3. Snap ring
4. Wave washer
5. Fan
6. Fan key
7. Nut
8. Stud
9. End bracket
10. Spring
11. Bering
12. Key
13. Collar
14. End bracket
15. Bearing
16. Rotor core
17. Rotor assy
18. Shaft
19. Stator frame
20. Stator core
21. Stator winding
22. Eyebolt
23. Conduit box

Figure 7-2. Radiator Fan Motor, Code A

(67 and 68) and nuts (67) and remove bearing (71) with fan hub.

(9) Separate fan hub from bearing (71).

c. Replacement.

(1) Install fan hub on bearing (71).

(2) Install bearing (71) on fan mount frame (87) with bolts (66), washers (67 and 68) and nuts (69),

(3) Install fan blades on fan hub using bolts (77) and washers (78).

(4) Install fan guard (76) and secure with bolts (72), washers (73 and 74), and nuts (75).

(5) Install key on bearing shaft (70) and slide fan sheaves (60) onto shaft.

(6) Install fan belts (59) on fan sheave (60) and motor pulley (61).

(7) Adjust fan motor mount (65) adjusting screw to provide about 1/2 inch belt play. Tighten adjusting screw.

(8) Install belt guard (58) using screws (55), nuts (57), and washers (56).

(9) Reconnect leads to fan motor (59).

7-7. RADIATOR REPLACEMENT, Code B. Remove and replace radiator as follows:

a. Removal.

(1) If generator set has a housing kit installed, remove panels and shutter assembly in accordance with Chapter 15, (see figure 7-3).

(2) Drain coolant from radiator, remove clamps (22, 29, 32, 6, 7 and 13) and disconnect hoses (25, 33, 12, 8 and 16).

(3) Turn off all power and tag and disconnect electrical leads to fan motor (76).

(4) Remove fan guard (68, figure 7-3) by removing hardware (69, 70, and 71).

(5) With hoist attached by fan motor (76) taut, remove bolts, nuts and washers (47 thru 50) from top portion of support leg (72).

(6) Carefully slide fan motor and fan blade out of unit.

(7) Remove fan by taking out key (13, figure 7-4) out of keyway on shaft (31).

(8) Remove motor stool (74) by removing screws (66) and nuts (67).

(9) Remove cross beam (73) by removing hardware securing it to support legs (72).

(10) Remove two support legs (72) by removing screws (47), washers (48 and 49), and nuts (50).

WARNING

The following steps involve removing parts that support the radiator and secure it to the skid base. For safety, attach a taut hoist line to radiator before proceeding to prevent accidental tipping over of radiator when the radiator becomes free standing.

(11) Remove two support tubes (41) by removing screws (38), washers (39) and nuts(40).

(12) Remove fan cowl (65) by removing screws (42), washers (43) and nuts (44). Brackets (45 and 78) will also be removed as they are secured with the same hardware.

(13) Remove screws (47), washers (48 and 49) and nuts (50) that secure radiator to skid base.

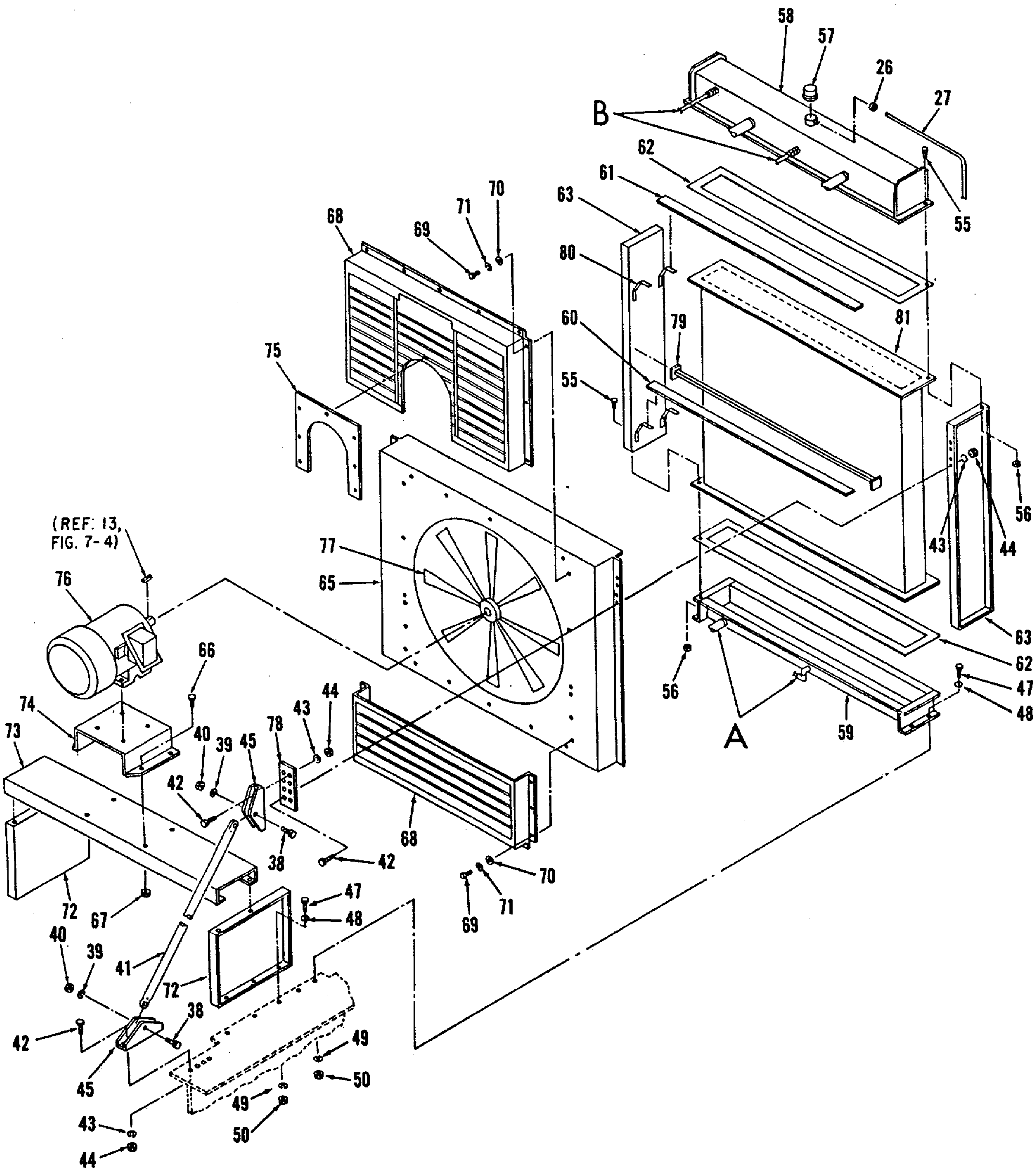


Figure 7-3. Radiator Assembly, Code B, Exploded View (Sheet 1 of 2)

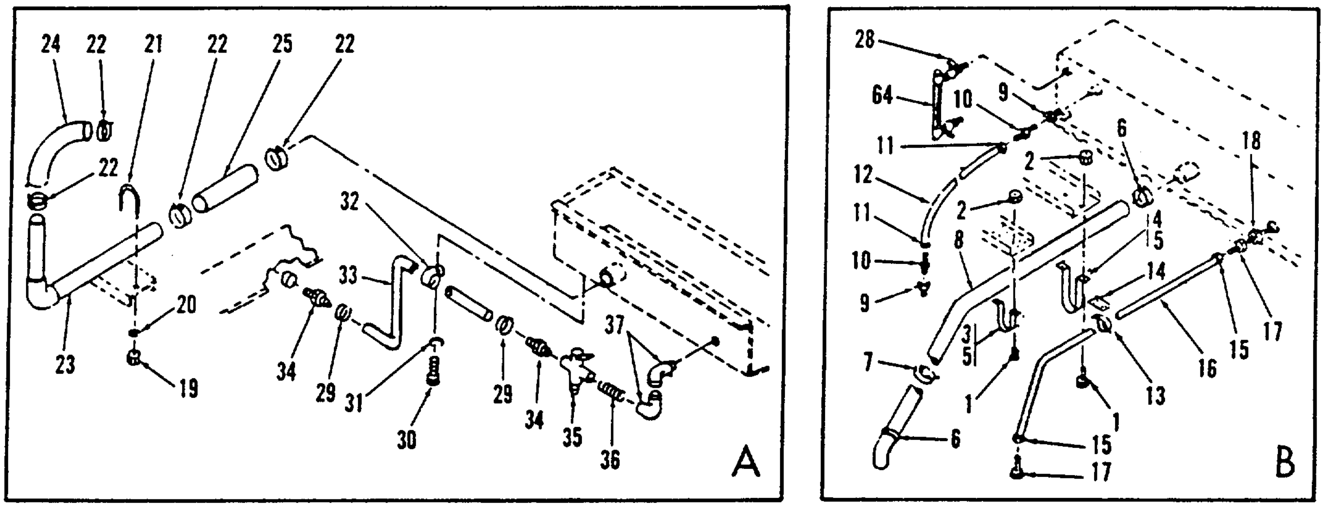


Figure 7-3. Radiator Assembly, Code B, Exploded View (Sheet 2 of 2)

LEGEND FOR FIGURE 7-3

1. Screw
2. Nut/washer
3. Clamp
4. Clamp
5. Extrusion
6. Clamp
7. Clamp
8. Hose
9. Reducer
10. Nipple
11. Fitting
12. Hose
13. Clamp
14. Bracket
15. Fitting
16. Hose
17. Nipple
18. Reducer
19. Nut
20. Washer
21. U-Bolt
22. Clamp
23. Pipe
24. Hose
25. Hose
26. Clamp
27. Hose
28. Valve (Code A Only)
29. Clamp
30. Screw
31. Washer
32. Clamp
33. Hose
34. Fitting
35. Drain cock
36. Nipple
37. Elbow
38. Screw
39. Washer
40. Nut
41. Support tube
42. Screw
43. Washer
44. Nut
45. Bracket
46. Support
47. Screw
48. Washer
49. Washer
50. Nut
51. Screw
52. Washer
53. Washer
54. Nut
55. Screw
56. Nut
57. Filler cap
58. Top tank
59. Bottom tank
60. Strap
61. Strap
62. Gasket
63. Side member
64. Sight(Code B)
65. Fan cowl
66. Screw
67. Nut
68. Fan guard
69. Screw
70. Washer
71. Washer
72. Support leg
73. Cross beam
74. Motor stool
75. Plate
76. Motor
77. Fan
78. Bracket
79. Core brace
80. Gusset
81. Radiator core

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED. DO NOT STAND UNDER HOISTED LOADS.

(14) With a hoist, carefully lift radiator (58, 59, 81 and attached parts) off skid base.

b. Replacement.

(1) Using a hoist, carefully set radiator (58, 59, 81, and attached parts) in place on skid base.

(2) Attach radiator to the skid base with screws (47), washers (48 and 49) and nuts (50).

(3) Attach fan cowl (65) with screws (42), washers (43) and nuts (44). Also attach brackets (45 and 78, two each) with the same hardware.

(4) Attach two support tubes (41) with screws (38), washers (39), and nuts (40).

(5) Attach two support legs (72) to skid base with screws (47), washers (48 and 49) and nuts (50).

(6) Attach cross beam (73 to support legs (72).

(7) Attach motor stool (74) to cross beam (73) with screws (66), and nuts (67).

(8) Slide hub of fan (77) onto shaft of motor (76). Use key supplied with motor.

(9) Carefully place motor (76) in position on motor stool (74) while at the same time positioning fan (77) in fan cowl (65).

(10) Attach motor (76) to motor stool using hardware previously removed.

(11) Attach two-part fan guard

(68) with screws (69) and washers (70 and 71).

(12) Attach plate (75) to fan guard (68) using hardware previously removed.

(13) Connect electrical leads on fan motor (76).

(14) Replace housing kit (if installed) panels and shutter assembly in accordance with Chapter 15.

(15) Connect hoses (25, 33, 12, 8, and 16) and secure with clamps (22, 29, 32, 6, 7, and 13).

(16) Fill radiator with coolant.

(17) Check for leaks.

7-8. RADIATOR REPAIR, CODE B.

a. Radiator. Clean and repair radiator core (81) as follows:

(1) Remove radiator in accordance with paragraph 7-7.

(2) Remove top tank (58) and bottom tank (59).

(3) Inspect tubes. Clean tubes with radiator core brush, if necessary.

(4) Check gaskets (62) for signs of erosion and replace if necessary.

(5) Replace top tank (58) and bottom tank (59).

(6) Test the radiator for leaks by placing the radiator with all outlet connections sealed in a tank of water. Apply compressed air to 10 to 15_2psi (0.7 to 1 kg/cm^2) at filler opening and observe for leakage, indicated by air bubbles in the water.

(7) Mark off any leaks in the radiator assembly.

(8) Dry out and clean the radiator thoroughly.

(9) Solder the leaks in the radiator with acid core solder.

(10) Straighten bent radiator fins.

(11) Replace radiator in accordance with paragraph 7-7.

7-9. MOTOR REPLACEMENT, CODE B. Remove and replace fan motor, referring to Figure 7-3 as follows:

a. Removal. Remove fan motor (76) as described in paragraph 7-7, a., steps (3) to (7).

b. Disassembly. Disassemble fan motor as follows (see figure7-4).

(1) Remove key (13).

(2) Remove mounting half (1) and gaskets (3 and 6) by removing screws (2 and 5).

(3) Remove plugs (7 and 10).

(4) Remove fan cover (17) by removing screws (16).

(5) Remove fan (26).

(6) Remove couplings (8 and 11) and nipples (9 and 12).

(7) Remove front bracket (32)

(8) Remove bearing cap (28) by removing screws (27).

(9) Remove bearing (29) and spring (30).

(10) Remove shaft (31).

(11) Remove stator (23) and rotor (24) from body assy (25).

(12) Remove slinger (18) and bearing (19) by removing screws (20).

(13) Remove rear bracket (15) by removing screws (14).

c. Inspection.

(1) Inspect for burnt or broken insulation.

(2) Inspect if insulation is dry, brittle or faded. Revarnish as necessary.

(3) Check bearings for visible signs of damage, excessive wear, or discoloration. Replace as necessary.

d. Repair. Repair of the fan motor consists of replacing broken, worn or defective components found during inspection and drying or revarnishing of windings if required as a result of the megger test.

e. Reassembly. Reassemble motor as follows (see figure 7-4).

(1) Install rear bracket (15) and secure with screws (14).

(2) Install slinger (18) and bearing (19) and secure with screws (20).

(3) Install stator (23) and rotor (24) in body assy (25).

(4) Install shaft (31) by sliding drive end into bearing (19).

(5) Install bearing (29) and spring (30) in front bracket (32).

(6) Install bearing cap (28) onto front bracket (32) and secure with screws (27).

(7) Install front bracket by sliding onto shaft (31).

(8) Install couplings (8 and 11) and nipples (9 and 12).

(9) Install fan (26) onto shaft (31).

(10) Install fan cover (17) and secure with screws (16).

(11) Install plugs (7 and 10).

(12) Install mounting half (1) and gaskets (3 and 6) and secure with screws (2 and 5).

(13) Install key (13) by placing on shaft (31).

f. Replacement. Replace fan motor (76, figure 7-3) as described in paragraph 7-7, b., steps (8) to (13).

7-10. FAN REPLACEMENT, CODE B. Remove and replace fan, referring to figure 7-3 as follows:

a. Removal. Remove fan (77) as described in paragraph 7-7, a., steps (3) to (7).

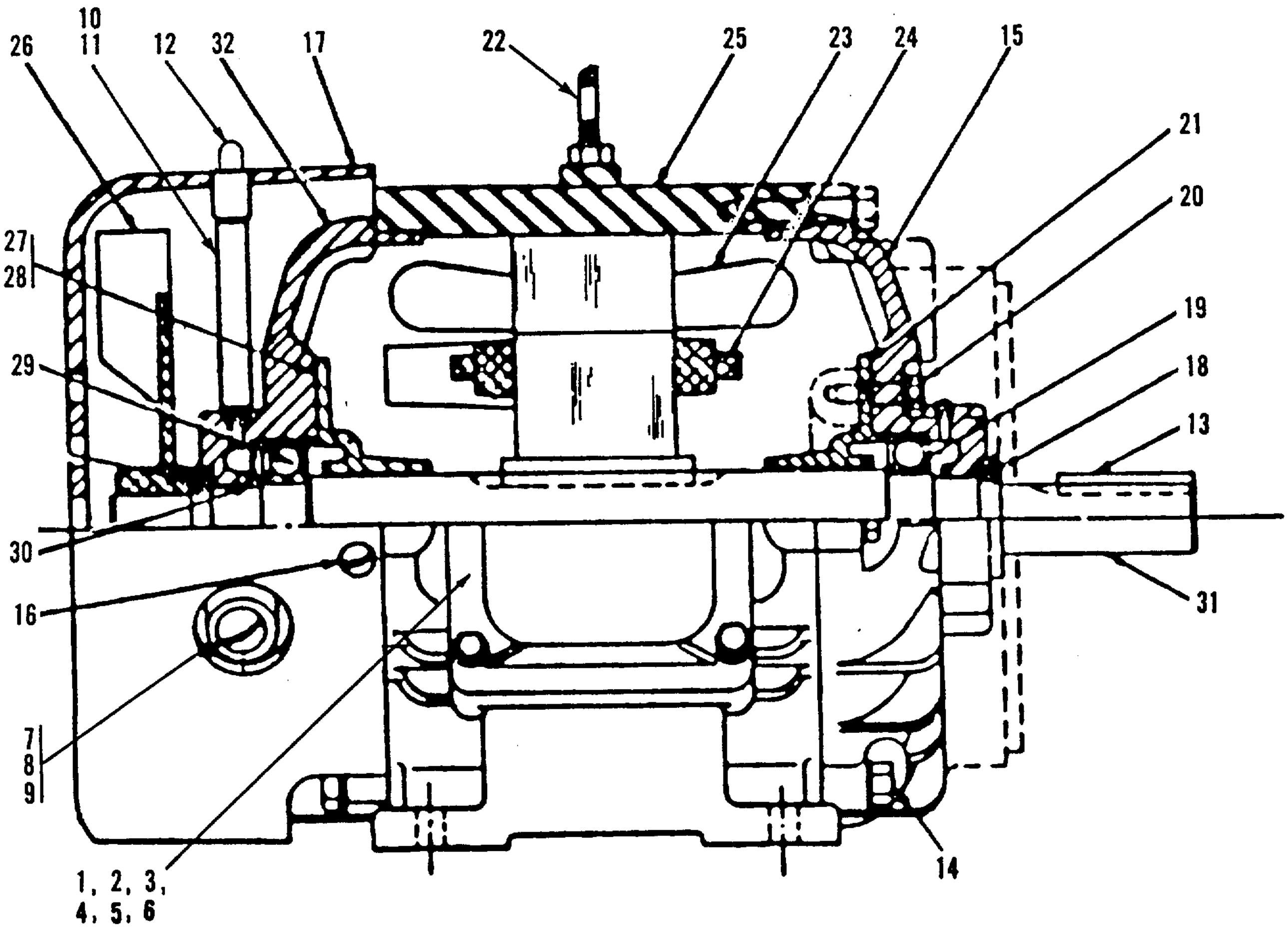
b. Inspection.

(1) Inspect fan (77) for bent or deformed blades.

(2) Inspect tightness of attaching bolt and washer for each fan blade.

(3) Inspect fan hub bearing for visible signs of damage, wear or deterioration.

c. Replacement. Replace fan (77) as described in paragraph 7-7, b., steps (8) to (12).



LEGEND

1.	Mounting half	12.	Nipple	23.	Stator
2.	Screw	13.	Key	24.	Rotor
3.	Gasket	14.	Screw	25.	Body assy
4.	Cover	15.	Rear bracket	26.	Fan
5.	Screw	16.	Screw	27.	Screw
6.	Gasket	17.	Fan cover	28.	Bearing cap
7.	Plug	18.	Slinger	29.	Bearing
8.	Coupling	19.	Bearing	30.	Spring
9.	Nipple	20.	Screw	31.	Shaft
10.	Plug	21.	Bearing cap	32.	Front bracket
11.	Coupling	22.	Eyebolt		

Figure 7-4. Radiator Fan Motor, Code B

CHAPTER 8

MAINTENANCE OF ENGINE PREHEAT ASSEMBLY

8-1. GENERAL. The engine preheat system maintains the engine in preheated, ready-to-start condition in ambient temperatures from 125°F (52°C) to 32°F (0°C), and with the optional housing kit installed, to -25°F (-32°C). The system operates from an external 115V AC power source. It consists of an electrically operated, thermostatically controlled engine coolant heater, piping and valves. Coolant temperature is thermostatically controlled at 100 to 120°F (47 to 49°C). The engine preheat assembly is located in the base assembly under the engine. See figure 8-1.

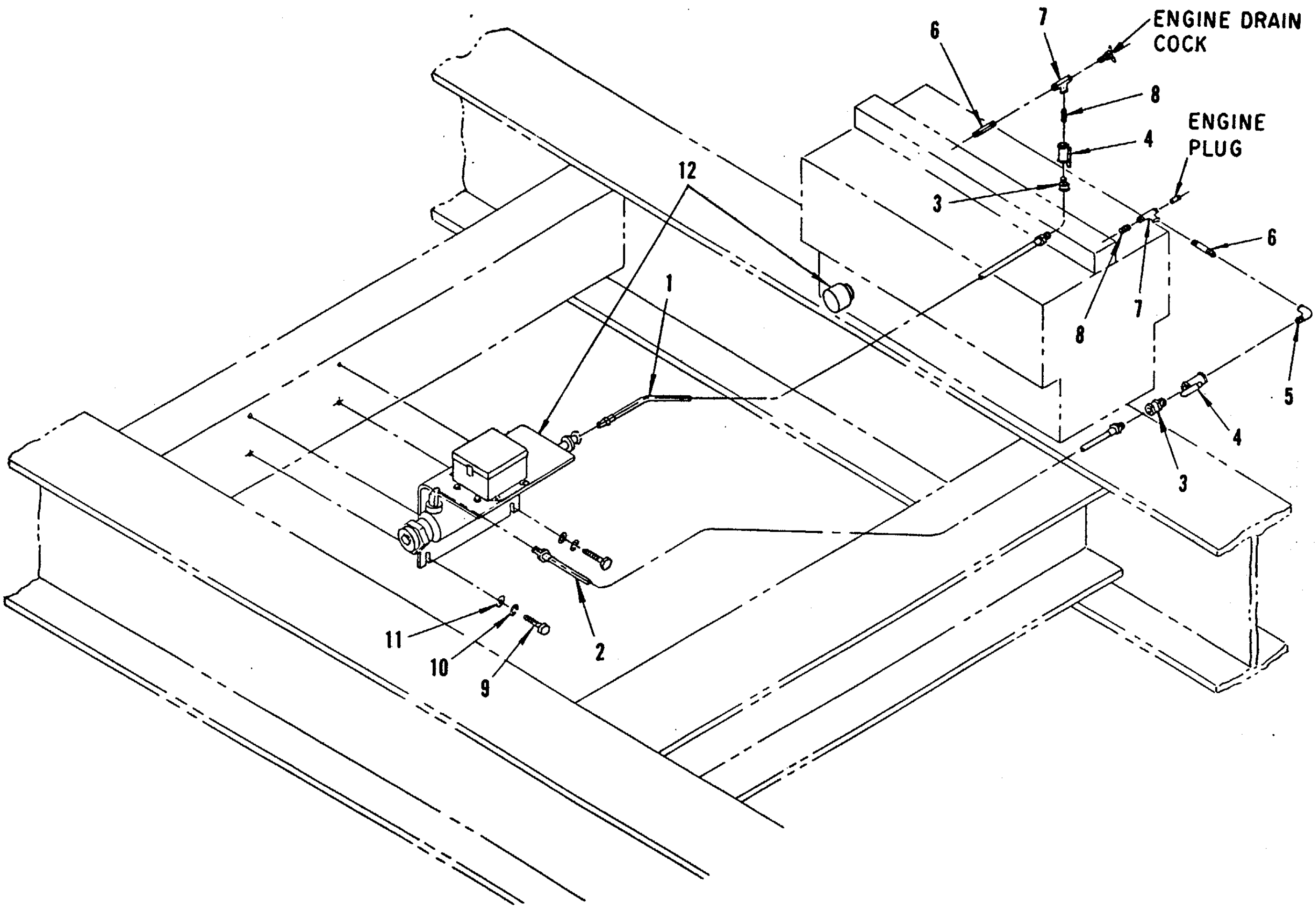
8-2. HEATING ELEMENT (see figure 8-2)

a. Replacement. Remove cover (4) to gain access to heating element terminations. Tag and disconnect wires. Unscrew heating element (6) from EB tank (23). When installing new element add sealing compound MIL-5-15204C to pipe threads.

b. Test. Heating element is actually comprised of two separate 120V, 2200 watt elements. Utilizing a 120V AC 20 AMP power source, energize each element in turn to verify that each element current draw is approximately 18.5 AMPS. See figure 8-3. If any element does not have proper current draw, replace entire element.

8-3. THERMOSTAT (see figure 8-2)

a. Replacement. Remove cap (8) and grommet (10) from cap (11) to gain access to sensing unit (13) terminations. Tag and remove wires from thermostat. Remove thermostat sensing unit (13). Immerse sensing unit into hot water. As hot water temperature reaches 120°F, sensing element contacts shall open (infinite ohms reading). As water temperature cools to 100°F, sensing element shall reclose (0 ohms reading). See figure 8-4.



LEGEND

1. Hose
2. Hose
3. Adapter
4. Lever valve
5. Elbow
6. Nipple
7. Tee
8. Nipple
9. Screw
10. Lockwasher
11. Washer
12. Heater assy kit

Figure 8-1. Preheat Installation

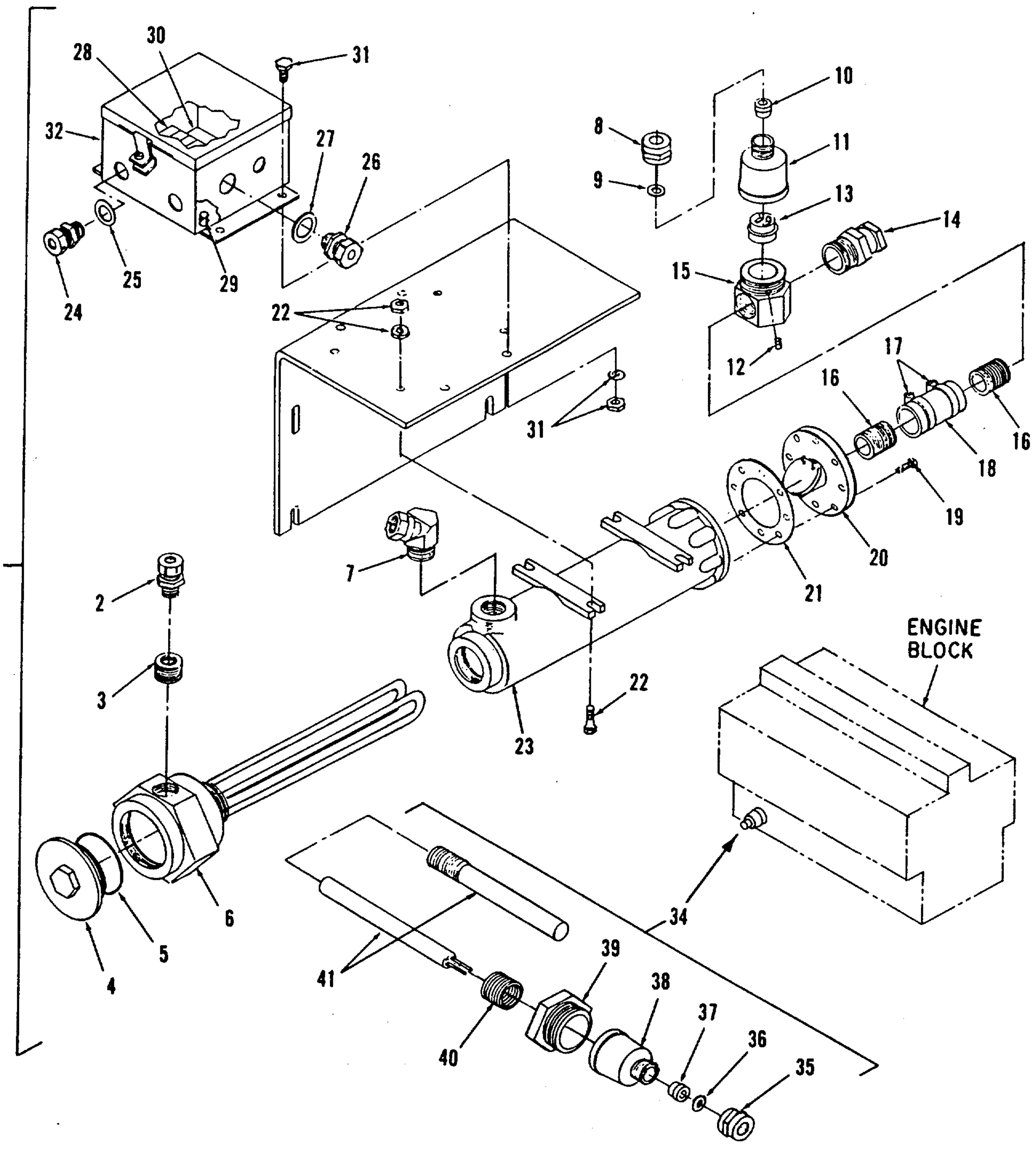


Figure 8-2. Heater Assembly

LEGEND FOR FIGURE 8-2

1. Heater assy
2. Cord grip
3. Reducer
4. Cover
5. O-ring
6. Heater element
7. Swivel adapter
8. Cap
9. Washer
10. Grommet
11. Cap
12. Set Screw
13. Sensing unit
14. Swivel adapter
15. Bur
16. Nipple
17. Clamp
18. Hose
19. Screw
20. EC flange and valve assy
21. Gasket
22. Bolt assy
23. EB tank
24. Cord grip
25. Seal ring
26. Cord grip
27. Seal ring
28. Terminal block
29. Ground lug
30. Plate
31. Bolt assy
32. Junction box
33. Mounting plate
34. Lub oil heater assy
35. Cap
36. Washer
37. Grommet
38. Cap
39. Burr
40. Reducer
41. Heating Element?

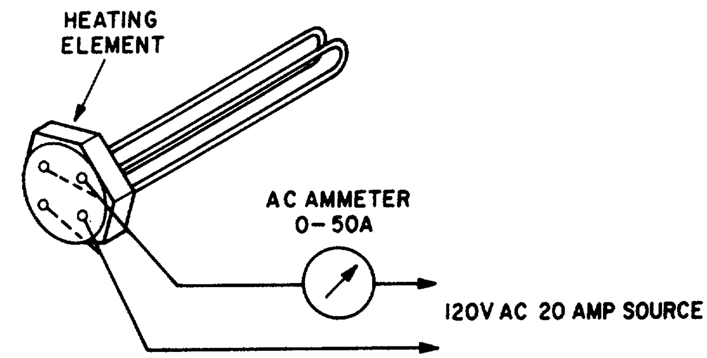


Figure 8-3. Heater Element Test Set-up

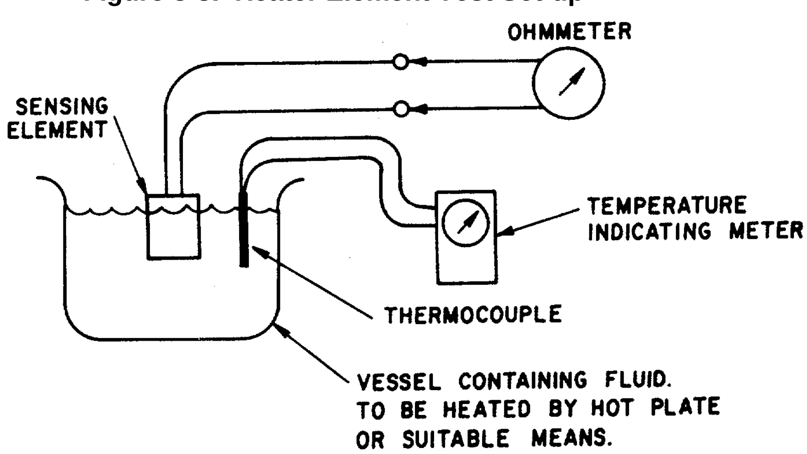


Figure 8-4. Thermostate Test Set-up

CHAPTER 9

MAINTENANCE OF FUEL TRANSFER PUMP ASSEMBLY

9-1. GENERAL. The fuel transfer pump (figure 9-1) is used to transfer diesel fuel from an external source to the generator set fuel tank. It is mounted on the left side of the generator set, in back of the AC-DC control box assembly. The fuel transfer pump assembly fuel inlet connection is located on the base assembly, below the fuel transfer pump assembly. The fuel transfer pump is electric motor driven and actuated by a control panel selector switch. In the automatic AUTO position, transfer pump operation is controlled by a float level switch in the generator set fuel tank and the fuel flow is controlled by a solenoid valve on the fuel transfer pump assembly.

9-2. REPLACEMENT.

a. Removal.

(1) With system off, disconnect hose assemblies connected to the inlet and outlet ports of the pump. Remove fittings from pump (8 and 10). Disconnect the electrical connector on the pump motor.

NOTE

When removing fuel transfer lines, guard against siphoning from the external fuel source.

(2) Remove four screws (13), washers (14), and nuts (15).

b. Installation. (See figure 9-1)

(1) Install pump (16) onto bracket (51) with four screws (13), washers (14) and nuts (15).

(2) Attach fittings (8 and 10) and hose assemblies to inlet and outlet ports of pump.

9-3. REPAIR. (See figure 9-2.) Pump repairs involve replacement of the inlet filter assembly (7), bypass assembly (9 through 14), pump blade (34), motor hearing (28 and 42), and motor brushes (25).

a. Inlet Filter. Remove inlet filter assembly (7) and seal (8) from end plate (31).

b. Bypass Assembly. Unscrew plug (9) from end plate (31). Remove spring (10), piston (11), seal (12), sleeve (13), and bypass spring (14).

c. Pump Blade.

(1) Remove wire (29) from screws (30). Remove screws and end plate (31).

(2) Remove pump blade (34) with shaft (35), drive blade (36), seal (37), plate (38), seal (39), and liner (33) with pin (32).

d. Motor Bearings. After pump blade assembly has been removed, remove motor bearings as follows:

(1) Remove wire (15) from screws (16). Remove screws (16) and washers (17), and remove front head (18).

(2) Separate front head (18) from body (43) and housing (40).

(3) Remove bearings (28) and (42) from armature (41) shaft.

e. Motor Brushes. Motor brushes are readily removable by unscrewing caps (24) and removing brushes (25). Replace brush after 2500 hours of operation or if square section of brush is less than ¼ inch in length.

f. Feed thru Capacitor. Remove wire (3) from four screws (4). Remove connector shell (5) and feed thru capacitor (6) by removing four screws (4).

g. Solenoid Valve L3.

(1) Test. Test solenoid valve 3 (19, figure 9-1) using an ohmmeter set on the Rx1scale. Check for continuity. If continuity is not indicated the valve is defective and should be replaced.

(2) Replacement. (See figure 9-1.)

Disconnect electrical connector from solenoid valve. Disconnect hose assemblies from elbows (8). Remove screws (18) and remove solenoid valve (19).

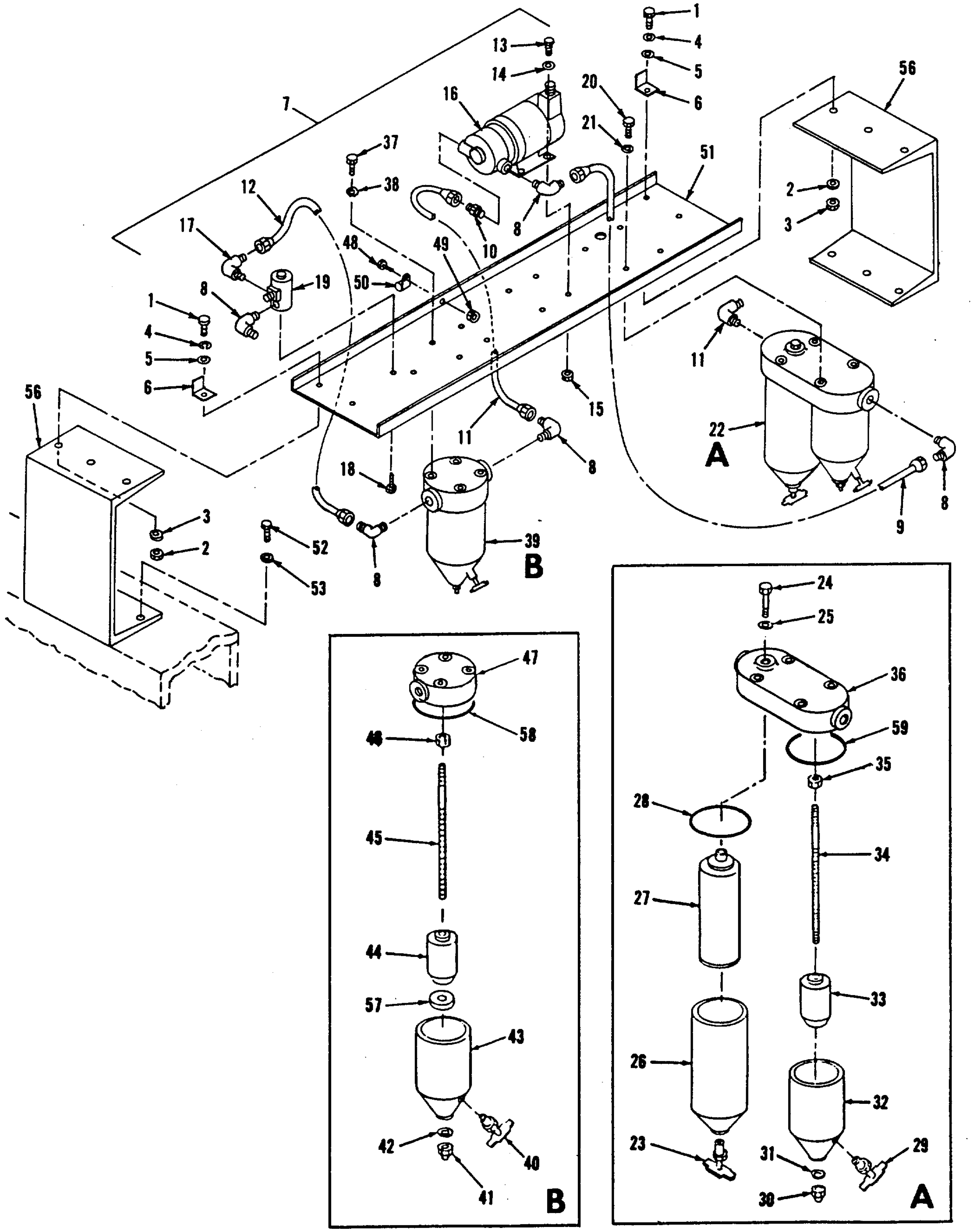
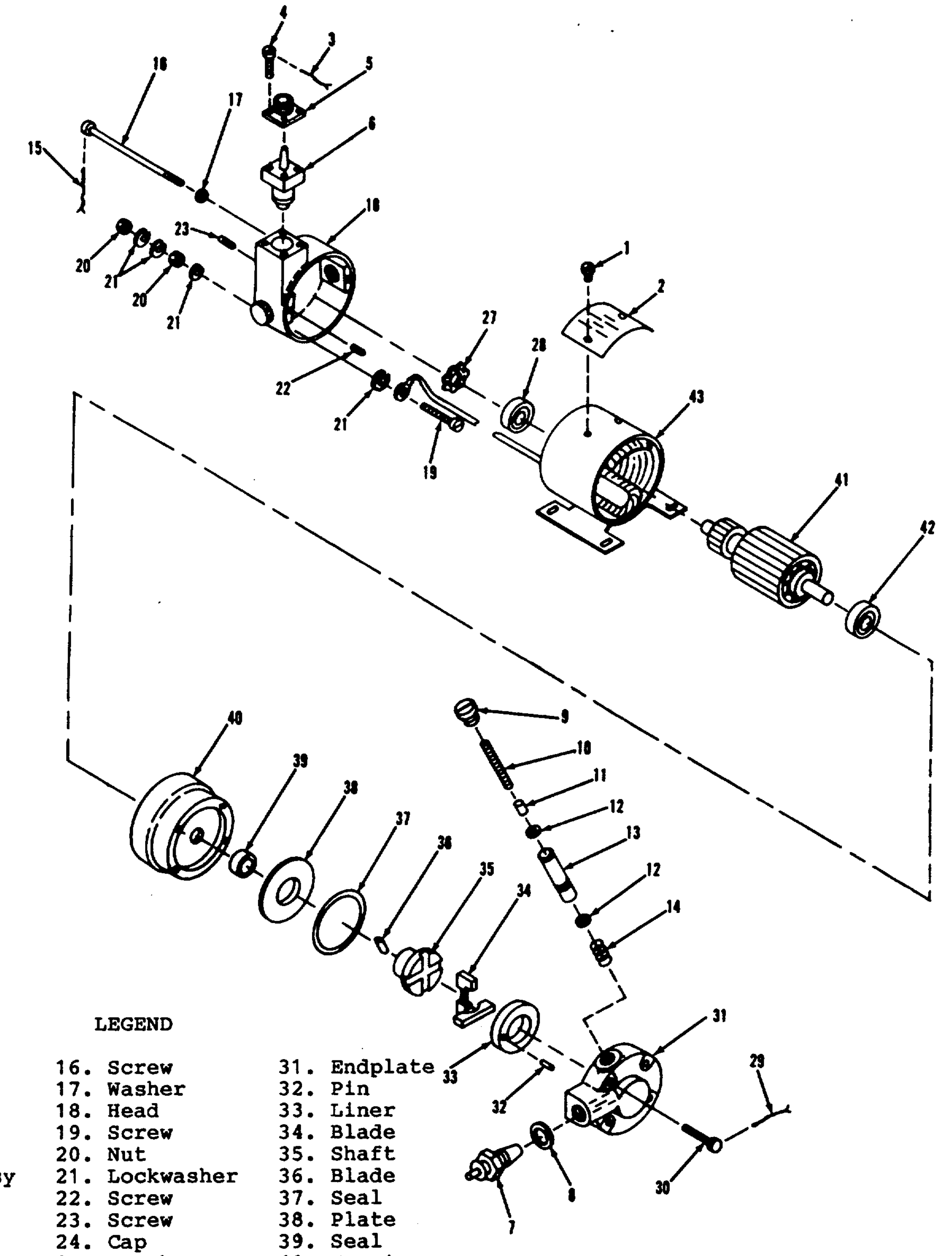


Figure 9-1. Fuel Transfer Pump Installation, Exploded View

LEGEND FOR FIGURE 9-1

1. Screw
2. Nut
3. Bevel washer
4. Lockwasher
5. Washer
6. Bracket
7. Transfer Pump-
   filter assy
8. Elbow
9. Hose
10. Connector
11. Hose
12. Hose
13. Screw
14. Washer
15. Nut
16. Pump
17. Elbow
18. Screw
19. Valve
20. Screw
21. Lockwasher
22. Filter-strainer assy
23. Drain cock
24. Screw
25. Washer
26. Can
27. Filter elements
28. Gasket
29. Drain cock
30. Nut
31. Washer
32. Can
33. Strainer
34. Rod assy
35. Nut
36. Filter-strainer
37. Screw
38. Washer
39. Strainer
40. Drain cock
41. Nut
42. Washer
43. Can
44. Strainer
45. Road assy
46. Nut
47. Strainer head
48. Screw
49. Nut
50. Clamp
51. Bracket
52. Screw
53. Bevel Washer
54. Lockwasher
55. Nut
56. Channel
57. Retainer
58. Gasket
59. Gasket



LEGEND

1. Screw
2. Namplate
3. Wire
4. Screw
5. Connector
6. Capactior assy
7. Filter assy
8. Seal
9. Plug
10. Spring
11. Piston
12. Seal
13. Sleeve
14. Spring
15. Wire
16. Screw
17. Washer
18. Head
19. Screw
20. Nut
21. Lockwasher
22. Screw
23. Screw
24. Cap
25. Brush
26. Holder
27. Washer
28. Bearing
29. Wire
30. Screw
31. Endplate
32. Pin
33. Liner
34. Blade
35. Shaft
36. Blade
37. Seal
38. Plate
39. Seal
40. Housing
41. Armature
42. Bearing
43. Body and field

Figure 9-2. Fuel Transfer Pump, Exploded View

CHAPTER 10

MAINTENANCE OF INTERCONNECTING ELECTRICAL HARNESSES AND PARALLEL CABLE ASSEMBLIES

Section I. MAINTENANCE OF INTERCONNECTING ELECTRICAL HARNESSES

10-1. GENERAL. Electrical interconnection of control devices and indicators is accomplished through wiring harnesses. Wires in the harnesses are bundled and secured to prevent unnecessary movement and chafing, and to conserve space.

10-2. REPLACEMENT. Replace the interconnecting, external power box, AC-DC control box or control cubicle harness if 30 percent of the wires in the assembly are defective. Refer to FO 10-1 through 10-21.

WARNING

SET MAINTENANCE LOCKOUT SWITCH TO LOCKOUT. DISCONNECT NEGATIVE CABLE FROM BATTERIES. REMOVE EXTERNAL POWER BY OPENING CB101 (120V RECEPTACLE BREAKER).

a. Removal. Remove harness assembly as follows:

(1) Tag all wires, connectors, and terminal boards.

(2) Disconnect harness connectors from receptacles by unscrewing connectors in counterclockwise direction.

(3) Remove all clamps that secure the harness.

b. Repair. Refer to Operator/Crew Organizational Maintenance manual for repair procedures.

c. Replacement. Replace harness as follows:

(1) Secure harness with clamps.

(2) Make necessary connections.

(3) Remove wire tags.

Section II. MAINTENANCE OF PARALLEL CABLE ASSEMBLIES

10-3. GENERAL. There are two parallel cable assemblies, a reactive load compensation cable and a governor circuit cable, used to interconnect sets for parallel operation.

10-4. INSPECTION.

a. Inspect connectors for damaged threads and bent, loose, or missing pins. Inspect wiring for defective insulation.

b. Perform continuity check, using ohmmeter between connecting points in the cable. Use wiring data in figure 10-1. Check for short circuits between connector pins of the same receptacle.

10-5. REPAIR. If a wire is broken from a connector, resolder and reassemble.

10-6. REPLACEMENT. To remove parallel cables, unscrew connectors from receptacles on generator set AC-DC control panel to replace parallel cables, unscrew dust caps on AC-DC control panel receptacles, labeled GOVERNOR PARALLELING CIRCUIT and REACTIVE LOAD COMPENSATION. Attach parallel cables to these receptacles at both generator set AC-DC control panels.

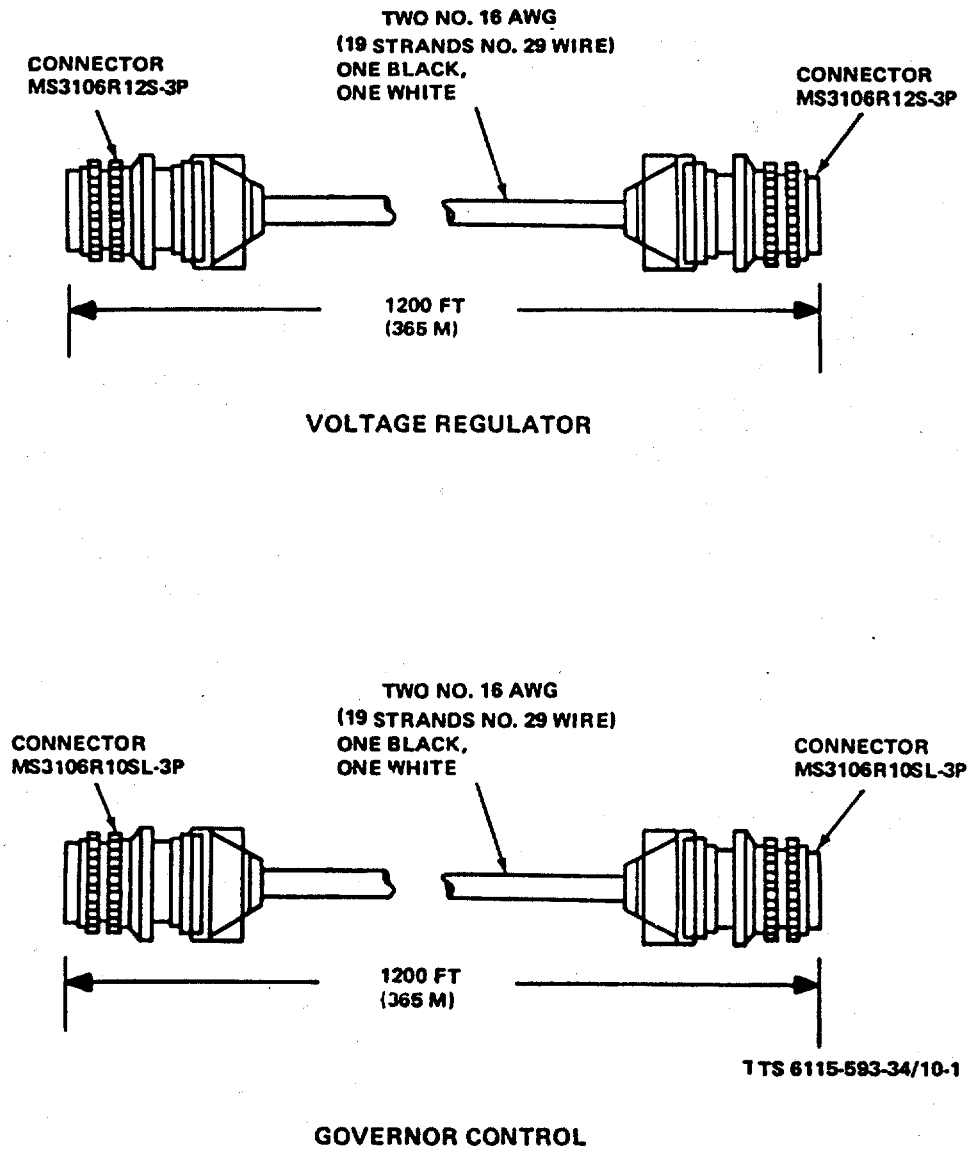


Figure 10-1. Parallel Cables, Diagram

CHAPTER 11

MAINTENANCE OF GENERATOR AND RECONNECTION ASSEMBLY

11-1. GENERAL. The generator is a single-bearing, brushless type with integral exciter. It is directly driven from the engine through a disc coupling. The bearing requires no lubricant and can be replaced without removing either the engine or generator. The excitation system consists of an exciter and voltage regulator. The excitor has a rotating armature and rotating rectifier. The reconnection box assembly provides access for reconnecting generator phase windings through current transformers. Windings of each phase may be connected in series or parallel on buss bars. Reconnection box also provides a means of converting the generator set from 120/208 volt to 240/416 volt operation.

11-2. RECONNECTION BOARD AND BUSS BARS REMOVAL AND REPLACEMENT.

a. Removal.

(1) Remove front panel (12, figure 11-1, sheet 1) by removing screws (1), washers (2 and 3), and hook (4).

(2) Remove panel support (13).

(3) Disconnect, tag, and remove harness (71) and (73) and power cables (74).

(4) Remove buss bars and jumper bars (38 thru (45) by removing their attaching hardware.

(5) Remove reconnection board assembly (15, figure 11-1, sheet 2) by removing the 14 screws (16), nuts (19), and washers (17 and 18).

b. Replacement.

(1) Replace reconnection board assembly (15) by replacing the 14 screws (16), nuts (19), and washers (17 and 18).

(2) Replace buss bars and jumper bars (38 thru 45, figure 11-1, sheet 1) by replacing their attaching hardware.

(3) Replace harness (71 and 73) and power cables (74).

(4) Replace panel support (13).

(5) Replace front panel (12) by replacing screws (1), washers (2 and 3), and hook (4).

c. Limit Switch.

(1) Test. Using an ohmmeter test limit switch S120 (14, figure 11-1, sheet 2) for continuity. Switch should have a distinct clicking action when operated from one position to another. Replace switch if no continuity is indicated.

(2) Replacement.

(a) Remove limit switch S120 (14) by removing locknut and washer that secures switch to reconnection board (15).

(b) Install new switch on reconnection board (100) and secure locknut and washer.

11-3. CURRENT TRANSFORMER REMOVAL AND REPLACEMENT.

a. Removal.

(1) Remove reconnection board and buss bars, par. 11-2 a.

(2) Remove current transformer assembly (22, figure 11-1, sheet 2) by removing ten screws (20) and washers (21).

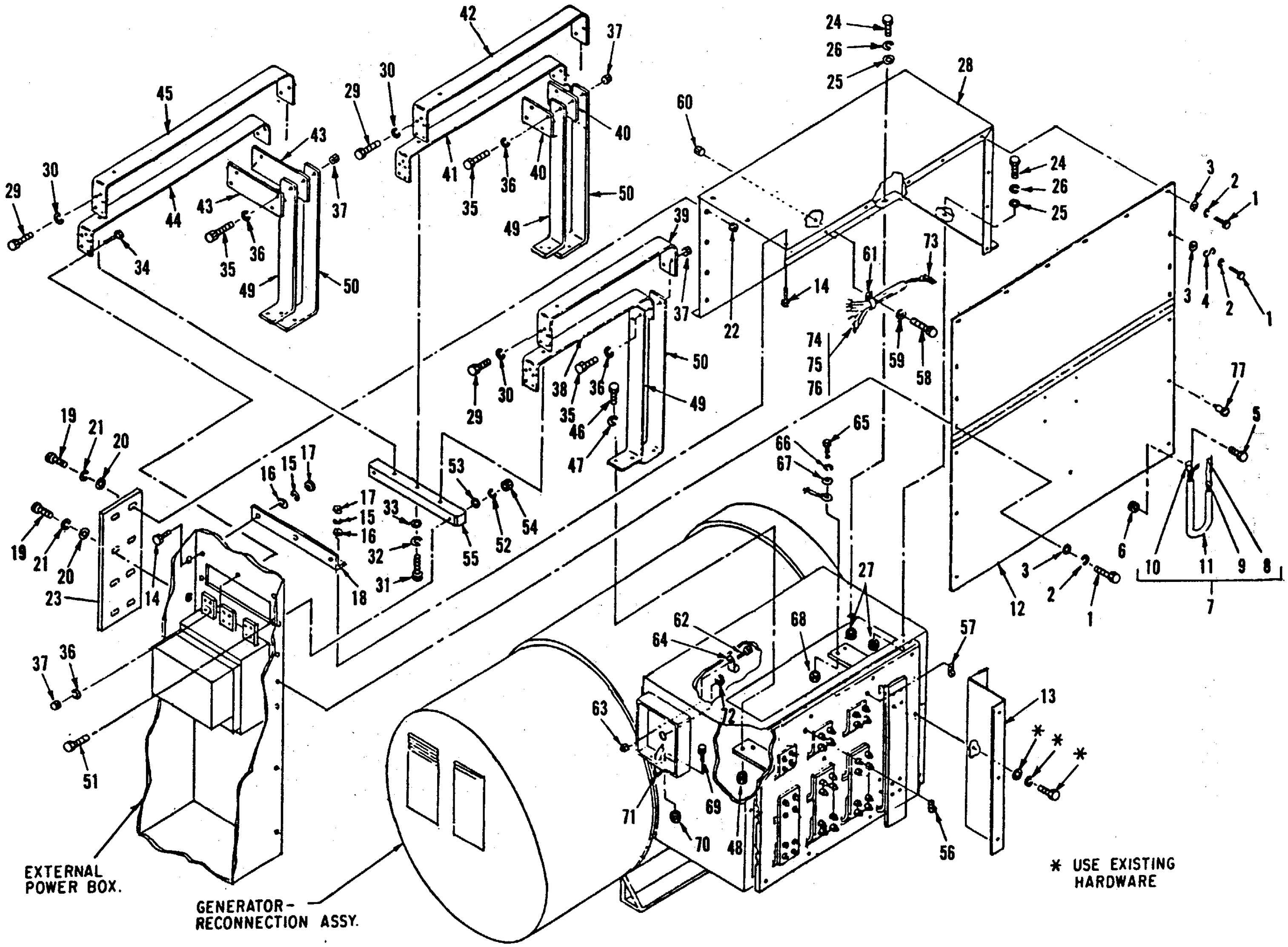


Figure 11-1. Generator Reconnection and Box Assembly, Exploded View (Sheet 1 of 2)

Legend for Figure 11-1 (Sheet 1)

1. Screw
2. Washer
3. Washer
4. S hook
5. Screw/washer
6. Nut/washer
7. Chain
8. Snap hook
9. S hook
10. Chain
11. Sleeving
12. Front panel
13. Support
14. Screw
15. Washer
16. Washer
17. Nut
18. Angle
19. Screw
20. Washer
21. Washer
22. Nut
23. Plate
24. Screw
25. Washer
26. Washer
27. Nut
28. Enclosure
29. Screw
30. Washer
31. Screw
32. Screw
33. Washer
34. Screw
35. Screw
36. Washer
37. Nut
38. Buss bar
39. Buss bar
40. Jumper bar
41. Buss bar
42. Buss bar
43. Jumper bar
44. Buss bar
45. Buss bar
46. Screw
47. Washer
48. Nut
49. Buss bar
50. Buss bar
51. Screw
52. Washer
53. Washer
54. Nut
55. Block
56. Clamp
57. Clamp
58. Screw
59. Washer
60. Nut
61. Clamp
62. Screw/washer
63. Nut/washer
64. Clamp
65. Screw
66. Washer
67. Washer
68. Nut
69. Screw/washer
70. Nut
71. Harness
72. Grommet
73. Harness
74. Power cable
75. Lug
76. Cable
77. Screw

b. Replacement.

(1) Replace current transformer assembly (22, figure 11-1, sheet 2) by replacing the ten screws (20 and washers (21).

(2) Replace reconnection boars and buss bars, par. 11-2 b.

11-4. CURRENT TRANSFORMERS. The current transformers are mounted on a plate in the reconnection box assembly enclosure, attached to the main generator. An on-equipment test is not feasible for current transformer assembly. Refer to figure 11-1, sheet 2 and 11-2 to provide access to current transformer for removal.

a. Inspection. Inspect the current transformers (figure 11-2) for cracks in the plastic, breaks, loose mounting, loose connections, or corrosion.

CAUTION

Current transformers must be demagnetized after checking any secondary terminals with any DC current such as a Wheatstone bridge, or their accuracy will be impaired.

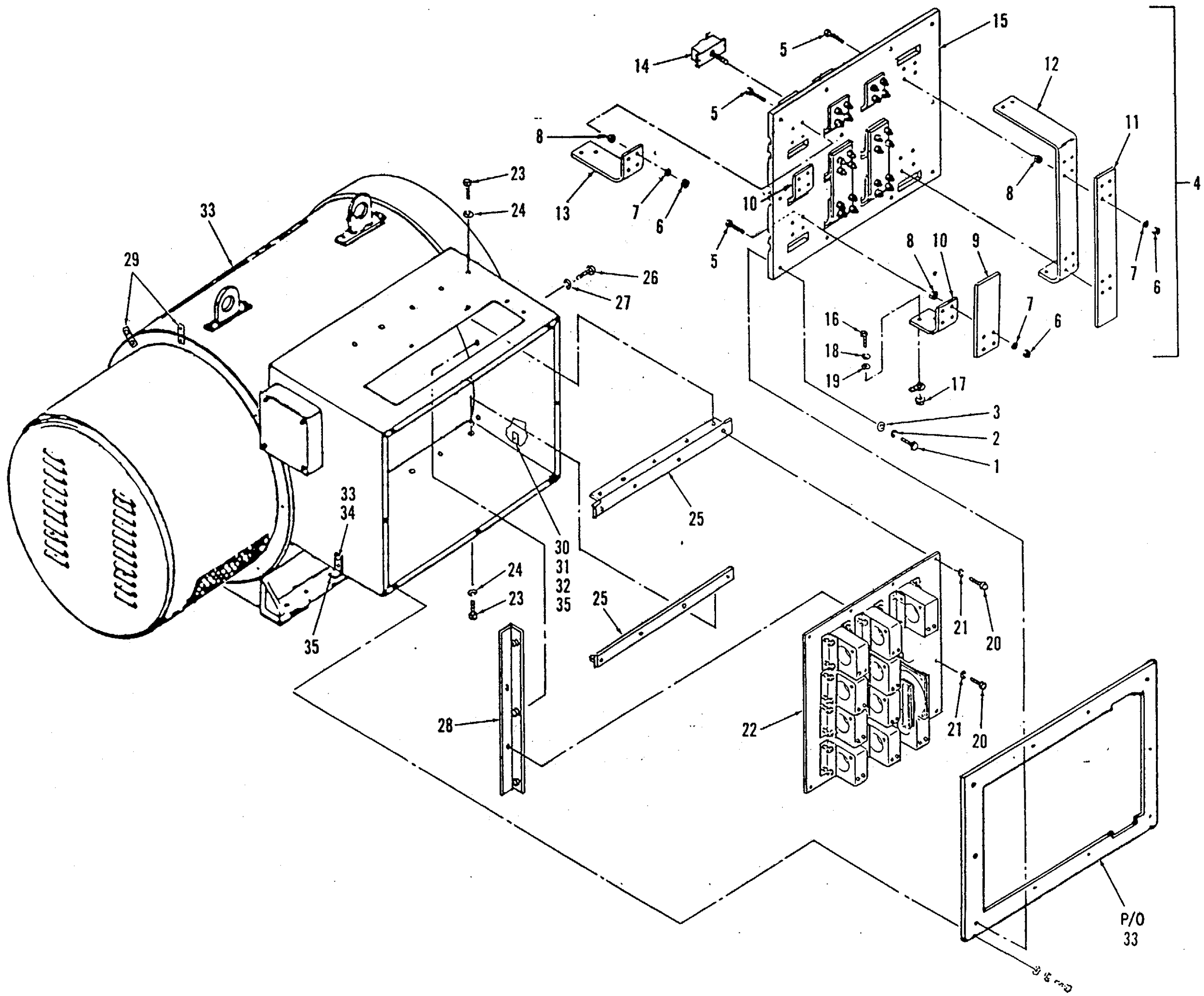


Figure 11-1. Generator-Reconnection and Box Assembly
(Sheet 2 of 2)

LEGEND FOR FIGURE 11-1 (Sheet 2)

1. Screw
2. Washer
3. Washer
4. Reconn. Board assy
5. Bolt
6. Nut
7. Washer
8. Nut
9. Jumper bar
10. Connection bar
11. Jumper bar
12. Neutral bar
13. Connection bar
14. Limit switch
15. Reconn. Board
16. Screw
17. Nut
18. Washer
19. Washer
20. Screw
21. Washer
22. Transformer assy
23. Screw
24. Washer
25. Angle
26. Screw
27. Washer
28. Angle
29. Bracket
30. Screw
31. Nut
32. Washer
33. Generator assy
34. Clip

(a) Current transformers CT1, CT2, CT3, CT11, CT12, and CT13 (7, figure 11-2) should read 7.5 ohms at 77°F (25°C).

(b) Current transformers CT4, CT5, CT6, and CT10 (8) should read 0.420 ohms at 77°F (25°C).

(c) Current transformer CT7 (16) should read 0.089 ohms at 77°F (25°C).

(d) Demagnetize the current transformers following the resistance tests by connecting secondary terminals to a variable AC power source such as a variac or similar device and slowly raise the current to 2 amps for CT1, CT2, CT3, CT11, CT12, and CT13 (10 amps for CT4, CT5, CT6, CT10, and CT7), then slowly lower current to 0 amps.

(2) Current Test.

WARNING

SECONDARY TERMINALS SHOULD NOT BE LEFT OPEN WHEN AC CURRENT IS APPLIED.

(a) Test CT1, CT2, CT3, CT11, CT12, CT13, CT4, CT5, CT6, CT10, and CT7, by wrapping 10 turns of a conductor around the current transformer.

(b) Apply an AC current of 10 amperes to the conductor.

(c) Current measured at current transformer terminals must be 86 milliamps for CT1, CT2, CT11, CT12, and CT13; 416 milliamps for CT4, CT5, CT6, and CT10; and 500 ma for CT7.

(d) Replace defective current transformers. Replace rubber pads (21) when reassembling current transformer (16).

c. Replacement.

(1) Removal. (See figure 11-2.)

LEGEND

1. Screw
2. Washer
3. Lockwasher
4. Screw
5. Lockwasher
6. Nut
7. Current transformer
8. Current transformer
9. Bracket
10. Screw
11. Nut
12. Terminal block
13. Screw
14. Lockwasher
15. Nut
16. Current transformer
17. Screw
18. Washer
19. Lockwasher
20. Bracket
21. Pad
22. Panel

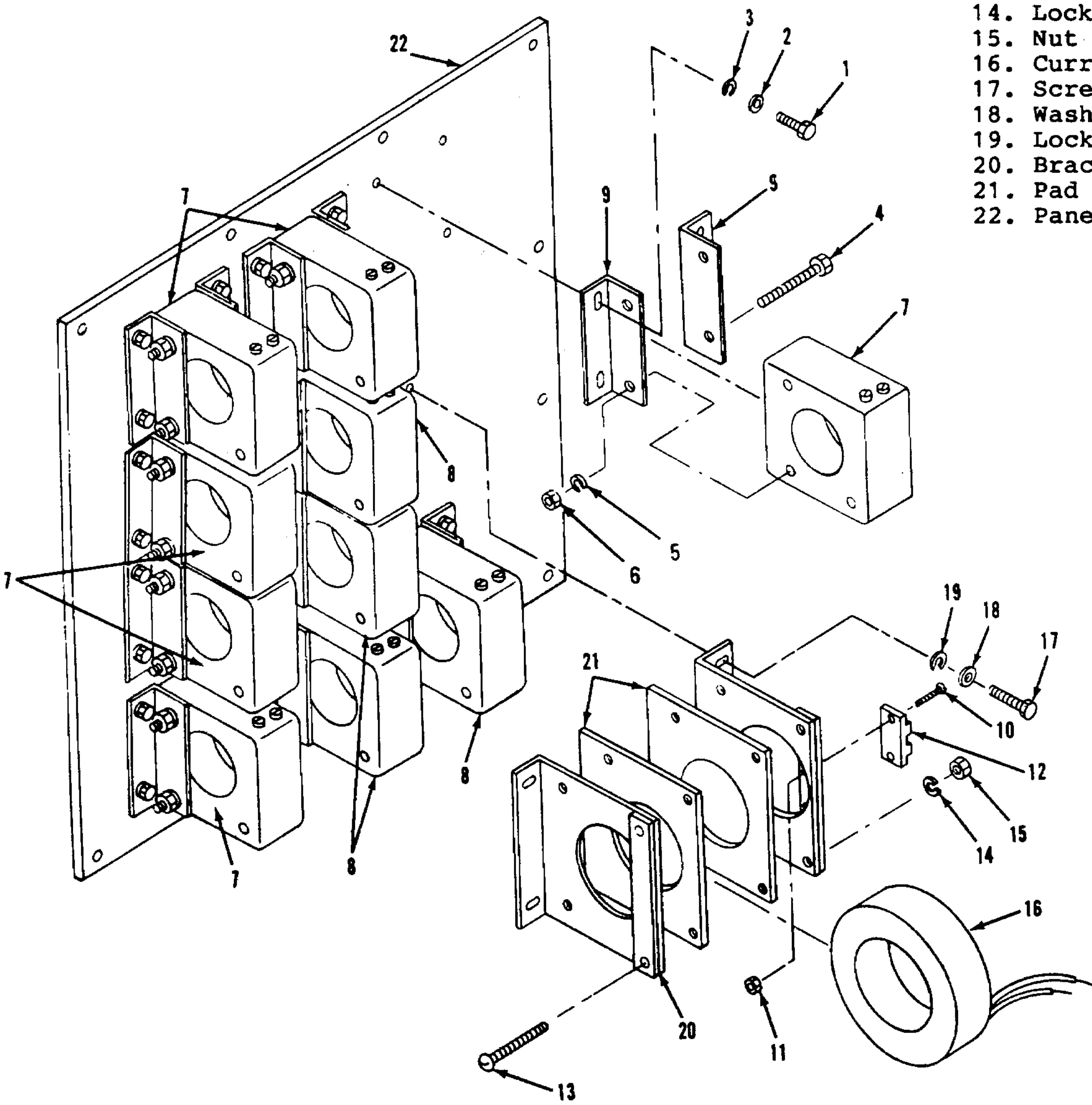


Figure 11-2. Current Transformer Assembly, Exploded View

(a) Remove and tag generator output leads and pass them through the associated current transformers, freeing the current transformer for removal.

NOTE

Count number of turns of each output lead in each current transformer.

(b) Current transformers (7 and 8) may be removed by first disconnecting and tagging wires, then removing screws (17) and washers (18 and 19) or screws (1) and washers (2 and 3).

(c) Current transformer (16) may be disassembled by removing screws (13), washers (14), and nuts (15) to separate brackets (20) and rubber pads (21). Remove current transformer (16) and terminal block (12) attached to bracket with screws (10) and nuts (11).

(d) Current transformers (7 and 8) may be disassembled by removing screws (4), washers (5), and nuts (6) to separate brackets (9). Remove current transformer (7 and 8).

(2) Installation.

(a) Install current transformers (7 and 8) by first replacing brackets (9) with screws (1) and washers (2 and 3).

(b) Secure current transformers (7 and 8) in brackets (9) with screws (4), lockwashers (5) and nuts (6).

(c) Assemble current transformer (16) with new rubber pads (21), brackets (20), screws (13), lockwashers (14) and nuts (15). Attach terminal block (12) with screws (10) and nuts (11).

(d) Secure current transformer assembly to panel (22) with lockwashers (19), washers (18), and screws (17).

(e) Refer to FO-10, Operator and Organizational Maintenance manual and reconnect generator output leads after passing them through the associated current transformers. Remove tags.

11-5. GENERATOR.

a. Test. Start and operate the generator set. Check voltage, current, and frequency outputs as indicated in Chapter 2 of the Operator/Crew and Organizational Maintenance manual. For an overall operational test of the generator, with specific testing condition, test setup, etc., refer to Chapter 16 of this manual.

WARNING

BEFORE TURNING OFF GENERATOR SET, ENGAGE MAINTENANCE LOCKOUT SWITCH. DISCONNECT AND ISOLATE ELECTRICAL LEADS.

(1) Insulation Resistance. To test insulation resistance, use a megohmmeter to measure the resistance between a winding and ground. The insulation resistance of each of the windings should be at least 1 megohm at 77°F (25°C). If this value is not met, clean or dry out the winding and repeat the test. Replace if defective.

NOTE

Low insulation resistance may be caused by dirt or excessive moisture. Insulation failure may be caused by wrong voltages, induced voltages caused by opening field circuits too quickly, oil and grease, high temperatures or excessive vibration.

If the insulation fails to meet the test standards, the generator may be dried out by heat from a warm air oven, heat lamps, or strip heaters. The temperature should not exceed 167°F (75°C).

CAUTION

When oven drying, use a forced air circulation oven, not a radiant type. Radiant type oven would overheat some generator parts before remote parts reached a satisfactory temperature.

NOTE

If the generator must be dried out, then it is necessary to revarnish the equipment immediately after drying to prevent damage to the unit.

(2) Generator and excitation system test.

(a) Generator Stator. Disconnect all leads to voltage regulator and all other points to completely isolate the winding before meggering.

(b) Generator Rotor. Disconnect field leads from the rotating diode assembly before meggering.

(c) Exciter Stator. Disconnect both field leads from terminals 1 and 2 of TB210.

(d) Exciter Rotor. Check this only if other windings have low insulation resistance as the leads must be unsoldered from all diodes before meggering

(e) Tag and disconnect the two leads from the voltage regulator to terminals in the lead separation box. Connect positive side of a DC ammeter to negative field terminal (F-) and the positive output of an adjustable DC source to the positive field (F+) terminal. Connect negative output of DC source to negative side of DC ammeter. The exciter field is rated at 5.6 amps and 50V DC. The adjustment should be set to minimum voltage.

(f) Select 60 Hz and start the engine. With the speed at 1800 rpm, turn on the adjustable DC power supply. Adjust the DC voltage so that the generator output voltage (no load) reads 208 or 416 volts depending on low or high voltage connection. The exciter field should draw approximately 1 ampere to produce rated voltage at no load. The voltage across the exciter field under these conditions is approximately 10.8V DC, ±15 percent.

(g) If the DC ammeter indicates incorrect input exciter current to obtain rated voltage in step (f) above, the generator has failed. If, however, the output is as specified, the voltage regulator, control or PM generator has failed.

(h) Test rotating rectifier diodes (paragraph 11-8b). If any defective diodes are replaced, repeat step (2), above, to determine if the generator defect has been corrected.

(i) Tag and disconnect the two top leads at terminals 1 and 2 of TB210 (14, figure 11-3). Read the exciter field resistance at terminals 1 and 2 with a Wheatstone bridge. The exciter stator field resistance should be 10.7 ±10 percent ohms at an ambient temperature of 77°F (25°C).

(j) Check insulation resistance with megger between terminals 1 and 2 and the frame (paragraph 11-5a(1)). Reconnect the two leads.

(k) Disconnect generator rotor leads from the rotating diode assembly and measure the field resistance with a Wheatstone bridge. The resistance should be approximately 1.66 ±10 percent ohms at an ambient temperature of 77°F (25°C).

(l) Megger between field leads and frame (paragraph 11-5a(1)).

(m) Disconnect diodes and use a double Kelvin bridge to read the resistance between leads on the exciter rotor. This value should be 0.048 ±10 percent ohms at 77°F (25°C).

(n) Check insulation resistance with megger between exciter armature leads and frame (paragraph 11-5a(1)).

(o) Check resistance of surge protector when disconnected from one side of generator field. Value should be 1 megohm or more in each direction. Check to be sure no physical damage is evident on the surge protector.

(p) Tag and disconnect the twelve stator leads to the voltage reconnection panel and measure each of the six stator windings with a Kelvin double bridge. Resistance should be 0.00237 ±10 percent ohm in each circuit at ambient temperature of 77°F (25°C).

(q) Connect all stator leads together and read between the leads and the generator frame with a megger (paragraph 11-5a(1)).

(3) Stator. Perform the following stator winding short circuit test.

(a) Use an inside-type growler, and test each coil in the stator. Position the growler in the stator and hold a thin metal strip, similar to a hacksaw blade, parallel to the core slots.

(b) Energize the growler and explore the core surfaces approximately one pole distance on each side of the growler. Continue testing one core slot at a time until all coils are tested. If the winding is shorted, the metal strip will vibrate when held over the slot containing the faulty coil.

(c) If the above test is not met, proceed with the removal and repair procedures.

(4) Rotor. Perform a growler test on the rotor as follows:

(a) Place the rotor on the growler and energize.

(b) Hold a thin piece of metal, such as a hack-saw blade, directly over the top slot of the rotor and along the length of the slot. If the coil is shorted the blade will vibrate rapidly and cause a growling noise.

(c) If the above test is not met, proceed with the repair procedures.

(5) PM Generator Exciter Field. Perform the following resistance checks:

(a) At lead separation box, disconnect and tag PM generator exciter field leads (there are three; the common; the 50 Hertz tap; and the 60 Hertz tap).

(b) Using a double Kelvin bridge, check the resistance between the common lead and the 50 Hertz tap. Resistance should be 1.1 ohms ±10 percent.

(c) Using a double Kelvin bridge, check the resistance between the common lead and the 60 Hertz tap. Resistance should be 1.35 ohms ±10 percent.

(6) PM Generator Permanent Magnet. The strength of the magnet field surrounding the permanent magnet (rotor), because of its in accessibility, may not be checked directly. However, if the AC output of the PM generator is within ±10 percent of 135V AC at 1800 rpm, the permanent magnet may be considered normal. If the PM generator output is out of tolerance and checking the resistance of the PM exciter field (as indicated in the previous subparagraph 5) produces positive results, the permanent magnet, by the process of elimination, may be considered defective. If defective, refer to paragraph 11-6 for replacement procedures for permanent magnet rotor assembly.

b. Replacement.

(1) Removal. The following steps are for the removal of the generator from the generator set frame.

(a) If generator set is equipped with a housing kit remove panels (34 and 30, figure 15-21) and strip (27).

(b) The permanent magnet assembly must be removed prior to removing generator from generator set, as follows (see figure 11-3):

(1) Remove screws (16 and 28), washers (29), and nuts (27) and remove cover (30).

(2) Remove screws (31) and washers (32) and remove permanent magnet stator (33).

WARNING

USE EXTREME CARE WHEN REMOVING ROTOR TO PREVENT INJURY TO HANDS DUE TO MAGNETIC ATTRACTION BETWEEN THE PERMANENT MAGNET GENERATOR ROTOR AND THE PERMANENT MAGNET GENERATOR STATOR OR GENERATOR SHAFT.

(3) Remove bolt (34), washers (35) and spring pin (36) and remove magnet rotor (37).

(c) Reconnection Box. Disconnect and tag generator wires, cables, and buss bars removed from the reconnection box assembly.

(1) Remove reconnection box enclosure (28, figure 11-1), by removing screws, washers, and nuts that attach enclosure to external power box assembly and output box.

(2) Remove screw (15, figure 11-3), nut (16), and lockwasher (17) and separate lead clamp (19) in order to remove generator cables.

(3) Disconnect and tag wires in lead box (14).

(4) Remove screws (8), washers (9), screws (23), and washers (24). Separate output box (25) and wires and cables from generator.

(d) Air Cleaners. To remove generator using hoist and sling assembly, air cleaners must be removed from the support frame. Refer to figure 11-4 and proceed as follows:

(1) Remove hose clamps connecting air hoses to air cleaners.

(2) Remove screws, washers, and nuts supporting the two mounting channels onto the frame assembly.

(3) Remove air clean assembly.

(e) Remove either EXTERNAL CONTROL BOX per paragraph 2-15a or AC-DC BOX per paragraph 2-14a.

(f) Generator Mounting Bolts. To remove the generator from the skid base, proceed as follows:

(1) Remove covers (63 and 67, figure 11-3) by removing screws (64), washers (66), and nut (65),

(2) Remove sixteen screws and washers securing generator assembly (fig. 11-5) to engine flywheel housing.

(3) Remove six screws, washers and locking plate to engine flywheel.

(4) Remove the four generator mounting bolts securing generator frame to the skid base assembly. Lift the generator by attaching an overhead hoist and slings to the eyebolts on the generator frame.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

CAUTION

Determine that the hoist is of sufficient strength to adequately support the weight of the generator. Hoist and hoist cables should have a rating of not less than 6000 pounds (2,724 kg). Always make certain extreme care is taken when moving the generator to prevent its striking other objects or personnel. Never apply a lifting force to structural points other than those provided for that purpose.

(2) Installation. Install repaired, rebuilt, or overhauled generator to the engine and skid base assembly are follows:

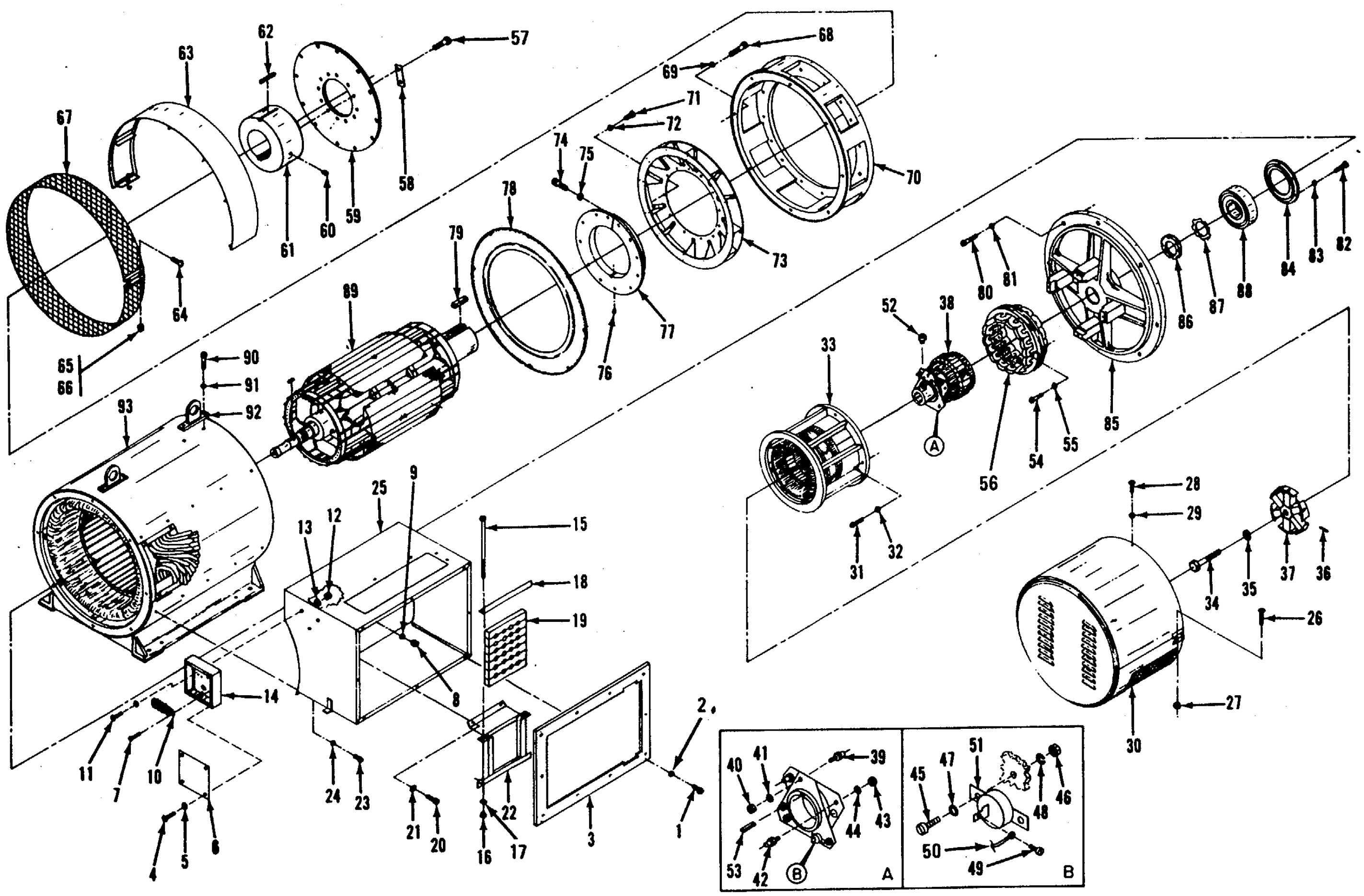


Figure 11-3. Generator Assembly, Exploded View

LEGEND FOR FIGURE 11-3

1. Screw
2. Washer
3. Plate
4. Screw
5. Washer
6. Cover
7. Screw
8. Nut
9. Washer
10. Terminal board
11. Screw
12. Nut
13. Washer
14. Lead box separation
15. Screw
16. Nut
17. Washer
18. Batten
19. Lead clamp
20. Screw
21. Washer
22. Bracket
23. Screw
24. Washer
25. Outlet box
26. Screw
27. Nut
28. Screw
29. Washer
30. Cover
31. Screw
32. Washer
33. Permanent magnet
34. Bolt
35. Washer
36. Pin
37. Permanent magnet
38. Exciter rotor unit
39. Diode
40. Nut
41. Washer
42. Diode
43. Nut
44. Washer
45. Screw
46. Nut
47. Washer
48. Washer
49. Screw
50. Lug
51. Surge protector
52. Setscrew
53. Key
54. Screw
55. Washer
56. Field
57. Screw
58. Bracket
59. Drive plate assy
60. Setscrew
61. Coupling hub
62. Key
63. Cover
64. Screw
65. Nut
66. Washer
67. Cover
68. Screw
69. Washer
70. Adaptor
71. Screw
72. Washer
73. Fan
74. Screw
75. Washer
76. Setscrew
77. Hub
78. Baffle
79. Key
80. Screw
81. Washer
82. Washer
83. Washer
84. Cap
85. Endbell
86. Nut
87. Washer
88. Bearing
89. Shaft and rotor
90. Screw
91. Washer
92. Lifting eye
93. Frame and stator

NOTE

Do not assemble permanent magnet generator assembly (stator and rotor) and end cover on the generator prior to installation.

(a) Check to make certain generator bearing end clearance is sufficient. Generator bearing end clearance should not be less than 0.015 inch (0.4 mm) plus 0.06 inch (1.6 mm).

(b) Check Flywheel Face Runout. Position the indicator finger on the drive disc recess of the flywheel as shown in figure 11-6. Set the dial indicator to zero. Turn the engine through one complete revolution. Total indicator reading should not exceed 0.005 inch (0.13 mm). If reading exceeds allowable limits, excessive vibration could result.

(c) Check pilot bore eccentricity. Position the indicator finger on the bore of the drive disc pilot recess as shown in figure 11-7. Rotate the engine through one revolution. Total indicator reading should not exceed 0.005 inch (0.13 mm).

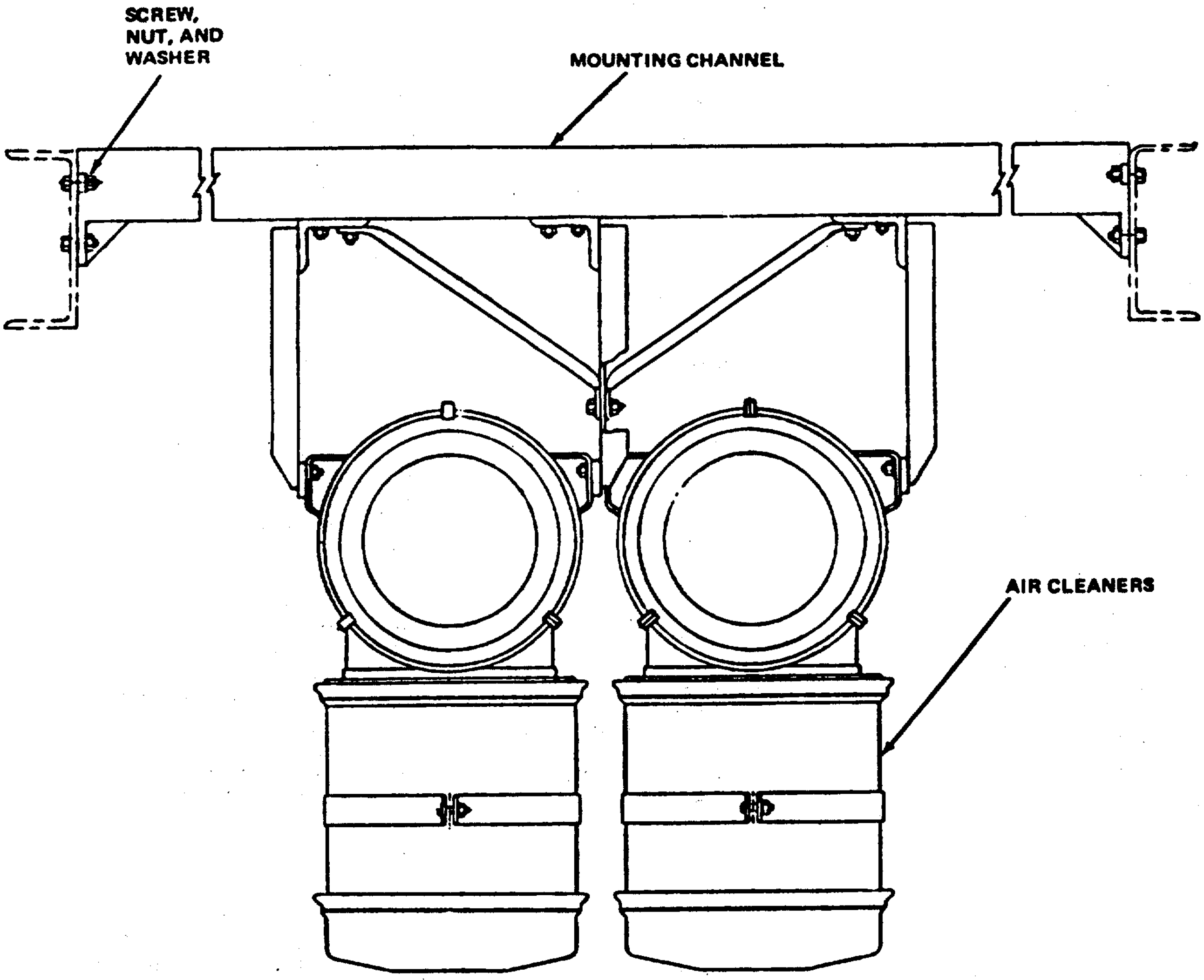


Figure 11-4. Air Cleaner Assembly Removal

(d) Check the Flywheel Housing Runout. Mount the base of a dial indicator on the flywheel and position the finger of the indicator on the machined surface of the flywheel housing (bellhousing) which bolts to the generator adapter. (See figure 11-8.) Set the dial indicator to zero. Turn the engine through one complete revolution. Total indicator reading should not exceed 0.006 inch (0.15 mm). If reading exceeds the allowable limit, excessive vibration could result.

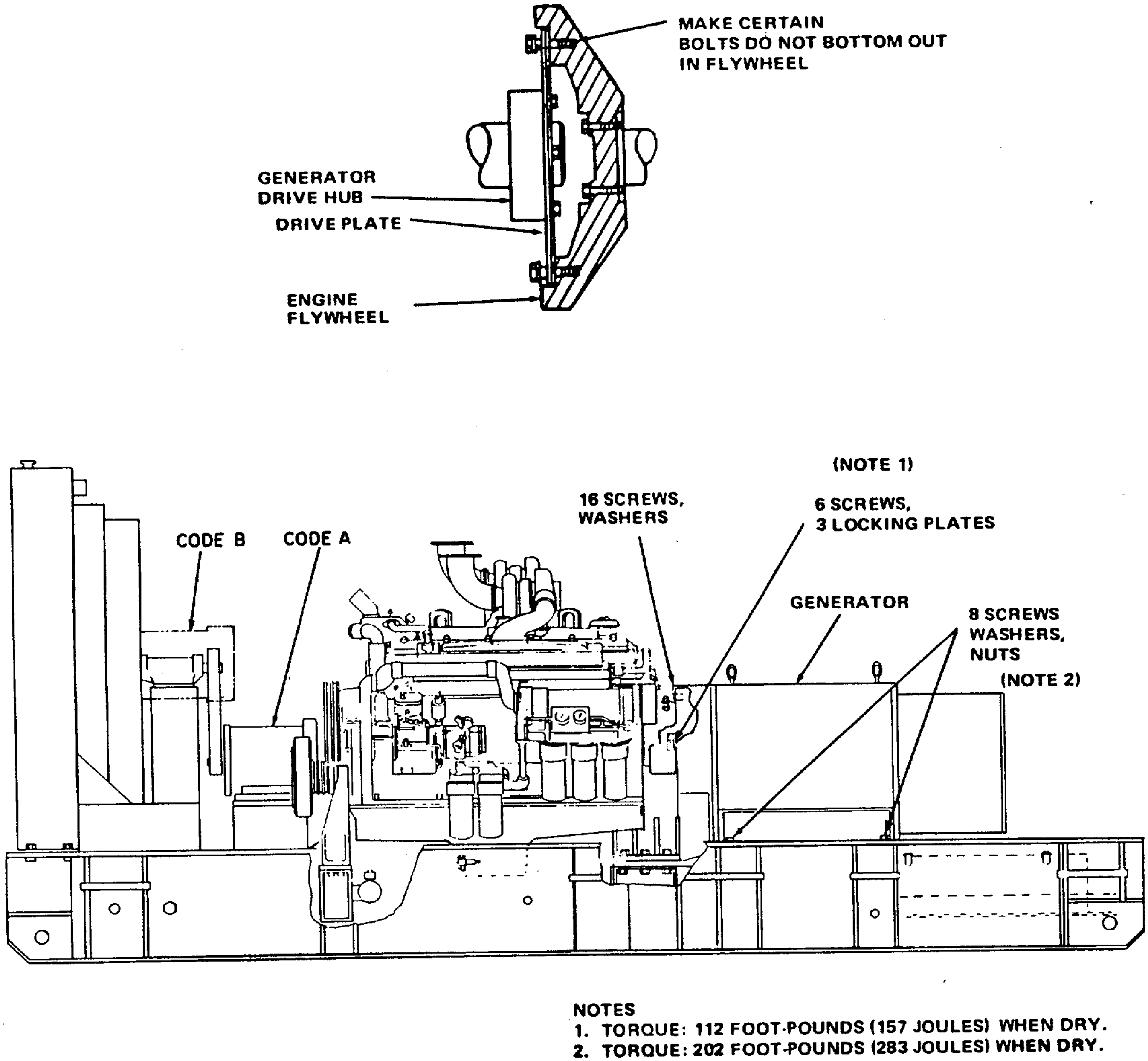


Figure 11-5. Generator Mounting Bolts

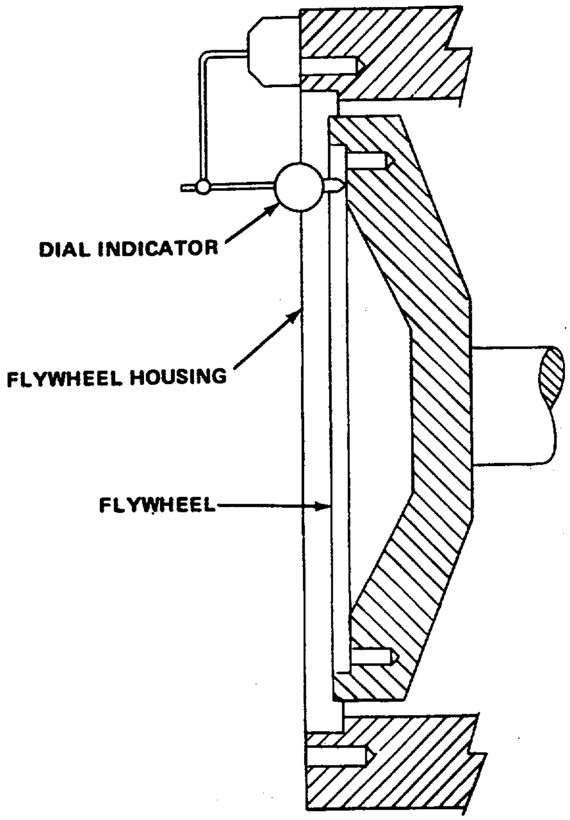


Figure 11-6. Checking Flywheel Face Runout

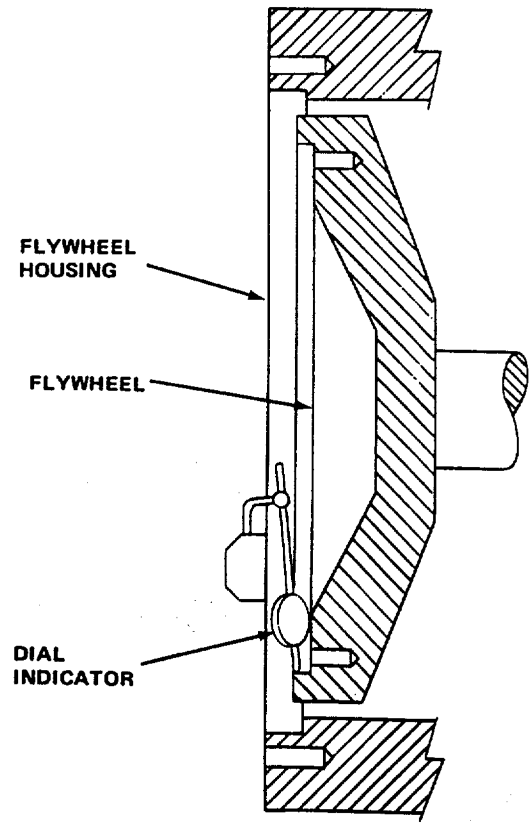


Figure 11-7. Checking Flywheel Pilot Bore Eccentricity

(e) Measure the distance from the surface on the generator adapter that bolts to the engine flywheel housing to the outside surface on the drive discs (Dimension "Y", figure 11-9). Then measure the distance from the machined surface on the engine flywheel (Dimension "C", figure 11-10). If the distance from the bellhousing to drive disc recess "C" is more than the distance from the generator adapter to the drive discs "Y", install additional spacers between the drive discs and the generator drive hubs. If "Y" is more than "C", remove spacers located between the drive discs and generator hub.

(f) Make certain drive discs "seat" in the drive disc recess.

WARNING

NEVER GRIND OD OF DRIVE DISCS AND NEVER ATTEMPT TO "DRILL OUT" HOLES IN DRIVE DISCS. IF DRIVE DISCS DO NOT FIT PROPERLY, REPLACE DRIVE DISCS.

(3) Locating Generator. Lift the generator by attaching an overhead hoist and slings to the eyebolts on the generator frame.

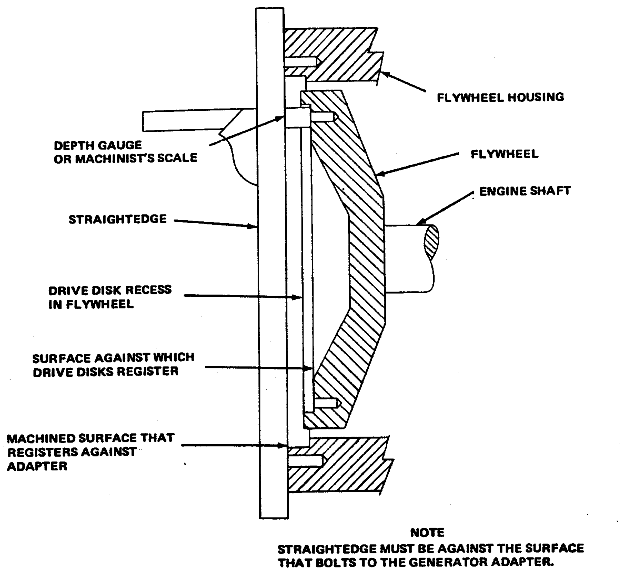


Figure 11-8. Checking Flywheel Housing Runout

CAUTION

Determine that the hoist is of sufficient strength to adequately support the weight of the generator. Hoist and Hoist cables should have a rating of not less than 6,000 pounds (2,727 kg). Always make certain extreme care is taken when moving the generator to prevent its striking other objects or personnel. Never apply a lifting force to structural points other than those provided for that purpose.

(a) Install sixteen screws and washers securing generator assembly (figure 11-5) and six bolts and locking plate to engine flywheel housing. Tighten screws.

(b) Move generator to location on skid base, line up mounting holes and install four generator mounting bolts (figure 11-5) securing generator frame to the skid base assembly. Do not tighten bolts at this time.

(c) Install Control Box Assembly per paragraph 2-14b.

CAUTION

If fan is moved, make certain that before generator set is placed in operation, fan is positioned with about 1/2 inch (13 mm) clearance between fan and baffle and all fan bolts are installed and tightened.

(d) Tighten mounting bolts to torque shown in figure 11-5. Make certain generator mounting pads contact the base evenly and with equal pressure. Use of shims may be required.

(e) After generator is assembled to the engine, check runout by placing the base of a dial indicator on a generator frame rib and positioning the indicator finger on the generator shaft. Set dial indicator to zero. Turn generator through at least one revolution. Total indicator reading should not exceed 0.005 inch (0.13 mm).

NOTE

Use inspection mirror to read indicator. It may be necessary to move fan out of the way. See CAUTION following step (c).

(4) Installing PMG.

(a) Install the exciter rotor assembly and the pilot exciter rotor. Make certain the key is in place in the shaft before installing exiter rotor assembly.

CAUTION

Do not apply force to rotating rectifier or to the armature windings.

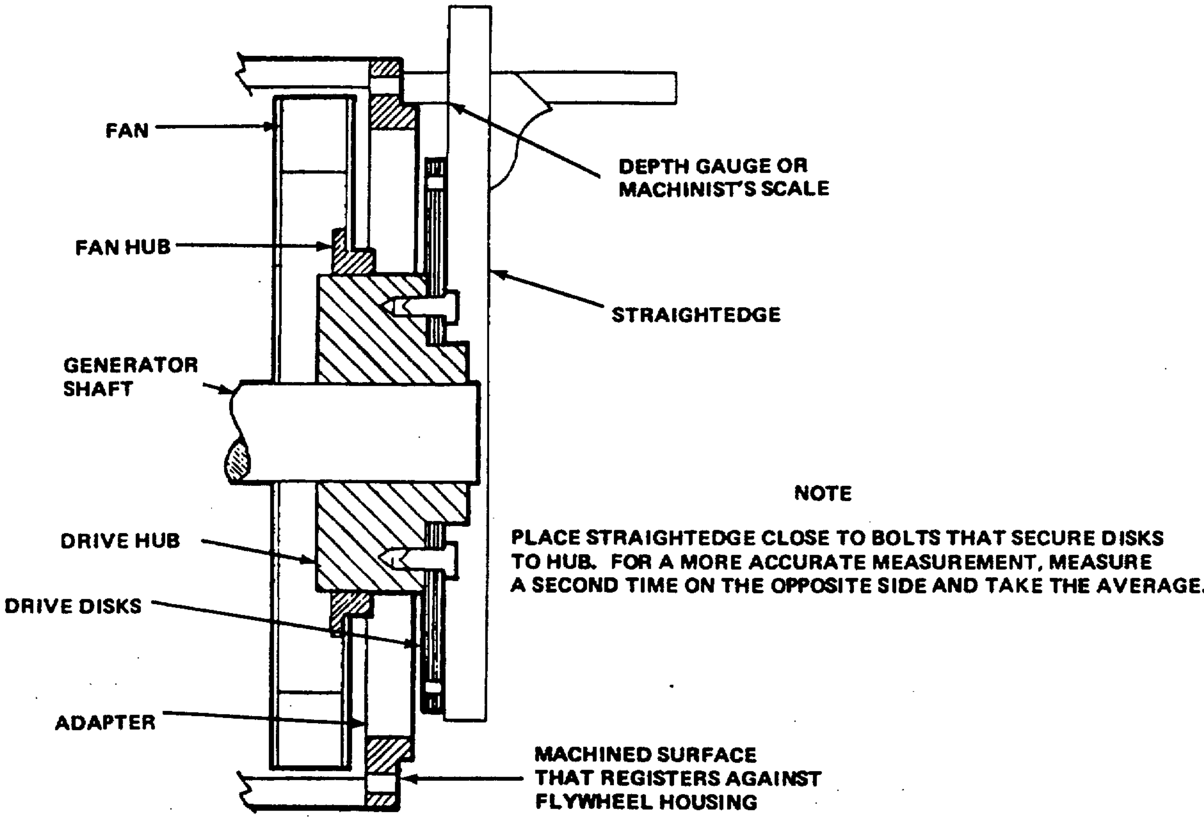


Figure 11-9. Obtaining Dimension Y

(b) Install permanent magnet rotor (37, figure 11-3) with spring pin (36), cover (30), bolt (34), and washer (35).

(c) Install permanent magnet stator (33) with screws (31) and washers (32).

(d) Install cover (30) with screws (26 and 28), washers (29) and nuts (27).

(e) Connect (+) and (-) leads from generator field onto (+) and (-) terminals located on the heat sinks of the rotating rectifier assembly.

(f) Before placing generator set in operation, visually inspect clearance between generator stationary and rotating parts.

(g) Visually inspect alignment of the exciter armature with the exciter field.

(h) Before placing generator set in operation, turn engine through several revolutions, but do not permit engine to start. visually inspect clearance between generator stationary and rotating parts. Listen for

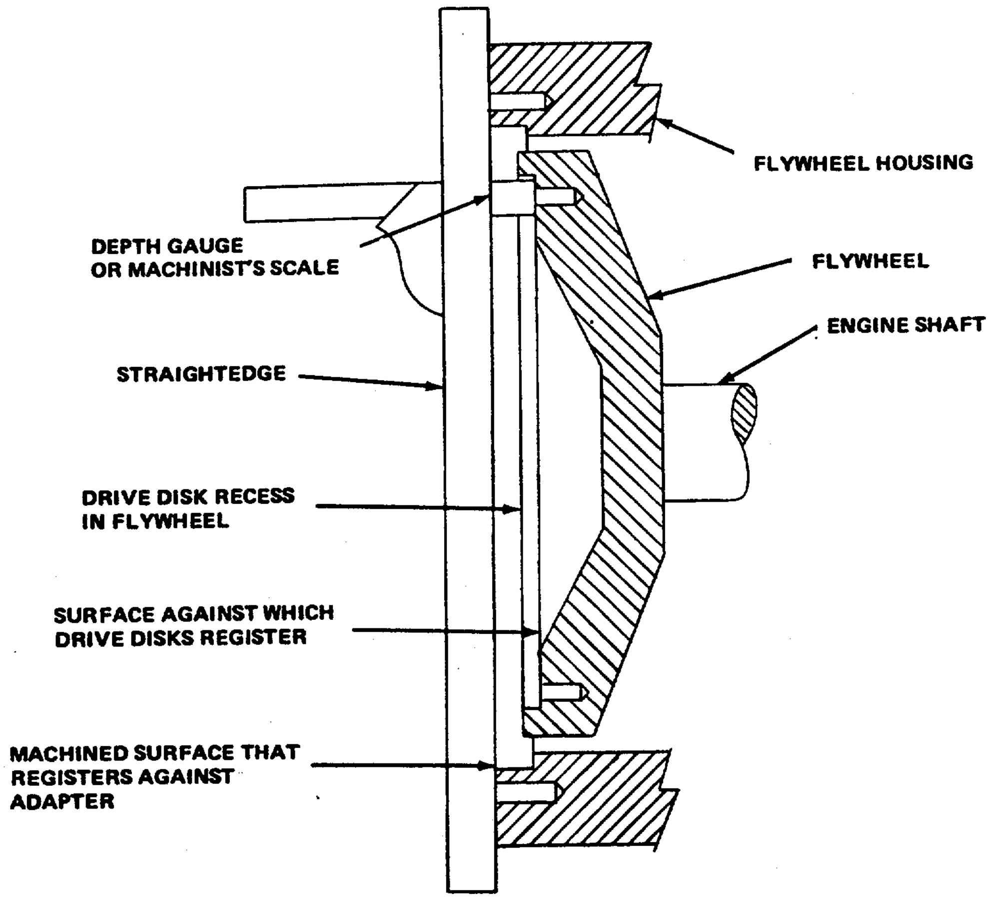


Figure 11-10. Obtaining Dimension C

unusual noises such as produced by parts rubbing together.

(i) When generator installation has been completed and inspected, install covers and guards.

c. Repair. Repair of the generator consists of testing, removing, replacing, and repairing components as listed in table 11-1.

(1) Replace or rebuild all defective parts.

NOTE

To remove coils from an iron core, it is recommended that the part be heated in a moderate oven temperature 302°F (150°C) to facilitate removal. Single coils should not be replaced as adjacent parts of the winding may be damaged during, coil removal.

(2) Apply varnish to any damaged areas of insulation.

(3) Replace damaged exciter rotor or stator.

d. Overhaul. Overhaul of the generator consists of the replacement of components after inspection and/or testing indicates the need for replacement. The inspection, test, replacement, and repair of generator components is described in paragraphs listed in table 11-1.

Table 11-1. Repair of Generator Components

COMPONENT	PARAGRAPH REFERENCE			
	TEST	REMOVAL	REPLACEMENT	REPAIR
PMG stator and frame	11-6c	11-6d	11-6d	
PMG rotor	11-7b	11-7c	11-7c	11-7d
Rotating rectifiers	11-8b	11-8c	11-8c	11-8d
Bearing			11-9a	11-9a
Drive plate			11-10b	11-10b
Fan			11-11a	11-11a
Rotor	11-12b	11-12c	11-12c	11-12d
Exciter stator	11-13b	11-13c	11-13c	11-13d
Exciter armature	11-14b	11-14c	11-14c	11-14d
Frame and stator	11-15b	11-15c	11-15c	11-15c

e. Rebuild. Generator rebuilding consists of restoring generator to "like new" condition. This requires the replacement of parts and the rewinding of coils on fields and armatures, new diodes and surge protector, bearing, covers, etc. All metal parts are cleaned with Federal Specification P-D-680 and thoroughly dried. Cracks in frame and other components are welded and painted parts are repainted in accordance with specification MIL-T-704, type A, semigloss, olive drab color no. X24087.

NOTE

Machined surfaces, screw threads, leads, and lead clamps are to be free from paint.

Rebuild generator components in accordance with procedures described in paragraphs listed in table 11-1.

11-6. PERMANENT MAGNET STATOR AND FRAME ASSEMBLY

a. General. The permanent magnet generator (PMG) stator furnishes power to the voltage regulator. The stator (33, figure 11-3) is bolted to the end-bell (85). It consists of armature windings in a laminated core welded to a steel frame. The revolving field or rotor (37) is made up of permanent magnets.

b. Inspection. Inspect assembly for:

(1) Cracked insulation of wiring.

(2) Accumulation of dust, moisture or other foreign matter.

(3) Cracks or breaks in welded steel frame.

c. Test. A resistance check of the stator winding can be made as follows:

(1) Connect a Wheatstone bridge to the stator leads.

(2) Resistance should be 0.0024355 ohms per winding, at an ambient temperature of 77°F (25°C).

(3) If resistance reading is incorrect, replace defective stator assembly.

d. Replacement. When disassembling the PMG stator from the generator, the PMG rotor and exciter assembly is also removed.

(1) Removal. Remove as follows:

(a) Remove screws (26 and 28, figure 11-3), washer (29), and nut (27), and remove cover (30).

WARNING

USE EXTREME CARE WHEN REMOVING ROTOR TO PREVENT INJURY TO HANDS DUE TO MAGNETIC ATTRACTION BETWEEN THE PMG ROTOR AND THE PMG STATOR OR GENERATOR SHAFT.

(b) Take out retaining bolt (34) and washer (35). Observe WARNING above, and remove pin (36) and PMG rotor (37).

NOTE

If the PMG rotor is to remain disassembled for an extended period, install a keeper on the rotor. Use a band of iron or steel.

(c) Support the PMG stator with an overhead crane or hoist.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

(d) Disconnect the PMG stator leads. Tag leads for reconnection.

(e) Disconnect and tag exciter field leads.

(f) Remove exciter rotor (38) as follows:

(1) Remove set screw (52).

(2) The exciter armature is a "slip-fit" on the generator shaft. If the armature cannot be removed by hand, remove with a puller.

CAUTION

Do not pull on rotating rectifier assembly of the exciter armature windings.

(3). Install a cap or plug to protect the shaft center. Using the tapped holes in the end of sleeve, bolt to the end of sleeve spacers and a metal plate. Refer to figure 11-11.

(4) Hook a bearing puller to the metal plate and pull exciter armature and rotating rectifier assembly from the shaft.

(g) Remove screws (31) and washers (32) holding the PMG stator frame, and screws (54) and washers (55) supporting the exciter field (56) to the endbell (85).

(2) Replacement. Replace as follows:

(a) Install exciter field (56) onto endbell (85) with screws (54) and washers (55). Connect exciter field leads to reconnection box. Remove tags from leads.

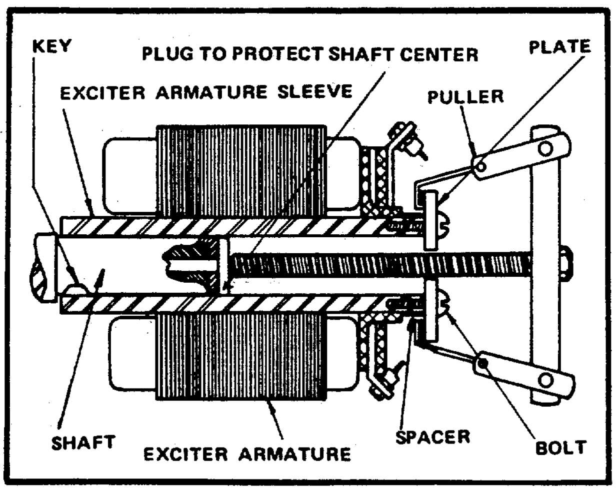


Figure 11-11. Removing Exciter Armature and Rotating Rectifier Assembly

(b) Install exciter rotor (38) on generator shaft as follows:

(1) If the "slip-fit" exciter armature and rotating assembly will not easily slide onto the shaft by hand, install with a fixture as shown in figure 11-12.

NOTE

Usually the exciter armature will slide onto the shaft most of the way by hand. The exciter armature can usually be "seated" by tapping lightly on the sleeve with a soft rubber or fiber mallet. Make certain mallet hits only the sleeve, not rectifier assembly or armature windings

CAUTION

Make certain the key is in place in the generator shaft and the keyway in the exciter armature sleeve is aligned with key before starting the exciter armature onto generator shaft.

(2) Refer to figure 11-12 for fixture setup. Start exciter armature and rectifier bridge on shaft. Thread stud in rotor shaft. Install large diameter washers on stud and start stud nut. Pull exciter armature and rotating rectifier onto shaft by turning stud nut.

(3) Install exciter armature retaining bolt (34, figure 11-3), washer (35), and pin (36). Connect alternator field leads to positive (+) and negative (-) terminals located on the heat sinks of the rotating rectifier assembly. Install exciter cover (30) with screws (26 and 28) washers (29), and nuts (27).

(c) Using a crane or hoist, install the PMG stator (33) over exciter assembly onto endbell (85) with screws (31) and washers (32). Connect PMG stator leads to reconnection assembly. Remove tags from leads.

(d) Remove iron band (if used) from PMG rotor assembly (37). Carefully attach PMG rotor (37), bolt (34), and washer (35).

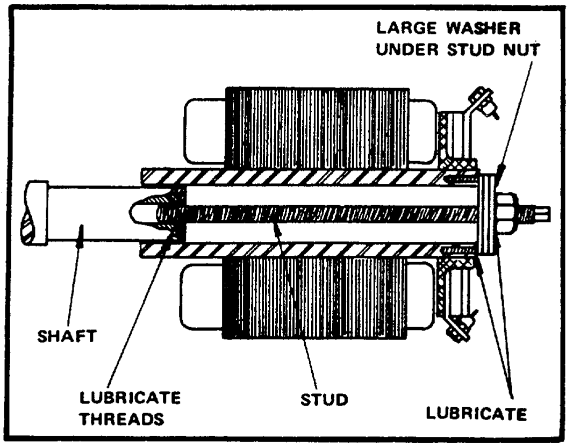


Figure 11-12. Installing Exciter Armature and Rotating Rectifier Assembly

(e) Replace cover (30) with screws (26 and 28), washers (29), and nuts (27).

11-7. PERMANENT MAGNET ROTOR ASSEMBLY. The permanent magnets and soft pale tips of the revolving field are permanently attached to a steel hub by nonmagnetic stainless steel bolts.

CAUTION

No attempt should be made to unbolt and separate rotorparts. This will alter permanent magnets, reducing their strength. Do not expose rotor to excessive heat or mechanical shock.

a. Inspection. Inspect the rotor for metal chips attracted to the magnets, accumulation of dust, and check security of bolts holding each magnet to hub.

b. Testing. No testing of the PMG rotor is required.

c. Replacement.

(1) Removal.

(a) Remove cover (30, figure 11-3) by removing screws 26 and 28), washer (29), and nut (27).

WARNING

USE EXTREME CARE WHEN REMOVING ROTOR TO PREVENT INJURY TO HANDS DUE TO MAGNETIC ATTRACTION BETWEEN THE PMG ROTOR AND THE PMG STATOR OR GENERATOR SHAFT.

(b) Remove bolt (34), washer (35), and pin (36) from PMG rotor (37). Carefully remove PMG rotor (37) from generator shaft.

NOTE

If the PMG rotor is to remain disassembled for an extended period, install a keeper on the rotor. Use a band of iron or steel.

(2) Replacement.

(a) Remove iron band (if used) from PMG rotor (37).Carefully attach PMG rotor (37) to generator shaft with pin (36), bolt (34), and washer (35).

(b) Replace cover (30) with screws (26 and 28), washers (29), and nuts (27).

d. Repair. Since there are no bearings, brushes, or slip rings and no semiconductor devices, there is no repair of the PMG rotor.

NOTE

No attempt should be made to unbolt and separate the parts of the rotor. Breaking the magnetic circuit would alter the permanent magnets, reducing their strength. Reassembling the rotor would not restore the magnetism to its prior state.

e. Rebuild. Since there are no bearings, brushes, or slip rings and no semiconductor devices, there is no rebuild of the PMG rotor.

NOTE

No attempt should be made to unbolt and separate the parts of the rotor. Breaking the magnetic circuit would alter the permanent magnets, reducing their strength. Reassembling the rotor would not restore the magnetism to its prior state.

11-8. ROTATING RECTIFIER. The rotating rectifier assembly is part of the exciter rotor. (See figure 11-13.) The rotating rectifier assembly consists of a full wave rectifier bridge made up of six semiconductor devices mounted on aluminum heat sinks. Rectifiers are retained in the heat sink assemblies with retaining nuts and washers.

a. Inspection. Check wiring for loose connections and diodes for looseness in frame.

b. Test. Remove cover (20, figure 11-3) to gain access to the rotating rectifier assembly on exciter rotor (38).

(1) Disconnect lead from diode under test.

(2) Refer to figure 11-14, then connect ohmmeter leads across rectifier in one direction. Note meter reading. Reverse leads and note meter reading. The meter should indicate a low resistance when leads are across rectifier in one direction and a high resistance when leads are across rectifier in the other direction.

(3) If the meter indicates a low resistance in both directions, the rectifier is shorted. A high resistance in both directions indicates an open rectifier.

(4) Check resistance of surge protector (varistor) when disconnected from one side of generator field. Value should be 1 megohm or more in each direction. Check to be sure no physical damage is evident on the surge protector.

c. Replacement.

(1) Removal. Remove the rotating rectifier assembly as follows:

(a) Remove cover (30, figure 11-3) by removing screws (26 and 28), washers (29), and nuts (27).

(b) Disconnect leads from (+) and (-) terminals located on the heat sinks of the rotating rectifier assembly.

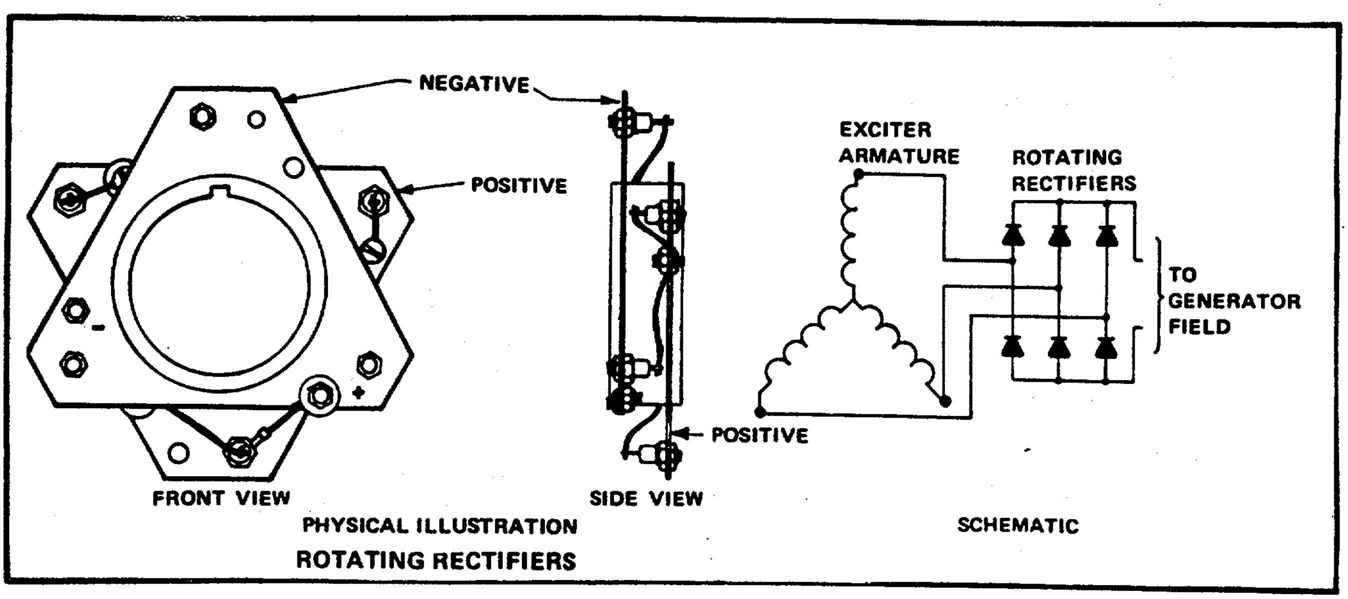


Figure 11-13. Rotating Rectifier Assembly

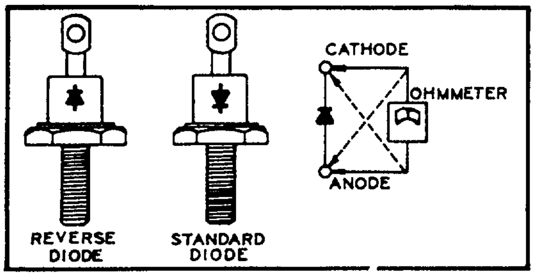


Figure 11-14. Testing Rotation Rectifiers with an Ohmmeter

Tag leads for later reconnection

(c) Remove rotating rectifier with key (53 from exciter rotor (38).

(2) Replacement.

(a) Install rotating rectifier assembly onto exciter rotor (38).

NOTE

Make certain the key is in place and the keyway in the rotating rectifier is aligned with key before installing.

(b) Connect leads to (+) and (-) terminals; remove tags.

(c) Replace cover (30) with screws (26 and 28), washers (29), and nuts (27).

d. Repair. The rotating rectifier assembly repairs involve replacement of diode and surge protector.

(1) Remove and replace standard diodes (39, figure 11-3), detail A) and reverse diodes (42) on rotating rectifier heat sinks with washers (41 and 44) and nuts (40 and 43). Reconnect leads.

(2) Remove and replace surge protector (51) from heat sink with screws (45), washers (47 and 48), and nuts (46).

11-9. BEARING. The generator bearing is permanently lubricated and sealed. If a defective bearing is indicated by vibration or noise at the bearing housing on the endball, the bearing can be replaced without removal of the generator from the set.

a. Replacement.

(1) Removal. To gain access to the bearing (88, figure 11-3), the endbell (85) with PMG stator (33) and exciter assembly must be removed as a unit. Use crane or hoist to remove.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

(a) Remove cover (30) by removing screws (26 and 28), washers (29), and nuts (27).

WARNING

USE EXTRA CARE WHEN REMOVING ROTOR TO PREVENT INJURY TO HANDS DUE TO MAGNETIC ATTRACTION BETWEEN THE PMG ROTOR AND THE PMG STATOR OR GENERATOR SHAFT.

(b) Remove PMG rotor (37) by removing pin (36), screw (35), and washer (34).

NOTE

Do not subject PMG rotor to severe mechanical shock.

(c) Loosen setscrews (52) in exciter rotor (38).

(d) Remove exciter rotor (38).

(e) Remove screws (82) and washers (83) to free bearing cap (84).

(f) Attach crane or hoist to endbell (85). Remove bolts (80) and washers (81). Remove endbell (85) and PMG stator and exciter stator as a unit.

NOTE

Tap lightly with rubber mallet to loosen endbell. Check for shims in the endbell bearing housing (well). Make certain shims, when incorporated, are reinstalled when unit is assembled.

(g) Remove nut (85) and lockwasher (86).

(h) Use a puller to remove the bearing from the shaft. (See figure 11-15.) Protect the shaft end with a cap. If bearing is to be used again, make sure puller applies pressure only against the bearing inner ring.

(1) Bearing Inspection. The following inspection of the bearing should be made: Results of the inspection will determine if the bearing is to be replaced.

(a) Wash the bearing and inspect the residue. If hips and flakes are found, replace the bearing.

(b) Observe the outer diameter of the bearing and the inner surface of the bearing housing section of the endbell for evidence of spinning.

(c) Check the bearing for flaking or denting by grasping the outer race and rotating slowing to feel for dented or flaked balls or races. Replace bearing if excessive roughness is felt.

(d) Examine the cage for wear. If a bad condition of smearing exists, remove the bearing from service.

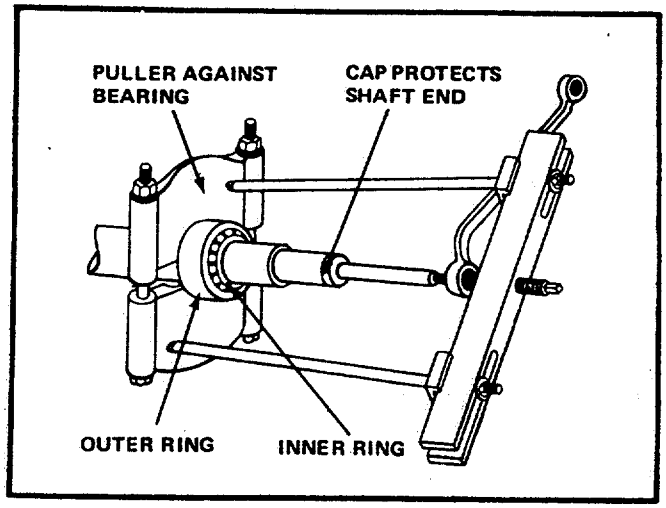


Figure 11-15. Removing Bearing from Generator Shaft

(e) Inspect the inner race. Examine the ball path to see that it is smooth and free from breaks. Dirt denting is not considered serious if it is not concentrated.

(f) Inspect the balls. Examine them visually to determine if metal has flaked from the surface. If flaking has occurred, remove the bearing from service. A small amount of evenly distributed denting marks on the ball is usually not considered serious. Several concentrated denting marks is serious enough to reject the bearing for further service.

(g) If there is a doubt that the bearing is not completely satisfactory, replace the bearing.

(h) If the bearing is satisfactory, replace it two thirds full with grease (MIL-G, type 23827AMI).

(2) Replacement.

(a) Heat the bearing to a

temperature of from 220 to 250°F (103 to 121°C) in a clean thermostatically controlled oven. Start the heated bearing into the shaft. Then use a fiber or soft metal tube to tap bearing into place. (See figure 11-16.) Make certain that pressure is applied only to the bearing inner ring.

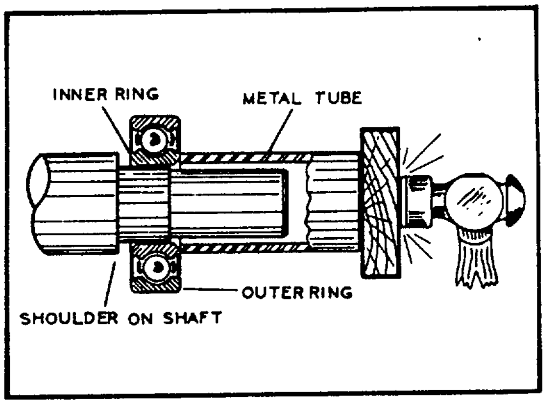


Figure 11-16. Install Bearing on Generator Shaft

(b) Press bearing onto shaft until inner ring is against bearing shoulder on the shaft. Continue assembly after the bearing has cooled.

(c) Using a crane, install endbell (85) and PMG stator and exciter assembly, over generator shaft.

(d) Install screw (80) and washers (81).

(e) Install screws and lockwashers (82 and 83) attaching bearing cap (84) to endbell (85).

(f) Line up lockwasher (87) and tighten nut (86) to secure bearing.

(g) Tighten setscrew (52) in exciter rotor (38).

(h) Install PMG rotor (37) with pin (36), scres (35), and washer (34).

(i) Replace cover (30) with screws (26 and 28), washers (29), and nuts (27).

11-10. DRIVE PLATE ASSEMBLY.

a. General. The generator shaft is directly driven by the engine shaft through the drive plate assembly, figure 11-17. The coupling compensates for misalignment between the two shafts to eliminate injurious stress on the connection components.

b. Replacement.

(1) Removal. Remove drive plate assembly (59, figure 11-3) as follows:

(a) Remove cover (63) and cover (67) by removing screws (64), washer (66), and nut (65).

(b) Remove screws attaching drive plate assembly to engine flywheel. (See figure 11-18.)

(c) Loosen setscrew (60) in coupling hub (61).

(d) Push drive plate assembly as far as possible towards the generator fan, in order to gain access to the hub screws (57).

(e) Remove screws (57) by straightening locking plate (58). Remove drive plate assembly.

(2) Replacement. Install drive plate assembly as follows:

(a) Locate drive plate assembly onto hub (61)

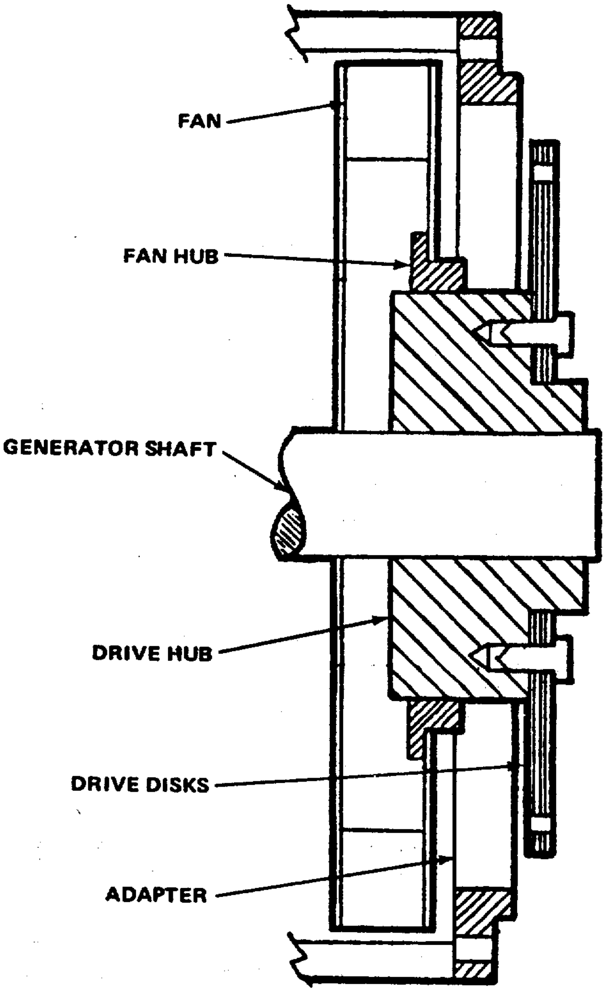


Figure 11-17. Drive Plate Assembly

and attach with screws (57) and locking plates (58). After tightening, turn tabs up on locking plates to lock bolts in place.

(b) Push drive plate assembly (with coupling hub attached) toward engine flywheel. Align holes and install bolts. Tighten and torque to 112 footpounds (157 joules) when dry. (See figure 11-18.)

(c) Tighten setscrew (60) on coupling hub (61).

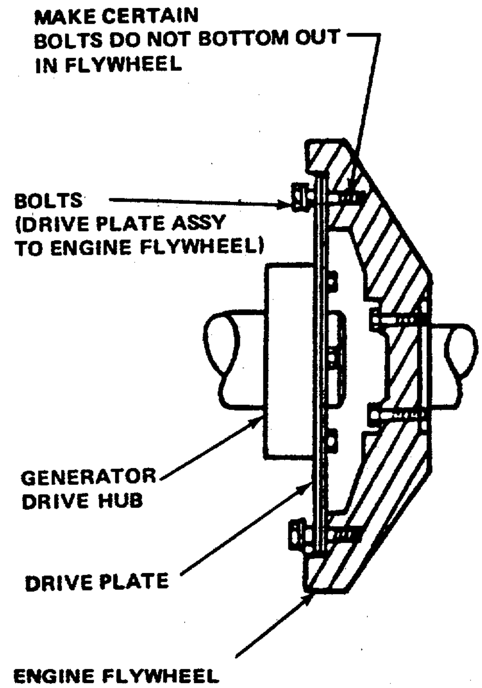


Figure 11-18. Drive Plate Assembly and Engine Flywheel Housing

11-11. FAN. The internal fan draws cool air through the cover at the exciter end of the generator, and exhausts warm air through the screen over the adapter assembly. The fan is key mounted directly to the drive plate assembly coupling hub.

a. Replacement. Remove and replace fan as follows:

(1) Removal. Refer to figure 11-3. To remove the fan, the drive plate assembly must be removed. Refer to paragraph 11-10.

(a) With covers and drive plate assembly removed, remove adapter (70) by removing bolts securing adapter to engine flywheel housing and screws (68) and washers (69) securing adapter to generator frame.

(b) Remove generator mounting bolts, and with crane, move generator away from engine enough to allow removal of coupling hub (61).

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

(c) Remove coupling hub (61) from shaft. Remove fan hub (73) by loosening screw (74) with washer (75) and loosen setscrews (76).

(d) Remove fan (73) with hub (77) attached.

(e) Remove hub (77) from fan (73) by removing screws (71) with washers (72).

(2) Inspection. Inspect fan hub and blades for visible signs of damage or wear.

(3) Replacement. Reinstall fan as follows: (See figure 11-3.)

(a) Attach hub (77) to fan (73) with screws (71) and washers (72).

(b) Attach coupling hub (61) to drive plate assembly (59) with screws (57) and lock in place with lockplates (58).

(c) Attach adapter (70) to generator frame with screws (68) and washers (69).

(d) Insert baffle (78) and fan (73) into adapter (70).

(e) Slide coupling hub (61) (with drive plate assembly) onto generator shaft aligned with fan hub (77) with both keys (62 and 79) in keyways.

CAUTION

Make certain that before generator set is placed in operation, fan is positioned with about 1/2 inch (13 mm) clearance between fan and baffle and all fan bolts are installed and tightened.

(f) Tighten screw (74) with washer (75) on fan hub (77). Tighten setscrews (76) on fan hub (77).

(g) With crane, move generator back to its original location and tighten mounting bolts. Refer to figure 11-5.

(h) Replace covers (63 and 67), bolts (64), washers (66), and nuts (65).

11-12. ROTOR ASSEMBLY. The rotor assembly is supported at one end by a single bearing in an endbell bolted to the stator frame. The opposite end of the rotor is provided with a fan assembly and drive plate assembly which bolts directly to the engine flywheel.

a. Inspection.

(1) Inspect rotor for loose, frayed, or burned windings.

(2) Inspect shaft for burrs or signs of wear.

(3) Inspect rotor assembly for cracks or other signs of damage.

b. Test. Check field winding resistance and shorts as follows:

(1) Connect a Wheatstone bridge to field winding leads.

(2) The resistance shall be 1.691 to 1.725 ohms at an ambient temperature of 77°F (25°C).

(3) Megger between field leads and rotor frame with a megohmmeter to measure the resistance between the winding and frame.

(4) Insulation resistance shall be at least 1 megohm at 77xF (25xC). If this value is not met, clean or dry out the winding and repeat test. Replace rotor if defective.

NOTE

Low insulation resistance may be caused by dirt or excessive moisture. Insulation failure may be caused by wrong voltages, induced voltages caused by opening field circuits too quickly, oil and grease, high temperatures, or excessive vibration.

(5) Perform a growler test on the rotor as follows:

(a) Place the rotor on the growler and energize.

(b) Hold a thin piece of metal, such as a hacksaw blade, directly over the top slot of the rotor and along the length of the slot. If the coil is shorted the blade will vibrate rapidly and cause a growling noise.

(c) If the above test is not met, proceed with the removal and repair procedures.

c. Replacement. For removal and replacement of the generator rotor assembly, the generator must be removed from the generator set. (See paragraph 11-5b). After generator has been removed from the generator set, locate it in a suitable maintenance area affording sufficient accessibility for maintenance and sufficient unobstructed flow of coolant air. Move the generator to the maintenance location either by attaching an overhead hoist to the eyebolts installed in the generator frame or by lifting the generator from underneath the base with a fork lift.
Determine that the hoist, when used, is of sufficient strength to adequately support the weight of the generator. Hoist and hoist cables and slings should have a rating of not less than 6,000 pounds (2,727 kg). when moving unit with a fork lift, make certain it is completely onto and balanced on the fork lift tines.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

CAUTION

Always make certain care is taken when moving the generator to prevent its striking other objects or personnel. Never apply a lifting force to structural points other than those provided for that purpose.

NOTE

Avoid maintenance locations which would subject the generator to excessive moisture, dust, steam or the fumes from acids, alkalines, or other corrosive chemicals.

(1) Removal. Remove the rotor from the generator as follows: (See figure 11-3.)

(a) Remove cover (30) by removing screws (26 and 28), washers (29), and nuts (27).

WARNING

USE EXTREME CARE WHEN REMOVING ROTOR TO PREVENT INJURY TO HANDS DUE TO MAGNETIC ATTRACTION BETWEEN THE PMG ROTOR AND THE PMG STATOR OR GENERATOR SHAFT.

(b) Remove PMG rotor (37) by removing pin (36), screw (35), and washer (34).

NOTE

Do not subject PMG rotor to severe mechanical shock.

(c) Loosen setscrew (52) in exciter rotor (38).

(d) Remove exciter rotor (38).

(e) Remove screws (82) and washers (83) to free bearing cap (84)

(f) Attach crane or hoist to endbell (85). Remove screws (80) and washers (81). Remove endbell (85) and PMG stator and exciter stator as a unit.

NOTE

Tap lightly with rubber or fiber mallet to loosen endbell. Check for shims in the endbell bearing housing (well). Make certain shims, when incorporated, are reinstalled when unit is assembled.

(g) Remove nut (86) and lockwasher (87).

(h) Use a puller to remove the bearing form the shaft. (See figure 11-15.) protect the shaft end with a cap. If bearing is to be used again, make sure puller applies pressure only against the bearing inner ring.

(i) Install pipes over generator shaft on the drive and exciter end of rotor. Attach slings and hoist to pipes and remove rotor assembly (89) from stator and frame (93). Make certain air gap is maintained between the rotor and stator during removal of the rotor.

CAUTION

Make certain pipes are of sufficient strength to support weight of rotor and that pipes do not have rough edges which would damage shaft surface.

(a) Install pipes over generator shaft on the drive and exciter end of rotor. Attach slings and hoist to pipes and remove rotor assembly (89) from stator and frame (93). Make certain air gap is maintained between the rotor and stator during removal of the rotor.

NOTE

Install bearing as described in paragraph 11-9 and PMG and exciter as described in paragraphs 11-6 and 11-7. Make certain generator armature (stator) and the exciter armature is aligned with the exciter field.

(b) Install generator as described in paragraph 11-5.

11-13. EXCITER STATOR. The brushless exciter provides excitation current for the generator. The stator is the stationary field for the exciter assembly.

a. Inspect. Inspect the exciter stator as follows:

(1) Inspect for loose, frayed, or burned windings.

(2) Inspect frame for cracks and burred mating surfaces.

b. Test. Disconnect all leads on the stator to completely isolate the winding.

(1) Using a Wheatstone bridge connected to a field winding, resistance shall be between 10.57 and 10.79 ohms at an ambient temperature of 77°F (25°C).

(2) Check insulation resistance with a megohmmeter between winding and frame. Resistance of each winding shall be at least 1 megohm at 77°F (25°C). If this value is not met, clean or dry out winding, and repeat test. Replace if defective.

NOTE

Low insulation resistance may be caused by dirt or excessive moisture. Insulation failure may be caused by wrong voltages, induced voltages caused by opening field circuits too quickly, oil and grease, high temperatures, or excessive vibration. Windings may be dried out by heat from a warm air oven, heat lamps, or strip heaters. The temperature should not exceed 167°F (75°C).

WARNING

WHEN OVEN DRYING, USE A FORCED AIR CIRCULATION OVEN, NOT A RADIANT TYPE. RADIANT TYPE OVEN WOULD OVERHEAT SOME GENERATOR PARTS BEFORE REMOTE PARTS REACHED A SATISFACTORY TEMPERATURE.

c. Replacement. For removal and replacement of the exciter stator, refer to paragraph 11-6.

d. Repair.

(1) Replace or rebuilt all defective parts.

NOTE

To remove coils from core, heat in a moderate oven temperature 302°F (150°C) to facilitate removal. Single coils should not be replaced as adjacent parts of the winding may be damaged during coil removal.

(2) Apply varnish to any damaged areas of insulation.

(3) Replace damaged exciter stator.

e. Rebuild.

(1) Rebuild exciter stator as follows:

(a) Single wires may be spliced by brazing. The splice is to be insulated by sliding sleeving over the wire prior to brazing and relocating the sleeving over the splice after completion. The sleeving is to extend a minimum of 1/2 inch (13 mm) beyond the bare uninsulated portion of wire. The sleeving material is to be the same as that used for crossovers on the connection end. Splices shall be made in the end turn of the coil only and shall not be made in the straight leg. Where more than one splice is required, the second splice must not occur on the same coil end and must not occur in adjacent coils. Where more than one splice is necessary in the same coil or an adjacent coil, the splice may be made in the connection end of the coil.

(b) Enamel is to be cleaned from coil extensions. Cleaning is to start as near sleeving as possible. Clean a 1/2 inch (13 mm) section of wire end projecting from a sleeving. Maximum uncleaned wire projecting from a sleeving section shall be 3 inches (76 mm) minimum to 5 inches (127 mm) maximum. Wire diameter is to be reduced a maximum of 5 percent. Cleaned area shall have enamel removed over 80 percent of the surface.

(c) Slot tubes should be inserted with overhang equally divided on ends. Minimum slot tube overhang (distance from core to end of slot tube) shall be 1/4 inch (6 mm). Position of the tubes should be adjusted so that height of sides is equal.

(d) After the slot tubes have been inserted, insulating tape shall be placed into the stator to form a bridge between slot tubes. It will be placed so as to bridge every other tooth in the stator core in one continuous length by stringing it through one slot, crossing over at the end of the slot to the next slot, back through and on to the third slot, continuing until it is back at the starting point. The starting and finish ends shall be securely tied together. This bridge is to restrain the end turn tie cord.

(e) Coils shall be inserted in slots so that overhanging ends are equally spaced. Wire bundles at entrance to slot should be brought out as straight and compactly as possible to reduce side pull on overhanging slot tube ends.

(f) Care should be taken to see that wire insulation is not scratched or otherwise damaged. Coil wires should not be linked or crossed in the slots. Tools inserted into slots to adjust position of wires or separators should be free from burrs or sharp edges to prevent damage to wire or slot insulation. If it is necessary to use a mallet when tamping down wires or separators in slots, tap the slot tools lightly. Heavy pounding will ruin the insulation.

(g) After bottom coil sides are in the slots, the separators are wedges in place with their overhanging ends equally spaced. These ends should project approximately 1-1/2 inches (38 mm) from edge of core. The separators should fit tightly enough to hold the coils down in the slots.

(h) Phase insulating strips are placed in the end turns to insulate between the coil groups on both ends of the winding. These strips should be placed so that the back edge reaches the ends of the wedges approximately 1/2 inch (13 mm) from core. The strips will then overlap the ends of the separators. After coil ends are properly shaped, trim phase insulating strips all around so that 1/16 to 1/4 inch (0.2 to 0.6 mm) of edge projects beyond edge of wires. Phase insulating strips may extend 1/2 inch (13 mm) beyond wire on coil outer diameters.

(i) Top sticks shall be carefully inserted so that slot tubes and wire are not damaged. The over hanging ends should be equal and they should be level. Top sticks which are broken or split during insertion should be replaced.

(j) Connections shall be twisted together and brazed using brazing alloy. The distance from the first twist to the film coating on the wire must not exceed 1-1/2 inches (38 mm). End of connection forming pigtail shall be fusion welded as much as possible with addition of alloy. When coil pole leads and ends consists of multiple wires, care must be taken to ensure that each wire is securely connected. All sharp wire ends or spikes of solder remaining on brazed joints should be trimmed off or flattened down to prevent puncturing of insulation tape.

(k) When connectors are used instead of brazing connections, wire must extend completely through the connector. The connector should be located as close to the insulated portion of the wire as is possible. Connectors must be applied using a wire crimping tool; crimping is not to be done using pliers, hammers, or other makeshift arrangements.

(l) Sleeving must be positioned to cover the coil to which it is attached to a point at least 1/2 inch (13 mm) under two layers of tape. The sleeving at the coil end must be positioned to provide a minimum of 3/8 inch (9.5 mm) creepage path from the coil extension to adjacent coils.

(m) All connections in stator winding shall be taped with tape per MIL-I-19166. Where tape is wide enough to cover the uninsulated wire and extend a minimum of 1/2 inch (13 mm) over insulated portion of wire, wrap one layer of tape over the connection, pressing the two adhesive sides together for approximately 1/4 inch (6 mm). The remaining length of tape should be long enough to make two or more wraps over the connection. The connection and any uninsulated part of the wires adjacent to the connection will be covered with three thickness of tape.

(n) Where the tape is not wide enough to provide coverage for the connection, the tape shall be wrapped around the connection such as to provide 1/2 inch (13 mm) lap plus 1/8 inch (3 mm) (minimum). The overlap is to be such as to provide a minimum of two layers of tape. The double layer of tape is to extend a minimum of 1/2 inch (13 mm) over the insulated portion of wire.

(o) Stator windings will be tied on lead end only. Use a hitch or chain stitch tie. Spacing between ties is not to exceed 3 inches (76 mm). A tie must be made over each connection. Tie on either side of cable bundle will be a double lace. Tie must pass through space between coils bridged by tape specified under tie cord bracing ((d) above).

(p) End turns on opposite lead side will not be tied. However, the string ties, placed on the individual coils during coil winding operation, will be left on untaped coil after insertion, to help keep wires from being displaced.

(q) Wind stator coils using number of turns and wire per winding data, figure 11-19.

(r) Sleeve leads with flexible braided glass treated sleeving.

(s) Apply slot liner insulation 5-5-5 (item (C)) and coil separator (item (B)) as shown in stator slot detail, figure 11-20.

(t) Make 14 pole series connections per winding diagram.

(u) Insert slot wedge (item A)) in slot as shown in figure 11-19.

(v) Make high potential test. Test voltage to be 2000 volts per coil connected in series.

(w) Bake stator as follows:

(1) Vacuum impregnate until bubbling ceases.

(2) Allow to drain.

(3) Bake in 300°F (149°C) oven for 8 hours.

(x) Type epoxy class F.

(y) The wound stator should be examined for complete coverage with not strings or beads, and with openings between extended position of slot tubes, blistering or peeling, and complete cure with tack-free surfaces and good bonding strength.

11-14. EXCITER ARMATURE. The exciter armature is the rotor part of the brushless exciter that provides excitation current for the generator. The exciter armature and rotating rectifer assembly is mounted on the shaft of the generator. The rotating rectifier has six diodes and a surge protector mounted on heat sinks.

a. Inspect. Inspect the rotor as follows:

(1) Inspect for loose, frayed, or burned windings.

(2) Inspect shaft for burrs or indications of wear.

b. Test. Disconnect leads from rotating diode assembly before testing.

(1) Growler Test. Perform a growler test on the rotor as follows:

(a) Place the rotor on the growler and energize.

(b) Hold a thin piece of metal, such as a hacksaw blade, directly over the top slot of the rotor and along the length of the slot. If the coil is shorted the blade will vibrate rapidly and cause a growling noise.

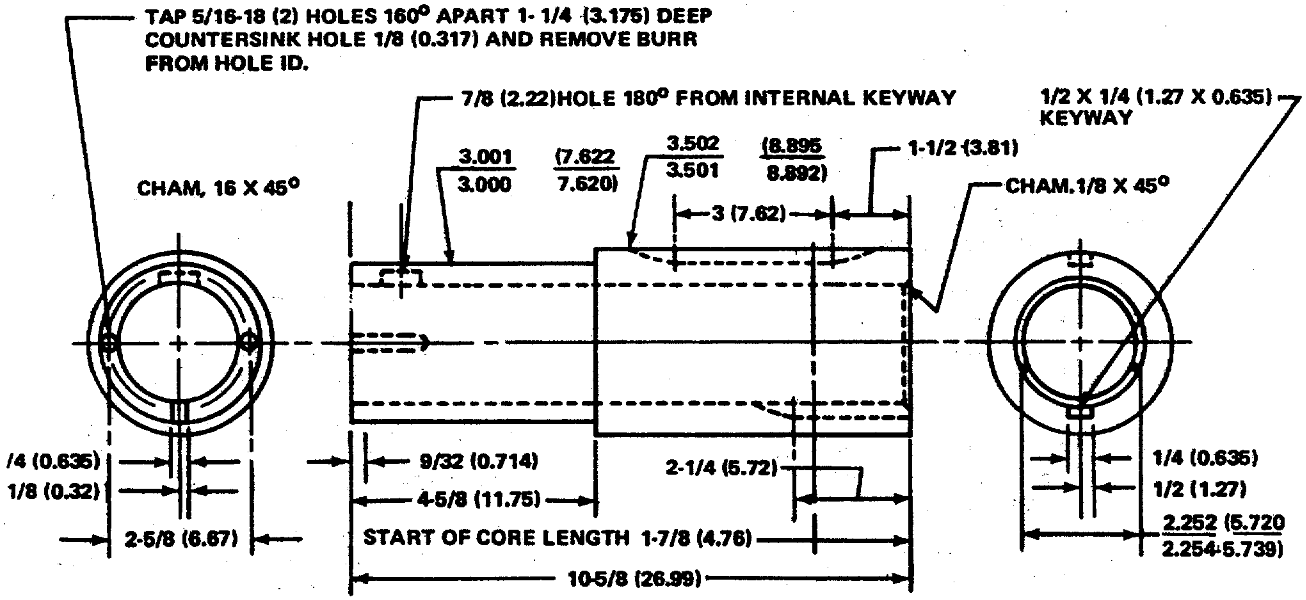
(c) If the above test is not within the limits specified, proceed with the repair procedures.

(2) Rotating Rectifier Test. Refer to paragraph 11-8b and test the diodes and surge protector on the rotating rectifier assembly.

c. Replacement. For removal and replacement of the exciter rotor, refer to paragraph 11-6.

d. Repair.

(1) Replace or rebuild all defective parts.



EXCITER CONNECTION DIAGRAM

A. BRUSHLESS EXCITER DATA
10 KW 123 VOLTS
3 PHASE, 210 CYCLE
1800 RPM 14 POLE

B. STATOR CORE
1. INSIDE DIAMETER - 9.875 IN. (25.08 CM)
2. CORE LENGTH - 2.375 INCHES (6.032 CM)

C. STATOR WINDING DATA
1. SLOTS - 14
2. COILS PER SLOT - 2
3. TURNS PER COIL - 170
4. PITCH OF COIL - 1 - 2
5. SIZE OF WIRE - HPT 1 NO. 17
6. WEIGHT OF WIRE PER COIL 1 LB. 10 OZS. (0.72 KG)
7. RESISTANCE OF WINDING AT 77°F (24°C)- 10.74 OHMS
8. 14 SERIES, 2 WIRE, NO. 14 LEAD WIRE

Figure 11-19. Exciter Stator Winding Data

NOTE

To remove coils from core, heat in a moderate over temperature 302°F (150°C) to facilitate removal. Single coils should not be placed as adjacent parts of the winding may be damaged during coil removal.

(2) Apply varnish to any damaged areas of insulation.

(3) Replace damaged excitor rotor.

e. Rebuild. Rebuild exciter rotor as follows: (See figure 11-20.)

(1) Inspect winding slots for any sharp corners at edge and in slot. Clean up as necessary.

(2) Wind armature coils using number of turns and wire per winding date. (See figure 11-20).

(3) Sleeve leads with flexible braided glass treated sleeving.

(4) Apply slot liner insulation 5-5-5 (polyester-mylarpolyester) as shown in slot detail, Item A, figure 11-20.

(5) Make pole series wye connections per winding diagram. (See figure 11-20.)

(6) Insert slot wedge (Item B) in slot as shown in slot detail and extend 1/4 inch (0.35 mm) beyond armature.

(7) Make high potential test. Test voltage to be 1500

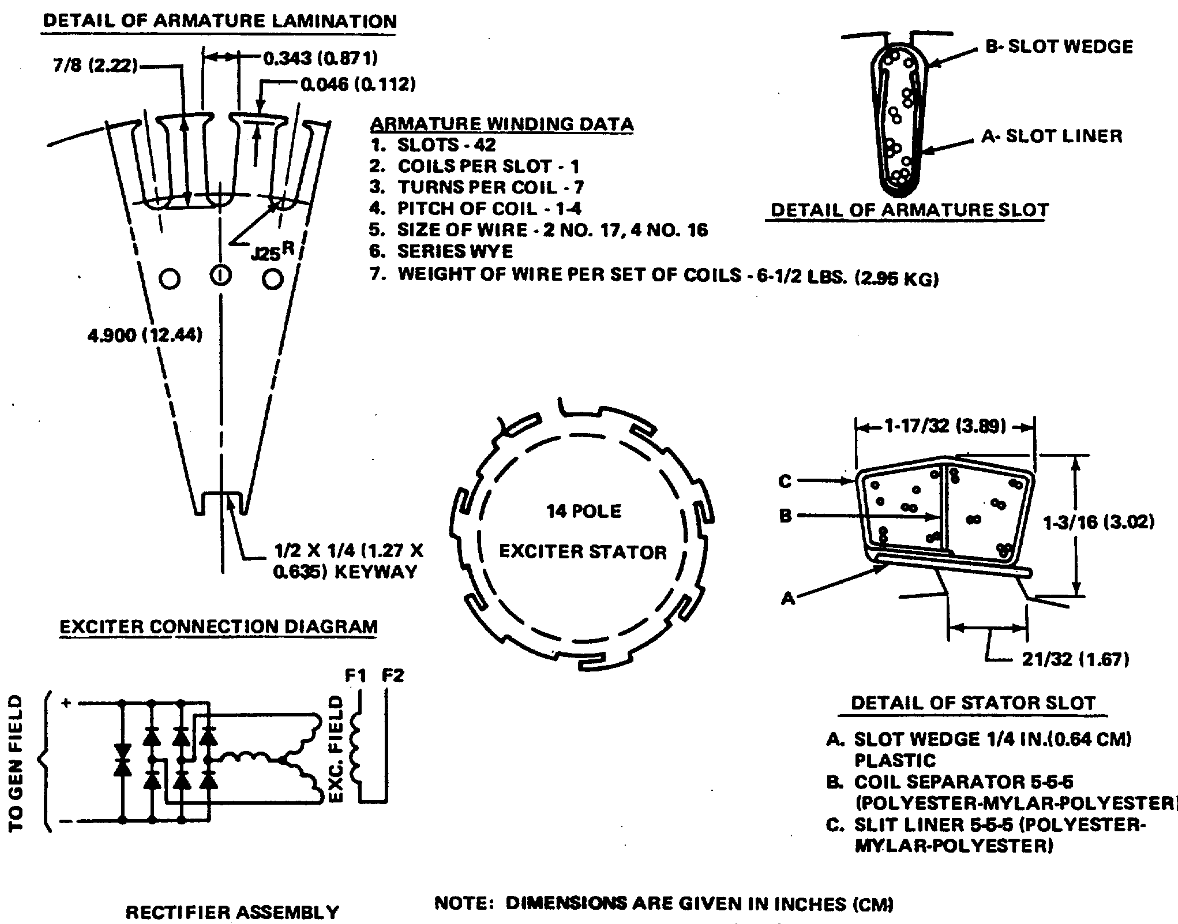


Figure 11-20. Exciter Rotor Winding Data

volts per coil connected in series, to ground.

(8) Bake armature as follows:

(a) Vacuum impregnate until bubbling ceases.

(b) Bake in 300°F (149°C) oven for 8 hours.

(9) Type epoxy class F.

11-15. FRAME AND STATOR COMBINATION. The generator stator is installed in the frame. Eyebolts on the top of the frame provide a means of lifting. The stator is mounted in an endbell positioned on the stator frame.

a. Inspection.

(1) Inspect stator frame for cracks and burred mating surfaces.

(2) Inspect stator of generator for loose, frayed, or burned windings.

(3) Inspect for missing or defective hardware.

b. Test. Disconnect all leads to completely isolate the winding.

(1) Measure each of the six stator windings with a Kelvin double bridge. Resistance shall be 1.691 to 1.725 ohms in each circuit.

(2) Connect all stator leads together and measure between the leads and the generator frame with a megger. To test insulation resistance, use a megohmmeter to measure the resistance between a winding and ground. The insulation resistance of each of the windings should be at least 1 megohm at 77°F (25°C). If this value is not met, clean or dry out the winding and repeat the test. Replace if defective.

NOTE

Low insulation resistance may be caused by dirt or excessive moisture. Insulation failure may be caused by wrong voltages, induced voltages caused by opening field circuits too quickly, oil and grease, high temperatures, or excessive vibration.

(3) Perform the following stator winding short circuit test:

(a) Use an outside-type growler, and test each coil in the stator. Position the growler in the stator and hold a thin metal strip, similar to a hacksaw blade, parallel to the core slots.

(b) Energize the growler and explore the core surfaces approximately one pole distance on each side of the growler. Continue testing one core slot at a time until all coils are tested. If the winding is shorted, the metal strip will vibrate when held over the slot containing the faulty coil.

(c) If the above test is not met, proceed with repair procedure.

c. Replacement. The generator stator core is not to be removed from the stator frame because the concentricity between bore and rabbit fits would be disturbed and cause voltage modulation problems.

d. Repair.

(1) Repair frayed insulation on leads connected to the stator windings by covering with tape or sleeving.

(2) Replace eyebolts if defective.

(3) If frame mounting assembly is cracked, weld, sand, and paint the damaged area.

(4) Repaint generator frame, if necessary. Cover stator windings before sanding and/or painting generator.

e. Rebuild. Seet step c, above

CHAPTER 12

MAINTENANCE OF ELECTRIC HYDRAULIC ACTUATOR

12-1. GENERAL. The electric hydraulic governing system controls the engine speed, either independently, in parallel with other sets, or with commercial power. Components of the system include the electronic governor controller A106, and the hydraulic governor actuator. The governor actuator is a proportional actuator with a backup centrifugal governor. The actuator has a transducer which directs oil pressure to actuate the fuel control mechanism on the engine. The governor actuator has two major sections, the electric governor section, and the centrifugal governor section.

12-2. TEST. The following test is required after repair or overhaul using a test stand.

a. Recommended Tools. Recommended tools are listed in tables 2-1 and 12-1.

Table 12-1. Recommended Tools
Electric Hydraulic Actuator

PART NUMBER	NAME
8909-032	Test Stand
8909-038	Centering Box
8959-028	Electronic Counter
8959-031	Magnet Pickup
370109	Pilot Valve Wrench
110-A	Gauss Meter, Bell Model

b. Preliminary Steps. (See figures 12-1, 12-2, 12-3 and 12-4.)

(1) Mount unit on test stand and connect oil inlet, pump pressure and drain connections (see figure 12-4). A minimum oil pressure of 5 psi (0.07 kg/cm^2) at a temperature of 140 to 150°F (60 to 66°C) is required.

(2) Drive the unit in the normal clockwise direction of rotation.

(3) Remove cover (13, figure 12-3) and use adapter plate shown in figure 12-1, to hold speed adjustment screw.

(4) Turn spring seat (56, figure 12-3) until the pilot valve plunger for the actuator gently bottoms, then back off two turns. Screw spring seat screw (56) until actuator's power piston (152, figure 12-3) is all the way up, eliminating interference from the actuator.

(5) Check pointer alignment with maximum position on dial plate by rotating terminal shaft in the increase fuel direction until the power piston is all the way up.

NOTE

This is important since the unit operates below minimum position due to the linkage arrangement between the actuator and governor. The unit becomes unstable when operated below minimum. This check of the dial plate and pointer position insures that the unit is operating in its correct range.

(6) Surge the unit by setting speed droop to zero and opening needle valve (92). Zero speed droop is set when the pin on bracket (32) is on a centerline

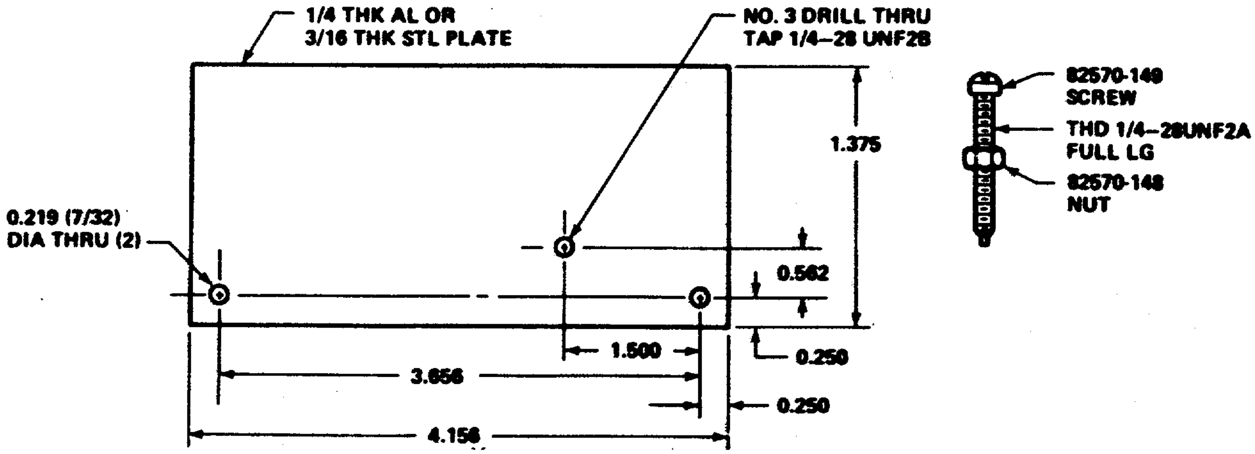


Figure 12-1. Speed Setting Adapter Plate

with the shaft hole in the droop lever (33).

(7) Close needle valve (92) 1/4 to 1/2 turn from bottoming to stabilize unit.

(8) Check governor section for leaks, hunting, drifting and oil pressure.

c. Governor Needle Valve Setting. Eliminate any air trapped in the actuator passages if not already done in the preliminary set-up. With the governor controlling, open needle valve (92) until the unit hunts or surges. After 2 or 3 minutes, gradually close the needle valve until the speed just settles out. Closing the needle valve further than necessary makes the unit slow to return to set speed after a load change. Never close the needle valve tight. Test the unit by manually disturbing the speed. Only a small overshoot or undershoot should occur before the unit returns to its steady-state speed. The actuator has no needle valve adjustment.

d. Speed Droop Adjustment. Speed droop is adjustable internally. The speed droop bracket (32) is clamped to the speed droop lever with a setscrew. A pin on the droop bracket carries the floating lever (19). When this pin is aligned with the droop lever shaft the droop will be zero. Move the speed droop bracket towards the ballhead to increase droop. Speed droop is normally set in the range of 3 to 6 percent.

e. Centering Pilot Valve Plunger.

(1) Adjust speed adjusting screw until governor is approximately 5 percent above steady-state speed.

(2) Disconnect test stand linkage from terminal shaft.

(3) Back out actuator pilot valve plunger screw (63) 1-1/2 to 1-3/4 turns after bottoming very carefully against spring. Use a 7/64 inch (2.8mm) hex wrench.

(4) Set test circuit (figure 12-2) to OFF and connect to transducer plug on actuator case.

(5) Connect a 9 VDC power source to test circuit. Set test circuit to CENTER.

(6) Adjust test circuit potentiometer to 400 ma then set switch to OFF.

(7) Adjust spring seat screw (56) with a 1/8 inch (3.2 mm) hex wrench until terminal shaft rotates approximately to its midpoint of travel. Turn spring seat screw (56) clockwise to move terminal

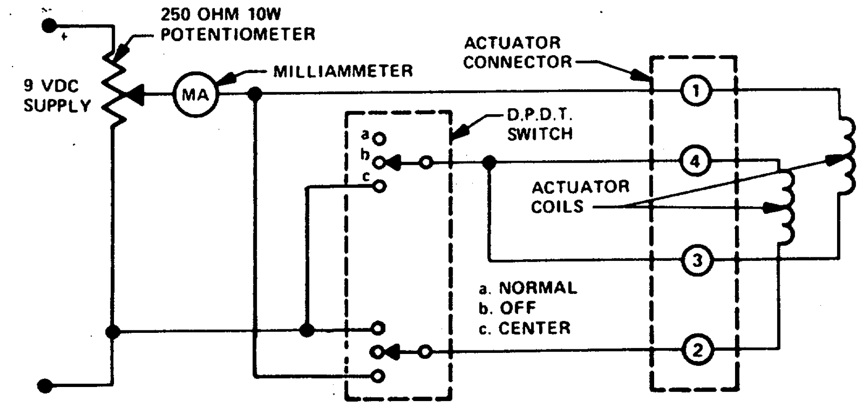


Figure 12-2. Actuator Test Circuit

shaft towards maximum fuel and counterclockwise to move it towards minimum fuel.

(8) Set test circuit to CENTER. Observe and note direction and position of terminal shaft movement.

(a) If terminal shaft moves to another position set test circuit to OFF.

1. For a clockwise movement turn pilot valve plunger screw (63) slightly counterclockwise.

2. For a counterclockwise movement turn screw (63) slightly counterclockwise.

3. Note the new position for reference in case more adjustment is needed.

4. Repeat steps 8(a)1. and 3. or 8 (a) 2. and 3. until no movement of the terminal shaft occurs when the test circuit is moved from OFF to ENTER. Continue on to step (9) and calibrate terminal shaft.

(b) If terminal shaft did not move from its original position, the pilot valve plunger is centered. Continue to step (9) and calibrate terminal shaft.

(9) Turn test circuit to OFF and set potentiometer to zero ma.

CAUTION

Do not exceed 200 ma during remainder of test to prevent damage to the magnetic properties of the magnet.

(10) Set test circuit switch to NORMAL.

(11) Adjust potentiometer to 20 ma.

(12) Turn spring seat (56) counterclockwise until actuator terminal shaft

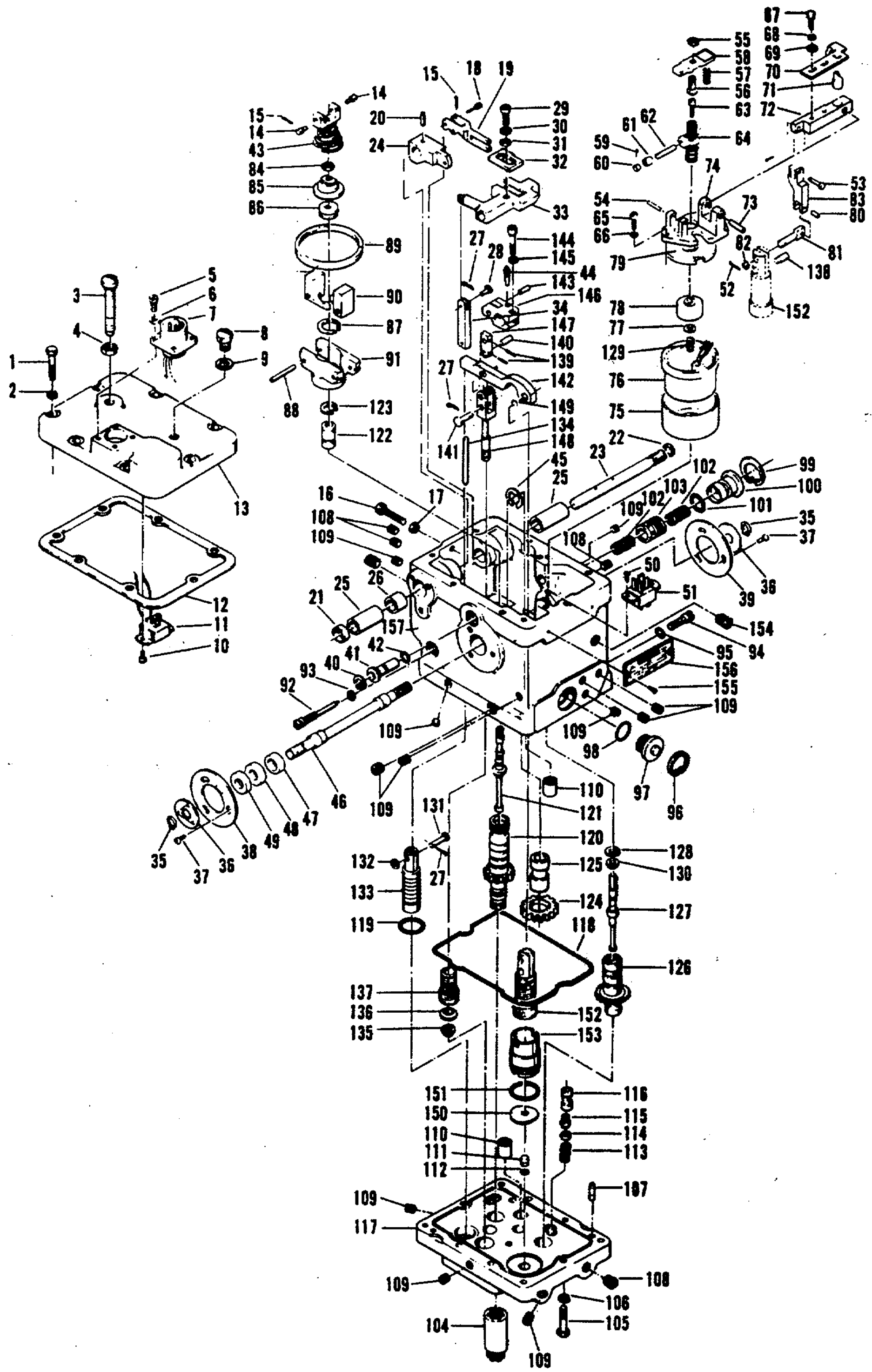


Figure 12-3. Governor Actuator, Exploded View

LEGEND FOR FIGURE 12-3

1. Screw
2. Lockwasher
3. Screw
4. Nut
5. Screw
6. Lockwasher
7. Receptacle
8. Screw
9. Washer
10. Screw
11. Socket
12. Gasket
13. Cover
14. Pin
15. Cotter pin
16. Screw
17. Nut
18. Pin
19. Lever
20. Pin
21. Tapered plug
22. Seal
23. Shaft
24. Lever
25. Bushing
26. Spacer
27. Pin
28. Pin
29. Screw
30. Lockwasher
31. Washer
32. Bracket
33. Lever
34. Link
35. Ring
36. Pointer
37. Screw
38. Plate
39. Plate
40. Retaining ring
41. Pin
42. Packing
43. Spring
44. Pin
45. Retaining ring
46. Shaft
47. Bushing
48. Seal
49. Washer
50. Screw
51. Plug
52. Pin
53. Pin
54. Pin
55. Nut
56. Seat
57. Spring
58. Lever
59. Cotter pin
60. Sleeve
61. Bearing
62. Pin
63. Screw
64. Spring assy
65. Screw
66. Lockwasher
67. Screw
68. Lockwasher
69. Washer
70. Plate
71. Pin
72. Lever
73. Pin
74. Bracket
75. Cup
76. Solenoid
77. Washer
78. Magnet
79. Cover
80. Pin
81. Pin
82. Washer
83. Link
84. Nut
85. Seat
86. Bearing
87. Ring
88. Pin
89. Ring
90. Ball arm
91. Ball Head
92. Needle valve
93. Packing
94. Screw
95. Packing
96. Ring
97. Cap
98. Packing
99. Ring
100. Plug
101. Packing
102. Spring
103. Piston
104. Coupling
105. Screw
106. Lockwasher
107. Pin
108. Plug
109. Plug
110. Check valve
111. Plug
112. Packing
113. Spring
114. Spacer
115. Plunger
116. Sleeve
117. Base
118. Ring
119. Packing
120. Bushing
121. Plunger
122. Bushing
123. Ring
124. Gear
125. Stud
126. Bushing
127. Plunger
128. Ring
129. Spring
130. Bushing
131. Pin
132. Washer
133. Piston
134. Pin
135. Nut
136. Washer
137. Piston
138. Pin
139. Pin
140. Pin
141. Pin
142. Lever
143. Pin
144. Screw
145. Lockwasher
146. Lever
147. Link
148. Link
149. Ring
150. Washer
151. Packing
152. Piston
153. Sleeve
154. Plug
155. Screw
156. Nameplate
157. Case

moves to minimum position on dial. Turn seat (56) clockwise until shaft moves 1 to 2° toward maximum.

(13) Adjust potentiometer for 160 ma. Terminal shaft movement should be an additional 29 (±1/2°) towards maximum.

(14) If adjustment is necessary, loosen screws (67) slightly and turn eccentric pin (71) in restoring lever (72) as required to shift position of ration adjustment clamping plate (70). Move plate tang towards transducer lever (58) to increase terminal shaft travel and away from lever to decrease terminal shaft travel.

(15) Repeat maximum and minimum ma adjustments until terminal shaft travels correct distance and steps (12), (13) and (14) are satisfied.

(16) Shut off test stand, if used. Disconnect test circuit. Remove speed setting adapter plate and replace it with cover. Be sure speed setting screws protrude the same distance below edge of case, or that the governor's speed is sufficiently high to prevent interference with actuator portion.

(17) Disconnect unit, remove and drain test fluid.

f. Adjustments After Tests. When actually operating, set the governor section approximately 5 percent higher than the actuator section. This allows the actuator to control.

12-3. ADJUSTMENTS. Speed adjustments may be performed with the governor actuator installed on the engine.

a. The speed adjustment screw in on top of the unit. Turn the adjustment screw clockwise to increase the speed and counterclockwise to decrease speed.

b. Figure 12-3 shows the speed adjustment shaft (23), and the high (16) and low (3) speed stop screws. Use the speed adjusting shaft to change speeds between these preset ranges. Speed may be changed remotely with the speed adjusting shaft and the proper connections.

c. Adjust the unit's speed using the speed adjustment screw or speed adjusting shaft until the desired steady-state speed is obtained. Simulate an underspeed condition until the terminal shaft travels to a position just short (1 to 2°) of maximum line on the dial plate. Readjust the speed-setting screw if necessary to obtain terminal shaft position at the required speed.

d. Simulate an overspeed condition until the terminal shaft travels to a position just short (1 to 2°) of the minimum line on the dial plate. At this point the speed should rise by the amount of droop percentage. If the speed droop needs to be increased, move the droop bracket towards the flyweights. Move the droop bracket away from the flyweights to decrease droop.

e. If droop is readjusted, readjust the speed as required to obtain the desired results.

12-4. REPLACEMENT.

a. Removal. Remove the governor/actuator from the engine as follows:

CAUTION
Disconnect negative terminal cable from battery. Remove external power.

(1) Disconnect linkage (figure 12-4) on governor/actuator.

(2) Disconnect electrical connector on governor/actuator.

(3) Disconnect oil line to the governor/actuator.

(4) Remove bolts securing unit to sump. Pull straight up, and remove unit and gasket.

b. Replacement. Reinstall or replace unit as follows (see figure 12-4):

(1) Using a new gasket between the base of the unit and the mounting pad, mount the governor/actuator unit on the mounting pad. Square the unit with the engine linkage and in line with the drive. Fit the splined drive shaft into the drive with a free, slip fit; no tightness is permitted. Set the unit on the mounting pad of its own weight without any force being applied. Also, make allowance for unrestricted oil flow drainage through the drive shaft bore and annulus within the base mounting

pilot. Install mounting bolts.

(2) Adjust the fuel linkage to use approximately 20° of the terminal shaft travel from no-load to full-load. Divide the unused terminal shaft travel equally on each side of the 20° range. The engine linkage must not bind and backlash must be minimal.

(3) Connect electrical connector.

(4) Maximum and minimum lines on the terminal shaft dial plate indicate the limits of terminal shaft travel during normal operation (approximately 32°). The pointer is preset at the factory and should not be moved.

(5) Connect the oil line from the oil supply to the inlet of the unit.

12-5. REPAIR.

a. Disassembly. When repairing, do not disassemble the unit or its various subassemblies any further than necessary. Refer to figure 12-3.

(1) Remove screw (1), lockwasher (2), cover (13), and gasket (12).

(2) Remove pins (14) from speeder spring assembly (43), pin (18) from floating lever (19) and take out floating lever.

(3) Remove pin (20) and tapered plug (21). Do not damage shaft bushing (25), or bore.

(4) Drive speed adjusting shaft (23) toward opposite side

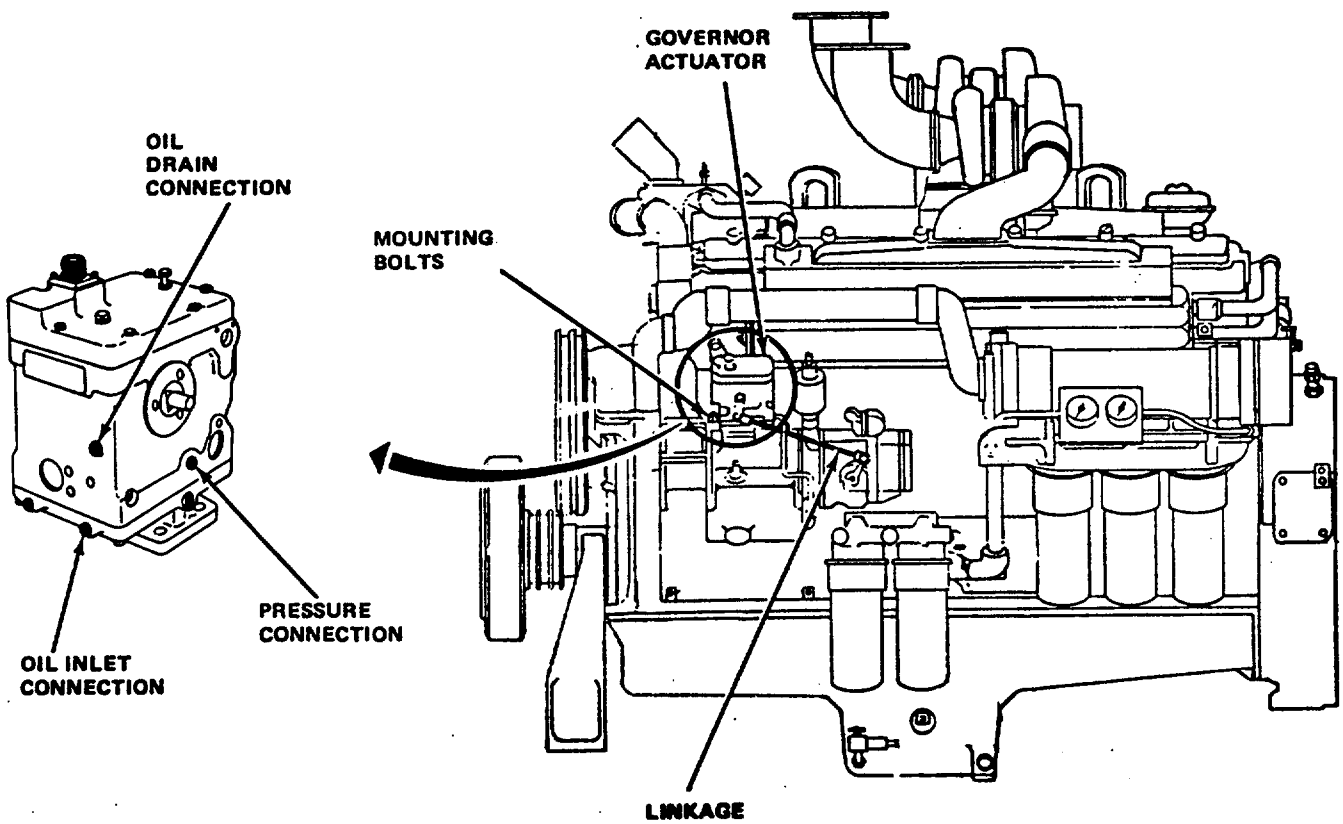


Figure 12-4. Governor/Actuator Mounting on Engine and Actuator Test Connections

of case to knock out the oil seal (22).

(5) Remove speed adjusting shaft (23), speed adjusting lever (24), bushings (25) and spacer (26). Do not remove bushings (25) unless they need replacement.

(6) Remove speed droop lever pin (28) connecting speed droop lever (33) and piston link (34).

(7) Remove two rings (35) and both dial plates (38 and 39) from the case (157).

(8) Remove retaining ring (40), pull out pivot pin (41) and take out speed droop lever (33).

NOTE

If the speed droop bracket is removed, mark its position on the speed droop lever for ease in reassembly.

(9) Use pilot valve wrench, figure 12-5, and place it between speeder spring (43) coils on spring seat (85). Disengage spring from its seat. Hold seat with wrench and bend spring towards open end of bottom coil. At the same time turn spring to disengage coil from seat lip.

(10) Remove taper pin (44) from terminal lever (146) using

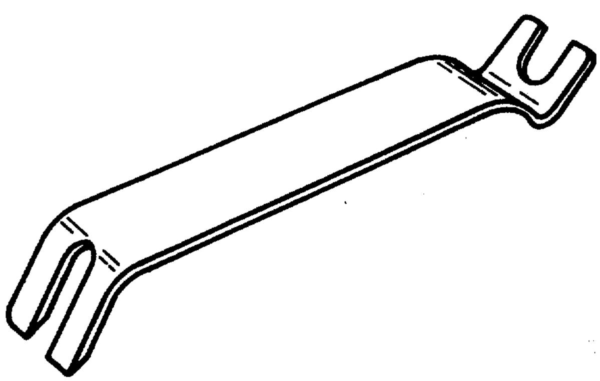


Figure 12-5. Pilot Valve Wrench P/N 370109

a 10-32 nut and two washers from the cover as a puller.

(11) Remove retaining ring (45) from terminal shaft (46) and pull shaft from case. Remove bushings (47) only if replacement is necessary, oil seal (48) and washer (49) from both sides of the case.

(12) Remove screws (50) that attach plug (51) to case. Do not disconnect plug from solenoid leads.

(13) Remove pin (53) and disconnect restoring lever (72) from piston link (83).

(14) Remove pin (54) from transducer bracket (74). Lift out transducer lever (58), spring seat (56) and spring (57).

NOTE

If spring seat is to be removed from transducer lever, measure and record projection of seat above top of transducer lever for ease in reassembly.

(15) Remove screw (63) and restoring spring assembly (64) including attached parts (59) through (62).

(16) Remove screws and lockwashers (65 and 66) and lift out transducer bracket assembly (74, 72, 71, and 67 through 70).

NOTE

If ratio adjustment plate (70) is removed, mark its position on restoring lever (72) so it can be replaced in the same position.

(17) Lift out temperature compensation cup (75), solenoid (76), washer (77), magnet (78), and cover (79) as a unit. Do not remove spring (129) from pilot valve plunger.

(18) Remove pivot pin (81) and piston link (83).

(19) Hold spring seat (85) with pilot valve wrench and remove nut (84).

(20) Remove spring seat (85) while holding pilot valve plunger (121) stationary.

(21) Remove thrust bearing (86).

(22) Remove retaining ring (87) from bushing (120) and lift flyweight assembly (87 through 91) out of case.

(23) Disassembly right (89) and ball arm (90) from ball head (91).

(24) Remove needle valve and packing (92 and 93).

(25) Remove screw and packing (94 and 95).

(26) Remove ring (96) and pull out buffer cap (97) with smooth jaw pliers. Remove packing (98).

(27) Remove retaining ring (99) and buffer system (100 through 103). Thread a base bolt into plug (100) to ease removal.

(28) Turn actuator over on its top with base up and remove drive coupling (104).

(29) Remove screws and lockwashers (105 and 106). Place two screwdrivers into the slots provided on each side of the base. Carefully work base off by twisting and prying to free taper pins and remove base. When separating the base from case be careful of parts falling out and becoming damaged.

(30) Remove oil seal ring (118), packing (119), plug (111), and packing (112).

(31) Remove relief valve parts (113 through 116).

(32) Remove rotating bushing (120), pilot valve plunger (121), compensation bushing (122) and retaining ring (123) from case.

(33) Remove idler gear (124).

(34) Remove bushing (126, pilot valve plunger (127) and retaining ring (128).

(35) Disengage magnet spring (129) from pilot valve plunger (127) and remove compensating bushing (130).

(36) Remove cotter pin (27), pin (131) and push power piston (133) out of case from top.

(37) Remove pushrod pin (134).

(38) Remove nut (135) and pivot washer (136), and push linkage return piston (137) out of case from top. Count number of turns when removing the nut for reassembly.

(39) Lift free end of floating lever (142) and turn it to a position where pin (138) can be driven out.

(40) Remove floating lever (142), terminal lever (146), terminal lever link (147) and pivot link (148).

(41) Remove snap ring (149).

(42) Remove power piston (152) through top of case.

(43) Pull sleeve (153) out of case using a hook-shaped tool.

b. <u>Ball Head Repair. Use an arbor press and tool T93163 to</u> disassemble the ball head. See figure 12-6. Press the drive cup and ball head out of the cover. Disassemble the drive cup, ball head, bearing and flyweights. Note which side of the bearing is "up" in the drive cup and reassemble it with the same side up.

12-6. OVERHAUL. Check all parts for wear, cracks, nicks, corrosion, or other damage. Check threads and serrations for tooth damage. Check the electrical connector for cracks or damage and wiring connections for breaks. Check all bearings for wear and damage.

Replace flyweights if worn areas on the toes are greater than 3/64 inch wide.

Insert flyweight pins in the flyweights and check for brinelling (wear pockets), looseness, or stickiness. At the same time check the flyweight bearings. Replace both flyweights together if either one is damaged.

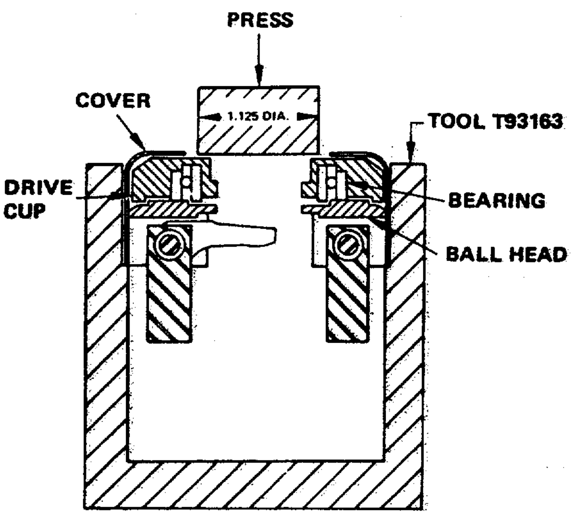


Figure 12-6. Ball Head Disassembly

Power pistons, buffer pistons, pilot valve bushings and rotating bushings must have sharp edges on all lands.

Replacement is necessary if any nicks, roundness or damage is found.

Check the magnet's magnetic field strength; it should be 1100 gauss. Jumper contacts 3 and 4 of plug (51) and measure total resistance across terminals 1 and 2. This resistance should be 31.6 (±5 percent) ohms at 70° F (21°C).

a. Assembly. Lubricate all packings with petrolatum. Lubricate all seals and metal parts before installation. Numbers on callouts of figures are the same as numbers on figure 12-3 for cross-reference.

(1) Install all pipe plugs in case and base per exploded view figure 12-3.

(2) Install check valves (110) in the case (157) bottom and base (117) as shown in figure 12-7.

(3) Assembly floating lever and

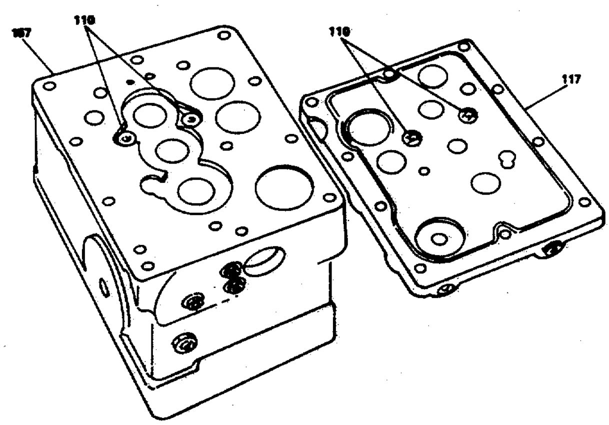


Figure 12-7. Check Valve Installation

speed adjusting lever as shown in figure 12-8.

(4) Assembly governor pilot valve bushing (120), pilot valve plunger (121), compensating bushing (122) and retaining ring (123), figure 12-9.

(5) Assemble actuator pilot valve bushing (126, figure 12-10), pilot valve plunger (127), compensating bushing (130), magnet adjusting spring (129 and retaining ring (128).

(6) Assembly clamp bracket (74, figure 12-11), restoring spring assembly (59 to 62, 64), transducer lever (58), restoring lever (72), eccentric pin (71), adjustable spring seat (56), and pilot valve plunger nut (55).

(7) See figure 12-12.

(a) Assembly packing (98), buffer cap (97) and retaining ring (96) in the case.

(b) Assembly packing (95) and screw plug (94) in case.

(c) Assembly spring (102), buffer piston (103), spring (102, packing (101), buffer plug (100), and retaining ring (99) in case.

NOTE

Insert buffer piston (103) into case correctly with cup ent out.

(8) Assembly needle valve (92) in case (figure 12-13).

(9) See figure 12-14.

(a) Assembly power piston (152) and floating lever (142) with pin (138) and ring (149).

(b) Assemble pivot link (148) and terminal lever link (147) with pin (140), and fasten together with roll pin (139).

(c) Assembly terminal lever (146) to terminal lever link (147) with pin (143).

(d) Assembly pivot pin (81) to piston link (83)with straight pin (80).

(10) Insert power piston (152) and floating lever (142) assembly into case per figure 12-15.

(11) Insert terminal lever (146), terminal lever link (147) and pivot link (148) into the case (figure 12-16). Insert floating lever (142) through the slot in pivot link (148). Fasten together with pin (141) and secure with a cotter pin.

(12) Insert piston link (83) and pivot pin (81) into top hole in power piston. Secure with washer (82) and cotter pin.
See figure 12-3.

(13) Refer to figure 12-17 and 12-18.

(a) Insert pin (134) into power piston (133). Place this assembly in case.

(b) Attach solid end of piston link (34) to power piston (133) with headed pin (131), washer (32) and secure with a cotter pin.

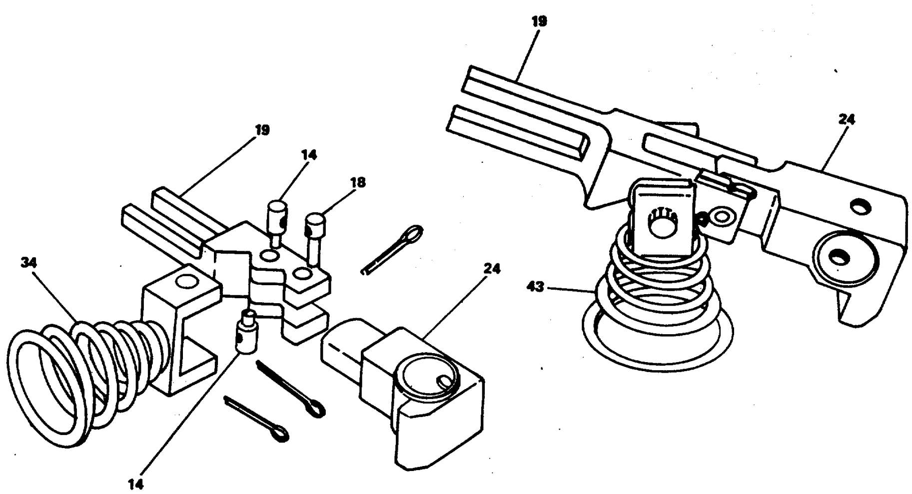


Figure 12-8. Speeder Spring Subassembly

(c) Place piston (137), pivot washer (136), and elastic stop nut (135) into the case as shown. Threat nut (135) onto pivot link (148) nine to nine and a half turns.

(d) Tighten and loosen nut (135) until no pivot motion exists between power pistons (152 and 133). Optimum adjustment is when the pistons have no play and are not tight.

(14) Refer to figure 12-19 and place packing (l119) in base. Lubricate and put packing (112) on plug (111) and push into base. Put spring washer (150) (concave side up) in place on top of plug (111) in base.

(15) Refer to figure 12-20.

(a) If idler gear stud (125) has been removed (although this should not be necessary), press it into case until its end is just below face surface.

(b) Insert pilot valve bushing assemblies (120 and 126) and idler gear (124) into case as shown. Gears should all mesh.

(16) Refer to figure 12-21.

(a) Lubricate packing (151) and place it on load sensing sleeve (153) and insert sleeve into case.

(b) Insert sleeve (116), plunger (115), spring (112), and spacer (114) into case.

(17) Place ballhead assembly (91) in case on pilot valve plunger (121). Secure with retaining ring (87). (See figure 12-22.) :

(18) Install thrust bearing (86), speeder spring seat (85) on pilot valve plunger (121) and secure with nut (84). Do not tighten nut (84).

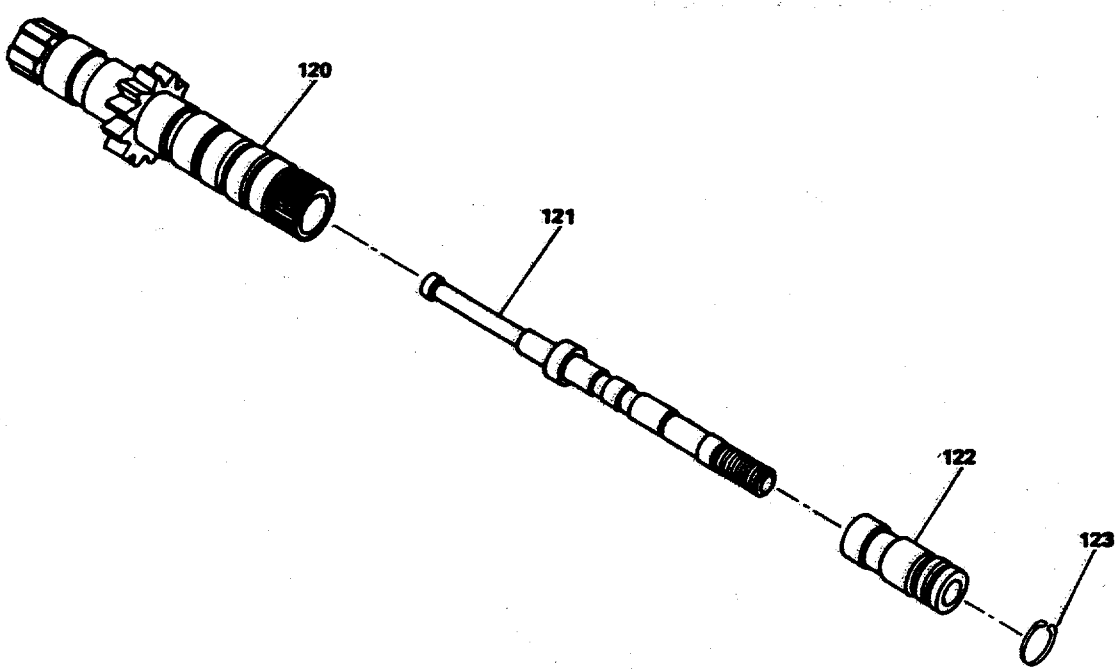


Figure 12-9. Governor Pilot Valve Assembly

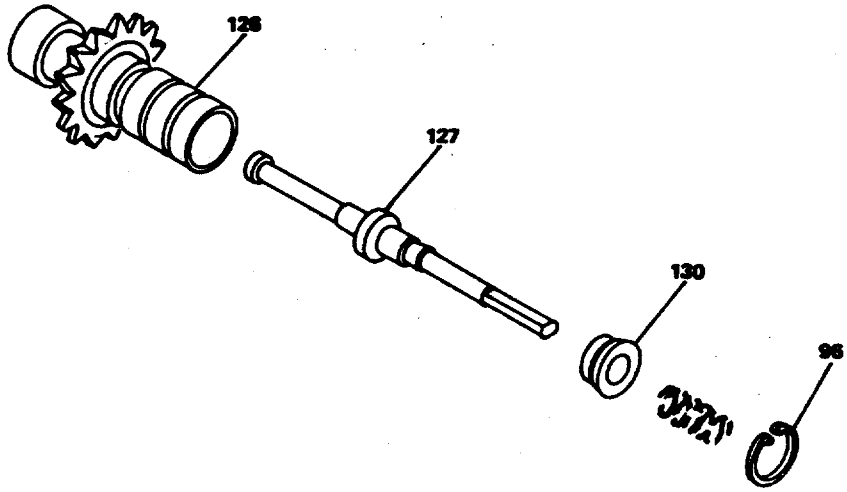


Figure 12-10. Actuator Pilot Valve Assembly

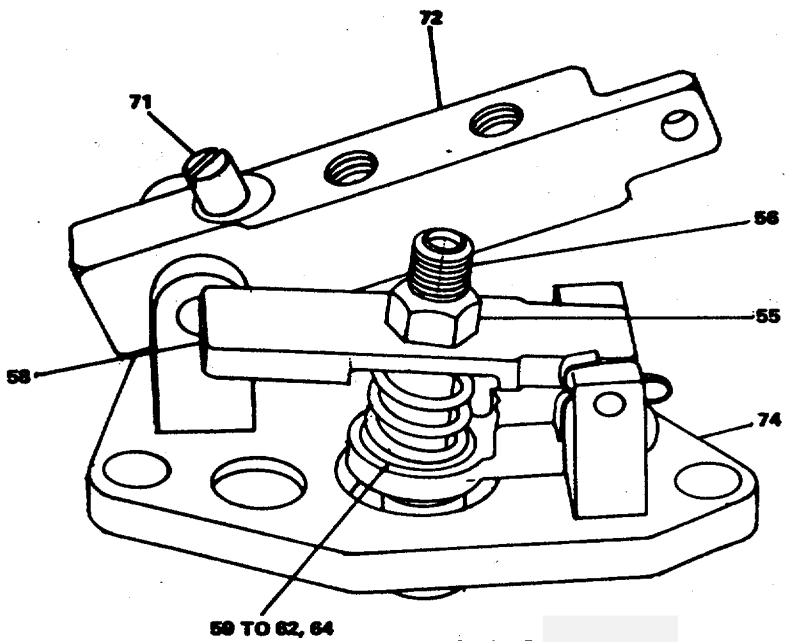


Figure 12-11. Clamp Bracket Subassembly

(19) Check centering of pilot valve plunger (121) by holding the pilot valve bushing (120) with one hand and pushing on the ball arm flyweight (90) toes with the other to lower the pilot valve plunger (121) as far as possible. Check distance "A" in figure 12-23. Pivot flyweights out as far as possible and check distance "B". Distance "A" must equal distance "B" when flyweights have been moved from their extreme inward to their extreme outward position. If the pilot valve plunger is too low, use pilot valve wrench (figure 12-5) to hold spring seat (85) stationary, and turn pilot valve plunger counterclockwise to raise it. If the plunger is too high, hold spring seat and turn plunger clockwise to lower it. When pilot

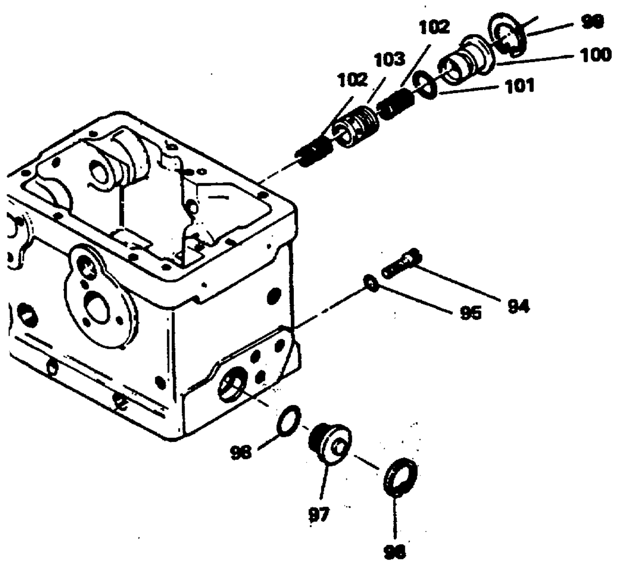


Figure 12-12. Buffer System Parts Layout

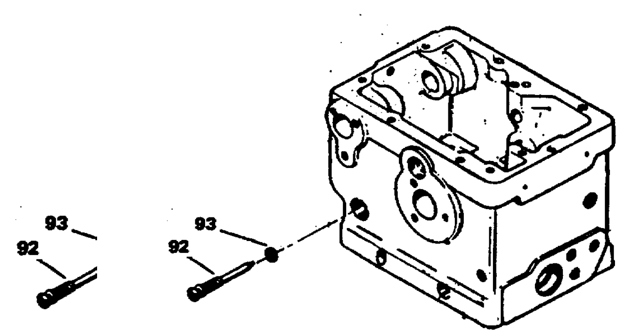


Figure 12-13. Needle Valve Assembly

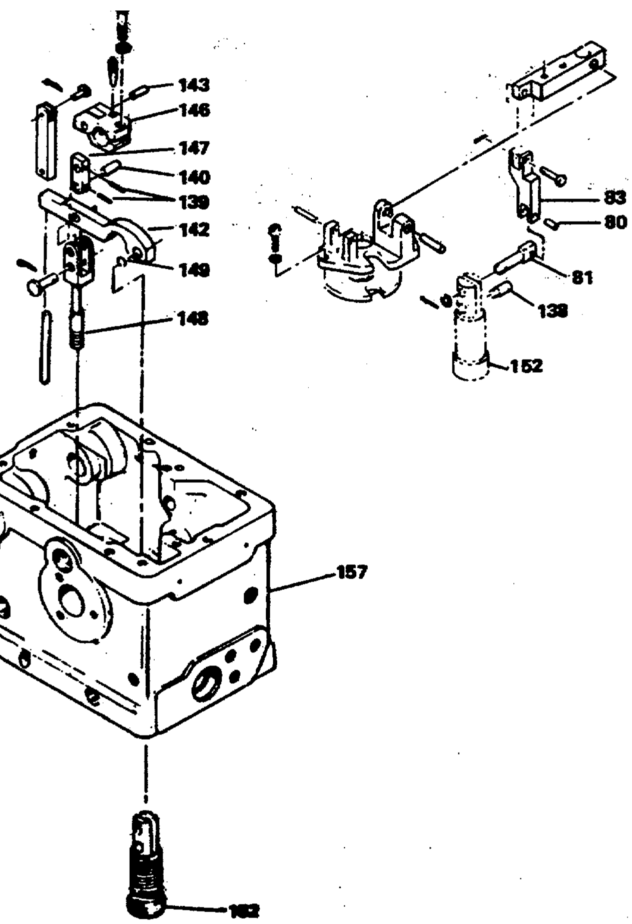


Figure 12-14. Power Piston Linkage Assembly

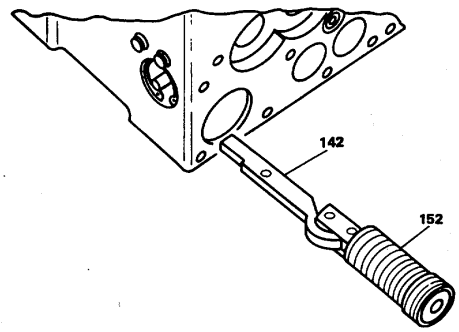


Figure 12-15. Power Piston Assembly

valve plunger is centered, tighten nut (84), figure 12-22, to 70 inch-pounds (8 joules).

(20) Lubricate base oil seal (118, figure 12-24) and place it in groove on base. Line up pins (107). Assembly base to case and secure it with lockwashers (106) and screws (105). Check bushing rotation for freeness before tightening screws.

(21) Assembly transducer cup (75), transducer solenoid (76), washer (77), magnet (78), and coil cover (79). See figure 12-25. Plug (51) is attached to the transducer.

(22) Install transducer assembly on pilot valve plunger and attaching plug (51) to case with screws (50). Be sure connections of plug (51) match the connections in cover.

(23) Install clamp bracket assembly (74, figure 12-3) with screws (65) and lockwasher (66). Line up guide pin on bracket (74) with slot in link (83). Insert centering screw (63) through hollow center of adjustable spring seat (64). Bottom centering screw to prevent binding when plate (70) is installed. Final adjustment is made later.

(24) Insert transducer compression spring (57) in position and pivot the transducer lever over to lie on top of the spring. Attach plate (70) to restoring lever with

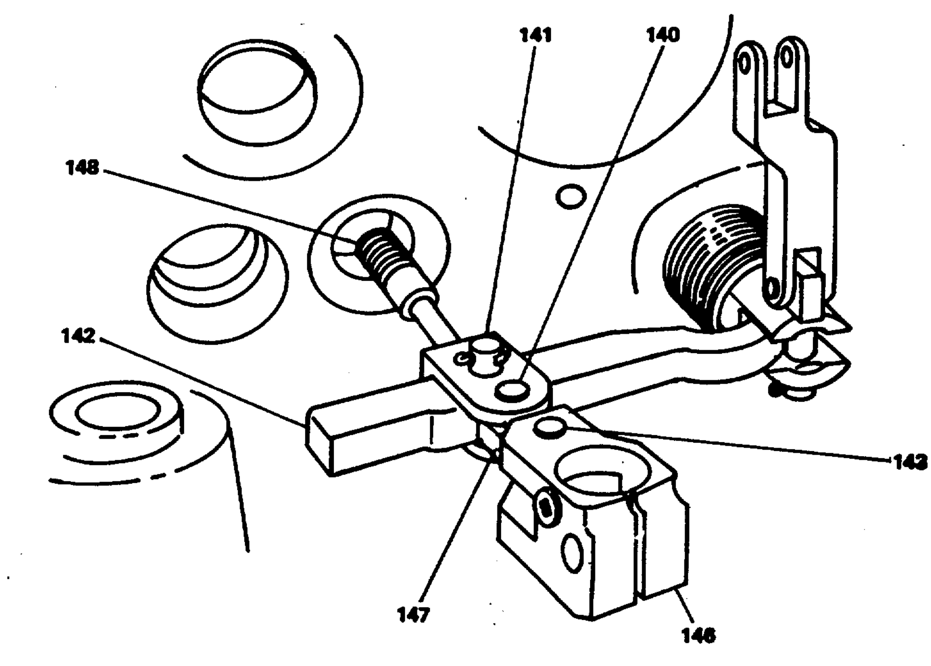


Figure 12-16. Power Piston and Linkage Installation

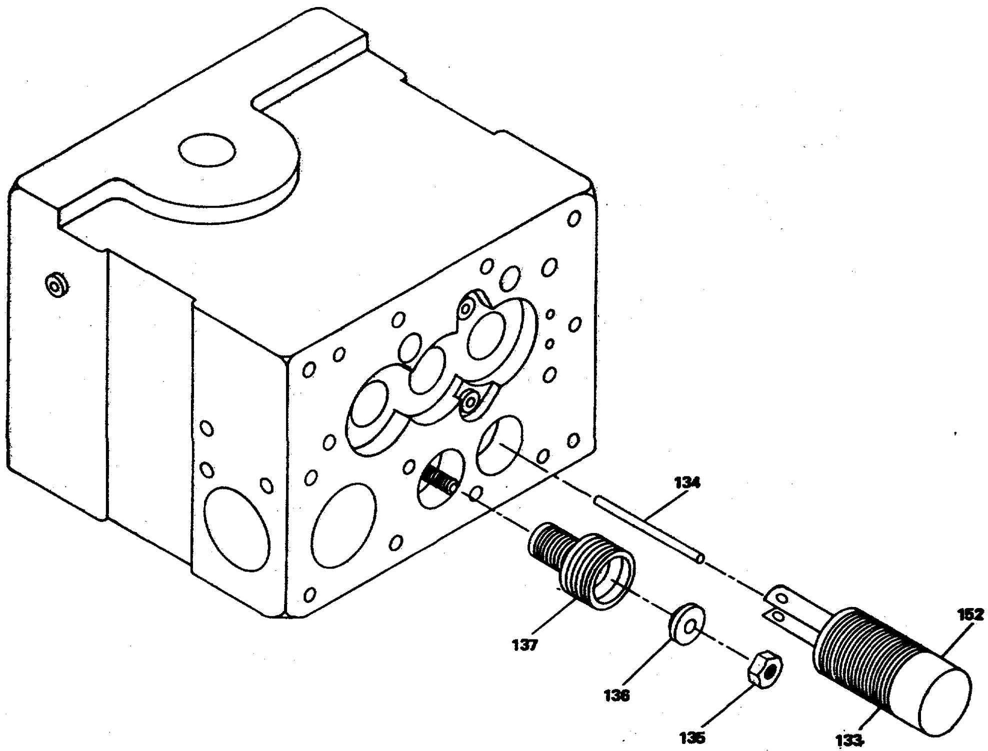


Figure 12-17. Piston Placement

screws (67) and washers (68 and 69).

(25) Insert terminal shaft (46, figure 12-26) through side of case (figure 12-26) and through terminal lever (146). Insert tapered pin (33) into hole tight enough for alignment and thread screw (144) with washer (145) into terminal lever (146). Insert tapered pin (44) into hole tight enough for alignment and thread screw (144) with washer (145) into terminal lever and tighten. Tap taper pin until it is tight.

(26) Assembly speed droop adjustment bracket (32, figure 12-27) on speed droop lever (33) with screw and washers (29, 30, and 31).

(27) Lubricate packings (42, figure 12-28 and place on speed pivot pins (41). Place speed droop-lever assembly in the case in line with hole above terminal shaft (46). Insert pivot pins (41) on both sides of case through holes into speed droop lever. Secure pivot pins with retaining rings (40).

(28) Attach dial plates (38 and 39) with screws (37, figure 12-29). Place oil seal (48, cup towards case) and washer (49) on terminal shaft. Turn terminal shaft to maximum position. Place pointers (36) on terminal shaft with pointer pointing at MAX., and secure them in place with retaining ring (35). Adjust dial plate (38) until MAX, line and

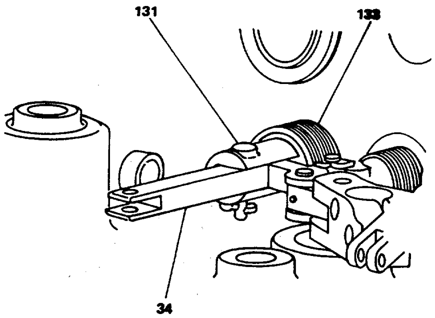


Figure 12-18. Piston Link Assembly

pointer are aligned.

(29) Place speeder spring assembly (43) figure 12-30) on top of ball head assembly. Press down and twist the spring clockwise to seat the spring on the spring seat (85).

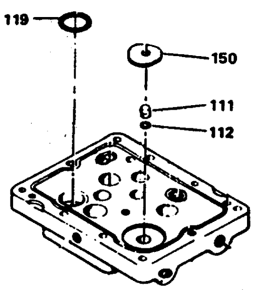


Figure 12-19. Base and Parts

(30) Insert speed adjustment shaft (23, figure 12-31) through speed adjusting lever (24), spacer (26) and into hole on opposite side of case. Keep 0.005 to 0.010 inch (0.3 mm)

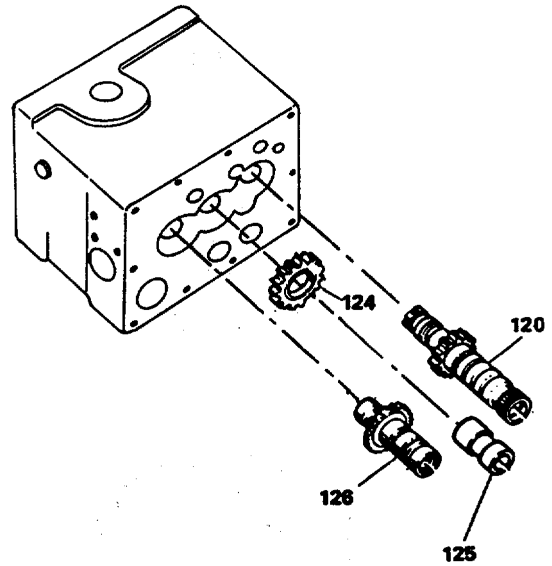


Figure 12-20. Bushing Assemblies

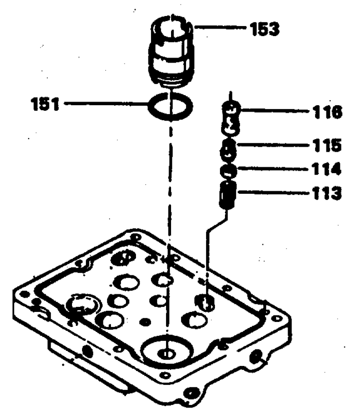


Figure 12-21. Relief Valve and Piston Sleeve Assembly

clearance between bushing (25) and speed adjusting lever (24), and bushing (25) and spacer (26).

(31) Install cover (13, figure 12-3) and gasket (12) on case (157) with bolts and washers (1 and 2).

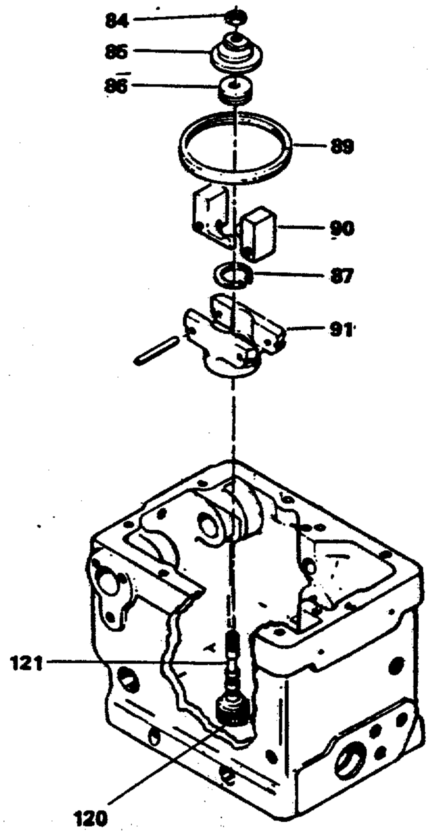


Figure 12-22. Ball Head Assembly

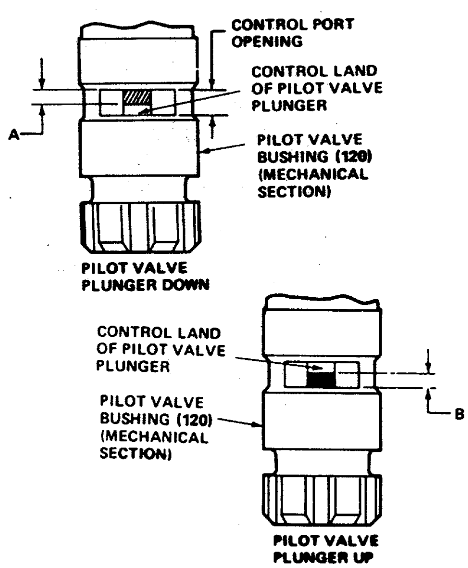


Figure 12-23. Centering Pilot Valve Plunger

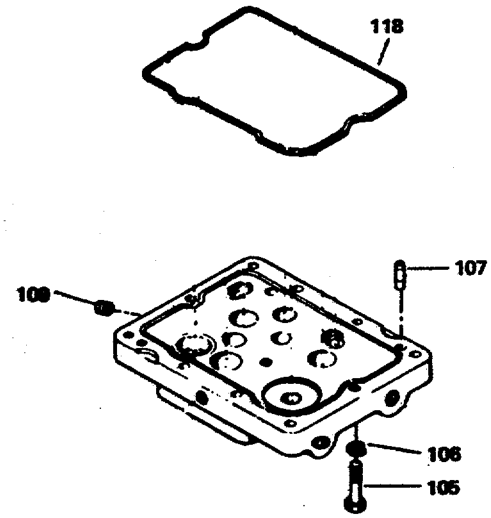


Figure 12-24. Base Assembly

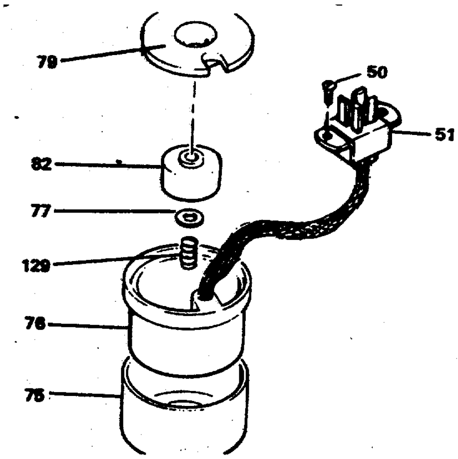


Figure 12-25. Transducer Parts Assembly

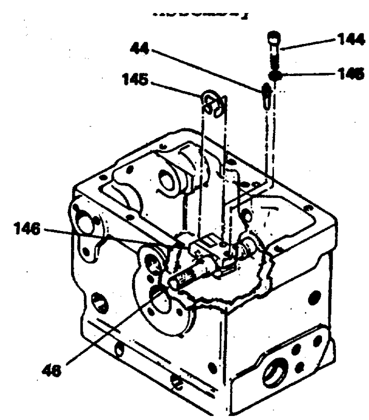


Figure 12-26. Terminal Shaft Installation

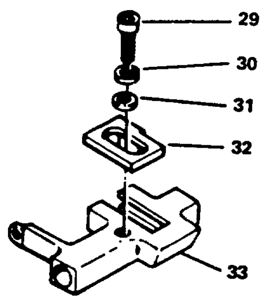


Figure 12-27. Speed Droop Lever

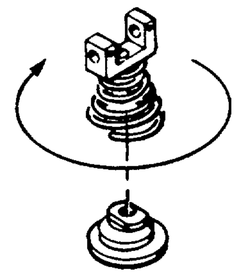


Figure 12-30. Speeder Spring Assembly

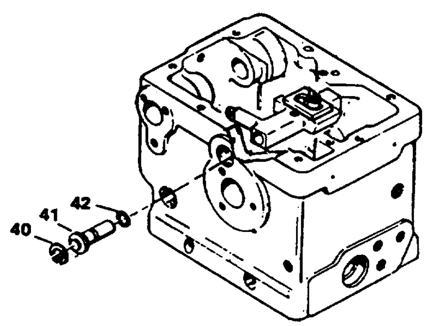


Figure 12-28. Speed Droop Lever Assembly

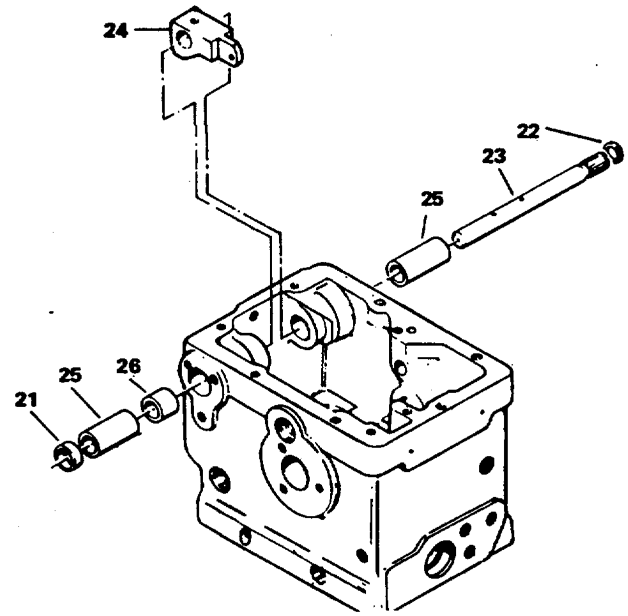


Figure 12-31. Speed Adjusting Shaft Assembly

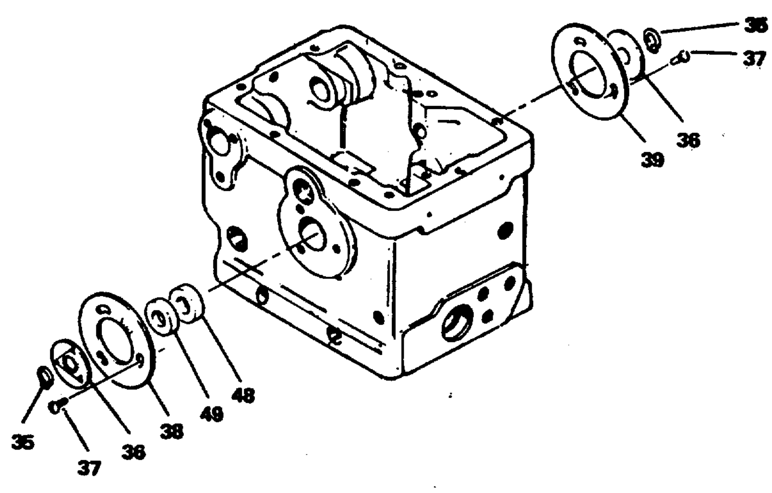


Figure 12-29. Dial Plate and Seal Assembly

12-7. GOVERNOR LINKAGE ADJUSTMENT

a. Adjust the fuel pump lever so that it rests against the idle stop at the angle shown in Fig. 12-32. Lock the lever in this position.

b. Assemble the governor control rod linkage with the dimension between the uniball mounting hole centerlines as shown in Fig. 12-32. Mount the lever to the governor shaft, but do not tighten the lockscrew.

c. Attach the uniball to the innermost hole in the fuel pump lever..

d. Use one 1 x 5/16 inch capscrew and lockwasher to attach the other uniball of the control rod assembly to the governor lever. See fig. 12-32 for the position of the governor lever-.

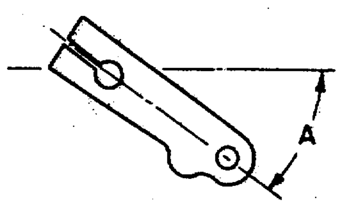
e. Rotate the governor output shaft to the full counterclockwise position. Tighten the governor lever lockscrew.

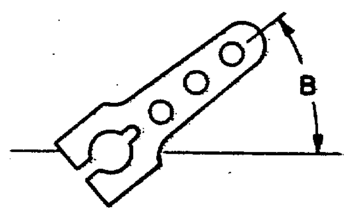
f. Loosen the locknuts on both uniballs. Take care not to rotate the control rod.

g. Rotate the fuel pump lever fully counterclockwise (full fuel stop) and hold the lever in this position.

h. Rotate the control rod just enough to raise the governor lever from its stop while the fuel pump lever is held at the full fuel stop. Tighten the uniball locknuts. Take care not to rotate the control rod.

i. Check the linkage for full free travel to make sure that there is no binding between the levers and uniballs.





EGB-2P ACTUATOR LEVER	FUEL PUMP LEVER
	EGB- 2P
GOVERNOR LEVER ANGLE · MIN. FUEL POSITION (A) :	68
FUEL PUMP LEVER ANGLE. MIN. FUEL POSITION (B)	55
DISTANCE BETWEEN UNIBALL CENTERS - INCH	*10-1/4

* IF THE LINKAGE ROD CANNOT BE ADJUSTED TO REQUIRED LENGTH, CUT (TYPICALLY 1-1/4") FROM THE RIGHT HAND THREAD END OF THE ROD AND RETHREAD.

Figure 12-32. Governor Linkage Adjustment

CHAPTER 13

MAINTENANCE OF ENGINE ASSEMBLY

Section I. GENERAL

13-1. DESCRIPTION. This chapter contains detailed instructions for maintenance of the engine assembly which provides the mechanical power to drive the main generator. The engine assembly consists of a 12-cylinder, V-type, turbocharged, after cooled diesel engine.

13-2. REMOVAL OF ENGINE ASSEMBLY. Refer to Chapter 2, Section IV, and remove the engine or generator assembly, as required, for the replacement of parts, repair, rebuilding, and overhaul of specific components listed in this chapter.

Section II. SPEED SWITCH, TACHOMETER DRIVE AND ADAPTER, AND STARTER

13-3. SPEED SWITCH (Code "A"). To adjust and repair the mechanical type speed switch, refer to figures 13-1 and 13-2 and proceed as follows:

a. General.

(1) The speed switch, driven by the camshaft through a tachometer drive assembly and an adapter, provides sequenced control of circuits during engine startup and protection against engine overspeed during operation. Three sets of contact elements, S9-1, SO-2, and S9-3, contained in the speed switch, are set to open, close, or transfer by centrifugal force at certain engine speeds. The speed switch drive gear is designed to drive the speed switch at one-half engine speed.

(2) At an engine speed of 580 to 620 rpm (accelerating) element S9-1 transfers two sets of contacts, energizing the field flash circuit and de-energizing the crank relay to stop the starting motor.

(3) When the engine reaches the speed range of 1180 to 1220 rpm, element S9-2 closes, energizing the electrichydraulic governor which takes control of engine speed.

(4) Speed switch element S9-3 consists of two sets of contacts which are set to transfer at an engine speed 2250 ±25rpm to shut down the engine and prevent damage to the equipment. Shutdown is achieved by de-energizing the fuel shut-off valve, cutting off fuel to the engine, and closing the air box solenoid.

(5) Elements S9-1 and S9-2 reset at 100 rpm (decreasing) below actuation speed. Element S9-3 is manually reset by a pushbutton on the speed switch housing.

b. Speed Switch Removal. Refer to Operator/Crew and Organizational Maintenance manual for removal of the speed switch.

c. Speed Switch Tests, Adjustment, Repair and Installation (Mechanical Type Switch).

(1) Connect a variable speed drive device to the speed switch drive. The drive device must have a tachometer in order to determine the speed of the device in rpm's.

(2) With an ohmmeter on the R1 scale, reading from the speed switch connector, check for the contact conditions of elements S9-1,

LEGEND

1. Screw	6. Rotor Assy
2. Lockwire	7. Packing
3. Washer	8. Cap and cover assy
4. Body assy	9. Screw
5. Spacer	10. ID plate

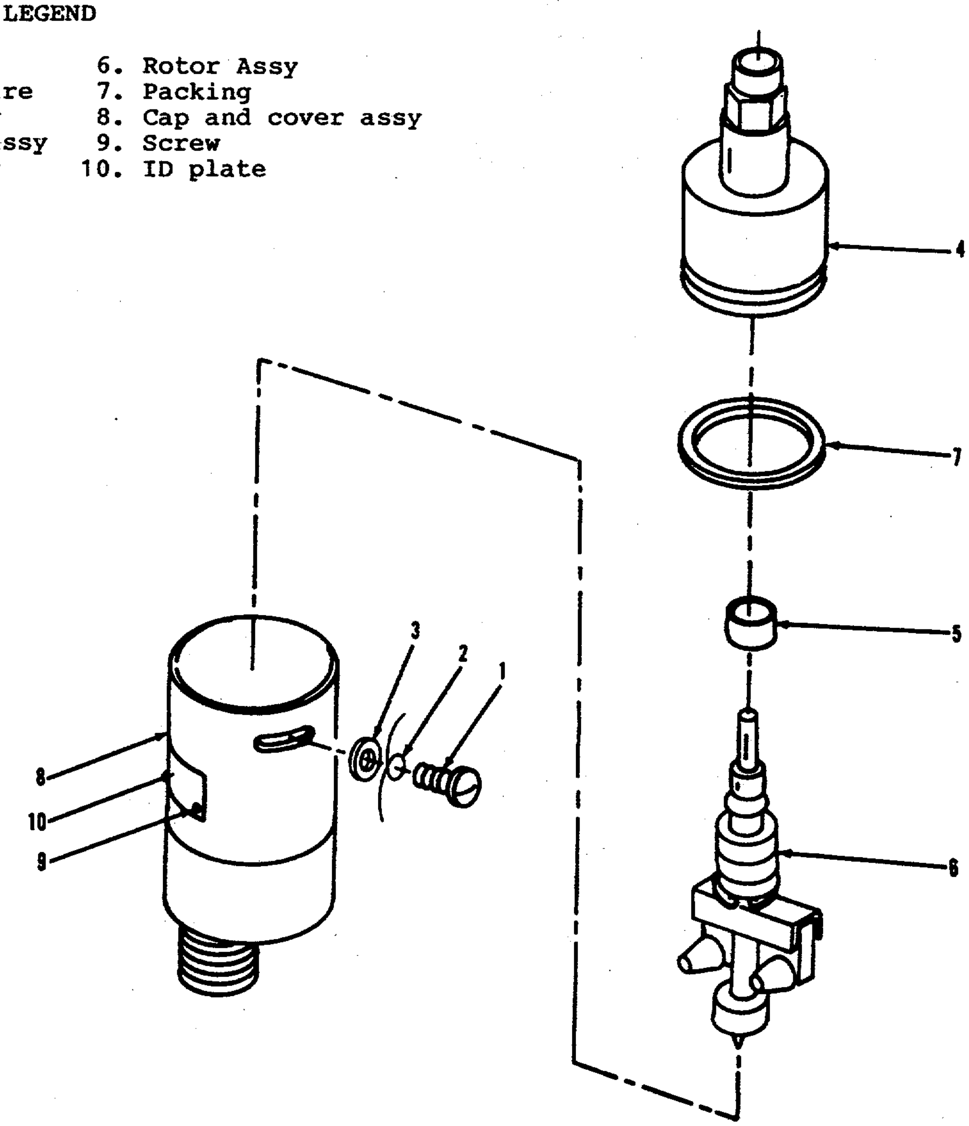


Figure 13-1. Speed Switch,-Exploded View (Mechanical Type Switch) (Code "A")

S9-2 and S9-3 illustrated in figure 13-2.

(3) When contact conditions are verified, as shown in figure 13-2, start variable drive and gradually increase speed, with ohmmeter connected to pins B and A. At a speed of 290 rpm's per minute, the ohmmeter should indicate that contact A and B opens. Hold the variable speed drive at that speed and transfer the ohmmeter leads to pins A and C. The ohmmeter should indicate a closed contact.

(4) Leave the ohmmeter leads connected to pins A and C and gradually reduce speed. In the range of 190 to 210 rpm, the contacts of element S9-1 should reset to the condition illustrated in figure 13-2. To verify operation of element S9-1 contacts A and C, increase

drive speed gradually and observe that the contacts close in the 290 to 310 range.

(5) Connect ohmmeter leads across pins D and E and verify an open circuit. Increase drive speed and observe that elements S9-2 (contacts D and E) closes in the speed range of 590 to 610 rpm. Gradually reduce speed to 490 minimum rpm. Observe that element S9-2 resets to the condition shown in figure 13-2.

(6) Connect ohmmeter across pins H and G connector and verify a closed circuit. Increase drive speed gradually. The contacts should open at a speed of 1100 to 1150 rpm. Hold drive speed and read contacts F and J. Meter should indicate a closed circuit. Reduce drive speed to less than 1000 rpm, press the manual reset switch and observe with the meter that element S9-3 contacts reset to the condition shown in figure 13-2.

(7) To obtain the required performance characteristics during tests (3) through (6), adjustments can be made. By loosening screws (1, figure 13-1) and rotating the cap and cover assembly relative to the body assembly, the trip points of all those elements can be raised or lowered. In addition, the trip speed of each individual element can be raised or lowered by removing cover screws as shown in figure 13-2 and turning appropriate set screw located beneath cover screws with a 1/16 inch Allen wrench.

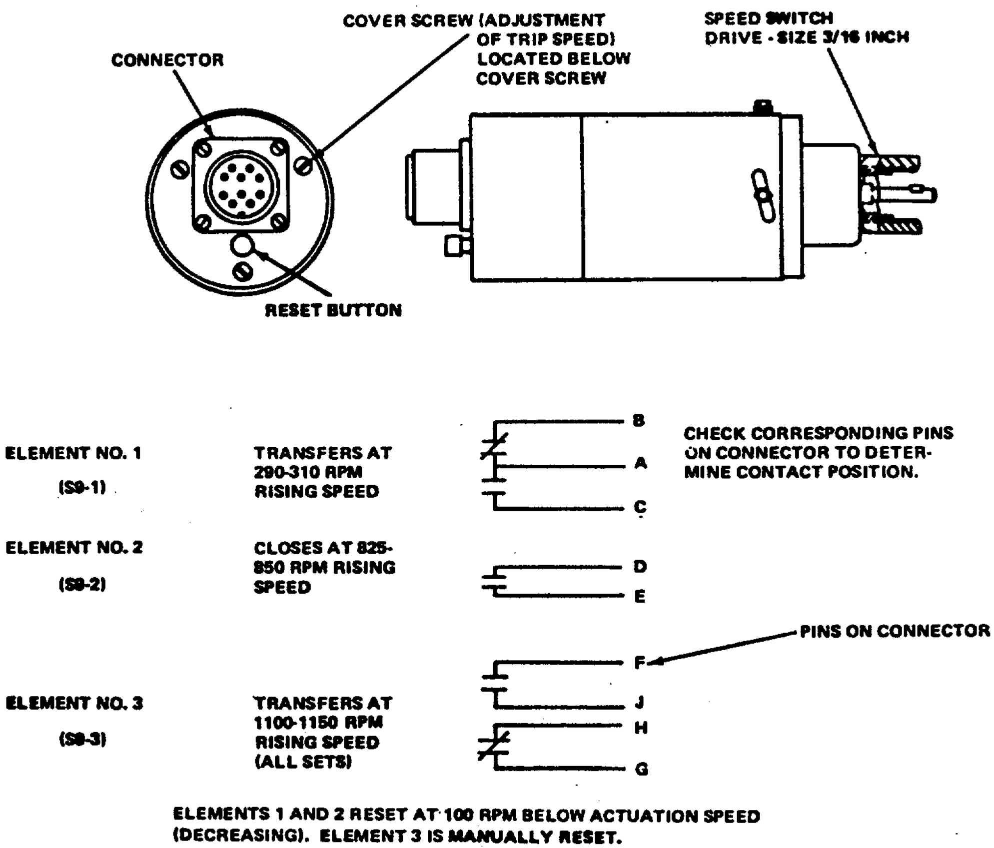


Figure 13-2. Speed Switch Sensitivity Tests (Mechanical Type Switch) (Code "A")

d. Speed Switch Disassembly. Refer to figure 13-1, cut safety wire and disassemble in sequence of index numbers observing the following:

(1) If either the rotor assembly, the body assembly, or the spacer are damaged or defective, replace, defective part. Reassembly. is the reverse order of figure 13-1 sequence of index numbers. Refasten with lockwire after readjustment.

(2) Repeat the test and adjustment procedures in paragraph C, above.

(3) Refer to Operator/Crew and Organizational Maintenance manual and install speed switch.

13-4. ELECTRONIC TYPE SPEED SWITCH (Code "B"). To test speed switch refer to figure 13-3 and the following:

a. General. The electronic speed switch performs in the same manner as described in paragraph 13-3a except, rather than operating by centrifugal force the switch operates electronically. Output switch contacts are rated for 10 amps. Elements S9-1 and S9-2 reset anywhere between 0 and 100 rpm (typically set for 50 rpm) below actuation speed.

b. Speed Switch Removal. The electronic speed switch is removed in the identical manner to the centrifugal switch referred to in the Operator/Crew and Organizational Maintenance Manual.

c. Speed Switch Tests

(1) With an ohmmeter on the RX1 scale, verify that the switch contacts are as shown in figure 13-3.

(2) Connect a variable speed drive device to the speed switch drive. The drive device must have a tachometer in order to determine the device speed in rpm's.

(3) Apply 24V DC (+) to pins A, D and F and (-) to pin I.

(4) Start variable drive and gradually increase speed. Using a DC voltmeter (0-50V DC minimum scale) across pins B (+) and (-) verify that voltage goes to zero between 290 and 310 rpm. At this speed voltage at pin C should be at 24V DC.

(5) Reduce speed gradually and verify that voltage at pin C goes to zero volts 0-100 rpm lower than pick-up rpm in step 4. At this speed voltage at pin B will return to 24V DC.

(6) With voltmeter between pins E (+) and I (-), zero voltage should be indicated. Increase speed and verify that pin E voltage goes to 24V DC between 590 and 610 rpm.

(7) Reduce speed gradually and verify that pin E voltage returns to zero volts 0-100 rpm lower than pick-up rpm in step 6.

(8) With voltmeter (+) connected to pin J, zero volts should be indicated. Gradually increase speed and verify that voltage goes to 24V DC between 1100 and 1150 rpm. At this speed, voltage at pin H will be at zero volts.

(9) Reduce drive speed to zero rpm. Voltage at pin H should remain at zero and voltage at pin J should remain at 24V DC until the blue reset button is depressed.

(10) All trip speed settings are factory set and cannot be field adjusted.

d. Speed Switch Disassembly Since there are nib moving parts except the speed switch drive with virtually no load applied, disassembly is not required since wear is practically non-existent.

13-5. STARTER ASSEMBLY (Code A). To service the components of the starter

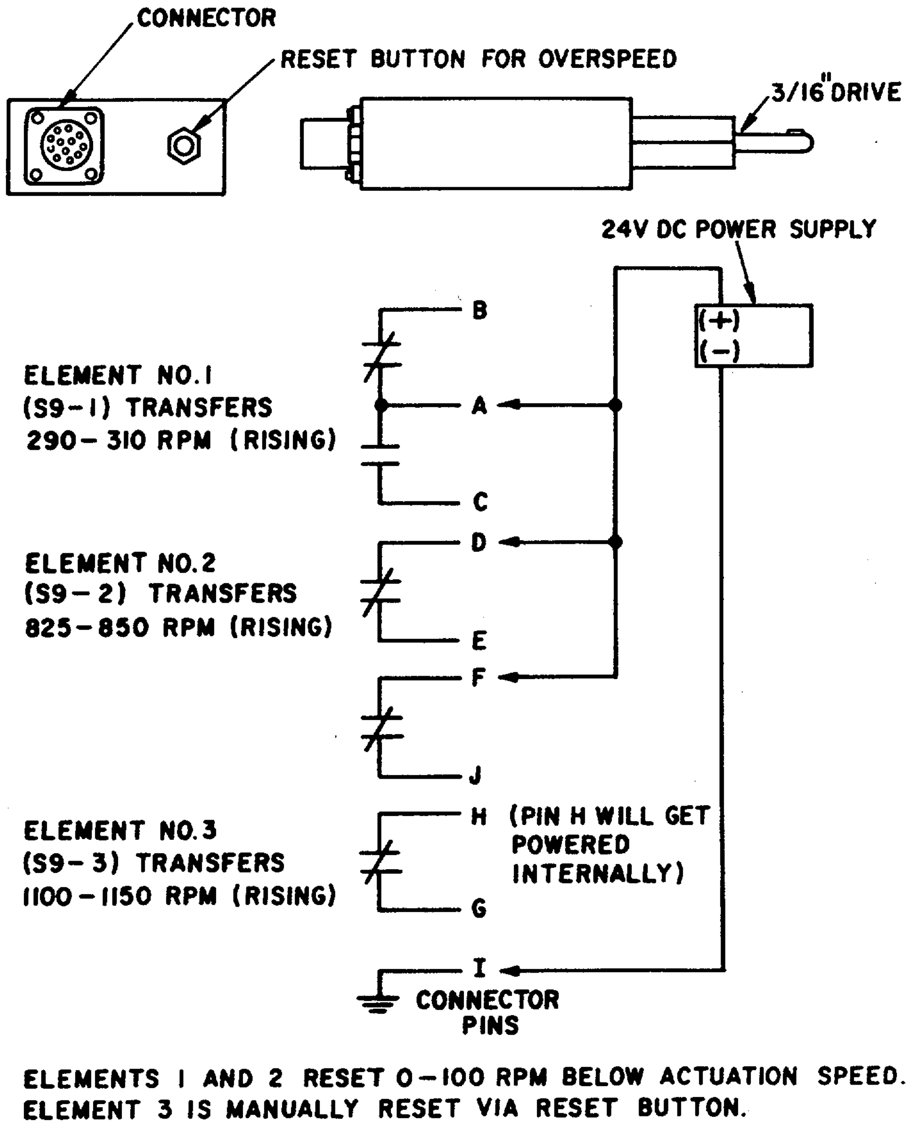


Figure 13-3. Speed Switch Test (Electronic Type) (Code B)

assembly, the ether lines and lubricating oil bypass filters must first be removed.

a. Removal.

(1) Remove six screws securing ether line support clamps to engine, then loosen ether line fittings from manifolds and solenoid valve (located on upright support) to remove ether lines. Store ether lines in a safe place to avoid damaging them.

(2) Disconnect lubricating bypass oil filter hose couplings from tee on oil pan.

(3) Disconnect bypass oil filter inlet hose coupling at top of rear bypass oil filter, then remove six screws securing bypass oil filter support bracket to engine block to remove bypass oil filter assembly.

(4) Remove starter by removing

battery cable connections to starter and three screws which secure housing (16, figure 13-4) to engine. Tag and remove wires to the pilot relay (6, figure 13-4).

b. Inspection. Remove inspection plug (102, figure 13-4). If any brush is less than 3/8 inch (9.5 mm) long, the complete set of brushes should be replaced.

c. Test. Testing of the starter motor assembly consists of a no-load test of the complete unit and component tests to determine part serviceability. Before conducting the no-load test check the armature for freedom of rotation. Use a screw driver to turn the pinion on the exposed drive assembly (25, figure 13-4) in the drive housing (16). Tight bearings, bent armature shaft, or a loose pole shoe screw will cause armature binding. If the armature does not turn freely, disassemble the unit immediately. If the armature rotates freely, conduct the no-load test below before disassembling the motor.

CAUTION

Do not allow the starter motor to operate more than 30 seconds. Allow it to cool at least two minutes before reenergizing the motor. Overheating will damage the motor.

(1) Connect the starter assembly as shown in figure 13-5.

(2) Close the switch and vary the carbon pile to obtain 20 volts on the voltmeter.

(3) Starter motor speed at a minimum current draw of 95 amps shall be 5500 rpm. Motor speed at the maximum current draw of 120 amps shall be 7500 rpm.

(a) Low speed and high current draw indicate armature drag caused by tight, dirty or worn bearings, bent armature shaft or loose pole shoes, a shorted or grounded armature and fields.

(b) Failure to operate with high current draw indicates a direct ground in the terminal or fields.

(c) Failure to operate with no current draw indicates an open field circuit, open armature coils, broken brush' springs, worn brushes, high insulation between commutator bars or other conditions resulting in poor contact between the brushes and commutator.

(d) Low speed and low current draw indicates high internal resistance due to poor connections, defective leads or a dirty commutator.

(e) High speed and high current draw indicate shorted fields. Replace the field coil assembly and retest the motor.

(4) Disassemble the starter motor, inspect and test components as necessary.

d. Disassembly. Disassemble the starter motor only to the extent necessary to repair or replace defective parts. Disassemble in accordance with figure 13-4.

(1) Note the relative positions of the nose housing (16), lever housing (37), and solenoid switch (36) so that the motor can be reassembled in the same manner.

(2) Tag and disconnect the field coil connector from the solenoid M terminal and lead from the ground terminal.

(3) Remove four screws and

lockwashers (1) and remove pilot relay (6). Separate the solenoid switch (36) from the lever housing (37).

(4) Remove six screws (54) and lockwashers (55), and remove the commutator end frame (61) with associated parts, and the plate assembly (65).

(5) Remove three screws (9) and remove the nose housing (16) and drive assembly (25) and associated parts.

(6) Remove screws (26) and washers (27) and remove the lever housing (37) and associated parts.

(7) Remove nuts (92 and 94), and washers (93, 95, and 96).

(8) Remove the pole shoe screws (90), pole shoes (91), field coil (99), and armature (89).

e. Cleaning.

(1) Blow out all dirt inside field frame and wipe interior with a clean cloth.

CAUTION

Do not submerge armature, field coils, solenoids or clutch drive in solvent.

(2) Clean field coils and frame thoroughly with a cloth dampened with cleaning solvent, Federal Specification P-D-680. Be careful not to damage protective insulation and fungus coating. Dry thoroughly with compressed air.

(3) Remove loose particles from armature with compressed air and wipe with a clean cloth dampened with cleaning solvent. Clean commutator lightly with No. 00 sandpaper and remove all traces of dust with lowpressure compressed air.

(4) Clean brush holders and springs with a brush and cleaning solvent, Federal Specification P-D-680, and dry them thoroughly with compressed air. Clean insulation and plate with a clean cloth dampened with cleaning solvent and dry compressed air.

(5) Clean solenoid relay assembly parts with a clean cloth dampened with cleaning solvent, Federal Specification P-D-680, and dry with low-pressure compressed air.

(6) Clean brushes with a clean, dry cloth only. Do not permit cleaning solvent to come in contact with the brushes.

f. Inspection.

(1) Inspect drive assembly pinion for chipped or badly worn teeth. Replace assembly if defective.

(2) Inspect internal splines in drive assembly shell for cracked, chipped, or broken condition. Replace drive assembly if defective.

(3) Inspect coil terminal lugs for damaged threads.

(4) Check brushes for excessive wear. If any brush is less than 3/8 inch (9.5 mm) long, the complete set of brushes should be replaced.

(5) Inspect if the armature commutator is worn, dirty, out of round, or has high insulation resistance. Clean or overhaul the armature as necessary.

(6) Inspect gaskets and O-rings for damaged or worn condition. Replace as necessary.

g. Armature Test. Check the armature for short circuits or grounds as follows:

(1) Use a growler to locate

armature short circuits. As the armature revolves in the growler, hold a steel strip (such as a hacksaw blade) above it. The blade will vibrate above the area of the armature core on which the short circuit is located.

(2) Use a 110 volt test lamp with test points to detect grounds. Place one test point on the armature core or shaft and the other on the commutator. If the lamp lights, the armature is grounded.

h. Field Coil Test. Test field coil insulation resistance with megger connected between frame and one coil terminal. Minimum resistance reading permissible is one megohm.

i. Solenoid Test. Disconnect all leads from the solenoid and make test connections as shown in figure 13-6.

(1) To check the hold-in winding, follow connections shown in solid line.

(2) Use the carbon pile to adjust the voltage to 20 volts. Voltmeter shall read 20 V DC and ammeter shall read 6.1 to 6.8 amps. A high ammeter reading indicates a shorted or grounded hold-in winding. A low reading indicates excessive resistance.

LEGEND FOR FIGURE 13-4

1. Screw and lockwasher
2. Screw
3. Washer
4. Lockwasher
5. Nut
6. Pilot relay
7. Lead
8. Bracket
9. Screw
10. Screw
11. Plug
12. Wick
13. Plug
14. Plug
15. Bushing
15A. Plug
16. Housing
17. Plug
18. Gasket
19. Nut
20. Ring
21. Packing
22. Packing
23. Lever
24. Lever
25. Drive assy
26. Screw
27. Washer
28. Oil seal
28A. Bushing
29. Plug
30. Plug
31. Plug
32. Wick
33. Gasket
34. Brake washer
35. Lead
36. Switch
37. Lever housing
38. Ring
39. Retainer
40. Spring shift lever
41. Retainer
42. Boot
43. Washer
44. Plunger
45. Nut
46. Washer
47. Nut
48. Lockwasher
49. Washer
50. Insulator
51. Packing
52. Plug
53. Wick
54. Screw
55. Lockwasher
56. Bushing
57. Plug
58. Plug
59. Bushing
60. Packing
61. Frame
62. Screw
63. Washer
64. Brush
65. Plate assy
66. Screw
67. Lockwasher
68. Screw
69. Screw
70. Spring
71. Lockwasher
72. Brush holder
73. Plate
74. Screw
75. Lockwasher
76. Washer
77. Brush holder
78. Insulator
79. Plate
80. Screw
81. Lockwasher
82. Washer
83. Plate and stud assy
84. Support plate
85. Brush
86. Packing
87. Washer
88. Washer
89. Armature
90. Screw
91. Pole shoe
92. Nut
93. Lockwasher
94. Nut
95. Washer
96. Washer
97. Gasket
98. Bushing
99. Coil
100. Insulator
101. Insulation
102. Plug
103. Gasket
104. Housing
105. Plug
106. Bushing

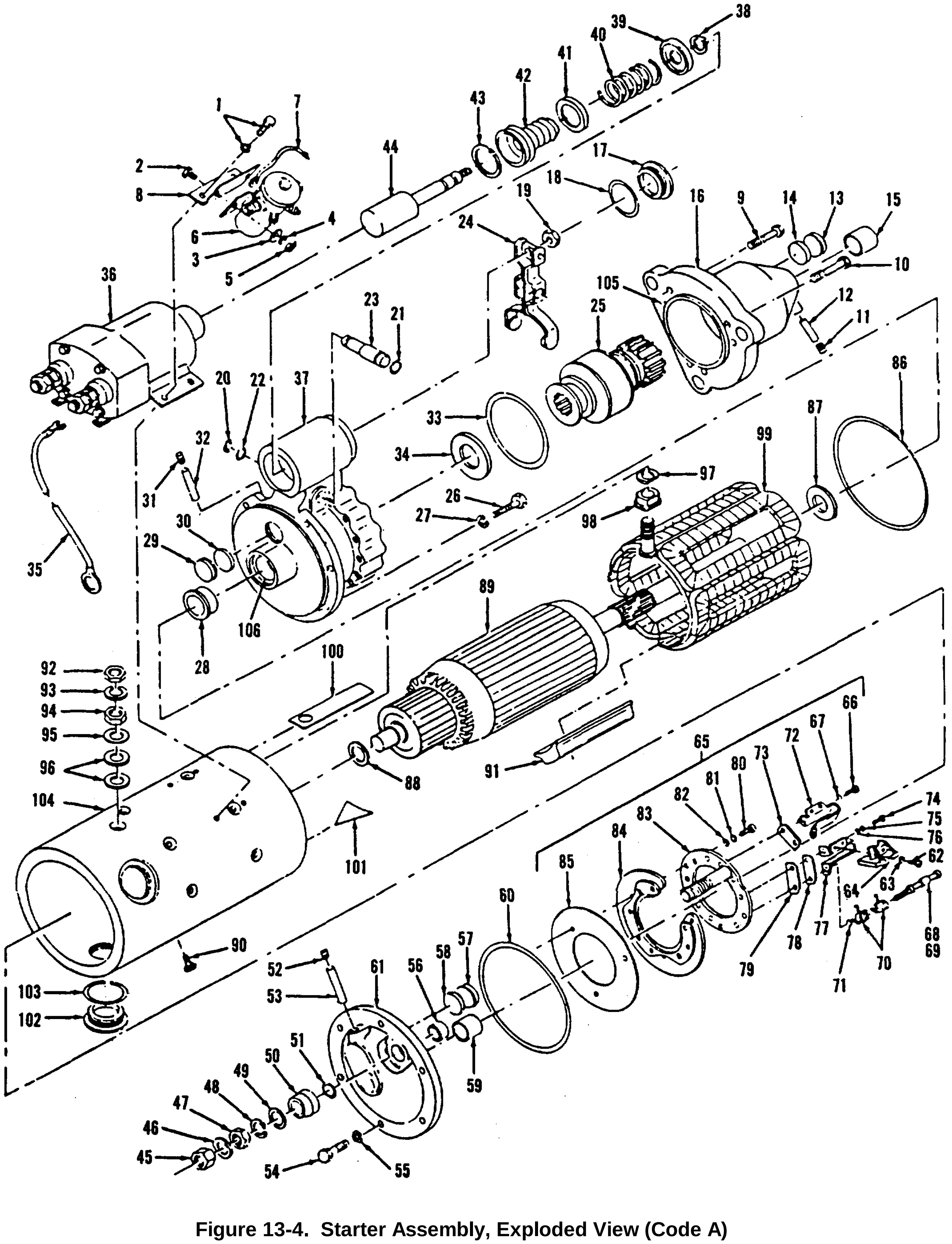


Figure 13-4. Starter Assembly, Exploded View (Code A)

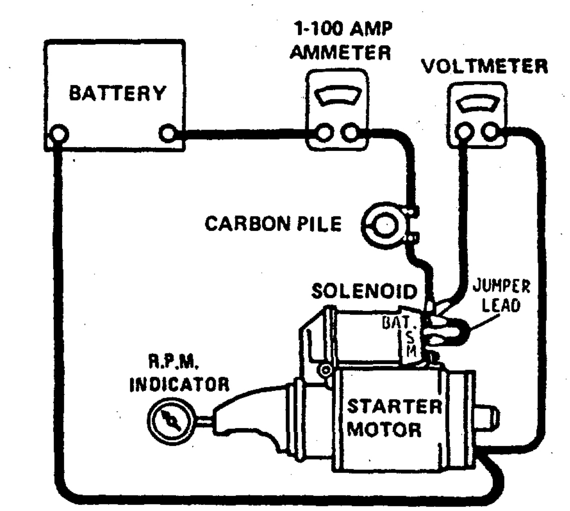


Figure 13-5. No Load Test Circuit (Code A)

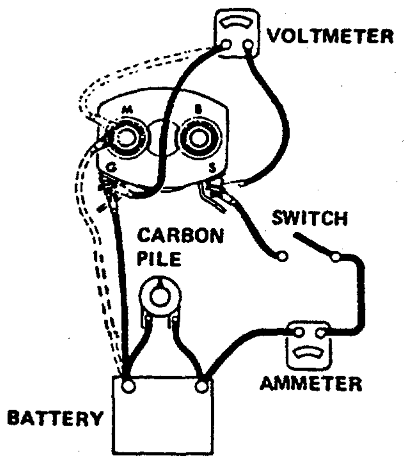


Figure 13-6. Checking Solenoid Hold-In and Pull-In Windings (Code A)

CAUTION

Do not leave pull-in winding energized for more than 15 seconds.

(3) To check the pull-in winding, connect the other battery lead to the M terminal (shown in dotted line).

(4) Adjust the voltage to 5 volts. Voltmeter shall read 5V AC and ammeter shall read 10 to 11.5 amps.

(5) Replace switch if either winding is shorted or shows excessive resistance.

j. Repair. Repair of the starter motor consists of repairing commutator bars whenever possible (if not badly burnt) and replacement of parts found defective during inspection. Repair commutator bars as follows:

(1) Using rosin flux, resolder or weld leads in the riser bars.

(2) Turn down the commutator in a lathe.

(3) Undercut and clean the commutator as indicated in paragraph k.

k. Overhaul. Overhaul of the starter motor consists of overhauling the armature commutator and replacement of parts found defective during inspection. Overhaul the commutator as follows:

(1) Turn down commutator in an appropriate lathe.

(2) Undercut the insulation 1/32 of an inch wide and 1/32 of an inch deep. Remove any trace of dirt or copper dust between slots.

(3) Sand the commutator lightly with No. 00 sandpaper to remove any burrs resulting from the undercutting procedure.

l. Assembly. Assemble the motor in accordance with figure 13-4.

(1) Install the pole shoes (91) and secure with pole shoe screws (90).

(2) Install the armature (89) and field coil (99) in the housing (104).

(3) Install the lever housing (37) with screws (26), and washers (27)..

(4) Position the washer (34) and gasket (33) in the lever housing and install the drive assembly (25) in

the housing. Make sure that the shift lever(24) properly engages the drive assembly.

(5) Secure the nose housing (16) to the lever housing with screws (9). Torque the screws to 11-15 foot-pounds.

(6) Install the end plate assembly (65) in the housing. Make sure that the brushes (64) ride on the commutator. Manually check that the brush springs (70) provide firm contact between the brushes and the commutator.

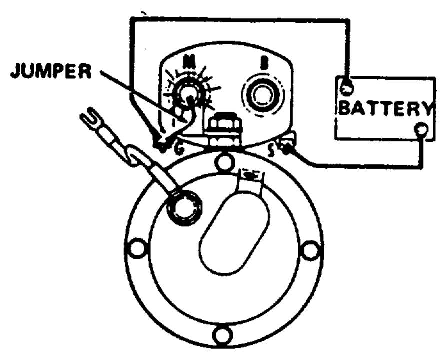


Figure 13-7. Circuit for Checking Pinion Clearance (Code A)

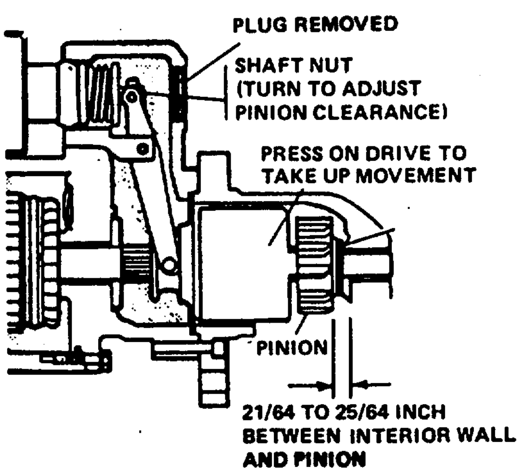


Figure 13-8. Checking Pinion Clearance (Code A)

(7) Install the commutator end frame (61) and packing (60) on the housing (104) and secure with screws (54) and lockwashers (55).

(8) Secure the solenoid switch (36), pilot relay (6) with bracket (8) on the housing with four screws and lockwashers

(1). Make sure that the plunger (44) engages the shift lever (24) properly.

m. Adjustments. Adjust pinion clearance as follows:

(1) Connect the starter motor as shown in figure 13-7.

(2) Momentarily flash a jumper lead between terminals M and G. The drive will shift into cranking position and remain so until the battery is disconnected.

(3) Push the drive assembly (25) back towards the commutator end to eliminate slack.

(4) Measure the distance between the pinion and the interior nose housing wall with a feeler gauge. Distance shall be within the 21/64 to 25/64 inch range (see figure 13-8).

(5) Adjust clearance by removing plug (17) and turning shaft nut (19). Turn nut clockwise to increase clearance and counterclockwise to reduce clearance. Replace plug after adjustment.

(6) Disconnect test set up.

n. Installation.

(1) Install three screws through housing (37, figure 13-4) to secure starter to engine assembly.

(2) Attach battery cable connections and connect wires to the pilot relay (6, figure 13-4).

(3) Secure bypass oil filter assembly bracket to engine with six screws.

(4) Attach bypass oil filter.

(5) Install ether lines with the six support clamps and screws.

13-6. STARTER ASSEMBLY (Code B) To service the components of the starter assembly, proceed as follows:

CAUTION

Remove negative battery cable first and tape cable terminal.

a. Removal. Remove starter motor by removing battery cable connections to starter and three screws which secure housing (21, figure 13-9) to engine. Tag and remove wires to the pilot relay (6, figure 13-4).

b. Inspection. Remove inspection plug (1, figure 13-9). If any brush is less than 3/8 inch (9.5 mm) long, the complete set of brushes should be replaced, para. 13-6 d (21).

c. Test. Testing of the starter motor and electrical solenoid assembly consists of a no-load test of the complete unit followed by a pinion clearance check and adjustment. Before conducting the no-load test, check armature for freedom of rotation. Use a screwdriver to turn the pinion on the exposed drive assembly in the drive housing. Tight bearings, bent armature shaft, or a loose pole shoe screw will cause armature binding. If armature does not turn freely, disassemble the unit. If armature rotates freely, conduct the no load test before disassembling the motor.

CAUTION

Do not allow starter motor to operate more than 30 seconds. Allow it to cool at least 2 minutes before reenergizing. Overheating will damage motor.

(1) Connect the starter assembly as shown in figure 13-10

(2) Use power supply to obtain 20v DC on voltmeter.

(3) Using rpm indicator and ammeter, at 95 amps rpm should be at 5500. At a maximum current draw of 120 amps rpm should be at 7500.

(4) To check pinion clearance connect as shown in figure 13-11.

CAUTION

To prevent overheating damage to windings, do not energize hold-in windings longer than 30 seconds. If adjustment cannot be made in this time, disconnect battery and allow windings to cool.

(5) Energize hold-in windings in electrical solenoid by connecting a 24V DC battery to the G and S terminals. Momentarily energize pullin windings by flashing a jumper lead from the G to the MTR terminal ((A} figure 13-11). Do not leave jumper lead connected. Hold-in windings will keep solenoid plunger in operating position as long as battery is connected between G and S terminals.

(6) Push drive assembly toward commutator end of starter to remove slack. Measure pinion clearance ({B) figure 13-11).

(7) Turn plunger rod nut (10, figure 13-9) clockwise to reduce clearance and counterclockwise to increase clearance as necessary to achieve a pinion clearance of 0.328 to 0.390 inches (8.33 to 9.9 mm). Apply pressure on stud to prevent turning while adjusting.

(8) After completing adjustment, disconnect battery from G and S.

d. Disassembly

(1) Remove four brush inspection plugs (1, figure 13-9) and gasket (2) from lever housing (3). Discard gasket.

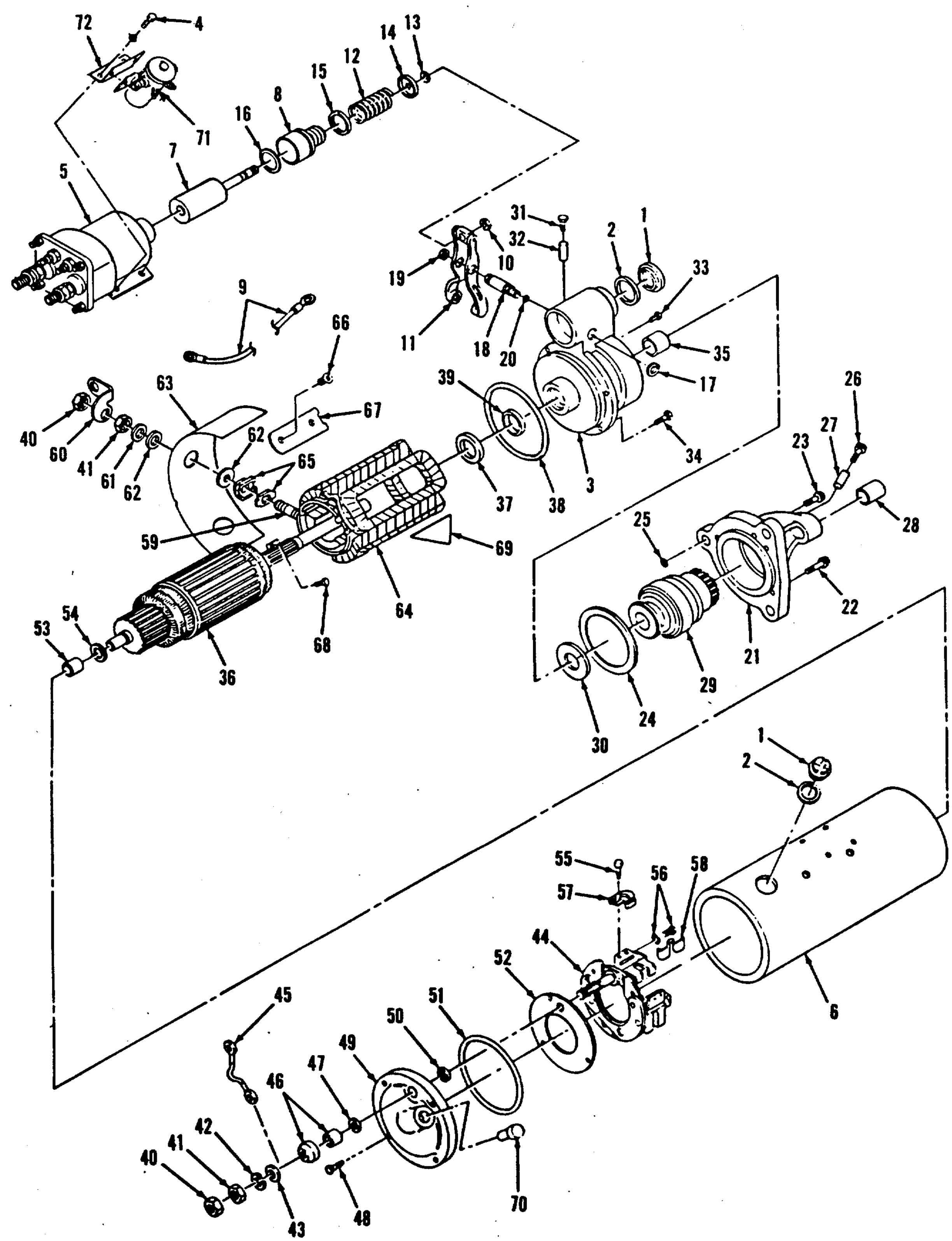


Figure 13-9. Starter Assembly, Exploded View (Code B)

LEGEND FOR FIGURE 13-9

1. Brush inspection plug
2. Inspection plug gasket
3. Lever housing
4. Bolt
5. Solenoid
6. Starter housing
7. Plunger
8. Protector bellows
9. Terminal lead
10. Plunger rod nut
11. Shift lever
12. Plunger spring
13. Snap ring
14. Recessed washer
15. Recessed washer
16. Spring retainer washer
17. Snap ring
18. Shift lever shaft
19. Preformed packing
20. Preformed packing
21. Stator housing
22. Bolt
23. Bolt
24. Gasket
25. Rubber ball
26. Dust cap
27. Oil wick
28. Drive housing bushing
29. Drive assembly
30. Brake washer
31. Protective dust cap
32. Oil wick
33. Lever housing plug
34. Machine bolt
35. Lever housing bushing
36. Armature
37. Spacer washer
38. Preformed packing
39. Oil seal
40. Plain external nut
41. Plain hexagon nut
42. Lockwasher
43. Flat washer
44. Electrical holder assembly
45. Braided strap
46. Electrical parts kit
47. Insulator washer
48. Machine bolt
49. Starter housing mounting plate
50. Insulator washer
51. Preformed packing
52. Brush plate insulator
53. Sleeve bearing
54. Flat washer
55. Machine screw
56. Brush plate screw
57. Electrical brush
58. Helical spring
59. Terminal stud
60. Terminal lug
61. Flat washer
62. Field terminal washer
63. Field coil insulator
64. Field coil
65. Terminal stud bushing
66. Pole shoe screw
67. Pole rotor shoe
68. Field coil screw
69. Insulator plate
70. Protective dust cap
71. Pilot relay
72. Bracket

(2) Disconnect terminal lead (9) from solenoid.

(3) Remove four bolts (4) securing solenoid (5) to starter housing (6). Slide solenoid off plunger (7) and free of bellows (8).

(4) Remove cap (1) from lever housing (3).

(5) Remove nut (10) securing plunger.(7) to shift lever (11) from inside of lever housing (3).

(6) Compress spring (12) and remove snap rincg:(13) from plunger (7). Remove washer (14), spring (12) and-washer (15), bellows (8) and washer (16). Discard snap ring.

(7) Remove snap ring (17) from shift lever shaft (18). Remove shaft and shift lever (11) from lever housing (3) Discard packings (19) and (20).

(8) Matchmark stator housing (21) to lever housing (3) and lever housing (3) to starter housing (6).

(9) Remove six bolts (23) securing stator housing (21) to lever housing (3).Separate housings and remove gasket (24).Discard gasket and remove six rubber balls (25).

(10) Remove dust cap (26) and oil wick (27) from stator housing (21). Discard oil wick.

(11) Remove bushing (28), drive assembly (29) and brake washer (30) from lever housing (3).

(12) Remove dust cap (31), oil wick (32) and plug (33) from lever housing (3).Discard oil wick.

(13) Remove seven bolts (34) securing lever housing (3) to starter housing (6).

(14) Remove bushing (35) from lever housing (3) and slide lever housing off armature (36) and away from starter housing (6).

(15) Remove washer (37), packing

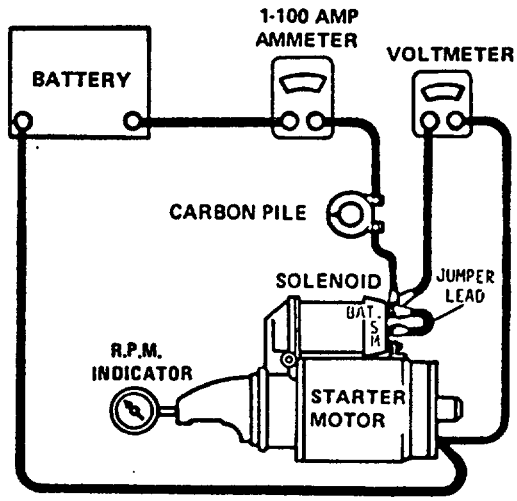


Figure 13-10. No-Load Test Circuit (Code B)

(38) and oil seal (39) from lever housing (3). Discard packing and oil seal.

(16) Remove nuts (40 and 41) and washers (42 and 43) from electrical holder assembly (44). Remove braided strap (45), electrical parts kit (46) and washer (47).

(17) Remove inspection plug (1) and gasket (2) from starter housing (6).

(18) Remove four bolts (48) securing starter housing mounting plate (49) to starter housing (46). Remove mounting plate washer (50), packing (51) and insulator (52) from electrical holder (44). Discard packing.

(19) Slide armature (36) from housing (6).

(20) Remove sleeve bearing (53) and washer (54) from armature (36).

(21) Remove two screws (55) and screw (56) and then remove electrical brush (57) and spring (58) from electrical holder assembly (44).

(22) Remove nut (40) from terminal stud (59) and then remove terminal lug (60).

(23) Remove nut (41), washer (61) and washer (62) securing field coil insulator (63) to field coils (64).

(24) Remove insulator (63), washer (62), bushing (65) from terminal stud (59)

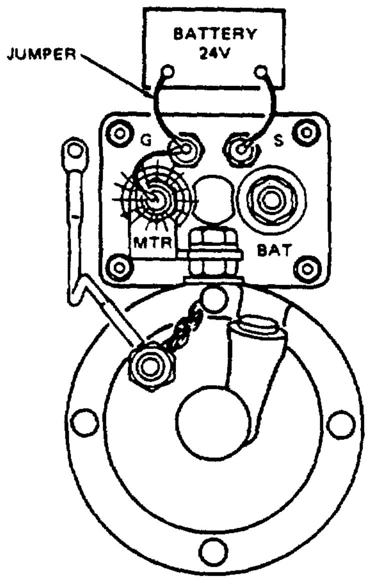
(25) Remove two screws (66) from each of four pole rotor shoes (67) and remove shoes.

(26) Remove screw (68) and insulator plate (69).

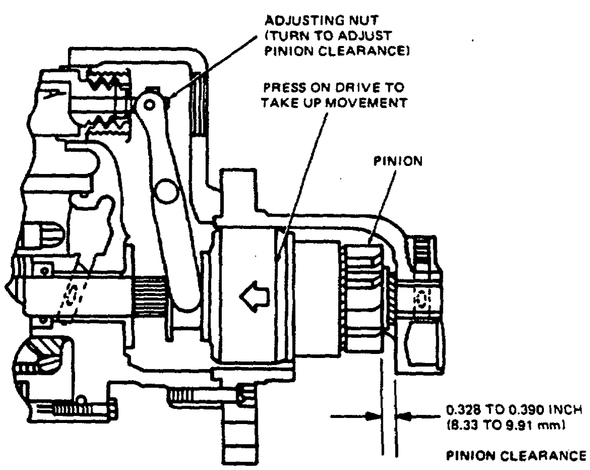
e. Cleaning.

WARNING

P-D-680, TYPE II, IS FLAMMABLE (WHEN ATOMIZED) AND IS MODERATELY TOXIC TO EYES, SKIN, AND RESPIRATORY TRACT. SKIN AND EYE PROTECTION IS REQUIRED. AVOID REPEATED OR PROLONGED CONTACT. USE IN WELL-VENTILATED AREA. COMPRESSED AIR USED FOR CLEANING OR DRYING CAN CREATE AIRBORNE PARTICLES THAT MAY ENTER THE EYES. PRESSURE SHALL NOT EXCEED 30 PSI (207 kPa). WEARING OF GOGGLES IS REQUIRED TO AVOID INJURY TO PERSONNEL.



(A) ENERGIZING SOLENOID WINDINGS



(B) MEASURING PINION CLEARANCE

Figure 13-11. Adjusting Starter Pinion Clearance

(1) Clean all parts except armature (36, figure 13-9), field coils (64), electric al solenoid (5), and drive assembly (29) in cleaning solvent P-D-680, Type II and blow dry with compressed air.

CAUTION

Do not immerse the drive assembly (29) in solvent. This would wash the lubricant from the overrunning clutch, and result in premature wear and failure of the drive assembly.

(2) Clean drive assembly (29) with solvent dampened cloth.

(3) Clean windings and insulated parts with a dry brush and dry compressed air to remove loose dust and dirt.

(4) Remove oily caked deposits from windings and insulated parts with a brush and solvent and blow dry. Do not immerse or soak insulation.

(5) Dry armature (36) or field coils (64) in an oven at 175° to 200°F (29° to 93°C) for 2 hours.

(6) Wipe brushes (57) with clean dry cloth to remove dirt or oil. Do not use solvent. Replace any oilsoaked brushes.

CAUTION

Do not use emery cloth or paper for the following operation. Emery dust could cause electrical shorts in the starter motor.

(7) If commutator is in good condition, polish it with 00 grade sandpaper P-P-105 to obtain a bright surface .Blow off with compressed air after sanding. Do not use emery cloth or paper. If commutator slots are filled with dirt, clean with toothpick or narrow piece of wood soaked in solvent and blow dry.

f. Inspection and Checks

(1) Visually inspect starter

housing (6, figure 13-9) and stator housing (21) for cracks or other damage.

(2) Check all threaded parts for crossed, deformed, or stripped threads.

(3) Drive housing bushing (28), lever housing bushing (35), and sleeve bearing (53). are pressfit into their respective bores, with clearance of -0.0005 to -0.0020 inch (-0.013 to -0.051 mm). Check that they are tight fit and cannot be rotated in bores.

(4) Check drive housing bushing (28), lever housing bushing (35), and sleeve bearing (53) for scoring and proper fit on armature (36). Clearance shall not exceed 0.006 inch (0.15 mm).

(5) Visually inspect armature (36) for the following defects:

(a) Scored or grooved bushing surfaces.

(b) Damaged laminations due to rubbing on pole rotor shoes (67).

(c) Burned or scored commutator bars.

(d) High insulation between commutator bars.

(e) Loose commutator bars.

(f) Damaged splines.

(g) Damaged or loose windings due to thrown solder.

g. Armature Test.
Check armature per paragraph 13-5g.

h. Field Coil Test.
Check field coil per paragraph 13-5h.

i. Repair/Overhaul.

(1) Replace starter housing (6, figure 13-9), stator housing (21), and lever housing (3) if cracks or other damage have been found.

Drive housing bushing (28), lever housing bushing (35), and sleeve bearing (53) must be lubricated and installed properly to achieve long service life.

(2) Replace worn bushings (28 and 35) and bearing (53) as follows:

(a) Remove bushings using bushing driver.

(b) Remove sleeve bearing (53) using a blind hole bushing puller or a bushing cutter. Do not cut into starter housing (6).

(c) With clean hands, place a new bushing on the palm of the hand and fill it with SAE 20 lubricating oil. Place thumb of free hand over open end of bushing and push hard to pressurize oil in bushing. Bushing is properly lubricated when oil seeps through entire outside diameter of bushing.

(d) Check that bore into which bushing is to be inserted is clean and grit free.

CAUTION

Do not drill, ream, or machine bronze bushings. Machining will seal or plug bushing pores and prevent proper lubrication.

NOTE

If new lubricated bushing is not going to be installed immediately, store in a clean plastic bag.

(e) Using correct size bushing driver, install new lubricated drive housing and lever housing bushings

(28 and 35) or sleeve bearing (53). Ensure that bushing is started square and driven straight into housings (21, 3 and 6) until level with, or slightly below, thrust surface. Bushings are sized to be a correct fit on armature shaft when installed. Do not ream, drill, or machine bushing.

(f) Check fit of bushings or bearing on armature (36). Correct clearance is 0.0015 to 0.003 inch (0.038 to 0.08 mm). If bushing fits too tightly, it was incorrectly installed; remove damaged bushing and install a new one. If fit is too loose, check armature shaft for wear.

(3) Replace armature (36) for any of the following defects:

(a) Thrown solder due to overheating.

(b) Loose windings.

(c) Loose commutator bars.

(d) Bushing surface worn to the extent that clearance between bushing exceeds 0.0015 to 0.003 inch (0.038 to 0.08 mm).

(e) Bushing surface scored to depth of more than 0.003 inch (0.08 mm).

(f) Damaged or uneven wear of splines.

(g) Shaft runout exceeds 0.005 inch (0.13 mm) TIR.

(h) Presence of electrical opens, shorts, or grounds.

(4) If commutator runout is over 0.005 inch (0.13 mm) or it is scored, uneven, or burned, repair as follows:

WARNING

LATHE OR MILLING OPERATIONS CREATE METAL PARTICLES WHICH MAY ENTER THE EYES. WEARING GOGGLES IS REQUIRED TO AVOID INJURY TO PERSONNEL.

(a) Resurface commutator using armature and undercutting lathe MIL-L-14576.

(b) After machining, undercut insulation between commutator bars to a depth and width of 0.031 inch (0.79 mm).

CAUTION

Do not use emery cloth or paper for the following operation. Emery dust could cause electrical shorts in the starter motor.

(c) After machining and undercutting, remove any burrs from commutator using sandpaper P-P105; do not use emery cloth. After deburring, remove any sanding or copper dust from slots between commutator bars.

WARNING

AVOID BREATHING FUMES GENERATED BY SOLDERING. REMOVE RINGS AND WATCHES. EYE PROTECTION IS REQUIRED TO AVOID INJURY TO PERSONNEL.

(5) Resolder any field coil leads as required, in accordance with MIL-S-6872, using solder QQ-S-571, Type SN 60, and rosin flux.(F) Refer to TO-00-25-234.

(6) If frayed field coil windings are present, wrap with insulating tape and paint with insulating varnish MS355632.

(7) If field coils have electrical shorts, opens, grounds, oil soaking, or insulation obviously damaged beyond repair, replace as follows:

(a) Place a pole shoe spreader between opposite pole rotor shoes (67, figure 13-9) and tighten in place.

(b) Using a pole shoe screwdriver and an arbor press, remove pole shoe screws (66). Remove pole screw spreader with pole rotor shoes (67).

(c) Repeat steps (1) and (2) for other two rotor pole shoes.

(d) Push in on field coil terminal stud (59) and slip field coils (64) out of starter housing (6).

(e) Remove field coil insulators (63), insulator plate (69), field terminal washer (62), and terminal bushings (65) and discard.

(f) Insert new field coil (64) into starter housing (6) with new field coil insulators (63), insulator plate (69), field terminal washer (62), and terminal bushings (65).

NOTE

If pole rotor shoes (67) have a long lip on one side, lip must face in direction of armature rotation (clockwise when viewed from the drive end). This locates lip as trailing edge of pole rotor shoe.

(g) Insert pole rotor shoes (67) into position in field coils and retain with pole shoe screws (66). Do not tighten screws at this time.

(h) Check that insulators (69) are properly placed and pole rotor shoes are not pinching field coils (64). Tighten pole shoe screws (66) using an ordinary screwdriver.

(i) Place a pole shoe spreader between opposite pole rotor shoes (67) and tighten in place.

(j) Using a pole shoe screwdriver and an arbor press, tighten pole shoe screws (66) and remove pole shoe spreader.

(k) Repeat steps (7) through (10) for other two pole shoes.

(l) Ensure that terminal bushings (65) and field terminal washer (62) are properly positioned on terminal stud (59). Install another field terminal washer (62), flat washer (61), and plain hexagonal nut (41) on terminal stud.

(m) Install terminal lug (60) and plain external nut (40) on terminal stud (59). Do not tighten nut at this time.

(8) Replace defective electrical holder assembly (44) and insulators as follows:

(a) Remove brush plate screws (56) and electrical holder assembly (44) with brush plate insulator (52) and insulator washer (47).Discard insulators if defective.

(b) Install new brush plate insulator (52) and insulator washer (47) on new electrical holder assembly (44) and insert stud through hole in starter housing (6) and preformed packing (51).

(c) Install insulator washer (50) terminal stud bushing (65) braided strap (45), flat washer (43), lockwasher (42), and hexagon nut (41). Do not fully tighten nut at this time.

(d) Install brush plate screws (56) and tighten.

(e) Tighten hexagon nut (41) to 20 to 25 foot-pounds (27 to 34 newton-meters).

(9) Replace oil soaked or cracked electrical brushes (57) or brushes which are less than 0.656 inch (16.66 mm) in length.

(10) Replace helical springs (58) if tension is under 2 pounds (0.9 kg).

(11) Remove nicks or accumulated dirt from plunger (7) or bore of electrical solenoid (5).

(12) Replace electrical solenoid (5) if tests show it to be defective.

(13) Replace plunger spring (12) if warped or if free length is less than 2.296 inches (58.32 mm).

(14) Replace shift lever shaft (18) if worn or grooved.

(15) Replace shift lever (11) if shaft holes are worn or elongated or if pads are worn or deformed.

(16) Remove slight nicks or burrs from pinion teeth of drive assembly (29).Replace drive assembly if teeth are cracked or excessively worn or if overrunning clutch is defective.

j. Assembly.

(1) Check that all parts are clean before starting assembly procedure.

(2) Lubricate spacer washer (37, figure 13-9) and flat washer (54) with a thin film of petrolatum V-V-P236 and install on armature (36).

(3) Soak new oil wicks (27 and 32) in SAE 20 motor oil and install in lever housing (3) and stator housing (21). Secure wicks with protective dust caps (26 and 31).

NOTE

To aid in installation of starter housing and electrical holder assembly on armature do not attempt to install starter housing and electrical holder assembly with electrical brushes loaded by helical springs.

(4) Position electrical brushes (57) in electrical holder assembly (44) so that tangs of helical springs (58) rest against side of electrical brushes and hold electrical brushes in retracted position. Once starter housing (6) and electrical holder assembly (44) have been installed on armature (36), tangs of helical springs (58) may be placed in their normal positions on electrical brushes (57), tensioning electrical brushes against commutator.

(5) Install protective dust cap (70) and new preformed packing (51) on starter housing (6). Install assembled housing and electrical holder assembly (44) over commutator of armature (36).

(6) Thread field coil brush leads through inspection holes in field frame. Install armature (36, figure 13-9) into field frame.

NOTE

Hold the field frame securely on the armature (36) when placed into the starter housing (6) so that the field frame does not slip off. Otherwise brushes (37) will have to be removed and re-installed as per step j(4).

(7) Put starter housing (6) in place on field frame. Ensure that matchmarks are lined up. Secure starter housing to field frame using machine bolts (34).

(8) Attach brush leads to brush holders using brush plate screws (56).

(9) With lip facing lever housing brushing (35), install a new spacer washer (37) in lever housing (3).

(10) Install a new preformed packing (38) on lever housing (3) and put lever housing in place on field frame. Ensure that matchmarks are lined up.

(11) Install brake washer (30) over shaft of armature (36), tilt shift lever (11), and install into lever housing (3). Ensure that shaft lever is properly positioned in collar of drive assembly (29).

(12) Install shift lever shaft (18) with preformed packings (20 and 19) and secure with new snap ring (17).

(13) Using new gasket, put stator housing in place on lever housing. Ensure that matchmarks are lined up. Install drive housing bolt (22) and internal housing bolts (23) Cross-tighten bolts to 13 to 17 footpounds (18 to 23 newtonmeters).

(14) Place spring retainer washer (16), protector bellows (8), recessed washer (15), plunger spring (12), and recessed washer (14) over plunger (7) and secure with snap ring (13).

(15) Install plunger (7) through shift lever (11). Install plunger rod nut (10) on shaft until several threads are engaged.

(16) Install electrical solenoid (5) over plunger (7) and into protector bellows (8).Secure electrical solenoids to starter housing (6) with machine bolts (4).

(17) Place terminal lug (60) on field terminal of electrical solenoid (5). Install external nut (40) and tighten it with other hexagonal nut (41) to 20 to 25 footpounds (27 to 34 newtonmeters).

(18) Check and adjust pinion and clearance per paragraph 13-6 (4).

k. Installation

(1) Install three bolts through housing (21, figure 13-9) to secure starter to engine assembly.

(2) Attach battery cable connections and connect wires to pilot relay (6, figure 13-4).

13-7. TACHOMETER DRIVE ADAPTER (Code A). To replace the tachometer drive adapter, code A, proceed as follows:

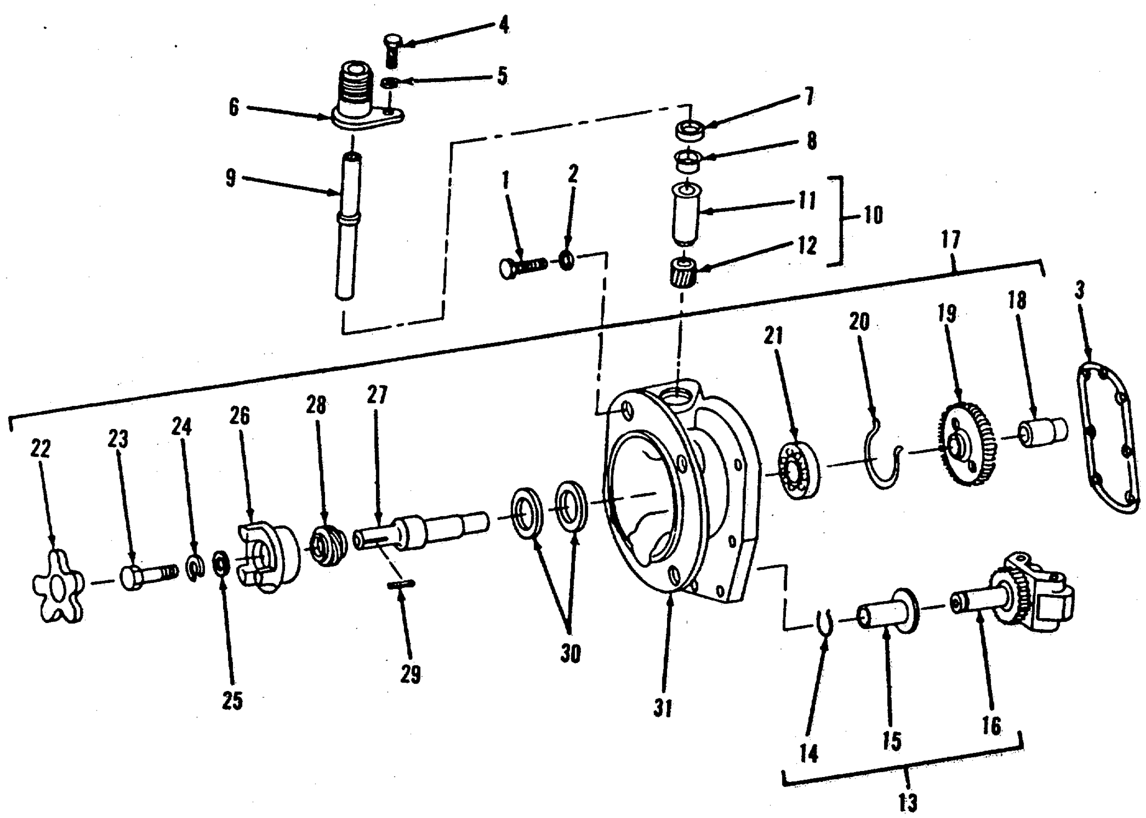
a. Remove the speed switch in accordance with the Operator/ Crew and Organizational Maintenance manual.

b. Unscrew the adapter (6, figure 13-12) from the tachometer drive housing.

c. Replace with a new adapter, if required.

d. Replace the speed switch in accordance with the Operator/ Crew and Organizational Maintenance manual.

13-8. TACHOMETER DRIVE (Code A). To inspect, replace, and repair the tachometer drive, refer to figure 13-12



LEGEND

1.	Capscrew	12.	Gear	23.	Screw
2.	Lockwasher	13.	Weight and carrier assy	24.	Lockwasher
3.	Gasket	14.	Ring	25.	Washer
4.	Screw	15.	Bushing	26.	Coupling
5.	Lockwasher	16.	Weight and carrier assy	27.	Shaft
6.	Adapter	17.	Tachometer drive and cover	28.	Gear
7.	Seal	18.	Coupling	29.	Key
8.	Spacer	19.	Gear	30.	Seal
9.	Shaft	20.	Ring	31.	Cover
10.	Drive	21.	Bearing		
11.	Bushing	22.	Coupling		

Figure 13-12. Mainshaft-Cover and Tachometer Drive, Exploded View, Code A

and proceed as follows:

a. Removal.

(1) Remove the speed switch and tachometer drive adapter in accordance with paragraph 13-7,

(2) Remove the fuel pump.

(3) Remove the main shaft cover assembly by removing the four capscrews and washers securing it to the engine assembly.

(4) Check governor weight carrier shaft (16) in its bushing (15) before removal. Excessive wear can be felt by moving shaft from side to side in the bushing.

(5) Observe gear backlash between weight shaft gear and drive gear (19). Normal backlash is 0.005 to 0.009 inch (0.13 to 0.23 mm).

(6) To remove the governor weight and carrier assembly (16) from the drive cover (31) use a puller to pull weight shaft assembly from front cover. The bushing (15) is locked on the shaft with snap ring (14) and will usually come out of the cover with weight shaft assembly; however, if snap ring pulls off shaft leaving bushing in front cover, use an internal engaging puller to pull bushing.

(7) Remove screw (4), lockwasher (5), and tachometer drive housing.

(8) Use a dowel puller to remove tachometer drive shaft (9), seal (7), spacer (8), bushing (11), and gear (12).

(9) Remove snap ring (20) with hose clamp pliers.

(10) Remove coupling (18), gear (19), and bearing (21).

(11) Remove spider coupling (22), screw (23), lockwasher (24), washer (25), and coupling hub (25A). Press drive shaft (27) from cover.

(12) Press gear (26) from shaft (27).

(13) Press oil seals (30) from cover.

b. Inspection.

(1) Inspect bushing (15); if worn larger than 0.504 inch (12.80 mm), replace bushing.

(2) Visually inspect gears for cracked, broken, or worn teeth.

(3) Inspect all shafts for wear or scoring.

c. Repair. Repair by replacing any worn or damaged parts.

d. Assembly.

(1) Clean all parts thoroughly with mineral spirits.

(2) Press first oil seal (30) into drive cover with lip toward outside of pump, and press second oil seal into drive cover with sealing lip toward inside of fuel pump. Seals must be spaced so the "telltale" hole is not covered.

(3) Lubricate oil seal assembly tool and install tool over main shaft (27). Place snap ring (20) between drive gear (19) and bearing (21). Press main shaft into front cover and through seals. Secure snap ring (20) in cover groove. Remove oil seal assembly tool and install coupling (18).

(4) Line up oil groove in top of tachometer drive bushing (11) with fuel pump drive shaft. Press gear (12), bushing (11), and shaft (9) into cover until bushing bottoms.

(5) Install spacer (8) on top of bushing with slotted edge down.

(6) Install new oil seal (7) with spring side down. Spacer (8) must bottom on bushing.

CAUTION

Do not overpress spacer; it can become flattened eliminating its effectiveness.

(7) Cover top of seal with a thin coat of lubricating oil. Secure tachometer adapter (6) to cover with

washer (5) and screw (4).

(8) Install key (29), press gear (26) and coupling (25A) into position on drive shaft (27). Press slow and straight. Be certain tachometer gear teeth are aligned.

(9) Install Washer (25), lockwasher (24), screw (23), and spider coupling (22). Hold coupling (25A) or main shaft (27) in a copperjawed vise while tightening.

(10) Coat governor bushing (15) with high-pressure lubricant and press governor weight and carrier assembly (16) into front cover. Mesh gears to avoid gear tooth damage. The bushing must seat against housing. Rotate weight assembly, with weights opened out, to be sure it will turn completely in housing. Install snap ring (14).

(11) Install mainshaft cover assembly to engine assembly with the four washers and capscrews.

(12) Replace the fuel pump, speed switch and tachometer drive adapter.

13-9. TACHOMETER DRIVE CONNECTOR (Code B). To replace the tachometer drive adapter, code B, proceed as follows:

a. Remove the speed switch in accordance with the Operator/ Crew and Organizational Maintenance manual.

b. Unscrew the connector (7, figure 13-13) from the tachometer drive housing.

c. Replace with a new connector if required.

d. Replace the speed switch in accordance with the Operator/ Crew and Organizational. Maintenance manual.

13-10. TACHOMETER DRIVE (Code B). To inspect, replace, and repair the tachometer drive refer to figure 13-13, and proceed as follows:

a. <u>Removal.</u>

(1) Remove the speed switch and tachometer drive connector in accordance with paragraph 13-9.

(2) Remove the fuel pump.

(3) Remove the main shaft cover assembly by removing the four cap screws and washers securing it to the engine assembly.

(4) Check the governor weight carrier shaft (24, figure 13-21) in its bushing before removal. Excessive wear can be felt by moving shaft from side to side in the bushing.

(5) Observe gear backlash between weight shaft gear and drive gear (22, figure 13-13). Normal backlash is 0.005 to 0.009 inch (0.13 to 0.23 mm).

(6) Remove carrier (24, figure 13-21).

(7) Remove drive shaft (9, figure 13-13), seal (8), bushing (10), and gear (11).

(8) Remove screw (13), hub (14).key (15), spacer (16) and gear (17). Pres drive shaft (25) from cover.

(9) Press gear (22) from cover

(10) Press oil seals (19) from cover.

b. <u>Inspection.</u>

(1) Visually inspect gears for cracked, broken, or worn teeth.

(2) Inspect all shafts for wear or scoring.

c. <u>Repair</u>. Repair by replacing damaged parts.

d. <u>Assembly</u>.

(1) Clean all parts thoroughly with mineral spirits.

(2) Press first oil seal (19) into drive cover with lip toward outside of pump, and press second oil seal into drive cover with sealing lip toward inside of fuel pump. Seals must be spaced so that the "tell tale" hole is not covered.

(3) Lubricate oil seal assembly tool and install tool over main shaft (25). Place snap ring (23) between drive gear (22) and bearing (24). Press main shaft into front cover and through seals. Secure snap ring (23) in cover groove. Remove oil seal assembly tool and install adapter (21).

(4) Line up oil groove in top of tachometer drive bushing (10) with fuel pump drive shaft. Press gear (11), bushing (10), and shaft (9) into cover until bushing bottoms.

(5) Install new oil seal (8)

(6) Cover top of seal with a thin coat of lubricating oil. Secure tachometer connector (7) to cover.

(7) Install key (15), press gear (17), hub (14,) and spacer (16) into position on drive shaft (25). Press slow and straight. Be sure tachometer gear teeth are aligned.

(8) Secure with screw (13).

(9) Install carrier (24, figure 13-4) into front cover. Mesh gears to avoid gear tooth damage. Rotate weight assembly, with weights opened out to be sure it will turn completely in housing.

(10) Install main shaft cover assembly to engine assembly with four capscrews and washers.

(11) Replace the fuel pump.

Section III. OIL FILTER AND SENSORS

13-11. LUBRICATING OIL COOLER. To test and repair the lubricating oil cooler, refer to figure 13-14 and 13-15 and proceed as follows:

NOTE

Figure 13-15 is given for informational purposes only, since older models may not contain removable cores.

a. Test.

(1) Refer to the Operator/Crew Organizational Maintenance manual for inspection and removal procedures.

(2) Clamp cooler assembly in fixture and assemble air connection.

(3) Place unit in water tank with spring side down. and apply 1 to 4 psi (7 to 28 kPa) air pressure to water side.

(4) Inspect for air leaks and porosity in castings.

(5) Apply 35 to 45 psi (241 to 176 kPa) to oil side.

(6) Inspect for air leaks and porosity in castings.

b. Repair and Reassembly. To repair the lubricating oil cooler, refer to figure 13-14, and proceed as follows:

(1) Remove screws (33), cover (36), and gasket (38). Then remove screws (26), washer (27), screw (25), connection (28) and gasket (29).

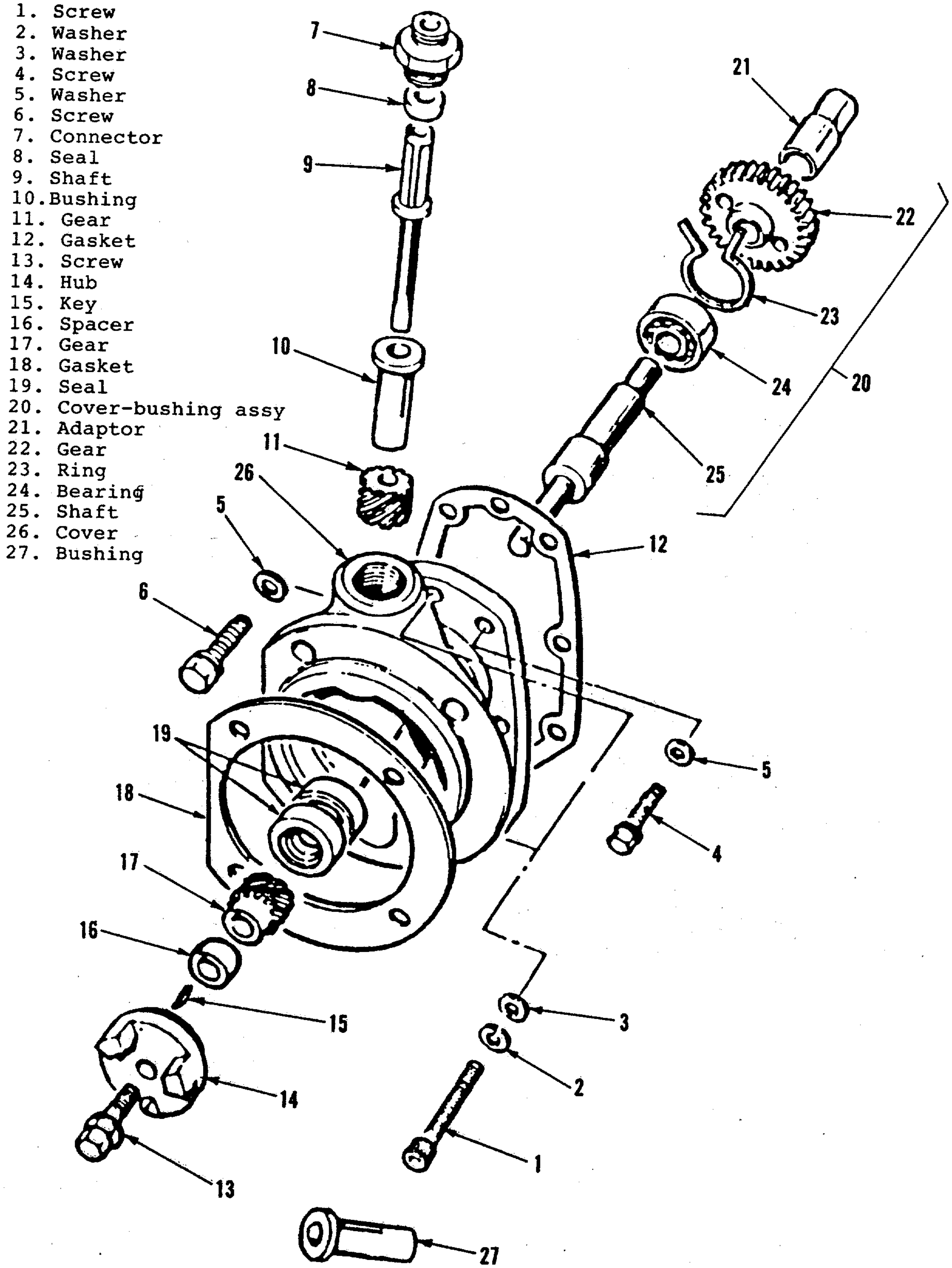


Figure 13-13. Mainshaft Cover and Tachometer Drive, Exploded View, Code B

NOTE

To prevent hardening and drying of foreign substances, clean cooler assembly immediately after removing end cover plates. Use approved cleaning solvent that will not harm non-ferrous metal. Finish cleaning by blowing through core with compressed air.

(2) Repair damaged tubes, by inserting a smaller OD tube inside damaged tube. Cut and flare ends, then solder securely. Do not restrict more than 5 percent of total number of tubes in this manner. If more than 5 percent of tubes are defective, discard cooler.

(3) To assemble the lubricating oil cooler, install new gasket (38), cover (36), new washers (27), new gasket (38), new gasket (29), connection (28), and new screws (25), (26) and (33).

c. Bypass Oil Filters. The bypass oil filters are located on a bracket mounted over the starter motor assembly on the right side of the engine. Service the bypass oil filters by replacement as follows:

(1) Clean filter case. Handle or store in a manner to prevent out-of-round.

(2) Insert new element in filter case, seating it securely on bottom.

(3) Fill element with proper lubricating oil. Refer to table 3-1 of the Operator/ Crew and Organizational Maintenance manual.

(4) Install new top gasket, position filter case, and tighten clamps securely.

(5) Run engine, check for leaks, recheck engine oil level; add oil as necessary to bring oil level to FULL mark on oil level gauge (dipstick).

NOTE

Always allow oil to drain back to oil pan before checking level. This may require several minutes.

13-12. BYPASS VALVE. To inspect, test, replace, and repair the lubricating oil filter bypass (relief) valve, refer to figure 13-14, and proceed as follows:

a. Removal.

(1) Drain the engine oil and remove the oil filters (13) in accordance with the Operator/Crew and Organizational Maintenance manual.

(2) Remove oil transfer tube (3) and discard O-ring (4).

(3) Remove capscrews (1) and washers (2).

(4) Remove capscrews (5), capscrews (6), and washers (7); discard gasket (11).

LEGEND FOR FIGURE 13-14

1. Screw
2. Washer
3. Tube
4. O-ring
5. Screw
6. Screw
7. Lockwasher
8. Tube
9. O-ring
10. Connection
11. Gasket
12. Lubricating oil filter assy
13. Filter
14. Adapter
15. Lockplate
16. Plug
17. Plug
18. Retainer
19. Spring
20. Disc.
21. Screw
22. Lockwasher
23. Head
24. Gasket
25. Screw
26. Screw
27. Lockwasher
28. Connection
29. Gasket
30. Tube
31. O-ring
32. Lubricating oil cooler assy
33. Screw
34. Screw
35. Lockwasher
36. Cover
37. Cover
38. Gasket
39. Cooler
40. Screw
41. Bracket

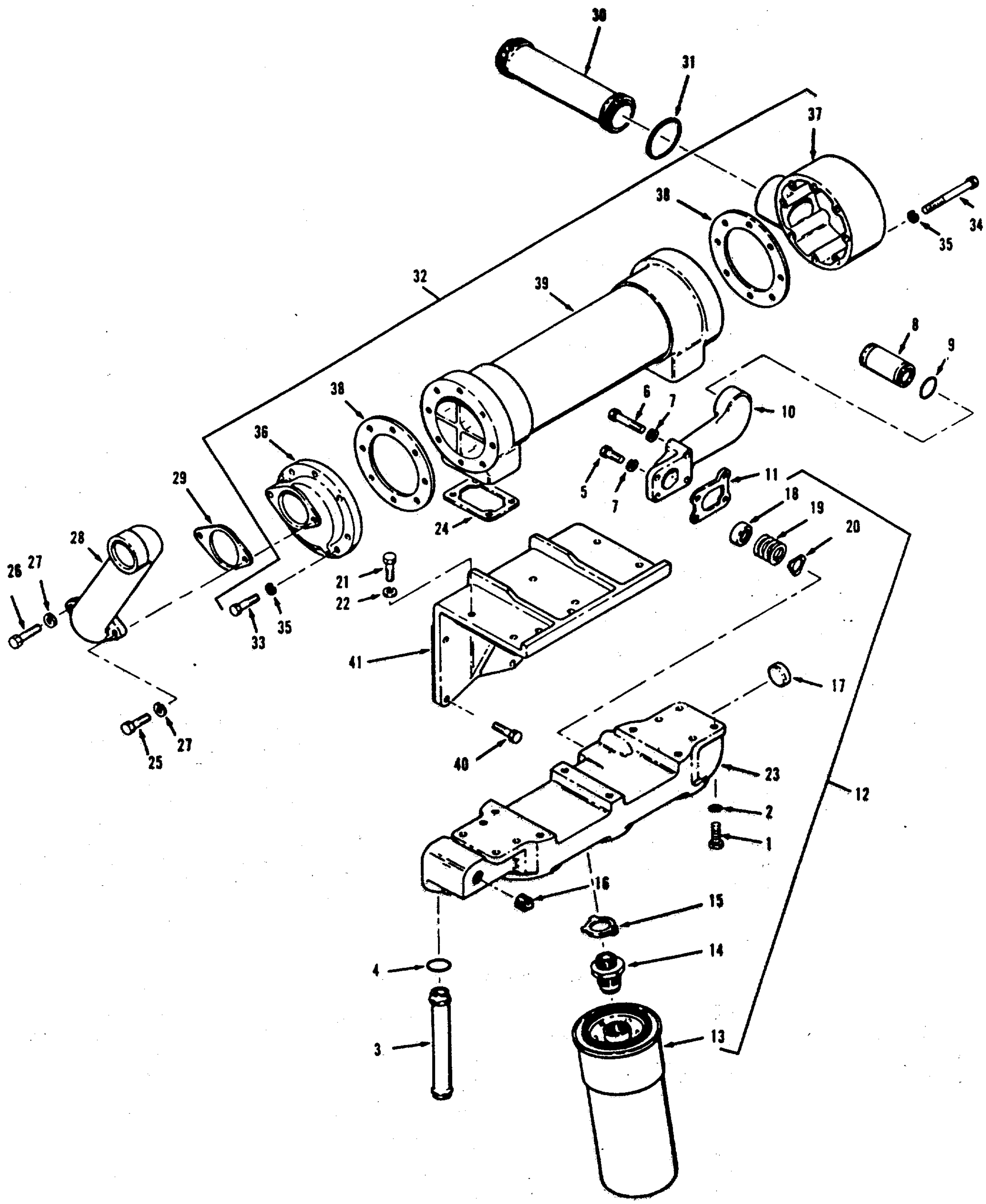


Figure 13-14. Lubricating Oil Cooler, Exploded View, Code A

(5) Remove retainer (18), spring (19), and disc (20).

b. Inspection and Test. Visually examine springs and disc for cracks and other damage.

c. Repair. Repair by replacing any damaged or defective parts.

d. Reassembly.

(1) Replace disc (20), spring (19), and bypass spring (18).

(2) Replace gasket (11) and install washers (7), capscrews (6), and capscrews (5).

(3) Install washers (2) and capscrews (1).

(4) Replace O-ring (4) and install oil transfer tube (3).

(5) Replace the oil filters and refill the engine oil in accordance with the Operator/Crew and Organizational Maintenance manual.

13-13. INJECTORS. The following paragraphs contain test, adjustment, and repair procedures for the injectors.(See figure 13-16.) Refer to Operator and Organizational Maintenance manual for removal procedures and proceed as follows:

a. Leakage Test. The leakage test is conducted using an injector leakage tester (see figure 13-17). Refer to paragraph g. and proceed as follows:

(1) Oil injector O-rings (10).

(2) Install plunger extension on plunger (7) and remove spring (4).

(3) Align injector delivery orifice with locating screw hole or bushing hole in adapter pot.

(4) Using hand pressure, press injector into pot until it bottoms.

(5) Insert and tighten locating screw.

(6) Plug fuel inlet port using plug provided with spray angle tester.

(7) Install injector into leakage tester and clamp into position. Support plate may be tilted for easier installation of injector.

(8) Operate retraction lever and read air flowmeter at top of ball float.

(9) Rotate plunger by small increments to find the highest reading on flowmeter. The maximum readings should not exceed 4.5 (worn limit).

(10) If maximum readings exceed 4.5 worn limit, repair injector.

(11) With this test completed, place retraction lever to "A" position; disconnect transfer line; exhaust the air cylinder, and remove injector.

(12) Remove plunger and reinstall spring and plunger.

b. Cup Spray Pattern Check. The cup spray pattern check is conducted using a spray angle tester. Refer to paragraph h, and proceed as follows:

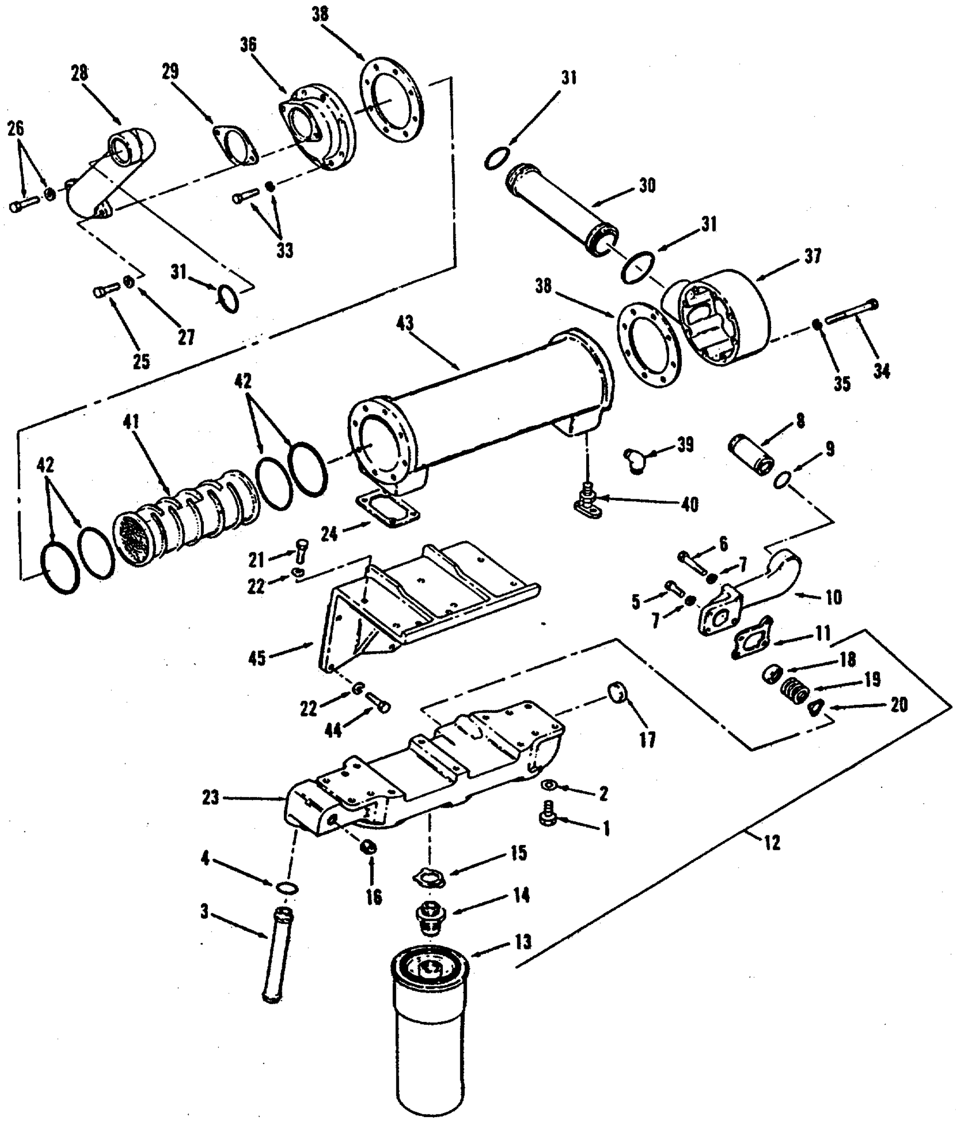
(1) Insert injector into adapter.

(2) Remove plunger (7) and spring (4) from injector.

(3) Install plunger bore plug and rubber seal in injector plunger bore. Protect injector plunger from dirt or damage during tests.

(4) Place injector into special seat and adjust holddown bracket into position required, then tighten thumb screw.

(5) Tighten knob against plug and seal in plunger bore so it seals thoroughly.



LEGEND

1.	Screw	11.	Gasket	23.	Filter head	34.	Screw
2.	Washer	12.	Lube oil filter	24.	Gasket	35.	Washer
3.	Oil transfer tube	13.	Filter element	25.	Screw	36.	Cover
		14.	Adapter	26.	Screw	37.	Cover
4.	Packing	15.	Lockplate	27.	Washer	38.	Gasket
5.	Screw	16.	Plug	28.	Connection	39.	Plug
6.	Screw	17.	Plug	29.	Gasket	40.	Draincock
7.	Washer	18.	Retainer	30.	Tube	41.	Core
8.	Oil transfer tube	19.	Spring	31.	Packing	42.	Packing
		20.	Disc	32.	Lube oil cooler	43.	Cooler
9.	Packing	21.	Screw			44.	Screw
10.	Connection	22.	Washer	33.	Screw	45.	Bracket

Figure 13-15. Lubricating Oil Cooler, Exploded View, Code B

(6) Jet fuel source pressure to 22 psi (152 kPa).

(7) Shift the target ring in base of tool so one spray stream hits center of No. 1 or index window. This window provides ±3 degrees tolerance on injector spray stream location.

(8) Check that spray stream hits a window in the target ring. No more than one stream must require the increased tolerance of the No. 1 window.

(9) After testing, assemble plunger with spring in body adapter and store in clean place until ready for next test.

c. Flow Test. The flow test is accomplished using the injector test stand (see figure 13-19).Refer to paragraph i, and proceed as follows:

(1) Seat injector in body so injector inlet aligns with body inlet hole. Tighten locating screw.

(2) Remove spring (4) and plunger (7) from injector adapter. Leave spring (4) off and install plunger (7).

(3) Attach test stand inlet pressure line to drain connection of test stand.

(4) Hold injector plunger down against its seat in injector cup with injector in a vertical position. Assembly may be held in hand; do not place in test stand holding device.

(5) Turn on test stand and adjust pressure to 150 psi (1034 kPa).

(6) Check orifice plug inlet opening or injector for leakage past ball valve.

NOTE

Make certain that plunger is seated in the cup.

(7) If leakage is observed, the ball (8) must be replaced. Slight seepage is harmful.

d. Disassembly. Proceed as follows:

(1) Lift out injector link (3), plunger (7), and spring (4). Remove spring (4) from adapter (15).

(2) If required, store plunger (7) by standing on coupling end.

NOTE

Injector barrels and plungers are class fit. Do not interchange.

(3) Remove O-rings (10) from injector adapter (15) and discard.

(4) Remove filter screen clip (11) and remove screen (12). Check screen and discard if damaged.

NOTE

Do not remove orifice plug (13) from inlet groove.

(5) Insert injector into holding fixture.

(6) Slide body wrench, over flats on injector.

(7) Place retainer wrench on injector.

(8) Activate air cylinder on holding fixture to hold injector in place. Loosen cup retainer (5) but do not remove.

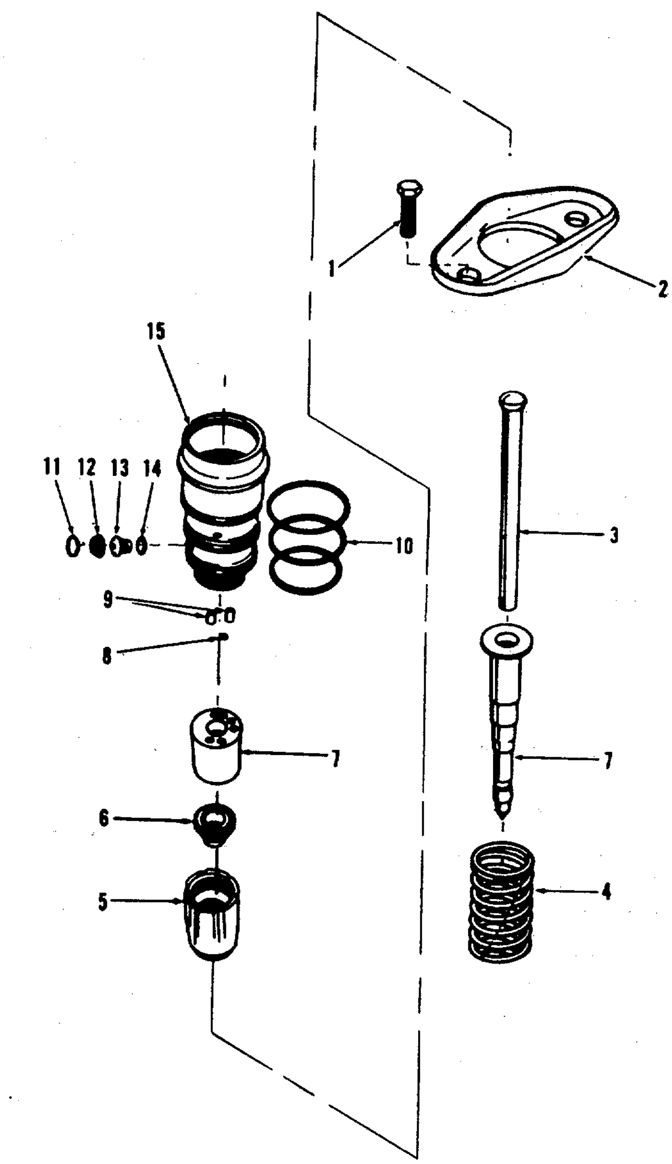
(9) Deactivate air cylinder.

(10) Remove injector clamp and retainer wrench from fixture.

(11) Screw off cup retainer (5) and remove injector cup (6) and barrel (7).

NOTE

Do not lose check ball (8)



LEGEND

1. Screw	5. Retainer	8. Ball	12. Screen
2. Clamp	6. Cup	9. Pin	13. Plug
3. Link	7. Barrel and plunger	10. O-ring	14. Gasket
4. Spring		11. Clip	15. Adapter

Figure 13-16. Injector, Exploded View

(12) Remove check ball (8) from top of barrel (7).

e. Repair. Proceed as follows:

(1) Replace injector link (3) if worn excessively.

(2) Check closely for metal seizure. As a rule this is the only true indication of scuffing or scoring.

(3) Narrow streaks running the length of the plunger (7) usually are the result of the varying thickness of penetrant treatment used to prevent rusting. Plunger is satisfactory for reuse unless surface disruption is evident.

(4) Test spring tension, on spring tester device that is capable of very accurate measurements of spring lengths and applied load by means of standard and dial indicator gauge. Load required to compress spring to 1.663 inches (42.2 mm) is 143.25 pounds (65 kg) minimum to 158.75 pounds (72 kg) maximum. Worn limit is when 138 pounds (63 kg) is required to produce the spring length. If spring does not compress at right load limit, replace spring.

(5) Inspect injector spray holes and tip with magnifying glass. Compare with new cup. Discard cup if cup shows abrasive wear, corrosion damage, or enlarged or distorted spray holes.

(6) Using a flat steel plate and "bluing" check injector cup barrel surface for flatness.

(7) Check cup retainer for nicks or burrs which could prevent proper seating with sleeve in head.

(8) Inspect injector barrel plunger bore for scoring. If injector will pass leakage test, barrel is usable. If leakage was too high, barrel and plunger must be replaced.

(9) Use strong magnifying glass to check for burrs, carbon, and distorted radii in orifice (13). If metering orifice shows signs of damage, replace orifice.

f. Adjustment and Reassembly. Proceed as following using any new parts required for repair:

(1) Drop check ball (8) into top of barrel (7).

CAUTION

Be certain all mating surface parts are clean and free of burrs or other imperfections which could result in incorrect flow or torque. Lap to repair.

(2) Hold barrel (7) with check ball (8) up and place new adapter spiral pins (9) into barrel (7).

(3) Turn adapter (15) and barrel (7) with barrel up and place cup (6) on barrel (7).

(4) Lubricate cup retainer threads (5) and cup flange contact area with 20 or 30W lube oil and assemble to adapter. Screw retainer (5) down finger tight and loosen 1/4 turn.

(5) Immerse injector plunger (7) in clean injector test oil and install in adapter without spring (4).

(6) Insert injector into fixture.

(7) Slide body wrench over flats on injector adapter.

(8) Place retainer wrench on injector retainer.

(9) Activate air cylinder on holding fixture to align cup and plunger.

(10) Tighten cup retainer (5) with crowfoot wrench and retainer wrench to 50 footpounds (68 joules).

(11) Remove injector from loading fixture being careful not to hit cup on stud.

(12) Hold injector in vertical position (cup down) and allow plunger to drip a few drops of test oil into cup.

(13) Insert plunger about 1/2 inch (12.7 mm) into barrel to be certain plunger is started straight.

(14) Jam coupling with palm of hand to seat plunger in cup and rotate 90 degrees while holding plunger firmly against cup seat.

(15) Hold injector with cup up and plunger should slide out when injector is lifted quickly.

(16) If plunger does not slide out, remove plunger, coat tip with test oil, and repeat test.

(17) If plunger sticks because of misalignment, loosen cup retainer, rotate cup 1/4 turn, and retorque. Repeat as necessary.

(18) Remove plunger from adapter and lubricate plunger with test oil. Install spring on plunger and insert into adapter.

(19) Test plunger in accordance with paragraphs a, b, and c above.

(20) Install new screen (12) and clip (11).

(21) Refer to the Operator/Crew and Organizational Maintenance manual for replacement procedures.

g. Installation, Assembly, and Operating Instructions for the Injector Leakage Tester (See figure 13-17).

(1) The following facilities are necessary for installation of the injector leakage tester:

(a) A clean area with good lighting. An enclosed fuel systems area is preferred. When a tightly enclosed room is used, due to the extreme sensitivity of the air flowmeter, the ball float will fluctuate slightly during opening and closing of the door. Other than not being able to obtain an accurate reading during actual swinging of the door, such a room has no adverse effects and is desirable.

(b) A work bench of standard height which is not subject to pounding or other heavy work. The bench must not have a vise or other shop equipment which is generally subject to impacts.

(c) An air supply of 80 psi (552 kPa) minimum pressure. The air line to the injector leakage tester should not be in a location where intermittent. pressure drops are caused by actuation of other shop air equipment.

(2) Mount rubber isolation pads to feet with capscrews provided.

(3) Mount feet to panel. When feet-to-panel capscrews are snug, panel must be installed in a vertical position to ensure proper operation of air flowmeter.

(4) Fill air cylinder oiler 1/3 to 1/2 full of injector test oil. Make sure sealing ring is in place before tightening bowl retainer.

(5) Fill bubble checker bowl with injector test oil to oil level marker. To more easily fill bowl to specified level, it may be filled approximately 3/4 full and then drained to proper level through valve at bottom of bowl.

(6) Use a vise-grip wrench while connecting air supply line to prevent disturbance to threads.

(7) Install T-handle clamping mechanism backed out approximately 1/2 thread turn from snug position.

(8) Install retraction handle and lock into-position with jam nut.

(9) Set pressure regulator at 60 psi (414 kPa).

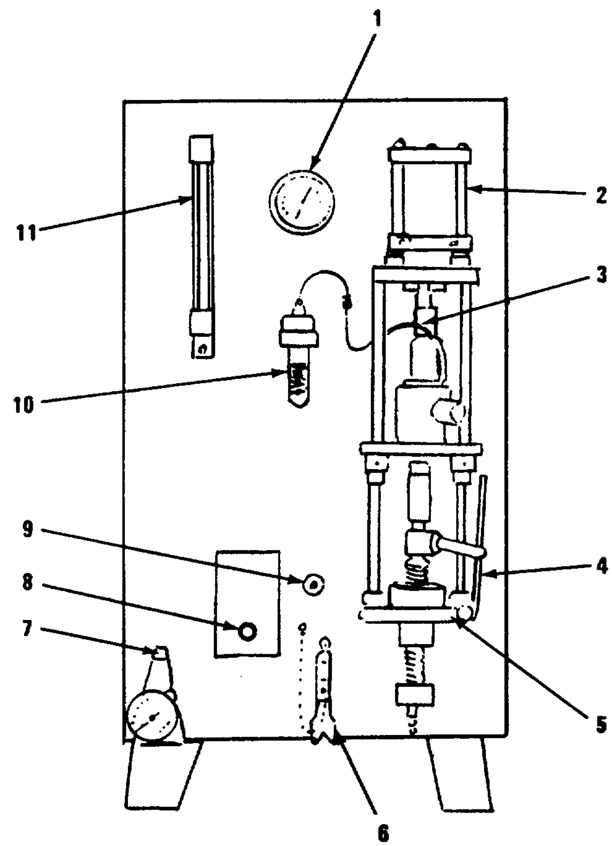
(10) Operate air cylinder a few times and set final pressure at precisely 60 psi (414 kPa). The air pressure must be held at 60 psi (414 kPa) during all tests.

(11) The velocity of air cylinder piston rod may be adjusted as desired with small valve at rear of panel. Loosen locknut and screw valve stem in to decrease piston speed or back screw out to increase piston speed. Lock the nut on the stem when desired piston speed is attained.

(12) With retraction lever in "A" position, install load cell and clamp into position.

(13) Adjust knurled knob until load cell reads 200 psi (1379 kPa). The psi (kPa) reading on load cell is a direct reading in pounds (kg) load, since load cell piston area equals 1 square inch (6.45 sq cm). Adjust knurled knob to obtain 200 lbs. (90.7 kg) load during several clamping cycles.

(14) With load cell clamped at 200 lbs. (90.7 kg) load, use the feeler gauge to adjust locknuts into position and tighten. Clamping mechanism should be checked daily with load cell and locknuts adjusted if necessary,



LEGEND

1. Gauge
2. Air cylinder
3. Injector
4. T-handle clamp
5. Retraction lever
6. Feeler gauge
7. Load cell
8. Pressure regulator
9. Cylinder actuation valve
10. Bubble checker
11. Flowmeter

Figure 13-17. Injection Leakage Tester

h. Installation, Assembly, and Operating Instructions for the Spray Angle Tester. The spray angle tester (figure 13-18) is used with the injector test stand which is described in paragraph i.

(1) Locate Spray angle tester on or near the injector test stand so injector inlet connection of test stand will reach injector to be spray checked. Use injector test oil or fuel oil to perform test.

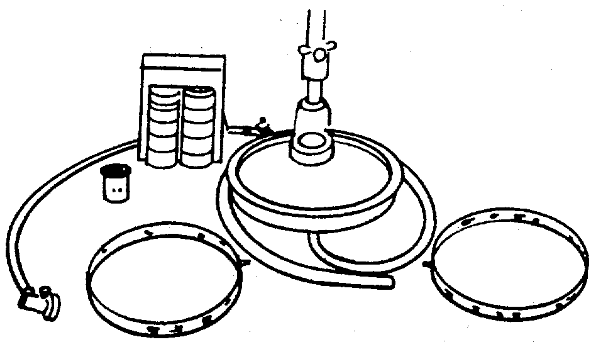


Figure 13-18. Spray Angle Tester

(2) Attach drain hose to spray angle tester base and place loose end in injector test stand drain pan.

(3) Assemble cup seat spacer H-10 to seat bracket bore.

(4) Place H-2 seat in seat spacer and bracket bore.

(5) Place target ring in base of spray angle tester.

i. **Installation, Assembly, and Operating Instructions for the Injector Test Stand**. The injector test stand must be located near hot and cold water connections. Water temperature, controlled by a mixing valve, is used to maintain test oil at a 90 to 95°F (32 to 35°) temperature range. If temperature exceeds 135°F 57°C) drain and replace with new test oil. (See figure 13-19.)

(1) Fill test oil tank 3/4 full of test oil and maintain this level or higher during test. Test oil capacity is approximately 5 gallons. It is available as Part No.99011-68.

(2) Fill the hydraulic fluid reservoir to half level in sight bulb with clean Type A automatic transmission fluid. Be careful not to allow oil to enter the standpipe in center of reservoir.

(3) Fill cambox with SAE 30 non detergent lubricating oil to top of sight glass. Refill when oil level gets low in sight glass.

(4) Plug electrical connection into receptacle carrying the necessary voltage to operate the test stand.

(5) A motor driven shaft and cam are housed in the cambox. The cam actuates the vertical push rod at the bottom of the housing.

(6) The push rod is connected to the injector by a link so the injector plunger will be actuated by cam action just as it is in the engine.

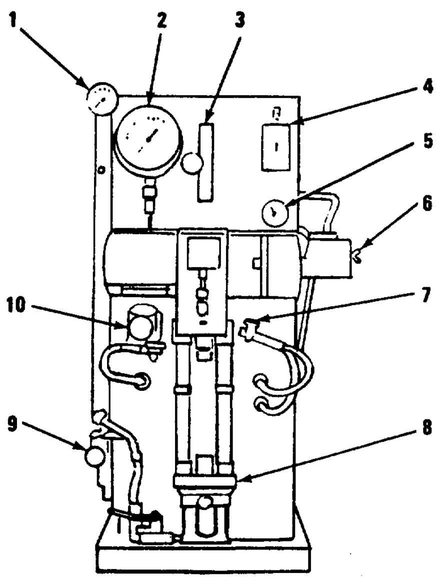
(7) Injectors are clamped in the test stand by hydraulic pressure from the cylinder, piston rod, and injector seat. The injector seat contains a removable orifice to restrict the metered fuel flow and cause a back pressure simulating compression pressures as found in the engine.

(8) Before clamping the injector in the test stand, the cam must be timed by rotating the timing wheel so the wheel mark and pointer are aligned.

(9) Shop air pressure regulated by air regulator is used to apply a balanced force on the hydraulic system. The air gauge at top of hydraulic reservoir is used as a reference indicating that pressure has not changed.

(10) When the air valve is opened, air travels up the pipe in the center of the tube type hydraulic reservoir and exerts a downward pressure against the column of hydraulic fluid.

(11) When both the air valve and the hydraulic valve are opened, hydraulic fluid is admitted under the piston in the cylinder and lifts the injector into clamped



LEGEND

1. Air gag	6. Counter
2. Fuel pressure gaug	7. Inbt
3. Vial graduate	8. Yoke
4. Start/stop switch	9. Air alve
5. Temperature gauge	10. Pressure Regulator
	11. Sight glass

LEGEND

1.	Air Gauge	6.	Counter
2.	Fuel pressure gauge	7.	Inlet
		8.	Yoke
3.	Vial graduate	9.	Air valve
4.	Start/stop switch	10.	Pressure regulator
5.	Temperature gauge	11.	Sight glass

Figure 13-19. Injector Test Stand

position. Any leak in the hydraulic clamping system will directly affect injector loading and must not be permitted.

(12) Fuel is delivered to the injector through the inlet connector. Fuel pressure is controlled at this point by a connecting line and pressure regulator.

(13) The second connection with the clean plastic line is the injector drain connection which carries drain fuel from the injector back to the tank.

(14) Fuel is delivered to the vial during a measured number of strokes as recorded by the counter.

13-14. FUEL INJECTION PUMP. To test, adjust, replace, repair, overhaul, and rebuild the fuel injection pump for Code "A" or Code "B", refer to figure 13-20 through 13-25 and proceed as follows:

a. Test and Calibration. The fuel pump should be tested using the fuel pump test stand; refer to paragraph b then proceed as follows:

(1) Remove the fuel pump and mainshaft cover from the assembly as follows:

(a) Remove the speed switch in accordance with the Operator/ Crew and Organizational Maintenance manual.

(b) Disconnect the fuel pump line from the pump shut-off valve.

(c) Disconnect the throttle lever linkage from the throttle lever.

(d) Disconnect the shut-off valve electrical connections.

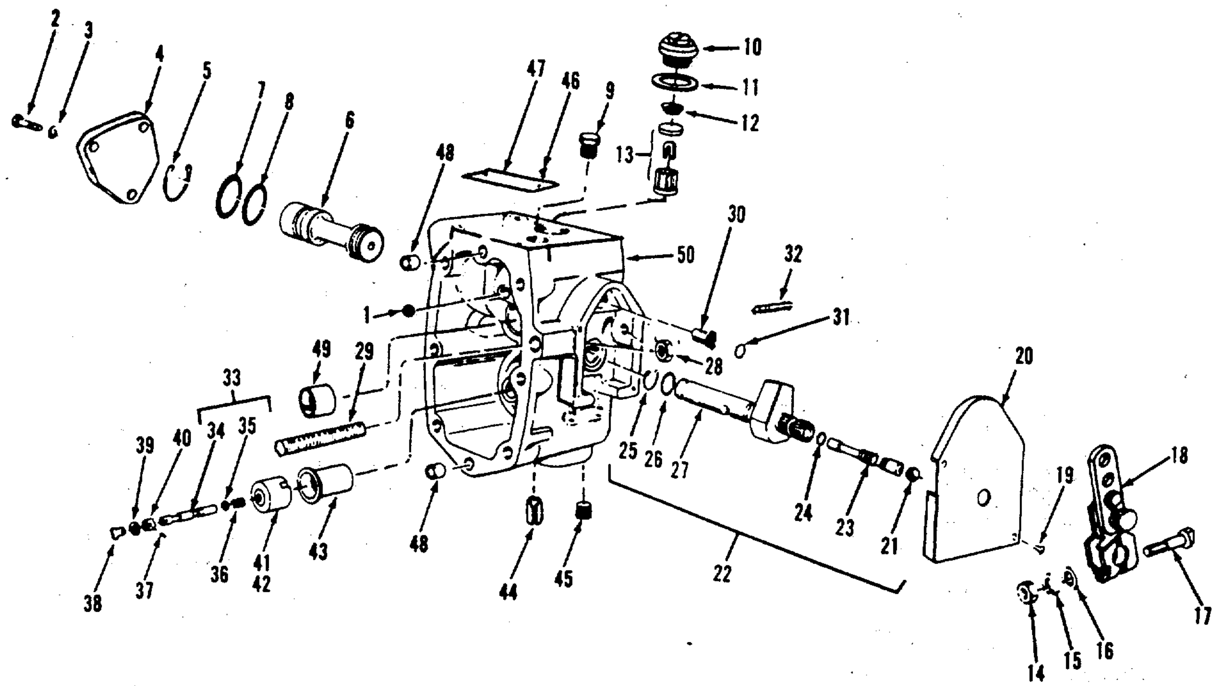
(e) Disconnect the pump cooling line to the check valve elbow (1, figure 13-24) on the gear pump.

(f) Remove the capscrews securing the mainshaft cover to the engine assembly.

(2) Install the fuel pump in the fuel pump test stand mounting bracket leaving about 1/16 inch (0.0625 mm) between fuel pump coupling and test stand drive coupling.

(3) Squirt some clean test oil into the gear pump inlet hole, so pump will pick up faster, then connect suction line.

(4) Fill the fuel pump housing with clean test fuel oil through the plug hole on



LEGEND

1. Ball
2. Screw
3. Lockwasher
4. Cover
5. Ring
6. Plunger
7. O-ring
8. O-ring
9. Plug
10. Cap
11. Seal
12. Spring
13. Screen assy
14. Nut
15. Lockwasher
16. Washer
17. Screw
18. Lever
19. Screw
20. Cover
21. Ball
22. Shaft assy
23. Screw
24. O-ring
25. Ring
26. O-ring
27. Shaft
28. Nut
29. Screw
30. Plug
31. O-ring
32. Screw
33. Plunger
34. Plunger
35. Shim
36. Spring
37. Pin
38. Driver
39. Washer
40. Spacer
41. Sleeve
42. Barrel
43. Spring housing
44. Clip
45. Plug
46. Screw
47. Nameplate
48. Dowel pin
49. Bushing
50. Housing

Figure 13-20. Fuel Injection Pump, Exploded View, Code A

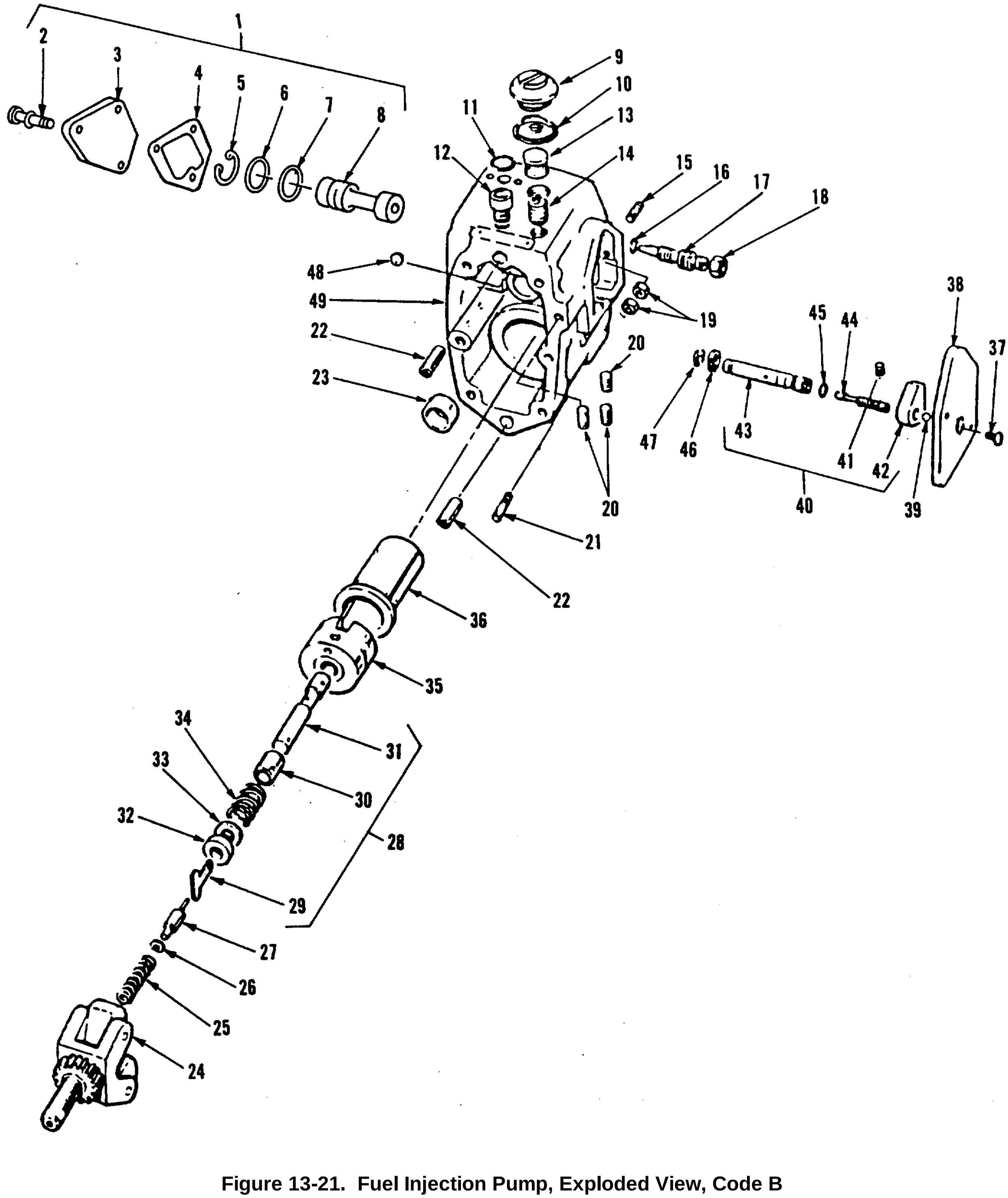


Figure 13-21. Fuel Injection Pump, Exploded View, Code B

LEGEND FOR FIGURE 13-21

1.	Barrel assy	11.	Seal	21.	Screw	31.	Plunger	41.	Screw
2.	Screw	12.	Connector	22.	Dowel	32.	Bearing	42.	Stop
3.	Plate	13.	Screen	23.	Bushing	33.	Shim	43.	Shaft
4.	Gasket	14.	Plug	24.	Carrier assy	34.	Plunger	44.	Adj.screw
5.	Ring	15.	Adj. nut	25.	Spring	35.	Barrel	45.	Seal
6.	Seal	16.	Seal	26.	Shim	36.	Housing	46.	Seal
7.	Seal	17.	Valve	27.	Plunger	37.	Screw	47.	Ring
8.	Plug	18.	Nut	28.	Plunger assy	38.	Cover	48.	Ball
9.	Cap	19.	Nut	29.	Driver	39.	Ball	49.	Body
10.	Spring	20.	Plug	30.	Spacer	40.	Throttle shaft assy		

top of the pump. Reinstall plug.

(5) Connect line to fuel pump shut-off valve.

(6) Connect a No. 4 hose to the cooling bleed check valve on the gear pump. Drain into splash tray under pump.

CAUTION

Never operate gear pump with the drain plugged.

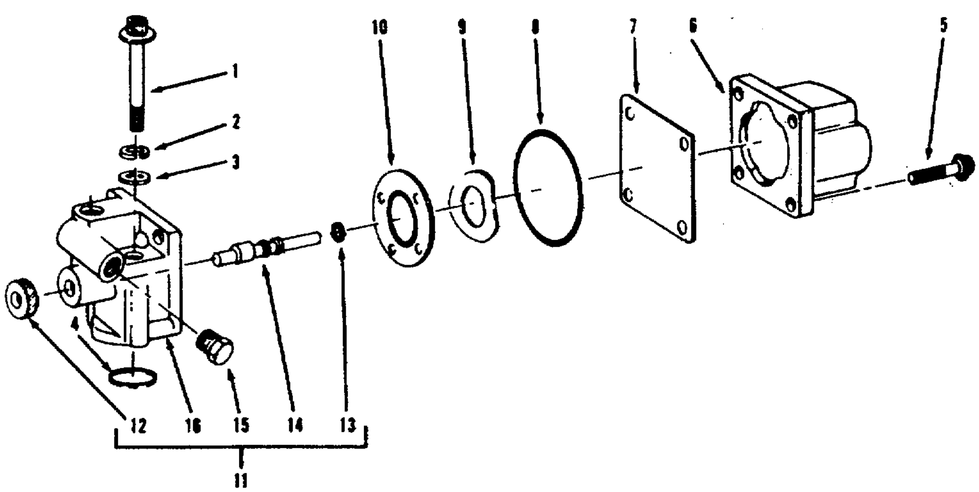
(7) Never remove fuel pump damper either during testing or operation as it will cause erratic pump performance and accelerate wear.

(8) Completely open the fuel pump shut-off valve by turning knob clockwise (12, figure 13-22), and the flow control valve.

(9) Open throttle to wide open position (secure open with a spring), and start and run pump at 500 rpm.

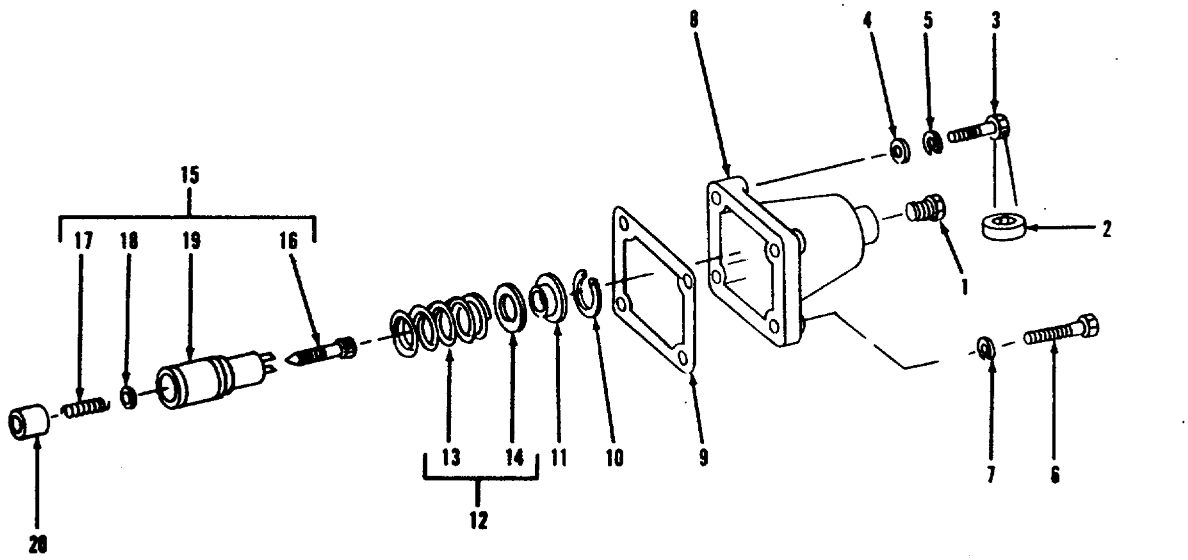
(10) If pump is newly rebuild or has been opened, run at slightly over rated speed for 5 minutes to flush,

LEGEND



1.	Screw	5.	Screw	9.	Washer	13.	O-ring
2.	Lockwasher	6.	Coil	10.	Valve	14.	Shaft
3.	Washer	7.	Shield	11.	Housing	15.	Plug
4.	O-ring	8.	O-ring	12.	Knob	16.	Housing

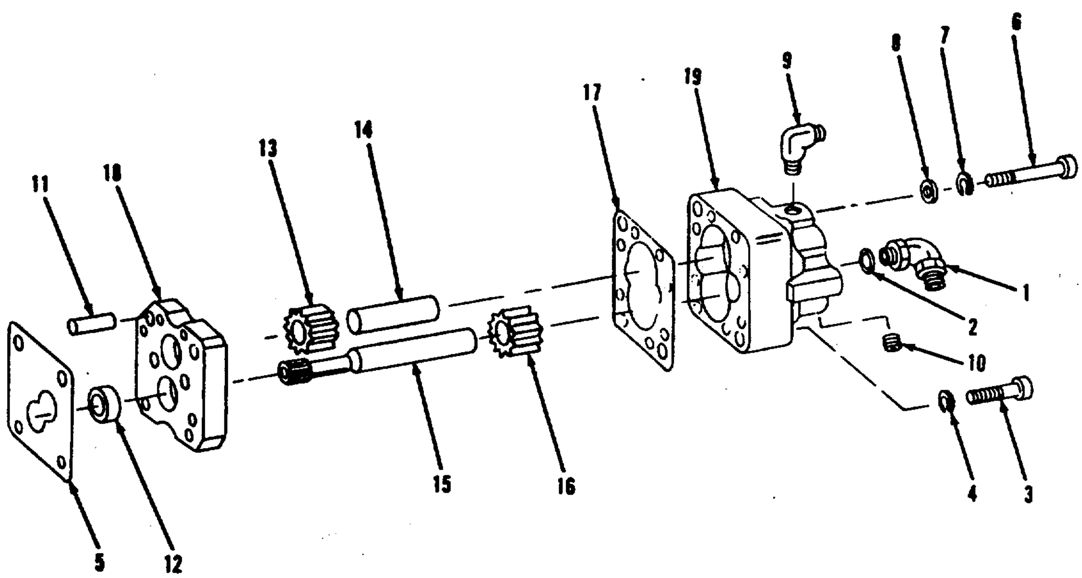
Figure 13-22. Fuel Shut-off Valve, Exploded View



LEGEND

1.	Plug	6.	Screw	11.	Retainer	16.	Screw
2.	Seal	7.	Lockwasher	12.	Spring assy	17.	Spring
3.	Screw	8.	Cover	13.	Spring	18.	Washer
4.	Washer	9.	Gasket	14.	Shim	19.	Guide and clip
5.	Lockwasher	10.	Ring	15.	Pack assy	20.	Plunger

Figure 13-23. Governor Spring Pack, Exploded View



LEGEND

1.	Elbow	5.	Gasket	10.	Plug	15.	Shaft
2.	O-ring	6.	Screw	11.	Dowel	16.	Gear
3.	Screw	7.	Lockwasher	12.	Ring	17.	Gasket
4.	Lockwasher	8.	Washer	13.	Gear	18.	Cover
		9.	Elbow	14.	Shaft	19.	Housing

Figure 13-24. Gear Pump, Exploded View

allow bearings to seat-, and to purge all air from the system.

(11) Before starting calibration, check pump fuel flow-in the flowmeter for air. If air is present, correct leak before continuing test.

(12) The test fuel oil must be 90 to 100°F (32 to 38°C).

(13) Set gear pump at 8 inches (203 mm) Hg. vacuum during run-in.

(14) Calibration Procedure.

(a) Close idle, leakage, and pressure valves. Open flow control or needle valve wide open.

(b) Increase pump speed to engine rated speed.

(c) Adjust vacuum valve in fuel pump suction line to obtain 8 inches (203 mm) Hg on vacuum gauge.

(d) If you cannot obtain 8 inches (203 mm) of vacuum, check for restriction in test stand filter or fuel supply line.

(e) Close the fuel manifold orifice valve until the flowmeter shows 168 psi (1159 kPa) at 1800 rpm. There must be no air visible in the flow- meter. Disregard change in vacuum readings at this setting.

(f) If flow cannot be obtained and held, check idle plunger and governor break. Inspect pulsation damper diaphragm.

(g) Open fuel pressure gauge valve. With throttle in full fuel position, increase pump speed until point at which fuel pressure just begins to decrease (peak point). This should occur at 2090 rpm.

(h) If speed is lower than specified, add shims between governor spring and retainer. To reduce speed, remove shims.

LEGEND

1. Screw
2. Washer
3. Lockwasher
4. O-ring
5. Body
6. O-ring
7. Diaphragm
8. O-ring
9. Washer
10. Cover

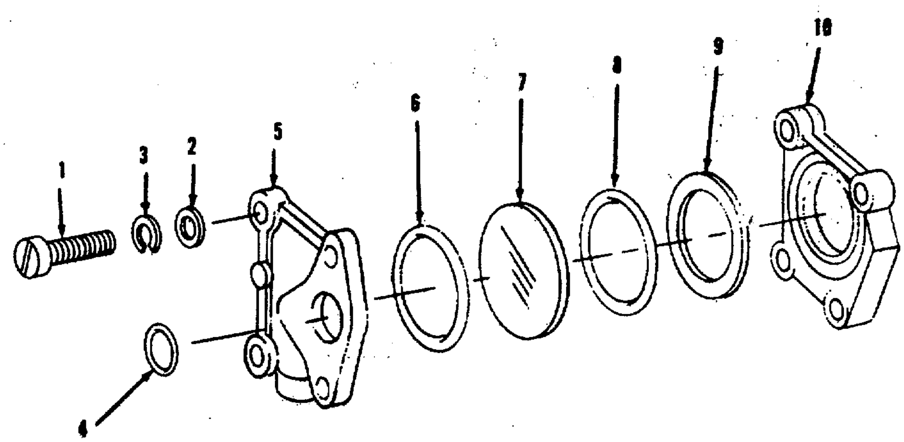


Figure 13-25. Fuel Pump Damper, Exploded View

NOTE

When pump is open to make adjustments, open main control valve to flowmeter wide open and move throttle lever back and forth until flowmeter shows no air, so air may be expelled more rapidly from system.

(15) Setting Idle Speed.

(a) Close test stand main flow control valve and open idle orifice valve.

(b) Set throttle shaft in idle position (toward gear pump) and hold firmly against stop.

(c) Run test stand at 168 psi (1159 kPa).

(d) Check pressure on fuel manifold pressure gauge; it should be 168 psi (1159 kPa). If pressure is low, screw idle adjusting screw (16, figure 13-23) in with the spring adjusting tool. To lower pressure, back out screw.

(16) Weight Assist Pressure Check.

(a) Decrease pump speed to 800 rpm. Adjust flowmeter if not as specified.

(b) The fuel manifold pressure should be 129 to 135 psi (890 to 931 kPa) at'1500 rpm.

(c) If fuel pressure is low, add shims behind the governor weight assist plunger in the governor weight carrier (16, figure 13-12) or (24, figure 13-21). To decrease pressure, remove shims. If adjustments are required, recheck entire pump calibration. Shims are available in 0.007 to 0.016 inch (0.178 to 0.406 mm).

CAUTION

Weight assist plunger must be installed with the smallest end to the governor plunger.

(17) Check Pressurizing Valve. Loosen the plug (1, figure 13-23) in the governor spring pack housing cover. Fuel should leak around the plug if the pressure valve is properly pressurizing the housing.

(18) Checking Pump Seals.

(a) With the test stand operating at 500 rpm, close vacuum valve in fuel pump suction line until vacuum gauge reads 15 inches vacuum. The fuel flow control valve should be open during this check.

(b) Put a small amount of light cup grease over the vent hole at the mainshaft seal bore of the mainshaft cover (30, figure 13-20).

(c) If lubricant is sucked into the hole at the 15 inch vacuum setting, this is an indication that the seals will not permit proper engine performance and should be replaced.

(d) During the above check, observe the flowmeter for air in the meter which may or may not indicate air leakage into the pump. Air may be entering lines between tank and pump. A slow leak may not show up promptly as air in the meter. Observe fuel level in tank for possibility of low fuel causing air bubbles.

(e) Leakage may occur at the gear pump to housing gasket if gear pump is not positioned correctly.

(f) Tighten all capscrews,

screws, hose connections, pipe plugs, and filter screen cap.

(19) Housing Porosity Check.

(a) Fill fuel pump with clean fuel or test oil.

(b) Remove suction fitting at gear pump and install fittings so an air pressure hose may be attached.

(c) Air supply.hose line must be equipped with a valve and gauge to control air pressure at a maximum of 20 psi.

(d) Apply 20 psi air pressure; do not exceed 20 psi or damage to seals may result.

(e) Pour fuel oil over pump and examine carefully for air bubbles, indicating leaks. Alternately wipe pump or specific area dry and check for wet seepage. Do not use this check for seals.

(20) Gear Pump Test.

(a) Use a fuel pump build up with only the parts required to drive the gear pump, minimum of pump body, with tachometer drive and a complete mainshaft cover assembly. If desired, a complete fuel pump can be used if the governor plunger and weight assist plunger and spring assembly are removed and pump housing is filled with fuel; this will prevent any possible damage to governor plunger or governor barrel. Gear pump may be mounted directly to test stand with adapter bracket.

(b) Install gear pump block plate, with gasket on each side, between gear pump and fuel pump body.

(c) Remove fuel pump damper from gear pump and connect copper line from orifice block to gear pump pressure tap.

(d) Connect the fuel suction line to the suction side of the gear pump. Run a line from the gear pump bleed connection to the fuel supply tank.

(e) Shut off the fuel manifold pressure gauge to prevent damage from over pressure.

(f) The valve in the suction line and the valve controlling the main flow orifice are to be fully open. All other valves must be completely closed. With the valves in this position, fuel will be routed through the manifold orifice.

(g) Start the pump drive and run the pump at 400 to 450 rpm. The gear pump must pick up at this speed without the aid of priming. Any gear pump which fails to pick up fuel must be rebuilt or replaced in accordance with paragraph 13-10f.

b. Instructions for the Fuel Pump Test Stand. The fuel pump test stand, figure 13-26, is required for accurate testing and calibration of the feel injection pump. Pump speeds may be varied continuously from 475 to 4750 rpm. Correct calibration of the fuel injection pump is one of the most important procedures to satisfactory engine operation.

(1) Test Oil. The fuel pump test stand must be filled with clean test oil No. 99011-68 or equivalent.

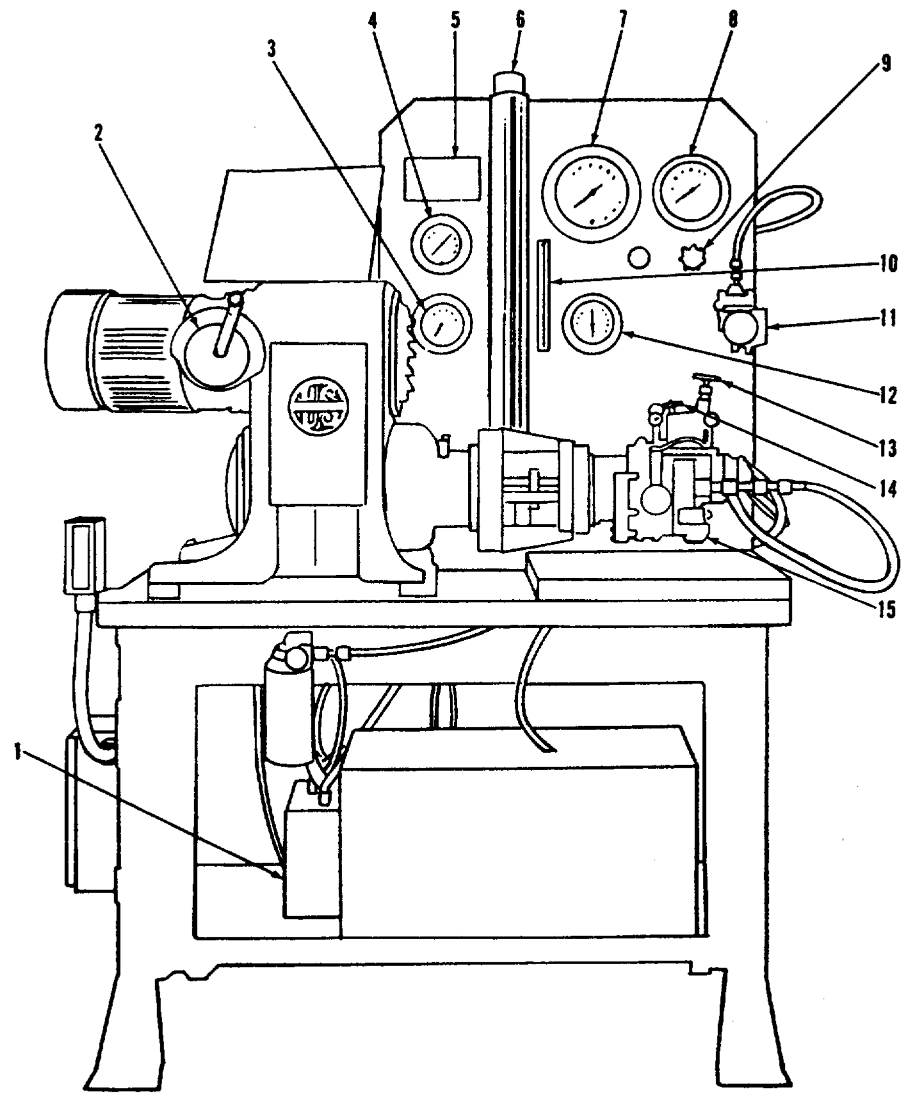


Figure 13-26. Fuel Pump Test Stand

NOTE

Hydraulic oils are not suitable to use as test oils. The test oil shall be a straight oil or blend of oils containing parafinic, aromatic, or naphthenic compounds, but not olefinic compounds, which show little or no change in physical properties during storage or use. The use of various additives and/or inhibitors to stabilize the oil is left to the discretion of the supplier. The additives must be antifoaming, anticorrosive, and antigumming. The fuel, additives, and color dye must be nontoxic and nonharmful to personnel. The chemical and physical requirements must be as follows:

Kinematic Viscosity
at 100°F (38°C) Centistokes
ASTM D445 .... 2.5 to 3.3
Viscosity at
100°F (38°C) Saybolt
Universal (SUS),
ASTM D2161 ....34.4 to 37.0
Specific Gravity
at 60°F (15.5°C),
ASTM D287 ....820 to 830

Gravity, Degrees, API,
60°F (15.5°C,
ASTM D287 .... 41 to 39
Flash Point, P.M.,
closed cup,
ASTM D93 160°F (71°C)
min. color, ASTM D1500.......................... 2 max.
Water, ASTM D1796 .... 0.005
Corrosion,
ASTM, D130 ....Must pass class I
Galvanic
corrosion,
ASTM 5322-1 .... Must pass
Sulphur percent
weight,
ASTM P 129, D1552 .... 0.4
Distillation at
20 percent point,
ASTM D86 ....440°F (226°C) min.

Sediment - Using a 10-micron filter, 22,260 particles per milliliter are permissible. Using a 40-micron filter, 195 particles per milliliter are permissible. Using a 50-micron filter, 5 particles per milliliter are permissible.

Mobil Oil Company Type MCL-41 is one source that meets the above requirements.

(2) The instruments on the fuel pump test stand must be periodically checked and maintained.

(3) Refer to paragraph 13-14a for detailed procedures for connecting a fuel pump to the test stand, and operating the test stand.

c. Adjustment on Engine. To adjust the fuel pump, refer to figure 13-23 and proceed as follows:

(1) Before making fuel pump adjustments, be certain the following initial conditions are observed:

(a) Engine is at operating temperature. Fuel temperature is not above 110°F (43° C).

(b) Timing, valves, and injectors are properly adjusted.

(c) Throttle control linkage is adjusted so full throttle is obtained, and when released throttle is stopped by front throttle leakage adjusting screw.

(2) Remove the speed switch in accordance with the Operator/Crew and Organizational Maintenance manual, and connect a high accuracy tachometer to the fuel pump tachometer drive connection.

(3) Operate the engine a sufficient period of time to bring engine up to operating temperature (at least 165° F (74°C) oil temperature.

(4) Remove pipe plug (1, figure 13-23) to provide access to the idle adjusting screw (16).

(5) Turn the idle adjusting screw (16) in to increase or out to decrease the speed using the fuel pump spring pack adjusting tool. The recommended idle speed is 550 ± 20 to 30 rpm.

d. Replace. Tolreplace the fuel pump, proceed as follows:

(1) Disconnect the fuel pump line from the pump shut-off valve.

(2) Disconnect the throttle lever linkage from the throttle lever.

(3) Disconnect the shut-off valve electrical connections.

(4) Disconnect the pump cooling line to the check valve elbow, (1, figure 13-24) on the gear pump.

(5) Remove the seven capscrews securing the fuel pump to the gear cover.

(6) Install a new gasket (3, figure 13-12) or (12, figure 13-13) and attach a new or repaired fuel pump with the

seven capscrews.

(7) Attach the pump cooling line to the check valve elbow (1, figure 13-24) on the gear pump.

(8) Connect the shut-off valve electrical connections.

(9) Connect the throttle lever linkage.

(10) Connect the fuel pump line to the pump shut-off valve.

e. Repair. Repair the fuel pump by replacing defective or worn parts as determined in paragraphs a and f.

f. Overhaul and Rebuilding. Refer to figures 13-20 through 13-25 and proceed as follows:

(1) Remove the fuel pump in accordance with paragraph d.

(2) Clean outside of fuel pump with an approved solvent that will not harm aluminum surfaces.

(3) Mount the fuel pump in holding fixture and swivel vise.

(4) Remove elbow (9, figure 13-24) and the orifice elbow assembly (1); clean parts in fuel oil and dry with compressed air blown through bottle ends.

(5) Remove the pulsation damper (figure 13-25) from the gear pump and discard O-ring (4).

(6) Remove the gear pump (figure 13-24) from the main housing by removing capscrews (3), lockwashers (4), screws (6), washers (8), and lockwashers (7). Tap lightly with a plastic hammer to loosen dowel; remove gear pump and discard gasket (5).

(7) Remove the fuel shut-off valve by removing screws (1, figure 13-22) from the top of the main housing and discard O-ring (4).

(8) Remove the governor spring pack (figure 13-23) by removing screws (3), washers (4), lockwashers (5), screws (6), and lockwashers (7). Lift off governor and discard gasket (9).

NOTE

Steps (9) thru (25) are rebuild instructions for the fuel pump housing assembly, code A. Steps (26) thru (41) are rebuild instructions for the fuel pump housing assembly, code B.

(9) Remove filter screen cap (10, figure 13-20), cap seal ring (11), filter spring (12), and fuel filter screen assembly (13).

(10) Remove pin (37), driver (38), washer (39), spacer (40), plunger (34), shim (35), and spring (36).

(11) Heat housing in oven to 300°F (149°C) and press out governor sleeve and barrel (41, 42).

(12) Remove three screws (2), lockwashers (3), fuel control cover (4), snap ring (5), and barrel plunger (6).

(13) Remove and discard O-rings (7 and 8).

(14) Remove nut (14), lockwasher (15), washer (16), screw (17), and throttle lever (18).

(15) Remove two screws (19), and throttle shaft cover (20).

CAUTION

Use extreme care when removing throttle shaft cover (20) to avoid dropping ball (21).

(16) Remove ball (21), unscrew fuel adjusting screw (23), and remove and discard O-ring (24).

(17) Remove snap ring (25), throttle shaft (27), and discard O-ring (26).

(18) Visually inspect throttle

shaft (27) and fuel adjusting screw (23) for signs of wear or damage; replace if necessary.

NOTE

Do not attempt to remove the throttle shaft sleeve; it is honed to size after assembly to housing and due to close tolerances, the housing and sleeve must be replaced if damaged or worn excessively.

(19) Visually inspect filter screen assembly (13) for holes or imbedded metal particles in mesh. Replace if damaged, otherwise, clean in fuel oil and dry with compressed air.

(20) Check drive shaft bushing (49) for signs of seizure or burrs. Replace if damaged.

(21) Check drive shaft bushing (49), XD with inside micrometers; if worn beyond 0.7525 inch (19.11 mm) replace bushing as follows:

(a) Remove worn bushing using a gouge chisel or half inch pipe tap. After tapping bushing, screw a half inch pipe cap on a close nipple and screw the half inch nipple into the bushing. Insert a punch through the rear of the housing and drive out the bushing.

(b) Apply a thin coat of high-pressure lubricant to a new front drive shaft bushing, press bushing into housing flush with housing bore using an arbor press.

(c) Line ream bushing to 0.7495 to 0.7505 inch. (19.04 to 19.06 mm) with the ream fixture, and a well-oiled 0.750 inch (3/4 inch {19.05 mm}) reamer. Check bushing ID.

(d) Visually check governor sleeve and barrel (41 and 42) and plunger (34) for wear; replace if worn or damaged.

(22) Governor Barrel Replacement.

(a) To locate a new governor sleeve and barrel (41 and 42, figure 13-20), scribe a center- line on the barrel and sleeve (41 and 42) and spring pack housing (43) lining up the fuel passages so fuel flow will not be restricted.

(b) Heat housing (50) in oven to 300° F (149° C).

(c) Coat new governor barrel with high-pressure lubricant.

(d) Place governor sleeve and barrel (41 and 42) in housing bore with chamfered end first and location pin hole on bottom side, lining up scribe marks, then press barrel in housing with arbor press until it bottoms against spring pack housing. This is important to align barrel retaining pin holes.

(e) Install spring (36), shim (35), plunger (34), spacer (40), washer (39), driver (38), and secure with pin (37).

NOTE

The chamfered side of washer (39) must be installed next to driver (38). There must be at least 0.002 to 0.005 inch (0.05 to 0.13 mm) clearance between washer face and driver so washer will float.

(23) Air Fuel Control Replacement.

(a) Lubricate new barrel O-rings (7 and 8, figure 13-20) on plunger (6).

(b) Secure plunger in housing with snap ring (5).

(c) Install cover (4) with lockwashers (3) and screws (2).

(24) Throttle Shaft Replacement.

(a) Lubricate new O-ring (24, figure 13-20) and slide on fuel adjusting screw (23).

(b) Insert fuel adjusting screw (23) into throttle shaft (27) about six turns. Do not restrict throttle shaft fuel port.

(c) Lubricate new O-ring (26) and slide on throttle shaft (27).

(d) Insert throttle shaft (27) in housing (50) with throttle stop up.

(e) Replace ball (21), cover (20), screws (19), lever (18), screw (17), washer (16), lockwasher (15), and nut (14).

(25) Filter Screen Replacement.

(a) Install fuel filter screen assembly (13, figure 13-20) in housing (50).

(b) Install filter spring (12), cap seal ring (11), and filter screen cap (10).

(26) Remove filter screen cap (9, figure 13-21), cap seal ring (11), filter spring (10), and fuel filter screen assembly (13).

(27) Remove spring (25), shim (26), plunger (27) and plunger assembly (28).

(28) Heat housing in oven to 300°F (149°C) and press out governor sleeve and barrel (35, 36).

(29) Remove three screws (2), fuel control cover (3), snap ring (5), and barrel plug (8).

(30) Remove and discard O-rings (5 and 6).

(31) Remove two screws (37), and throttle shaft cover (38).

CAUTION

Use extreme care when removing throttle shaft cover (38) to avoid dropping ball (39).

(32) Remove ball (39), unscrew fuel adjusting screw (44), and remove and discard O-ring (45).

(33) Remove snap ring (47), throttle shaft (43), and discard O-ring (46).

(34) Visually inspect throttle shaft (43) and fuel adjusting screw (44) for signs of wear or damage; replace if necessary.

NOTE

Do not attempt to remove the throttle shaft sleeve; it is honed to size after assembly to housing and due to close tolerances, the housing and sleeve must be replaced if damaged or worn excessively.

(35) Visually inspect filter screen assembly (13) for holes or imbedded metal particles in mesh. Replace if damaged, otherwise, clean in fuel oil and dry with compressed air.

(36) Check drive shaft bushing (23) for signs of seizure or burrs. Replace if damaged.

(37) Check drive shaft bushing (23), ID with inside micrometers; if worn beyond 0.7525 inch (19.11 mm) replace bushing as follows:

(a) Remove worn bushing using a gouge chisel or half inch pipe tap. After tapping bushing, screw a half inch pipe cap on a close nipple and screw the half inch nipple into the bushing. Insert a punch through the rear of the housing and drive out the bushing.

(b) Apply a thin coat of high-pressure lubricant to a new front drive shaft bushing, press bushing into housing flush with housing bore using an arbor press.

(c) Line ream bushing to 0.7495 to 0.7505 inch. (19.04 to 19.06 mm) with the ream fixture, and a well-oiled 0.750 inch (3/4 inch (19.05 mm)) reamer. Check bushing ID.

(d) Visually check governor sleeve and barrel (35) and plunger (31) for wear; replace if worn or damaged.

(38) Governor Barrel Replacement.

(a) To locate a new governor sleeve and barrel (35, figure 13-21), scribe a centerline on the barrel and sleeve and spring pack housing (36) lining up the fuel passages so fuel flow will not be restricted.

(b) Heat housing (49) in oven to 300° F (149° C).

(c) Coat new governor barrel with high-pressure lubricant.

(d) Place governor sleeve and barrel (35) in housing bore with chamfered end first and location pin hole on bottom side, lining up scribe markes, then press barrel in housing with arbor press until it bottoms against spring pack housing. This is important to align barrel retaining pin holes.

(e) Install spring (25), shim (26), plunger (27), and plunger assembly (28).

(39) Air Fuel Control Replacement.

(a) Lubricate new barrel O-rings (5 and 6, figure 13-21) on plunger (8).

(b) Secure plunger in housing with snap ring (5).

(c) Install cover (3) with screws (2).

(40) Throttle Shaft Replacement.

(a) Lubricate new O-ring (45, figure 13-21) and slide on fuel adjusting screw (44).

(b) Insert fuel adjusting screw (44) into throttle shaft (43) about six turns. Do not restrict throttle shaft fuel port.

(c) Lubricate new O-ring (46) and slide on throttle shaft (43).

(d) Insert throttle shaft (43) in housing (49) with throttle stop up.

(e) Replace ball (39) and cover (38) with screws (37).

(41) Filter Screen Replacement.

(a) Install fuel filter screen assembly (13, figure 13-21) in housing (49).

(b) Install filter spring (10), cap seal ring (11), and filter screen cap (9).

(42) Gear Pump Overhaul.

(a) Drive against dowels (11, figure 13-24) with flat end punch to remove gear cover from dowels in gear body.

Discard gasket (17).

(b) Lift drive and driven gears and shafts from gear pump body.

(c) Check pump shafts (14 and 15) for wear or scoring; discard if damaged. Replace shaft if worn smaller than 0.4998 to 0.5001 inch (12.695 to 12.703 mm) diameter.

(d) If gears are scored or worn badly, the gears must be replaced.

(e) Check gear body and cover for scoring or wear; replace parts as needed.

(f) Check lubrication holes in cover and body; they must be clean.

(g) Lubricate and slide shafts and gears into cover.

(h) Position new gasket (17) and install body to cover. Align locating notches together.

(i) Secure cover and body with dowels, tighten capscrews to 11 to 13 foot-pounds (15 to 18 joules). Check to see that pump turns freely with finger pressure.

(j) Install a gear pump to fuel pump with screws (3), lockwashers (4), screws (6), washers (8), and lockwashers (7).

(k) Install elbow (9) and orifice elbow (1).

(43) Pulsation Damper Overhaul.

(a) Remove body (5, figure 13-25) from cover (10).

(b) Remove spring steel diaphragm (7); discard O-rings (6 and 8) and nylon washer (9).

(c) Check for corrosion, excessive wear, or cracks in cover or diaphragm. Replace if necessary.

(d) Install new O-rings (6 and 8) in grooves and new nylon washer (9).

(e) Coat the diaphragm (7) with 10W or 20W oil and lay in cover (10).

(f) Assemble cover to housing, and attach to fuel pump; replace O-ring (4) and torque capscrews to 11 to 13 foot-pounds (15 to 18 joules).

(44) Fuel Shut-Off Valve Overhaul.

(a) Remove four screws (5, figure 13-22), coil (6), fuel shield (7), O-ring (8), spring (9), and valve (10). Discard O-ring (8).

(b) Remove manual override knob (12) and unscrew override shaft (14). Remove and discard O-ring (13).

(c) Clean all parts except the coil assembly (6) in mineral spirits.

NOTE

Do not wet the coil with solvent; instead, wipe it with a clean lint-free cloth.

(d) Visually check valve and valve seat for wear, bonding, failure, or corrosion. Replace if necessary. Valve seat should have a minimum seat 0.015 inch (0.38 mm) wide.

(e) Check coil resistance with an ohmmeter; replace if coil resistance is below 30 ± 2 ohms.

CAUTION

<u>Be sure starting switch is in OFF position when checking coil.</u>

(f) Install a new O-ring (13) on override shaft (14) and coat with 10W or 20W oil.

(g) Screw override shaft (14) into housing until it reaches bottom of its bore. Use a depth micrometer set at 0.118 inch (2.997) mm) and check distance from face of valve housing to tip of shaft. If necessary, screw override shaft (14) out until it is 0.118 inch (2.997 mm) below housing face. Do not move shaft, or press on knob until it contacts valve housing which will act as a stop.

(h) Place valve (10) into valve housing (16) with rubber side toward housing.

(i) Apply lubricant to new housing O-ring (8) and seat in groove.

(j) Drop spring washer (9) on valve with concave side up and piloted around valve locator.

(k) Place fuel shield (7) on valve housing (16) and tighten screws (5) to 25 to 30 inch-pounds (2.8 to 3.4 joules) torque.

(l) Install fuel shut-off valve to fuel pump with capscrews (1), lockwashers (2), washers (3), and new O-ring (4). Torque to 25 to 30 inch-pounds (2.8 to 3.4 joules).

(45) <u>Governor Spring Pack Overhaul.</u>

(a) Remove snap ring (10, figure 13-23) which holds governor spring pack in sleeve with a pair of snapring pliers.

(b) Remove high-speed spring (13), spring retainer (11), and ship (14).

(c) Remove idle spring plunger (20), idle spring (17), plunger (19), and washer (18).

(d) Examine governor spring pack components for any worn or damaged parts.

(e) Assemble idle screw (16) into plunger guide (19), place washer (18) over screw point inside guide.

(f) Place small idle spring (17) into plunger guide (19) and place idle plunger (20) against spring in guide.

(g) Install the spring pack (15) into spring pack housing (43, figure 13-20) or (36, figure 13-21)..

(h) Install spring (13, figure 13-23), shim (14), retainer (11), and snap ring (10).

(i) Install new gasket (9), cover (8), lockwashers (7), screws (6), wash- ers (4), lockwashers (5), screws (3), and new seal (2).

(46) <u>Mainshaft Cover assembly Overhaul</u>. Refer to paragraphs 13-8 and 13-10.

(47) The reassembled fuel pump should be tested and calibrated in accordance with paragraph a and replaced in accordance with paragraph d.

13-15. TURBOCHARGER (Code A). To repair the turbocharger, refer to figure 13-27 and proceed as follows:

a. Refer to the Operator/Crew and Organizational Maintenance manual for removal instructions.

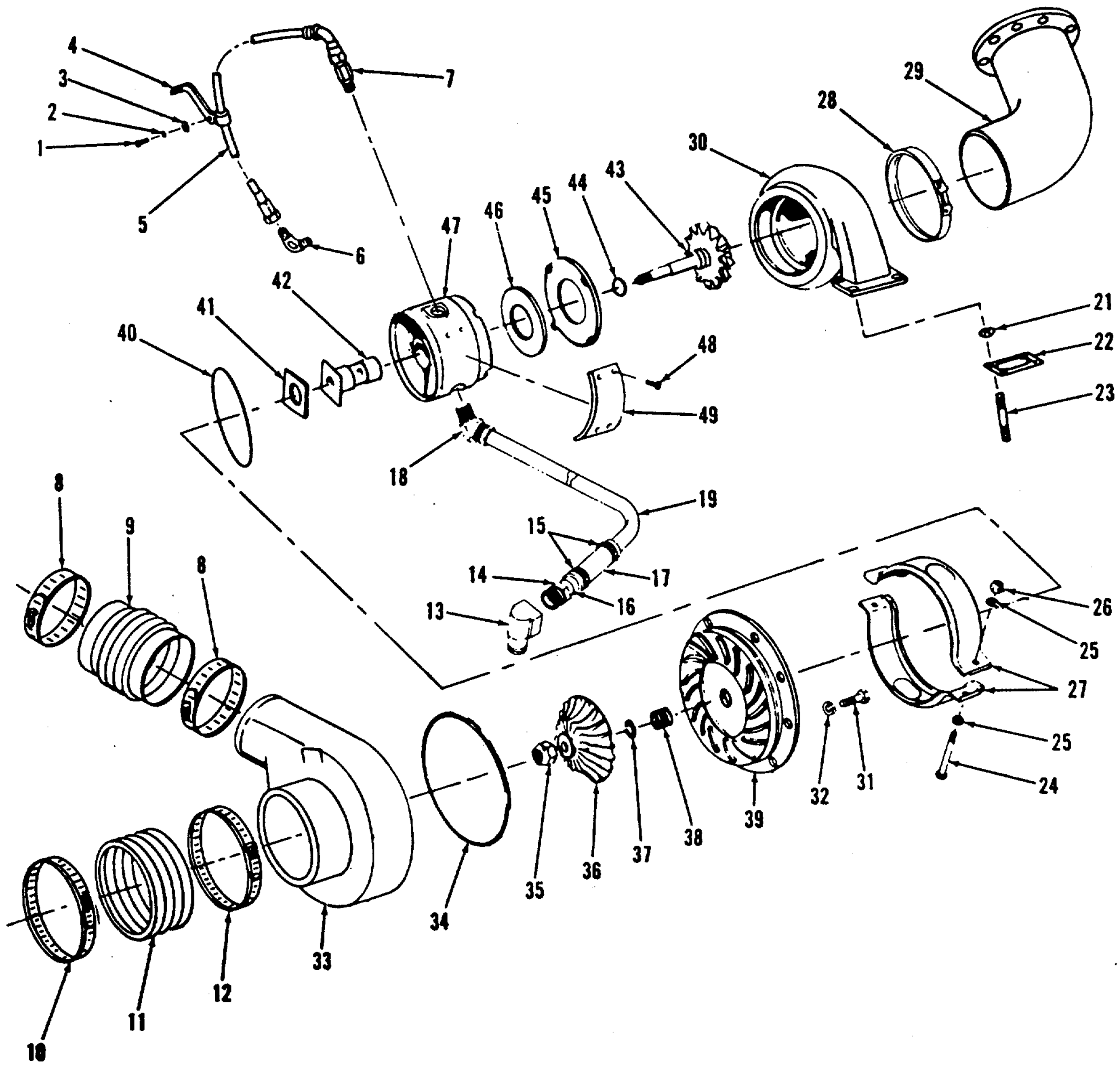


Figure 13-27. Turbocharger, Exploded View, Code A

LEGEND FOR FIGURE 13-27

1. Screw
2. Lockwasher
3. Washer
4. Support
5. Hose
6. Adapter
7. Adapter
8. Clamp
9. Hose
10. Clamp.
11. Hose
12. Clamp
13. Elbow
14. Nut
15. Clamp
16. Tube
17. Hose
18. Elbow
19. Elbow, R.B.
20. Elbow, L.B. (not shown)
21. Nut
22. Gasket
23. Stud
24. Screw
25.. 'Washer
26. Nut
27. Clamp
28. Clamp
29. Exhaust elbow
30. Case
31. Screw
32. Lockwasher
33. Housing
34. O-ring
35. Nut
36. Impeller
37. Seal
38. Sleeve
39. Plate
40. O-ring
41. Insert
42. Bearing
43. Wheel
44. Ring
45. Shield
46. Packing
47'. Housing
48. Screw
49. Nameplate

b. Remove screws (24), washers (25), nuts (26), and clamps (27).

c. Remove case (30), screws (31), lockwashers (32), nut (35), impeller (36), seal (37), sleeve (38),. O-ring (40), insert (41), bearing (42), housing (47), packing (46), shield (45), ring (44) and wheel (43).

d. Inspect diffuser plate (39) for cracks, burrs, and distortion. Discard and replace if damaged.

e. Inspect wheel (43) for cracked or broken vanes. Discard and replace if damaged.

f. Inspect impeller (36) for damage. Discard and replace if damaged.

g. Check all bearings for wear, chips, and cracks. Discard and replace if damaged.

h. If slight scratches or nicks are present in the compressor casing, they may be smoothed out with a very fine polishing cloth. Discard and replace casing if it is cracked or distorted.

i. Reassemble the turbocharger, as follows (replace any worn or damaged parts):

(1) Install wheel (43), new ring (44), shield (45), new packing (46), housing (47), bearing (42), insert (41), new O-ring (40), sleeve (38), seal (37), impeller (36), nut (35), lockwashers (32), screws (31), and case (30).

(2) Install clamps (27), washers (25), screws (24), and nuts (26).

(3) Refer to the Operator/Crew and Organizational Maintenance manual for replacement instructions.

13-16. TURBOCHARGER, CODE B. To repair turbocharger, refer to figure 13-28, and proceed as follows:

a. Refer to the Operator/Crew and Organizational Maintenance manual for removal instructions.

b. Remove screws (14), washers (15), nuts (12), and seals (13). Remove clamp (16).

c. Remove clamps (5) and (8), fittings (6) and (7), and remove hoses (9) and tubing (10) and (37).

d. Remove hose (11).

e. Disassemble turbocharger as shown in figure 13-28.

f. Inspect impeller (21) for damage. Discard and replace if' damaged.

g. Inspect wheel (28) for cracked or broken vanes. Discard, and replace if damaged.

h. If slight scratches or nicks are present in the compressor housings, (32), (36), or (19), they may be smoothed out with a very fine polishing cloth. Discard any housing that is cracked or distorted.

i. Reassemble turbocharger as shown in figure 13-28, being sure to replace any worn or damaged parts.

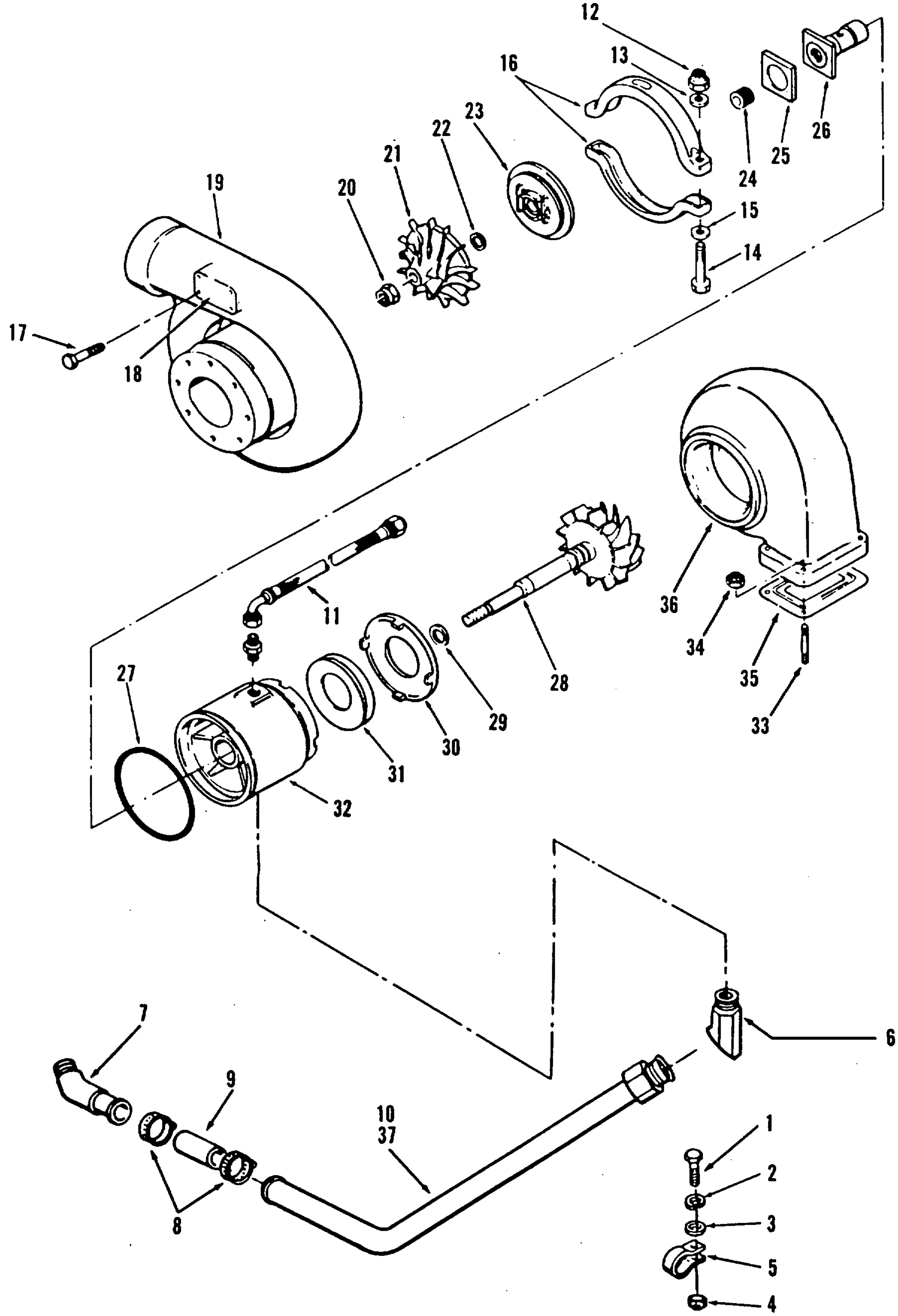


Figure 13-28. Turbocharger, Exploded View, Code B

LEGEND FOR FIGURE 13-28

1.	Screw	9.	Hose	16.	Clamp	24.	Sleeve	31.	Pad
2.	Washer	10.	Tube	17.	Screw	25.	Insert	32.	Housing
3.	Washer	11.	Hose	18.	Dataplate	26.	Bearing	33.	Stude
4.	Nut	12.	Nut	19.	Housing	27.	Seal	34.	Nut
5.	Clip	13.	Seal	20.	Nut	28.	Wheel	35.	Gasket
6.	Elbow	14.	Screw	21.	Impeller	29.	Seal	36.	Housing
7.	Coupling	15.	Washer	22.	Ring	30.	Shield	37.	Tube
8.	Clamp			23.	Plate				

Section IV. WATER PUMP

13-17. REPAIR. There are two types of water pumps used on the engine assembly, All generator sets after engine serial number 10605201 are equipped with the new style pump incorporating an idler assembly. This section provides disassembly and repair instructions for both types of water pumps.

a. Water Pump Without Idler Assembly.

(1) Disassembly. Prior to disassembly, remove the water pump from the engine assembly in accordance with the Operator/Crew and Organizational Maintenance manual. Refer to figure 13-29.

(a) Disassemble the water pump by removing five screws (13), lockwashers (14), cover (41), and gasket (30).

(b) Pull impeller (29) with puller and pull sheave hub (19) from pump drive shaft (25). Remove three screws (16) and washers (17) to disassemble sheave hub assembly.

(c) Remove snap ring (21) from pulley end of body (15) and press out shaft spacer (23) and bearings (22). Remove carbon face seal (26) and seat (28) from pump body (15); discard seal and seat.

(d) Press shaft (25) from bearings (22) and spacer (23); only if damaged, remove retaining ring (24) from groove in shaft.

(2) Repair. Proceed as follows:

(a) Inspect bearings for rough or worn races, or damaged shield. Replace if necessary.

(b) Inspect impeller and cover for cracks or corrosion that could interfere with circulation. Replace if necessary.

(c) Measure internal clearances and press fits in accordance with tabulated data in Chapter 1. Replace parts as necessary.

(d) Inspect water pump mounting parts for cracks. Replace as necessary.

(3) Reassembly. Reassemble the water pump as follows:

(a) Place bearing retaining ring (24) over long end of water pump drive shaft (25); press into first ring groove with a piece of tapered steel tubing.

(b) Pack bearings (22) full of grease, MIL-G-3545.

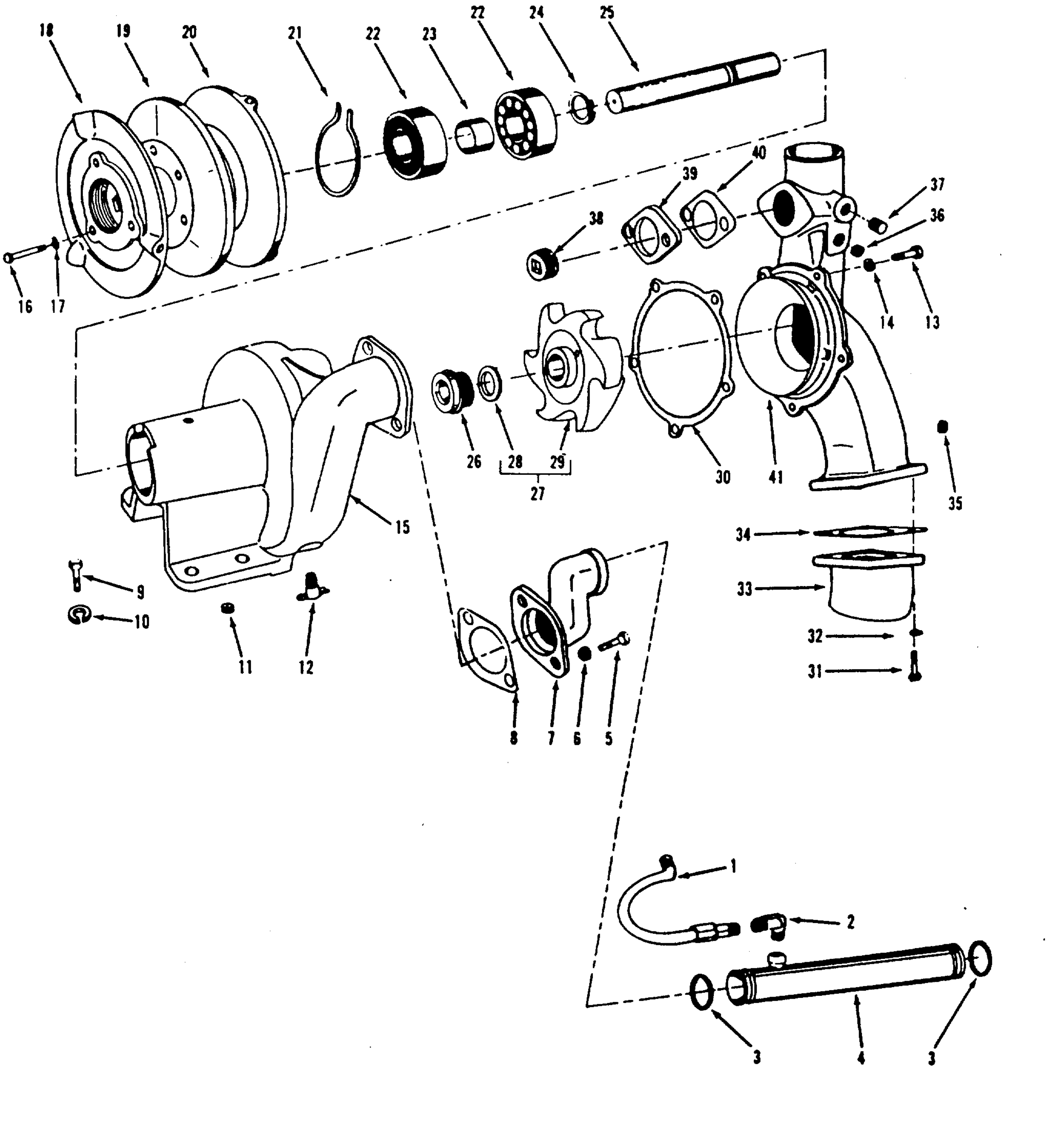


Figure 13-29. Water Pump, Exploded View

LEGEND FOR FIGURE 13-29

1. Hose assy	14. Lockwasher	28. Seat
2. Elbow	15. Body	29 Impeller
3. O-ring	16. Screw	30. Gasket
4. Water transfer tube assy	17. Lockwasher	31. Screw
5. Screw	18. Sheave	32. Lockwasher
6. Lockwasher	19. Sheave	33. Connection
7. Connection	20. Sheave	34. Gasket
8. Gasket	21. Ring	35. Plug
9. Screw	22. Bearing	36. Plug
10. Lockwasher	23. Spacer	37. Bushing
11. Plug	24. Ring	38. Plug
12. Drain cock	25. Shaft	39. Flange
13. Screw	26. Seal	40. Gasket
	27. Impeller assy	41. Cover

(c) Press shielded bearing (22) with shielded side to retaining ring (24) over shaft until bearing seats against retaining ring. Bearings go on "long" end of shaft using the retainer ring as a guide point.

NOTE

Apply load to inner bearing race only.

(d) Slide bearing spacer (23) over shaft (25) against bearing.

(e) Place bearing (22) with open side to spacer, over water pump shaft and press into place.

(f) Pack space between bearings 55 to 65 percent (0.84 to 0.99 ounces - 24 to 28 g) full of grease MIL-G-3545.

(g) Press shaft and bearing assembly into water pump body (15).

(h) Assemble large snap ring (21) to hold bearing and shaft in position.

(i) Place rear adjustable sheave (20) on pulley hub (19); press pulley hub and sheave onto drive shaft until hub seats against bearing race. Support other end of shaft during pressing operation; mount front adjustable sheave (18). Turn water pump body assembly over and press in new carbon face seal (26) with a section of 1-3/4 inch (44.5 mm) inside diameter by 2 inch (50.8 mm) outside diameter tubing until it seals.

(j) Lubricate the inside diameter of the new rubber seat (28) with a light coat of permanent antifreeze.

CAUTION

Do not allow any lubricant on the seal face.

(k) Slide the seal seat assembly (rubber and metal seat washer) over the water pump shaft until the chrome oxide side of the washer bottoms against the carbon face of the pump seal.

(l) Press impeller (29) onto shaft until there is 0.022 to 0.031 inch (0.56 to 0.79 mm) clearance between back of impeller and water pump body (15).

(m) Install water pump

cover (41) and new gasket (30) to water pump body (15). Check clearance between impeller vanes and cover; it should be 0.020 to 0.040 inch (0.051 to 1.01 mm).

b. Water Pump With Idler Assembly.

(1) Disassembly. Prior to disassembly, remove the water pump and idler assembly in accordance with the Operator/Crew and Organizational manual. Refer to figure 13-30.

(a) Remove screws (3) and washers (4) and separate cover (21) from the body (52). Remove and discard gasket (17).

(b) With a suitable puller, remove impeller (11) and pulley (6). Remove front water pump oil seal (7).

(c) Support water pump body (52) on impeller end. Press the water pump shaft (16) and bearing assembly (8) from the body by applying pressure to the pulley end of the shaft.

(d) Remove bushing (14), gasket (15) and water pump seal (13) from the shaft (16).

(e) Remove the inner race (cone and bearing) of the roller bearing assembly (8) with a suitable puller.

(f) Remove the two bearing races of the roller bearing assembly (8) from the water pump body (52) with a suitable puller.

CAUTION

Exercise care when removing the retaining ring. Do not damage pump body.

(g) Remove large retaining ring of bearing assembly (8) from the water pump body.

(h) Remove screw (22) and washer (23) and take off idler pulley cover (24) and gasket (25).

(i) Remove locknut (26).

(j) Remove idler pulley (29) and bearing assembly (28) from idler shaft (31).

(k) Remove rear oil seal (30) from the idler pulley (29).

(l) Remove inner bearing races (cones) from the pulley.

(m) With a suitable puller or punch, remove the bearing races (cups) from the pulley.

CAUTION

Exercise care when removing the retaining ring. Do not damage idler pulley.

(n) Remove the bearing retaining ring inside the idler pulley.

(o) Remove the retaining ring (37) and washer (38) from the pivot shaft (35).

(p) Remove the pivot arm bushing (40) and O-rings (36) from the shaft.

(2) Repair. Proceed as follows:

(a) Inspect pump body and idler bearings for rough or worn races, or damaged shield. Replace if necessary.

(b) Inspect impeller and cover for cracks or corrosion. Replace if necessary.

(c) Measure internal clearances and press fits in accordance with tabulated

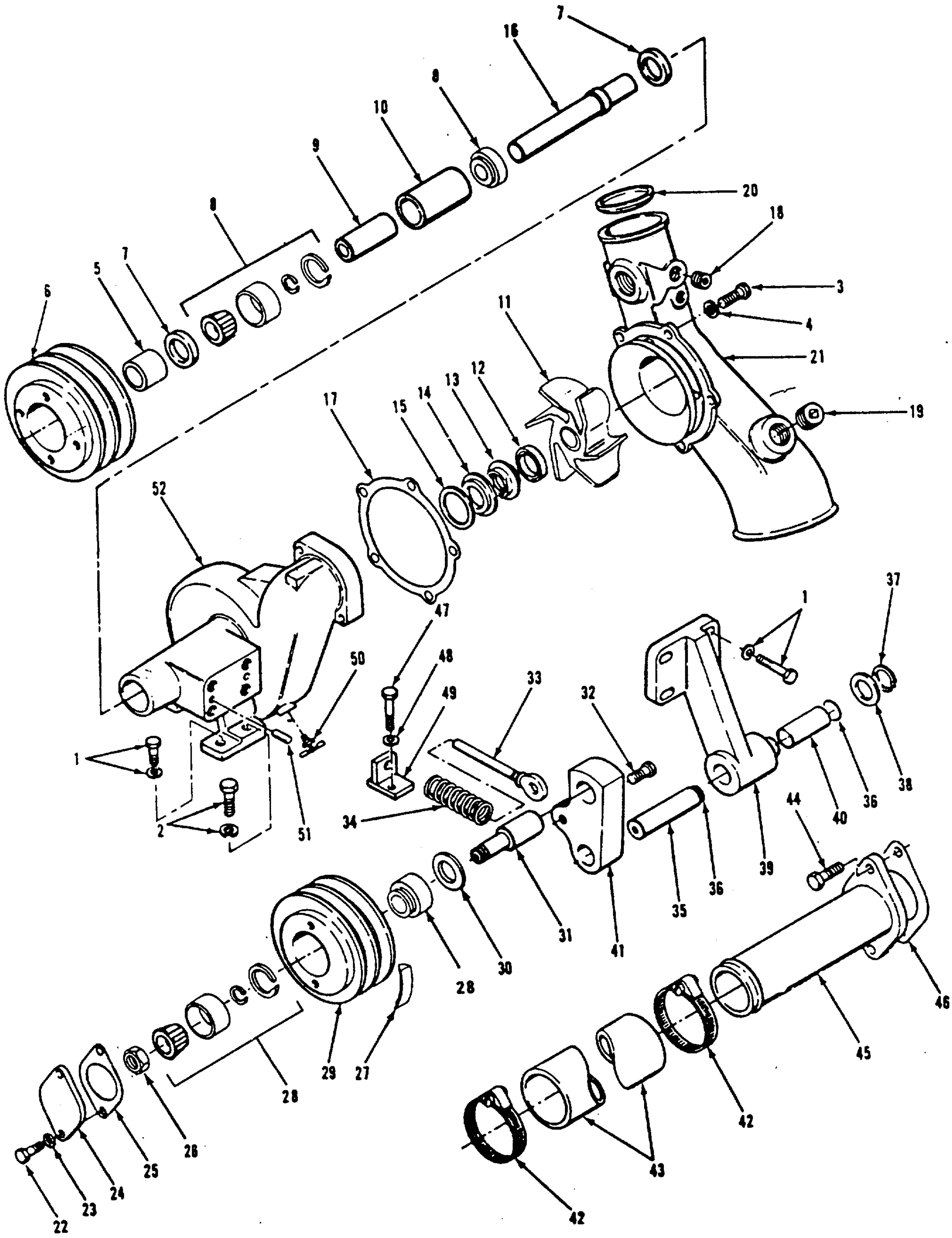


Figure 13-30. Water Pump with Idler Assembly

LEGEND FOR FIGURE 13-30

1. Screw/washer
2. Screw/washer
3. Screw
4. Washer
5. Sleeve
6. Pulley
7. Seal
8. Bearing
9. Spacer
10. Spacer
11. Impeller
12. Seal
13. Seal
14. Bushing
15. Gasket
16. Shaft
17. Gasket
18. Plug
19. Plug
20. Plug
21. Cover
22. Screw
23. Washer
24. Cover
25. Gasket
26. Nut
27. Belt
28. Bearing assy
29. Pulley
30. Seal
31. Shaft
32. Screw
33. Spring locator
34. Spring
35. Shaft
36. Seal
37. Ring
38. Washer
39. Idler pulley bracket
40. Bushing
41. Idler arm
42. Clamp
43. Hose
44. Screw
45. Tube
46. Gasket
47. Screw
48. Washer
49. Retainer
50. Drain cock
51. Pin
52. Body

data in Chapter 1. Replace parts as necessary.

(d) Inspect spring locator rod (33) and spring (34) for visible signs of damage or wear. Replace as necessary.

(e) Inspect water pump mounting parts for cracks. Replace as necessary.

(3) Reassemble the water pump and idler assembly (install replacement parts as necessary) with new gasket (17), Figure 13-30. Water Pump with Idler Assembly oil seal (7) and bracket bushing (40 as follows:

(a) Install large retaining ring from bearing assembly in retaining groove inside the front of the water pump body (52).

(b) Install bearing race into front of water pump body. Seat race or retaining ring using a suitable mandrel.

(c) Insert bearing cup spacer (9) from the rear of the pump body (52).

(d) Install the other bearing race into the rear of the pump body. Seat race on spacer (9) using a mandrel.

(e) Apply MIL-T-3545 grease to one inner race (bearing and cone) and install race on the shaft (16). Seat race on shaft shoulder using a mandrel.

(f) Insert shaft (16) with bearing into pump body (52) from the impeller end.

(g) Position the water pump pulley end up and in- stall spacer (10) over water pump shaft (16).

(h) Place small bearing cone spacer over water pump shaft (16).

NOTE

Water pump must be lubricated during reassembly.

(i) Fill water pump cavity with 0.97 to 1.15 ounces (.025 to .030.1) of MIL-G-3545 grease.

(j) Support the pump on its impeller end and install the remaining race (bearing and cone) in the shaft (16) using a suitable mandrel.

(k) Check water pump shaft end play with a dial indicator. End play must be 0.003 to 0.010 inch (0.08 to 0.25 mm).

(l) Install front oil seal

(7) on the shaft (16). Seal shall be installed flush to 0.020 inch (0.51 mm) below chamfer in water pump body (52).

(m) Support the water pump on its pulley end and install the rear oil seal (7). Seal shall be installed flush to 0.020 inch (0.51 mm) below chamfer in the water pump body (52).

(n) Install gasket (15) and bushing (14) from rear of water pump body (52).

(o) Apply Locktite No. 3375066 to outside diameter of water pump seal (13). Press seal (13) into bushing (14). Make sure seal bottoms on bushing.

(p) Press the seal seat (12) onto the shaft (16) using a suitable mandrel.

(q) Position the pulley (6) on the shaft (16) and press the pulley until it bottoms on the inner race (bearing and cone) of the bearing assembly (8).

(r) Apply a thin coat of Locktite 601 to the impeller bore. Support the pump on its pulley end and press the impeller (11) on the shaft. Clearance between the impeller vanes and the housing shall be 0.020 to .031 inch (0.51 to 0.79 mm).

(s) Install new gasket (17) and secure pump cover (21) to the body (52) with screws (3) and washers (4). Torque screws from 30 to 35 foot-pounds (41 to 47 joules).

(t) Install O-rings (36) on idler pivot shaft (35).

(u) Install washer (38) and retaining ring (37) on shaft (35).

(v) Install retaining ring from bearing assembly (28) in groove inside idler pulley (29).

(w) Install bearing races inside pulley (29) and seat races against retaining ring.

(x) Apply MIL-G-3545 grease to inner race (bearing and cone) and install race in rear of idler pulley (29).

(y) Install rear oil seal (30) in idler pulley (29) using a suitable mandrel. Seat seal flush to 0.020 inch (0.51 mm) below chamfer in pulley.

(z) Install small spacer from bearing assembly (28) into front of idler pulley (29).

(aa) Apply MIL-G-3545 grease to remaining inner race (bearing and cone) and install race in front of the idler pulley (29).

(ab) Place idler pulley assembly (29) on idler shaft (31).

(ac) Install locknut (26) and torque nut from 70 to 75 foot-pounds (95 to 102 joules).

(ad) Check idler pulley end play with a dial indicator. End play shall be 0.003 to 0.10 inch (0.08 to 0.25 mm).

(ae) Fill idler pulley cavity with 0.4 to 0.5 ounces of MIL-G-3545.

(af) Install idler assembly on water pump with four screws (1). Finger tighten mounting screws.

(ag) Retract idler assembly and install drive belts (27). Align belt by moving idler assembly either forward or backward. Torque mounting screws from 30 to 35 foot-pounds (41 to 47 joules).

Section V. HOUSING

13-18. CRANKSHAFT PULLEY VIBRATION DAMPER. To replace the crankshaft pulley vibration damper, first remove the guard in accordance with Operator/Crew Organizational Maintenance manual and proceed as follows:

a. Removal. To remove the crankshaft pulley vibration damper, refer to figure 13-31, and proceed as follows:

(1) Remove crankshaft pulley retaining screw (1) and washer (2).

(2) Remove lockwires and six capscrews securing vibration damper (3) to crankshaft pulley (6).

(3) Remove capscrews (4) and washers (5).

CAUTION

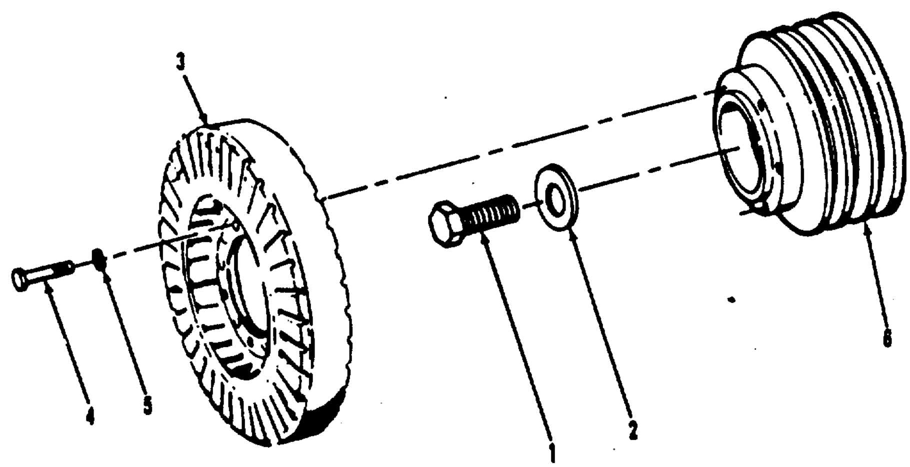
Do not use a gear puller that applies pressure to pulley outside diameter. To do so will result in damage to pulley.

(4) Remove crankshaft pulley (6) using universal puller kit with threaded adapters that fit into tapped holes on face of pulley.

b. Installation. Proceed as follows:

(1) Install pulley (6) on crankshaft as far as possible.

(2) Secure with washers (5) and capscrews (4); torque capscrews 60 to 70 foot-pounds (81 to 95 joules).



LEGEND

1. Screw	3. Damper	5. Washer
2. Washer	4. Screw	6. Pulley

Figure 13-31. Crankshaft Pulley Vibration Damper, Exploded View

(3) Install vibration damper (3) and fasten with washer (2) and screw (1); torque screw to 450 to 500 foot-pounds (610 to 678 joules).

(4) Install six screws securing vibration damper (3). Torque conical screws to 70 to 80 foot-pounds (95 to 108 joules). Torque hexagon head capscrews to 100 to 120 foot-pounds (136 to 163 joules).

NOTE

Crankshaft must be kept to front or rear limit of thrust clearance while wobble is being checked.

CAUTION

Do not pry against or strike damper.

(4) With a dial gauge mounted to gear case cover and arm resting on the inner machined surface of the outer member, check vibration damper eccentricity and wobble at points (1) and (2) as show in figure 13-32. Wobble must not exceed 0.009 inch (0.23 mm) per inch of radius. Eccentricity must not exceed 0.030 inch (0.76 mm).

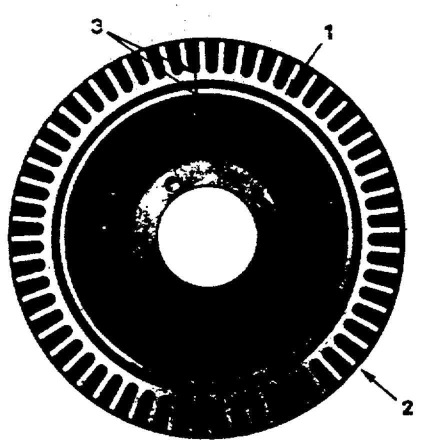


Figure 13-32. Vibration Damper Wobble Check Points

13-19. ENGINE FRONT SUPPORT. To inspect and replace the engine front support, refer to figure 13-33, and proceed as follows:

a. Inspection. Inspect the engine front support for signs of cracking or other signs of damage. Replace if necessary, as follows:

b. Removal.

(1) Refer to Chapter 2, Section IV to remove engine assembly.

(2) Remove screws (4), lockwashers (5), screws (6), and lockwashers (7).

(3) Remove screws (1), nuts (3), and lockwashers (2).

c. Installation.

(1) Install new engine front support screws (1), lockwashers (2), and nuts (3).

(2) Replace engine assembly.

(3) Install lockwashers (7), screws (6), lockwashers (5), and screws (4).

13-20 OIL PAN ASSEMBLY. To replace or repair the oil pan assembly, refer to figure 13-34, and proceed as follows:

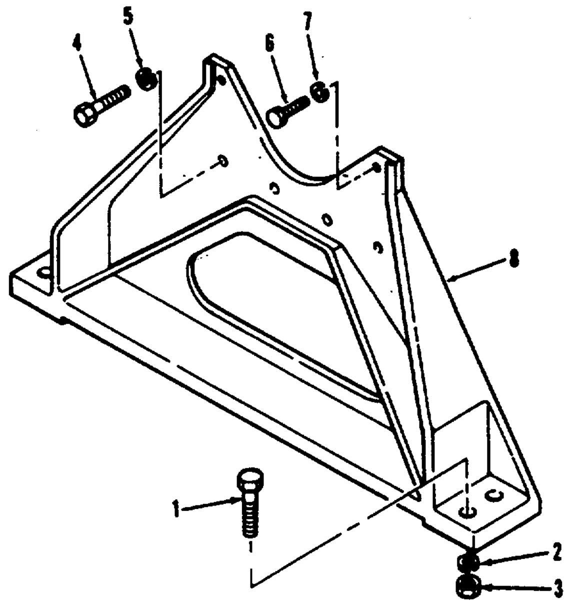
a. Removal.

(1) Drain oil in accordance with the Operator/Crew and Organizational Maintenance manual.

(2) Disconnect temperature sensor (34, figure 13-34) electrical connector. Remove screw and washer securing temperature sensor cable clamp, then move and secure cable away from work area.

(3) Disconnect engine preheat hose coupling on radiator line and two couplings on preheater assembly, then remove three screws and washers securing preheat hose support brackets to engine. Move and secure preheat hoses away from work area.

(4) Remove four nuts and washers from preheater assembly V-bolts, then move and secure preheater assembly away from work area.



LEGEND

1. Screw	3. Nut	5. Lockwasher	7. Lockwasher
2. Lockwasher	4. Screw	6. Screw	8. Support

Figure 13-33. Engine Front Support, Exploded View

(5) Disconnect fuel inlet hose coupling at fuel filters, then move and secure hose away from work area.

(6) Remove six screws securing ether line support clamps to engine, then loosen ether line fittings from manifolds and solenoid valve (located on upright support) to remove ether lines. Store ether lines in a safe place to avoid damaging them.

(7) Disconnect two bypass oil filter hose couplings from tee on oil pan.

(8) Disconnect bypass oil filter inlet hose coupling at top of rear bypass oil filter, then remove six screws securing bypass oil filter support bracket to engine block to remove bypass oil filter assembly.

(9) Remove two support brackets (31, figure 13-34) from generator end of oil pan by removing screws (1), lockwashers (2), washers (3), screws (29), and lockwashers (30).

(10) Remove two screws and washers securing battery cable clamps to engine. Using a suitable rope or cord, tie battery cables to upper engine block out of the way of the work area.

(11) Remove 45 screws (24), lockwashers (25), and washers (26), and drop oil pan (32).

(12) Remove three screws (8), lockplate (9), screws (16), clamp (18), and tube assembly (22), and remove oil pan.

(13) Remove all gasket material from oil pan mating surfaces.

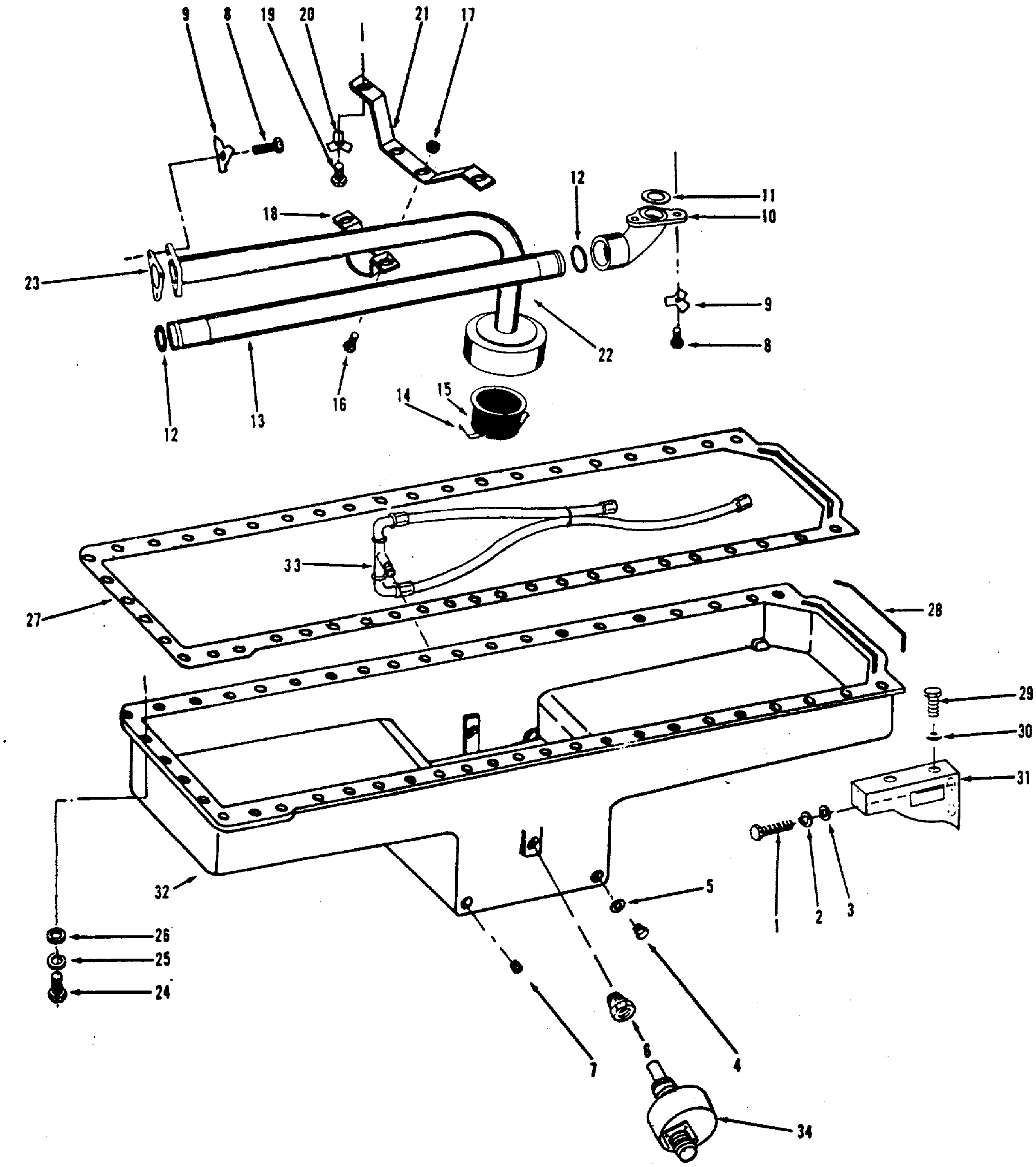


Figure 13-34. Oil Pan Assembly, Exploded View

LEGEND FOR FIGURE 13-34

1. Screw
2. Lockwasher
3. Washer
4. Plug
5. Gasket
6. Bushing
7. Plug
8. Screw
9. Lockplate
10. Connection
11. Gasket
12. O-ring
13. Tube
14. Support
15. Screen
16. Screw
17. Nut
18. Clamp
19. Screw
20. Lockplate
21. Bracket
22. Tube
23. Gasket
24. Screw
25. Lockwasher
26. Washer
27. Gasket
28. Seal
29. Screw
30. Lockwasher
31. Bracket
32. Pan
33. Hose assy
34. Temperature sensor

(14) Steam clean pan and all mounting parts.

CAUTION

Do not use solvent that will harm non-ferrous metal.

(15) Visually check oil pan for cracks, or if a leak is suspected, check using dye penetrant.

(16) Spray suspected area with dye penetrant. Allow penetrant to dry for 15 minutes. Do not force dry.

(17) Spray area with dye developer. Check for crack indications. Check all holes for damaged threads.

b. Repair.

(1) A cracked oil pan should be replaced.

(2) If oil plug drain hole is damaged, repair as follows (two oversize plugs are available to permit rethread of oil drain holes at least twice):

(a) When using Part No. 62117 oil pan drain plug, size 1-1/4 inch by 12 thread, proceed as follows:

1. Enlarge damaged hole by drilling to 1-11/64 inch (27.76 mm).

2. Tap hole with 1-1/4 inch by 12 tap. Use fuel oil lubricant to prevent tearing of metal.

3. Install new drain plug with a new copper gasket. Torque to 60 to 70 foot-pounds (81 to 95 joules).

c. When using Part No. 120349 (if drain plug has previously been repaired with Part 62117) proceed as in (a) above, except enlarge damaged hole by drilling to 1-19/64 inch (33.94 mm) and tap hole with 1-3/8 inch by 12 tap.

d. Installation. Proceed as follows:

NOTE

Position oil pan prior to installing screen assembly.

(1) Install screen assembly (15, figure 13-34) with clamp (18), screws (16), lockplate (9) and screws (8).

(2) Check for proper location of oil gauge hole in relation to oil gauge tube location.

(3) Install new seal and gasket (28 and 27) in groove at rear of pan. Use grease to hold seal and gasket in place.

(4) Assemble oil pan (32) to block with 45 screws (24), washers (26), and lockwashers (25), but leave screws loose.

(5) Snug tighten screws (24) at four corners.

(6) Finish tightening oil pan screws. Torque to 20 to 25 foot-pounds (27 to 34 joules).

(7) Install two screws and washers securing battery cables and clamps to engine.

(8) Install support brackets (31) with screws (1), lockwashers (2), washers (3), screws (29), and lockwashers (30).

(9) Install six screws securing bypass oil filter support bracket to engine block, then connect bypass oil filter inlet hose coupling at top of rear bypass oil filter.

(10) Connect two bypass oil filter hose couplings to tie on oil pan.

(11) Install ether lines with six clamps and screws and attach ether line fittings at manifolds and solenoid valve.

(12) Connect fuel inlet hose coupling at fuel filters.

(13) Connect engine preheat hose coupling on radiator line and two couplings on preheat assembly. Install preheat hose support brackets, screws, and washers.

(14) Install temperature sensor electrical connector, then connect cable and secure with clamp, screw, and washer.

(15) Refill engine with proper lubricating oil in accordance with the Operator/Crew and Organizational Maintenance manual.

13-21. OIL PUMP. To inspect, test, replace, and repair the oil pump, remove the oil pan in accordance with paragraph 13-20, refer to figure 13-35, and proceed as follows:

a. <u>Disassembly</u> <u>and</u> <u>Inspection</u>. To inspect the components of the lubricating oil pump, the pump must first be removed and disassembled. Proceed as follows:

(1) Remove suction tube and discharge tube from oil pump and lift off pump.

(2) Remove screws (16, 20, and 21) and lockplates (17) securing pump body (38) to cover (25).

(3) Carefully drive cover (25) (with soft hammer or brass punch) from body (38) and remove gasket (32).

(4) Remove idler gears (29) from shafts (26); remove shafts from pump body (38).

(5) Remove nut (6), spacer (7), intermediate drive gear (8) and thrust washer (11). Press out shaft (14).

(6) Press drive gear (15) from drive shaft (30). Remove drive shaft assembly from body.

(7) Press internal gear (31) from shaft (30), if shaft or gear is worn or damaged.

(8) Remove plunger cap (33); remove spring (34) and plunger (35) from body (38).

(9) Inspect and replace all bushings and shafts if worn or damaged.

(10) Replace cover, or body if finished surfaces in gear pockets are scored or visibly worn.

(11) The drive and idler gears must be replaced if worn, scored or damaged. Check all hardware for worn or damaged threads. Replace as necessary.

b. <u>Test</u>. Following reassembly, crank gears by hand; they should turn smoothly and freely.

c. <u>Reassembly and Repair</u>. Repair by replacing any worn or damaged parts and proceed as follows:

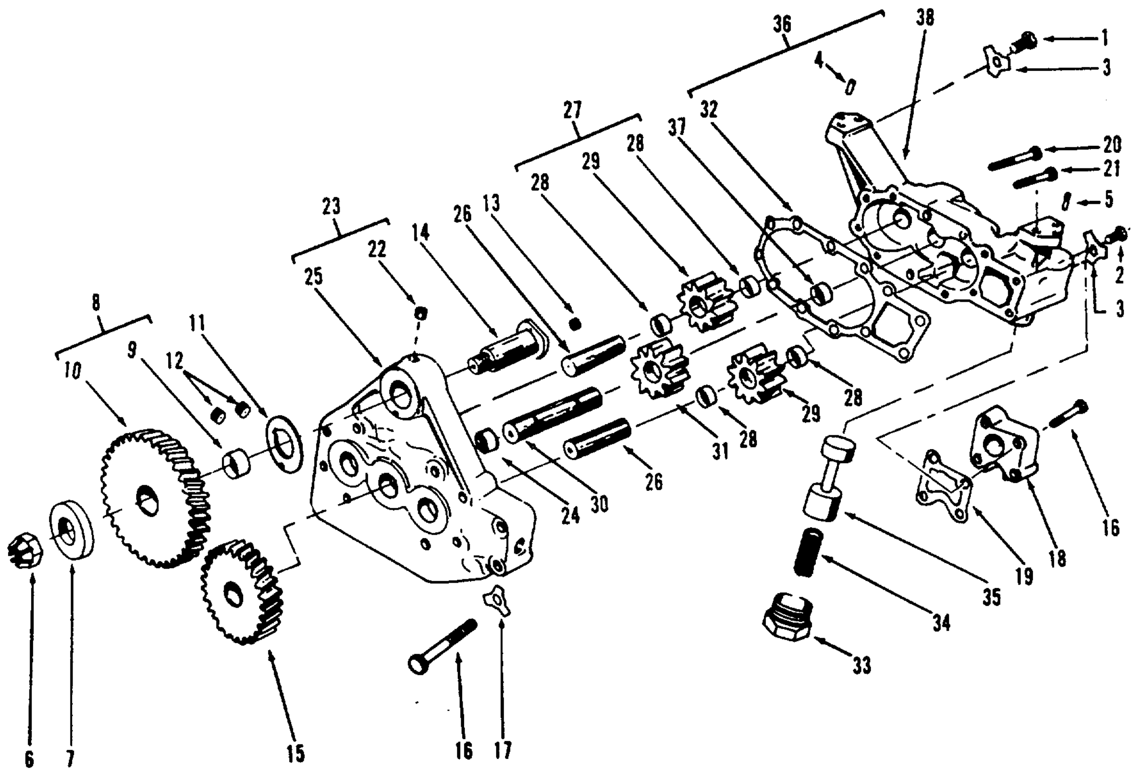


Figure 13-35. Oil Pump, Exploded View

LEGEND

1. Screw	10. Gear	20. Screw	30. Shaft
2. Screw	11. Washer	21. Screw	31. Gear
3. Lockplate	12. Plug	22. Plug	32. Gasket
4. Dowel	13. Plug	23. Cover	33. Cap
5. Dowel	14. Shaft	24. Bushing	34. Spring
6. Nut	15. Gear	25. Cover	35. Plunger
7. Spacer	16. Screw	26. Shaft	36. Body
8. Gear and bushing	17. Lockplate	27. Gear	37. Bushing
9. Bushing	18. Connection	28. Bushing	38. Body
19. Gasket	29. Gear		

(1) Place plunger (35) and spring (34) in body and secure with cap (33).

(2) Press internal drive gear (31) onto short end of drive shaft (30) until shaft extends through gear 1.020 to 1.040 inch (25.91 to 26.41 mm).

(3) Install drive shaft assembly in pump body.

(4) Press external drive gear (15) on drive shaft, leaving 0.061 to 0.063 inch (1.55 to 1.60 mm) end thrust.

(5) Press in intermediate drive gear shaft (14) until it seats. Mount thrust washer (11), intermediate drive gear (8), spacer (7) and nut (6) Torque nut (6) to 70 to 80 foot-pounds (95 to 108 joules).

(6) Place idler gears (29) in pump body. Install shafts

(26) first. Press shafts in until they protrude 0.860 to 0.890 inch (21.84 to 22.61 mm) above face of body.

(7) Place a new gasket (32) on pump body (38). Assemble cover (25) to body. Press together using pilot capscrew near each end to pilot gasket.

(8) Secure cover to body with lockplates (17) and screws (16, 20, and 21). Check drive shaft for freeness.

(9) Lock screws in position with lockplate tangs.

d. Replacement. Proceed as follows:

(1) Remove suction tube and discharge tube from oil pump and lift off pump.

(2) Position lubricating oil pump to block and secure with dowel pins, lockplates, and capscrews.

CAUTION

Make sure that lubricating oil pump gear is fully engaged before final tightening of capscrews.

(3) Attach a dial indicator to block. Place indicator on gear teeth.

(4) Rotate gear by hand to advance position; "zero" indicator. Back gear to retard position and note reading; permissible backlash is 0.006 to 0.15 inch (0.15 to 0.38 mm). If not within limits gear train must be replaced.

(5) Assemble lubricating oil suction and discharge lines, connections, and clamp, using new O-rings, gaskets, and lockplates. Torque screws to 30 to 35 foot-pounds (41 to 47 joules). Secure lockplates. Suction screen must have 1/2-inch (12.70 mm) clearance.

Section VI. FLYWHEEL AND HOUSING

13-22. RING GEAR, FLYWHEEL, AND HOUSING. To inspect and replace the ring gear, flywheel, and housing, refer to figure 13-35, and proceed as follows:

a. Inspection.

(1) Check for cracks or other flaws in flywheel, ring gear, and housing.

(2) Check ring gear teeth for excessive wear and damage from improper starter gear meshing.

(3) Replace any damaged or cracked parts.

b. Removal.

(1) Refer to Chapter 2, Section IV and remove the generator assembly to provide access to the flywheel housing.

(2) Remove lockwires, ten screws (1) and lockwashers (2) securing flywheel to camshaft flange.

(3) Insert two 5/8-18, 7-inch (178 mm) long studs through two capscrew holes in flywheel 180 degrees apart and screw into crankshaft flange to support flywheel during removal.

(4) In two holes provided, place two 1/2-13, 2-1/2 inch (63.5 mm) screws which are threaded their entire length. Turn in screws alternately to pull flywheel from crankshaft dowels. Using a suitable hoist, lift flywheel from guide studs.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

(5) Drive ring gear (5) from flywheel with a blunt chisel.

(6) Install two 5/8-11 studs in block to guide flywheel housing during removal.

(7) Drive housing from dowels by tapping on back side with a soft hammer or wooden block. Using a suitable hoist, lift housing from guide studs.

c. Installation

(1) Install housing on dowels by tapping with a soft hammer or wooden block.

(2) If an oven with heat control is not available, heat ring gear (5) with a heating torch from inside diameter so heat travels outward to teeth.

(3) Use a Templistick crayon or equivalent to determine amount of heat applied.

(a) Stroke gear with 600°F (316°C) crayon several times while applying heat.

(4) The crayon will leave a chalk mark until temperature reaches 600°F (316°C). At 600°F (316°C), the crayon will leave a liquid smear.

CAUTION

Overheating to temperatures above 660°F (349°C) will soften gear.

(5) Place ring gear on flywheel and quickly drive onto flywheel until gear is firmly seated.

(6) Index the zero on crankshaft with the zero on flywheel and assemble flywheel over studs to crankshaft flange.

(7) Insert lockwashers (2) and screws (1). Tighten screws alternately, a little at a time, to pull flywheel up evenly. Continue until all screws are tight.

(8) Attach indicator gauge to side of flywheel housing to indicate bore of flywheel. The total indicator reading must not be greater than 0.005 inch (0.13 mm).

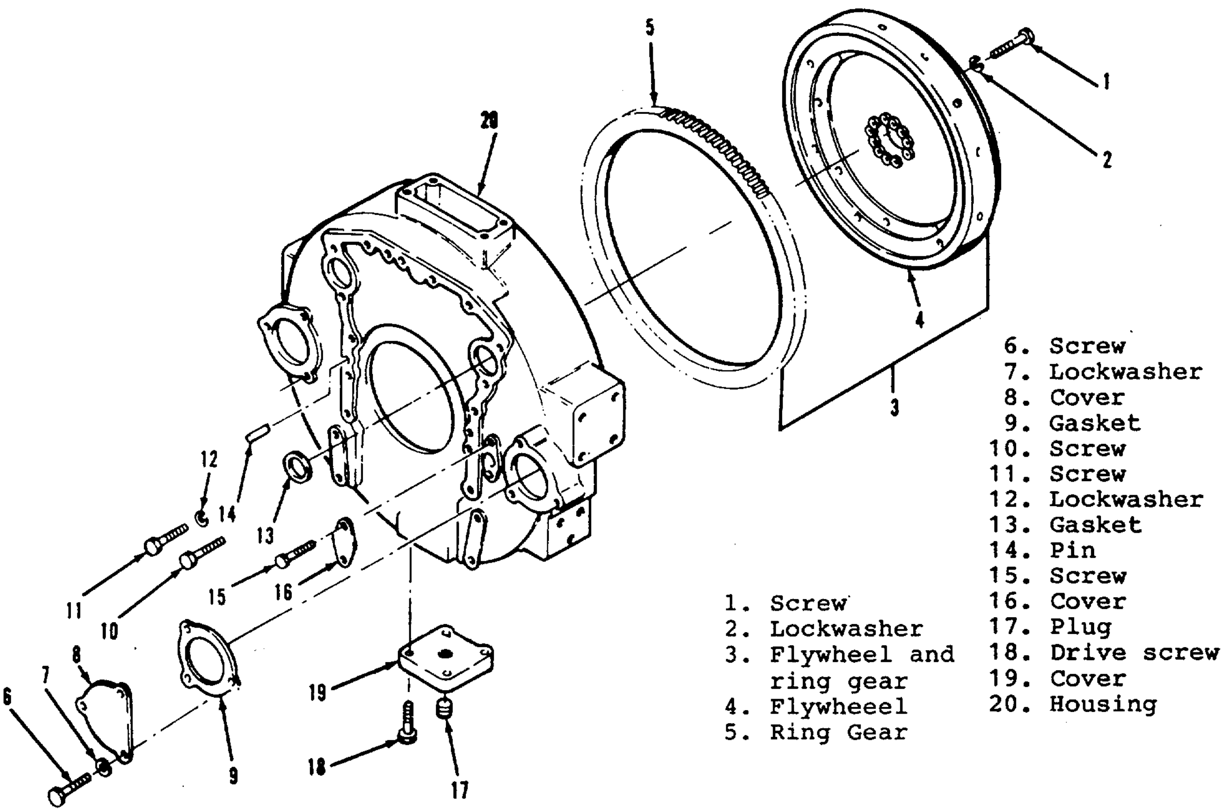
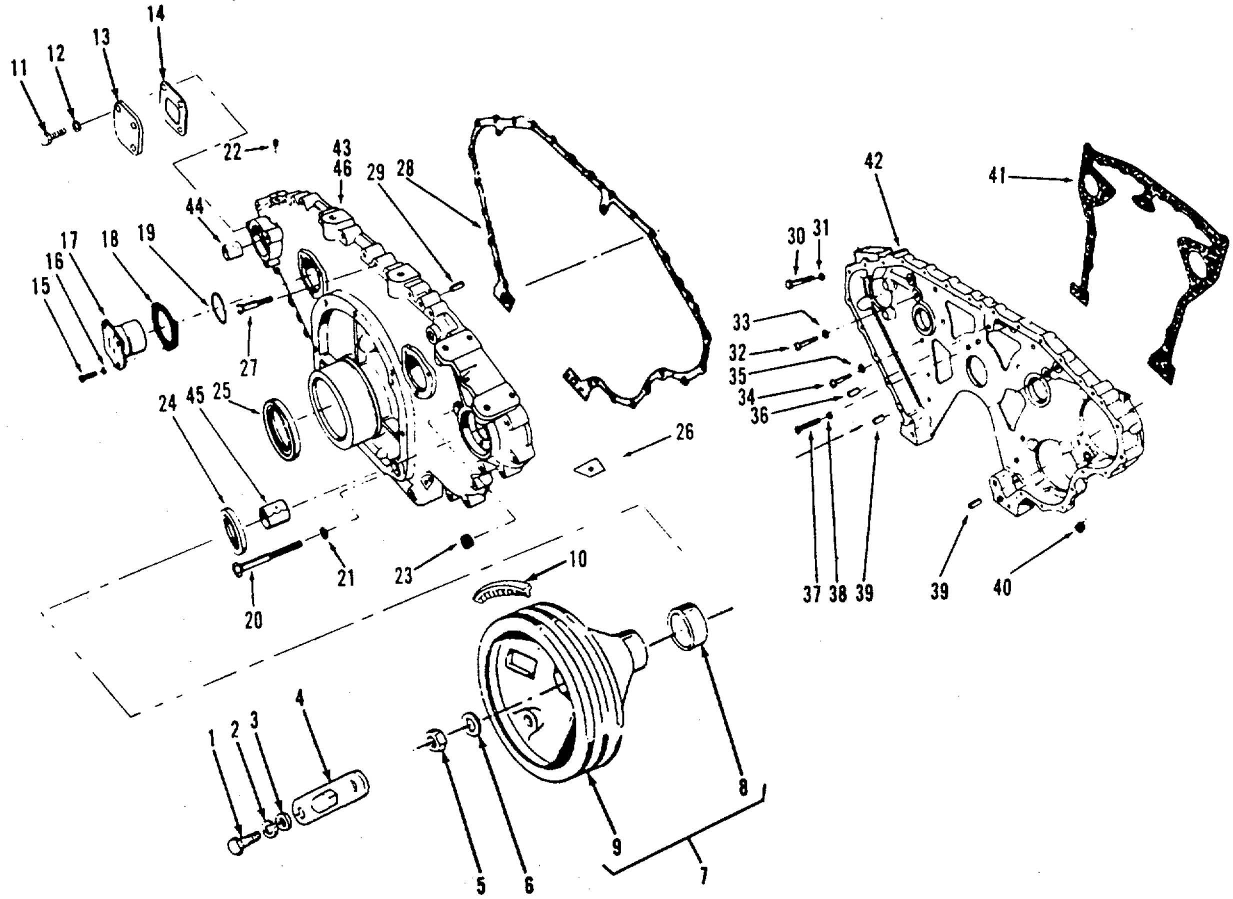


Figure 13-35A. Ring Gear, Flywheel, and Flywheel Housing



LEGEND

1. Screw
2. Lockwasher
3. Washer
4. Plate
5. Nut
6. Washer
7. Water pump pulley assy
8. Sleeve
9. Pulley
10. Belt
11. Screw
12. Lockwasher
13. Plate
14. Gasket
15. Screw
16. Lockwasher
17. Support
18. Shim
19. O-ring
20. Screw
21. Lockwasher
22. Plug
23. Plug
24. Seal
25. Seal
26. Pointer
27. Screw
28. Gasket
29. Dowel
30. Screw
31. Lockwasher
32. Screw
33. Lockwasher
34. Screw
35. Lockwasher
36. Dowel
37. Screw
38. Lockwasher
39. Dowel
40. Plug
41. Gasket
42. Housing
43. Cover
44. Bearing
45. Bushing
46. Cover

Figure 13-36. Gear Case, Exploded View

13-23. TIMING GEAR AND COVER. To inspect and replace the timing gear and cover, refer to figures 13-36, and 13-37, and proceed as follows:

a. Removal. Proceed as follows:

(1) Remove 26 screws (27, figure 13-36) and two screws (20) and lockwashers (21).

(2) Install two 6-inch (152 mm) guide studs through top of gear case into block to prevent gear case from falling during removal.

(3) With a soft hammer, tap case alternately top and bottom, left and right, to drive from dowels.

(4) Lift gear case from guide studs and remove studs from block.

(5) Remove capscrew (1, figure 13-37) lockwasher (2), front thrust washers (4 and 5), gear and bushing (7 and 8) and rear thrust washer (5).

b. Inspection.

(1) Inspect gear for cracks, broken teeth, or visible wear. Replace if damaged or excessively worn.

(2) Inspect gear case for cracks, burrs, or breaks. Replace if damaged.

(3) Inspect screw threads and repair with heli-coil inserts if found damaged.

(4) Inspect dowels for damage; replace or bore out for oversize if required.

c. Installation.

(1) Install thrust washer (5, figure 13-37) on idler shaft (6) with oil grooves facing away from shaft shoulder.

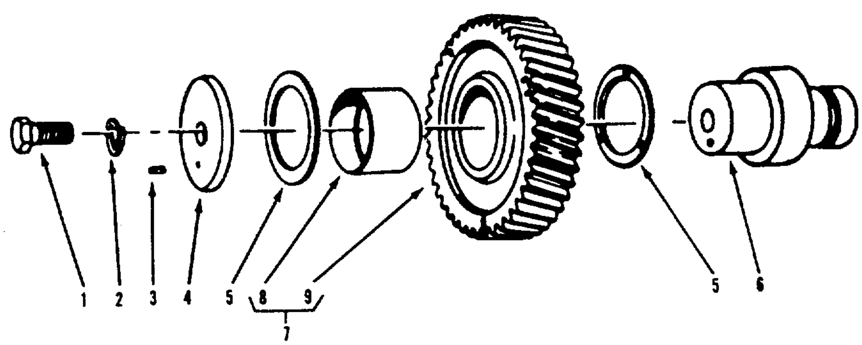
(2) Insert dowel pin (3) in drilled hole in end of idler shaft (6), if removed.

(3) Install timing gear (7) on shaft (6) indexing two "O" marks on gear astride single "O" mark on crankshaft gear.

(4) Install outer thrust washers (5 and 4) over shaft with oil grooves next to idler gear.

(5) Install lockwasher (2) and screw (1).

(6) Timing gear thrust limit is 0.001 to 0.016 inch (0.03 to



LEGEND

1. Screw
2. Lockwasher
3. Pin 6. Shaft
4. Washer
5. Washer
9. Gear
7. Idler gear assy
8. Bushing

Figure 13-37. Timing Gear, Exploded View

0.41 mm); check clearance with feeler gauge.

(7) Install guide studs in engine block.

(8) Install new gasket (28, figure 13-36).

(9) Secure gear cover with capscrews (27), lockwashers (21) and screws (20).

Section VII. CYLINDER HEAD AND VALVE OPERATING MECHANISM

13-24. GENERAL. The following paragraphs contain maintenance instructions for components comprising the cylinder head.

13-25. ROCKER ARM SHAFT AND ROCKER ARM ASSEMBLY. To service the rocker arm shaft and rocker arm assembly, refer to figure 13-38 and proceed as specified in the following paragraphs:

a. Removal. Proceed as follows:

(1) Refer to the Operator/Crew and Organizational Maintenance manual for inspection and cylinder head cover removal instructions.

(2) Remove pipe plug (12).

(3) Remove pipe plug (13) from end of rocker lever housing (8), and set screw in bottom of housing that secures shaft.

(4) Use a flat or drift punch to force out shaft (14) and cup plug (11).

(5) Locate shaft in V-block and remove shaft plug (15).

(6) Remove rocker levers from housing. Tag rocker levers for correct position as removed to ensure proper reassembly.

(7) Remove adjusting screw lock nuts (17) and (25) and adjusting screws (18) and (26).

b. Repair of Rocker Arm Shaft Assembly.

(1) If shaft outside diameter is not between 1.123 inches to 1.124 inches (28.52 mm to 28.55 mm) replace shaft.

(2) Rocker arm shaft bore inside diameter should be 1.243 to 1.125 inches (28.577 to 28.558 mm). If lever shaft does not meet these dimensions, replace shaft.

c. Reassembly.

(1) Install adjusting screws (20) and (24) and locknuts (19) and (23) in rocker levers.

(2) Coat rocker lever shaft with clean lubricating oil. Start shaft (14) into housing (8). Install levers on shaft as shaft is pushed through housing.

(3) Coat cup plug (11) contact surfaces with Locktite sealer. Install new cup plug (11) in rocker lever housing (8).

(4) Install pipe plug (13) and shaft plug (15) in end of rocker lever housing. Use sealing tape or Locktite to prevent oil leakage.

(5) Check all levers for freedom of movement on shaft.

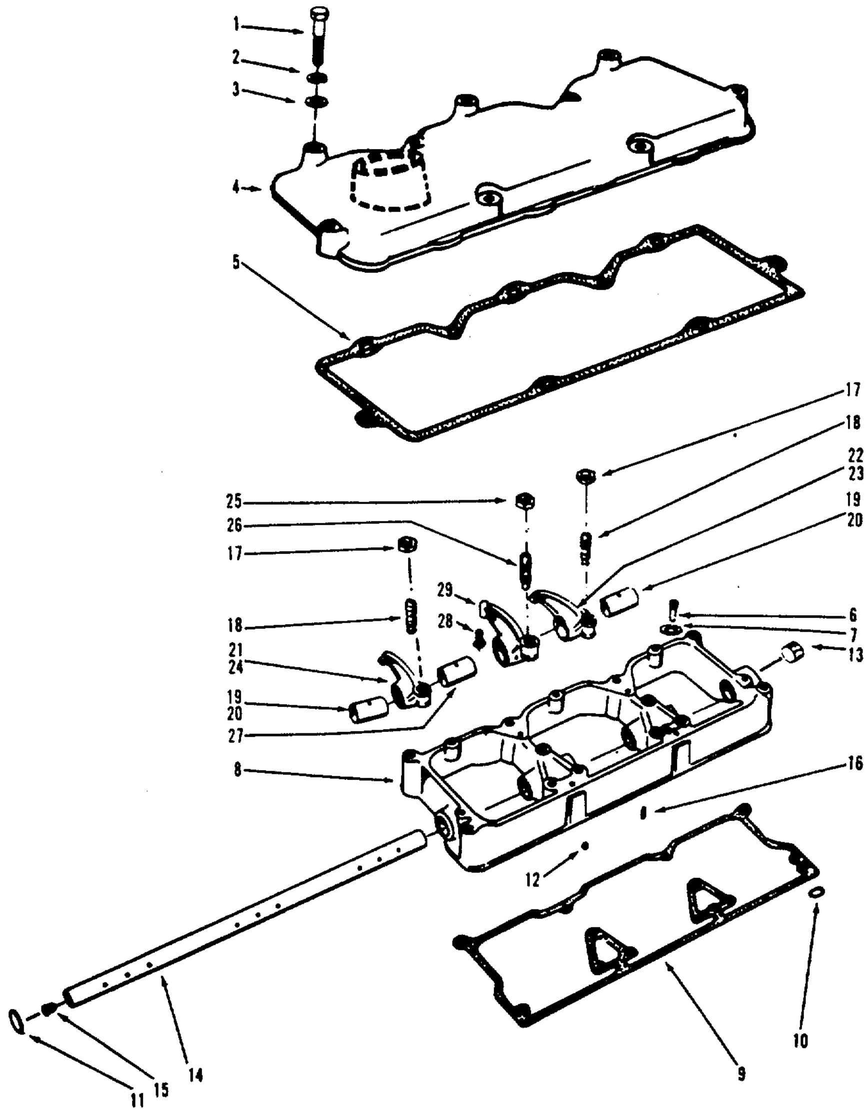
(6) Install pipe plug (12).

(7) Tighten shaft lockscrews (18) and (26) and adjust so screws contact valve stem, then advance 20 degrees and lock with nuts (17) and (25).

NOTE

On worn crosshead and guide, it may be necessary to advance 30 degrees to straighten crosshead to guide.

(8) Hold adjusting screw in



LEGEND

1. Screw
2. Lockwasher
3. Washer
4. Cover
5. Gasket
6. Screw
7. Washer
8. Housing
9. Gasket
10. O-ring
11. Plug
12. Plug
13. Plug
14. Shaft
15. Plug
16. Pin
17. Locknut
18. Screw
19. Bushing
20. Rivet
21. Lever
22. Lever
23. Lever
24. Lever
25. Nut
26. Screw
27. Bushing
28. Socket
29. Lever

Figure 13-38. Rocker Arm Shaft and Rocker Arm Assembly, Exploded View

position and tighten nut with torque wrench to 25 to 35 foot-pounds (34.6 to 41.5 joules).

(9) Using a wire gauge, check to make sure there is a minimum of 0.020 inch (0.51 mm) clearance between crosshead and valve spring retainer.

(10) Refer to the Operator/Crew and Organizational Maintenance manual for adjustment and reassembly instructions.

13-26. PUSHRODS AND TAPPETS. To inspect and replace the pushrods and tappets, refer to figures 13-39 and 13-40, and proceed as follows:

a. Removal, Code A (Figure 13-39)

(1) Lift crossheads.

(2) Remove pushrods by lifting them from their tappets.

(3) Remove lockwires (3) and (10) and copper washers (17) holding tappet guides (16). Discard copper washers.

(4) Lift tappets (8) and (15) from block with a long wire hook or other suitable tool.

b. Removal, Code B (Figure 13-40)

(1) Lift crossheads.

(2) Remove pushrods by lifting them from their tappets.

(3) Remove lockwires (2) and (16), guides (6) and (11), and sockets (1) and (15).

(4) Lift tappets (7) and (9) from block with a long wire hook or other suitable tool.

c. Replacement, Code A (Figure 13-39). Replace any defective parts (refer to paragraph c) and reassemble as follows:

(1) Insert 0.006 inch (0.15 mm) shim between side of roller (5) and (11) and tappet (8) and (15); press pin (4) and (12) through tappet and roller with new lockwire (3) and (10) in pin. Make sure lockwire seats in groove of tappet.

CAUTION

Lubricating oil passage in pin and tappet must index for adequate lubrication.

(2) Install new copper washers (17) and holding tappet guides (16).

d. Replacement, Code B (Figure 13-40). Replace any defective parts (refer to paragraph e) and reassemble as follows:

(1) Insert 0.006 inch (0.15 mm) shim between side of roller (4) and (12) and tappet (7) and (9); press pin (5) and (10) through tappet and roller with new lockwire (2) and (16) in pin. Make sure lockwire seats in groove of tappet.

(2) Install new sockets (1) and (15) and guides (6) and (11).

e. Inspection.

(1) Using a fine wire, check indexing of pin and body lubricating oil passage.

(2) Check freeness of roller by rotating two or three turns.

(3) Check injector and valve pushrod ball end for wear.

(4) Check socket of pushrod with ball end of new rocker lever adjusting screw.

(5) Check pushrod for straightness.

(6) Check pushrod for out-of-round condition.

13-27. CYLINDER HEAD ASSEMBLY. Refer to the Operator/Crew and Organizational Maintenance manual for injector, turbocharger, exhaust manifold, water manifold, and cylinder head cover removal instructions. Refer to figure 13-41 and proceed as follows:

a. Replacement. Proceed as specified in the following paragraphs:

(1) Remove screws (1) and washers (2). Install guide studs to aid in removal of the cylinder heads.

CAUTION

Do not crank engine with cylinder head removed unless screws (1) have been reinstalled to prevent movement of cylinder lines.

NOTE

Tag cylinder heads for position occupied on engine so that they may be installed in the same position.

(2) Using a suitable hoist, remove cylinder heads.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

b. Installation.

NOTE

Cylinder heads should have valve guides, valves, and springs assembled in position before installation.

(1) Check that breather hole in cylinder head is open.

(2) Clean mating surfaces of cylinder block and cylinder head. Make certain that cylinder walls are clean and well lubricated with clean lubricating oil.

(3) Check head gasket to be sure all grommets and seals are in position. Install gasket over dowels so that the work "top" on gasket is visible.

(4) Position ferrule on O-ring into each lubricating oil passage between cylinder head and block.

(5) Install guide studs into block.

(6) Carefully lower cylinder heads over guide studs and dowels.

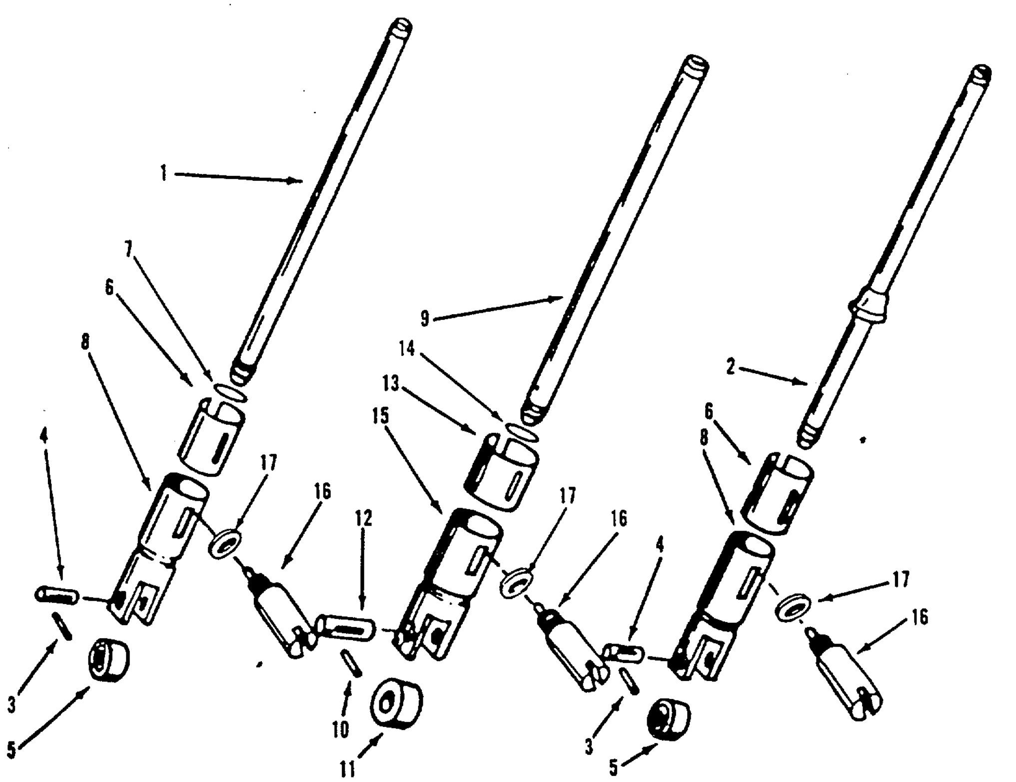
(7) Remove guide studs.

(8) Lubricate capscrew threads with clean engine lubricating oil and allow oil to drain from threads.

CAUTION

Excessive oil in capscrew holes in block could cause an error in torque value when cylinder head capscrews are tightened.

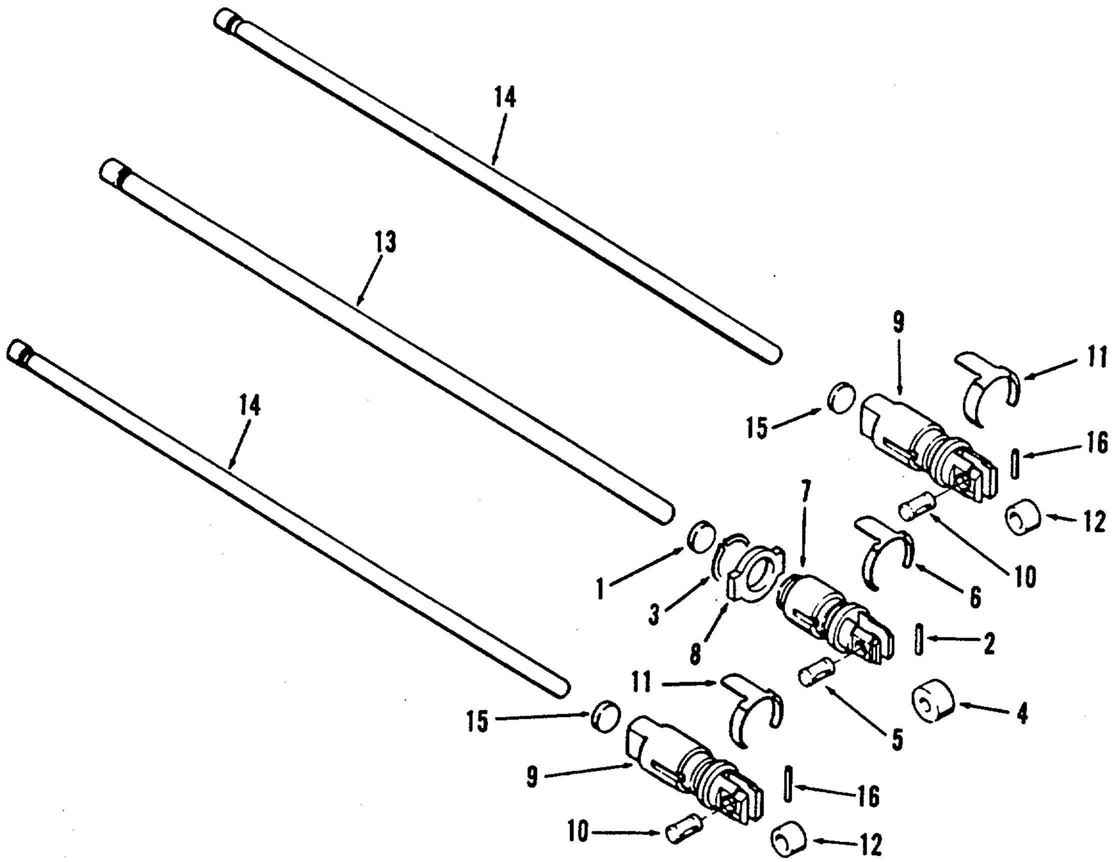
(9) Lubricate washers and cap- screw head washer mating surfaces with SAE 140-W lubricant.



LEGEND

1.	Pushrod	5.	Roller	9.	Injector	13.	Sleeve
2.	Pushrod	6.	Sleeve	10.	Lockwire	14.	Socket
3.	Lockwire	7.	Socket	11.	Roller	15.	Tappet
4.	Pin	8.	Tappet	12.	Pin	16.	Guide
						17.	Washer

Figure 13-39. Pushrods and Tappets, Code A



LEGEND

1.	Socket	5.	Pin	9.	Valve	13.	Rod
2.	Lock wire	6.	Guide	10.	Pin	14.	Rod
3.	Ring	7.	Injector	11.	Guide	15.	Socket
4.	Roller	8.	Retainer	12.	Roller	16.	Lockwire

Figure 13-40. Pushrods and Tappets, Code B

(10) Tighten capscrews to 25 to 40 foot-pounds (34 to 54 joules) in sequence shown in figure 13-42.

(11) Continue tightening in sequence to 150 to 200 foot-pounds (203 to 270 joules) and to 275 to 305 foot-pounds (373 to 414 joules) torque. Breakaway torque in direction of tightening is 275 to 340 foot-pounds (373 to 461 joules).

(12) Place a straight edge on top of, and parallel to, the cylinder head exhaust ports to check port flatness across all six points with feeler gauge. Variance up to 0.016 inch (0.41 mm) is acceptable.

NOTE

Replace water manifold seals when replacing water manifolds.

(13) Reinstall the injectors, cylinder head cover, water manifold, exhaust manifold, and turbocharger in accordance with the Operator/Crew and Organizational Maintenance manual.

LEGEND

1. Capscrew
2. Washer
3. Coilet
4. Valve
5. Retainer
6. Spring
7. Guide
8. Insert
9. Guide
10. Nut
11. Screw
12. Crosshead
13. Guide
14. Sleeve
15. O-ring
16. Screw
17. Lockwasher
18. Cover
19. Gasket
20. Plug
21. Capscrew
22. Lockwasher
23. Cover
24. Gasket
25. Plug
26. Plug
27. Plug
28. Plug
29. Dowel
30. Head
31. Gasket
32. Grommet
33. Retainer
34. Grommet
35. Grommet

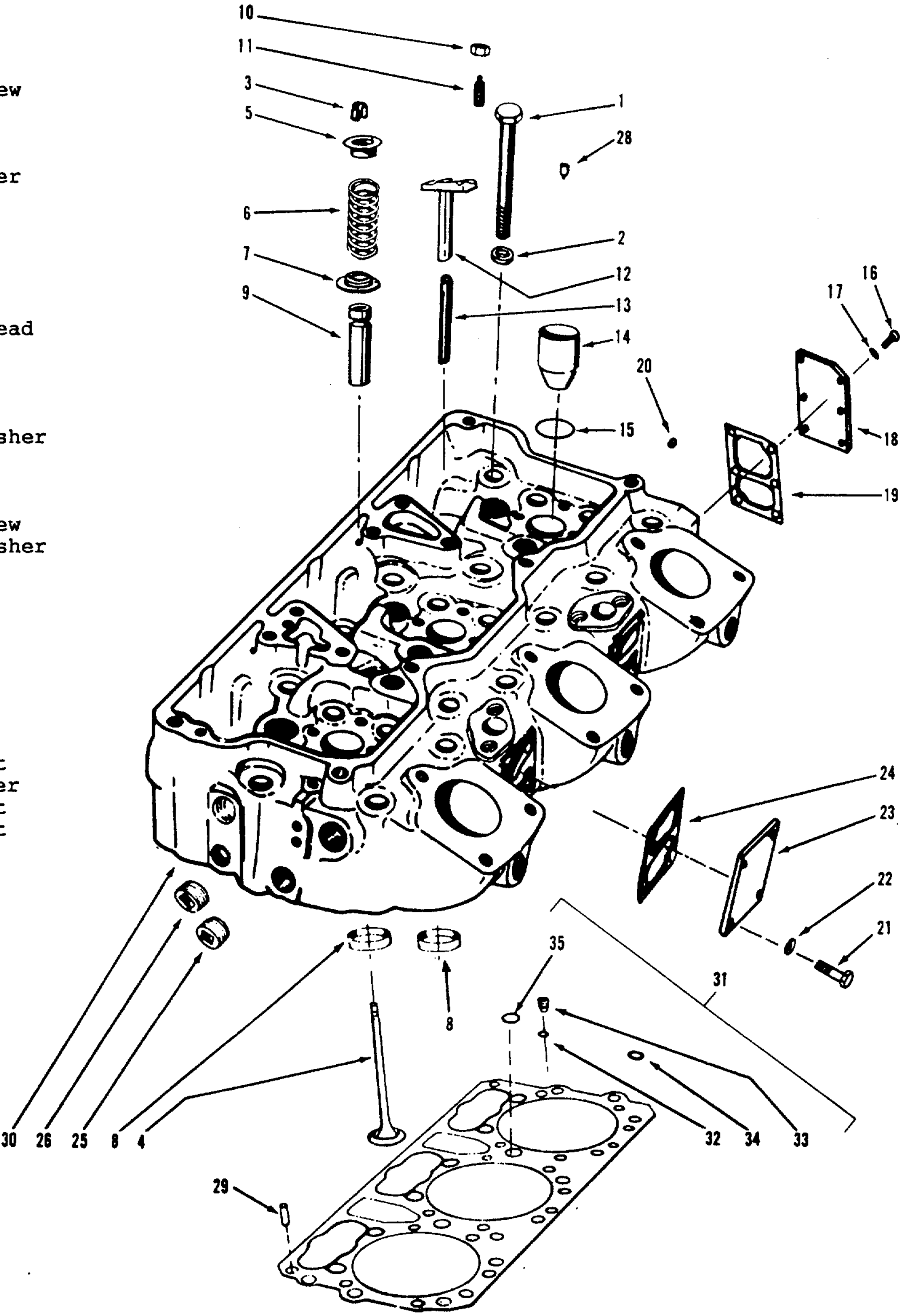


Figure 13-41. Cylinder Head, Exploded View

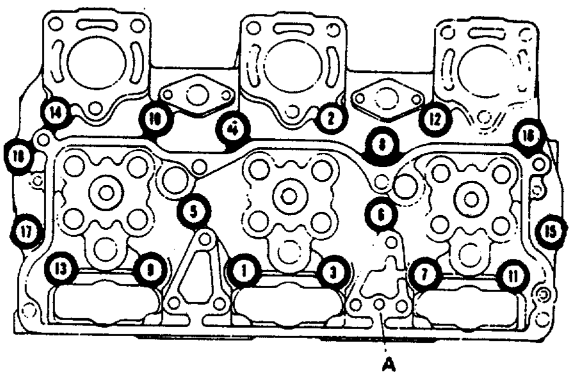


Figure 13-42. Head Capscrew Tightening Sequence

c. Inspection.

(1) Check valve seats and injector sleeve for cracks. Discard cylinder head if cracked.

(2) Check all valve springs for damage.

(3) Check for signs of metal erosion around water holes.

(4) Check cylinder head for worn or uneven surface at point of contact with gasket.

(5) Examine fuse plug for signs of overheating. If plug shows signs of overheating, check for further damage and replace if necessary.

d. Repair.

(1) Replace any damaged valve springs.

(2) Insert sleeves into water holes that have become enlarged due to metal erosion. Refer to paragraph 13-27 f.

(3) Resurface head surface that is deeply scratched or worn. Rework valve seat insert counterbore by removing amount of stock equal to that removed during head resurfacing operations. Refer to paragraph 13-27 f.

(4) If exhaust ports are not flat, resurface exhaust ports. Exhaust ports should not be more than 0.003 inch (0.08 mm).

e. Overhaul.

(1) Using a valve spring compressor, compress valve springs (6), remove half collets (3), retainers (5), spring (6), valve spring guides (7), and guides (9).

NOTE

Perform the necessary tests to determine the extent of overhaul or the scope of rebuilding required to the cylinder head.

(2) Hydrostatic Testing

(a) Install injector sleeve holding tool or a scrap injector assembly in each injector sleeve. Tighten tool or injector hold-down capscrews to 10 to 12 foot-pounds (14 to 16 joules) torque to seal lower end of injector sleeve and place cylinder head in the hydrostatic tester or equivalent.

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

(b) Use hoist to position head and tester over water tank, connect air line, and apply 30 to 40 psi (207 to 276 kPa) air pressure. Submerge head in water deep enough to cover entire head.

(c) Check carefully around valve seats and injector sleeve for cracks. Discard head if cracked.

(d) Test cylinder head for leaks at 75 to 85 psi (517 to 686 kPa) water pressure with water at 17a to 200°F (79 to 93° C). Check carefully around valve seats and injector sleeves for cracks even though such cracks may not show water leakage. Discard head if cracked.

(e) Open water outlet of test fixture; check for free water circulation through cylinder head. If restriction is evident, remove all pipe plugs and fuse plugs; clean water jackets of salt, lime, or sludge.

WARNING

THE USE OF ACID IS EXTREMELY DANGEROUS TO WORKMEN AND INJURIOUS TO MACHINER. ALWAYS PROVIDE A TANK OF STRONG SODA WATER AS A NEUTRALIZING AGENT.

(f) Clean fuel passage with a brush and flush passages with solvent to remove deposits.

(g) Check water passage running full length of head between valves for restrictions. If plugged, open by rodding or drilling.

(h) Check lubricating oil restrictor plug and lubricating oil passages to be sure they are open.

(i) Install "dummy" injectors in head (plugged fuel passages).

(j) Block fuel outlet and attach an air pressure gauge.

(k) Install air fittings in fuel inlets and apply air pressure of 90 to 100 psi (620 to 689 kPa).

(l) Close air inlet valve and inspect passage for leaks.

(m) Check air gauge; there must be no drop in pressure for 15 seconds; discard an unserviceable head.

(3) Cylinder heads are equipped with fuse plugs containing a metal-alloy center that melts if the engine is over- heated. Examine fuse plug for signs of overheating. If fuse plug has melted, check carefully for further damage to head and engine, and proceed as follows:

(a) Drill through center of melted plug.

(b) Tap hole with left-handed threads.

(c) Insert a screw and turn until plug breaks loose; remove screw and melted plug.

(d) Install new fuse plug.

(4) Check for loose valve seat inserts by lightly tapping head near inserts. A slight looseness may be found by tapping when head is cold and covered with film of oil.

(5) If seat area width exceeds 0.125 inch (3.18 mm) at any point and cannot be narrowed sufficiently, it is unlikely that seat can be successfully reground.

(6) Note results of hydrostatic test. Leaks indicate need for replacement of injector

sleeves. Visually check sleeves which pass pressure test, for scratches on cup seat area. If seat area is scratched, mark for replacement.

(7) Injector tip Protrusion Test. Cylinder heads that have passed the above tests must be checked further for injector tip protrusion (seat depth) and seating pattern.

(a) Lightly coat injector cup with bluing, install injector assembly into injector sleeve of head and torque to 11 to 12-foot-pounds (15 to 16 joules). Remove and check seat pattern. Bluing band must be 0.060 inch (1.5 mm) minimum in width and located approximately 15.32 inch (11.9 mm) from bottom of head surface.

(b) Measure tip protrusion with dial indicator or protrusion checking tool. Tip protrusion must be 0.045 to 0.055 inch (1.14 to 1.40 mm).

(8) Check guide outside diameter with micrometers. See tabulated data in Chapter 1 for worn replacement limits.

(9) Check guide for straightness. It should be at right angles with milled surface of head. Replace if not straight.

(10) Check crosshead guide protrusion above cylinder head. Protrusion should be 1.860 to 1.880 inch (47.24 to 47.75 mm).

(11) Check stem inside diameter (3, figure 13-43) using a small bore gauge set at 0.4402 inch (11.181 mm). Use as a "No Go" gauge to check for wear beyond replacement limit.

(12) Check for out-of-round holes. Do not use plug gauge for this operation.

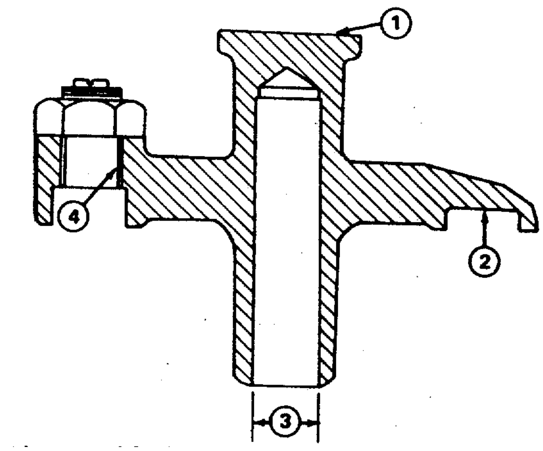


Figure 13-43. Crosshead Dimensions

(13) Visually check for excessive wear on rocker lever (1) and valve stem contact surface (2). Check adjusting screw and crosshead threads (4) for wear or distortion. Mark for replacement, if excessive wear is found.

(14) Check reamed depth of crosshead bore, minimum of 1.00 inch (25.4 mm) in depth, valve stem counterbore depth on underside of crosshead should be 0.120 to 0.140 inch (3.05 to 3.56 mm).

(15) Check valve guide inside diameter (bore) using a small bore gauge set at 0.4545 inch (11.544 mm). Use bore gauge as "No Go" gauge (refer to tabulated data in Chapter 1).

(16) Check for out-of-round holes, gauge at several points crosswise and endwise of head full length of guide. Do not use a plug gauge for this operation. Visually check valve guides for chips, cracks, or burrs. Mark for replacement any guides showing excessive wear or damage.

f. Rebuilding. Proceed as follows:

(1) Coat water passage sleeves with sealant, align sleeve in top of water passage hole, drive into position

using bushing driver and hammer.

(2) Use a flat mill file to file sleeve flush with top of cylinder head. Do not damage head surface. Remove burrs from inside diameter of sleeve, clean all cuttings and filings from water passages.

(3) If proper sleeve is not available, heavy wall copper tubing may be used. Tubing must provide 0.002 to 0.005 inch (0.05 to 0.13 mm) press fit. Overall length should be approximately 1/2 inch (12.70 mm); inside diameter must be 7/16 inch (11.11 mm) to allow proper water flow.

(4) Resurface head if it has been scratched, etched, or worn unevenly at point of contact with gasket sealing areas. Check erosion around water holes which could cause failure of head gasket to seal. If eroded, install bushings before resurfacing head.

(5) Remove 0.005 to 0.006 inch (0.13 to 0.15 mm) material at one time and no more than 0.030 inch (0.76 mm) total. Refer to tabulated data in Chapter 1.

NOTE

Waviness on mounting surface must not exceed 0.0004 inch (0.010 mm) in depth and distance between high and low points must not be closer than 1.00 inch (25.4 mm). Surface not to deviate from a true plane more than 0.0003 inch (0.008 mm) within 0.250 inch (6.35 mm) of any opening and entire surface must not deviate from true plane more than 0.004 inch (0.10 mm) T.I.R.

(6) Rework valve seat insert counterbore by removing amount of stock equal to that removed during head resurfacing operation.

(7) Sand surface of cylinder head with an orbital sander. Do not use a disc sander. Do not allow the sander to tilt or rock, since this may result in rounding of the machined edges.

(8) After resurfacing check head height, use micrometer or vernier depth gauge. Do not remove more than indicated as worn limit. See tabulated data in Chapter 1.

(9) Check exhaust ports for flatness after head has been resurfaced. Ports should not be out of plane more than 0.003 inch (0.08 mm).

(10) Install new injector sleeves to maintain correct injector tip protrusion.

(11) Check overall height of assembled valve springs to see if it is necessary to install spacers (1/16 inch (1.59 mm) maximum) under springs to obtain correct assembled height.

CAUTION

Only 1/32 inch (0.79 mm) spacer can be used if head has not been resurfaced.

(12) Drive out worn guides from underside of cylinder head.

(13) Install new guides with arbor press and mandrel.

(14) If proper valve guide mandrels are not available, press guides into head to obtain 1.270 to 1.280 inch (32.26 to 32.51 mm) protrusion above head surface.

(a) Ream valve guide from bottom side of cylinder head using a drill press and floating tool holder.

NOTE

Use lubricating oil or soluble oil and water solution for good finish.

(b) Ream valve guides with reamer to dimensions 0.4525 to 0.4532 inch (11.493 to 11.511 mm).

CAUTION

<u>Special care must be used to avoid breaking carbide tips. Sharpen tipped tools on a diamond-impregnated wheel.</u>

(15) Remove crosshead guides marked for replacement using a dowel puller.

(16) Using a crosshead guide mandrel, press new guides into cylinder head to obtain protrusion of 1.860 to 1.880 inch (47.24 to 47.75 mm).

(17) If crosshead guide bore is worn or mutilated, install oversized guides as follows:

(a) Drill guide bore in head to original depth with a 29/64-inch drill.

(b) Lubricate and ream bore with a 15/32-inch reamer.

(c) Install oversized guide until guide protrusion is 1.860 to 1.880 inches (47.24 to 47.75 mm).

(18) Remove loose or excessively worn valve seat inserts by striking insert sharply with a chisel, causing it to crack and release the press fit. Remove all inserts if head has been resurfaced.

CAUTION

<u>Cover the valve seat with a rag to avoid injury from broken pieces of the seat.</u>

(19) Enlarge counterbore to next oversize using valve seat insert cutter. Inserts are available in standard and oversizes as tabulated in Chapter 1.

NOTE

If head was resurfaced and standard inserts are to be used, deepen counterbore only.

(20) A valve seat insert tool must be used to hold and drive cutters.

(21) Cut counterbore 0.006 to 0.010 inch (0.15 to 0.25 mm) deeper than insert thickness to permit peening of head to hold insert. It is important to allow cutter to dwell for several revolutions upon reaching proper depth in order to ensure a perfectly flat surface at the bottom for the insert to seat on.

(22) Install valve seat insert and peen around insert at least five places with a 1/4 inch (6.35 mm) diameter round end punch.

(23) After checking condition of grinding equipment, grind valve seats holding seating motor as nearly vertical as possible.

(24) Check valve seat which should be 1/16 to 1/8 inch (0.159 to 3.17 mm).

(a) If seating area (2, figure 13-44) is wider than 1/8 inch (3.175 mm) maximum, stock can be removed from points "A" and "B" with specially dressed valve seat grinder stones.

(b) Narrowing should not extend beyond chamfer on seat insert. Chamfer provides for peening metal.

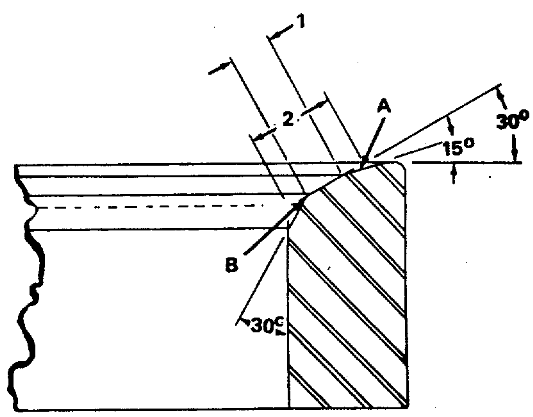


Figure 13-44. Valve Seat Insert, Cross Sections

(25) Dress wheel for final finish.

(26) Finish grind with light touches of stone against face.

(27) Check valve seat concentricity with valve seat indicator.

(a) Use valve guide as center.

(b) Total run out should not exceed 0.002 inch (0.05 mm).

(c) The gauge must be a perfect fit on pilot mandrel.

(28) Check seat with mating valve to ensure proper sealing.

(29) Test valve spring on spring tester that is capable of accurate measurements of spring lengths by means of standards listed below.

Valve spring part no.	211999
Approx. free length	2.685 in. (68.2 cm)
Assemble height	1.724 in. (42.8 cm)
Pounds (kilograms) required to compress	
New min.	147.25 (66.3)
New max.	162.75 (73.2)
Worn limit	142.0 (63.9)

(30) Spacers may be used under valve spring when insert and valve have been refaced to make valve spring check within load limit.

NOTE

A maximum of 1/16 inch (1.59 mm) spacers may be used under valve spring when head has been resurfaced and valve and seat have been refaced.

(31) If valve springs compress to dimension shown, at less than load indicated under worn limits above, valve springs should be discarded and replaced.

(32) Remove worn sleeves with a muffler sleeve cutting tool using extreme caution to prevent damage to head surfaces.

(33) Remove all foreign material from injector sleeve sealing area. Clean O-ring groove to remove all foreign material.

(34) Clean thoroughly and dry with compressed air.

CAUTION

Avoid use of cleaning compounds containing ammonia which may react with the brass sleeves.

NOTE

Machine head in sleeve seat area of head if mutilated.

(35) Install seat cutter holder and position with pilot in a drill press. Set drill press speed at not more than 75 rpm. Cutter may be turned by hand using a tap wrench.

(36) Place cylinder head on drill press table, allowing clearance for end of heat cutter to protrude below head surface into a pilot. A pilot can be made by recessing a 1/2-inch (12.7 mm) drill bushing in a plate which is centered below drill spindle and secured in place.

(37) Before starting drill press motor, insert cutter, adapter, and pilot into injector bore to ensure proper alignment.

(38) Lift cutter, adapter, and pilot, lubricate cutter with cutting oil and start cutting operation; apply a steady, moderate pressure.

CAUTION

Do not cut more than 0.010 inch (0.25 mm) deep.

(39) When proper depth has been obtained, allow cutter to dwell for approximately 10 seconds to ensure a good seat and clean grooves.

(40) Coat new O-ring with clean engine lubricating oil. Install O-ring into groove of injector sleeve bore in head.

(41) Using an injector sleeve driver, push new injector sleeve into bore of cylinder head until it bottoms. Do not strike mandrel with hammer during this step. Remove mandrel.

(42) Install an injector sleeve holding tool and tighten nut to 35 to 40 foot-pounds (47 to 54 joules) torque.

(43) Insert mandrel into sleeve bore, strike mandrel two moderate blows with hammer to ensure that injector sleeve is properly seated. Retighten injector sleeve holding tool to 35 to 40 foot-pounds (48 to 55 joules) torque.

(44) Roll top 1/2 inch (12.70 mm) area of sleeve with expanding roller. Use inch-pound torque wrench to turn mandrel until a 75 inch-pound (8.5 joules) maximum torque reading is obtained on torque wrench.

CAUTION

Over-rolling of injector sleeve will cause deformation of sleeve into O-ring groove.

(45) Cut injector seat to provide proper seat and injector tip protrusion. Use the injector sleeve cutter in a drill press with pilot, using a solid stream of good cutting oil to allow cutter to cut freely without grabbing, etc. To determine amount of cut, insert injector, and torque to specifications, then measure tip protrusion (see tabulated data in Chapter 1). Depth of cut must provide protrusion of injector cup tip beyond milled face of cylinder head, as specified in Chapter 1 under Injector Tip Protrusion, when injector is installed.

(46) Sleeve must "blue in" with Prussian Blue 360 degrees around injector seat when injector is installed in cylinder head. Bluing band must be 0.060 inch (1.52 mm) minimum width.

(47) Perform the hydrostatic test of paragraph 13-27 e (2).

(48) Using the adapter wrench, remove spark plug adapters from heads.

(49) Clean and lubricate spark plug adapter threads in the cylinder head by "chasing" with a 7/8-14 UNF tap or cap- screw coated with lubricating oil. Clean the machined O-ring seating surface in the cylinder head with fine emery paper to remove scale build-up, etc., and to ensure proper seating of the adapter O-ring.

(50) Clean spark plug adapter seating areas.

(51) Clean threads and gasket seating area of the adapter.

(52) Lubricate O-rings and O-ring seating areas in bores of heads with clean engine oil. Position new gaskets and O-rings on spark plug adapters. Screw adapters into cylinder heads and tighten to 70 to 80 foot-pounds (95 to 105 joules).

g. Assembly and Testing. Proceed as follows:

(1) Clean cylinder head, valves, springs, etc. Before assembling.

(2) Lubricate valve stem with clean engine oil and insert valves in valve guides.

(3) Place cylinder head face

down on a wooden bench or protective surface to prevent marring milled surface.

(4) Assemble lower valve spring guide over valve guides.

(5) Assemble springs, reground valve heads seat deeper in cylinder head causing valve stem to protrude further above the guide. This allows spring to extend beyond length limits and causes weak spring action. There- fore, up to 1/16 inch (1.59 mm) of spacers may be used to reduce valve spring length. See tabulated data in Chapter 1.

CAUTION

Too many spacers will cause the compressed spring to become a solid sleeve.

(6) Assemble upper valve spring retainer and use a valve spring compressor stand and compressor plate to compress valve springs. Insert new half collets.

(7) Replace all pipe plugs. Use sealing tape or lead sealer to prevent leakage. Torque plug as follows: (Torque values are given in foot-pounds followed in parentheses by the metric equivalent in joules.)

PLUG	MINIMUM		MAXIMUM	
1/8 inch	5	(7)	10	(14)
Fuse plug	5	(7)	10	(14)
3/8 inch	35	(47)	45	(61)
1/2 inch	60	(81)	70	(95)
3/4 inch	65	(88)	75	(102)
1 inch	135	(183)	145	(197)

(8) Install pipe plugs in fuel inlet and drain fittings in same position, as removed, in each cylinder head. Position and secure water header plates with new gaskets.

(9) Install an injector sleeve holding tool or a scrap injector and cup assembly in each injector sleeve. Tighten sleeve holding tool to 7 to 8 foot-pounds (9 to 11 joules) to seal lower end of injector sleeve, or install injectors and secure with capscrews torqued to same value.

(10) Test cylinder heads for leaks at 35 to 85 psi (241 to 586 kPa) using the hydrostatic tester and, if possible, at 175 to 200xF (79 to 93xC) water temperature. Check carefully around valve seats and injector sleeve seats for any cracks.

(11) Open water outlet valve of test fixture; check for free water circulation through cylinder head.

13-28. INTAKE AND EXHAUST VALVES AND SPRINGS. To service the intake and exhaust valves and springs, refer to figure 13-41, and proceed as follows:

a. Removal. Proceed as follows:

(1) Using a valve spring compressor, compress valve spring, remove half collets, retainers, springs, valve spring guides, and valves.

(2) Place valves on a numbered board for inspection.

b. Inspection.

(1) Clean valves with buffer and polish with crocus cloth.

(2) Inspect, then discard if heads are cupped, cracked, pitted, or worn too thin to regrind within limits. Check valve head rim thickness (1, figure 13-45). Discard valve if rim is less than 0.105 inch (2.67 mm).

(3) Inspect then discard if stem is scored or worn beyond worn limits; new dimensions are 0.450 to 0.451 inch (11.43 to 11.45 mm).

(4) Inspect then discard if collet recesses are worn so new collets will not fit securely in recesses.

c. Testing. Refer to paragraph 13-27 f (29) for spring testing.

d. Repair. Repair by replacing any worn or damaged valves and springs, as determined in paragraph b and c above.

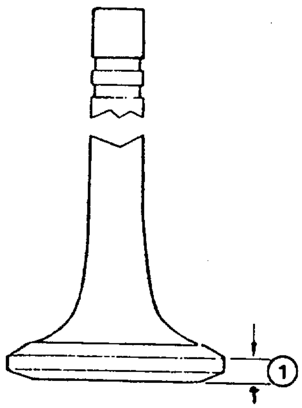


Figure 13-45. Minimum Valve Head Rim Thk.

e. Installation.

(1) Lubricate valve stem with 140W lubricating oil and insert valve into valve guide.

(2) Place cylinder head face down on a wooden bench or protective surface to prevent marring of milled surface.

(3) Assemble lower valve spring guide over valve guide.

(4) Assemble springs. Install, if required, up to 1.16 inch (1.59 mm) of spacers to reduce valve spring length.

(5) Assemble upper valve spring retainer. Compress valve springs and install new half collets.

13-29. INTAKE AND EXHAUST VALVE SEATS. Refer to paragraph 13-27 for procedures covering inspection and replacement of the intake and exhaust valve seats.

13-30. CYLINDER HEAD. Refer to paragraph 13-27 for procedures covering inspection, replacement, overhaul, and rebuilding of the cylinder head.

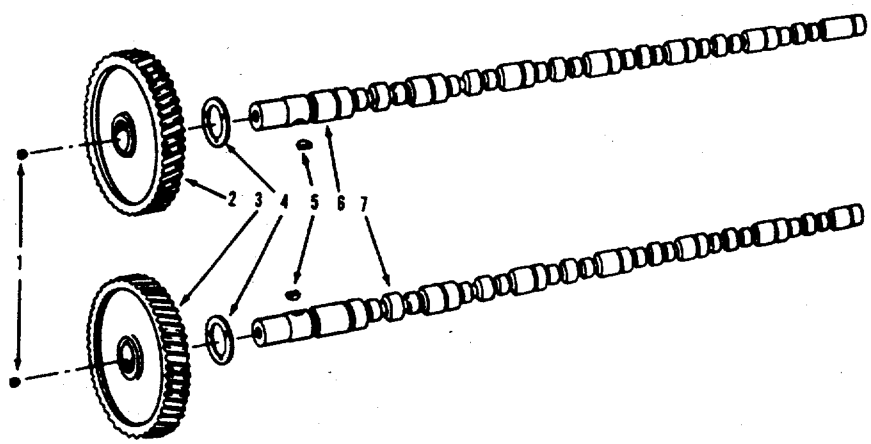
13-31. VALVE LIFTERS. Refer to paragraph 13-25 for inspection and replacement of the valve lifters (levers).

13-32. CAMSHAFT. Refer to figure 13-46 and proceed as follows:

a. Removal.

(1) Remove push rods and tappets as specified in paragraph 13-26.

(2) Remove gear cover as specified in paragraph 13-23.



LEGEND

1. Plug
2. Gear
3. Gear
4. Washer
5. Key
6. Camshaft
7. Camshaft

Figure 13-46. Camshafts, Exploded View

(3) Lift and rotate camshaft slightly while pulling from block.

(4) Tag camshaft to identify left-bank or right-bank.

b. Inspection.

(1) Check camshaft bushing journals with micrometer. Replace camshaft if journals are worn beyond 2.120 inches (53.85 mm).

(2) Replace camshaft that has scuffed, scored, or cracked injector valve lobes.

c. Installation.

(1) Apply clean engine lubricating oil to camshaft journals and lobes. Carefully rotate camshaft through bores into position.

(2) Slide the camshaft into position with two "0" marks on camshaft gear aligned with "0" marks on side of timing gear.

(3) Attach a dial indicator to gear case. Place indicator to gear case. Place indicator arm on camshaft gear teeth.

(4) Rotate gears by hand to advance position; "zero" indicator. There must be a minimum of 0.003 inch (0.08 mm).

Section VIII. PISTON AND.RINGS

13-33. PISTON CONNECTING RODS, CONNECTING ROD BEARINGS, PISTON PINS, AND RINGS. To inspect and replace the pistons and connecting rods, refer to figure 13-47 and proceed as follows:

a. Removal.

(1) Clean all carbon from upper inside wall of each cylinder liner with ridge reamer and fine emery cloth.

(2) Remove connecting rod bolt nuts (2) and washers (3).

(3) Pull caps (7) and bearing shells (5) from connecting rods.

(4) Tape bearing shells together and label each pair by cylinder number for later reference.

(5) Using a soft hammer, drive rod bolts (4) from rods.

CAUTION

Do not mutilate inner walls of cylinder liners.

(6) Push connecting rod and piston assembly from cylinder liners with a wooden stick, holding pistons so they will not be lost or damaged.

(7) Reassemble each connecting rod cap to assembly as it is removed; the rod caps are not interchangeable. Label each assembly by cylinder number.

NOTE

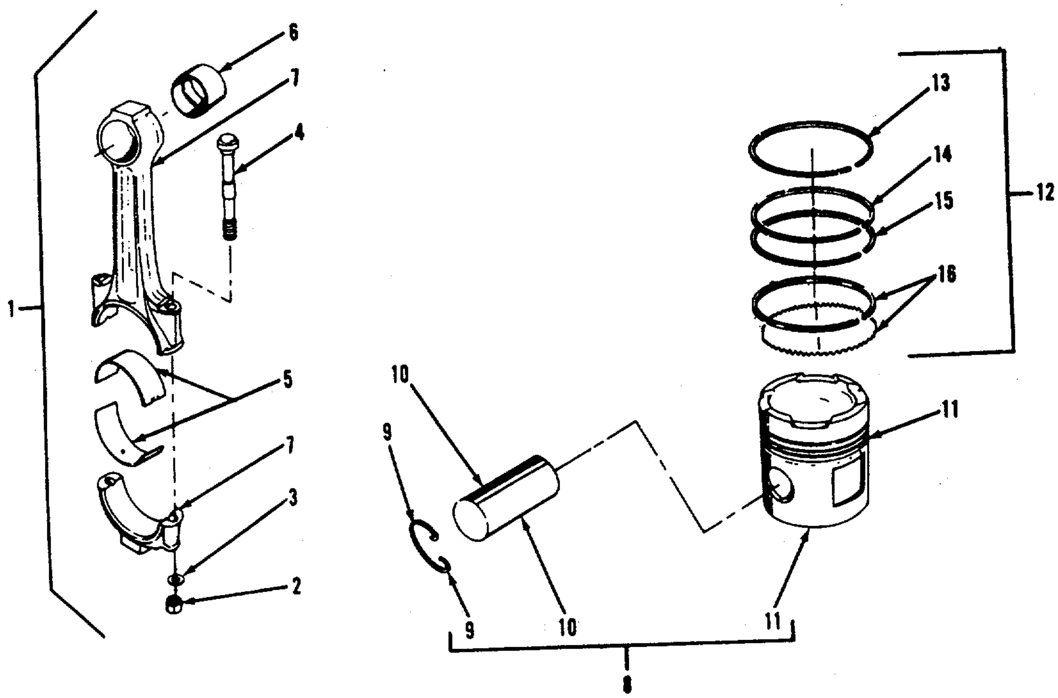
Rods and caps are matched assemblies; as removed make sure parts are stamped, so they can be reassembled correctly. Phase 3 rods are stamped 1/4 inch (6.4 mm) either side of the bolt hole centerline. If a new assembly is used, be sure to stamp before installing in engine.

(8) Remove piston snap rings (9).

(9) To facilitate removal of piston pins (10), first heat piston in boiling water, then push pin from piston, using finger pressure. Do not drive or otherwise force pin from piston.

(10) Remove piston rings (13, 14, 15, and 16).

(11) Remove cylinder liners from



LEGEND

1. Connecting rod assy	6. Bushing	11. Piston
2. Nut	7. Connecting Rod	12. Ring set
3. Washer	8. Piston assy	13. Ring
4. Bolt	9. Ring	14. Ring
5. Bearing	10. Pin	15. Ring
		16. Ring

Figure 13-47. Piston and Connecting Rod, Exploded View

block using a cylinder liner puller and a puller bridge.

b. Inspection. Proceed as follows:

(1) Cylinder liners.

(a) Check for cracks just under top flange, at bottom of liner, and above top seal ring groove.

(b) Discard and replace any liner with excessive corrosion or erosion and pits 1/16 inch (1.59 mm) deep or more, or if dents, pitting, or fretting on underside of liner flange cannot be removed by lapping.

(c) Check worn liners with dial bore gauge. Replace if worn more than worn limit specified in Chapter 1.

(d) Deglaze cylinder liner walls. Used liners only.

(2) Connecting rod bearing.

(a) Gauge shell with ballpoint micrometer, dial indicator thickness gauge, or comparator. Discard shells if they are worn more than

0.001 inch (0.03 mm) or if chipped, flaked, or scored. See tabulated data in Chapter 1 for shell thickness.

(b) Total worn maximum oil clearance should not vary more than 0.001 inch (0.05 mm) between adjacent main bearings. Refer to tabulated data in Chapter 1.

NOTE

Under no circumstances should an attempt be made to scrape bearing shells, nor should they be lapped or filed to increase oil clearances. A properly fitted bearing will appear dull gray after a reasonable period of service, indicating it is running on an oil film. Bright spots indicate metal-to-metal contact and black spots indicate excessive clearance.

(3) Connecting rods.

(a) Magnaflux all connecting rods, caps and bolts; discard if cracks are detected.

NOTE

Be sure rod and cap are mated at all times.

(b) Check rods for cracks with 1800-ampere current AC equipment or 1500-ampere current DC or rectified AC equipment longitudinally between plates.

(c) Check rods for cracks with 3000 to 3400 ampere-turns with AC equipment or 2600 to 2800 ampere-turns with DC or rectified AC equipment in a coil.

NOTE

Ampere-turns is defined as the amperage flowing through the coil, multiplied by the number of turns in the coil. Most coils contain four turns and therefore only 700 amperes need to be applied with DC equipment, or, 850 amperes with AC equipment.

(d) Apply 1.5 percent wet solution while current is on. Make visual inspection after each application of current.

(e) Assemble cap to rod and alternately tighten nuts to operating tension by torque method as specified in Chapter 1.

(f) Check crank pin bore with a dial bore gauge or inside micrometers. Correct size is important to provide correct bearing crush. New dimension after rod separations are 4.0018 to 4.0028 inch (101.646 to 101.671 mm).

(g) Check piston pin bushing diameter with plug gauge or with inside micrometers. Refer to tabulated data in Chapter 1.

(h) Use rod checking fixture and locating mandrel to check rod alignment.

NOTE

Difference in reading should not exceed 0.015 inch (0.38 mm).

(i) Check connecting rod bolts, bolt holes, and bolt pads. The bolt head must rest squarely on milled surfaces of the rod.

(j) If connecting rod bolts have been tightened excessively, they may be permanently stretched, in which case they must be discarded. Discard bolt if smallest diameter is less than 0.540 inch (13.72 mm).

(k) Check bolt pilot OD; discard bolt if pilot is smaller than 0.6242 inch (15.855 mm).

(l) Discard all bolts and

nuts that have distorted threads.

(m) Check bolt hole diameter. If diameter exceeds 0.6249 inch (15.872 mm), discard rod.

(n) Check bolt pad radius.

(4) Piston rings.

(a) New rings should be checked in cylinder liner in which they are to be used to make sure the gaps are correct.

(b) Insert each ring in mating cylinder liner; position with head of piston so it is seated squarely in ring travel area of liner.

(c) Measure ring gap with a feeler gauge. Gap should fall within limits specified in Chapter 1.

(d) Do not file or stone chrome-plated rings; be certain top and intermediate rings are installed in chrome plated cylinder liners.

(5) Piston and piston pin.

(a) Check top and second piston ring grooves with a segment of new ring and a feeler gauge. Hold ring in groove, flush with land and insert 0.006 inch (0.15 mm) feeler gauge; if gauge enters groove without forcing or disengaging ring, wear is excessive and piston should not be used.

(b) Measure piston skirt diameter with a micrometer at right angle to piston bore (A, figure 13-48 for the barrel-ground pistons), measure straight or tapered ground pistons at point B, 1 inch (25.4 mm) below ring groove and C, 1 inch (25.4 mm) above bottom of piston. Pistons should not be reused if worn more than indicated in Chapter 1.

(c) Pistons should be checked at room temperature of 70 to 90°F (21 to 32°C); refer to tabulated data in Chapter 1.

(d) Piston pin bore check at 70°F (21°C) should fall within limits specified in table 13-2; add 0.005 inch (0.013 mm) per 10°F (-12°C) up to 90°F (32°C).

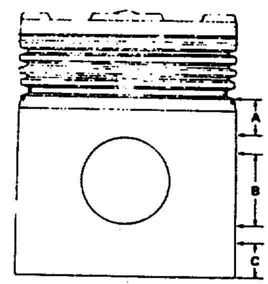


Figure 13-48. Piston Check Points

(e) Check piston pin outside diameter with micrometer. Pins should not be reused if out-of-round more than 0.001 inch (0.03 mm) or worn smaller than indicated in Chapter 1.

c. Installation. Refer to figure 13-47 and proceed as follows:

(1) Insert one snap ring (9) in piston pin bore.

(2) Heat piston in water or an oven to 220°F (104°C) for 5 minutes.

(3) Insert piston pin (9) through piston and rod by hand. Lock pin in place with second snap ring.

(4) Assemble rings to pistons

with word "top" at top.

(5) Lubricate pistons, rings, and cylinder liners with clean lubricating oil.

(6) Using a standard hand-type ring compressor to compress rings, insert piston and rod assembly in liner from bottom of liner.

(7) Assemble new O-ring packings and crevice seals on cylinder liner as follows:

NOTE

To prevent swelling of O-rings, lubricate lightly with clean engine lubricating oil, just prior to installation.

(a) Roll black O-ring with one yellow mark into position in upper groove. Install the red silicone O-ring with two blue marks in lower groove.

(b) Check for twisted O-ring in grooves using mold mark on rings as guide, straighten as required.

(c) Install new crevice seal on liner.

(8) Lubricate machined portions of block, on which packing rings seat, with clean lubricating oil.

CAUTION

<u>Never use white lead for lubricant. White lead will harden and make cleaning difficult at next engine teardown.</u>

(9) Lift liner, piston and rod assembly and slide into cylinder liner bore. Numbers on connecting rods must be toward outside of engine. Connecting rods and caps are numbered to correspond with their respective cylinders; numbers on rods and caps must be matched. Two rods are assembled on each crank journal.

CAUTION

If liner is difficult to push down, the packing rings may be twisted or have slipped. Remove liner to check rings; use extreme care to avoid twist or cut of O-rings.

(10) Drive liners to seat with cylinder liner driver; when liner is near seat, tap gently to prevent bouncing off seat as liner is driven in place.

(11) With piston at lowest possible point, check liner bore for roundness at several points within range of piston travel. See figure 13-49.

(a) Check with precision dial bore gauge.

(b) Micrometer readings to be taken as near points C, D, E, F, and G along axis A-A and B-B.

(c) At point C, approximately 1 inch (25.40 mm) below top of liner, it is permissible to have up to 0.003 inch (0.08 mm) of out-of-round.

(d) At other points, each about 2 inches (50-80 mm) lower than preceding depth, out-of-round must not exceed 0.002 inch (0.05 mm).

(12) Check liner protrusion at four equidistant points with a gauge block to determine if protrusion is uniform and 0.004 to 0.006 inch (0.10 to 0.14 mm) above block.

(13) Lubricate crankshaft side of bearing shells with a thin coat of clean engine lubricating oil. Slide upper connecting rod bearing shells into position between the crankshaft journals and rods. Be certain bearing shell locating tang makes firm contact with the recesses in the rod.

(14) Place lower connecting rod

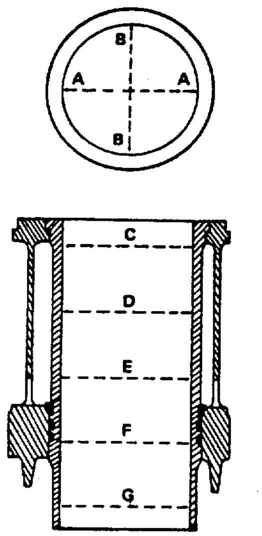


Figure 13-49. Cylinder Liner Check Points

bearing shells in connecting rod caps. The locating tang on the shell must index with milled recess in cap. Numbers on rod and cap must match (1 to 1, 2 to 2, etc.) and must be toward outside of their respective banks and must indicate proper position in cylinder block: IL for left bank, IR for right bank, etc. Stamp if new rod is being used. This provides proper clearance between rod crankpin end chamber and crankshaft rod journal fillet.

(15) Completely lubricate bolt threads with engine lubricating oil. Lubricate hardened washers and bolt head mating surface with SAE 140-W lubricant.

(16) Assemble caps and bearing shells over rod bolts and install washers and nuts.

(a) Tighten connecting rod bolt nuts alternately to 70 to 80 foot-pounds (95 to 108 joules).

(b) Tighten the nuts on each connecting rod alternately to 140 to 150 foot pounds (190 to 203 joules).

(c) Completely loosen both nuts on each connecting rod to relieve all tension.

(d) Tighten the nuts on each connecting rod alternately to 70 to 80 foot-pounds (95 to 108 joules).

(e) Tighten the nuts on each connecting rod alternately to 140 to 150 foot-pounds (190 to 203 joules).

(f) The breakaway torque in tightening direction should be 140 to 180 foot-pounds (190 to 244 joules).

(17) Check for clearance of 0.008 to 0.022 inch (0.20 to 0.56 mm) between rod assemblies located on same journal. Rods should move freely sideways with hand pressure. Also check position of rod on piston pin and make sure there is visible clearance between rod and piston boss. This is extremely important to prevent scoring or seizing of piston and liner.

(18) Turn crankshaft as each piston and rod assembly is added to gauge additional drag. Increase will be perceptible but must not be excessive for any one rod assembly.

Section IX. CRANKSHAFT AND BLOCK

13-34. CYLINDER LINERS, MAIN BEARINGS, CRANKSHAFT, CAMSHAFT BUSHINGS, AND CYLINDER BLOCK. To replace and inspect these components, refer to figure 13-50 and 13-51, and proceed as follows:

a. Removal.

(1) Refer to paragraph 13-33 for cylinder liner replacement and inspection instructions.

(2) Remove 14 side bolts (33, figure 13-50) and washers (34) from each side of block (39) securing main bearing caps (38) to side of block.

(3) Remove main bearing capscrews (35 and 36) and remove and discard lockplates (37).

(4) With a small prybar, loosen each main bearing cap (38). When caps are free, lift caps from block.

(5) Remove lower thrust washers (19, figure 13-51) from each side of rear main bearing.

(6) Remove lower bearing shells (11, 13, 15, and 17) from crankshaft or cap and remove upper thrust washers (19). Tag and tape thrust ring halves together to prevent damage.

(7) Using a chain hoist with rubber-covered hooks to protect bearing surfaces, lift crankshaft from cylinder block. Remove upper bearing shells (12, 14, 16, and 18).

WARNING

OVERHEAD OPERATIONS HAVE INHERENT HAZARDS THAT CANNOT BE MECHANICALLY SAFEGUARDED. HARD HATS AND SAFETY SHOES ARE REQUIRED.

NOTE

Replace bearing caps in same position as removed. Main bearing caps are not interchangeable. Tape corresponding upper and lower bearing shells together and number by position removed.

(8) Using a camshaft bushing drive remove the camshaft bushings (23, figure 13-50).

b. Inspection.

(1) Cylinder Liners. Refer to paragraph 13-33 for cylinder liner inspection procedure.

(2) Main Bearings. Gauge shell with a ball-point micrometer, dial indicator thickness gauge, or comparator. Discard shells that are worn more than 0.001 inch (0.03 mm) or if chipped, flaked, or scored. Refer to tabulated data in Chapter 1.

(3) Crankshaft. Proceed as follows:

(a) If crankshaft gear is chipped, cracked, broken, or worn, replace gear.

NOTE

If crankshaft gear condition is satisfactory, do not remove gear.

(b) Attach a circular-type puller behind the crankshaft gear.

(c) Apply 75 to 100 foot- pounds (102 to 136 joules) on puller screw.

LEGEND FOR FIGURE 13-50

1. Liner
2. O-ring
3. Seal
4. O-ring
5. Drain cock
6. Coupling
7. Tube
8. Elbow
9. Valve
10. Elbow
11. Tee
12. Nipple
13. Bushing
14. Shaft
15. Screw
16. Screw
17. Plug
18. Plug
19. Bypass spring
20. Disc
21. Drain cock
22. housing
23. Bushing
24. Plug
25. Dowel
26. Dowel
27. Plug
28. Screw
29. Lockwasher
30. Washer
31. Nozzle
32. Plug
33. Bolt
34. Washer
35. Capscrew
36. Capscrew
37. Lockplate
38. Cap
39. Block

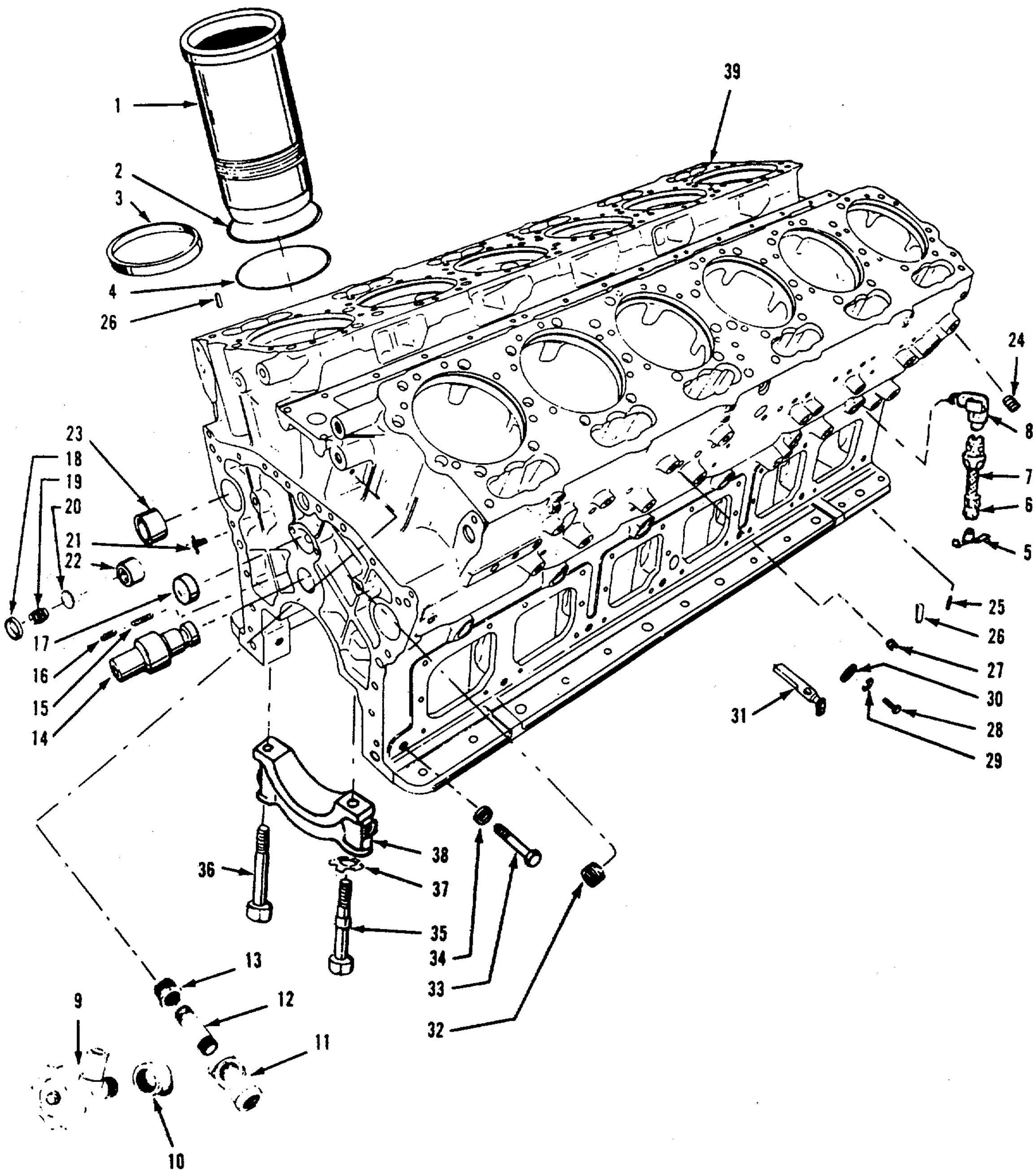


Figure 13-50. Cylinder Block, Exploded View

(d) Heat gear with heating torch (not a 8utting torch) to 400°F (205°C). The gear will expand, making it easier to pull. Remove gear key.

(e) Inspect crankshaft visually for scratches, nicks, cracks, and obvious wear pattern.

(f) Measure crankshaft journals with micrometers. Refer to tabulated data in Chapter 1.

(g) Check crankshaft for out-of-round condition. Crankshafts should be replaced if main bearing or crankpin journals are worn out-of-round more than 0.001 inch (0.05 mm).

(h) Measure and carefully examine crankshaft thrust flange at No. 7 main bearing; refer to tabulated data in Chapter 1. If surfaces are scored or scratched, crankshaft should be replaced.

(4) Camshaft Bushings.

(a) Use inside micrometers or dial bore gauge to measure camshaft bushing inside diameter. Mark bushings for replacement if worn larger than worn limit specified in Chapter 1.

(b) Check for chipped, scored, or scratched surfaces.

(c) If bushings show signs of turning, in block bore, check block bore sizes. Refer to tabulated data in Chapter 1.

(5) Cylinder Block.

(a) Use dye penetrant method for locating cracks, porosity, leaks and other faults. Clean suspected defective area with kerosene or other grease-removing cleaner.

(b) Apply dye penetrant allowing time for it to dissolve or enter in the defect. Allow approximately 15 minutes for dye to act. Do not "force" dry. Remove all excess penetrant and apply developer so defect will stand out. Cracks usually show up as a solid or dotted line. Porosity usually shows up as dots in local area.

(c) Check for signs of corrosion. Corrosion most frequently occurs on portions of block nearest cylinder liners and is evidenced by pitting.

c. Repair. To repair the cylinder block, proceed as specified in the following paragraphs:

(1) Tappet Bores.

(a) Measure tappet bores with a small bore gauge.

(b) If worn beyond limit specified in Chapter 1 or out-of-round more than 0.0015 inch (0.038 mm), replace cylinder block.

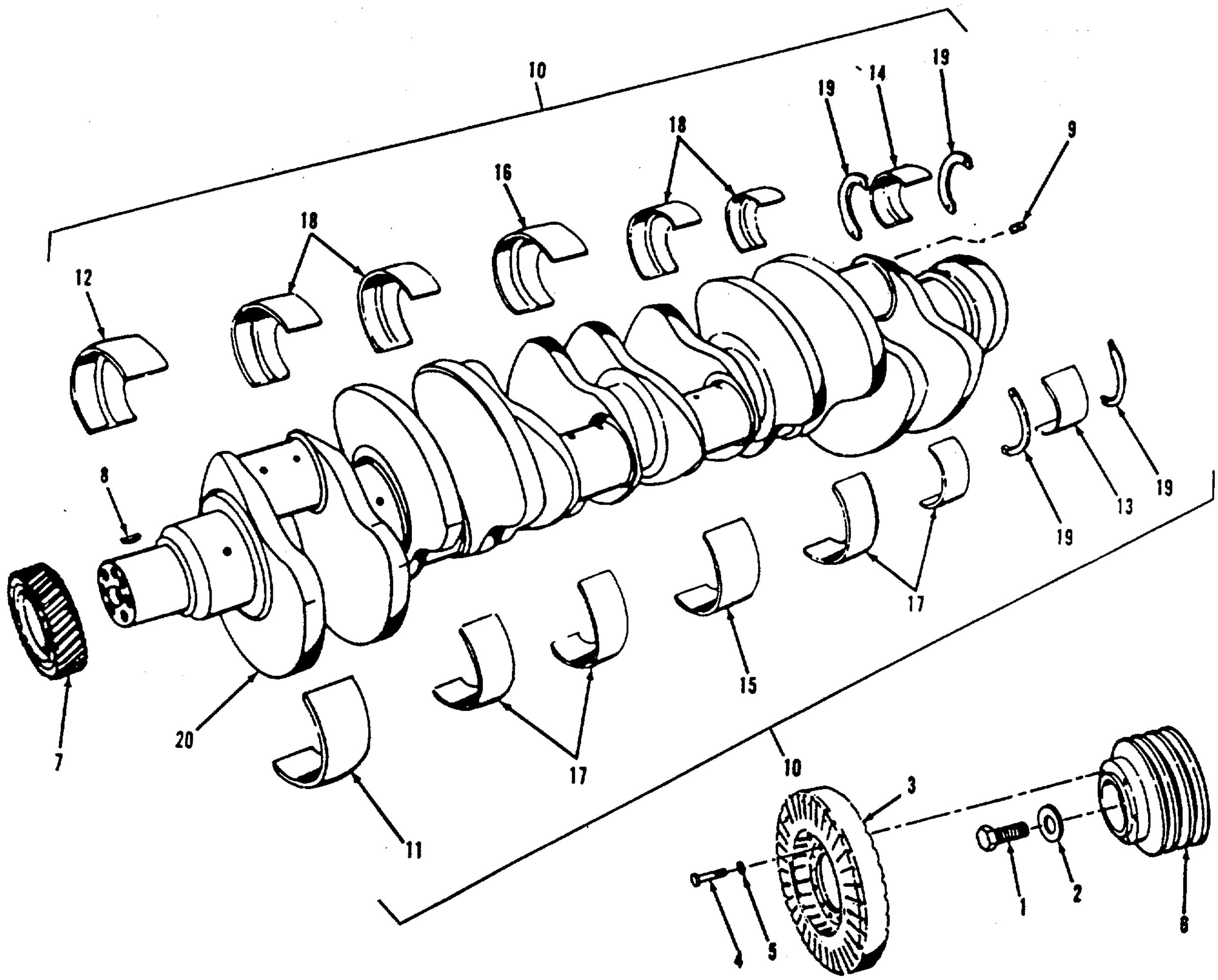
(2) Idler Gear Shaft.

(a) Replace idler gear shaft if worn smaller than 1.9965 inch (50.711 mm).

(b) Remove outer screw (16, figure 13-50) from left side of idler shaft boss; then remove screw (15) which secures shaft in cylinder block.

(c) Using a suitable puller, pull idler shaft (14) from block.

(d) Place new idler shaft in block bore and drive



LEGEND

1.	Screw	6.	Pulley	11.	Shell	16.	Shell
2.	Washer	7.	Gear	12.	Shell	17.	Shell
3.	Damper	8.	Key	13.	Shell	18.	Shell
4.	Screw	9.	Plug	14.	Shell	19.	Washer
5.	Washer	10.	Bearing	15.	Shell	20.	Crankshaft

Figure 13-51. Crankshaft, Exploded View

shaft into cylinder block until it seats on shoulder.

(e) Install screw (15) to secure idler shaft in cylinder bloc; install screw (16) in boss.

(3) Camshaft Bushing Bore in Block.

(a) If camshaft bushing bore in block is damaged, first determine cause of damage and correct. Bore may then be repaired installing a sleeve as follows:

(b) Pilot boring bar in two good camshaft bushing bores either fore or aft of one being repaired.

(c) Cut piece of 2-1/2 inch (63.50 mm) OD seamless steel tubing with 1/8 inch (3.17 mm) wall to length of bore in block. Chamfer one end to facilitate installation.

(d) Measure OD of tubing.

(e) Perform boring operation. Bore must be 0.002/0.005 inch (0.05/0.13 mm) smaller than tubing OD to provide press fit.

(f) Remove boring bar and carefully clean block to remove all shavings.

(g) Apply a thin coat of Permatex to tubing OD and block bore ID to prevent galling during installation and to provide a tighter press fit.

(h) Install tubing with short mandrel to prevent collapsing. Mandrel must have shoulder on drive end.

(i) Pin sleeve with 1/16 inch-27NPTF x 1 inch pipe plug or soft steel pipe plug through side wall of block or through camshaft bushing bore. Stake plug.

(j) Reinstall boring bar and bore sleeve to 2.2535/2.2545 inch (57.239/57.264 mm) ID. Remove bar and clean all shavings from block.

(k) Install bushings.

(4) Tappet Guide Screw Holes. Tappet guide screw threads may be repaired using heli-coil inserts.

(5) <u>Main Bearing Cap Sidebolt Hole Repair</u>.

NOTE

This procedure cannot be followed in off-centered holes due to thin-wall construction.

(a) Drill out stripped or damaged threads with a 53/64 inch drill (0.83 mm) to 1.000 to 1.150 inch (25.40 to 29.21 mm) deep.

(b) Countersink 0.885 to 0.895 inch (22.48 to 22.73 mm) diameter by 86-degree angle.

(c) Tap hole with 7/8-14 UNF-2B tap to 0.800 to 0.900 inch (20.32 to 22.86 mm) deep.

(d) Install heli-coil insert.

(e) Screw in insert finger tight; locking tangs will automatically stop insert.

(f) For proper engagement, visually check insert flush or below surface of cap.

(g) Secure in position by driving heli-coil insert down flush with cap surface by lightly tapping.

(6) <u>Top Surface Refinishing</u>.

NOTE

If necessary, a cylinder block may be salvaged by removing a maximum of 0.010 inch (0.25 mm) of material from the top surface.

(a) Use either a milling machine or large surface grinder; locate block on main bearing pads.

(b) Remove dowels from head mounting surface and make light cuts of 0.001 to 0.003 inch (0.03 to 0.08 mm) deep, removing only enough material to make block usable.

(c) Check distance from centerline of main bearing to top of block (1, figure 13-52). Refer to tabulated data in Chapter 1 for dimensions.

(d) Finish surfaces to 125 rms.

(e) Resurface counterbore to obtain proper linear protrusion. Check liner to block contact in crevice seal area.

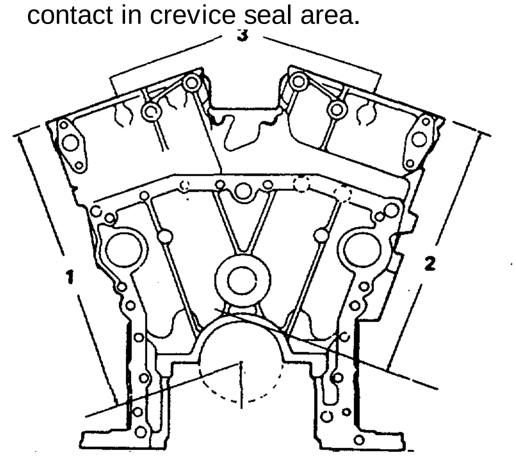


Figure 13-52. Cylinder Block Height Checking Location

(7) Cylinder Head Capscrew Threads.

(a) Drill out old threads with 23/31 inch drill to a depth of 1-7/8 inch drill to a depth of 1-7/8 inches (47.63 mm) from the cylinder block top surface.

(b) Tap drilled hole to a depth of 1-3/4 inch (44.45 mm).

(c) Install heli-coil insert with inserting tool until it is 1/2 inch (12.70 mm) below top surface. Break off insert tang using a punch and hammer, not an inserting tool.

d. Overhaul and Rebuilding of Cylinder Block. Proceed as follows:

(1) Cylinder Liner Counterbore.

(a) Check upper liner counterbore and remove burrs and dirt so liner will enter cylinder block without distortion. If counterbore exceeds limits listed in Chapter 1 for the top 0.400 inch (10.16 mm) depth, mark block for counterbore repair. The counterbore ledge must be smooth and perpendicular to the liner bore to within 0.005 inch (0.13 mm) total indicator reading. Use straightedge to check flatness of top of block.

(b) Check counterbore depth so installed liner will be assembled to correct protrusion and to determine if refinish of counterbore surface is necessary. Depth of counterbore in a new block is listed in Chapter 1. If worn to or beyond limit, the cylinder block must be salvaged. If worn less than worn limit, the surface can be refinished and shims installed under the cylinder liner to restore proper protrusion. Refinished counterbore radius must be 0.025 to 0.30 inch (0.63 to 0.76 mm).

(c) Installed cylinder liners must protrude 0.003 to 0.006 inch (0.08 to 0.15 mm) above block. To check for proper protrusion without installing a liner, proceed as follows:

1. Measure liner flange outside bead with micrometer. Do not include bead on top of liner flange in taking measurement.

2. Measure block counterbore

depth with dial indicator depth gauge. Always measure counterbore depth on ledge at the edge of liner bore.

3. Check depth at four equidistant locations. Ledge must not be "cupped" more than 0. 0014 inch (0. 036 mm). Depth must not vary more than 0. 001 inch (0. 03 mm) throughout counterbore circumference.

4. Counterbore must always be resurfaced if it slants downward toward the center or if dimensions do not meet standards.

5. Subtract counterbore depth from liner flange thickness to determine amount of shims and depth of counterbore cut that must be used to provide 0.004 to 0.006 inch (0.10 to 0.15 mm) liner protrusion; 0.007 inch (0.18 mm) shims are thinnest available.

(d) The most accurate method of checking protrusion is as follows:

1. Install liner in block with proper number of liner shims beneath the flange. Shims are available from 0.007 to 0.068 inch (0.18 to 1.73 mm). Use cylinder liner hold-down tool. Tool should be spaced so even load is applied.

2. Use gauge block and check liner protrusion above the cylinder block at four equidistant points outside the bead. Add or remove shims beneath the liner flange as needed to reach 0.004 to 0.006 inch (0.10 to 0.15 mm) protrusion.

3. With lines installed, check for out-of-round.

(2) Cylinder Liner Lower Bore.

(a) Install a new cylinder liner in the block without packing rings or crevice seal.

(b) Desirable clearance between liner and block should be as listed, but liner contact with block is permissible as long as it does not cause liner out-of-round.

(c) If clearances do not fall within limits, recheck after counterboring; limits do not apply with cylinder head installed and tightened to operating torque. If clearance is not correct, check lower block packing ring bore inside diameter.

(d) Lower liner bore concentricity should be checked with concentricity gauge. If a piston seizure has occurred or after counterboring the cylinder block, check the counterbore to lower cylinder liner bore concentricity. Liner bore should be concentric within 0. 005 inch (0. 13 mm) total indicator reading.

(3) Main Bearing Bore.

(a) Assemble main bearing caps to block in operating position. Tighten capscrews to operating tension.

(b) Gauge main bearing bores horizontally, vertically, and diagonally with dial bore gauge or properly adjusted micrometers. Refer to tabulated data in Chapter 1 for dimensions.

NOTE

A boring tool may also be used to check main bearing bore alignment. If it is definitely determined that a main bearing cap has been distorted, mark block for reaming.

(4) Installation of Brass Sleeve using Boring Bar. Proceed as follows:

NOTE

The OD of brass sleeve 163401 is approximately 0.012 inch (0.30 mm) larger than recommended bore. This press fit is sufficient interference to hold sleeve in place.

(a) Bore block as shown in figure 13-53 and to dimensions as follows:

1. Bottom of block bore (11) is 6.361 to 6.363 inch (161.57 to 161.62 mm) diameter, to block deck (1) is 8.565 to 8.585 inch (127.55 to 228.06 mm).

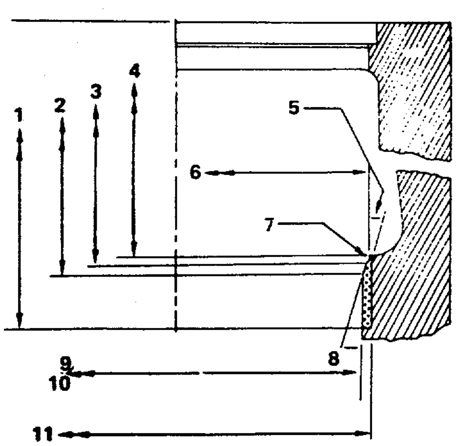


Figure 13-53. Sleeve and Block Boring Dimensions 13-102

2. The 20-degree chamfer (5) in block is 0.010 to 0.020 inch (0.25 to 0.51 mm).

(b) Clean all chips from block.

(c) Mix sealer of three parts glycerine to one part litharge to a smooth paste.

(d) Wipe bore with a clean cloth and apply sealer.

(e) Sleeve is larger than top bore. Place OD of sleeve against top of bench and press out-of-round just enough to push through bore.

(f) Turn sleeve in cylinder bore so OD chamfer is down.

(g) Provide a driver which closely pilots sleeve and with clearance flats on outside diameter.

(h) Index driver so flats will allow it to pass through top bore and place driver on sleeve.

(i) Turn so driver is on bottom and press sleeve over driver by using a wooden hammer handle or equivalent. This is slightly difficult due to limited space.

(j) Coat OD of sleeve with sealer.

(k) Position driver and sleeve in chamfered edge of bore.

(l) Place driver extension in driver; make sure sleeve is centered in bore and tap lightly on extension to seat driver in sleeve and start sleeve into bore.

(m) Drive sleeve into bore of block until it bottoms in bore with a heavy hammer or use a hydraulic ram.

(n) Should driver stick in sleeve due to interference, a cylinder liner puller can be used to pull driver.

(o) Bore sleeve inside diameter as shown in figure 13-53 and to dimensions as follows:

1. Bottom of sleeve (8) 20-degree chamfer to (2) block deck 7.314 to 7.326 inch (185.78 to 186.08 mm).

2. Top of sleeve 20degree chamfer to (3) block deck is 7.265 to 7.285 inch (184.53 to 185.04 mm).

3. Bottom of sleeve (7) 0.040 to 0.060 inch (1.02 to 1.52 mm) radius to block (4) deck 7.187 inch (182.55 mm) maximum.

4. Top of sleeve (7) radius is 0.040 to 0.060 inch (1.02 to 1.52 mm) (6) diameter 6.250 to 6.260 inch (158.75 to 159.00 mm).

5. Sleeve (9) bore diameter is 6.124 to 6.126 inch (155.55 to 155.60 mm) to a (10) depth of 8.850 to 8.875 inch (224.79 to 225.42 mm).

(p) Remove boring bar from bore. Use fine emery cloth to break sharp corners in entrance of bore so rubber packing rings will not be damaged when liners are installed.

(q) Clean bore thoroughly to remove all emery dust and boring chips. Blow dry with compressed air and coat machined surfaces with engine lubricating oil.

(r) After boring and sleeve installation check alignment as described in paragraph d(2).

(5) Cylinder Liner Counterbore. Resurface cylinder liner counterbore if block has been resurfaced, ledge is uneven or where liner protrusion is incorrect.

(6) Oil Control Valve. If oil control valve housing has been removed from bore, located between oil drillings in front center of block, install housing as follows:

(a) Scribe a centerline on the boss perpendicular to the bored hole, using the capscrew holes as locators.

(b) Align the scribe-line on the oil control valve housing; align the two oil passage holes with those in cylinder block. Press housing into the bore until it is flush to 0. 020 inch (0. 51 mm) below the cylinder block face.

(c) Insert oil control bypass disc and spring into valve control housing.

(d) Position expansion plug over spring and into bore.

(e) Drive expansion plug into housing bore with plug driver until flush with housing surface.

e. Reassembly. To reassemble the cylinder block and components, refer to figures 13-50 and 13-51 and proceed as follows:

(1) Refer to paragraph 13-33 for

cylinder sleeve installation.

(2) Be certain crankshaft, main bearing shells, and block main bearing bore are clean. Place all upper main bearing shells in position in block; locate in place with tang. Upper shells have oil holes in center that align with oil passages in block leading to oil header.

(3) Lubricate crankshaft journals and upper main bearing shells with a thin coat of clean engine lubricating oil.

(4) Using a suitable chain hoist and hooks protected by rubber hose, carefully lower crankshaft into position.

(5) Slide upper thrust washers (19, figure 13-51) in position around No. 7 journal. Lower thrust rings are dowelled to main bearing caps and hold upper rings in position.

NOTE

Thrust rings are available in 0. 01 inch (0. 25 mm) and 0. 020 inch (0. 51 mm) oversizes for reconditioned crankshafts.

(6) Place lower main bearing shells (11, 13, 15, and 17) in caps and engage locating tangs. Lubricate with a thin coat of clean engine lubricating oil.

(7) Install main engine bearing caps so numbers stamped on cap correspond with numbers stamped on block.

NOTE

The cylinder block is precision machined for the cap to fit into its correct position. Never file caps to reduce bearing clearance. Main bearing caps are not interchangeable.

(8) Install new lockplates (37, figure 13-50) (base "L" of lockplate down over cap to outside wall of engine). Lubricate lockplates (37), and capscrews (35 and 36) with clean engine lubricating oil.

CAUTION

All main bearing capscrews on right bank (fuel pump side) except No. 7 are dowel fit.

(9) Torque each capscrew in alternate steps as follows, and secure lockplates.

(a) Start capscrews by hand.

(b) Tighten both capscrews on each cap alternately to 200 to 210 footpounds (271 to 285 joules).

(c) Tighten both capscrews on each cap alternately to 410 to 420 foot-pounds (556 to 570 joules).

(d) Loosen both capscrews to remove all tension.

(e) Tighten both capscrews on each cap alternately to 200 to 210 footpounds (271 to 285 joules).

(f) Tighten both capscrews on each cap alternately to 420 to 460 footpounds (271 to 285 joules).

(g) The breakaway torque in the tightening direction is 420 to 490 foot-pounds (570 to 666 joules).

(10) Test crankshaft for free turning. Operation must be free enough so it can be hand cranked easily.

(11) Attach a dial indicator gauge securely to cylinder block with contact point of gauge resting on crankshaft flange and face.

(12) Move crankshaft toward front

of engine, taking up all end play, and set gauge at zero. The crankshaft must move freely.

(13) Move crankshaft toward rear of engine. The gauge should indicate 0.006 to 0.013 inch (0.15 to 0.33 mm) end clearance for a new engine, or an engine with new crankshaft and new bearings.

(14) If end clearance is less than stated in step (13), loosen capscrews slightly and shift crankshaft toward front of engine, then toward rear of engine. If capscrews have been loosened, retighten as described in step (9). Recheck end clearance.

NOTE

When an engine is being rebuilt, always bring crankshaft end clearance to 0.006 to 0.013 inch (0.15 to 0.33 mm) by using standard new parts or by using oversize thrust rings and a reconditioned crankshaft.

(15) Bend in ear of each lockplate (37) against the main bearing capscrew to lock it in place.

(16) Install and torque main bearing capscrews on engines to the following values:

(a) Torque all right side capscrews to 70 to 75 foot-pounds (95 to 102 joules).

(b) Torque all left bank side capscrews to 70 to 75 foot-pounds (95 to 102 joules).

(c) Return to right bank and torque side capscrews to 135 to 145 foot-pounds (183 to 197 joules).

(d) Return to left bank and torque side capscrews to 135 to 145 footpounds (183 to 197 joules).

(e) Breakaway torque is 135 to 190 foot-pounds (183 to 258 joules) in tightening direction.

(17) Install camshaft bushings (23, figure 13-50) using a bushing driver. Make certain that oil passages between bushings and block oil holes are properly aligned.

13. 35. INJECTION TIMING. After repair or overhaul, the engine should be timed as follows:

NOTE

Timing No. 1 cylinder on right and left bank will accomplish complete engine timing. Repeat following steps for each of the two cylinders.

a. Injector push tubes should be installed in their sockets for timing operation.

b. Check No. 1 cylinder on each bank with injector timing tool at 19 degrees before top center firing position.

c. Install timing tool in place of injector with one rod in push tube socket and with other rod resting on piston. Follow procedures as shown on figure 13-54 and steps e(1) through e(4), below. The numbers on the diagram show check points corresponding to numbered instruction steps.

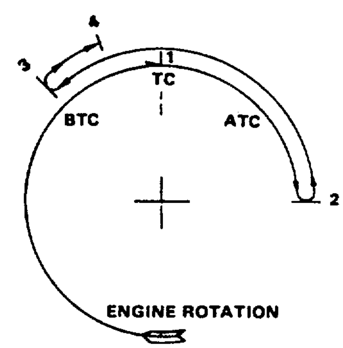


Figure 13-54. Engine Injection Timing Procedure Diagram

d. When indicator gauges are set at "0", they must be near fully compressed position. Gauges should have at least 0. 25 inch (6. 35 mm) travel range.

e. Engine must be barred accurately to each check point as specified for the gauge above piston.

(1) Bar engine in direction of rotation to No. 1 top center firing position (highest point of piston travel). Set indicator above piston at "0".

(2) Advance engine to 90 degrees after top center. Top of tool rod above piston will be 90-degree mark on tool scale. Set indicator above push tube to "0".

(3) Bar engine opposite rotation to 45 degrees before top center. This is to take up gear lash. Top of tool rod will be at 45-degree mark.

(4) Bar engine forward until piston is 0. 2032 inch lower than at top center position which results in a minus reading on indicator (-0.2032 inch) (-5.161 mm). This is 19 degrees before top center. Indicator above push tube should read within fast and slow limits as follows: -0.050 inch (-1.27 mm) and -0.555 inch (-1.40 mm).

CHAPTER 14

MAINTENANCE OF BASE ASSEMBLY

14-1. GENERAL. The base assembly, figure 14-1, mounts major assemblies of the generator set. It is constructed of steel beams, strips, and plates welded into one rigid skid base. The base contains the generator set fuel tank assembly at the front end of the generator set.

14-2. MAINTENANCE. All maintenance functions for the base assembly are performed at the Operator/Organizational levels. Refer to Operator and Organizational Maintenance manual.

LEGEND FOR FIGURE 14-1

1. Nut
2. Washer
3. Nut
4. Washer
5. Terminal
6. Hose assembly
7. Hose
8. Fitting
9. Elbow
10. Coupling
11. Nipple
12. Cock
13. Nipple.
14. Nut
15. Washer
16. Strap
17. Screw
18. Washer
19. Nut
20. Screw
21. Washer
22. Brace
23. Webbing

23A. Webbing

24. Fuel tank
25. Screw/washer
26. Nut/washer
27. Clamp
28. Screw
29. Washer
30. Plate
31. Screw
32. Washer
33. Plate
34. Screw
35. Washer
36. Angle
37. Screw
38. Washer
39. Angle
40. Screw
41. Washer
42. Washer
43. Plate
44. Adapter
45. Plug
46. Coupling
47. Nipple
48. Plug
49. Base

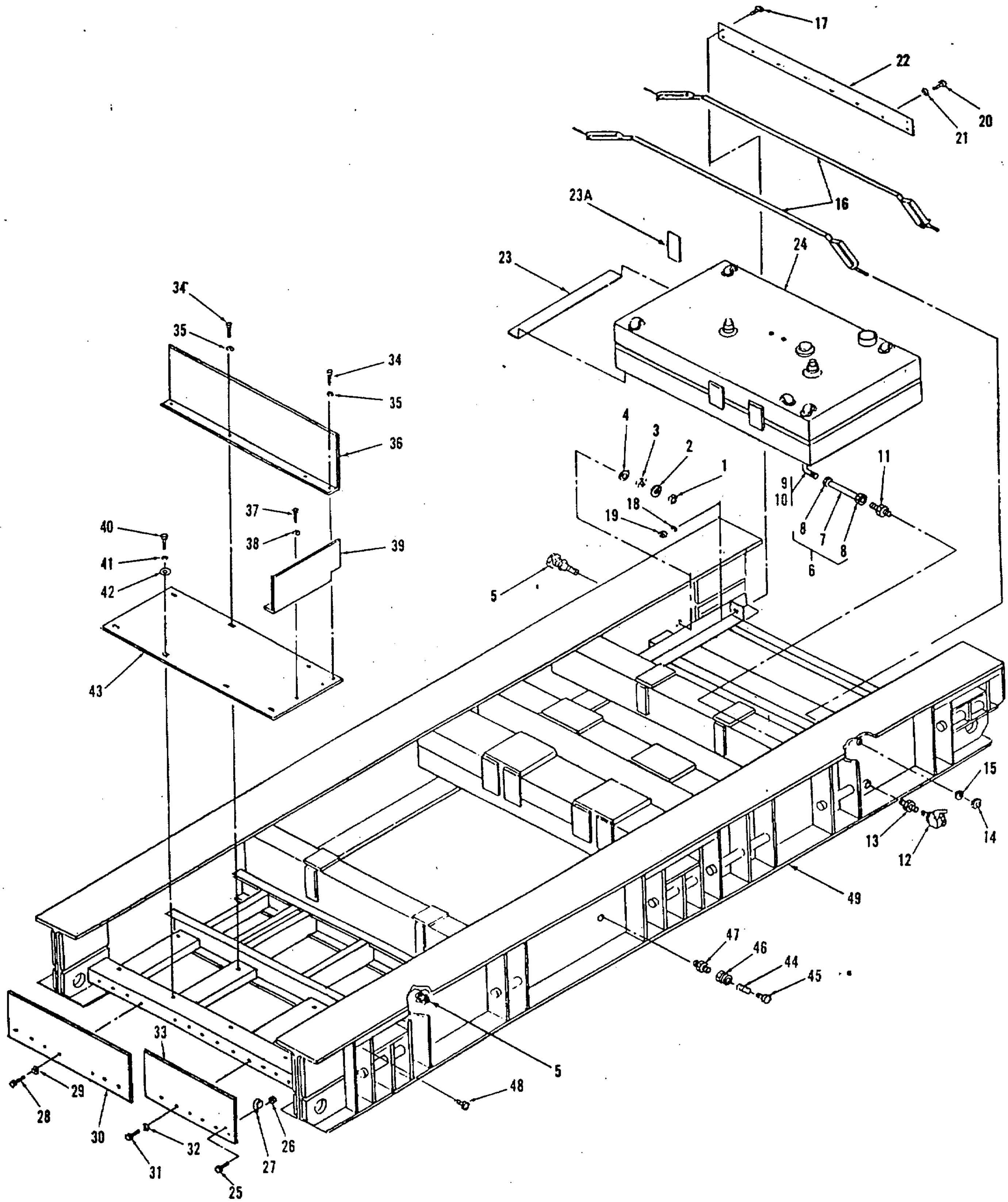


Figure 14-1. Base Assembly, Exploded View

CHAPTER 15

MATERIEL USED IN CONJUNCTION WITH THE GENERATOR SET

15-1. GENERAL. Auxiliary equipment used in conjunction with the generator set includes the remote control module and cable, the automatic control module, and the housing kit. The. remote control module allows remote start, stop, monitoring and control of single or parallel operation of generator sets. Control devices on the remote control panel are similar to the control panel on the generator set control cubicle. It is connected to the generator set by a 1000 foot (300 m) cable. The automatic control module provides an unattended automatic control system. When the automatic system requires one to four generator sets to support the load, one automatic control module is required. The housing kit encloses the generator set with shutters and access doors. It is attached to the generator set support frame assembly and the base assembly. The housing kit assembly louvers are automatically controlled by a mechanical linkage, motor-driven system. Auxiliary equipments also include a fuel hose, two electrical male connectors, and two sling assemblies.

Section I. MAINTENANCE OF REMOTE CABLE ASSEMBLY

15-2. REMOTE CONTROL CABLE. The remote control cable assembly is used to connect the remote control module to the generator set. The cable assembly may be of any length up to a maximum of 1000 feet (300 m).

15-3. INSPECTION. Inspect cable assembly for damaged connectors, loose pins, poor and loose electrical connections, and damaged cable.

15-4. REPLACEMENT. The remote cable assembly is connected from J2, J1, and J4 connectors at the rear of the generator set control cubicle to the rear of the remote control module at connectors J2, J1, and J4. Cable (6, figure 15-1) is a 25-conductor, AWG 14 wire with PVC jacket and two connectors P2 (2) at each end. Cable (5) is a 37-conductor, AWG 14 wire with two connectors P1 and P4 (1 and 3) at each end. The cable is assembled with self-locking tie wraps (4) approximately 6 inches (152 mm) apart. Refer to Chapter 10 for detail interconnection data and wire list.

15-5. REPAIR. Test each parallel wire for continuity. Be sure wire is not shorted either to the connector, or to another wire. Wire routing is common between like pins of connectors: E to E, D to D, etc. Wires are AWG 14, 1000 feet long (300 m), and color coded. When replacing connectors, solder in accordance with requirements 5 of MIL-STD-454.

Section II. MAINTENANCE OF REMOTE CONTROL MODULE

15-6. GENERAL. This section contains maintenance information on the synchroscope, relays, circuit card, and flashing circuit. The troubleshooting procedures contained in tables 5-2 and 5-3, of the Operator and Organizational Maintenance manual completely isolate any faults that may occur. For maintenance of other remote control module components, refer to the Operator and Organizational Maintenance manual.

15-7. SYNCHROSCOPE.

a. Inspection. Inspect the synchroscope for loose electrical connections, damaged case, or scratched glass.

b. Testing.

(1) Connect the synchroscope as shown in figure 15-2 test setup. Frequency generators used should be capable of providing minimum 50 volts, maximum 240 volts. Frequency 0 to 60 Hz. For testing, the pull-in frequency is 47 Hz.

(2) The synchroscope axial

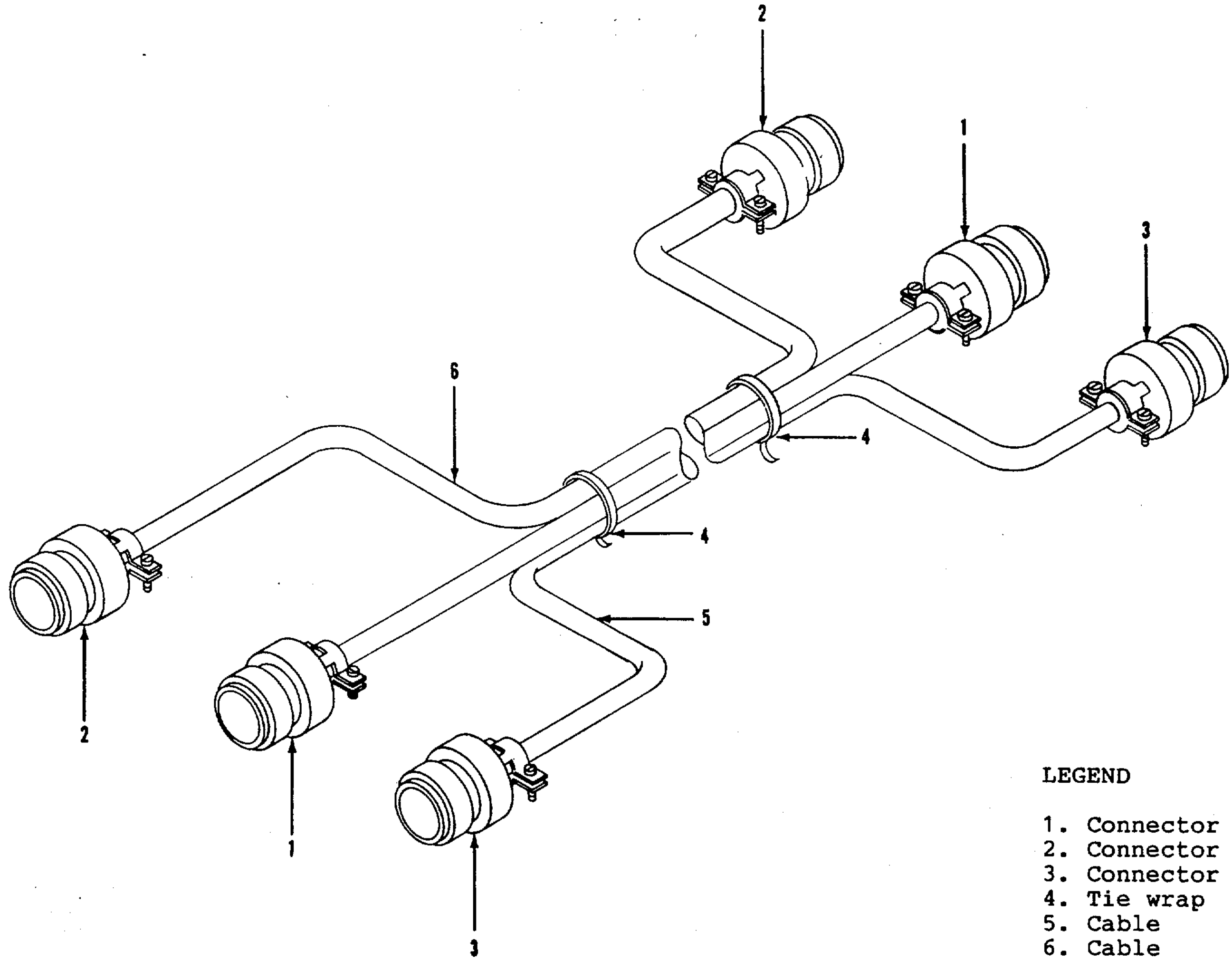


Figure 15-1. Remote Cable Assembly

polarizing coils are energized from the 'incoming' frequency, while the radial field coils are connected to the 'running' circuit. If there is no difference between the two circuits either in phase angle or frequency, the pointer will remain motionless at the 12 o'clock position on the dial. With no frequency difference, any phase angle difference will cause the pointer to take up a position away from the point. If, however, there is a difference in frequency, this phase relationship will be constantly changing and the pointer will consequently rotate continuously in one direction or the other at a speed corresponding to the difference in frequency. If 'incoming' is at a higher speed than the 'running', the pointer rotates clockwise, and counterclockwise if its speed is lower.

(3) When the lamps turn off together, the two sources are synchronized. When the 'incoming' frequency has been adjusted to equal that of the 'running' frequency, the pointer will come to rest at a point on the scale depending on the phase displacement of the two voltages. The speed of

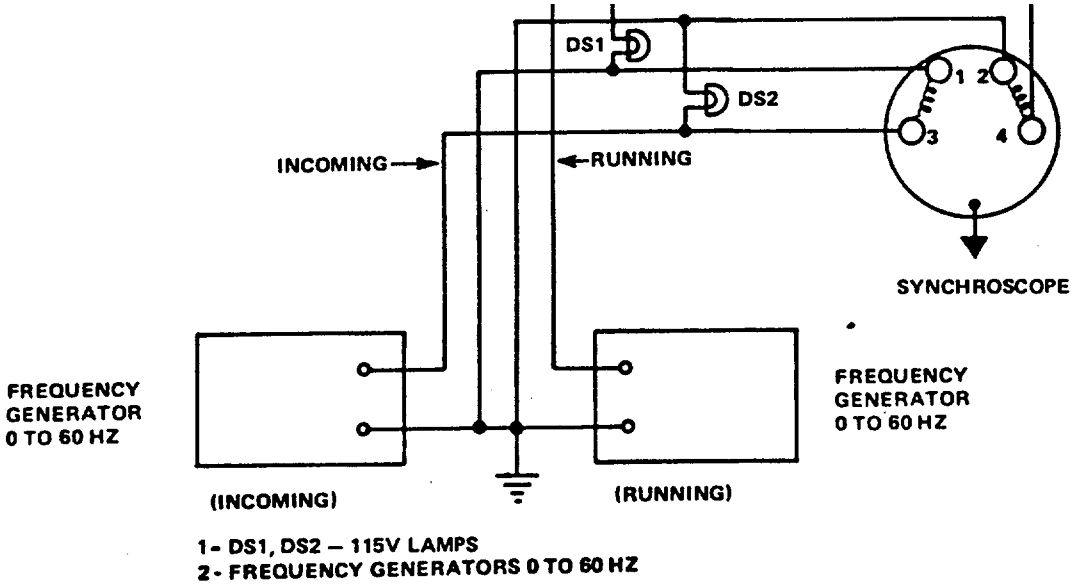


Figure 15-2. Synchroscope, Test Setup

the 'incoming' must then be inched up or down until the pointer takes a steady position at 12 o'clock.

c. Replacement. The synchroscope is mounted on the remote control module control panel. Disconnect and tag wires and remove attaching hardware to remove the synchroscope from the control panel.

15-8. RELAYS. Test and replace undervoltage relay K115 and underfrequency relay K116 as follows:

a. Test.

(1) Undervoltage relay K115 (2, figure 15-3).

(a) Connect relay as shown in test setup figure 15-4.

(b) Connect a variable 0 to 160V AC source and variable frequency (50 to 60 Hz) source to terminals 1 and 2 with switch S1 in series.

(c) Connect lamp DS1 and 24V DC power supply in series with switch S2 to terminals 3 and 4, also with terminals 7 and 8 (DS2).

(d) Adjust AC power supply to 120 volts, 60 Hz. With Sl and S2 closed, lamp DS1 should extinguish and DS2 should light.

(e) Reduce voltage slowly to 104 volts and hold for 2 minutes. Lamp DS1 and DS2 shall maintain states.

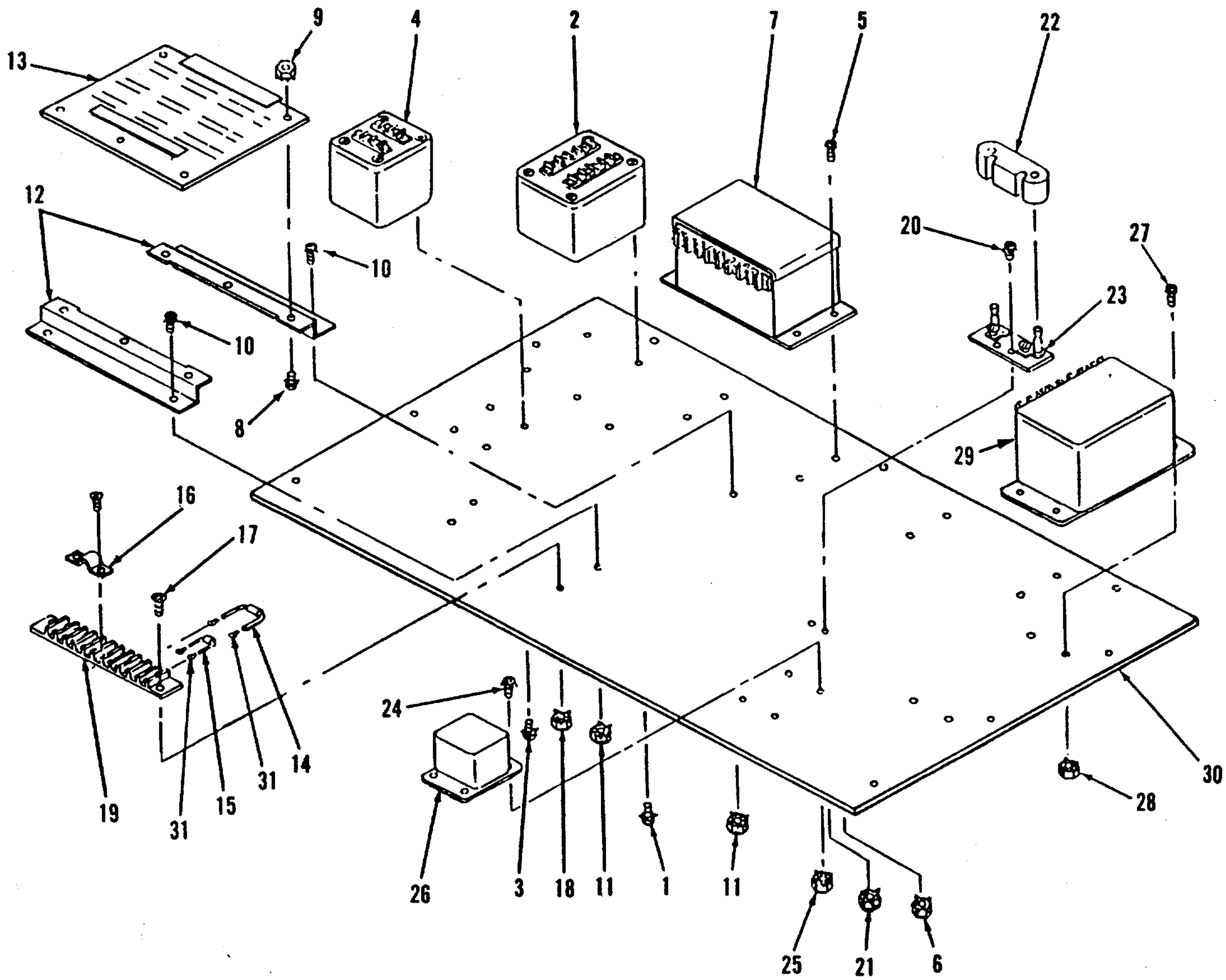
(f) Reduce voltage to 99 volts. DS1 and DS2 shall transfer states within 4 to 8 seconds.

(g) Increase voltage slowly to 113 volts. Lamps DS1 and DS 2 shall transfer states.

(h) Reduce voltage to 48 volts. Transfer of states of DS1 and DS2 shall be instantaneous

(i) Reduce frequency to 50 HZ and repeat the procedures in steps

LEGEND



1. Screw
2. Undervoltage relay
3. Screw
4. Underfrequency rely
5. Screw
6. Nut
7. Converter
8. Screw
9. Nut
10. Screw
11. Nut
12. Bracket
13. Annunciator
14. Resistor
15. Diode
16. Jumper
17. Screw
18. Nut
19. Terminal block
20. Screw
21. Nut
22. Terminal block
23. Flasher
24. Screw
25. Nut
26. Transducer
27. Screw
28. Nut
29. Transformer
30. Plate
31. Terminal lug

Figure 15-3. Remote Control Module, Plate Assembly, Exploded View

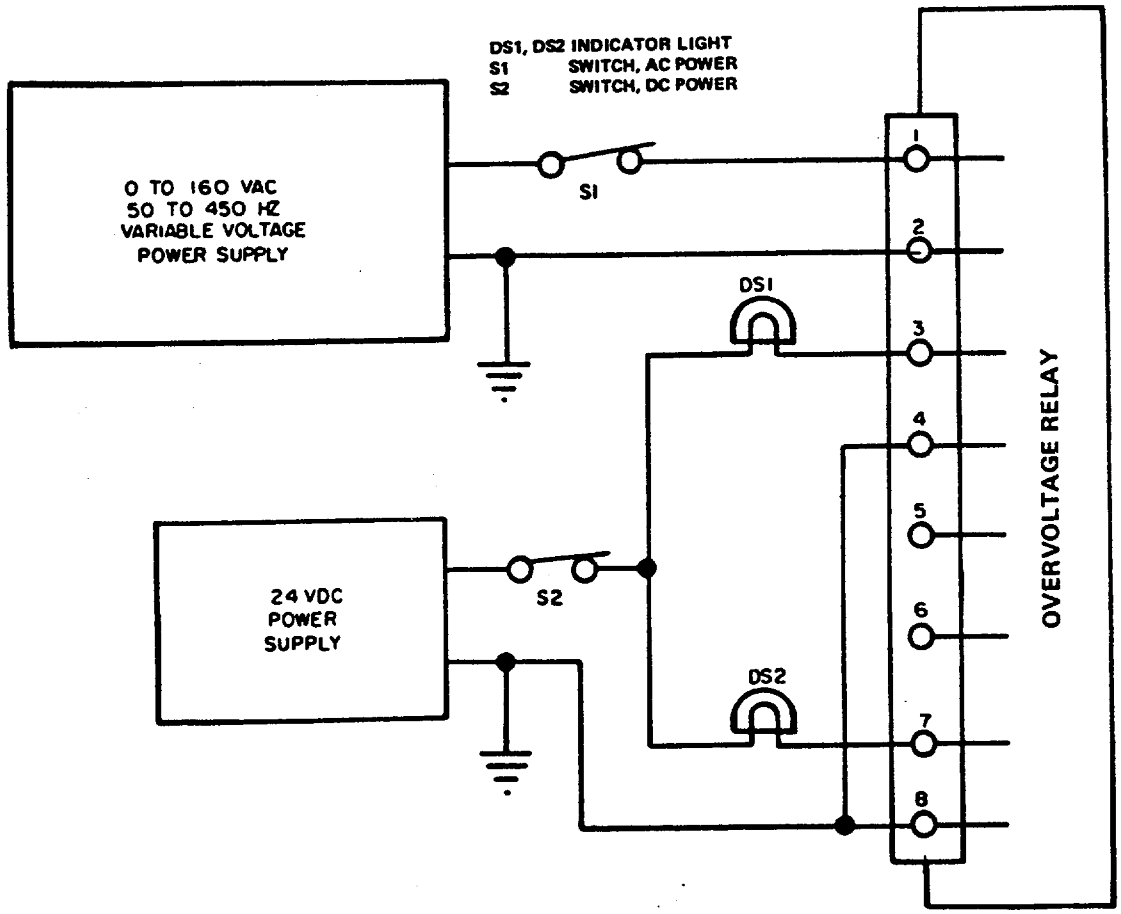


Figure 15-4. Undervoltage Relay K115, Test Setup

(e) through (i) with the same results.

(2) Underfrequency relay K116 (4, figure 15-3).

WARNING

HIGH VOLTAGES ARE PRESENT DURING TEST.

(a) Connect relay to test setup as shown in figure 15-5.

(b) Open switch S1 for 60 Hz test.

(c) Adjust the frequency to 60 Hz and the input voltage to 120 volts. Relay contacts should pick up. Lamp DS1 should light and DS2 should extinguish.

(d) Lower frequency slowly until relay contacts drop out (lights transfer). Contacts should drop at 55 Hz ±0.1 Hz.

(e) Close switch S1 for 50 Hz test.

(f) Adjust the frequency to 50 Hz and the input voltage to 120 volts. Relay contacts should pick up. Lamp DS1 should light and DS2 should extinguish.

(g) Lower frequency slowly until relay contacts drop out (lights transfer). Contacts

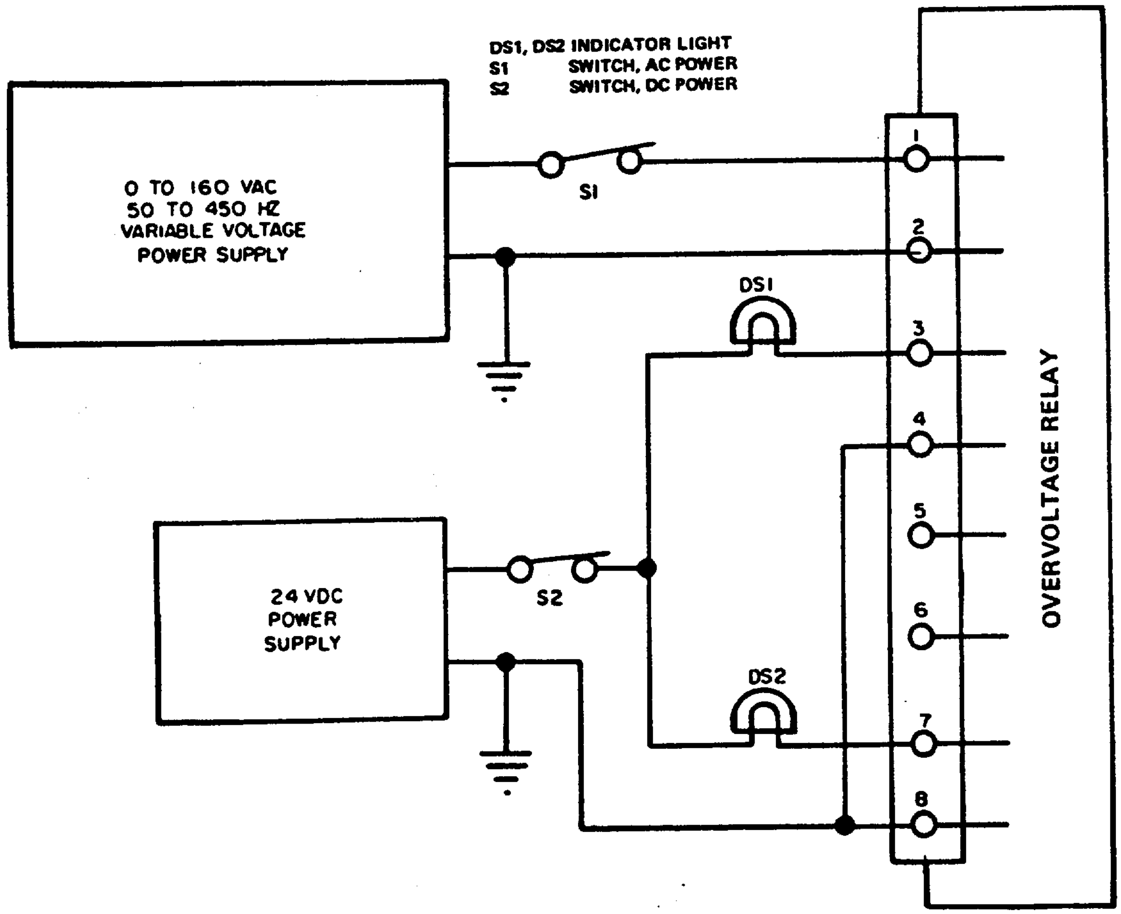


Figure 15-5. Underfrequency Relay K116, Test Setup

should drop out at 46 ±0.1 Hz.

b. Replacement. Remove relay (2, figure 15-3) by disconnecting and tagging wires and removing four screws (1). Remove relay (4) by disconnecting and tagging wires. Remove four screws (1) and remove-relay from plate assembly (30).

15-9. TRANSDUCERS. Remove transducers A103, A107, and A108 according to paragraph 15-9 b, and test as follows:

a. Test.

(1) Transducer A103. This transducer and generator set frequency meter are a matched set, and must be tested as a set. Refer to the Operator/Crew and Organizational Level Maintenance manual and remove frequency meter from the generator panel of the control cubicle-

WARNING

HIGH VOLTAGES PRESENT DURING TEST.

(a) Connect a test setup as shown in figure 15-6.

(b) Vary the frequency from lowest scale reading to full scale reading at 120 volts and at frequencies between 48 and 53 Hz, the generator set meter shall read within 1 percent of the generated frequency (to the left); at 120 volts and at frequencies between 57 and 62 Hz, generator set meter shall read within 1 percent of the generated frequency (to the right). The error at any point on frequency meter shall not be greater than 1 percent.

(c) If the above requirements are not satisfied, replace both the frequency meter and transducer as a matched set.

(2) Transducers A107 and A108 (7, figure 15-3) are tested as follows:

WARNING
HIGH VOLTAGES PRESENT DURING TEST.

DEATH
OR SEVERE BURNS MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS.

(a) Connect transducer

REF DES
K25A
K25B
K26
K27
K28
K29
K30
K31
K32
K33
K34
K35
K36

(either A107 or A108) as shown in figure 15-7, using test equipment as shown.

(b) Adjust T1, T2, and T3 to their minimum position, fully counterclockwise.

(c) Close S1 and open S2 and S3.

(d) Energize 120/208V AC 3 phase, 4 wire, 60 Hz power source.

(e) Adjust T1 until 0.7 ampere is indicated on ammeter A1. At this point, the percentage of RATING METER shall indicate 33 percent.

(f) With S1 closed, close switch S2, and adjust T2 until 0.7 ampere is indicated on ammeter A2. The percentage of RATING METER shall indicate 66 percent.

(g) With S1 and S2 closed, close S3. Adjust T3 until 0.7 ampere is indicated on ammeter A3. The percentage of RATING METER shall indicate 100 percent.

(h) If requirements of steps (e), (f), and (g) are not met, replace the transducers.

b. Replacement. Transducers A103, (26, figure 15-3), and

FUNCTION
Alarm Silence
Alarm Silence
Alarm Arming
High Coolant Temperature
High Oil Temperature
Low Oil Pressure
Low Fuel Level
Overspeed
Overvoltage
Undervoltage
Reverse Power
Overload
Short Circuit

A107 and A108 (7), are removed from the plate assembly (30) by disconnecting and tagging wires. Remove transducer (26) by removing four screws (24) and nuts (25). Remove both transducers (7) by removing screws (5) and nuts (6).

15-10. ANNUNCIATOR CONTROL ASSEMBLY A20 (13, figure 15-3). The annunciator control relay assembly contains four terminal boards, 20 diodes, and 13 relays:

a. Test.

(1) Check each relay using test circuits shown in figure 15-8. Energize each set of relay contacts individually by applying 24V DC directly to leads. Check for open or closed contacts (no continuity or continuity) as indicated in figure 15-8. Check that each set of contacts revert (to either closed or open position) when deenergized. If only relay fails to either open or close as indicated, it is defective and must be replaced.

(2) Check diodes for polarity. A good diode will read high resistance one way and low resistance the other way. A defective diode will read full scale both ways, or will read infinity (no reading) in either direction.

(3) Check terminal boards and printed circuit wiring by repeating steps (1) and (2), but apply 24V DC to A20 terminals.

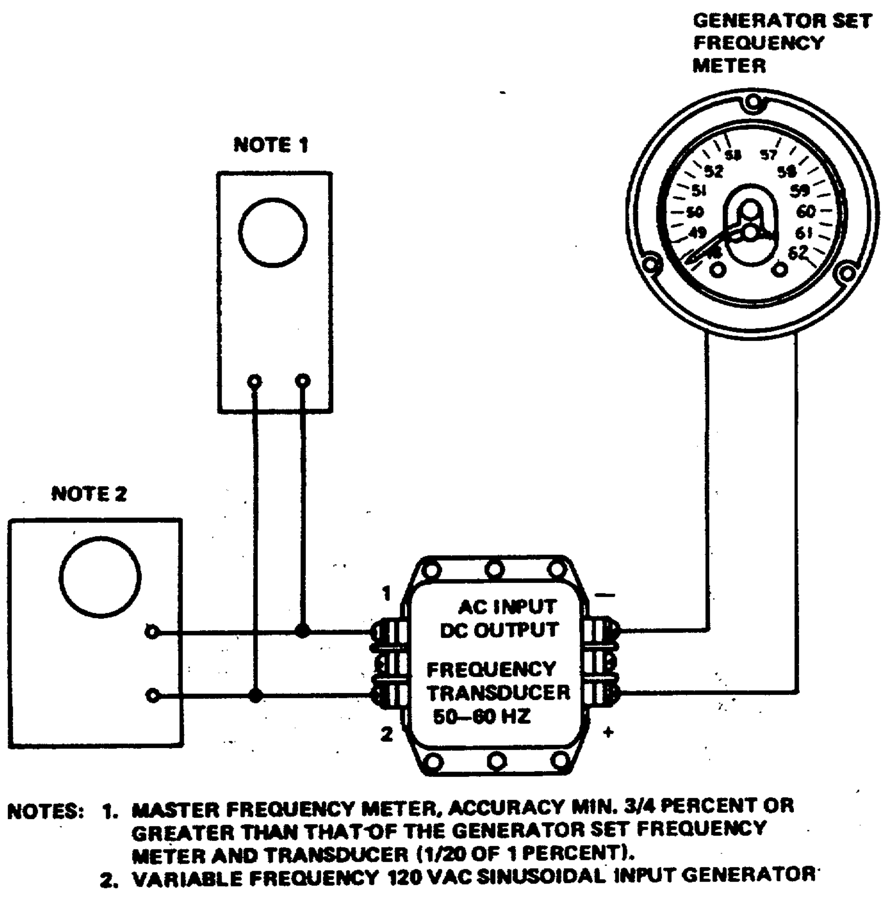


Figure 15-6. Transducer A103, Test Setup

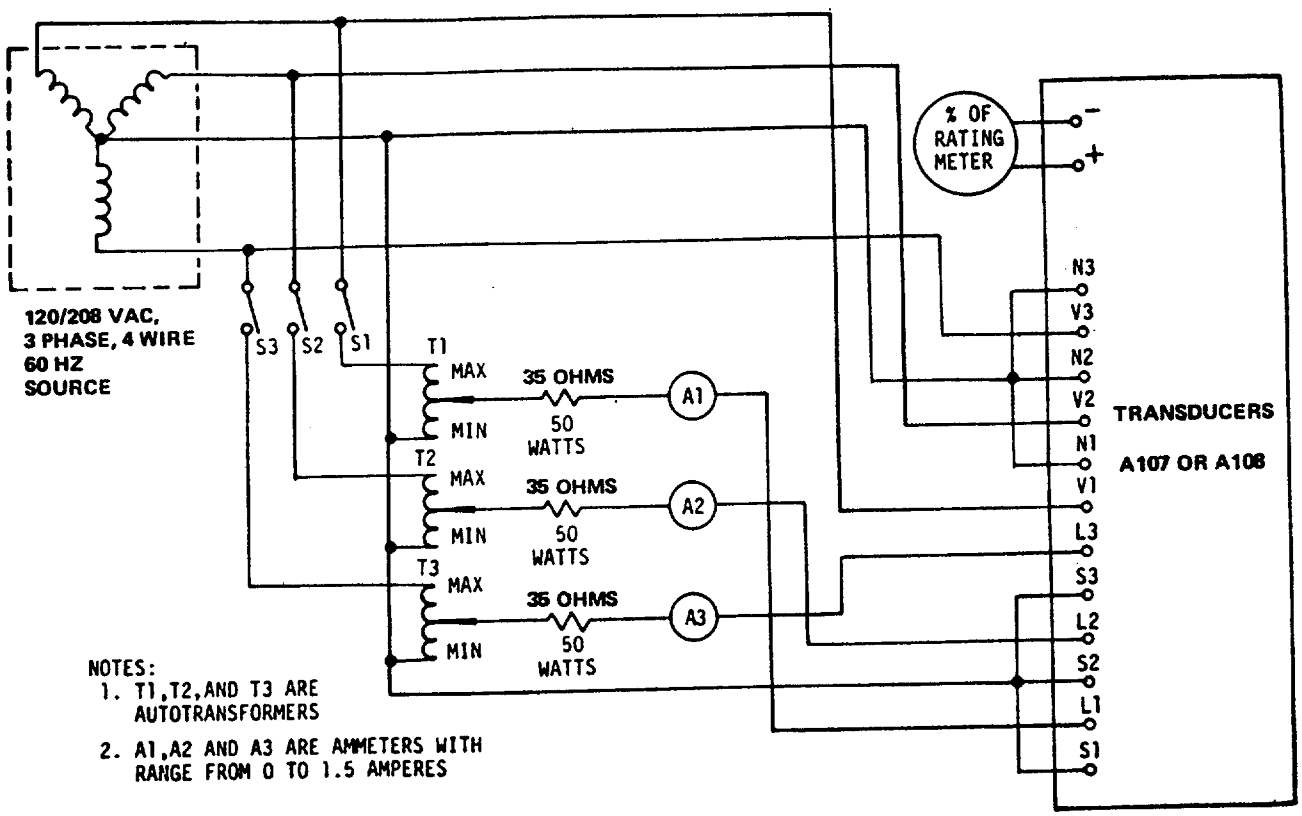


Figure 15-7. Transducer A107 and A108, Test Setup

b. Repair. If any of the relays or diodes are defective, Annunciator Control Relay Assembly A20 is repairable by replacing the defective component. If the printed circuit wiring or a terminal board proves defective, or a non-replaceable component is defective, the entire assembly must be replaced.

c. Replacement.

(1) Remove annunciator (13, figure 15-3) as follows:

(a) Tag and then disconnect wires from terminal boards.

(b) Remove screws (10) and nuts (11) to remove annunciator (13) and brackets (12).

(c) Components are replaced by carefully unsoldering them from the printed circuit board.

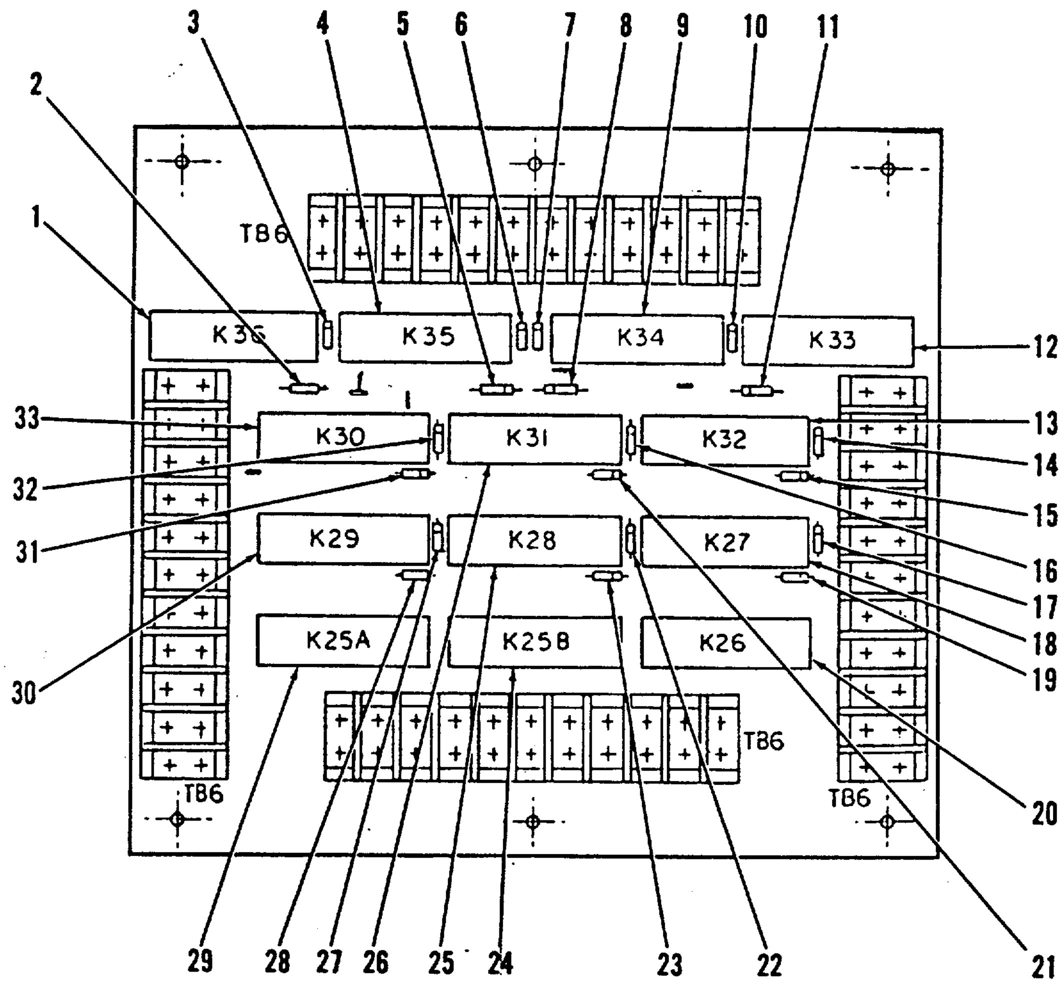
CAUTION

Do not apply excessive heat when soldering or unsoldering components. It may damage the printed circuit wiring.

(d) If Annunciator Control Relay Assembly is to be replaced, remove screws (8) and nuts (9) to release annunciator (13) from brackets (12).

(e) Prepare annunciator (13) for installation by attaching brackets (12) using screws (8) and nuts (9).

(f) If components are being replaced, carefully solder new component into place.



LEGEND

1. Relay K36
2. Diode CR21
3. Diode CR22
4. Relay K35
5. Diode CR19
7. Diode CR20
8. Diode CR17
9. Relay K34
10. Diode CR16
11. Diode CR15
12. Relay K33
13. Relay K32
14. Diode CR14
15. Diode CR13
16. Diode CR12
17. Diode CR4
18. Relay K27
19. Diode CR3
20. Relay K26
21. Diode CR11
22. Diode CR6
23. Diode CR5
24. Relay K25B
25. Relay K28
26. Relay K31
27. Diode CR8
28. Diode CR7
29. Relay K25A
30. Relay K29
31. Diode CR9
32. Diode CR10
33. Relay K30

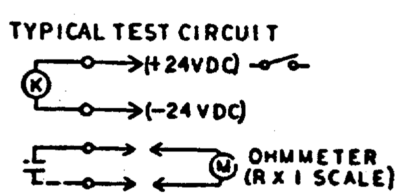


Figure 15-8. Annunciator Control Assembly A20 (Sheet 1 of 2)

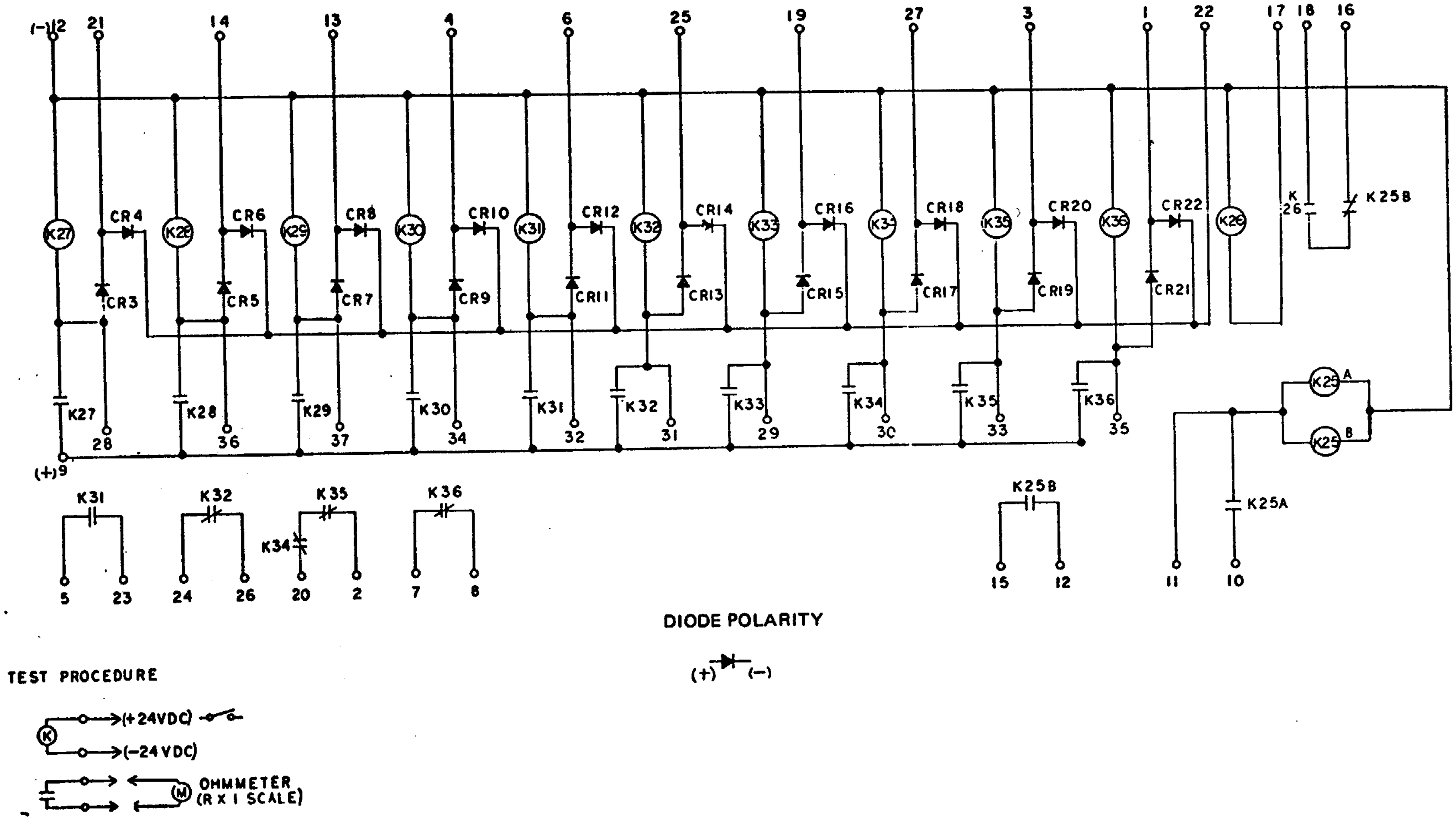


Figure 15-8. Annunciator Control Assembly A20 (Sheet 2 of 2)

(g) Install annunciator (13) by securing brackets (12) using screws (10) and nuts (11).

(h) Connect wires to terminal boards, then remove wire tags.

15-11. FLASHER FC1. The flasher (23, figure 15-3) is plugged into terminal block (22) which is mounted on the plate assembly (30) with two screws (20) and nuts (25). Test the flasher by connecting it in series with a 24V DC power source and test lamp. The test lamp should flash on and off; otherwise the flasher is defective and should be replaced.

15-12. TRANSFORMER T103 (29, figure 15-3).

a. Remove phase shift transformer T103 as follows:

(1) Tag and disconnect lead wires.

(2) Remove screws (27) and nuts (28) and remove T103 (29).

b. Test transformer T103 in accordance with procedures in paragraph 5-3 b.

c. Install T103 as follows:

(1) Secure transformer T103 to plate (30) using screws (27) and nuts (28).

(2) Connect wires and remove tags.

15-13. RESISTOR R30 (14, figure 15-3).

a. Remove R30 (14) from terminal block (19) by removing screws (17).

b. Use an ohmmeter to test R30 for resistance of 39,000 ohms ±5 percent. Replace R30 if specified resistance value is not met.

c. Install resistor R30 (14) onto terminal block (19) using screws (17).

15-14. DIODE CR36 (15, figure 15-3).

a. Disconnect one end of the diode (15) by removing screw (17).

b. Connect an ohmmeter (scale set at Rx100) across the diode, and note reading.

c. Reverse ohmmeter leads to the diode, and again note reading. A good diode will read high resistance one way and low resistance the other way. A shorted diode will read full scale both ways. An open diode will read infinity (no reading, in either direction.

d. Remove shorted or open diode (15) by removing remaining screw (17).

e. Reconnect lead of good diode, or install new diode with screws (17).

Section III. MAINTENANCE OF AUTOMATIC CONTROL MODULE

15-15. GENERAL. the Automatic Control Module can automatically control up to four generator sets by monitoring the utility bus voltage and frequency. If voltage should vary by ±10 percent or frequency should vary by ±3 percent the module will start the generators, open the utility breaker and sequentially load generators. The troubleshooting procedure contained in Table 5-5 and 5-6 of the Operator and Organizational Maintenance manual isolates most faults that may occur. Test and adjustment procedures are contained in this section.

15-16. UNDER/OVERVOLTAGE DEVICE. There is one under/over voltage device. The device is preset for a ±10 percent deviation in the 120V AC bus sensing power. The device is adjustable within the range specified in the tabulated data in Chapter 1 of the Operator and Organizational Maintenance manual. Trip settings are made by removing protective plastic caps on front of the device and turning adjustment screws beneath caps. A clockwise rotation of adjustment screw will increase trip point. Figure 15-9 shows component layout of Automatic Control Module.

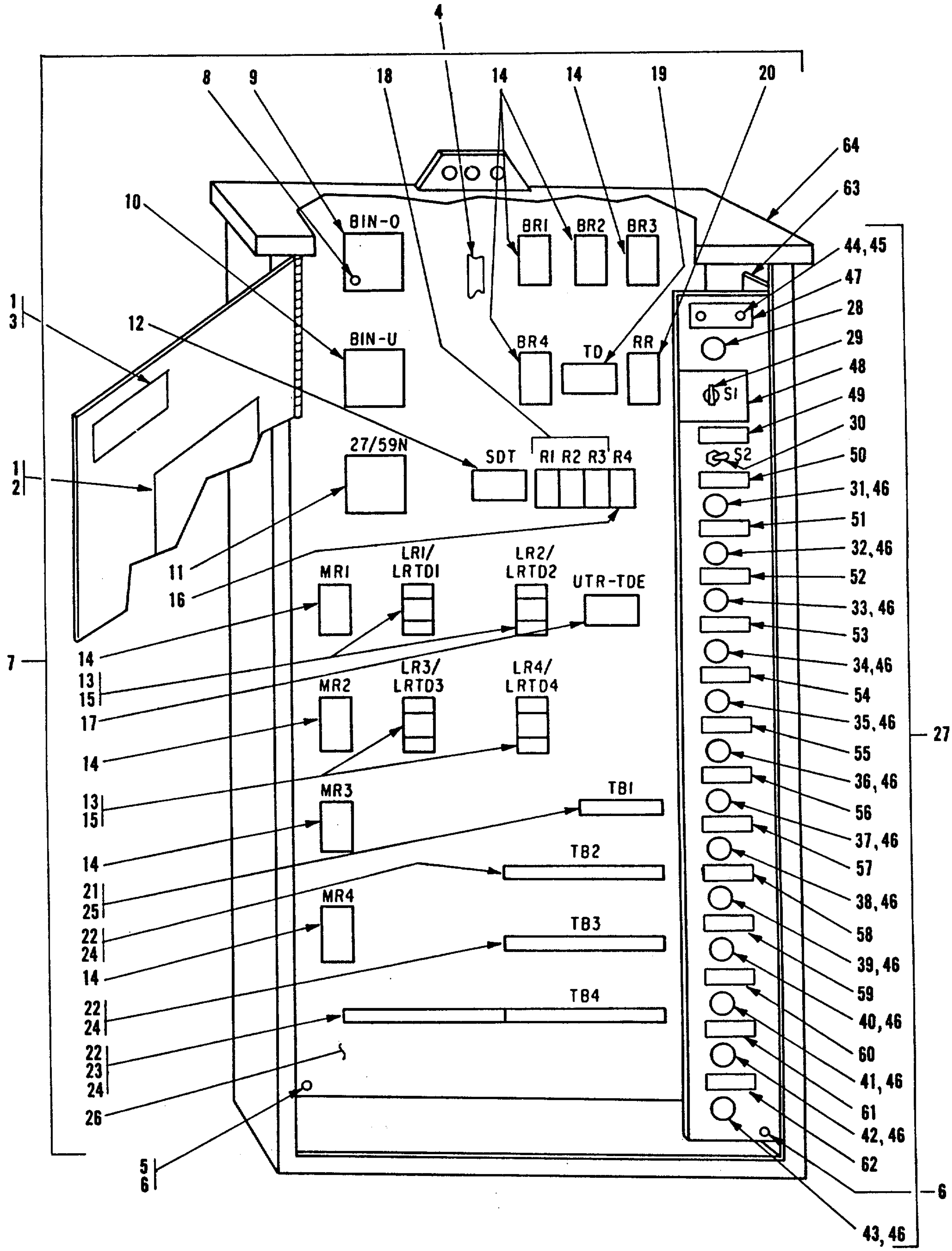


Figure 15-9. Automatic Control Module

LEGEND FOR FIGURE 15-9

1. Rivet
2. Schematic plate
3. Data plate
4. Harness assy
5. Nut
6. Washer
7. Relay panel assy
8. Screw
9. Over frequency relay
10. Under frequency relay
11. Under/overvoltage relay
12. Time delay relay
13. Time delay relay
14. Relay
15. Relay
16. Diode
17. Time delay relay
18. Diode pack
19. Time delay relay
20. Run relay
21. Terminal block
22. Terminal block
23. Marker strip
24. Marker strip
25. Marker strip
26. Panel
27. Fuse panel assy
28. Panel light
29. Selector switch
30. Toggle switch
31. AC fuse
32. Fuse, BR1
33. BR2 fuse
34. BR3 fuse
35. BR4 fuse
36. Unit 1 fuse
37. Unit 2 fuse
38. Unit 3 fuse
39. Unite 4 fuse
40. MR1 fuse
41. MR2 fuse
42. MR3 fuse
43. MR4 fuse
44. Nut
45. Screw
46. Fuse holder
47. Plate, "normal Power"
48. Plate, "return"
49. Plate, "freq. select"
50. Plate, "AC-15A"
51. Plate, "BR1-5A"
52. Plate, "BR2-5A"
53. Plate, "BR3-5A"
54. Plate, "BR4-5A"
55. Plate, "unit 1DC-5A"
56. Plate, "unit 2DC-5A"
57. Plate, "unit 3DC-5A"
58. Plate, "unit 4DC-5A"
59. Plate, "MR1-5A"
60. Plate, "MR2-5A"
61. Plate, "MR3-5A"
62. Plate, "MR4-5A"
63. Fuse panel
64. Box assy

a. Test. Test the under/over voltage module as follows:

(1) Under/over voltage relay (11, figure 15-9)

(a) Connect the under/over voltage device as shown in figure 15-10.

(b) Close S1, adjust variac for 110V AC on AC voltmeter.

(c) With ohmmeter connected between terminals 5 and 7, reduce AC voltage. Relay should trip at 103V AC at this point, ohmmeter will no longer show continuity.

(d) With ohmmeter connected between terminals 5 and 6 adjust AC voltage to read 130 volts.

(e) Increase voltage. Relay should trip at 132V AC. Ohmmeter will no longer show continuity.

b. Replacement.

WARNING

REMOVE 120V AC POWER PRIOR TO MOVING AND REPLACING DEVICE.

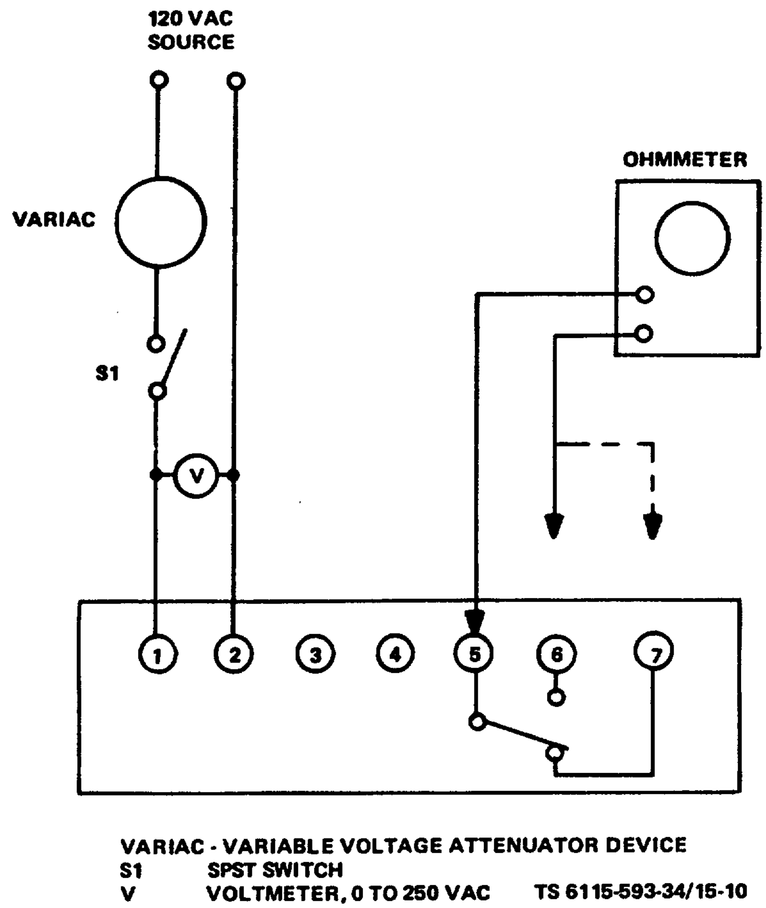


Figure 15-10. Under/Over Voltage Relay, Test Setup

Under/overvoltage relay (11, figure 15-9) is removed as follows:

(1) Disconnect and tag wires to under/overvoltage device terminal board.

(2) Remove four screws and washers. Remove device.

(3) Replace under/overvoltage device by attaching to panel with four screws and washers. Connect wires and remove tags.

15-17. UNDERFREQUENCY RELAY. (10, figure 15-9). The device is adjustable within the range specified in the tabulated data in Chapter 1 of the Operator and Organizational Maintenance manual. Test numbers given in the procedures below are nominal. Trip setting is adjusted with the adjustment screw on the device. Test and replace as follows:

a. Test.

(1) Connect underfrequency relay as shown in figure 15-11. Switch S1 closed.

(2) Adjust variable frequency generator for 50 Hz output.

(3) With ohmmeter connected between terminals 5 and 7, adjust frequency generator to 48.5 Hz. Relay should trip as frequency is decreased. Ohmmeter will no longer show continuity.

(4) Open switch S1. Adjust frequency generator for 60 Hz output.

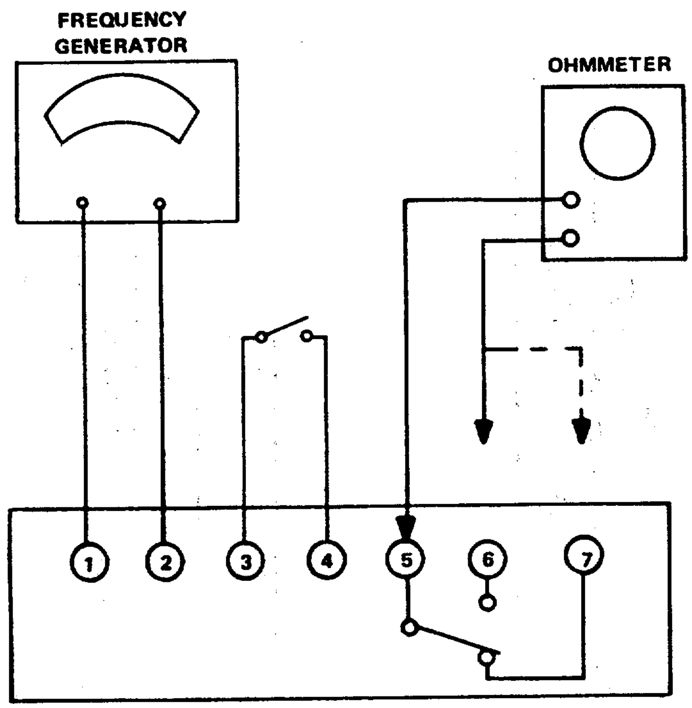


Figure 15-11. Underfrequency and Overfrequency-Relay, Test Setup

(5) Decrease frequency generator frequency to 58. 2 Hz. With ohmmeter connected between terminals 5 and 6, relay should trip at 58. 2 Hz (57. 7 to 58. 7 Hz), at which time ohmmeter will no longer show continuity.

(6) Turn adjustment screw clockwise to raise trip point.

b. Replacement. The underfrequency relay (10, figure 15-9) is removed and replaced a follows:

(1) Disconnect and tag wires connected to the underfrequency terminal board.

(2) Remove four screws and washers. Remove device (10) from panel (7).

(3) Replace underfrequency relay (10) by attaching to panel (7) with four screws and washers. Connect wires and remove tags.

15-18. OVERFREQUENCY RELAY. The overfrequency relay (9,. figure 15-9) is adjustable within the range specified in the tabulated data in Chapter 1 of the Operator and Organizational Maintenance manual. Trip setting is adjusted with the adjustment screw on the device. Test the device as follows: a. Test.

(1) Connect overfrequency relay as shown in figure 15-11.

(2) Adjust variable frequency generator for 50. 0 Hz output. Close switch SI.

(3) With ohmmeter connected between terminals 5 and 7, adjust frequency generator to 51. 5 Hz (51 to 52). At this point, relay should trip. Ohmmeter will no longer show continuity.

(4) Open switch S1.

(5) Set frequency generator output to 60. 0 Hz and connect ohmmeter between terminals 5 and 6; ohmmeter should indicate continuity. Increase frequency generator output to 61. 8 Hz; relay should trip at 61. 8 Hz (61. 3 to 62. 3) and ohmmeter indicate infinite ohms.

(6) Turn adjustment screw clockwise to raise trip point.

b. Replacement. The overfrequency relay (9) is removed and replaced as follows:

(1) Disconnect and tag wires connected to the overfrequency terminal board.

(2) Remove four screws and washers. Remove device from panel (7).

(3) Replace relay (9) by attaching to panel (7) with four screws and washers. Connect wires and remove tags.

15-19. TIME DELAY RELAY. The time delay relay (19, figure 15-9) is a "delay on drop-out" type relay, set for 1. 5-15 seconds delay. The relay is adjustable within the range specified in the tabulated data in Chapter 1 of the Operator and Organizational Maintenance manual. Timing is adjusted with the calibrated dial on the relay. Test and replace relay as follows:

a. Test.

(1) Connect the time delay relay as shown in figure 15-12.

(2) Momentarily close switch S1. Lamp DS1 will light and remain lit for 1. 5-15 seconds.

(3) Turn calibrated dial clockwise to increase timing.

b. Replacement. Remove and replace time delay relay (19) as follows:

(1) Disconnect and tag wires connected to the time delay relay.

(2) Remove four screws and washers. Remove relay from panel (7).

(3) Replace relay (19) by attaching to panel (7) with four screws and washers. Connect wires and remove tags.

15-20. RELAYS (BR1-BR4, MR1-MR4, RR). BR1-BR4, MR1-MR4 (14, figure 15-9) and RR (20) relays are mounted on panel (7).

a. Test.

(1) Connect a 120V AC power source to relay coil as shown in figure 15-13.

(2) Check that normally open contacts close and normally closed contacts open relay coil is energized, by verifying ohmmeter indication of 'zero' with contacts closed and 'infinity' with contacts open.

b. Replacement. Relays (14 and 20, figure 15-9) are removed and replaced as follows:

(1) Disconnect and tag wires connected to relays.

(2) Remove two screws and two washers for each relay, remove relay from panel (7).

(3) Replace relay (14 or 20) by attaching the panel (7) with two screws and washers. Connect wires and remove tags.

15-21. RELAYS (LR1-LR4, LRTD1-LRTD4). Relays LR1-LR4 (15, figure 15-9) and LRTD1-LRTD4 (13) are mounted on relay panel (7).

a. Test.

(1) Connect a 24V DC power supply across coil of relay as shown in figure 15-14.

(2) Check that normally open contacts close and normally closed contacts open

instantly on LR relays, by verifying ohmmeter indication.

(3) Check that normally open contacts close and normally closed contacts open after a time delay of . 2-20 seconds on LRTD relays. The LRTD relays are adjustable from . 2-20 seconds.

NOTE

The LRTD relays are designed for horizontal mounting. When testing, it must be placed in this position to operate properly.

b. Replacement. Relays (15, 13, figure 15-9) are removed and replaced as follows: (1) Disconnect and tag wires to relays.

(2) Remove two screws and two washers. Remove relay from panel (7).

(3) Replace relay (15) by attaching to panel (7) using two screws and washers. Connect wires and remove tags.

15-22. TIME DELAY RELAY. (SDT) (12, figure 15-9) is a delay on a drop-out type relay set for 5 minute delay. The relay is adjustable within 1-300 seconds and allows the engines to cool down after load has been removed.

a. Test.

(1) Connect a 24V DC supply to L1(-) and L2(+) as shown in figure 15-15.

(2) With ohmmeter across terminals 5 and 3 note that resistance reading does not change until 5 minutes after power has been applied.

b. Replacement. Remove and replace time delay relay (12) as follows:

(1) Disconnect and tag wires connected to relay.

(2) Remove four screws and washers. Remove relay from panel (7).

(3) Replace relay (12) by attaching to panel (7) with four screws and washers. Connect wires and remove tags.

15-23. TIME DELAY RELAY. (UTR) (17, figure 15-9) is a time delay on energize type relay set for 5 minutes delay. The relay is adjustable within 3-30 minutes and prohibits load to be transferred back to utility power until timed out.

a. Test.

(1) Connect the relay as shown in figure 15-12.

(2) Close switch S1. The lamp DS1 will not light until the relay has timed out (5 minutes).

b. Replacement. Remove and replace relay (17) as follows:

(1) Disconnect and tag wires to relay.

(2) Remove four screws and washers. Remove relay from panel (7).

(3) Replace relay (17) by attaching to panel (7) with four screws and washers. Connect wires and remove tags.

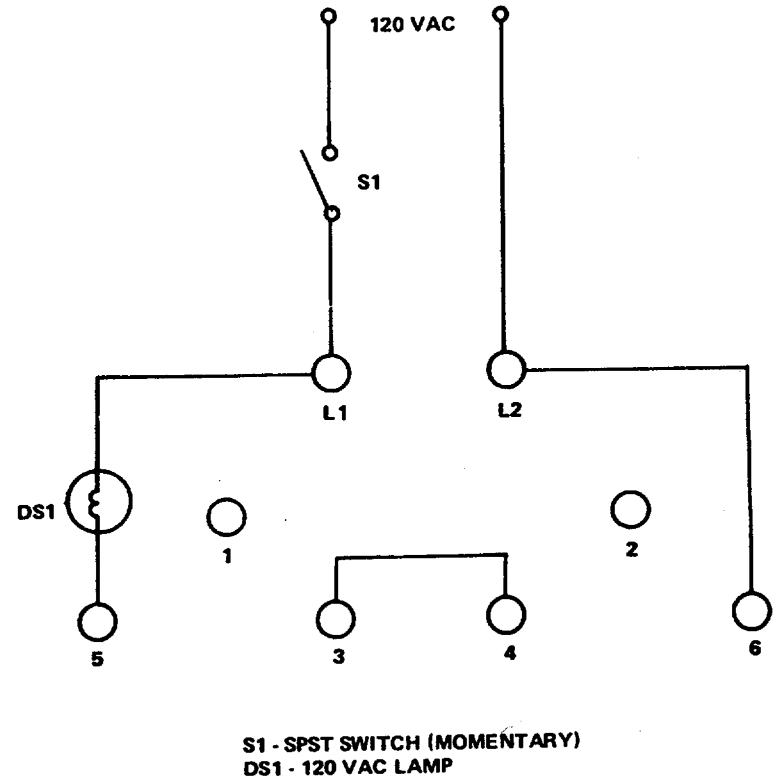


Figure 15-12. Time Delay Relay, Test Setup

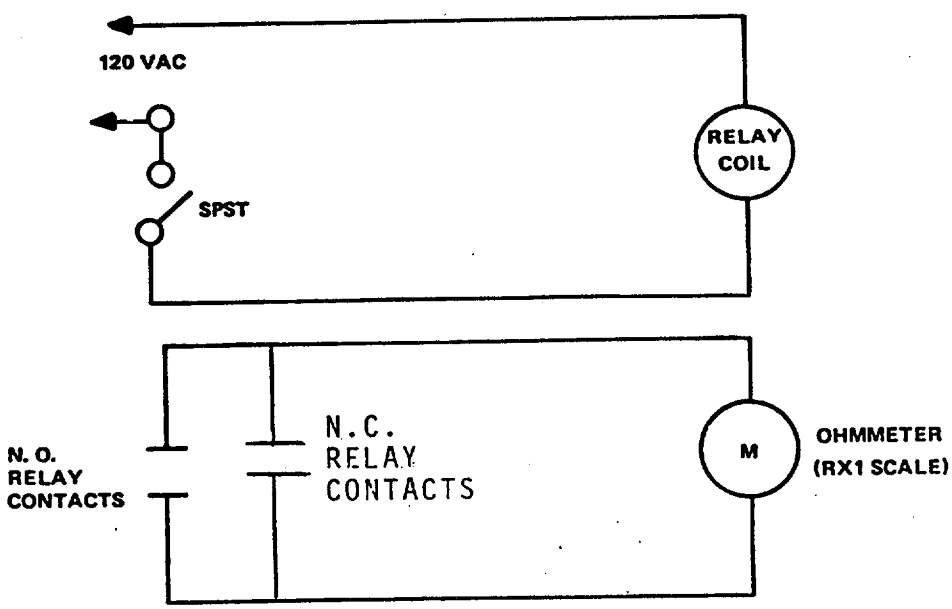


Figure 15-13. Relay Test Setup

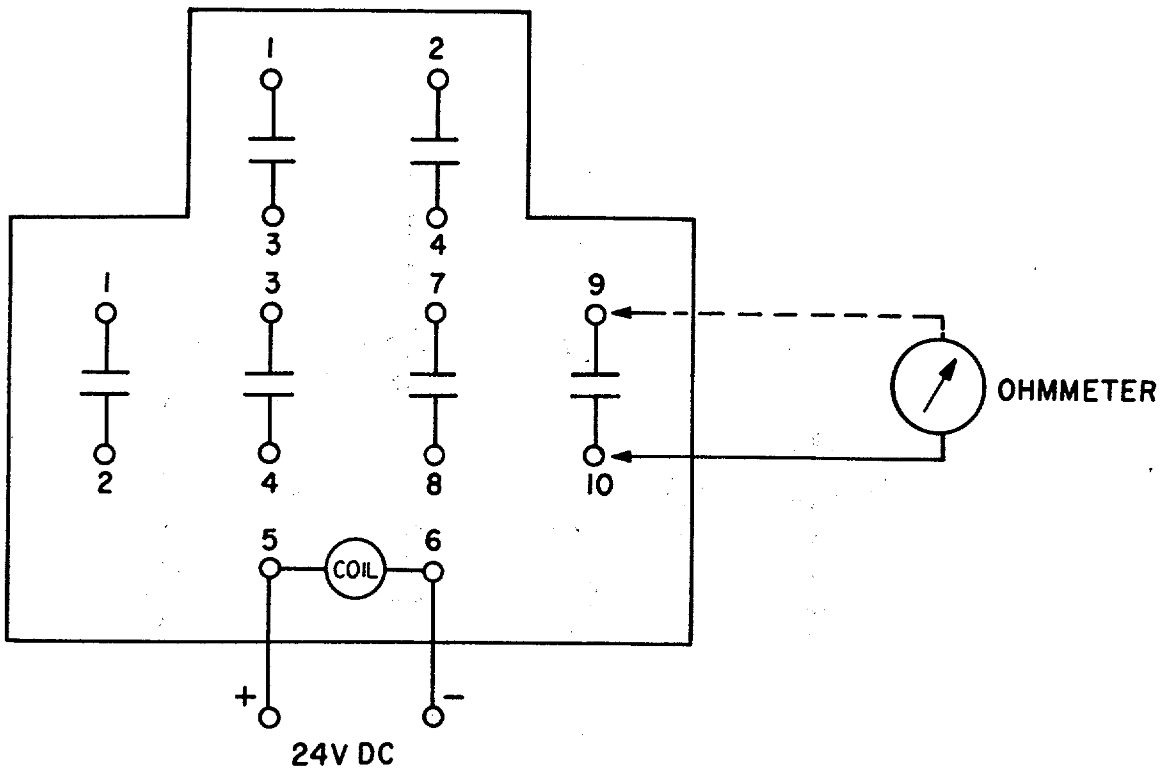


Figure 15-14. LR, LRDT, Test Setup

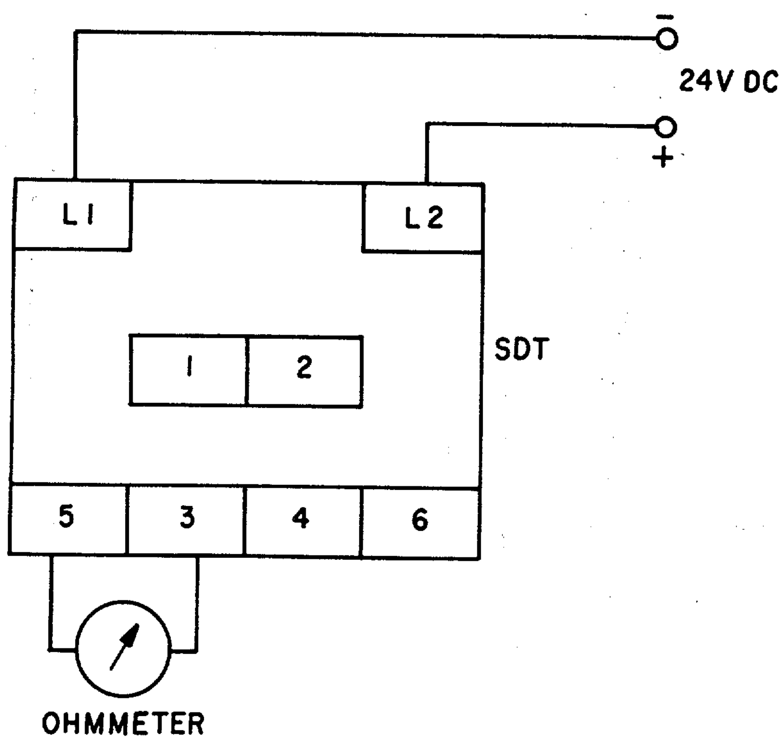


Figure 15-15. SDT Timer Test Setup

Section IV. HOUSING KIT

15-24. GENERAL. The housing kit encloses the top, sides, and ends of the generator set and is removable to provide access for overhaul or replacement of major components of the generator set. The housing is attached to the base assembly and the support frame assembly. With the housing kit installed the generator set can be operated at ambient temperatures from 125°F (51.7°C) down to -25°F (-31.7°C). The housing doors allow access to the inside of the generator set. The shutter assembly at the radiator end of the generator set is automatically controlled and helps in maintaining correct temperatures of the generator set. Major portions of the housing kit include panels, doors, shutters, electrical harness, and necessary hardware items to assemble the housing kit. The troubleshooting procedures contained in table 5-8, of the Operator and Organizational Maintenance manual completely isolate any faults that may occur. Test and adjustment procedures are contained in this section.

15-25. INSTALLATION. Install housing kit in the following sequence: door and shutter assembly, right side, front (radiator end), left side, rear, top, and electrical harness.

a. Door and Shutter Assembly. There are four door and shutter assemblies (figure 15-16). Two are for the right side of the generator set, and two are for the left side. Assemblies are similar, except that the lower actuator assemblies are mounted in different locations, depending upon right-hand or left-hand door location. Assemble two right-hand doors as follows:

(1) Attach shutter assembly (32, figure 15-16) to door (39) with screws (29), washers (31), and nuts (30).

(2) Attach both brackets (13) to drive support bracket (17) with four flat head screws (10), washers (12), and nuts (11).

(3) Install bracket (25) to control bar (36) with two screws (24).

(4) Install spacer (14) and bracket (17) on door with four screws (7), washers (9), and nuts (8) attaching clamp (40) with the same hardware. Install actuator (6) on bracket (17) with two clamp assemblies (1), washers (2), and nuts supplied with clamp assembles (1). Install rod (5) with pin (4) onto actuator (6) shaft and through hole in bracket (25), then secure with quick-release pin (3).

(5) Install switch support (21) with spacers (23) and shim (22) and switch cover (16) using two screws (18), washers (20), and nuts (19). Install switch (15) onto switch support (21) with its attaching hardware. Line up toggle switch (15) with slot in bracket (25), so that lateral movement of shutters will actuate switch.

(6) Install chain (28) with screw (26) and nut (27).

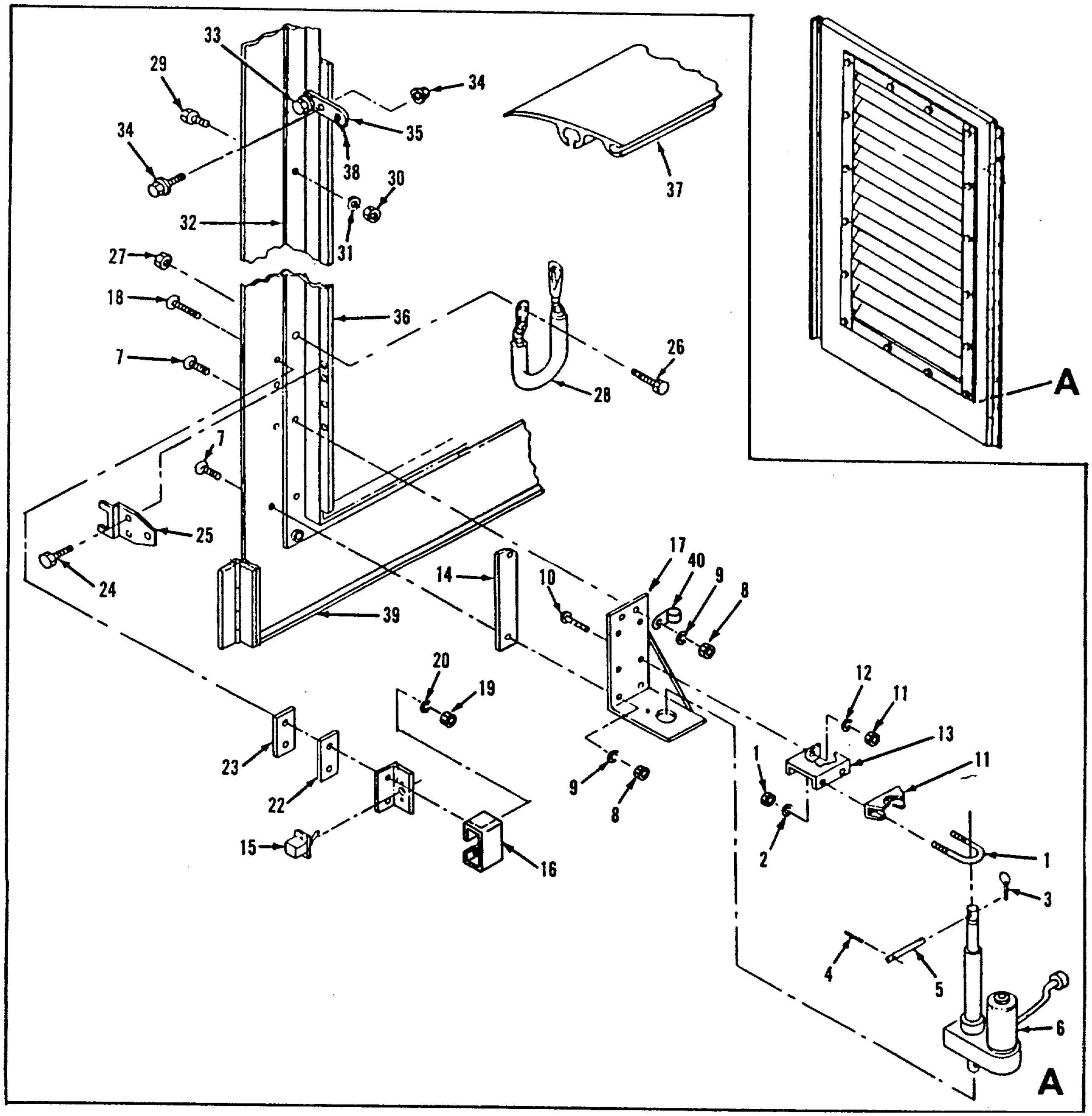
(7) This completes assembly of right-hand doors. Left-hand doors are similarly assembled, except actuator mechanism is on the opposite side.

b. Right Side. Refer to figure 5-17 and install as follows:

(1) Attach upper side panel (42) to the support frame with nine screws (39), washers (41), and nuts (40).

(2) Attach lower side panel (35) to the base assembly with nine screws (32), washers (34), and nuts (33); and one screw (59), washer (34), and nut (33).

(3) Attach side panel (54) to the support frame (at the top and bottom only) with five screws (52), and nuts (53). Install two screws (36), washers (38),



1. Clamp	11. Nut	21. Switch support	31. Lockwasher
2. Lockwasher	12. Lockwasher	22. Shim	32. Shutter assy
3. Quick-release pin	13. Bracket	23. Spacer	33. Bolt
4. Dowel pin	14. Spacer	24. Screw	34. Bolt with lock
5. Drill rod	15. Switch	25. Bracket	35. Arm
6. Actuator	16. Switch cover	26. Screw	36. Control bar
7. Screw	17. Bracket	27. Nut	37. Vanes
8. Nut	18. Screw	28. Chain assy	38. Hook
9. Lockwasher	19. Nut	29. Screw	39. Access door
10. Screw	20	Lockwasher	30. Nut40. Clamp

Figure 15-16. Housing Kit, Door and Shutter Assembly

and nuts (37) joining side panel (54) and upper side panel (42).

(4) Install side panel (45) to support frame with eleven screws (43) and nuts (44). Install two screws (39), washers (41), and nuts (40) joining side panel (45) and upper side panel (42).

(5) Similarly, install side panel (51) with eleven screws (49), and nuts (50) to support frame. Add two screws (29), washers (31), and nuts (30) to attach side panel (51) to lower side panel (35), and attach two clamps (58) with the same hardware.

NOTE

Clamps (17, 23 and 31A) are used to secure louver wiring harness (3, figure 15-23)

(6) Install side panel (48) to support frame (at the top and bottom only) with five screws (46), and nuts (47). Install two screws (29), washers (31), and nuts (30) joining lower side panel (35) and side panel (48) together.

(7) Install top side panel (28) to support frame with nine screws (25), washers (27), and nuts (26).

(8) Install bottom side panel (24) to support frame with nine screws (20), washers (22), and nuts (21). Use the same hardware to attach three clamps (23).

NOTE

Door and shutter assemblies are left-hand and right-hand assemblies. (Two left-hand assemblies on left side of housing and two right-hand assemblies on right side of housing). Use correct door assembly.

(9) Install right-hand preassembled door and shutter assembly (19) by attaching hinge to side panel (54) with twelve screws (14), washers (15), and nuts (16). Using the same hardware, attach two clamps (17). Attach door holder rod (18); then close loop ends.

(10) Similarly, install other right-hand pre-assembled door and shutter assembly (19) to side panel (51) with hinge attached with twelve screws (14), washers (15), and nuts (16). Using the same hardware attach one clamp (17). Attach door holder rod (18); then close loop ends.

NOTE

All access doors (two on each side of housing) are different. Identify and locate by comparing to illustrations.

(11) Install access door (8) by attaching hinge to side panel (45) with twelve screws (1), washers (2), and nuts (3). Attach rod holder (18); then close loop ends.

(12) Similarly, install the other access door 98) by attaching hinge to side panel (48) with twelve screws (1), washers (2), and nuts (3). Attach door holder rod (18); then close loop ends.

(13) Install relay assembly (4) in the external power box with four screws (5), washers (7), and nuts (6). Install DC wiring diagram plates (10 and 11) and DC schematic plate (12) using eighteen rivets (9).

(14) Attach corner post (57) to support frame with eight screws (55) and washers (56) and install three screws (52) and nuts (53) attaching corner post (57) to support frame at the bottom.

c. Front. See figure 15-18 and install as follows:

(1) Install identification plate (32) to enclosure panel (30) with two rivets (31).

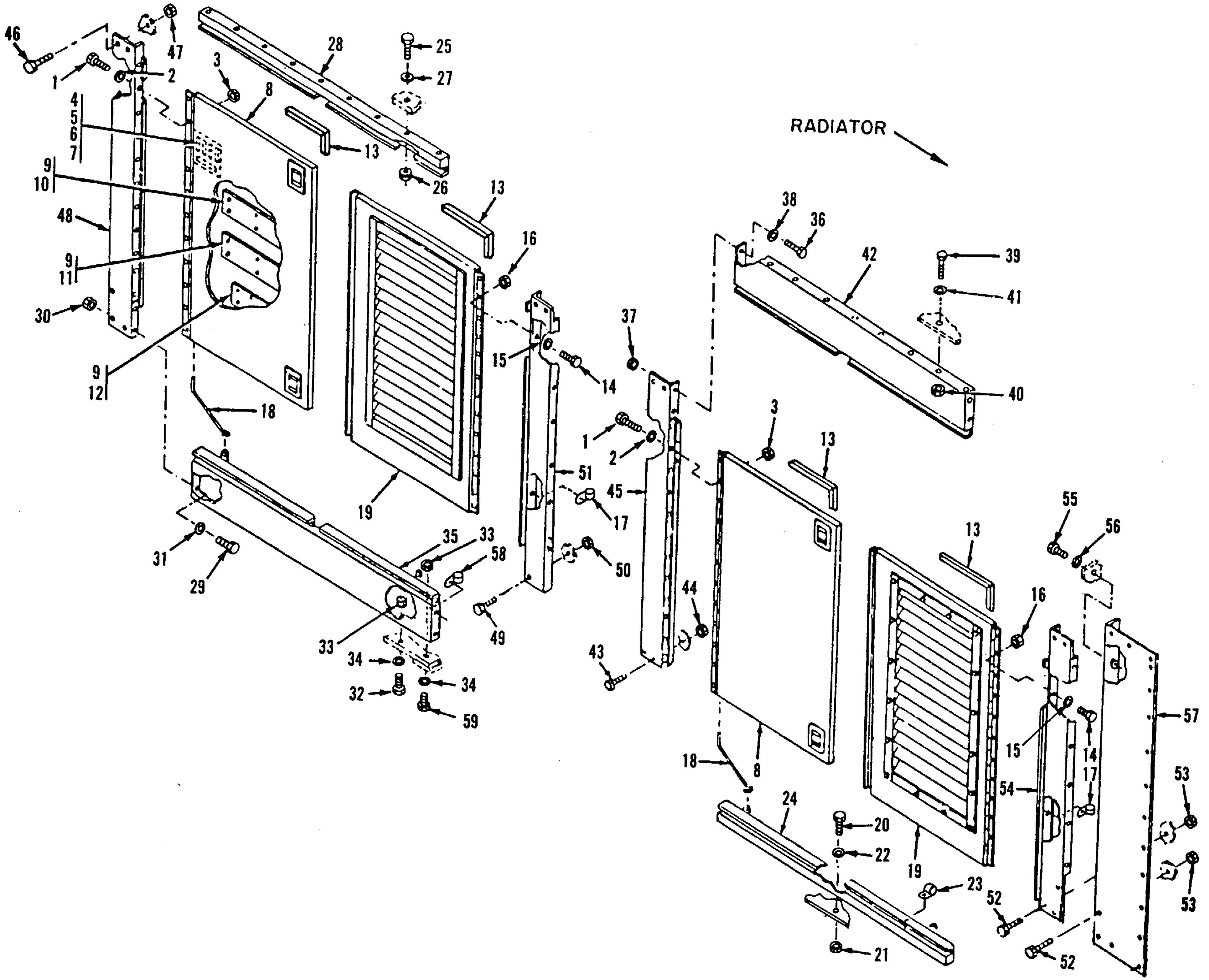


Figure 15-17. Housing Kit, Right side

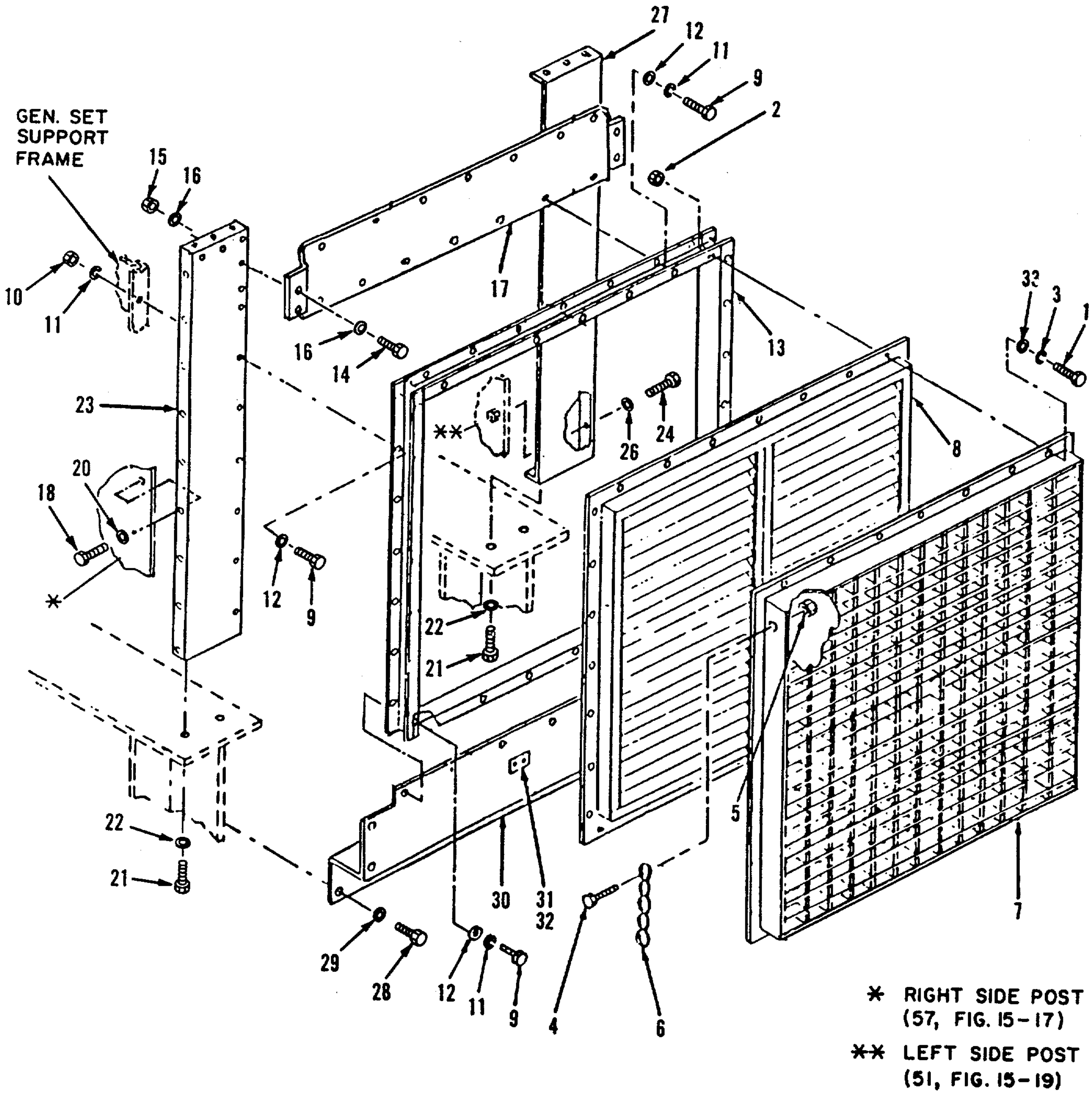
LEGEND FOR FIGURE 15-17

1. Screw
2. Washer
3. Nut
4. Screw
5. Screw
6. Nut
7. Washer
8. Access door
9. Rivet
10. DC wiring diagram
11. DC wiring diagram
12. DC schematic plate
13. Stripping
14. Screw
15. Washer
16. Nut
17. Clamp
18. Door holder road
19. Soor and shutter assy
20. Screw
21. Nut
22. Washer
23. Clamp
24. Bottom panel
25. Screw
26. Nut
27. Washer
28. Top side panel
29. Screw
30. Nut
31. Washer
32. Screw
33. Nut
34. Washer
35. Lower side panel
36. Screw
37. Nut
38. Screw
39. Screw
40. Nut
41. Washer
42. Upper panel
43. Screw
44. Nut
45. Side panel
46. Screw
47. Nut
48. Side panel
49. Screw
50. Nut
51. Side panel
52. Screw
53. Nut
54. Side panel
55. Screw
56. Washer
57. Post
58. Clamp
59. Screw

(2) Line up panel (23) with right side post and attach with eight screws (18) and washers (20). Install two screws (21) and washers (22) at bottom of panel (23) through base assembly.
(3) Line up panel (27) with left side post and attach with eight screws (24) and washers (26). Install two screws (21) and washers (22) at bottom of panel (27) through base assembly
(4) Attach sides of upper panel (17) to panels (23 and 27) with two screws (14), washers (16) and nuts (15) per side.
(5) Install enclosure panel (30) to base assembly with twelve existing screws (28) and washers (29).
(6) Install support frame (13) at sides on panels (23 and 27), with seven screws (9), washers (11 and 12), and nuts (10), per side. (Use five (5) sets of hardware for code 'B').
(7) Install support frame (13) on panels (17 and 30) with seven screws (9), and washers (11 and 12), at the top; and six screws (9), and washers (11 and 12), at the bottom.
(8) Install exhaust shutter (8) and grille (7) to support frame (13) with 28 screws (1), washers (3 and 33), and nuts (2).
(9) Install two chain assemblies (6) with screws (4) and nuts (5).

d. Left Side. Refer to figure 15-19 and install as follows:

(1) Attach upper side panel (36) to support frame with nine screws (33), washers (35), and nuts (34).
(2) Attach lower side panel (29) to the base assembly with nine screws (25), washers (28), and nuts (27); and one screw (26), washer (28), and nut (27).
(3) Attach side panel (42) to the support frame (at the top and bottom only) with five screws (40) and nuts (41). Install two screws (30), washers (32), and nuts (31) joining side panel (42) and upper side panel (36).
(4) Install side panel (48) to support frame with eleven



LEGEND

1. Screw
2. Nut
3. Lockwasher
4. Screw
5. Nut
6. Chain assy
7. Grille
8. Exhaust shutter
9. Screw
10. Deleted
11. Lockwasher
12. Washer
13. Support frame
14. Screw
15. Nut
16. Washer
17. Upper panel
18. Screw
19. Deleted
20. Washer
21. Screw
22. Washer
23. Panel, LH
24. Screw
25. Deleted
26. Washer
27. Panel, RH
28. Screw
29. Washer
30. Enclosure
31. Rivet
32. Identification plate
33. Washer

Figure 15-18. Housing Kit Front

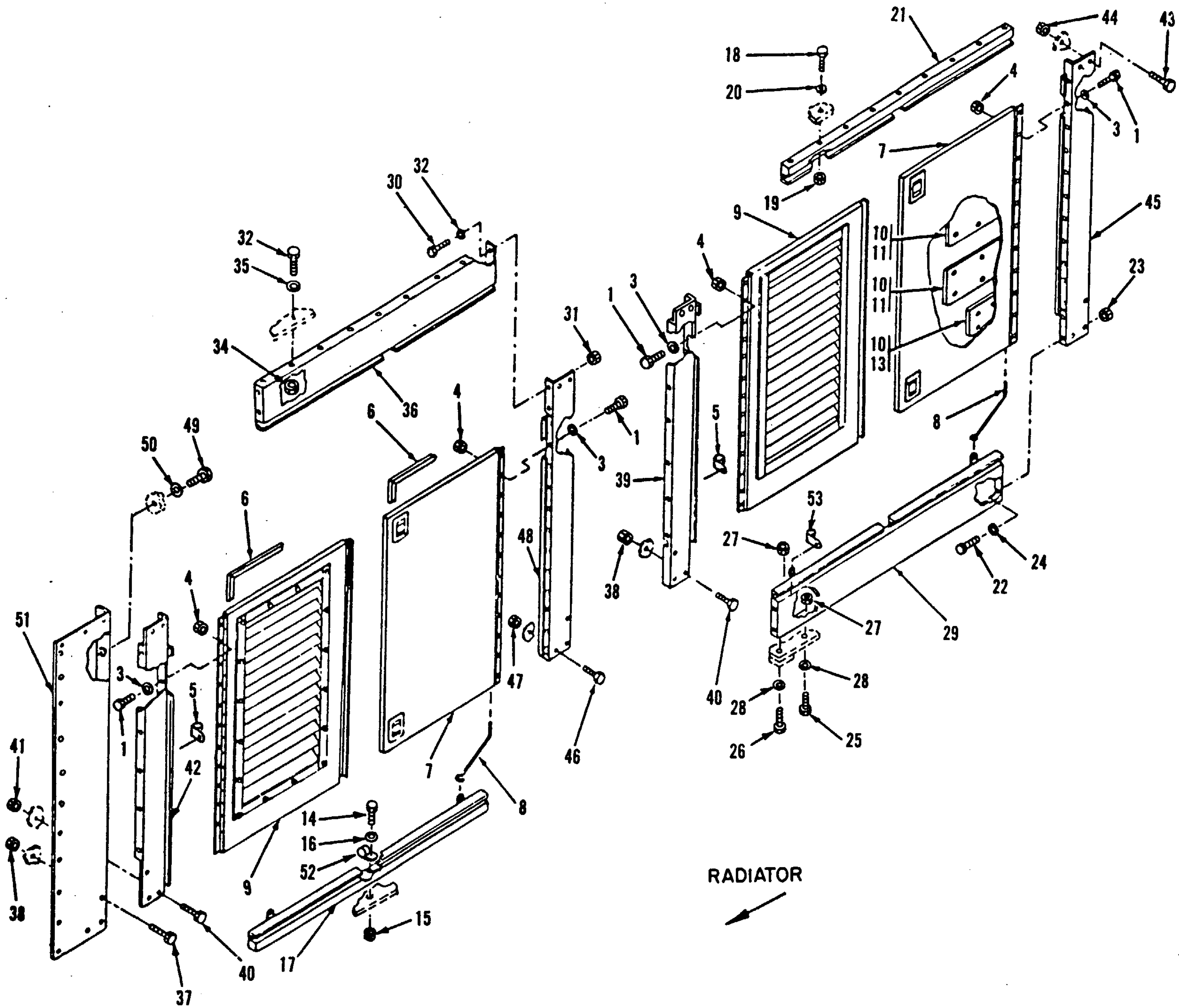


Figure 15-19. Housing Kit, Left Side

LEGEND FOR FIGURE 15-19

1. Screw
2. Deleted
3. Washer
4. Nut
5. Clamp
6. Stripping
7. Door LH
8. Door holder rod
9. Door and shutter assy
10. Rivet
11. AC wiring diagram
12. AC wiring diagram
13. AC schematic plate
14. Screw
15. Nut
16. Washer
17. Bottom side panel
18. Screw
19. Nut
20. Washer
21. Top side panel
22. Screw
23. Nut
24. Washer
25. Screw
26. Screw
27. Nut
28. Washer
29. Lower side panel
30. Screw
31. Nut
32. Washer
33. Screw
34. Nut
35. Washer
36. Upper side panel
37. Screw
38. Nut
39. Side panel
40. Screw
41. Nut
42. Side panel
43. Screw
44. Nut
45. Side panel
46. Screw
47. Nut
48. Side panel
49. Screw
50. Washer
51. Post
52. Clamp
53. Clamp

screws (46) and nuts (47). Install two screws (30), washers (32), and nuts (31) joining side panel (48) and upper side panel (36).

(5) Similarly, install side panel (39) with five screws (40) and nuts (38) to support frame. Add two screws (22), washers (24), and nuts (23) to attach side panel (39) to lower side panel (29). Use same hardware to attach two clamps (24A).

NOTE

Clamps (5, 52 and 53) are used to secure louver wiring harness (3, figure 15-23).

(6) Install side panel (45) to support frame (at the top and bottom only) with five screws (43) and nuts (44). Install two screws (22), washers (24), and nuts (23) to join side panel (45) and lower side panel (29).
(7) Install top side panel (21) to support frame with nine screws (18), washers (20), and nuts (19).
(8) Install bottom side panel (17) to support frame with nine screws (14), washers (16), and nuts (15). Use same hardware to attach three clamps (16A).
(9) Install pre-assembled door and shutter (9) by attaching hinge to side panel (42) with twelve screws (1), washers (5), and nuts (4). Use same hardware to attach two clamps (5). Attach door holder rod (8); then close loop ends.
(10) Similarly, install the other pre-assembled door and shutter assembly (9) to side panel (39) with twelve screws (1), washers (3), and nuts (4). Use same hardware to attach one clamp (5). Attach door holder rod (8); then close loop ends.
(11) Install access door (7) by attaching hinge to side panel (48) with twelve screws (1), washers (5) and nuts (4). Attach door holder rod 98); then close loop ends.
(12) Similarly, install the other access door (7) by attaching hinge to side panel (45) with twelve screws (1), washers (3), and nuts (4). Attach door holder rod (8); then close loop ends.
(13) Install AC wiring diagrams (11 and 12) and AC schematic (13)

to access door (7) with eighteen rivets (10).

(14) Attach corner post (51) to support frame with eight screws (49) and nuts (50); and install three screws (37) and nuts (38) attaching corner post (51) to support frame at the bottom.

e. Rear. Refer to figure 15-20 and install as follows:

(1) Attach corner post (36) to support frame with screws (34) and washers (35).
(2) Similarly, attach corner post (39) to frame with screws (37) and washers (38).
(3) Install upper panel (33) to both corner posts (36 and 39) with six screws (30), washers (32), and nuts (31).
(4) Attach lower panel (24) to panel (20) with six screws (17) and washers (18). Attach bottom of panel (24) to top of panel (29) with seven screws (21), washers (22) and nuts (23). These three panels will be installed later on.
(5) Install right-hand panel (12) to corner post (36) and upper panel (33) with ten screws (10).
(6) Similarly, install left-hand panel (15) to corner post (39) and upper panel (33) with ten screws (13).
(7) Install panels (20, (24), and (29) pre-assembled in step (4) by attaching to the base assembly with four screws (25), nuts (48), washers (26); and four screws (27), and washers (28). Bolt right-hand panel (12) to panel (20) with three screws (17), washers (18), and nuts (19). Bolt panel (24) to right-hand panel (15) with three screws (10). Bolt left-hand panel (15) bottom to panel (24) with three screws (10). Bolt ends of panel (24) to corner posts (36 and 39) with four screws (21), washers (22) and nuts (23). Install twelve screws around fuel tank filler neck area. Bolt panel (20) to left-hand panel (15) with three screws (17), washers (18), and nuts (19).
(8) Install access door (9) to right-hand panel (12) with six screws (4) and nuts (5). Attach door holder rod (6); then close loop ends.
(9) Install operating instructions plate (8) to access door (9) with six rivets (7).
(10) Install access door (3) to left-hand panel (15) with six screws 91) and nuts (2). Attach door holder rod (6); then close loop ends .
(11) Assemble cover and sleeve assembly by attaching sleeve (41) to cover slate panel (47) with bushing (40) and retainer plate (44) fastened with four screws (42) and nuts (43). Attach assembled panel to panel (20) with fourteen screws (45) and nuts (46).

f. Top. Refer to figure 15-21, partially disassemble muffler assembly, and install housing kit top, as follows:

(1) Refer to detail A of figure 15-21, remove eight screws and washers from the muffler support brackets as indicated.

NOTE
Retain screws and washers; they will be replaced later on.

(2) Install panel (34) to support frame with fifteen screws (31) and washers (32).

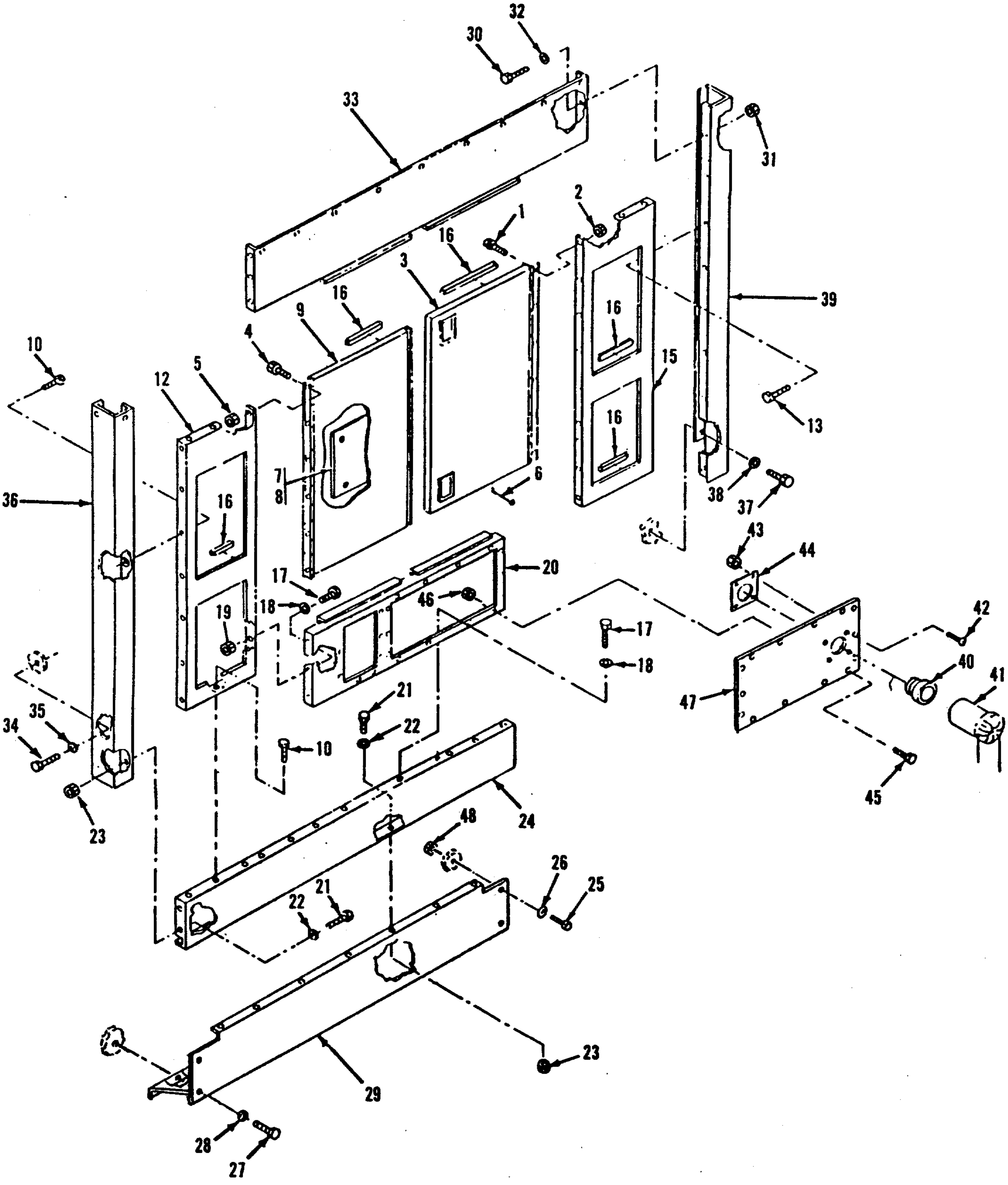


Figure 15-20. Housing Kit, Rear

LEGEND FOR FIGURE 15-20

1.	Screw	25.	Screw
2.	Nut	26.	Washer
3.	Access door	27.	Screw
4.	Screw	28.	Washer
5.	Nut	29.	Washer
6.	Door holder rod	30.	Screw
7.	Rivets	31.	Nut
8.	Operating instructions plate	32.	Washer
9.	Access door	33.	Upper rear panel
10.	Screw	34.	Screw
11.	Deleted	35.	Washer
12.	Rear panel	36.	Corner Post, LH
13.	Screw	37.	Screw
14.	Deleted	38.	Washer
15.	Rear panel	39.	Corner post, RH
16.	Stripping	40.	Bushing
17.	Screw	41.	Sleeve
18.	Washer	42.	Screw
19.	Nut	43.	Nut
20.	Rear panel	44.	Retainer plate
21.	Screw	45.	Screw
22.	Washer	46.	Nut
23.	Nut	47.	Cover plate
24.	Lower rear panel	48.	Nut

NOTE

Fasten front of panel with the top panel located over the control cubicle.

(3) Install panel (30) to support frame with ten screws (28) and nuts (29). Install five screws only on each outside edge of panel (30).

(4) Radiator access door (10) must be attached to panel (7) by first assembling and attaching stud receptacle (13). Insert stud (13A) into receptacle (13) and secure stud with cross pin (13B). Attach stud receptacle (13) to panel (7) with two rivets (12). Next install access door (10) with its seal (11) to panel (7) with three screws (8) and nuts (9).

(5) Install panel (7) (with radiator access door installed) to support frame with nineteen screws (5) and washers (6). Install screws only in outer edges of panel (7).

NOTE

Be sure to line up front of panel (7) with top of panel located over shutter assembly.

(6) Install panel (16) onto support frame with twenty screws (14) and nuts (15). Install screws on edge nearest muffler assemblies, and on both side edges.

(7) Panel (23) must be located under muffler assemblies. Carefully lift both muffler assemblies (just enough to allow panel (23) to slip under) and locate panel (23) over support frame holes. Line up muffler assembly brackets with holes. Attach panel (23) with sixteen screws (21) and nuts (22). Do not install screws on front end of panel at this time.

(8) Replace the eight screws and washers, previously removed, on the muffler assembly brackets.

(9) Install strip (4), over panels (7) and (16), with twenty

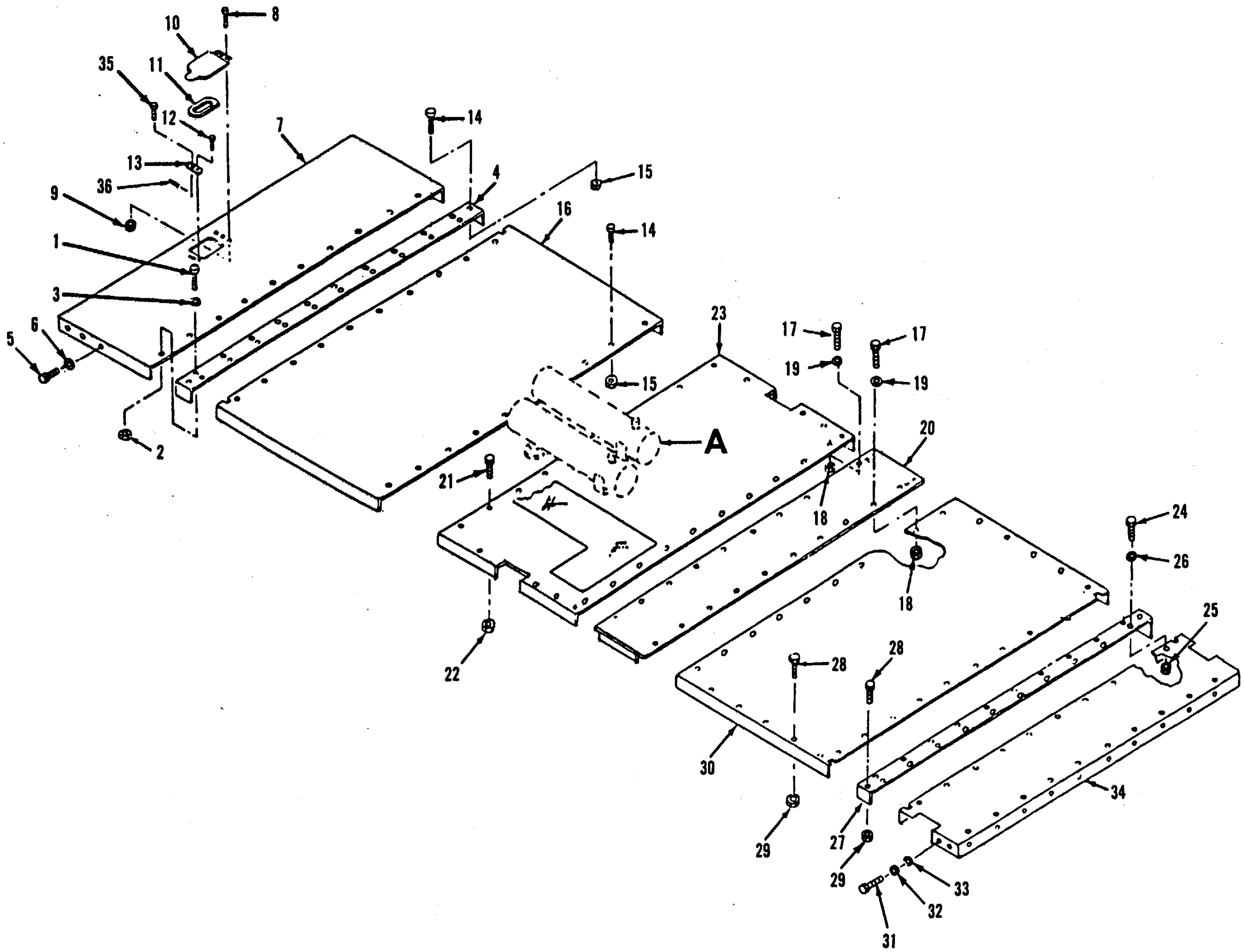
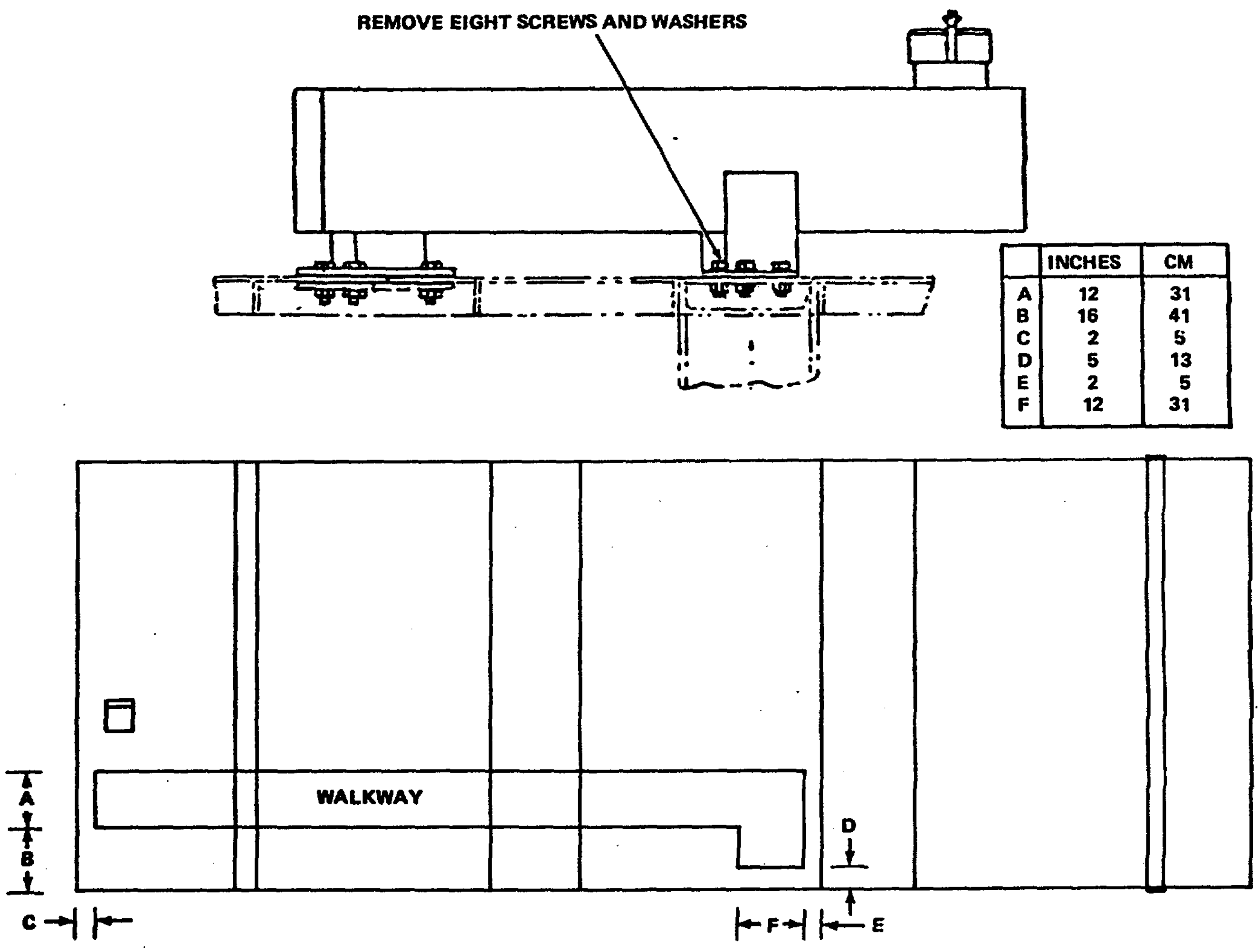


Figure 15-21. Housing Kit, Top (Sheet 1 of 2)

LEGEND FOR FIGURE 15-21

1. Screw
2. Nut
3. Washer
4. Strip
5. Screw
6. Washer
7. Front panel
8. Screw
9. Nut
10. Access door
11. Seal
12. Rivet
13. Receptacle
14. Screw
15. Nut
16. Panel
17. Screw
18. Nut
19. Washer
20. Panel
21. Screw
22. Nut
23. Formed panel
24. Nut
25. Nut
26. Washer
27. Strip
28. Screw
29. Nut
30. Formed panel
31. Screw
32. Washer
33. Deleted
34. Panel
35. Stud
36. Crosspin



	INCHES	CM
A	12	31
B	16	41
C	2	5
D	5	13
E	2	5
F	12	31

Figure 15-21. Housing Kit, Top (Sheet 2 of 2)

LEGEND

1.	Spring	13.	Control bar
2.	Bolt	14.	Stud
3.	Locknut	15.	Angle
4.	Pin	16.	Vanes
5.	Lever	17.	Frame
6.	Spring	18.	Outlet hose
7.	Bolt	19.	Inlet hose
8.	Cosntrol block	20.	Connector
9.	Cotter pin	21.	Connector
10.	Rod	22.	Elbow
11.	Screw	23.	Outlet hose
12.	Control assy	24.	Clamp

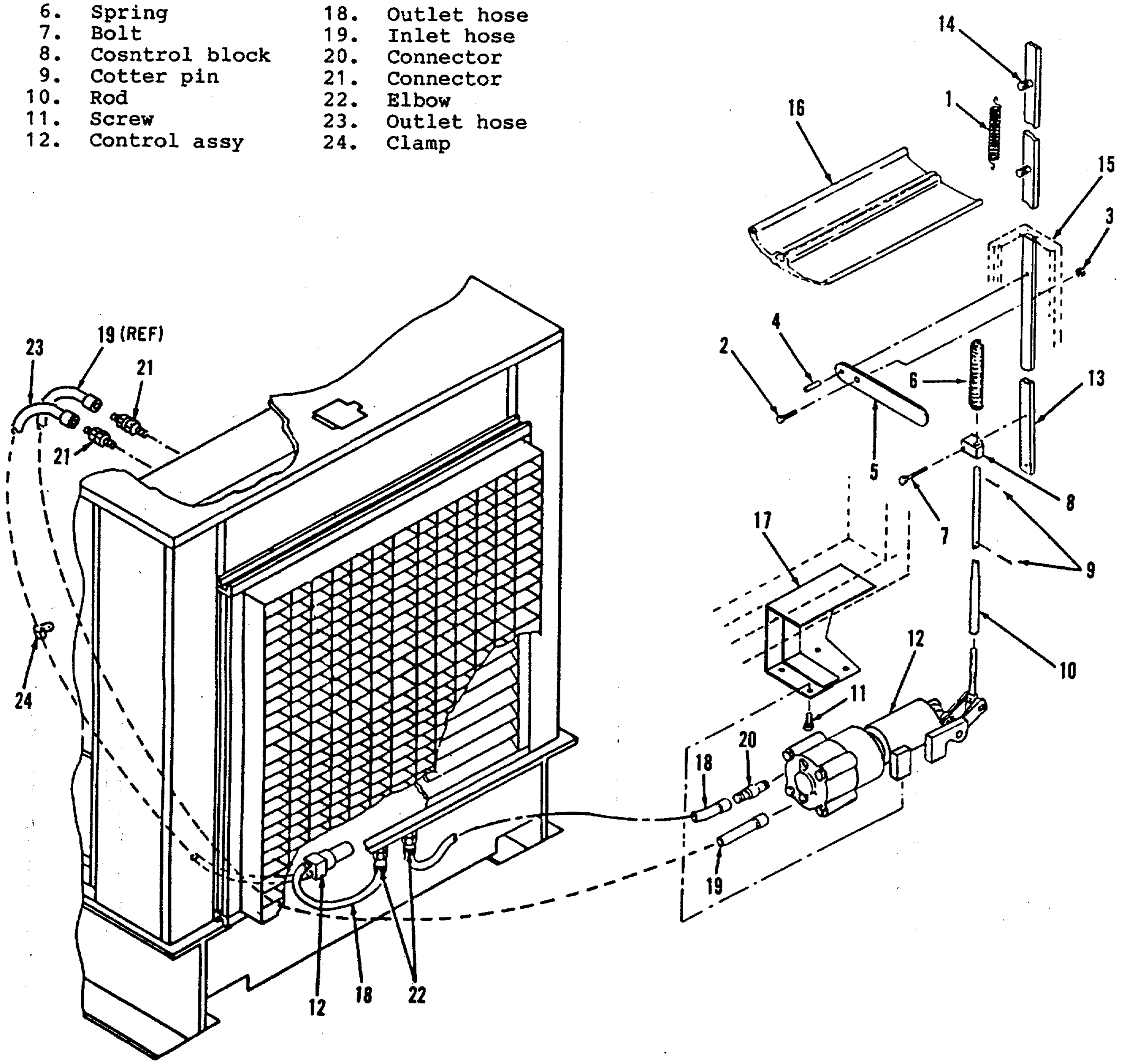


Figure 15-22. Housing Kit, Shutter Assembly

screws (1), washers (3), and nuts (2). In the one hole at each end of the strip (4), install one screw (14), and nut (15).

(10) Similarly, install strip (27) over panels (34) and (30), with screws (24 and 28), washers (26), and nuts (25 and 29).

(11) Install panel (20) with eighteen screws (17), washers (19), and nuts (18).

(12) Walkway tread (detail A, figure 15-21) is a nonskid walkway compound MIL-W-5044B, Type II. Color is FED-STD-595, No. X24087. Install in accordance with dimensions shown in detail A.

g. Shutter Assembly. Refer to figure 15-22 and install as follows:

(1) Attach control assembly (12) to shutter frame (17) with four screws (11).

(2) Attach rod (10) to control (12) with cotter pin (9).

(3) Mount studs (14) in control bar (13) and install control bar (13) in angle (15).

(4) Mount control block (8) to bar (13) with bolt (7).

(5) Attach lever (5) to angle (15) with bolt (2) and nut (3).

(6) Install pin (4) in lever (5) and control bar (13).

(7) Assemble vanes (16).

(8) Install cotter pins (9), assemble springs (1 and 6).

(9) Install connectors (20) in control (12) then connect hoses (19 and 20).

(10) Connect other end of hose (18) to elbow (22). Connect other end of hose (19) to connector (21). Install two hose clamps (17A) using existing hardware.

(11) Fill radiator with coolant in accordance with paragraph 13 b, Operator and Organizational Maintenance manual.

h. Electrical Harness. See figures 15-23 and fold outs FO-14 and FO-15. The electrical harness assembly for the housing kit louver control consists of two harnesses and a relay assembly. The relay assembly is mounted in the external power box with a harness connecting it to the other terminal boards in the external power box, and an electrical connector to be installed in an existing opening in the external power box enclosure. The other harness connects from the external power box to louver actuators and their switches and is secured with clamps using existing hardware. Figure 15-23 is the wiring harness installation and FO14 and FO-15 are the wiring information. Install as follows:

(1) Install the relay assembly (1) in the external power box as specified in paragraph 15-25 b, step (13).

(2) On external power box assembly enclosure wall, remove plate covering existing hole (next to electrical connectors) and install connector J32 of harness (2) on wall.

(3) Refer to figure 15-23 and connect this harness as shown to terminal board TB303 on relay assembly and terminal boards TB202 and TB203 on external power box assembly rear wall.

(4) Install harness (3) with sixteen clamps (4) using existing hardware.

(5) Connect Jacks and connectors to the respective actuators and switches located on the four door and shutter assemblies. Connect P32 to connector installed in step (2).

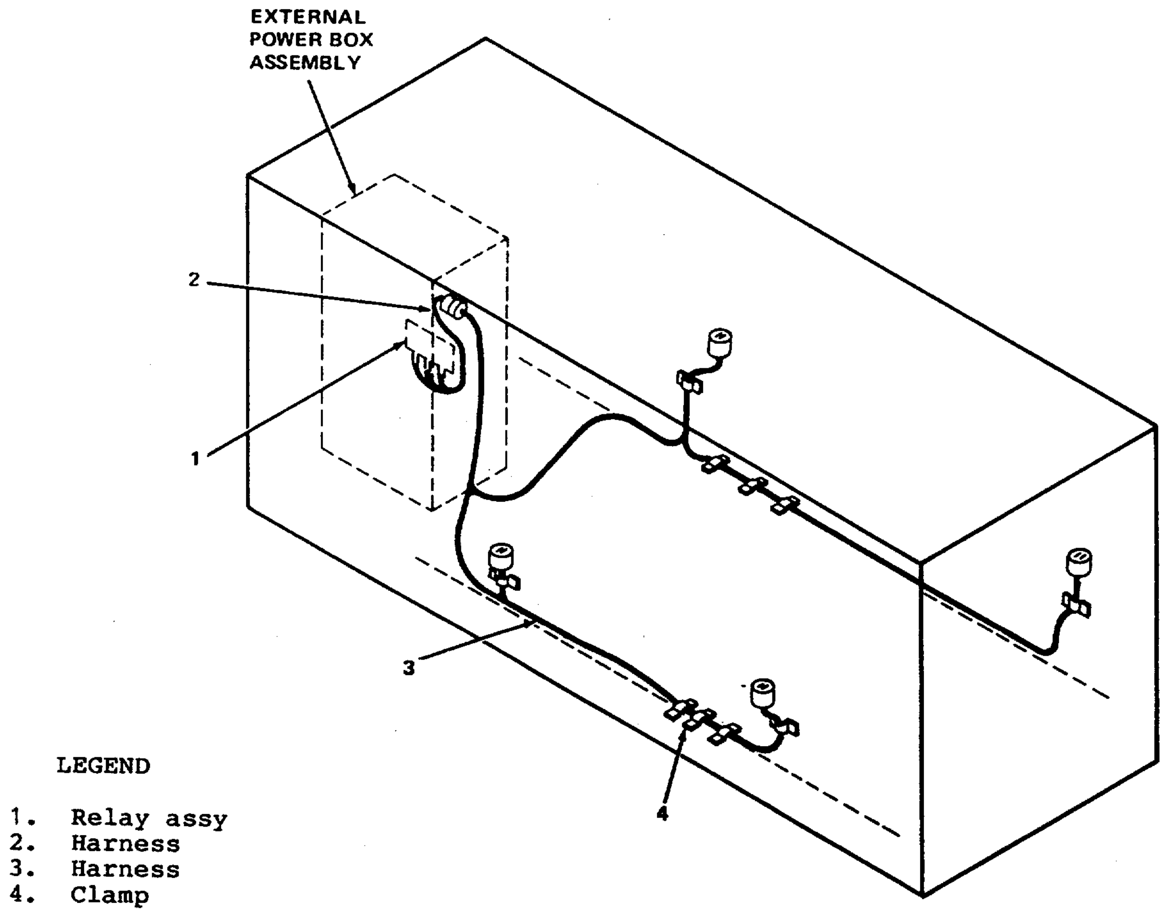


Figure 15-23. Housing Kit Wiring

15-26. REMOVAL. Remove housing kit in the following sequence: Electrical harness, top, rear, left side, front (radiator end), and right side.

a. Electrical Harness. See figures 15-23 and fold outs FO-14 and FO-15.

WARNING

TURN OFF ALL POWER

(1) Disconnect jacks and connectors from louver actuators and switches.
(2) Remove all clamps (4) securing harness (3) to housing kit structure.
(3) Disconnect J32 from external power box assembly. Remove harness.
(4) Disconnect harness (2) (in external power box assembly) from TB303 on relay assembly (1) and TB202 and TB203 in the rear wall of external power box assembly.
(5) Remove relay assembly (1) from rear wall of external power box assembly. Restore existing hardware.
(6) Remove connector J32 on harness (2) from wall of external power box assembly enclosure.
(7) Cover hole (created by removing connector J32) with plate.
(8) Remove harness (2).

b. Shutter Assembly. See figure 15-22 and remove shutter assembly as follows:

(1) Remove grille (7), (figure 15-18) by removing hardware, (1, 2, 3, 33). Open draincock (33, figure 7-1), and drain coolant into suitable container.
(2) Disconnect hoses (18, 19, 25, Figure 15-22) from actuators (12).
(3) Remove two hose clamps (24) and replace the hardware that secured them. Remove hoses (23 and 19) and connectors (21). Place plug after removing connectors (21) in radiator (86), (figure 7-1).
(4) Remove shutter assembly (8) figure 15-18, by removing screws (1), nuts (2), washers (33) and support (13) with screws (9), washers (11, 12) and nut (10).

c. Top. Refer to figure 15-21 and remove housing kit top as follows:

(1) Remove strip (4) by removing screws (1), washers (3), and nuts (2); and screws (14) and nuts (15).
(2) Similarly, remove strip (27) by removing screws (24), washers (26), and nuts (25); and screws (28) and nuts (29).
(3) Remove panel (20) by removing screws (17), washers (19), and nuts (18).
(4) Referring to detail A in figure 15-21, remove the eight screws and washers from the muffler support brackets as shown.

NOTE

Retain screws and washers. The will be replaced later on.

(5) Remove screws (21) figure 5-21 and nuts (22) attaching panel (23) to support frame. Now carefully lift both muffler assemblies (just enough to allow panel to slip out) and remove panel (23)
(6) Replace the eight screws and washers, previously removed, on the muffler assembly brackets.
(7) Remove panel (16) by removing screws (14) and nuts (15).
(8) Remove panel (7) by removing screws (5) and washers (6).
(9) If so desired, remove radiator access door (10) by removing screws (8), nuts (9), and seal (11). Remove stud receptacle (13) and its stud and pin by removing rivets (12).
(10) Remove panel (30) by removing screws (28) and nuts (29).
(11) Remove panel (34) by removing screws (31) and washers (32).

d. Rear. Refer to figure 15-20 and remove as follows:

(1) Disassemble cover and sleeve assembly by removing plate (47) from housing by removing screws (45) and nuts (46). Disassemble sleeve (41), bushing (40), and retainer plate (44) by removing screws (42) and nuts (43).
(2) Remove access door (3) by first opening loop ends on door holder rod (6) and then removing rod and screws (1) and nuts (2).
(3) Remove access door (9) by first opening loop ends on door holder (6) and then removing rod, screws (4) and nuts (5).
(4). Remove all three panels (20, 24, and 29) as a unit. Remove screws (17), washers (18), and nuts (19) which secure panel (12) to panel (24). Remove screws (21), washers (22) and nuts (23) which secure panel (24) at each end to corner

posts (36 and 39). Remove screws (17), washers (18), and nuts (19) which secure panel (12) to panel (20). Remove screws (13) which secure left-hand panel (15) to bottom panel (24). Remove screws around fuel tank filler neck area. Remove screws (13) left-hand panel (15) which secure panel (20). Remove screws (25), washers (26), and nuts (48); and screws (27) and washers (28) securing panel (29) to base assembly.

(5) Remove right-hand panel (12) from corner post (36) and upper panel (33) by removing screws (10).
(6) Similarly, remove left-hand panel (15) from corner post (39) and upper panel (33) by removing screws (13).
(7) Disassemble panels (20, 24 and 29). Remove screws (17), and washers (18) which secure panel (20) to panel (24). Remove screws (21), washers (22), and nuts (23) which secure panel (24) to panel (29).
(8) Remove upper panel (33) from corner posts (36 and 39), by removing screws (30), washers (32), and nuts (31).
(9) Remove corner post (36) from support frame by removing screws (34) and washers (35).
(10) Similarly, remove other corner post (39) by, removing screws (37) and washers (38).

e. Left Side. Refer to figure 15-19 and remove as follows:

(1) Remove corner post (51) by removing screws (37), and nuts (38); and screws (49) and washers (50) which secure the post to the support frame.
(2) Remove access door (7) by first opening loop ends on door holder rod (8) and then removing rod, screws (1), and washers (3), and nuts (4).
(3) Similarly, remove the other access door (7) by first opening loop ends on door holder rod (8) and then removing rod, screws (1), washers (3), and nuts (4).
(4) Remove door and shutter assembly (9) by first opening loop ends on door holder (8) and then removing rod, screws (1), washers (3), nuts (4), and clamps (5).
(5) Similarly, remove the other door and shutter assembly by first opening loop ends on door holder rod (8), then removing rod, screws (1), washers (3), nuts (4), and clamps (5).
(6) Remove bottom side panel (17) by removing screws (14), washers (16), nuts (15), and clamps (16A).
(7) Remove top side panel (21) by removing screws (18), washers (20), and nuts (19).
(8) Remove side panel (45) by removing screws (43) and nuts (44) from support frame, and remove screws (22), washers (24), and nuts (23) from panel (29).
(9) Remove side panel (48) from support frame by removing screws (46) and nuts (47). Remove screws (30), washers (32), and nuts (31) from panel (36).
(10) Similarly, remove side panel (39) from support frame by removing screws (40) and nuts (38). Also remove screws (22), clamps (53), washers (24), and nuts (23) from end of panel (29).
(11) Remove side panel (42) from support frame by removing screws (40) and nuts (41).

Also remove screws (30), washers (32), and nuts (31) from end of panel (36).

(12) Remove lower side panel (29) from base assembly by removing screws (25), washers (28), and nuts (27); and one screw (26), washer (28), and nut (27).

(13) Remove upper side panel (36) from support frame by removing screws (33), washers (35) and nuts (34).

f. Front. Refer to figure 15-18 and remove as follows:

(1) Remove screws (4), nuts (5), and chain assemblies (6). Remove shutter (8) and grille (7) from support frame (13) by removing screws (1), nuts (2), and washers (3 and 33).

(2) Remove support frame (13) by removing seven screws (9) and washers (11 and 12) from top flange and six screws (9), and washers (11 and 12) from bottom flange; and remove seven screws (9), washers (11 and 12), and nuts (10) from each side flange.

(3) Remove enclosure panel (30) from base assembly by removing screws (28) and washers (29), and replace hardware in base assembly.

(4) Remove upper panel (17) by removing screws (14), nuts (15), and washers (16).

(5) Remove right-hand panel (23) from right side post by removing screws (18), and washers (20); and from base assembly by removing screws (21) and washers (22).

(6) Remove left-hand panel (27) from left side post by removing screws (24), and washers (26); and from base assembly by removing screws (21) and (22).

g. Right Side. Refer to figure 1'5-17 and remove as follows.

(1) Remove corner post (57) by removing screws (52) and nuts (53); and screws (55) and washers (56) which secure the post to the support frame.

(2) Remove access doors (8) by first opening loop ends on door holder rod (18), then removing rod, screws (1), washers (2), and nuts (3).

(3) Remove door and shutter assemblies (19) by first opening loop ends on door holder rods (18), then removing rod. Remove screws (14), washers (15), nuts (16), and clamps (17).

(4) Remove bottom side panel (24) from support frame by removing screws (20), washers (22), nuts (21) and clamps (23).

(5) Remove top side panel (28) from support frame by removing screws (25), washers (27), and nuts (26).

(6) Remove side panel (48) from support frame by removing screws (46) and nuts (47). Also remove screws (29), washers (31), and nuts (30) from lower side panel (35).

(7) Remove side panel (45) from support frame by removing screws (43) and nuts (44). Also remove screws (36), washers (38), and nuts (37) from panel (42).

(8) Similarly, remove side panel (51) by removing screws (29), washers (31), nuts (30), and clamps (31A) from panel (35).

(9) Remove side panel (54) from support frame by removing screws (52) and nuts (53). Also remove screws (36), washers (38), and nuts (37) from upper side panel (42).

(10) Remove lower side panel (35) from base assembly by removing screws (32), washers (34), and

nuts (33); and one screw (59), washer (34) and nut (33).

(11) Remove upper side panel (42) from support frame by removing screws (39), washers (41), and nuts (40).

h. Door and Shutter Assembly. Refer to figure 15-16 and disassemble the door and shutter assembly as follows:

NOTE

The following procedure is for right-hand doors. The disassembly of left-hand doors is similar, except that the actuator mechanism is on the opposite side.

(1) Remove chain (28) by removing screw (26) and nut (27).

(2) Remove switch cover (16), switch support (21), spacer (23), and shim (22) by removing screws (18), washers (20), and nuts (19). Unsolder wires from switch (15) and remove switch.

(3) Remove electrical connector on actuator (6). Remove actuator (6) from bracket (17) by removing clamps (1), washers (2), and nuts. Remove quick-release pin (3) and pin (4) from rod (5) and remove from actuator shaft.

(4) Remove bracket (17) spacer (14) and clamp (10A) from door by removing screws (7), nuts (8) and washers (9).

(5) Remove brackets (13) from bracket (17) by removing screws (10), washers (12), and nuts (11).

(6) Remove shutter assembly (32) from door by removing screws (29), washers (31), and nuts (30).

5-27. REPAIR AND ADJUSTMENT

a. Sheet metal tears in doors, covers, and panels can be repaired by welding.

b. Paint scratches that reveal bare metal or paint that is removed during repair should be touched up as follows:

(1) Smooth edges of remaining paint with fine sandpaper.

(2) Clean area with Federal Specification P-D-680 solvent and wipe dry with clean cloth.

(3) Treat area and paint in accordance with service requirements.

c. Replace any cover, door, panel, or hardware that is damaged beyond repair.

d. Adjust louver actuators in accordance with paragraph 15-28a.

e. Adjust radiator shutter actuators in accordance with paragraph 15-28b.

15-28. LOUVER ACTUATORS. The following paragraphs provide test, adjustment and replacement instructions for the four identical louver actuators (6, figure 15-16) which are installed with the housing kit.

a. Test.

(1) Connect the positive lead of 24V DC power source to the black lead of the actuator, and the negative lead of the power source to the orange lead of the actuator. The actuator piston should extend.

(2) Reverse the leads of the power source. The actuator piston should retract.

b. Adjustment. Refer to figure 15-16 and adjust the louver actuators by adjusting the switch support (21) of toggle switch (15) so that the switch closes when the shutters are fully open.

c. Replacement. Remove the actuators in accordance with paragraph 15-26h and replace them in accordance with paragraph 15-25a.

15-29. LIMIT SWITCHES. There are four limit switches (15, figure 15-16) used in conjunction with the four louver actuators.

a. Test.
   (1) Connect ohmmeter (Rx1 scale) to terminals of switch.
   (2) Toggle switch several times to closed position; ohmmeter should read zero to 1 ohm in the closed position and read infinite ohms in the open position.

b. Replacement. Remove the limit switches in accordance with paragraph 15-26h and replace them in accordance with paragraph 15-25a.

15-30. RELAY ASSEMBLY. The actuator control relay assembly used in conjunction with the housing kit is located in the external power box and consists of four relays K60, K61, K62, and K63; terminal board TB303; four fuses F60, F61, F62, F63; and a mounting bracket.

a. Test. Refer to figure 15-24 and proceed as follows:
   (1) Apply 24V DC across relay coil K60, monitor contacts of relay with ohmmeter. Check that normally open contacts (3, 6, and 1, 4) are now closed and check that normally closed contact (3, 5, and 2, 4) are now open.
   (2) Remove 24V DC and check that normally open contacts (3, 6, and 1, 4) are now open, and check that normally closed contacts (3, 5, and 2, 4) are now closed.
   (3) Repeat steps (1) and (2) for relay coils K61, K62, and K63.

15-31. RADIATOR SHUTTERS AND ACTUATORS. Two shutter actuators (see figure 15-22) are used in conjunction with the housing kit. Radiator coolant is circulated to the actuators which expands parafin contained inside the actuator housing. The parafin expands as coolant temperature increases and, in turn, drives the actuator piston which is connected to the shutter assembly.

a. Inspect. Inspect the radiator shutters for bent or broken vanes. Inspect the radiator coolant lines to the actuators for leaks and loose connections.

b. Adjustment. Refer to figure 15-22 and proceed as follows:

NOTE

The following adjustment must be made when the radiator coolant is cold.

   (1) Remove cotter pins (9) and adjust rod (10) so that radiator shutters are fully closed. Ensure that actuator piston is fully retracted.
   (2) Reinstall cotter pins (9).

c. Replacement. Remove the radiator shutter actuators in accordance with paragraph 15-26b. and replace them in accordance with paragraph 15-25f.

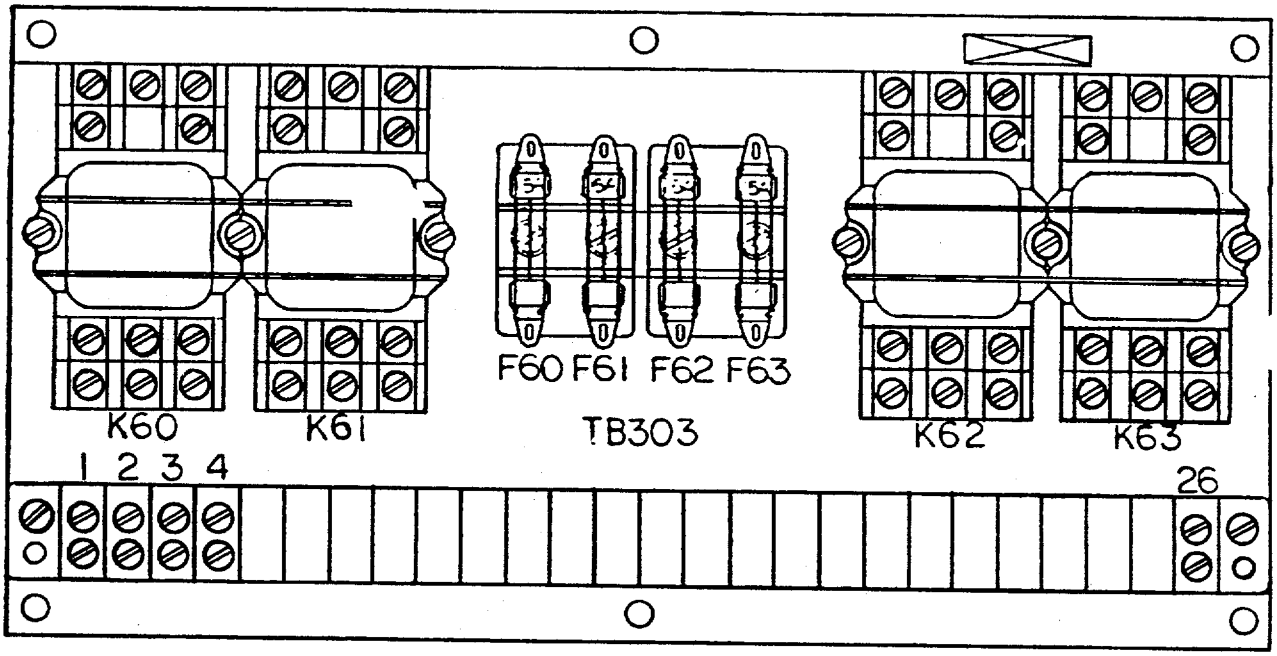


Figure 15-24. Actuator Control Relay Assembly

CHAPTER 16
GENERATOR SET TEST AND INSPECTION AFTER REPAIR OR OVERHAUL
Section I. GENERAL REQUIREMENTS

16-1. The activity performing the repair or overhaul is responsible for the performance of all applicable tests and inspections specified herein. Activities performing maintenance on any portion of the generator set must perform those tests and inspections required by the applicable component or system repair instruction.

Section II. INSPECTION

16-2. GENERAL. A thorough inspection of the generator set shall be conducted to ensure that workmanship and materials are satisfactory. The inspection shall be conducted each time the generator set is overhauled or rebuilt.

16-3. HOUSING AND FRAME INSPECTION.

a. Check that drain holes are open to prevent moisture accumulation.
b. Ensure that exposed parts are properly treated to resist corrosion.
c. Open and close panel doors, engine area doors, and generator area doors to ensure proper installation and freedom of motion.
d. Inspect movable door gasketing to ensure that it is weatherproof.
e. Check that all caps and covers are equipped with ties, chains, or other ties to prevent loss.

16-4. ENGINE INSPECTION.

a. Check mounting bolts of all components and accessories to ensure that they are firmly secured.
b. Check designation and data plates for legibility.
c. Ensure that fuel and hydraulic oil lines are protected from damage due to vibration.

16-5. GENERATOR INSPECTION.

a. Ensure that generator leads are properly identified and protected from damage due to vibration.
b. Ensure that inspection openings are protected by screening or protective plates.
c. Check that the engine generator screws are firmly secured. See table 1-1 for proper torque values.

16-6. ELECTRICAL ACCESSORIES INSPECTION.

a. Check all cable and harness assemblies for secure fastenings and protection against chafing and vibration.
b. Ensure that all cable and harness connectors are firmly secured in their proper place.

Table 16-1. OPERATIONAL TESTS

	TEST	MIL-STD-705B PROCEDURE	TEST PARAMETER
1.	Start and Stop	503.1	Unit will start and stop
2.	Regulator and governor stability and transient response (short term)	608.1a	See tables 1-2 and 1-3
3.	Overspeed protection device	505.2a	2225 ±25 rpm
4.	Phase balance	508.1c	All L-L and L-N voltages only.
5.	Circuit interrupter (short circuit)	512.1c	Instantaneously at 425 ±25 percent of rated current
6.	Circuit interrupter (overload trip)	512.2c	8 ±2 minutes at 130 percent of rated current
7.	Circuit interrupter (undervoltage)	512.3c	Instantaneously below 48 volts. 6 ±2 seconds at 99 ±4 volts or less
8.	Circuit interrupter (overvoltage)	512.3c	Not more than 1 second after voltage has risen to and remained at any value greater than 163 ±3 volts for not less than 200 milliseconds
9.	High oil temperature	(4.7.2 of MIL-G-52880)	255 ±3 Warning 265 ±3 Shutdown
10.	Low oil pressure protective device	515.la	Trip pressure 13 ±2 psi Warning pressure 21 ±2 psi
11.	Reverse power protective device	-	Refer to paragraph 16-8
12.	High coolant temperature protective	515.2a	Warning temperature +213 ±3°F. (+100.5 ±1.70C) Trip temperature +222 ±3°F. (+105.5 ±1.70C)
13.	Low fuel protective device	515.5	Refer to paragraph 16-9.
14.	Regulator range	511.lc	Test at both 50 Hz and 60 Hz. See tables 1-2 and 1-3
15.	Phase sequence (rotation)	507.1c	L_1, L_2, L_3
16.	Frequency adjustment range	511.2b	See tables 1-2 and 1-3
17.	Parallel operation		Refer to paragraph 16-10 provisions

Table 16-1. OPERATIONAL TESTS - Continued

	TEST	MIL-STD-705B PROCEDURE	TEST PARAMETER
18.	Malfunction indicator system	-	Refer to paragraph 16-12
19.	Maximum power	640.1b	In excess of 110 percent of rated load
20.	Test parameters at		At 60 Hz 500 KW at 1500 ft (457 m) at 90°F (32.2°C) 400 KW at 5000 ft (1524 m) at 107°F (41.7°C) 375 KW at 8000 ft (2435 m) at 95°F (25°C) At 50 Hz 417 KW at 1500 ft (457 m) at 90°F (32.2°C) 332 KW at 5000 ft 1524 m) at 107°F (41.7°C) 375 KW at 8000 ft (2435 m) at 95°F (35°C)

CAUTION

Prior to performing any of the operating tests listed in table 16-1, ensure that the generator set is serviced with the correct fuel, oil, and coolant as listed on the data plate.

Section III. OPERATIONAL TESTS

16-7. GENERAL.

a. The tests described in this section require generator set operation and provide verification of generator set performance characteristics.

NOTE

All tests shall be conducted with the 240/416 volt connections, unless otherwise specified.

b. Unless otherwise specified, all test instrumentation will be in accordance with Military Standardization Handbook MIL-HDBK-705 and Military Standard MIL-STD-705B.

c. Temperatures will be measured by means of approximately located thermocouples and properly calibrated read-out devices. Thermocouples will be insulated from contact with other metals, as practical. Temperatures will be recorded in degrees Fahrenheit or Centigrade, depending on the instrument scale, but will be converted to degrees Fahrenheit in all cases. Barometric pressures will be measured by a mercurial barometer which will be corrected for the temperature of the scale, the mercury, for vapor pressure and for the location of the barometer with regard to altitude and latitude. Aneroid barometers will not be used.

d. Operation procedures required in support of the individual tests specified herein shall be performed as in the Operator/Crew and Organization Maintenance manual.

e. All test results, for generator set overhaul, shall be logged on the appropriate forms as required.

f. Perform the operating tests as indicated in table 16-1.

16-8. REVERSE POWER PROTECTIVE DEVICE TEST.

a. Start generator and apply 15 percent load.

b. Depress the red button, marked PRESS TO ADJUST AND TEST, on the control cubicle. Reverse power relay should activate and open load connector.

16-9. LOW FUEL PROTECTIVE DEVICE.

a. To conduct the low fuel protective device test, load instrumentation (as described and illustrated in MIL-HDBK-705) and a stopwatch are required.

b. Test the low fuel protective device as follows:

(1) Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1.

(2) Level the generator set.

(3) Fill the fuel tank using the fuel transfer pump.

(4) Disconnect the auxiliary fuel lines from the fuel tank.

(5) Start and operate the generator set at rated load, till the low fuel fault lights and alarm is energized. This indicates that there is enough fuel in the day tank to operate at rated load and frequency for one hour. Simultaneously start the stop watch.

(6) Continue operating the set for approximately 50 to 60 minutes or until the low fuel protective device switch FL4 shuts down the generator set. This indicates that there is enough fuel left to operate the set at rated load for 15 minutes. Record the time

when the low fuel protective device actuates and shuts down the set.

(7) If the low protective device does not actuate within an hour after the LOW FUEL ENGINE FAULT indicator lights up, the device is faulty. Shut down the generator set immediately and replace the low fuel protective device.

16-10. PARALLEL OPERATION PROVISIONS (Real Power).

a. For 0% Droop Sets:

(1) Place the FREQUENCY DROOP-ISOCHRONOUS switch in the ISOCHRONOUS position.

(2) With rated (500 kw) load on the generator set, measure the DC voltage across pins A and B of one of the paralleling receptacles. Adjust the LOAD GAIN potentiometer, located on the electronic governor controller, until 5 volts DC is indicated. Ensure that pin A is positive. For decrease in load, voltage will decrease proportionately.

b. For 3% Droop Sets:

(1) Place FREQUENCY DROOP-ISOCHRONOUS switch, located on the AC-DC control panel, in the DROOP position.

(2) Adjust the DROOP potentiometer, located on the electronic governor controller for 3 percent droop.

16-11. PARALLEL OPERATION PROVISION (Reactive Power).

a. Remove the shorting plug.

b. With rated load 500 kw at 0.8 PF on the generator set, and the PARALLEL OPERATION-SINGLE UNIT OPERATION switch, located on the generator panel, in the PARALLEL OPERATION position, adjust the REACTIVE LOAD COMPENSATION TM5-6115-593-34 NAVFAC P-8-631-34 TO-35C2-3-463-2 CONTROL, located on AC-DC control panel, until 7.2 volts AC is indicated across pins A and B of one of the paralleling receptacles. For decrease in load, voltage will decrease proportionately.

c. Install the shorting plug.

d. With 500 KW 0.8 PF load applied, the voltage change from no load should be approximately 3 percent.

16-12. MALFUNCTION INDICATOR TEST.

a. The malfunction indicator system is electrically insolated and independent of the protection system. Testing of the indicators can be accomplished at the same time that the protective devices are tested in tests 3, 5, 6, 7, 8, 9, 10, 11, 12, and 13 of table 16-1.

b. In the event that one of the indicator circuits does not work, verify that the lamp is functional by operating the ANNUNCIATOR TEST switch located on the generator panel.

16-13. PHASE BALANCE TEST VOLTAGE.

a. General. Polyphase electrical equipment may not operate properly or may be damaged if the phase voltages of a polyphase generator differ greatly from each other. Also, large differences between the phase voltages of a polyphase generator may be an indication that the generator set has been improperly manufactured or damaged.

b. Apparatus. An rms indicating AC voltmeter, having an accuracy of ±0.1 percent of reading, is required.

c. Test.

(1) Start and operate the generator at rated frequency and at no load.

(2) Adjust the excitation so that any one of the output voltages is at rated power.

(3) Read and record the

generator frequency (speed) and the voltage of each L-L and L-N condition. With the generator operating at rated voltage, frequency, and no load, the maximum difference in the three line-to-neutral voltages shall be not more than 1 percent of rated line-to-neutral voltage. The maximum difference between the voltages of the 120-volt windings of any one phase shall be not more than one volt.

d. Generator with separate excitation.

(1) Determine from the data obtained in 16-13d(2) the maximum and minimum L-L and L-N voltages.

(2) The voltage unbalance is the difference between the maximum and minimum L-L voltages. To express this in percent, divide this difference by rated L-L and multiply by 100.

$$\text{Voltage Unbalance (Coil) in percent} = \frac{V\ max - V\ min}{V\ Rated} \times 100$$

(3) Compare the results of step (2) above with the requirements.

16-14. REGULATOR RANGE TEST.

a. General. The voltage adjust device associated with the voltage regulator provided with the generator set must have adjustment capable of varying the regulated voltage throughout the limits and under the various load conditions and temperature ranges without causing the voltage droop of the set to exceed specification limits. The voltage adjust device also must be capable in some cases of providing and operating voltage other than rated voltage for special types of equipment and to compensate the external line drop.

b. Apparatus. Instrumentation for measuring load conditions, ambient temperature, and the generator field (or exciter field) voltage and current shall be as described in MIL-HDBK-705.

c. Preparation for Test.

(1) Preparation for test.

(a) Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, paragraph 205.1.10 for one voltage and frequency.

(2) Test.

(a) Start and operate the generator set and allow the set to stabilize at rated load, rated voltage and rated frequency. During this period record all instrument readings including thermal instrumention at minimum intervals of 10 minutes. If necessary, adjustments of the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust advices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made. Adjustments to load, voltage or frequency controls shall be recorded on the data sheet at the time of adjustment. Stabilization shall be considered to have occurred when four consecutive voltage and current readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

(b) No further adjustments shall be made to any set control for the remainder of this test except the control panel voltage adjust device.
(c) Record all instrument readings.
(d) Remove load.
(e) Record all instrument readings (after transients have subsided).
(f) Adjust the terminal voltage to the maximum specified value.
(g) Record all instrument readings.

NOTE

All voltages above rated values, the generator will be supplying less than rated current; and at voltages below rated values, the generator will be supplying greater than rated current. Caution should be taken to avoid damage to instrumentation and load banks.

(h) Apply rated load (rated kw at rated power factor).
(i) Record all instrument readings (after transients have subsided).
(j) Remove load and adjust voltage to the maximum attainable value or to a value just prior to actuation of the overvoltage protection device.

NOTE

The output voltage may exceed the rating of-connected equipment.

(k) Record all instrument readings (after transients have subsided).
(l) Apply rated load.
(m) Record all instrument readings (after transients have subsided).
(n) Adjust voltage to the minimum specified value at rated load.
(o) Record all instrument readings (after transients have subsided).
(p) Remove load.
(q) Record all instrument readings (after transients have subsided).
(r) Adjust voltage to the minimum attainable value or a value just prior to activation of the undervoltage protection device.
(s) Record all instrument readings (after transients have subsided).
(t) Repeat steps (a) through (s) above for all other voltage connection(s).

d. Sample Calculations. Regulation (droop) is defined for the purpose of this method as the no-load value minus the rated load value divided by the rated load value the quantity expressed in percent.

$$\% \text{ Regulation} = \frac{NLV - RLV}{RLV} \times 100$$

Where:
NLV = No-Load Voltage
RLV = Rated Load Voltage

e. Results. The data sheets shall indicate the voltage regulation as a percent of rated voltage within the specified limits at the minimum and maximum specified voltages and the regulation as a percent of rated voltage at the extremes, the maximum and minimum voltages attainable and the actuation of the protection devices (if applicable). Compare these results with the requirements of table 16-1.

16-15. FREQUENCY AND VOLTAGE REGULATION, STABILITY AND TRANSIENT RESPONSE TEST (SHORT TERM).

a. General. The frequency regulation (sometimes referred to as droop) of a generator set is the maximum difference between the no load value of frequency and the value at any load up to and including rated load. This difference is expressed as a percentage of the rated frequency of the generator set. The voltage regulation is expressed similarly except that the rms value of voltage is used.

Frequency stability describes the tendency of the frequency to rea3in at a constant value. Generally, the instantaneous value of frequency is not constant but varies randomly above and below a mean value. Stability may be described as either short-term or long-term depending upon the length of time that the frequency is observed. Another term, bandwidth, describes the limits of these variations. Bandwidth is expressed as a percentage of the rated frequency of the generator set. Voltage stability is described similarly.

Frequency transient response describes the reaction of the frequency to a sudden change in some condition; such as, a load change on a generator set. This response consists of the amount of excursion beyond the mean of the new operating band, and the recovery time. The recovery time is the interval beginning at the point where the frequency leaves the original prescribed operating band and ending at the point where it enters and remains within the new prescribed operating band. The amount of surge is expressed as a percentage of the rated frequency of the generator set. The recovery time is expressed in seconds. The voltage transient response is described similarly.

b. Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition, recording meter(s) for recording voltage and frequency shall be required. The recording meters shall be as described in table 2-1.

c. Procedure.

(1) Preparation for test.

(a) Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, paragraphs 205.1.10, for one voltage and frequency. Connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator. (Power the recording meter(s) from the commercial utility.)

(b) Set the recording meter charge speed(s) to a minimum of 6 inches per hours. The following items shall be recorded on both the data sheets and recording chart(s):

1. The date
2. The serial number(s) of the recording meter(s)
3. Generator set identification
4. The recording chart speed(s)
5. The data reading number.

(c) Place all instrumention referred to in paragraph 16-15b in operation.

(2) Test.

(a) Start and operate the generator set and allow the set to stabilize at rated load, rated voltage, and rated frequency. During this period operate the recording meter(s) at a chart speed of not less than 6 inches per hour, and record all instrument readings including thermal instrumentation at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made. Adjustments to load, voltage, or frequency controls shall be recorded on both the data sheet and the recording chart(s) at the time of an adjustment. Stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment of the load, voltage or frequency has been made.

(b) After stabilization has occurred, drop the load to no load and reapply rated load in 50 percent load increments a number of times (three should be sufficient) to ensure that the no load and rated load voltage and frequency are repeatable and that the frequency and voltage regulation is within the limits specified in the procurement document. If any adjustments are necessary, paragraph (a) must be repeated. Reapply rated load.

(c) The recording meter chart speed(s) shall be 12 inches per minute throughout the remainder of this test. At each of the following load conditions (one step) operate the set for a minimum of 40 seconds (or the short terms stability period plus the allowable recovery time as specified in the procurement document). During each load condition read and record all instrument readings except termal instrumentation (for three-phase sets it is not necessary to record line-to-line voltages). Each load condition shall be applied to the generator set in one step at the end of the short-term stability period for the previous load condition. The load conditions are:

1. No load
2. 1/2 rated load
3. No load
4. 1/2 rated load
5. No load
6. 1/2 rated load
7. No load
8. 1/2 rated load
9. Rated load
10. 1/2 rated load
11. Rated load
12. 1/2 rated load
13. Rated load
14. 1/2 rated load
15. Rated load
16. 1/4 rated load
17. 3/4 rated load
18. 1/4 rated load
19. 3/4 rated load
20. 1/2 rated load
21. 3/4 rated load
22. 1/4 rated load
23. 3/4 rated load

(d) Repeat (a) through (c) for all voltage connection(s) and frequency(ies).

d. Results.

(1) Prepare a chart giving for each load change the momentary overshoot or undershoot and the recovery time. For each constant load, give the maximum voltage variation.

(2) Referring to figure 16-1, begin by determining the observed (B) and steady-state (D) voltage bandwidths.

(a) Mark numerically the stabilizations occurring after each load change, starting with the stabilization obtained before the first load change.

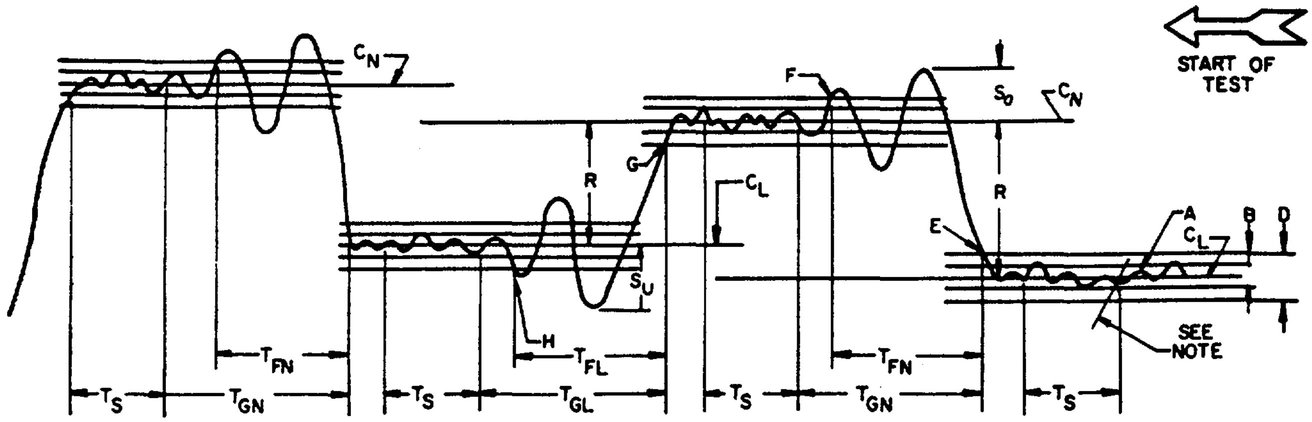
(b) Determine the observed voltage bandwidth (B) by marking the maximum trace excursion and minimum trace excursion in the stabilized portion. Draw two lines parallel to the axis of chart movement, one each passing through these maximum and minimum trace excursions respectively.

(c) Draw a line (C) parallel to and equidistant from the edges of the observed voltage bandwidth. Determined in (b) above.

(d) Using the rated voltage of the generator and given requirements of table 16-1, calculate the steadystate voltage bandwidth (D). Draw this steady-state voltage bandwidth as two parallel lines, parallel to and equidistant from the median (C) at the observed voltage bandwidth.

(3) To determine the maximum voltage variation at constant load:

(a) One-half the observed voltage bandwidth (B) is the plus or minus value of voltage deviation at constant load.



TRACE AND DEFINITIONS APPLY TO EITHER VOLTAGE OR FREQUENCY.

NOTE

CHART MARKED AT START OF TEST.

A ACTUAL INSTRUMENT TRACE OF FUNCTION.

B OBSERVED STEADY-STATE BAND (TWO LINES PARALLEL TO THE AXIS OF CHART MOVEMENT, ONE EACH PASSING THROUGH THE CENTER POINTS OF MAXIMUM AND MINIMUM TRACE EXCURSION, RESPECTIVELY DURING THE SHORT-TERM STABILITY SAMPLE PERIOD, T_S).

C MEAN OF OBSERVED BAND.

C_L MEAN VALUE AT SELECTED LOAD.

C_N MEAN VALUE AT NO LOAD.

D PRESCRIBED STEADY-STATE BAND.

E POINT AT WHICH TRACE INITIALLY LEAVES PRESCRIBED LOAD BAND UNDER CONDITION OF DECREASE IN LOAD.

F POINT AT WHICH TRACE ENTERS AND REMAINS WITHIN PRESCRIBED NO LOAD BAND.

G POINT AT WHICH TRACE INITIALLY LEAVES PRESCRIBED NO LOAD BAND.

H POINT AT WHICH TRACE ENTERS AND REMAINS WITHIN PRESCRIBED LOAD BAND.

R REGULATION BETWEEN ANY TWO LOADS.

S SURGE AFTER A LOAD CHANGE.

S_O OVERSHOOT

S_U UNDERSHOOT

T_{FL} OBSERVED RECOVERY TIME, NO LOAD TO LOAD.

T_{FN} OBSERVED RECOVERY TIME, LOAD TO NO LOAD.

T_G MAXIMUM ALLOWABLE RECOVERY TIME

T_{GL} MAXIMUM ALLOWABLE RECOVERY TIME, NO LOAD TO LOAD.

T_{GN} MAXIMUM ALLOWABLE RECOVERY TIME, LOAD TO NO LOAD.

T_S PRESCRIBED SHORT-TERM SAMPLE TIME FOR DETERMINING STABILITY.

Figure 16-1. Overshoot and Undershoot Chart Recording

(b) Divide each of the values obtained in (a) by the rated voltage of the generator and multiply by 100 to convert to percentage.

(4) To determine the maximum overshoot and undershoot at each load step, and express this as a percentage of its rated voltage, proceed as follows:

(a) From the meter recording charts, determine the maximum amount that the voltage trace goes beyond the line (3) of the observed voltage band following the load change. See figure 16-1 for illustration of overshoot and undershoot.

(b) Divide the result obtained in (a) by rated voltage (as given on the generator nameplate), then multiply by 100 to convert to percentage.

CAUTION

Do not use the constant operating voltage at each load as the divisor in the computation. Use only the rated voltage of the generator.

(5) To determine the time required to restore stable voltage conditions after each load change (recovery time):

(a) The prescribed steady-state voltage bandwidth, extended to the point at which the voltage trace leaves the prescribed steadystate band, shall be considered as the time at which the transient conditions begin. The point at which the voltage trace enters and remains within the prescribed band after a load change shall be considered as the point at which stabilization begins.

(b) Measure the distance (in inches) on the chart from the point where the voltage trace leaves the prescribed steady-state band to the point where it re-enters and remains within the prescribed voltage band for the next load condition.

(c) Divide this distance by the chart speed (in inches per second). This will give the voltage recovery time, in seconds.

(6) Determine the voltage regulation for all load changes (for example, rated load to no load, 1/2 rated load to no load to 1/4 load, etc.) as follows:

(a) Using the indicating voltmeter readings subtract the load value of voltage from the no load value for each load change (for example step (a) to step (b)). (For voltage regulators utilizing single-phase voltage sensing, the value of voltage in the sensed phase only shall be used in the above calculations. For voltage regulators utilizing multiphase sensing the average value of the sensed voltage shall be used.)

(b) Convert each of the values obtained (1) above to a percentage of rated voltage by dividing by the rated voltage and multiplying by 100. This is the voltage regulation expressed in percent.

(c) Repeat paragraph 16-15d(1) above substituting frequency for voltage.

(d) Compare the results tabulated in paragraphs 16-15d(1) and 16-15d(6)(c) with the requirements of table 16-1.

16-16. FREQUENCY ADJUSTMENT RANGE TEST.

a. General. It is necessary that the frequency of a generator set be adjustable to provide rated frequency at various load conditions as required in certain applications and to synchronize two or more generator sets for parallel operation.

b. Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705.

c. Procedure

(1) Preparation for test. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1., paragraph 205.1.10.

(2) Test.

(a) Start and operate the generator set and allow it to stabilize at rated load, rated voltage, and rated frequency. During this period, readings of the load and field instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage, and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments available to the operator, specifically adjustments to voltage and frequency adjust devices. Adjustments to the load, voltage or frequency shall be noted on the stabilization data sheet. Stabilization will be considered to have occurred when four consecutive voltage and current readings of the exciter field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last load, voltage, or frequency adjustment has been made.

(b) No further adjustments shall be made to any set control for the remainder of this test except for the control panel frequency adjust device.

(c) For each of the conditions in the following steps allow approximately 2 minutes between each adjustment and the subsequent instrument readings.

(d) Adjust the generator set frequency for the specified minimum frequency at rated load. Read and record all instrument readings.

(e) Reduce the load to zero.

(f) Adjust the generator set frequency for the maximum attainable frequency. Read and record all instrument readings. If the over-frequency or overspeed protection device actuates, read and record all instrument readings just prior to the point of actuation and note on the data sheet that the protection device actuated.

NOTE

This step is not applicable to generator sets having governors that utilize a threaded shaft and locknut(s) or other mechanical means as a method of operator speed adjustment.

(g) Adjust the generator set frequency for the minimum attainable frequency. Read and record all instrument readings.

(h) Repeat 16-16c(1) and 16-16c(2)(a) through (e) for each frequency.

d. Results. The data sheet shall show the maximum and minimum frequencies attained at rated load, the maximum and minimum attainable frequencies at no load and actuation of the protection devices (if applicable). Compare these results with the requirements of table 16-1.

16-17. OVERSPEED PROTECTIVE DEVICE TEST.

a. General. Overspeeds will not be possible to obtain due to limiting factors incorporated in the fuel injection pump.

b. Overspeed Switch. Perform a bench test on the overspeed switch to check the proper trip points.

c. Functional Check. Perform a function check of the circuit manually. Refer to AC-DC schematics.

16-18. CIRCUIT INTERRUPTER TEST (Short Circuit).

a. General. A circuit interrupter is connected between the generator voltage reconnection system and the generator set output terminals to disconnect the generator output from the load and also to protect the generator from a short circuit. The circuit interrupter is operated from a current sensor external to the interrupter.

b. Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705. In addition, a noninductive shunt; a short-circuiting switch; a galvanometer matching networks; as oscillograph as described and illustrated in MIL-HDBK-705, Method 106.1, paragraph 106.1.3; and galvanometers having a flat frequency response (flat within plus or minus five percent) from DC to 3,000 Hz will be required.

c. Procedure.

(1) Preparation for the test.

(a) Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705,Method 205.1, paragraph 205.1.10 for one for one voltage and frequency.

(b) Connect the shunt, galvanometer matching network, oscillograph, and short-circuiting switch as illustrated in figure 512.1.1.

(2) Test.

(a) Start and operate the generator set at rated voltage, rated frequency and rated load.

(b) Set the oscillograph time marker to a minimum of 0.01 seconds or use a 60 Hz timing trace set the chart speed such that the individual peaks of the current waveform are clearly visible and adjust the peak-to-peak rated current amplitude to a minimum of 0.5 inch (or approximately 12 millimeters).

(c) Prior to closing the short-circuiting switch, record a portion of the steady state load for calibration. With the same load conditions record all instrument readings.

(d) With oscillograph still recording the steady state current, close the short-circuiting switch.

CAUTION

If the circuit interrupter fails to operate within the specified time, remove the short circuit to prevent damage. Note the failure to operate on the data sheet.

(e) The generator set contains a short-circuit malfunction indicator, check and, record its indication.

(f) Repeat steps (a) through (e) above for each possible short circuit condition (L_1-L_0,L_2-L_3, L_1-L_2-L_3 etc.)

(g) Repeat steps (a) through (f) above for both voltage connections if applicable.

d. Results.

(1) From the oscillograms taken in 16-18c(2)(d), determine the time between the indicated closure of the short-circuiting switch and the opening of the circuit interrupter. See figure 512.1-II.
(2) Calculate the short-circuit current using the peak-to-peak amplitudes of the current trace and the steadystate ammeter reading prior to application of the short circuit. See figure 512.1-II.
(3) Tabulate the above results and the malfunction indicator indication for each line connection at each voltage connection and compare the results with the requirements in table 16-1.

16-19. CIRCUITS INTERRUPTER TEST (OVERLOAD CURRENT).

a. General. A circuit interrupter is connected between the generator voltage reconnection system and the generator output terminals to disconnect the generator output from the load and to protect the generator from sustained overload current. The circuit interrupter is operated from a current sensor external to the interrupter.

b. Apparatus. Instrumentation for measuring load conditions and field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition, a stopwatch or an oscillograph with galvanometer matching network and a noninductive shunt as described and illustrated in MIL-HDBK-705. Method 106.1, paragraph 106.1.3 and galvanometers having a flat frequency respond (within plus or minus 5 percent) from DC to 3,000 Hz.

c. Procedure.

(1) Preparation for Test. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, paragraph 205.1.10 for one voltage and frequency.

CAUTION

If the circuit interrupter fails to operate within the time specified in table 16-1 at any time during the performance of this method, manually open the circuit interrupter and reduce the load impedance to rated value before reclosing the circuit interrupter. Record on the data sheet the failure of the interrupter to operate and the total elapsed time the overload was on the set.

(2) Test.

(a) Start and operate the generator set at rated voltage, rated frequency, and rated load.

(b) Allow the generator set to stabilize at rated load, voltage, and frequency. During this period, readings of the load and field instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage, and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the load, voltage, or frequency shall be noted on the data sheet. Stabilization will be considered to have occurred when four consecutive voltage and current readings of the exciter field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last load, voltage, or frequency adjustment has been made.

(c) In one step, increase the load current to the overload current value specified in table 16-1 (the increase in current may be accomplished by any practical means; for example, reactively or using reduced voltage levels).

NOTE

The frequency shall be maintained at rated conditions, the load current shall be kept constant and the load current shall be balanced equally among the phases. Simultaneously with the load current increase, start the stopwatch.

(d) Record all load instrumentations and the time, in seconds, required for the circuit interrupter to operate.

(e) The generator set contains an overload malfunction indicator, check and record its indication.

(f) Allow the generator set to cool at rated load for a minimum of 15 minutes.

(g) Repeat steps (c) through (f) except that the load current is increased to the overload current value in Phase A only. Phase B and C remain at the rated load current value.

(h) Repeat step (g) except that the load is increased to the overload current value in phase B only. Phases A and C remain at the rated load value of current.

(i) Repeat step (g) except that the load is increased to the overload current value in phase C only. Phases A and B remain at the rated load value of current.

d. Results. The data sheets shall show, as a minimum, whether or not the circuit interrupter operated, the time(s) required for the interrupter to operate, the indication of the malfunction indicator, the overload load conditions and the stabilization data. Compare the time(s) requirements of table 16-1.

16-20. CIRCUIT INTERRUPTER TEST (OVERVOLTAGE AND UNDERVOLTAGE).

a. General. To protect the load from generator malfunction (for example, overvoltage or undervoltage) a circuit interrupter is connected between the generator voltage reconnection system and the generator output terminals. A voltage sensing circuit operates the circuit interrupter if an overvoltage or an undervoltage condition occurs and thus protects the load from a generator malfunction.

b. Apparatus. Instrumentation for measuring voltage and frequency shall be as described and illustrated in MIL-HDBK-705. Resistor(s), galvanometer matching networks, an oscillogram (as described and illustrated in MIL-HDBK-705, Method 106.1, paragraph 106.1.3) and galvanometers having a minimum flat frequency response (flat within plus or minus 5 percent) from DC to 3,000 Hz and the voltage divider transformer network will be required.

c. Procedure I (Overvoltage).

(1) Preparation for test.

(a) Locate and disconnect the input circuit to the input terminals of the overvoltage protective sensing circuit and connect the apparatus as illustrated in figure 512.3-I for one voltage connection.

(b) Connect the frequency meter to the output terminals of the generator set.

(2) Test.

(a) Start and operate the set at rated frequency and no load.

(b) Close the switch (see figure 512.3.I) and use resistance, R1 to adjust the voltage to the overvoltage value specified in table 16-1. The set has provisions for shutdown upon an overvoltage condition, it will be necessary to temporarily deactivate this provision to permit adjustment of the overvoltage value. This may be done by activation of the "protective bypass" (BATTLE SHORT) switch. Do not deactivate the circuit interrupter trip circuitry.

(c) Open the switch, reset the overvoltage circuit and adjust the resistance, R2, until voltmeter number 2 reads rated voltage.

(d) Repeat (b) and (c) to ensure that the specified overvoltage and rated voltage settings are correct.

(e) Set the oscillograph chart speed such that the individual waveform peaks are clearly visible. Set the timing lines to a minimum of 0.01 seconds per line or use a 60 Hz time trace. Adjust the trace peak-to-peak amplitude to a minimum of one inch (or 25 millimeters).

(f) Read and record both voltmeter readings.

(g) With the oscillograph recording and the circuit interrupter closed, close the switch. (See figure 512.3-I.)

(h) Reactivate the shutdown provision if used.

(i) The generator set contains an overvoltage malfunction indicator, check and record its indication.

(j) Record whether or not the set shuts down.

(k) Open the switch, reset the overvoltage circuit if necessary, restart the set if required, and close the circuit interrupter.

(l) Repeat steps (d) through (k) above two additional times.

d. <u>Procedure II</u> (<u>Undervoltage</u>).

(1) Preparation for test.

(a) Locate the input terminals of the undervoltage sensing circuit and connect the apparatus as illustrated in figure 512.3-I.

(b) Repeat step (b) of paragraph 16-20c(1)(b).

(2) Test.

(a) Start and operate the set at rated frequency and no load.

(b) Close the switch (see figure 512.3-I) and use the resistance, R1 to adjust the voltage to the rated value.

(c) Open the switch and adjust the resistance, R2 until voltmeter number 2 reads the undervoltage value specified in table 16-1. This test shall be repeated for each under undervoltage value.

(d) Repeat steps (b) and (c) above to ensure that the specified undervoltage and rated voltage settings are correct.

(e) Set the oscillograph chart speed such that the individual waveform peaks are clearly visible. Set the timing lines to a minimum of 0.01 seconds per line or use a 60 Hz timing trace. With the switch open, adjust the trace peak to-peak amplitude to a minimum of one inch (or 25 millimeters).

(f) With the set operating and the circuit interrupter and the switch open, read and record both voltmeter readings.

(g) Close the switch and circuit interrupter.

(h) With the oscillograph recording, open the switch.

(i) After allowing sufficient time for the circuit interrupter to operate, check, and record the indication of the undervoltage malfunction indicator.

(j) Close the switch, and close the circuit interrupter.

(k) Repeat steps (e) through (j) above two additional times.

(l) Repeat (a) through (k) for the other undervoltage value specified in paragraph 16-1.

e. Results.

(1) From the oscillograms made in paragraph 16-20c determine and tabulate the time between the application of the overvoltage and operation of the circuit interrupter for each application of overvoltage.

(2) From the oscillograms made in paragraph 16-20d determine and tabulate the time between the application of the undervoltage and the operation of the circuit interrupter for each application Of undervoltage.

(3) Compare these results with the requirements of table 16-1.

16-21. LOW OIL PRESSURE PROTECTIVE DEVICE TEST.

a. General. Since generator sets frequently operate unattended for long periods, the engine is equipped with a low oil pressure protective device. This device shuts down the engine when the oil pressure drops below the safe limit.

b. Apparatus. The following equipment shall be required to perform this test:

(1) Oil pressure gauge (±1 percent)

(2) Flexible oil line (or copper tubing).

(3) Regulating valves

(4) Brass fittings.

c. Procedure.

(1) Preparation for test. With set not operating remove the protective device tap from the engine block and reconnect as shown in figure 515.1-I with the protective device and oil pressure gauge in approximately the same horizontal plane as the protective device tap located on the engine.

(2) Test.

(a) With the bleeder valve closed and the shut-off valve in the oil pressure line open, start and operate the set at rated speed (use the set instrumentation) and at no load.

(b) Open the bleeder valve slightly to purge air from the system.

(c) Close the bleeder valve and record the oil pressure as indicated on the external gauge.

(d) Almost completely close the shut-off valve.

(e) Slowly open the bleeder valve until the low oil pressure protective device shuts down the engine. Record the reading of the oil pressure gauge at the point of set shutdown (see figure 515.1-II).

(f) Record operation of the malfunction indicator light.

(g) Repeat (a) through (f) for the warning switch.

d. Results. Compare the value of shutdown pressure with the requirement of table 16-1.

16-22. OVERTEMPERATURE PROTECTIVE DEVICE TEST.

a. General. The overtemperature device must be capable of protecting the engine in the set against overheating for any reason.

b. Apparatus. Instrumentation for measuring load conditions and set and ambient temperatures shall be as described and illustrated in MIL-HDBK-705, Method 205.1, paragraph 205.1.10.

c. Procedure.

(1) Preparation for test.

(a) Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, paragraph 205.1.10.

(b) Install a thermocouple to measure the same temperature as seen by the protective device sensor.

(2) Test.

(a) Start and operate the generator set at rated voltage, rated frequency (speed), and rated load.

(b) Block the cooling air to the generator set or manually trip overload sensors on fan motor contactor, located in the 2c central box.

(c) Continuously monitor the temperature seen by the thermocouple installed in paragraph 16-22c(1)(b) above. Record the temperature at which the overtemperature protective device actuates. Record the temperature at which the coolant temperature indicator illuminates.

CAUTION

If the engine fails to shutdown when the temperature exceeds the maximum trip value specified in table 16-1, the test shall be immediately discontinued.

d. Results. Compare the results with the requirements of table 16-1.

16-23. PHASE SEQUENCE TEST (ROTATION)

a. General. Unless the phase sequence (rotation) of the load terminals of a 3 phase generator set is correct, serious damage or injury could be done to connected equipment and to personnel as a result of reversed motor rotation or excessive current surges.

b. Apparatus. A phase sequence (rotation) indicator as described and illustrated in MIL-HDBK-705, Method 116.1 or a 3 phase motor whose direction of operation in relation to phase sequence is known shall be required.

c. Procedure.

(1) Connect the generator set load terminals to the applicable test apparatus for one of the set 3 phase voltage connection. Recheck the connections to ensure that L_1, L_2, and L_3 of the generator set age connected to L_2, and L_3 of the test apparatus respectively.

(2) Start and operate the generator set at rated voltage and frequency. The set indicating instruments shall be sufficient indication of output voltage and frequency.

(3) Close the circuit interrupter and determine the direction of phase sequence (rotation) by observing the indicator, or by noting he direction of rotation if a 3 phase motor is used. Record results.

(4) Repeat steps (a) through (d) above for all other 3 phase voltage output connections of the generator set.

(5) Phase sequence can also be checked by placing PHASE SEQUENCE-BUSS-OFF-GEN switch, located on the generator panel, to the GEN position and the 1-3-2 lamp should illuminate.

(6) Place the AC PWR CKT BKR, located on the generator panel, to the close position and the PHASE SEQUENCE-BUSS-OFF-GEN switch to the BUSS position. The 1-3-2 lamp should illuminate.

d. Results. The phase sequence (rotation) as indicated by the test shall be checked against the requirements of table 16-1.

16-24. MAXIMUM POWER TEST.

a. General. The maximum power of a generator set is a function of the ambient conditions (temperature and altitude) and the mechanical condition of the engine at any particular time. See table 16-1 for test parameters for various altitudes.

b. Apparatus. Instrumentation for measuring load conditions, field voltage and current, pressures and temperatures shall be as described and illustrated in MIL-HDBK-705.

c. Procedure.

CAUTION

This procedure subjects the generator set to a severe overload which may be damaging if maintained for too long a period of time.

(1) Preparation for test.

(a) Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, paragraph 205.1.10 for one voltage and frequency.

(b) Install appropriate thermocouples to measure the following temperatures:

1. Engine coolant (engine outlet and inlet).

2. Exhaust gas(es)(the exhaust manifold(s) shall be drilled

and tapped as close as possible to the combustion chamber(s).

3. Lubricating oil sump.

4. Engine combustion air in (located at the inlet of the intake manifold).

(c) Install appropriate pressure instrumention to measure the following items:

1. Exhaust pressure (combined exhaust gases in exhaust manifold).

2. Intake air manifold pressure (between air filters and manifold).

(d) Obtain and record the barometric and water vapor pressures (see MIL-HDBK-705, Method 220.2).

(e) Bypass the set circuit interrupter.

(f) Connect the set to a source of fuel containing a specified fuel required by the procurement document.

(2) Test.

(a) Set governor to zero-droop.

(b) Start and operate the generator set and allow it to stabilize at rated load, rated voltage and rated frequency (speed). During this period, reading of all instruments including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and rated frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator. Specifically adjustments so the voltage or frequency adjust devices. No other adjustments to the voltage and frequency control systems should be made. Adjustments to the load, voltage, or frequency controls shall be recorded on both the data sheet and recording chart(s). Stabilization will be considered to have occurred when four consecutive voltage and current recordings of the exciter field either remain unchanged or have only minor variations about an equilibrium conditions with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

(c) Perform this test using resistive load only. Remove reactive load after stabilization.

(d) Alternately increase the load, voltage and frequency in small increments until the fuel system controls are in the maximum fuel position as permitted by the governor control linkage and the voltage and frequency are within 1 percent of their rated values.

NOTE

Small increments should be taken to avoid passing the maximum power at the rated voltage and frequency point and to avoid racing and bogging the engine.

CAUTION

Do not exceed 125 percent of rated load.

(e) Hold the conditions in step (c) above for two minutes. However, if the voltage and frequency cannot be maintained within 1 percent of their rated values, the load must be adjusted to the point at which the voltage and frequency can be maintained within 1 percent of their rated values for two minutes.

CAUTION

It may be necessary to reduce the load to a value below the rated kilowatt load for a short period of time to prevent serious over-heating or damage to the generator set if the above conditions cannot be readily attained. (Monitor instrumentation.)

(f) During the two minute period record all instrument readings including thermal and pressure instrumentation. (On 3-phase sets it is not necessary to record line-to-line voltages).

(g) Reduce the load to rated kilowatt load and allow the generator set to cool for 10 minutes.

(h) Repeat steps (d) through (g) above until three valid sets of maximum power data are obtained.

CHAPTER 17

GENERATOR SET INSTALLATION PRACTICES

Section I. SAFETY PRECAUTIONS

17-1 GENERAL. This chapter provides safety precautions, site selections guidelines, air, cooling, fuel, exhaust, electrical, and service requirements relevant to the proper installation of the generator set. All other input requirements not covered in this chapter and required by the user are the responsibility of the cognizant installation manager.

17-2. Do not use a lifting device with a marginal capacity when lifting and moving the generator set. Observe the center of gravity of the equipment to be lifted and do not allow the generator set to swing while it is suspended. Make certain the structure to support the generator set is strong enough to support the weight of the set. Failure to observe this warning may result in serious injury or death to personnel.

17-3. The voltage produced by generators is dangerous to personnel coming in contact with any part of the electrical system during operation. Severe, possible fatal shock may result. See that adequate grounding provisions have been made and the generator sets are grounded using the ground studs provided before operation. Be extremely careful when unit or surrounding area is damp or wet.

17-4. In case of an accident from electrical shock, shut down the set at once. If the set cannot be shut down, free the victim from contact with a nonconductor, and avoid direct contact with victim. Use a dry rope, dry board, or any nonconducting implement to free the victim. If the victim is unconscious, apply artificial respiration and get medical help.

17-5. When servicing any part of the electrical system or making any connections, be sure the maintenance switch is in the MAINTENANCE position and padlocked. Clean or service the generator set only when the engine is shut down.

17-6. If the unit stops by operation of the safety devices, do not attempt to operate it until the cause has been eliminate.

17-7. When filling the fuel tank, do not smoke or use open flame in the vicinity. Be extremely careful when using a carbon tetrachloride fire extinguisher in an enclosed area. A poisonous gas is generated by the contact of carbon tetrachloride with heated surfaces. Provide adequate ventilation before entering an enclosed area where carbon tetrachloride has been used.

17-8. When operating in an enclosed area, pipe the engine exhaust outside. Be sure to increase the pipe diameter and use a minimum amount of bends and elbows to prevent back pressure in the engine exhaust system. Be sure the enclosure has proper ventilation to accommodate the engine cooling system.

17-9. When servicing batteries, do not smoke or use an open flame in the vicinity. Batteries generate explosive gas during charging.

7-10. DANGER signs must be placed in the vicinity of the engine. There is to be no smoking in the vicinity. No work is to be performed on the engine involving open flames, such as cutting, welding, grinding, chiseling, or any similar operation which may produce sparks.

17-11. A fire extinguisher (dry powder or carbon dioxide, CO_2) must be placed next to the mechanic's working area, handy for immediate use.

17-12. Pay particular attention that all generator output phase leads are properly insulated before starting set. Neglect to do this may result in extensive damage to equipment and personnel injury. This condition is most prevalent when set is started before electrical installation is completed.

CAUTION

For proper unit operation, battery minus (-) terminal must be connected to ground.

Section II. LOCATION

17-13. A complete housing kit is available for the 500 KW generator set and should be used when the unit is installed outdoors on a pad. Without the housing kit, the generator set may be installed indoors on a pad. Both the indoor and outdoor pads should be fitted with twelve spring-loaded shock mounts for mounting the generator set.

17-14. The location of the unit is governed primarily by its related systems and proximity to the incoming electrical service. Weather conditions will also affect both location and the accessory equipment required to provide proper system operation. Locations where extreme ambient temperatures occur should be avoided. Where the generator set must be exposed to low temperature ambients, the integral engine heater may be used to assist starting.

17-15. Whether located indoors or outdoors, preventive maintenance is an important consideration when selecting or designating a generator set location. In addition to the control cubicle, the following service points should be accessible to the operator:

a. Air cleaner

b. Primary fuel filter

c. Secondary fuel filter

d. Lube oil dip stick

e. Lube oil filter

f. Lube oil drain

g. Fan belt adjustment

h. Radiator filler opening

i. Cooling system drains

j. Fuel tank drain

k. Hand-hole covers

l. Removal of oil -pan

m. Removal of rocker covers

n. Battery servicing and removal

o. Starter

p. Battery charger

q. Diode removal from generator endbell.

17-16. Before final plans are made for locating a generator set, the following points should be considered for both housed and unhoused units:

a. Mounting provisions must be strong enough to support the set and related equipment.

b. Vibration should be effectively isolated and dampened to reduce noise and prevent damage.

c. Area should be clean and dry and not subject to flooding.

d. Area should be large enough to provide easy access for servicing and repair, and free movement of cooling air (see figure 17-1).

e. The set should be in close proximity to the auxiliary fuel tank.

f. For generator sets installed indoors:

(1) Ventilation should be available in the area with a minimum amount of duct work and which will maintain set temperature in a range for efficient engine operation.

(2) Exhaust gases should be expelled safely out of and away from the structure.

Section III. MOUNTING THE GENERATOR SET

17-17. The 500 KW generator set should be mounted on a substantial level base, preferably class B concrete with a design strength of 2500 psi.

17-18. For generator sets enclosed

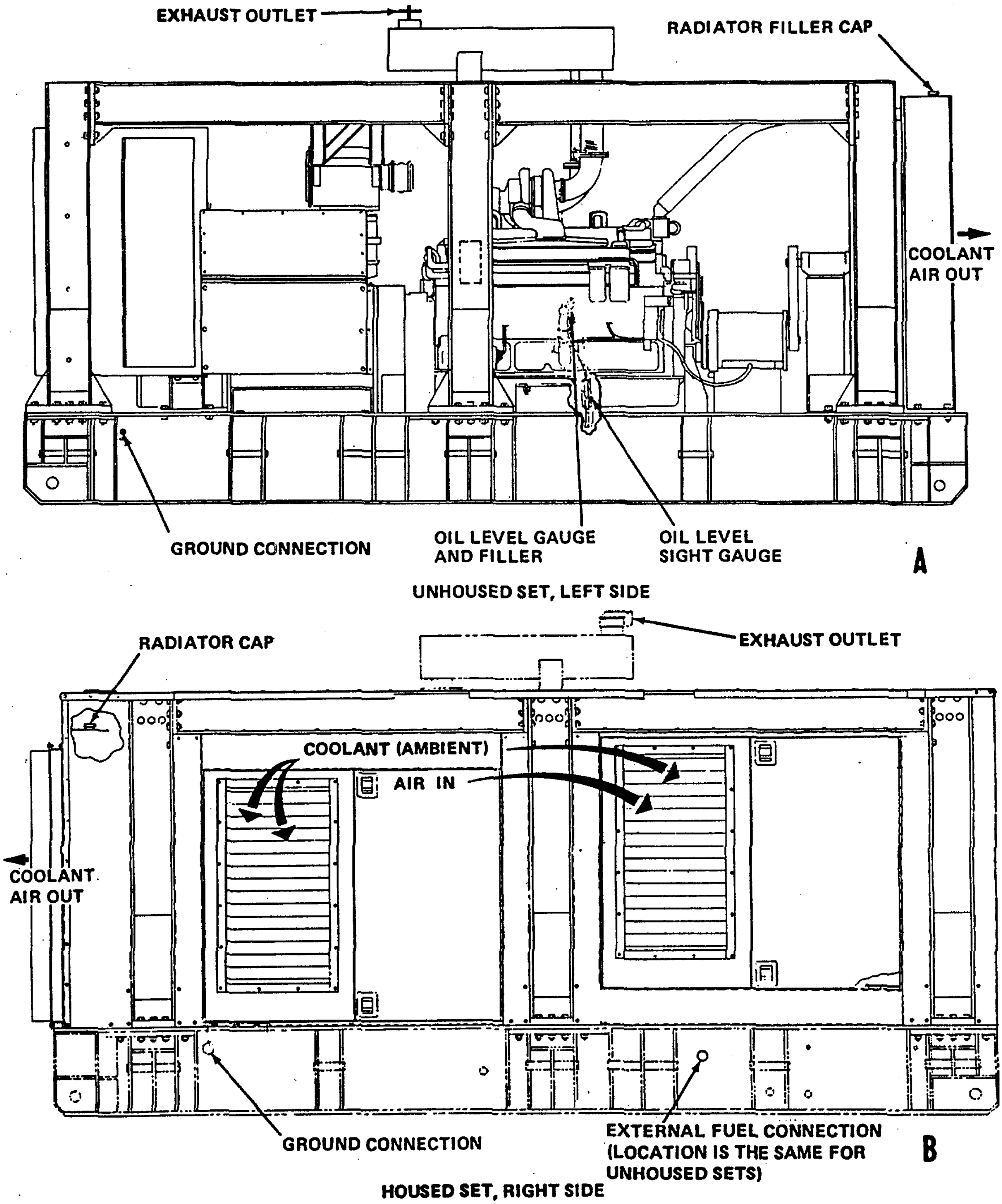


Figure 17-1. Generator Set Operational Requirements (Sheet 1 of 2)

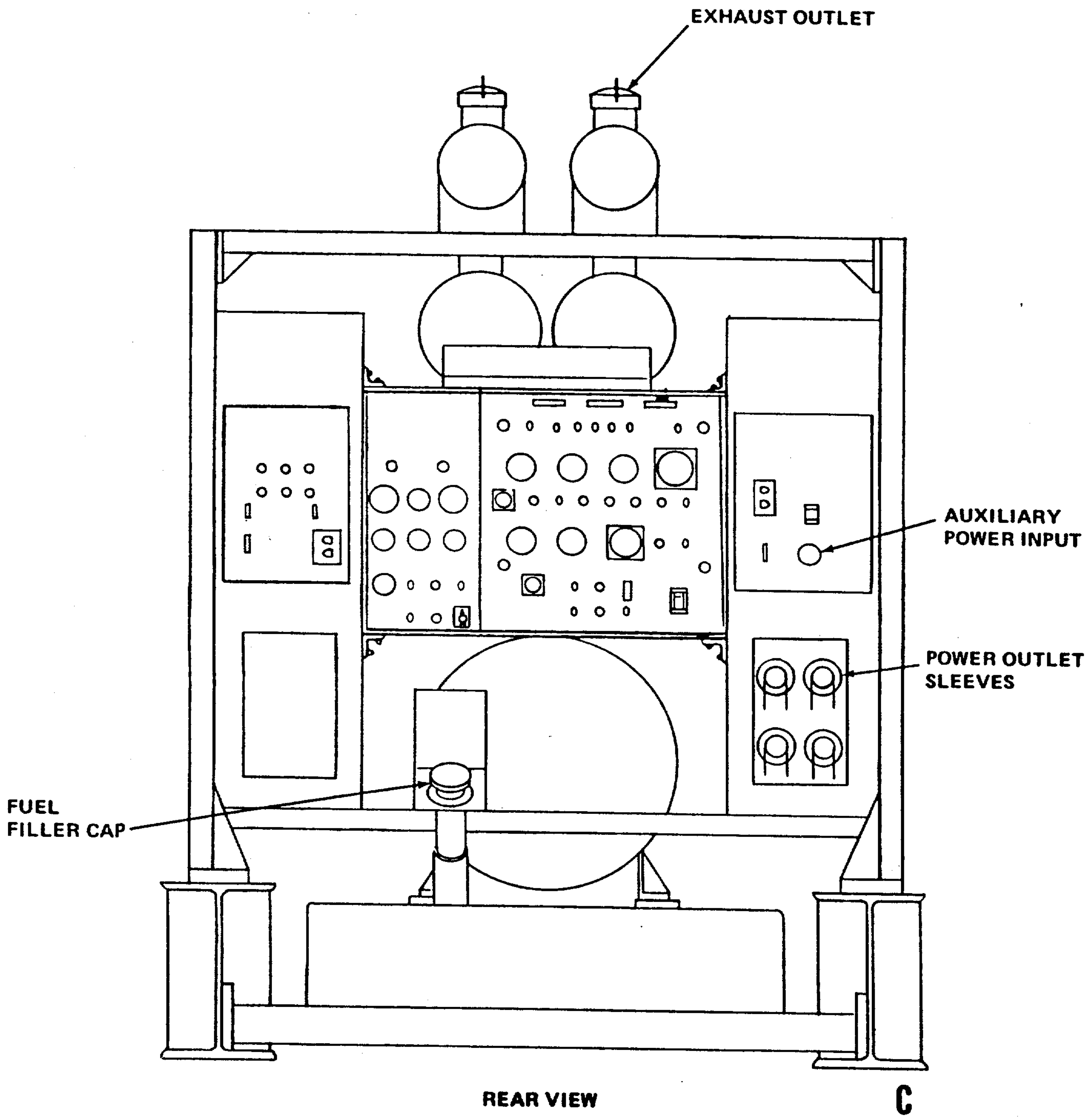


Figure 17-1. Generator Set Operational Requirements (Sheet 2 of 2)

within a building where maximum vibration isolation is required, the following methods provide vibration isolation between the generator mounting foundation and the structure.

17-19. The foundation should be separated from the floor slab and the subsoil so vibrations will not be transmitted to the structure (see figure 17-2). Water resistant, processed natural cork has been found to be one of the most effective organic materials for isolating the foundation from the subsoil. By lining the foundation pit and its perimeter with cork plates before pouring the concrete foundation, it is usually possible to reduce the units vibration to a satisfactory degree.

17-20. Another method of isolating a foundation is to use 8 or 10 inches (20 or 25 cm) of wet gravel or sand as a bed in the foundation pit. Tests have shown sand and gravel are capable of reducing the amount of unit vibration transmitted by as much as one-third to one-half. The isolating value of gravel is somewhat greater than that of sand and does not vary appreciably with its depth. To minimize settlement of the concrete foundation from the floor slab, expansion joints should be incorporated between the slab and the foundation.

17-21. If the floor slab has sufficient strength to support the weight of the unit, and a separate foundation is not used, a satisfactory mounting can be accomplished by the use of vibration isolators between the floor slab and the unit. To limit vibration effects to an absolute minimum, the unit should be isolated from its foundation by flexible mounts and the foundation isolated, as described, from the floor.

17-22. To facilitate maintenance on the unit once it is installed, the foundation should be constructed so as to protrude above floor level by 6 to 8 inches (15 to 20 cm) as illustrated in figure 17-2 and extend 8 inches (20 cm) wider beyond the front and sides of skid and 18 inches (20 cm) beyond the rear skid as shown in figure 17-3.

17-23. A minimum clearance of 5 feet (15 m) between an installed set and adjacent walls should be maintained on three sides of the unit. A minimum clearance of 8 feet (24 m) should be maintained at the rear of the unit to facilitate the removal of the generator should it become necessary. See table 17-1 for generator set weight and dimensions.

Table 17-1. Weight and Dimensions

GEN SET	WEIGHT (FILLED)	WIDTH	HEIGHT (WITHOUT MUFFLER)	HEIGHT (WITH MUFFLER	LENGTH
500	34,050 pounds (15,445 kg)	88 (226 cm)	101 (265.5)	120 (304.5)	219 (556)

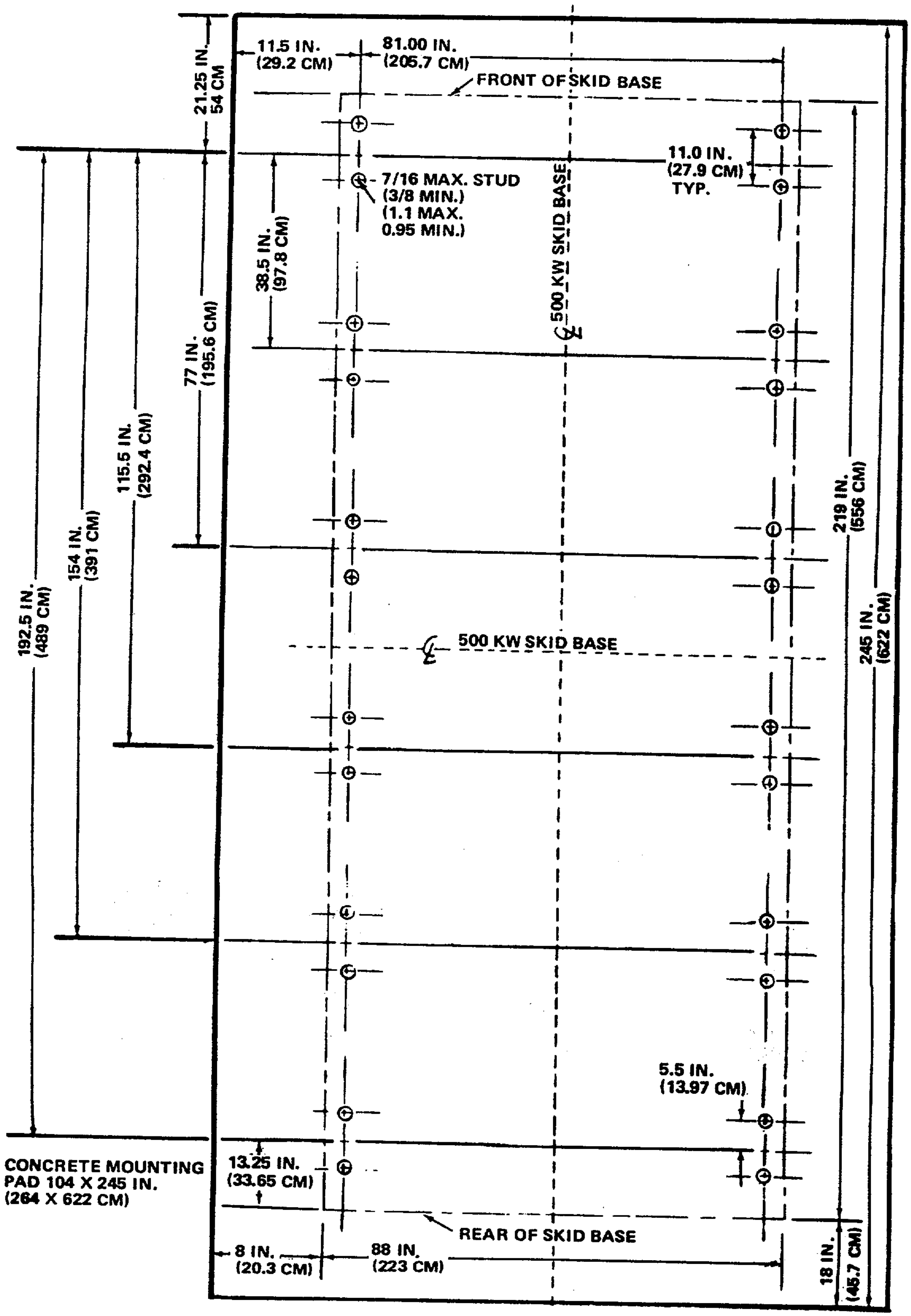


Figure 17-2. Mounting Bolt Layout in Concrete Pad

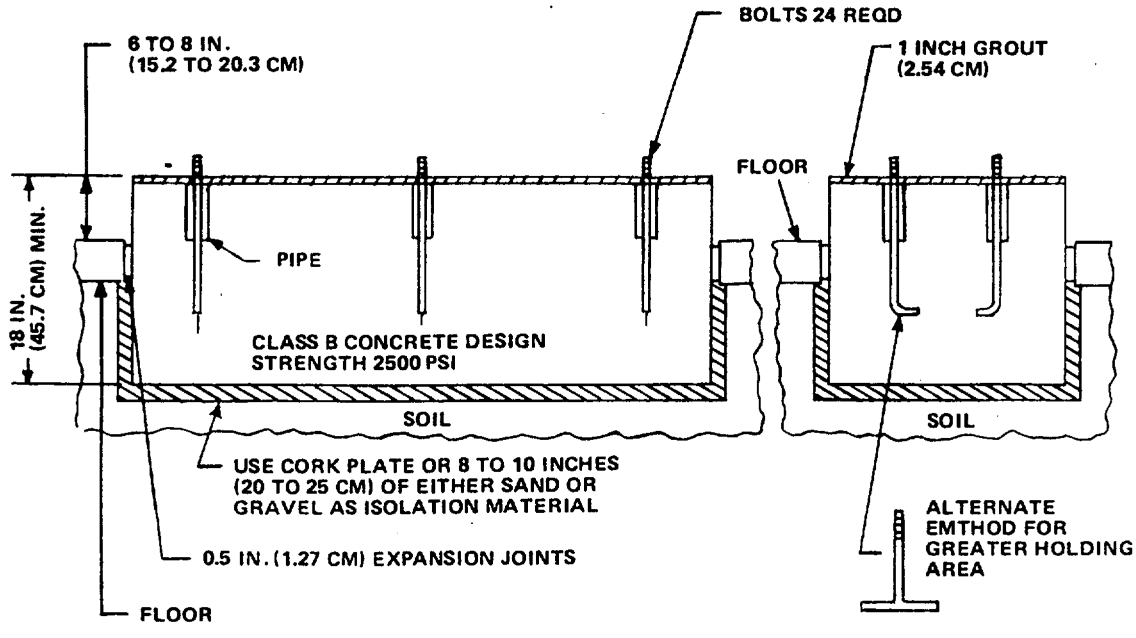


Figure 17-3. Cross Section View of Pad and Mounting Bolt Installation

Section IV. VIBRATION

17-24. A certain amount of vibration is inherent in the operation of any generator set. If vibration is transmitted to surrounding areas, the noise level increases. The engine generator is mounted directly to the skid; therefore, twelve vibration isolators are recommended to be installed between the skid and foundation. Figure 17-4 illustrates the recommended type of isolator.

17-25. When the generator set is installed within a building, all fuel, coolant, exhaust, and electrical connections must have flexible sections so that vibration is not transmitted along these lines. See Figure 17-5.

Section V. AIR REQUIREMENTS FOR UNHOUSED 500 KW GENERATOR SETS INSTALLED WITHIN A BUILDING

17-26. A ventilation system must be installed to provide adequate air at the generator set to remove heat radiated by the engine generator and supply combustion air for the engine.

17-27. When installing the ventilation system the following factors should be considered:

a. Location of inlet and outlet air ports.

b. Method of actuation of inlet and outlet louvers.

c. Ambient temperature.

d. Routing of exhaust air duct.

e. Placement of discharge louver.

f. Whether radiator and fan assembly will be separated from the generator set.

17-28. The air inlet and outlet must be in the same room position to allow convection air flow from the inlet, across the unit, and exhausted through

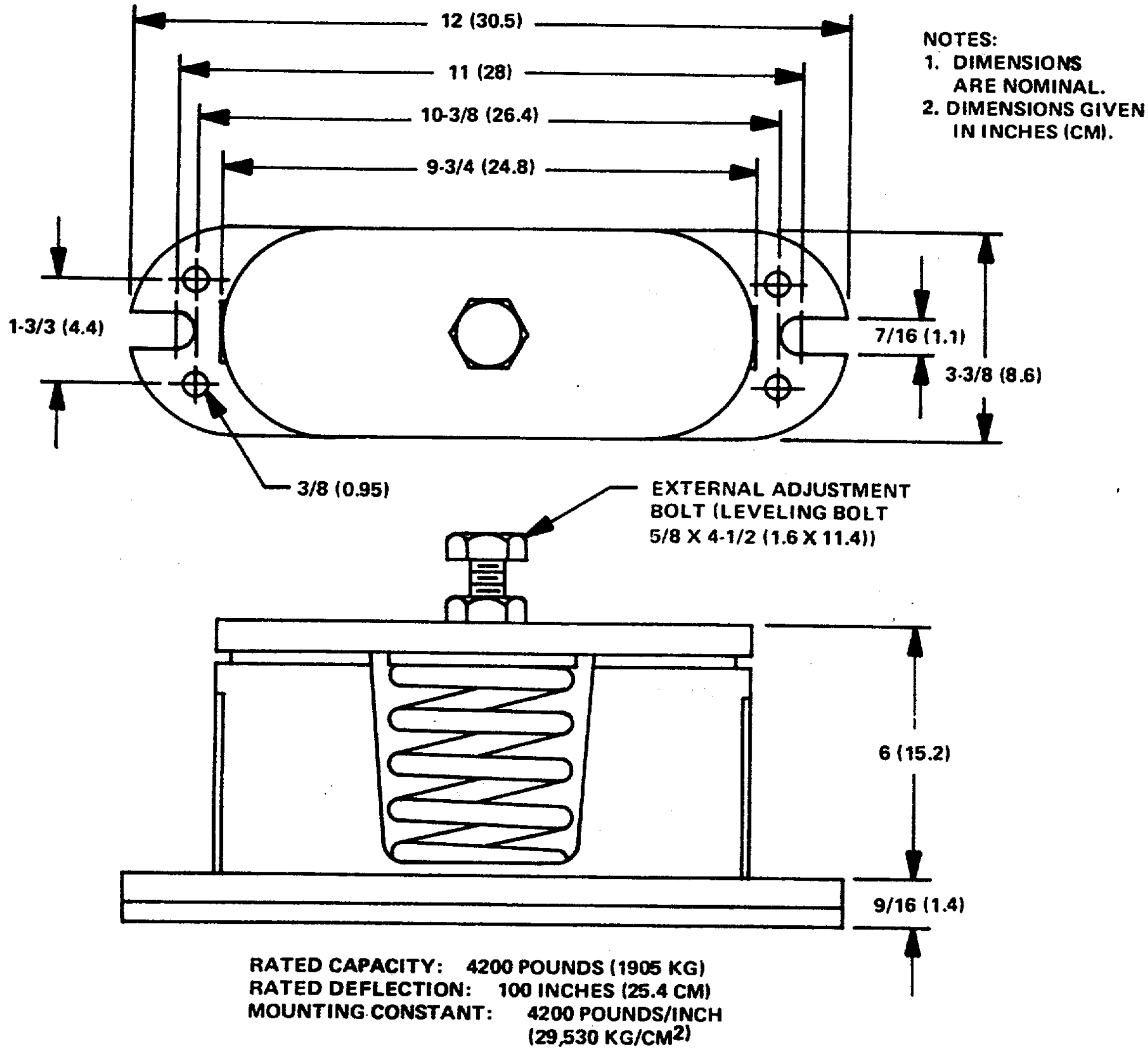


Figure 17-4. Vibration Isolator (12 required)

the outlet positioned slightly higher than the inlet. The inlet and outlet openings must be large enough to provide the volume/time flow air necessitated by the heat rejection rating of the generator set.

NOTE

Output cooling air ducting should never be smaller than engine radiator core. When radiator and fan assembly remains mounted with the generator set.

17-29. To determine the air needed to remove unit heat rejection in the installation enclosure or room, use the heat rejection factors from table 17-2 and the following formula:

$$Q = \frac{H}{1.08\,T}$$

Where:

Q = Air in cubic feet/minute
H = heat in BTU/HR to be removed
T = Permissible room temperature rise in degrees F.

Table 17-2. Air Requirements Cubic Foot Per minute (Cubic Liters Per Sec)

RPM	COMBUSTION AIR	COOLING AIR	TOTAL AIR
1800	1640 (774)	33,500 (15,812)	35,140 (16,586)

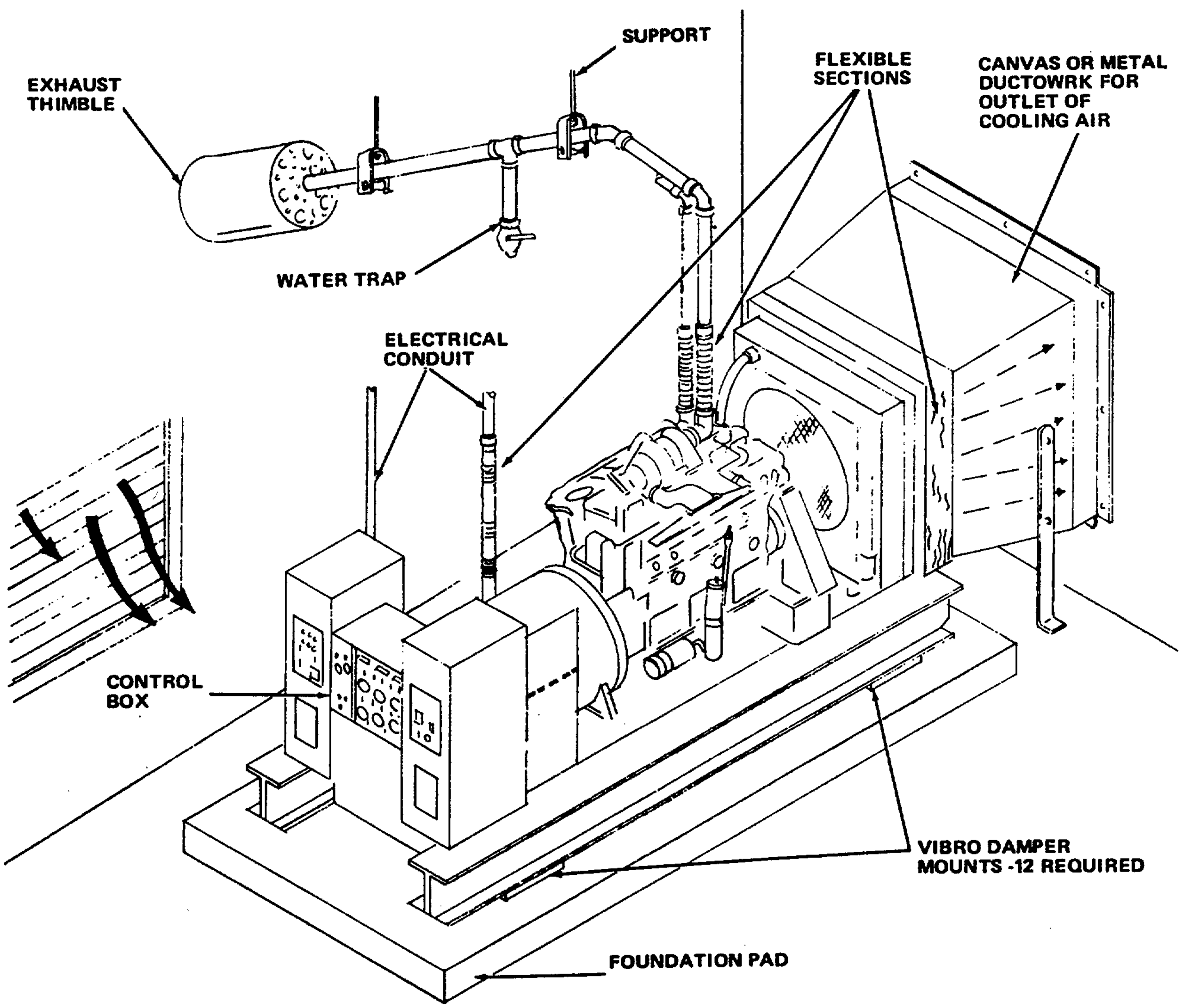
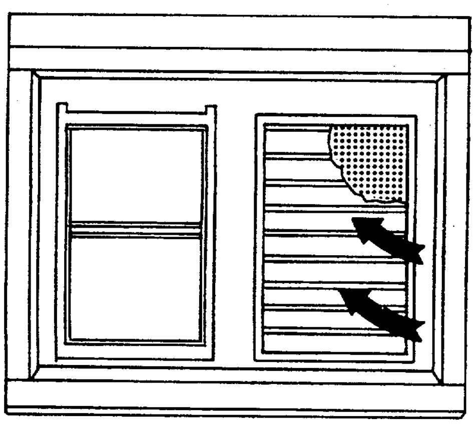


Figure 17-5. 500 KW Generator Set Installation

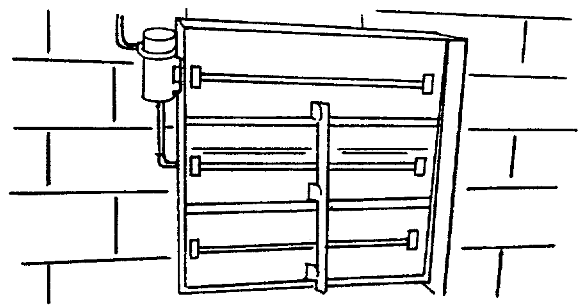
17-30. In most installations, intake and exhaust louvers are used. Figures 17-6 through 17-9 illustrate a variety of louver installations which may be used. The use of louvers requires the opening area to be increased by a factor of 1/4 to 1/2 times that of an unobstructed opening. Where possible, the inlet duct should be on the shaded side of the building. Care should be taken to provide adequate unobstructed space outside the outlet to prevent development of back pressure and consequent limiting of outlet air flow. Where possible, the outlet duct should not be exposed to strong prevailing winds, since wind may cancel fan effect and impair cooling. A duct should be installed between the radiator and the outlet vent to prevent recirculation of air passed through the radiator, as its effectiveness as a heat exchanger would be diminished. The duct should be installed between the radiator and outlet vent with as few bends as possible.



NOTE:
FIXED LOUVERS REDUCE
EFFECTIVE OUTPUT AIR
FLOW BY 50%

Figure 17-6. Fixed Louvers for Air Inlet

17-31. All units can be fitted with radiator duct flanges. If bends are required, they should be in the form of gradual sweeps to allow an air flow against minimum restriction. Increase duct size 1/4 to 1/2 to compensate for bends. Exhaust duct static pressure should be essentially zero. If a duct is not used, the outlet vent should be twice the area of the radiator and the unit should be mounted as close as possible to the outlet vent.



NOTE:
LOUVERS SHOULD BE
CENTER PIVOTED OR
TOP PIVOTED

Figure 17-7. Thermostatically Controlled Louvers

17-32. Intake and exhaust ventilation shutters are used to prevent entry of cold air, which would reduce the ambient temperature of the area in which the unit is located causing difficulty in engine starting. Shutters also exclude entry of rain, snow, and insects into the building.

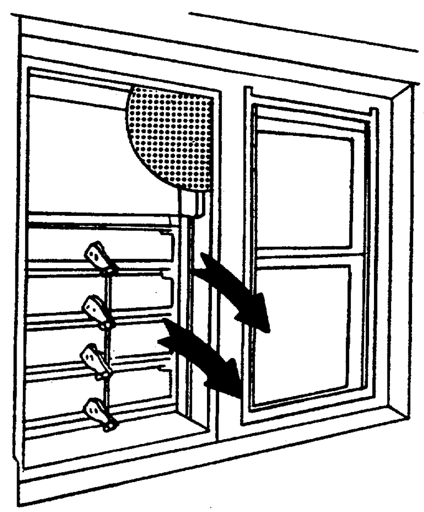


Figure 17-8. Exhaust Fan Operated Louvers

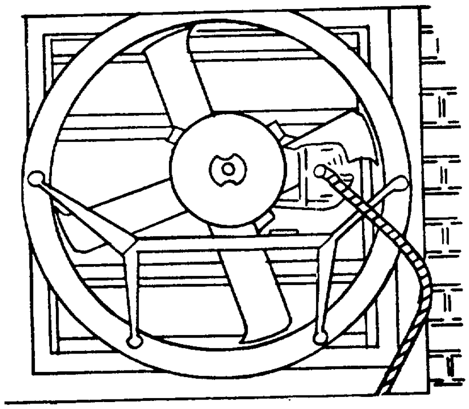


Figure 17-9. Exhaust Fan

17-33. For electric generating sets that do not utilize automatic starting provisions, manual shutters may be used. A gravity drop shutter may be used for the exhaust duct if the shutters are of light metal. When the set operates, outlet air flow will open the shutter, which closes automatically due to gravity when the unit is shut down. Manual intake shutters operated by a pull chain or pulley device must be opened to provide intake air. The open-closing operation is a manual function.

17-34. For electric generating sets utilizing automatic start functions, the use of motor-operated intake shutters is recommended. The exhaust shutter may be of the gravity drop type if the shutters are of lightweight material. Motor-operated shutters are held closed by spring tension and are driven to the open position by a stall type motor operating through a mechanical linkage. Care should be taken in wiring the system to ensure that the intake shutter motor is supplied during all possible modes of unit operation; i.e., true power failure, simulated power failure due to incorporation of a system test switch, or automatic plant exercising due to the incorporation of a plant exercising timer.

17-35. Supplying the intake shutter motor from the generator output (before any incorporated line circuit breaker) will ensure its operation whenever the unit operates. The shutter motor is usually of the reconnectible type to accommodate either 110/220V AC supplies. Special application transformers are available to supply these values if the generator output does not permit its use directly.

17-36. Thermal fusible links are available connected in the motor circuitry to de-energize the motor and cause the shutter to close in case of fire.

17-37. In some cold weather applications, the opening of inlet shutters immediately on the starting may cause carburetor icing, and vaporizing problems. Diesel engines may not operate efficiently if extreme cold air is admitted through fully open louvers. Thermostatically controlled shutters can be used to counter the difficulties inherent in cold weather applications.

Section VI. COOLING SYSTEM

17-38. A properly functioning cooling system is extremely important to any internal combustion engine since only a fractional part of the heat energy (fuel) supplied to the engine is converted into useful work. The excess heat of combustion is rejected in three ways, by radiation to ambient air and engine oil, etc., via the engine's exhaust system, and via the engine's cooling system. See table 17-3.

17-39. LIQUID COOLING SYSTEM. The engine utilizes a liquid coolant with jackets or chambers surrounding each cylinder. Coolant water and engine

Table 17-3. Generator Set Heat Rejection, Radiator Connections

Heat rejection to room by engine generator	564,900 BTU/HR
Heat rejection to radiator by engine generator	1,368,000 BTU/HR
Radiator inlet (2) size	3 inches (7.62 cm)
Radiator outlet	3-1/2 inches (8.89 cm)
Radiator water flow	210 gal./min. (13.25 liters/ sec.)

oil heat exchangers are also utilized. A liquid coolant under pressure enters the water jackets absorbing heat from the cylinders and other components described above, and by the time it reaches the outlet has risen in temperature. Water cooling systems are configured such that the temperature differential between inlet and outlet does not exceed 10 to 12°F (-12 to -11°C). It is not good practice, and may be destructive to the engine to have a low intake temperature.

17-40. The coolant leaving the engine outlet enters a radiator heat exchanger to exchange its heat to the environment.

17-41. RADIATOR COOLING. See table 17-4.

Table 17-4. Radiator and Crankcase Capacities

Radiator and block capacities	54 gallons (204 liters)
Crankcase oil capacity	18 gallons (168 liters)

17-42. A radiator is a closed system heat exchanger consisting of finned tubes through which the engine coolant passes. The heat exchanging air stream over the fins is produced by a beltdriven, pusher-type fan (air flow from rear of set towards the radiator). Cooling air is drawn over the engine and pushed through the radiator into a duct leading to the outlet vent, or unducted toward the outlet vent. A radiator cannot itself absorb heat (except for the very small amount to warm its own metal) and is not to be regarded as a bottomless pit capable of absorbing unlimited heat. The radiator exposes the finned surface of its tubes to the passing air stream to carry off engine heat.

17-43. A free supply of fresh air must be available and recirculation of the air must be avoided. If the cooling air is allowed to recirculate it would soon acquire enough heat to raise the ambient temperature to approximately the same temperature as the radiator, resulting in engine overheating. A few basic rules should be observed in locating a radiator cooled generating unit.

a. Provide an entrance for fresh air at least as large in area as the radiator itself. Do not depend solely on apertures such as windows, etc. Where possible, inlet shutters are utilized to increase the inlet opening area by a factor of one quarter to one half that of the radiator area. In areas of extremely cold ambient temperatures, thermostatically controlled inlet shutters should be considered.

b. Cool inlet air should not be required to find its way to the engine room through stairwells, corridors, etc., nor should it be required to travel upward through a duct.

c. Provide an exit for heated air, preferably ducted, allowing it to be carried completely away. The exit opening should be larger than the inlet opening to compensate for the expansion of air due to heat. Bends in the exhaust duct should be avoided where possible, but if they are required, they should be proportionally enlarged.

d. Cooling fan pressure generally should not be required to force air through semiclosed openings, louvers, swinging traps, etc. However, if gravity drop louvers are utilized, the louvers should be lightweight metal.

e. Where possible, position so that the direction of fan output is directly toward the outlet.

f. Avoid ducting so the outlet constructed to the air must make one or more right angle bends after leaving.

g. Where possible, position the engine so that minimum distance

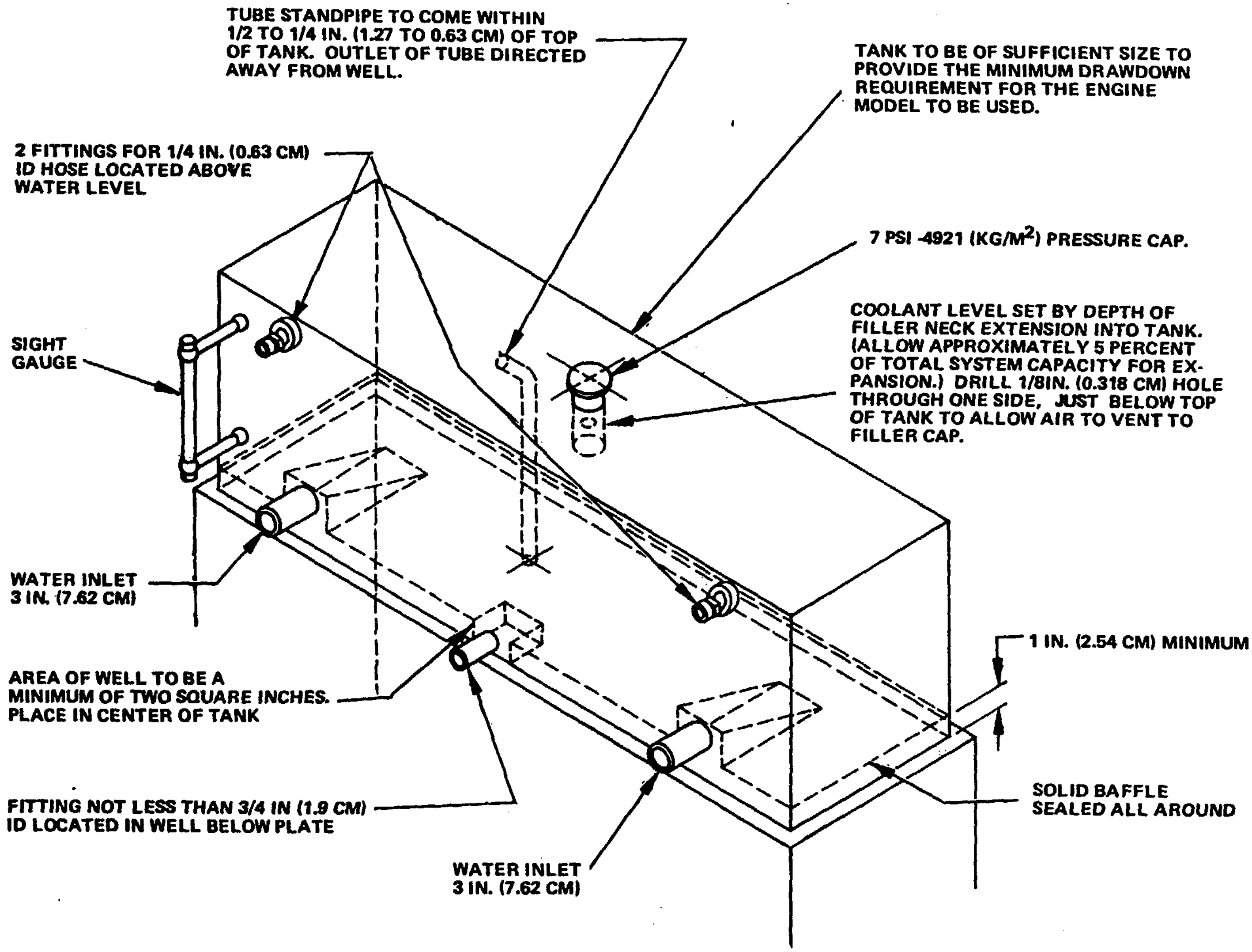
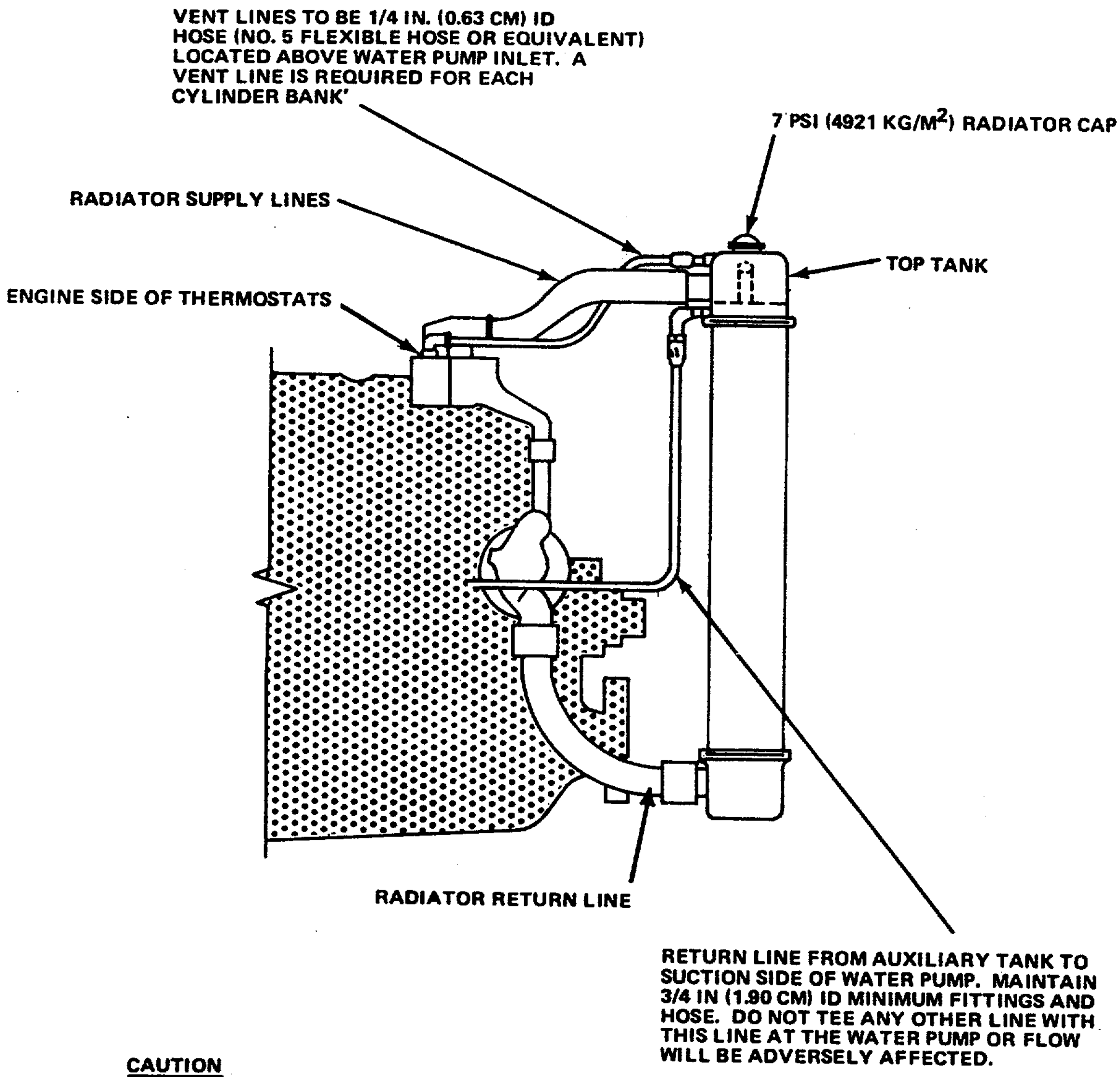


Figure 17-10. 500 KW Deaerating Top Tank Design



CAUTION

NO LINES OTHER THAN THE VENT LINES ARE TO BE PLUMBED TO THE TOP TANK SINCE THE FLOW MAY EXCEED THE FLOW CAPACITY OF THE LINE FROM THE TOP TANK TO THE WATER PUMP INLET.

Figure 17-11. 500 KW DOD Deaerating Top Tank Piping

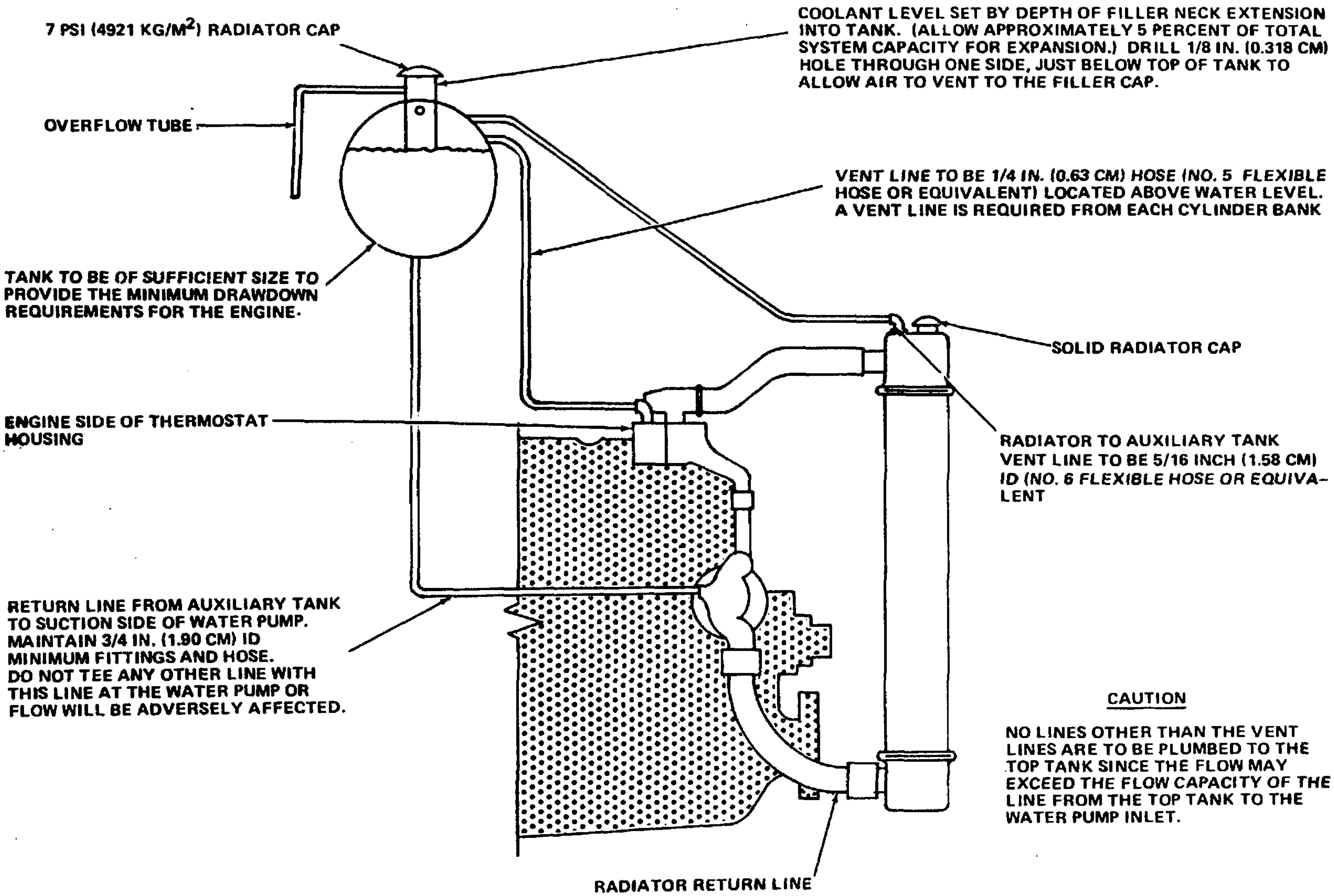


Figure 17-12. Recommended Auxiliary Tank Piping

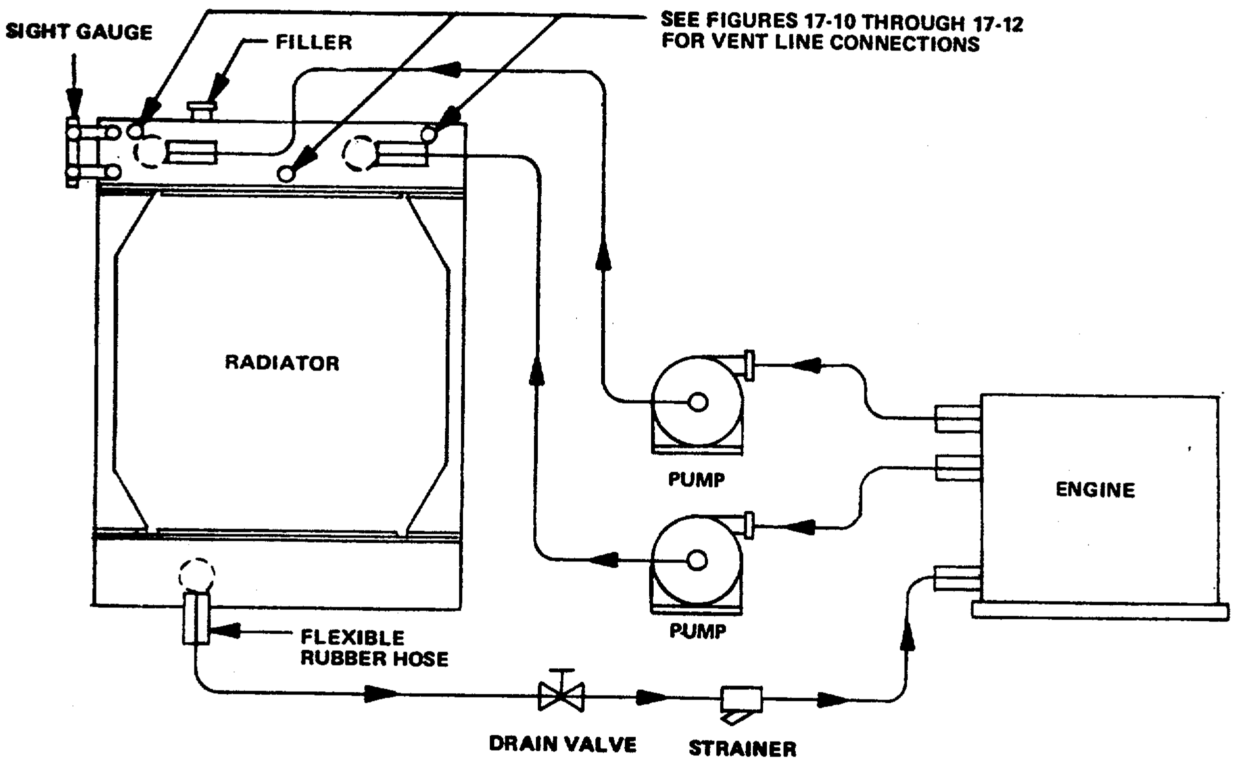


Figure 17-13. Remote Radiator Application "A"

exists between the outlet and the face of the radiator, and arrange so that hot air cannot re-enter.

NOTE

Engine exhaust outlets should not be placed adjacent to either intake air or outlet air louver openings.

17-44. The 500 KW radiator assembly may be mounted separately from the generator set. The horizontal and vertical displacement of the radiator from the engine's centerline will determine the additional system components necessary for the installation. Since particular installation requirements will vary, it is advisable to contact the Cognizant Authority regarding remote radiator system requirements. Figures 17-10 through 17-12 illustrate deaerating and auxiliary tank piping. Figure 17-13 illustrates a simple remote radiator installation, with an electric motor driven fan used as a heat exchanger for engine coolant. The radiator is mounted so that the radiator top tank is the highest point in the water system, preventing air pockets which could cause stoppage of coolant flow and consequent engine overheating. The top tanks of the radiators used on the 500 KW generator set are of oversized design and in the application shown act as a surge tank. A filler neck and pressure cap are supplied to allow for coolant filling and pressurized system operation. Air can be-vented from the system by means of a float-type trap which allows the escape of air, but not allow water to escape. The air escape trap should have a pipe extending down into the top part of the top tank, from 1 to 3 inches (2.54 to 7.62 cm), so that a cushion of air is trapped here to take care of normal surge.

17-45. A strainer is used in the water line returning from the radiator to catch dirt, scale, and core sand. The electric auxiliary water pump shown in figure 17-13 is used to assist the engine driven pump in maintaining the desired coolant flow rate which would have been reduced in remoting the radiator by the line and fitting drop incurred by the additional piping. A drain valve should be incorporated to facilitate servicing the radiator.

17-46. The pipe size utilized should be the same size as the radiator inlet an outlet fittings. Use the same pipe size throughout the entire system. Use straight lengths of pipe wherever possible in conjunction with radius elbows wherever turns are required.

17-47. Flexible hoses used to isolate vibration should be used at the inlet and outlets of both the engine and radiator.

17-48. The fan motor and electric auxiliary pump must be electrically connected to ensure their operation whenever the unit is running.

17-49. For applications in which the radiator is positioned at some horizontal distance from the unit and is not the highest point in the water system the configuration shown in figure 17-14 is recommended. The surge tank, located in a position elevated above the radiator provides the space to accommodate the natural expansion of heated water and the air and gases trapped and dissolved in the water. The surge tank is vented permitting escape of vapor and air.

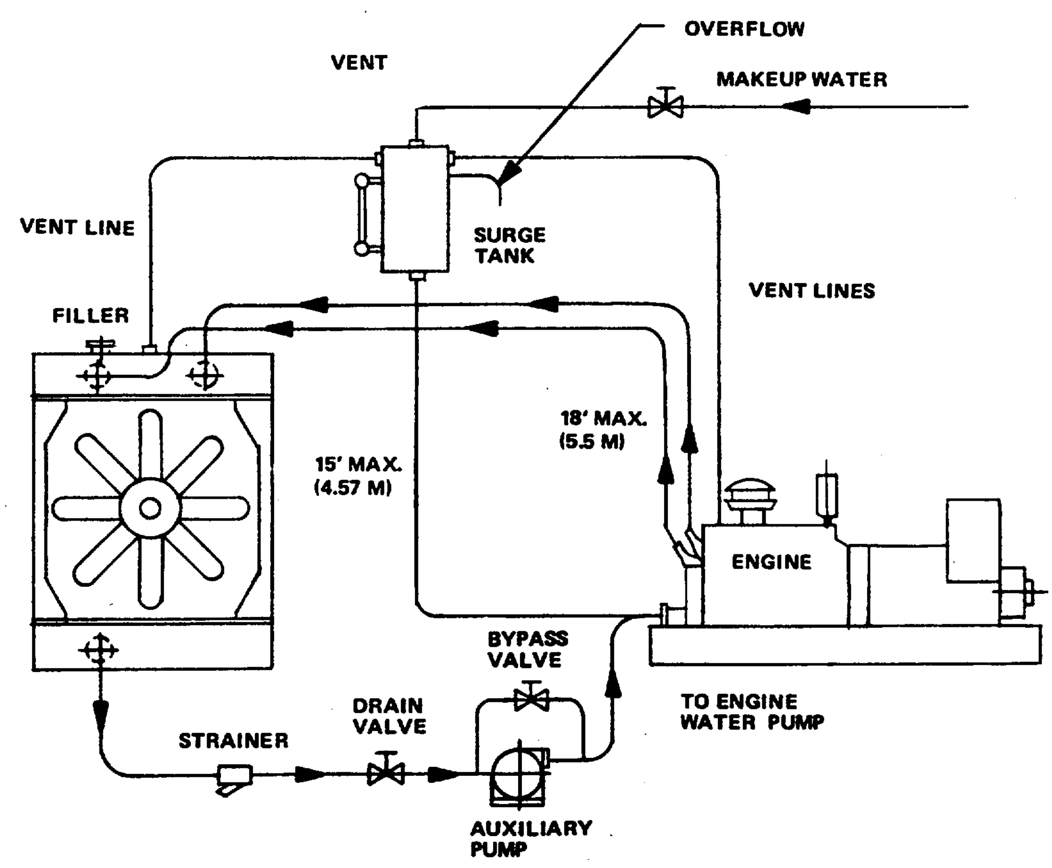


Figure 17-14. Remote Radiator Application "B"

17-50. The surge tank should also be equipped with a sight gauge, overflow pipe, and vent to atomosphere. It should also have connections for makeup feed water.

17-51. Another important function of the surge tank is the maintenance of a positive head of pressure on the engine water pump inlet. The line connecting the bottom of the surge tank to the engine water pump inlet services this function.

17-52. The electric auxiliary water pump shown in figure 17-14 is used to assist the engine driven pump in maintaining the desired coolant flow rate which would have been reduced in remoting the radiator by the line and fitting drop incurred by the additional piping. In the event of a failure of the auxiliary pump, a bypass valve connected across the pump can be opened preventing the complete loss of an emergency standby unit. No component failure which by itself could prevent operation should be overlooked.

17-53. A drain valve should be incorporated to facilitate servicing the radiator. As shown in figure 17-14, the use of a drain valve and water pump bypass valve permits the draining of the radiator, surge tank, and the engine. A strainer is used in the line returning from the radiator to catch dirt, scale, and core sand.

17-54. The fan motor and electric auxiliary pump must be connected to ensure their operation whenever the unit is running.

17-55. For applications in which the radiator is positioned at some distance above the engine centerline, a hot-well tank and an auxiliary water pump are

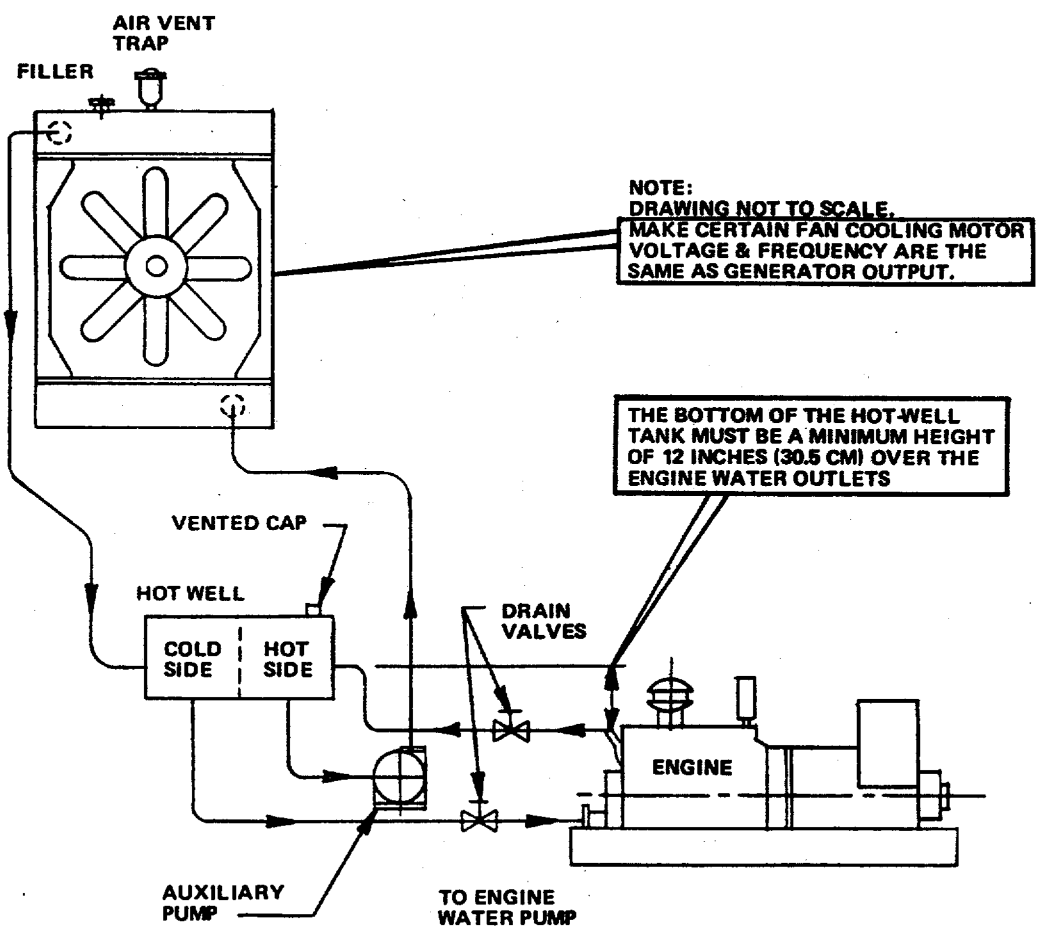


Figure 17-15. Remote Radiator Application "C"

required (see figure 17-15). The hot-well tank protects the cooling system component seals against the pressure produced by the column of water whose vertical distance is the height of the radiator above the engine.

17-56. The tank is divided into two sections by a partial baffle separating the hot side (engine outlet) from the cold side (engine inlet). Engine connections to the hot-well tank must be below the radiator connections to prevent aeration of the engine. The bottom of the hot-well tank must be a minimum of 12 inches (30.5 cm) above the engine coolant outlet. The engine driven water pump supplies heated coolant from the engine to the hot side of the tank. The tank provides a quiet area of low flow velocity with a large surface area to permit entrained air to dissipate and escape through the vent. The auxiliary water pump draws water from the hot side of the tank and pumps it through the radiator and back to the cold side of the tank where it is tempered to prevent too low an inlet of the engine driven water pump.

17-57. The hot-well tank must be capable of containing 60 percent of the coolant system capacity when the unit is not in operation. The 60 percent figure includes the radiator and its piping to the tank, an additional 130 percent of the radiator piping capacity must be allowed for expansion and surge damping. See table 17-5 for radiator data.

17-58. When the unit is shut down, the radiator coolant drains into the hot-well tank, whose hot and cold sides are interconnected by a small opening, thereby reducing the head of pressure on the engine later pump seals. A 10 psi (7031 kg/m²) maximum external static pressure at the water pump is held to be the upper limit to provide for satisfactory water pump seal operation. Static pressures exceeding this limit may cause fact-type, spring-loaded seals to lift causing engine coolant leakage.

17-59. The hot-well tank should be vented and mounted within 10 feet (3 m) of the engine. To prevent aeration of the cooling system, the auxiliary pump connected to the tank must be below normal water level in the tank.

Table 17-5. 500 KW DOD Generator Set Radiator data

Coolant capacity.......	54 gal. (204 1)
GPM....................	210 (13.2 1/sec.)
BTU/minute.............	23,400
Fan motor hp...........	15
Fan rpm................	860
Fan cfm................	33,579 (15.8 1/sec)
Radiator assm.wt.......	1340 lbs. (608 kg)

Section VII. FUEL SYSTEM

17-60. Since diesel fuel is less volatile than gas or gasoline, it may be considered a safer fuel from the standpoint of storage and handling. This is often reflected in less stringent regulations for placement of tanks. In some locations, fuel tanks of considerable size are permitted inside the building or enclosure; however, planning the installation.

17-61. The very fact that diesel fuel is a safe fuel can lead to careless installation practices which can result in poor performance of the engine and generator set. Diesel fuel may not leak out of an improperly tightened fitting; however, air can be drawn in through this loose fitting when the engine is operating.

Air trapped in the fuel causes erratic performance and hard starting. For this reason, piping must be completely sealed against entrance of air and fine dust or dirt.

17-62. Auxiliary tank fuel filters and sediment drains are located in the set and are easily accessible to promote regular and frequent service. Cleanliness of the fuel is especially important on diesel engines which have easily clogged, precision fuel injectors, and pumps.

17-63. Black iron pipe or copper tubing must be used for diesel fuel systems galvanized tanks and piping must not be used since the diesel fuel and the galvanized coating react chemically to produce flaking which quickly clogs filters or causes failure of the fuel pump or injectors. Flexible lines must be of the type approved for diesel fuels.

17-64. The auxiliary fuel tank should be vented so that air and other gases can escape to atmosphere (see figure 17-16 through 17-18). The vent must, however, prevent dust, dirt, and moisture from entering the tank. Where return lines are required, keep the return spaced at least 12 inches (30.5 cm) away from the pickup or fuel dip tube if this is not done, air bubbles could be entrained in the fuel and cause erratic operation. At least 5 percent of capability should be allowed in a diesel main tank for expansion of the fuel. Auxiliary fuel tank capacity can be computed by using table 17-6.

Table 17-6. Fuel Consumption for 500 KW DOD Generator Set

FUEL CONSUMPTION AT 1800 RPM
IN GALLONS (LITERS

1/4 LOAD	1/2 LOAD	3/4 LOAD	FULL LOAD
11.4 (43.1)	19.2 (72.6)	27 (102.2)	37 (140)

MINIMUM FUEL CONSUMPTION (AT NO LOAD):

6 gal (~22.7 1)

17-65. SET FUEL TANK. The capacity of the fuel tank is determined by the fuel consumption of the unit and the continuous operating time necessary. Fuel supply capacity for generator service is 2 hours under full load without refueling. All auxiliary tanks must have:

a. A vent line terminating above grade level in a screened or hooded type vent cap with unrestricted opening to atmosphere.

b. A fuel fill line terminating above grade level and fitted with an appropriate cap or terminating in a fuel filler box with an appropriate cap and plainly marked for the fuel utilized.

c. A fuel supply line connected from the tank to the electric fuel transfer pump.

d. The tank should be fitted with a foot valve (permits flow in one direction only) to prevent loss of transfer pump prime when the transfer pump is not in operation.

17-66. The auxiliary fuel oil transfer pump is an internal part of the generator set and has the capacity to fill the fuel tank in one hour when pumping fuel at a temperature of 25°F (-31.7°C). Additionally, the pump is capable of lifting fuel 10 feet (3 m) and provides sufficient pressure to supply fuel through the filtration system under all possible viscosities of the fuel.

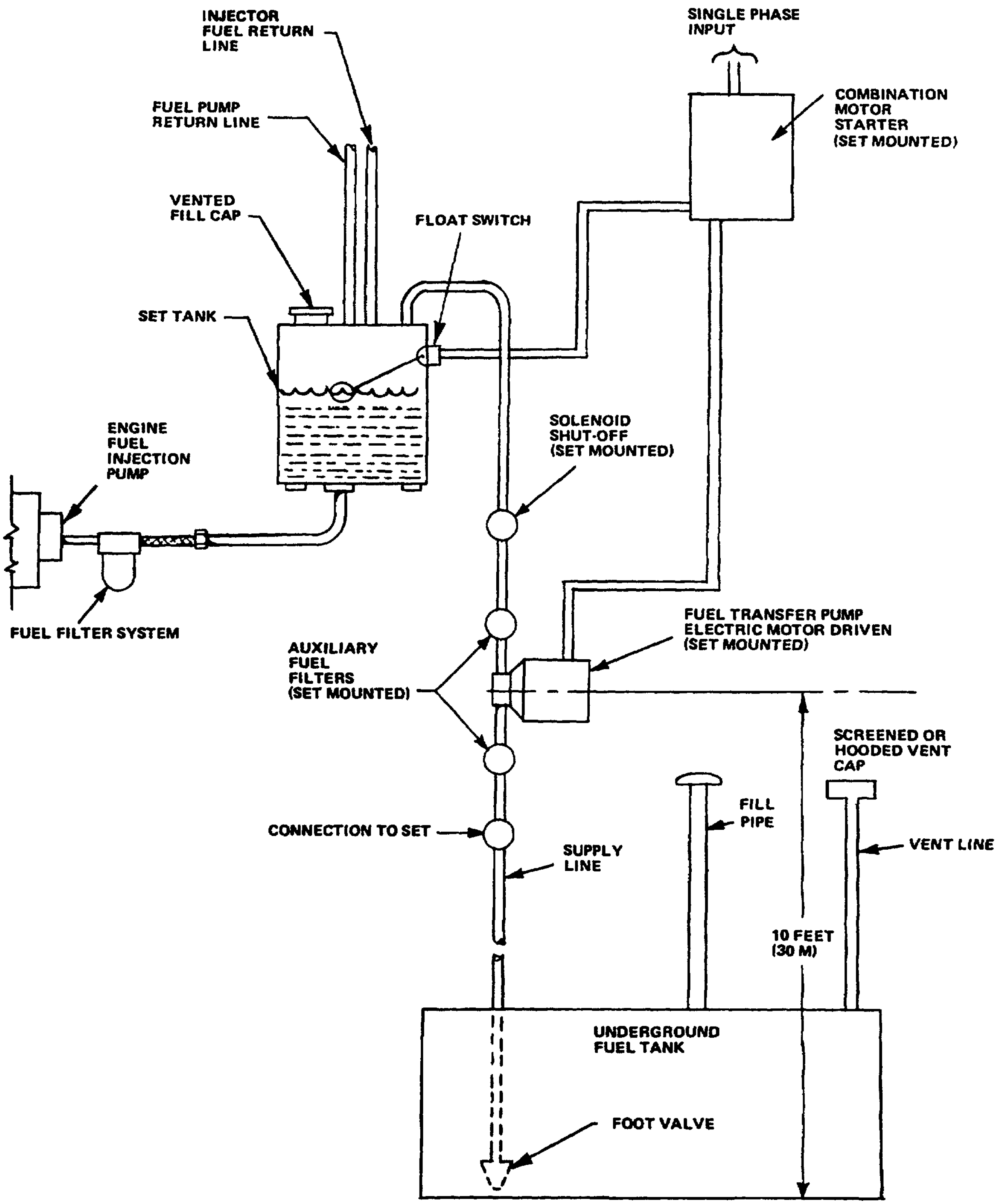


Figure 17-16. Auxiliary Diesel Fuel System

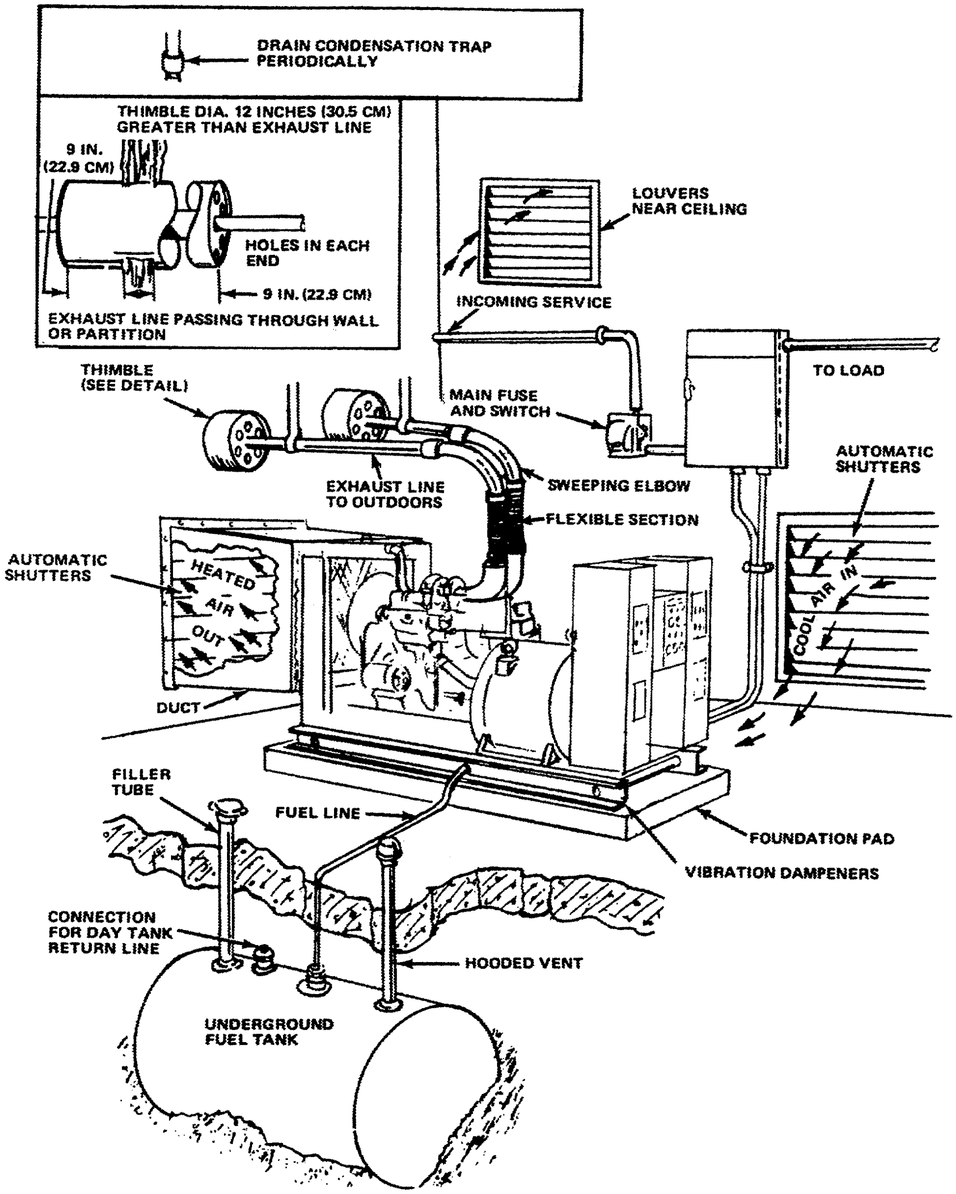


Figure 17-17. 500 KW Generator Set Installation

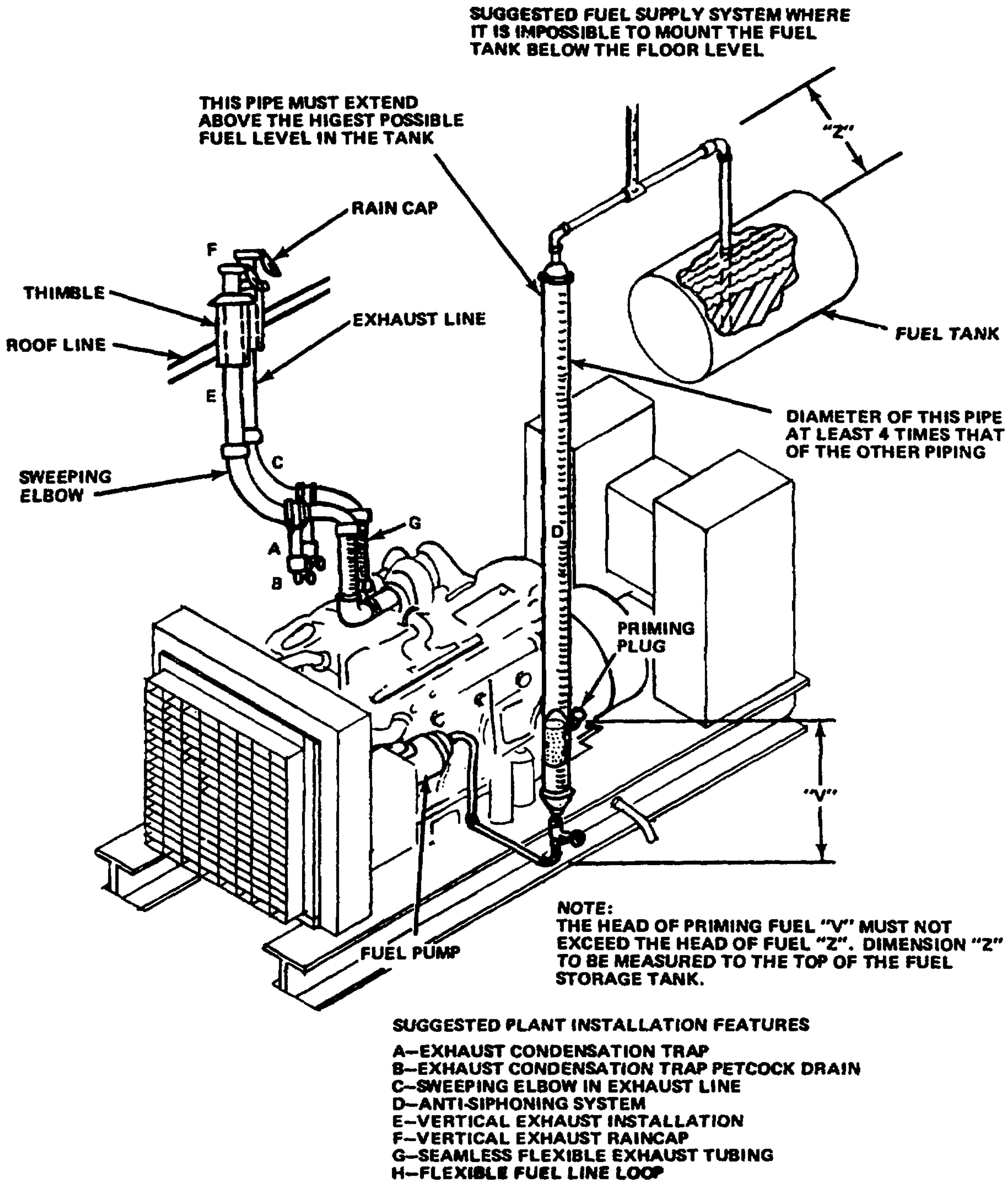


Figure 17-18. 500 KW Generator Set Anti-Siphon Installation

17-67. A motor starter will cause the fuel oil transfer pump to operate when its pilot circuit is closed by the action of the float switch. Fuel is then drawn from the auxiliary tank via a foot valve and is pumped into the set tank. Operation continued until the fuel level in the set tank causes the float to rise, opening the float switch and disconnecting the fuel transfer pump motor from the power supply.

17-68. FUEL LEVEL INDICATING SYSTEMS. When remote indication of the quantity of fuel in an underground tank is required, a levelometer system can be provided. Two types are available. The automatic type operated by compressed air can be located up to 1000 feet (300 m) from gauged. The manually operated type makes use of a hand pump located in the indicator case and can be located up to 150 feet (45 m) from the tank. Dials for the levelometer gauges can be supplied calibrated in pounds, gallons, liters, feet, inches or any other unit of measurement.

17-69. A typical levelometer system is shown in figure 17-19. Levelometers should be used only with vented tanks.

17-70. FUEL AND LUBRICANTS. The set is capable of satisfactorily starting and operating on fuels conforming to VV-F-800 Grades DF-A and DF-2, MIL-F16884, and turbine fuel conforming to MIL-T-5624 Grade JP-5. All components of the engine and fuel system are capable of operating on Grade JP-5 turbine fuel, except that rated load may be reduced to a maximum of 20 percent of rated kw. When operated continuously on Grade JP-5 fuel, the set meets all requirements except that the injectors and fuel pumps may be changed and timing adjusted from the diesel setting at the time of changing fuel. The set is capable of continuous operation using lubricating oil conforming to MIL-L-9000, MIL-L-46167, and MIL-L-2104.

Section VIII. EXHAUST SYSTEM

17-71. The engine exhaust system must dispose of the exhaust gases remaining after combustion with a minimum of back pressure applied to the engine. The exhaust gas flow for any engine will be approximately three times the engine's intake and consumption. The adverse effects of materially exceeding back pressure recommendations of the engine manufacturers loss of power, poor fuel economy, high combustion temperatures resulting in shorter service life, jacket water overheating, and crankcase sludging and corrosion or bearing damage. When the generator set is installed indoors, the exhaust system back pressure can be kept within the acceptable limits by the selection of properly sized and installed exhaust pipe and the use of the two mufflers supplied with the set.

17-72. When the generator set is installed indoors, it is desirable but not mandatory, to have the mufflers outdoors. This will greatly reduce the heat radiated within the building; insulating the exhaust piping with asbestos will further reduce radiated heat.

17-73. To ensure an exhaust system which will not produce a back pressure in excess of the engine manufacturer's specifications (shown in table 17-7).

a. Use an exhaust flex connector not less than 5 inch (12.7 cm) ID.

b. Use the silencers supplied with the generator set.

c. Do not exceed the maximum equivalent exhaust pipe length in feet in table 17-8.

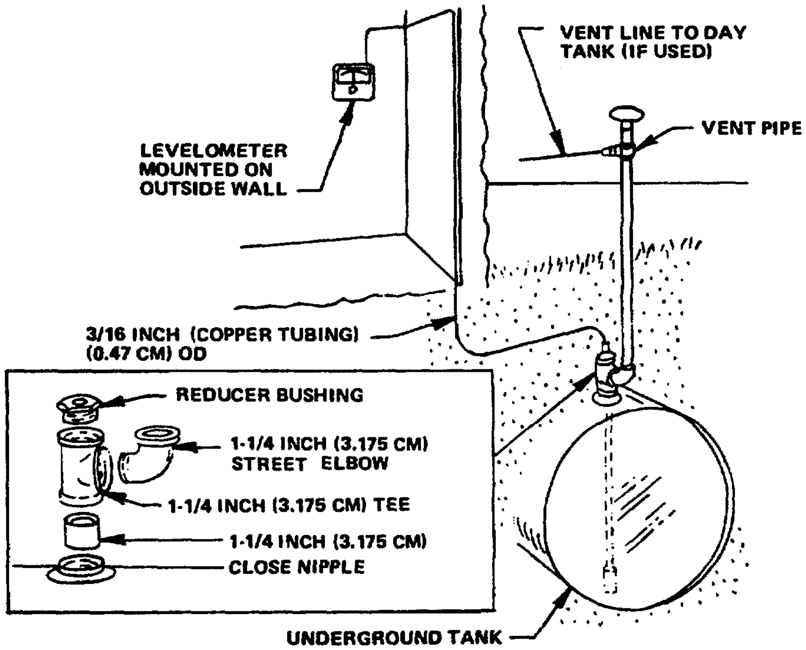


Figure 17-19. 500 KW Levelometer System Installation

Table 17-7. Data On Engine
Used in 500 KW DOD Generator Set

Cylinders	12
Operating Cycles	4
Hp	750 at 1800 rpm
Weight	8500 pounds (3856 kg)
Oil capacity	18 gal. (68 1)
Coolant capacity	54 gal. (204 1)
Displacement	1710 cu. in. (28,142 cc)
Combustion air	1640 cfm (774 1/sec.)
Exhaust flow	4300 cfm (2030 1/sec.)
Max. allowable back pressure in. (cm) of H_2O	27.2 in. (69 cm)
Exhaust temperature	1000xF (537xC)
Muffler ID	5 in. (12.7 cm)

17-74. The engine exhaust manifold should be connected to the exhaust piping with a flexible exhaust connector (see figure 17-20). The flexible exhaust connector provides a means of taking up thermal growth of the exhaust system due to the hot exhaust gas and absorbing vibration.

17-75. Adequate support must be given to the exhaust piping, no more than 4 feet (12 m) should be allowed to extend from the engine exhaust manifold without adequate support.

Table 17-8. Exhaust Line Recommendations

EXHAUST OUTLET SIZE ENGINE	UP TO 10 FT (3 M)	10 TO 20 FT (3 TO 6 M)	20 TO 30 FT (6 TO 9 m)	30 TO 80 FT (9 TO 24 M)
5 in. (12.7 cm)	5 in (12.7 cm)	6 in. (15.2 cm)	6 in. (15.2 cm)	7 in (17.8 cm)

NOTE

When installing mufflers, make certain air flow direction is correct.

17-76. Exhaust piping passing through combustible walls or partitions shall be guarded at the point of passage by a metal ventilated thimble not less than 12 inches (30.5 cm) larger in diameter than the exhaust pipe or metal or burned fire clay thimbles built in brickwork providing not less than 8 inches (20.3 cm) of insulation between the thimble and combustible material (see figure 17-20). Exhaust pipes must not terminate near inlet vents of any type or near combustible materials.

17-77. Engine exhaust piping can accumulate a considerable amount of condensed moisture after unit shut down, particularly if the exhaust system is run through lengthy piping. To prevent condensed moisture from running back into the engine, a condensate trap and drain should be incorporated at some low point ahead of the engine manifolds (see figures 17-21 through 17-23).

17-78. Where vertical exhaust stack is necessary, a rain cap should be fitted to exclude rain and snow from the exhaust pipe. Fully automatic counter-balanced rain caps are provided with each generator set.

Section IX. ELECTRICAL REQUIREMENTS

17-79. BATTERIES. The sets lead acid batteries are shipped dry. They can be stored indefinitely and when ready to use filled with electrolyte (acid) with a specific gravity of 1.265 to 1.280. It is recommended that batteries be placed on charge after electrolyte is added.

17-80. Coat battery terminal connections with grease to prevent corrosion. Check the electrolyte level periodically. Make certain all battery vent caps are in place and unobstructed.

17-81. The integral charger will maintain batteries in a fully charged condition. It will float at a very low rate to overcome the self-discharge characteristics of idle batteries.

17-82. SYSTEM DESCRIPTION. The 500 KW DOD generator set is designed to be used as a single unit or in conjunction with as many as three additional units. Two to four units may be paralleled with the use of one automatic control module (ACM). Another added feature of the generator set is the ability to either add a remote set control box or to remove the set's control box for remote operation. The ACM is designed to automatically control up to four MEP-029A, 500KW generator sets.

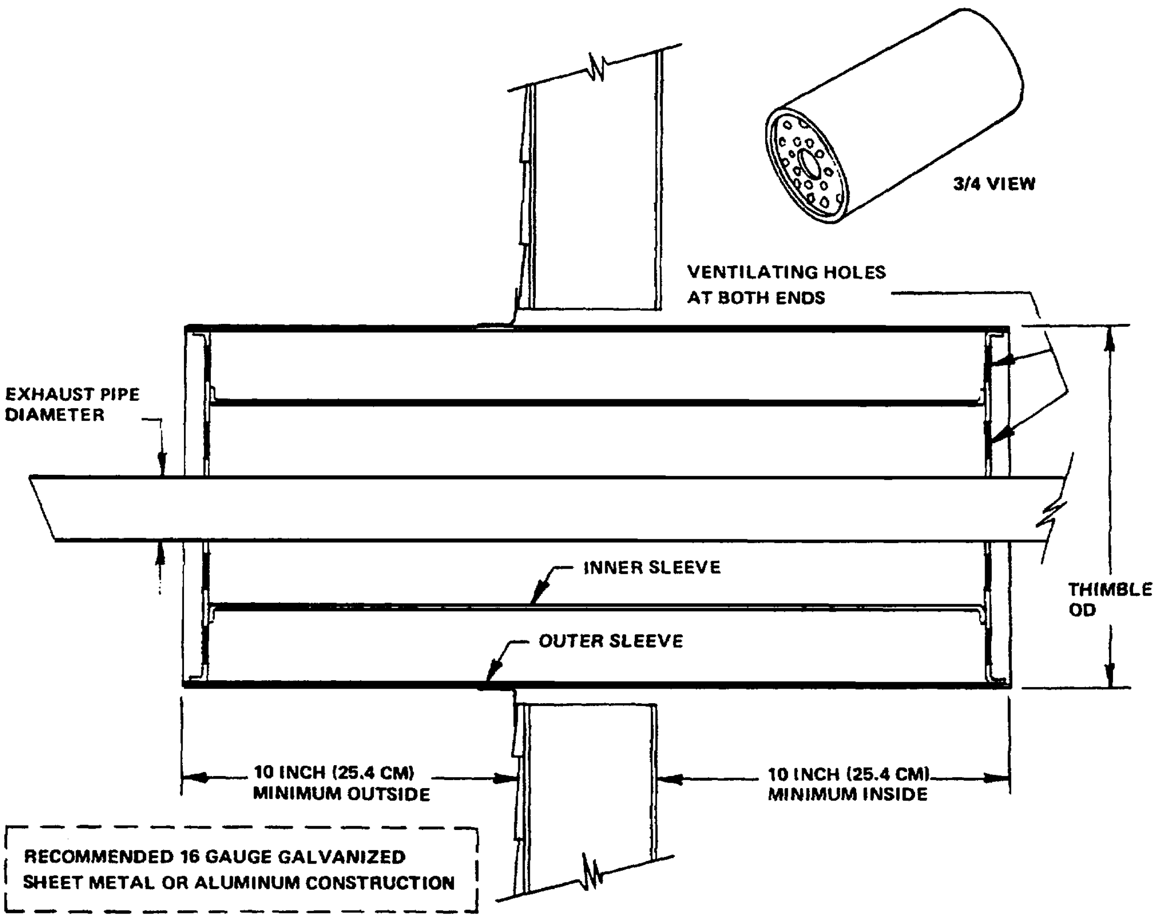


Figure 17-20. Double Thimble-Wall Outlet Details

Table 17-9. Typical Full Load AC Generator Amps

THREE PHASE 0.8 POWER FACTOR

FREQ.	KW	KVA	120/208V	240/416V
60 Hz	500	625	1736	868
50 Hz	417	521.25	1449	724

$$3 \text{ phase amps} = \frac{\text{kw} \times 1000}{1.73 \times \text{Volts} \times .8\ \text{PF}}$$

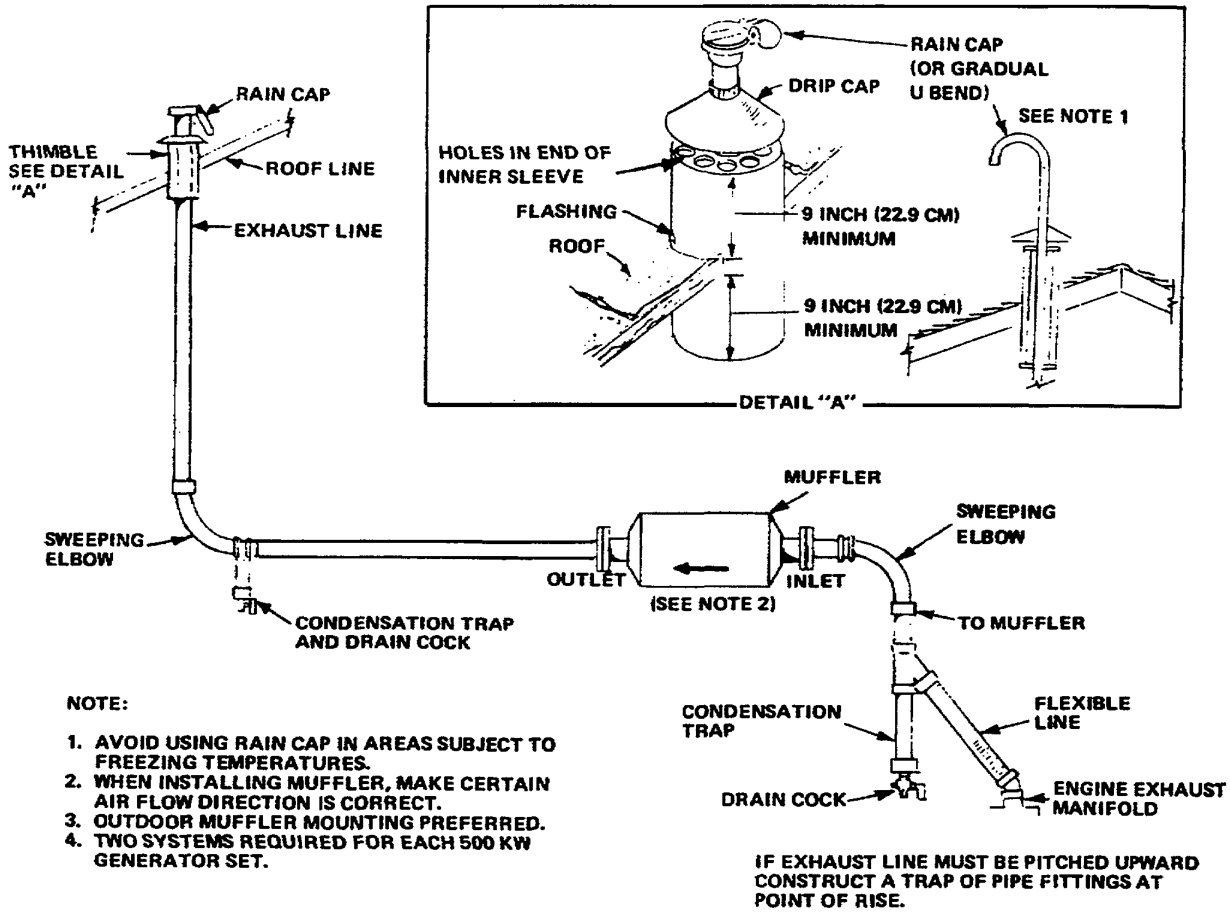


Figure 17-21. 500 KW Exhaust System

The utility monitor circuit which includes 120 VAC over/under voltage relay (27/59N), under frequency relay (81N-U), over frequency relay 81N-0), 1.5 - 15 second (adjustable) time delay relay (TD), 50/60Hz frequency select switch and a run rely (RR), continually monitors the 120 VAC utility voltage from the line side of the utility breaker.

When the utility power is normal, relays 27/59N, 81N-U and TD are energized (81N-0 will only energize during an over-frequency condition) and the normal power available lamp will be on.

If the utility power completely fails or voltage varies by more than ±10% and/or frequency varies more than ±3%, TD relay after a 1.5 - 15 second time delay will allow all generators to begin a start-up cycle providing the generators are in the automatic mode. Relays 27/59N, 81N-U, TD and RR de-energize allowing 24 volts D. C. to energize the K5 engine start circuit via normally closed contacts TD and RR through TB4-5, 6, 7, 8 through J3-B through the automatic position of the auto-trip manual switch (s53) on each set. The utility breaker (located within user switchgear will open via additional sets RR contacts at TB3-17, 18, and 19.

As the generators run up to speed, each generator's quality circuit (81G-0, 81G-U, 27/59G and CR) monitors the condition of their respective set. This circuit has identical voltage and frequency specifications as the utility monitor circuit in the ACM and is only completely functional if the generator set is in the automatic mode.

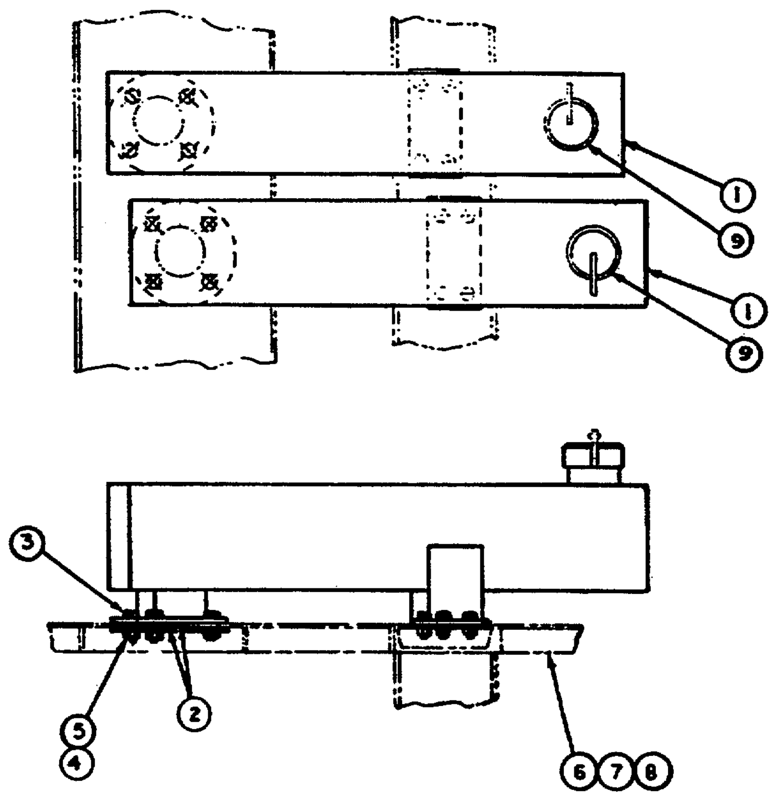
As each generator satisfies its own quality circuit, control relay (CR) will energize and provide 120 VAC through J3-N to TB2-5, 6, 7, or 8 to its applicable MR relay (MR1, 2, 3, or 4) in the ACM. However, the first MR to be energized will lock out all other MR relays and also provide a closure to its generator circuit breaker control circuit via its applicable normally open contact (TB3-1 through TB3-8) through J3-D and J3-E. The first set to close its circuit breaker via MR will also energize its own breaker control relay (BCR)which now disconnects its synchronizer to electric governor (2301) connection which is no longer needed since this generator is already on line. Once all other units have satisfied their quality circuit and energized CR, their respective synchronizers will be energized via CR contacts at terminal one of the synchronizer. The fact that all other MR relays have locked out and synchronizers are now energized, enables the remaining units circuit breakers to be closed only when proper synchronization has taken place. It should be noted that K106 sync check relay (N. O. contacts 5 and 6) is always in the circuit breaker closure circuit in series with MR closure contacts and/or the synchronizer closure contacts. This will preclude any set circuit breaker closure, in automatic or manual unsynchronized.

As each set circuit breaker (CB2) closes, its auxiliary contacts (CB2-5) will close allowing 120 V.A.C. via J3-P to TB2-9, 10, 11 or 12 to energize each sets respective BR1-BR4 relay. These BR relays along with the 24 VDC available to LR1 (LRTD1) - LR 4 (LRTD4) make up the prioritized feeder breaker control circuits. The first set to close to the bus will energize a BR relay which will always close LR1 (Load Relay) and its .2 - 20 second (adjustable) time delay (LRTD1) secondly. Each LR and LRTD should control loads not to exceed 250KW each. LRTD's allow a time delay between load applications as to allow engine turbochargers to build up speed. LR1 relay will always be the first relay to energize on start-up and the last relay to de-energize when the sets are shut down. Therefore, it is classified as the #1 priority feeder breaker control. When LR1 relay energizes, it also prevents RR relay from being re-energized if utility power returns via LR1 normally closed contacts in series with RR relay coil. This allows all sets, which are in the automatic mode, to complete their start-up and parallel cycles regardless of utility power returning. As each remaining set is automatically synchronized and paralleled to the bus, the remaining LR and LRTD relays will energize in numerical order.

The ACM has a 3 position rotary switch labeled “Instant”, "Time Delay" (TD) and "No Return". This switch allows the user three options as to what will happen when the utility power returns after a failure. If the switch is in the "Instant" return position, immediately, when the utility power returns, the utility 120 VAC will be supplied through energized T. D. relay normally open contacts through S1 to TB2-1, 2, 3, and 4 to J3-C on all units, energizing the breaker trip relay (BTR) which will shunt trip each unit's circuit breaker (CB2). At this time, all BR, LR and LRTD relays de-energize causing the LR1 normally closed contact, in series with RR coil, to re-close allowing RR relay to re-energize, thereby allowing the utility breaker to close back to the load. In the "TD" position, a 3-30 minute (adjustable) time delay via UTR (Utility Trip Relay) allows a pre-determined time delay after the utility power returns before the unit circuit breakers (CB2) are tripped. This insures utility power has returned to stay, avoiding unnecessary transfer and re-transfers of the utility breaker control. In the "no return" position, the generators will carry the load until switched off by the operator.

At the same instant when all units CB2's are tripped open via BTR, SDT (Shut Down timer) begins a 1-300 second (adjustable) time out before de-energizing. This SDT relay allows the engines to continue to run and cool down after the load has been removed.

At the end of this time delay period, SDT N. O. contacts re-open, removing the 24 VDC to TB4-5, 6, 7, 8 and J3-B which in turn allows K5 relays to de-energize and stop all units.



FIND NO.	SYM	CODE IDENT	DWG SIZE	PART NO. IDENTIFYING NO.	QTY RQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
1			C	76-11054	2	MUFFLER, EXHAUST	
2			B	76-11100	4	GASKET, EXHAUST	
3				MS90725-189	8	SCREW, HEX. HD 2.50 LG	3/4-10 UNC
4				MS35338-51	8	WASHER, LK, SPLIT 3/4 NOM	
5				MS51967-23	8	NUT, HEX	3/4-10 UNC
6				MS90725-110	8	SCREW, HEX. HD. 1.25 LG	1/2-13UNC
7				MS35338-48	8	WASHER , LK, SPLIT 1/2 NOM	
8				MS27183-18	8	WASHER FLAT, 1/2 NOM	
9			C	76-11055	2	CAP, RAIN, MUFFLER	

Figure 17-22. Installation of Mufflers on Generator Set.

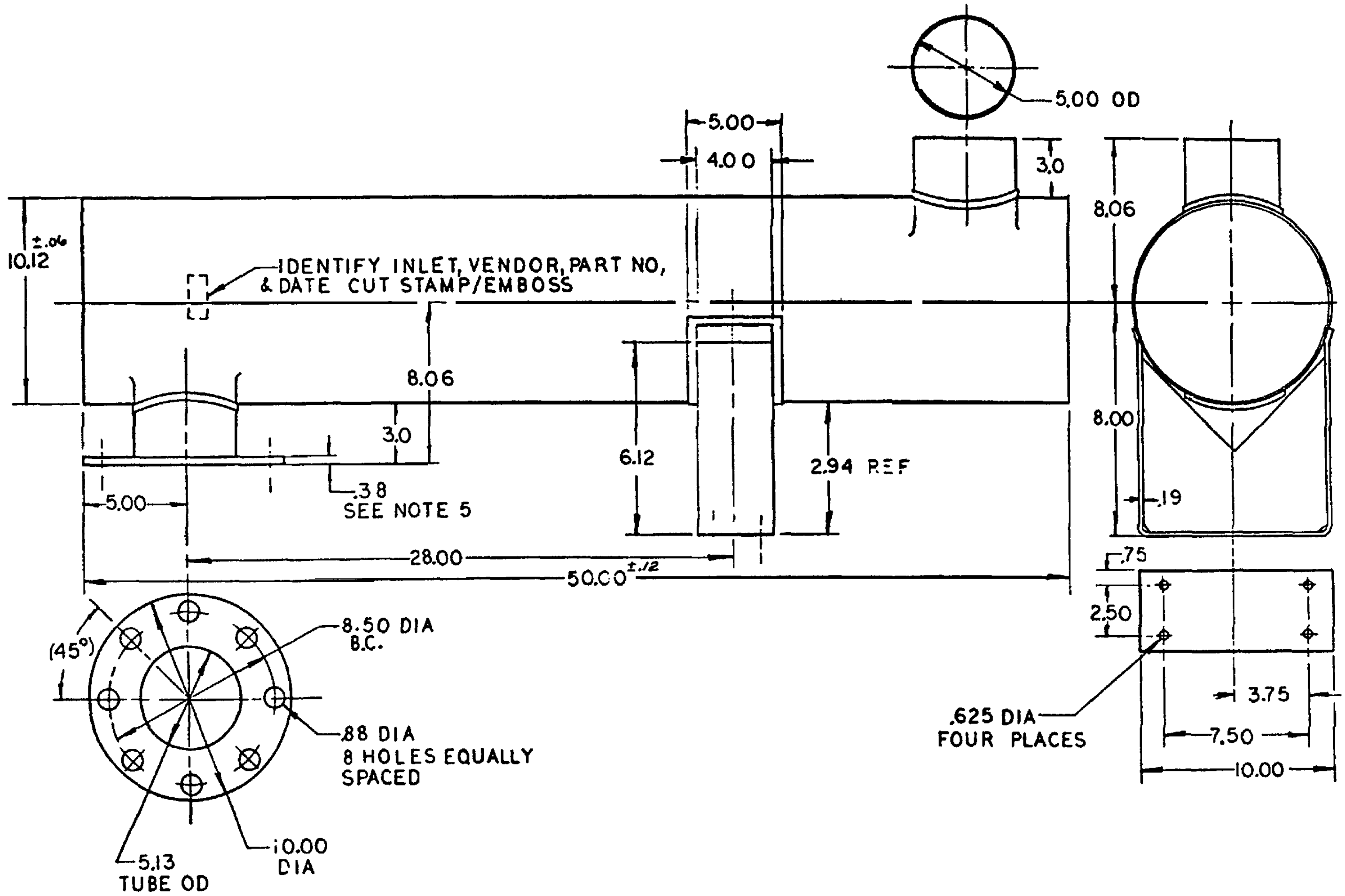


Figure 17-23. Muffler Provided with Generator Set

THE 500 KW GENERATOR IS A 24 LEAD, 6 COIL RECONNECTABLE GENERATOR CAPABLE OF PRODUCING VOLTAGES SHOWN BELOW. EITHER 50 OR 60 CYCLE OUTPUT CAN BE GENERATED ACCORDING TO THE RPM OF THE ENGINE.

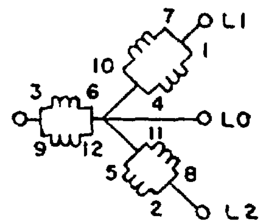
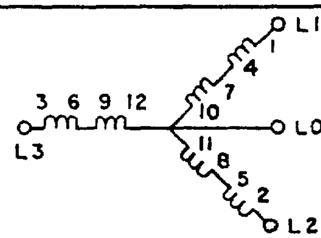
VOLTAGE	PHASES	FREQUENCY (HZ)	GENERATOR CONNECTION	GENERATOR SCHEMATIC
120/208	3	60	LOW WYE	
240/416	3	60	HIGH WYE	

Figure 17-24. Generator Voltages and Schematic

17-83. Generator sets should be located in easy-to-clean, dry areas. When installed outdoors, the set should be a housed unit, or an enclosure should be built to protect it from inclement weather. Don't overlook the possibility of spring flooding or high water level during storms if the set is to be located in a low area such as a water front or basement installation.

17-84. Screens or other protection should be provided to safeguard against potential fire hazards and/or operational problems which can be caused by rodents, insects, birds, etc. They have been known to live or build nests inside enclosures and even inside generators.

17-85. Whenever possible, install the set in an area which can be quickly reached for repair in case of malfunction. Service entrances should be large enough to permit removal of large components such as engine, radiator, or generator in the even major overhaul or replacement becomes a necessity.

17-86. Service items that are hard to reach will not be properly maintained. Make sure ample room is provided around the set especially at points requiring regular attention. Figure 17-25 illustrates the location of items requiring regular service. An item requiring daily attention must, of course, be made more accessible than one requiring service every 5000 hours.

NOTE

For standby units it is important that servicing is performed on a calendar basis since it may take years to accumulate any significant number of hours to the set. Failure to do this may result in the set not starting or operating properly when the unit is most needed.

17-87. Before initial startup, refer to the installation check list, table 17-10 to ensure that the generator set is installed properly.

Connect battery just prior to starting set. Be sure connections are tight and polarity is correct. (Check wiring diagram.) All 500 KW DOD generator sets are designed for negative ground. Make certain muffler is installed with proper air flow. Inlet and outlet connections must be made as labeled on the muffler.

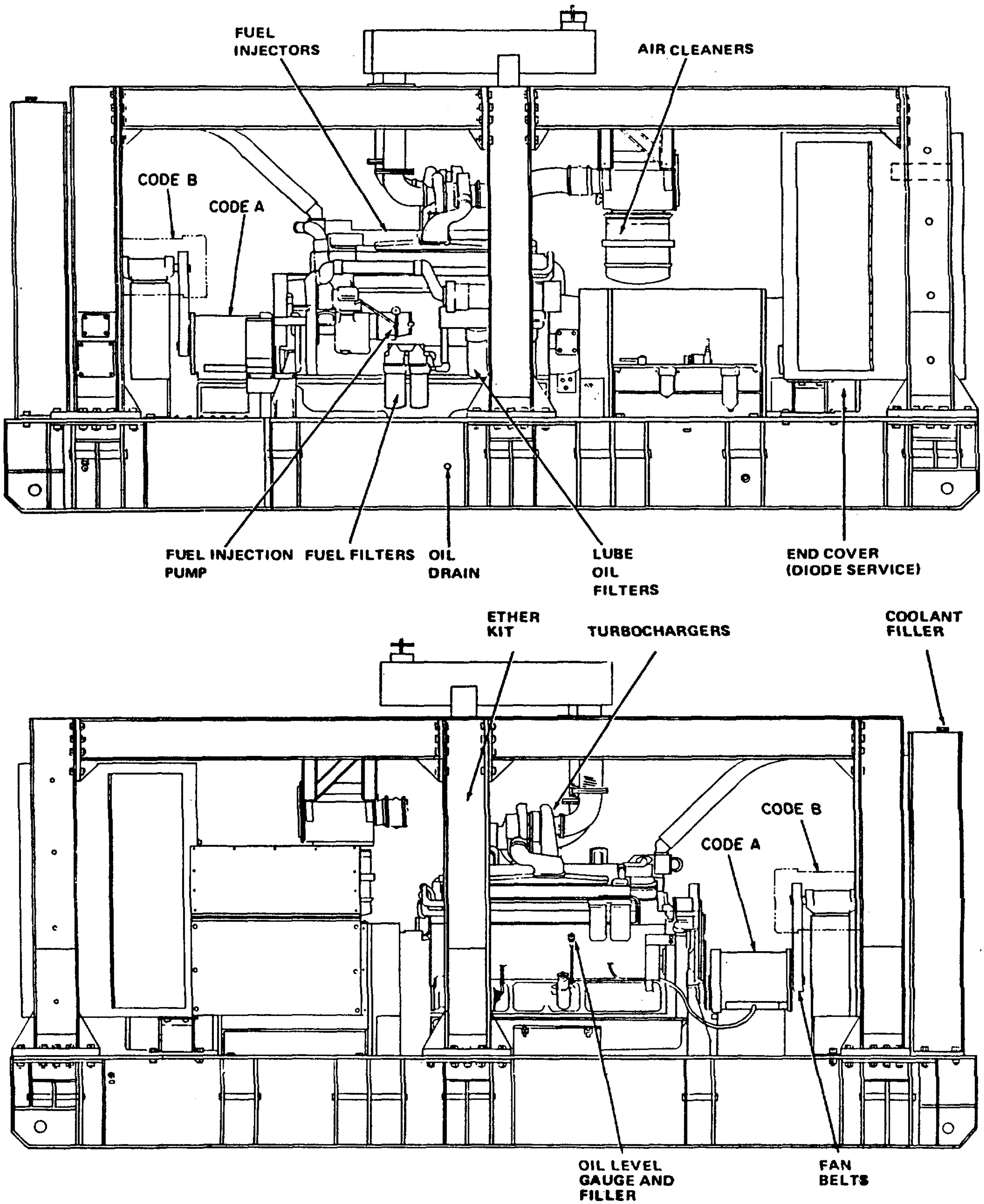


Figure 17-25. Service Points on 500 KW Generator Set

Table 17-10. Installation Check List

CHECK	OK	CHECK	OK
1. Adequate clearance all sides		13. Exhaust slope corrrect	
2. Adequate incoming air		14. Condense trap installed	
3. Adequate outgoing air		15. Mufflers installed	
4. Radiator duct flange connected		16. Exhaust line free of excessive elbows and restrictions	
5. Antifreeze reqired		17. Exhaust line covered	
6. Water heater properly connected and of proper voltage		18. Battery charger operating	
7. Proper size fuel line connectors		19. Generator properly connected	
8. Fuel lines protected		20. Battery properly charged	
9. Fuel pump lift adequate		21. Transfer switch operating correctly	
10. Proper size exhaust line		22. Binding post tight	
11. Flexible exhaust connection installed		23. Operator has instruction manual	
12. Nipple installed on manifold below flexible exhaust connection		24. Maintenance schedule posted	

APPENDIX A

REFERENCES

A-1.	Fire Protection TB 5-4200-200-10	Hand Portable Fire Extinguishers Approved by Army Users.
A-2.	Lubrication	
	C9100-IL L05-6115-593-12	Identification list for Fuels, Lubricants, Oils and Waxes.
	LI-6115-12/1	Lubrication Order
A-3.	Painting T.O. 35-1-3	Painting and Marking of USAF Aerospace Ground Equipment.
	TM 43-0139	Painting Instructions for Field Use.
A-4.	Radio Suppression	
	MIL-STD-461	Radio Interference Suppression.
	TM 11-483	Radio Interference Suppression.
A-5.	Maintenance	
	T.O. 00-25-225	Repair of External Power Cables, Aerospace Ground Equipment.
	T.O. 00-25-234	General Shop Practice Requirements for the Repair, Maintenance and Test of Electrical Equipment.
	T.O. 1-1-1	Cleaning of Aerospace Equipment.
	T.O. 1-1-2	Corrosion Control and Treatment for Aerospace Equipment.
	T.O. 1-1A-14	Installation Practices for Aircraft Electric and Electronic Wiring.
	T.O. 35-1-75	General Maintenance Practices
	T.O. 35-1-11	Organization, Intermediate and Depot Level Maintenance for FSC 6115 Non-Airborne Equipment.
	T.O. 35-1-12	Components and Procedures for Cleaning Aerospace Ground Equipment.
	T.O. 35-1-26	Repair/Replacement Criteria for FSC 6115 Aerospace Ground Equipment.
	T.O. 35-1-524	USAF Equipment Registration Number System Applicable to FSC 6115 Equipment.
	T. B. 750-651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems.
	DA PAM 738-750	The Army Maintenance Management System
	TM 9-237	Welding

APPENDIX A

REFERENCES

	TM 5-6115-593-12 T.O. 35C2-3-463-1 P-8-631-12 TM-6115-12/6	Operator/Crew and Organizational Maintenance Manual.
	TM 5-6115-593-34 T.O. 35C2-3-463-2 P-8-631-34 TM-6115-34/7	Intermediate (Field) (Direct and General) Support) and Depot Level Maintenance Manual.
	TM 5-6115-593-24P P-8-631-24P SL-4-6115-24/2 T.O. 35C2-3-463-4	Organizational, Intermediate (Field) (Direct and General Support) and Depot Maintenance Repair Parts and Special Tools List.
A-6.	Shipment and Storage	
	T.O. 35-1-4	Processing and Inspection of Aerospace Ground Equipment for Storage and Shipment.
	T.O. 38-1-5	Processing and Inspection of Non-mounted, Non-Aircraft Gasoline and Diesel Engines for Storage and Shipment.
	TB 740-97-2	Preservation of USAMEC Mechanical Equipment for Shipment and Storage.
A-7.	Destruction of Material	
	TM 750-244-3	Procedures for Destruction of Equipment to Prevent Enemy Use.
A-8.	Radioactive Material	
	TB 750-248	Instructions for Safe Handling, Maintenance, Storage, and Disposal of Radioactive Commodities Managed by U.S. Army Mobility Equipment Command.

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* Use individual part number to identify specific cables.

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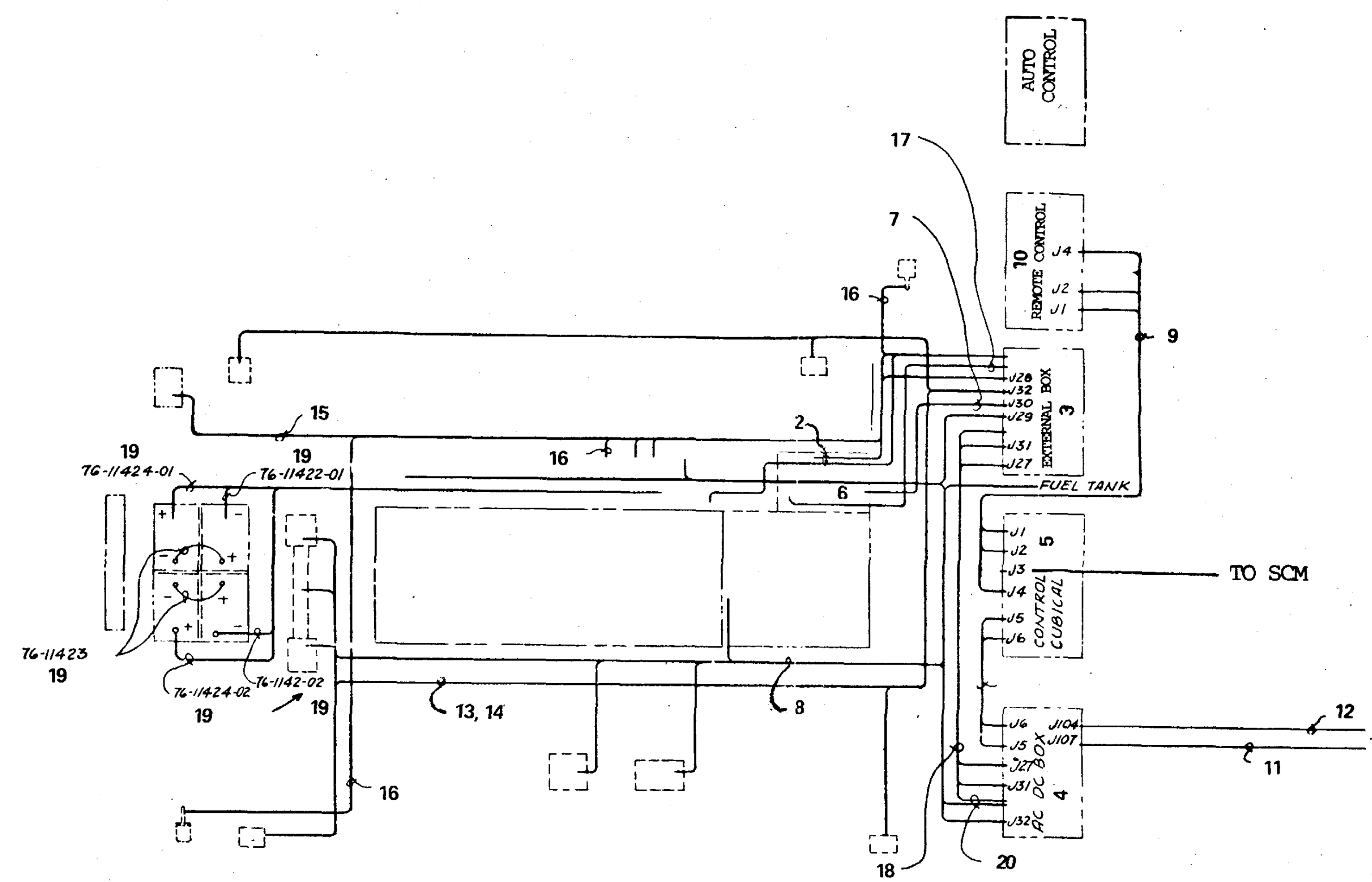
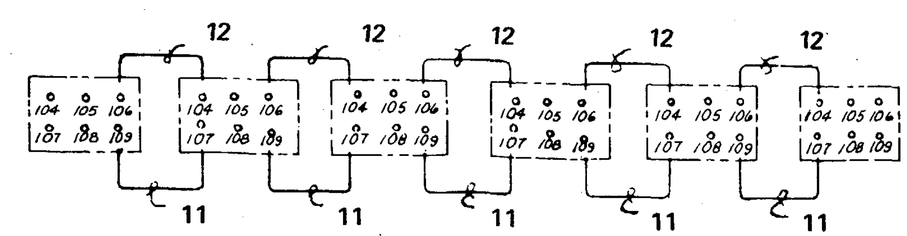
Louver Control Harness	FO-17

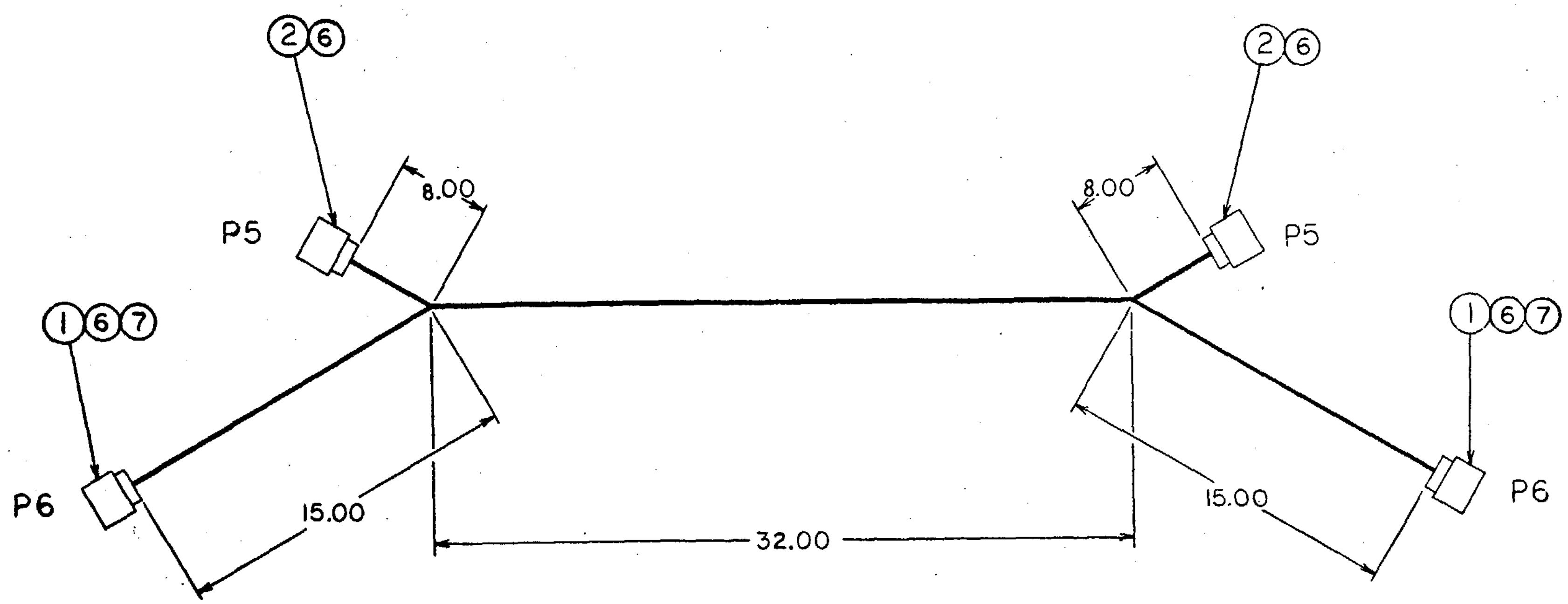


PARALLELING CONNECTIONS



FO-1. Generator Set, Electrical Layout

FP-1/FP-2 blank)



NOTES:

1. INTERPRET DWG PER DOD-STD-100.
2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING STRAPS FIND NO. 3. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. FOR WIRING INFORMATION, SEE FO-5 AND FO-7 IN TM5-6115-593-12.
6. INSTALL NYLON FILLER PLUGS, FIND NO. 6 OR 7, IN UNUSED OPENINGS OF CONNECTOR BUSHING.

7				MS25251-16	10	PLUG,END SEAL,ELEC CONN		
6				MS25251-12	14	PLUG,END,SEAL		
5				SN60WRAP2	AR	SOLDER	QQ-S-571	SEE NOTE 3
4				M5086/2-16-9	AR	WIRE,16AWG,COLOR,WHITE	MIL-W-5086/2	
3				MS3367-1-9	AR	STRAP,CABLE,ADJUSTABLE		
2				MS3106R36-7P	2	CONN,PLUG,ELEC		
1				MS3106R 32-7S	2	CONN,PLUG,ELEC		
FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
						LIST OF MATERIALS		

FO-2. Main Control Harness (Sheet 1 of 2)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
KILC16	16	48.00	RED	P5-I	SOLDER	P5-I	SOLDER
K5LC16	16	48.00	RED	P5-f	SOLDER	P5-f	SOLDER
L20LC16	16	48.00	RED	P5-B	SOLDER	P5-B	SOLDER
E30LC16	16	48.00	RED	P5-j	SOLDER	P5-j	SOLDER
E31LC16	16	48.00	RED	P5-k	SOLDER	P5-k	SOLDER
E32LC16	16	48.00	RED	P5-m	SOLDER	P5-m	SOLDER
E33LC16	16	48.00	RED	P5-n	SOLDER	P5-n	SOLDER
P40LC16	16	48.00	RED	P5-C	SOLDER	P5-C	SOLDER
P41LC16	16	48.00	RED	P5-A	SOLDER	P5-A	SOLDER
P42LC16	16	48.00	RED	P5-E	SOLDER	P5-E	SOLDER
P46LC16	16	48.00	RED	P5-b	SOLDER	P5-b	SOLDER
P50LC16	16	48.00	RED	P5-K	SOLDER	P5-K	SOLDER
P52LC16	16	48.00	RED	P5-a	SOLDER	P5-a	SOLDER
P53LC16	16	48.00	RED	P5-p	SOLDER	P5-p	SOLDER
P54LC16	16	48.00	RED	P5-c	SOLDER	P5-c	SOLDER
P55LC16N	16	48.00	RED	P5-T	SOLDER	P5-T	SOLDER
P59LC16	16	48.00	RED	P5-F	SOLDER	P5-F	SOLDER
P65LC16	16	48.00	RED	P5-H	SOLDER	P5-H	SOLDER
P66LC16	16	48.00	RED	P5-N	SOLDER	P5-N	SOLDER
P70LC16	16	48.00	RED	P5-d	SOLDER	P5-d	SOLDER
P69LC16	16	48.00	RED	P5-g	SOLDER	P5-g	SOLDER
P71LC16	16	48.00	RED	P5-L	SOLDER	P5-L	SOLDER
P72LC16	16	48.00	RED	P5-M	SOLDER	P5-M	SOLDER
P73LC16	16	48.00	RED	P5-P	SOLDER	P5-P	SOLDER
P74LC16	16	48.00	RED	P5-R	SOLDER	P5-R	SOLDER
Q80LC16	16	48.00	RED	P5-h	SOLDER	P5-h	SOLDER
P93LC16	16	48.00	RED	P5-S	SOLDER	P5-S	SOLDER
P94LC16	16	48.00	RED	P5-J	SOLDER	P5-J	SOLDER
P142LC16	16	48.00	RED	P5-r	SOLDER	P5-t	SOLDER
P143LC16	16	48.00	RED	P5-s	SOLDER	P5-s	SOLDER
P200LC16	16	48.00	RED	P5-U	SOLDER	P5-U	SOLDER
P201LC16	16	48.00	RED	P5-V	SOLDER	P5-V	SOLDER
P202LC16	16	48.00	RED	P5-W	SOLDER	P5-W	SOLDER
P203LC16	16	48.00	RED	P5-X	SOLDER	P5-X	SOLDER
P60G16	16	48.00	RED	P5-O	SOLDER	P5-O	SOLDER
P64LC16	16	48.00	RED	P5-v	SOLDER	P5-v	SOLDER
P204LC16	16	48.00	RED	P5-Y	SOLDER	P5-Y	SOLDER
P210LC16	16	48.00	RED	P5-Z	SOLDER	P5-Z	SOLDER
P211LC16	16	48.00	RED	P5-e	SOLDER	P5-e	SOLDER

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
X360LC16	16	48.00	BLACK	P5-D	SOLDER	P5-D	SOLDER
X361LC16	16	48.00	BLACK	P5-G	SOLDER	P5-G	SOLDER
P62LC16	16	48.00	RED	P5-u	SOLDER	P5-u	SOLDER
P364LC16	16	48.00	RED	P5-t	SOLDER	P5-t	SOLDER
P61516	16	48.00	RED	P5-z	SOLDER	P5-z	SOLDER
X101LC16A	16	62.00	BLACK	P6-K	SOLDER	P6-K	SOLDER
X102LC16B	16	62.00	BLACK	P6-J	SOLDER	P6-J	SOLDER
X103LC16C	16	62.00	BLACK	P6-I	SOLDER	P6-I	SOLDER
X104LC16A	16	62.00	BLACK	P6-L	SOLDER	P6-L	SOLDER
X105LC16B	16	62.00	BLACK	P6-M	SOLDER	P6-M	SOLDER
X106LC16C	16	62.00	BLACK	P6-N	SOLDER	P6-N	SOLDER
X106LD16C	16	62.00	BLACK	P6-b	SOLDER	P6-b	SOLDER
X105LD16B	16	62.00	BLACK	P6-Z	SOLDER	P6-Z	SOLDER
X107LC16	16	62.00	BLACK	P6-A	SOLDER	P6-A	SOLDER
X108LC16	16	62.00	BLACK	P6-g	SOLDER	P6-q	SOLDER
X109LC16	16	62.00	BLACK	P6-h	SOLDER	P6-h	SOLDER
X110LC16N	16	62.00	BLACK	P6-S	SOLDER	P6-S	SOLDER
X111LC16	16	62.00	BLACK	P6-W	SOLDER	P6-W	SOLDER
X112LC16	16	62.00	BLACK	P6-X	SOLDER	P6-X	SOLDER
X113LC16	16	62.00	BLACK	P6-d	SOLDER	P6-d	SOLDER
X114LC16	16	62.00	BLACK	P6-B	SOLDER	P6-B	SOLDER
X115LC16	16	62.00	BLACK	P6-C	SOLDER	P6-C	SOLDER
X116LC16	16	62.00	BLACK	P6-D	SOLDER	P6-D	SOLDER
X117LC16	16	62.00	BLACK	P6-E	SOLDER	P6-E	SOLDER
X124LC16	16	62.00	BLACK	P6-j	SOLDER	P6-j	SOLDER
X126LC16	16	62.00	BLACK	P6-e	SOLDER	P6-e	SOLDER
X127LC16	16	62.00	BLACK	P6-f	SOLDER	P6-f	SOLDER
X129LC16	16	62.00	BLACK	P6-k	SOLDER	P6-k	SOLDER
X304LC16	16	62.00	BLACK	P6-Y	SOLDER	P6-Y	SOLDER
P40LD16	16	62.00	RED	P6-P	SOLDER	P6-P	SOLDER
P41LD16	16	62.00	RED	P6-R	SOLDER	P6-R	SOLDER
MOD138A	16	48.00	RED	P6-w	SOLDER	P6-w	SOLDER
MOD139A	16	48.00	RED	P6-x	SOLDER	P6-x	SOLDER
P99PF16	16	62.00	RED	P6-U	SOLDER	P6-U	SOLDER
P41PE16	16	62.00	RED	P6-Y	SOLDER	P6-Y	SOLDER

FO-3. Main Control Harness (Sheet 2 of 2)

NOTES:

1. WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS FIND NO 3 LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

2. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED THREE INCHES SEE TABLE #1 FOR MARKING INFORMATION.

3. FOR WIRING INFORMATION SEE FO-6, FO-10 AND FO-11, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

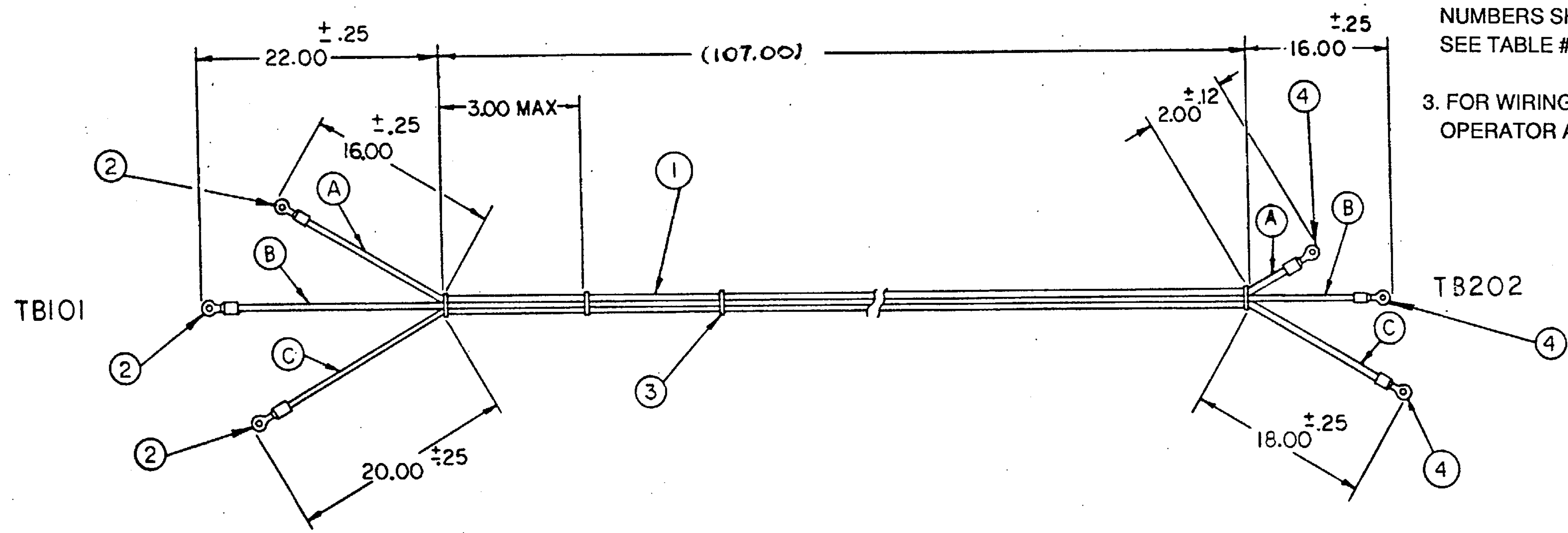
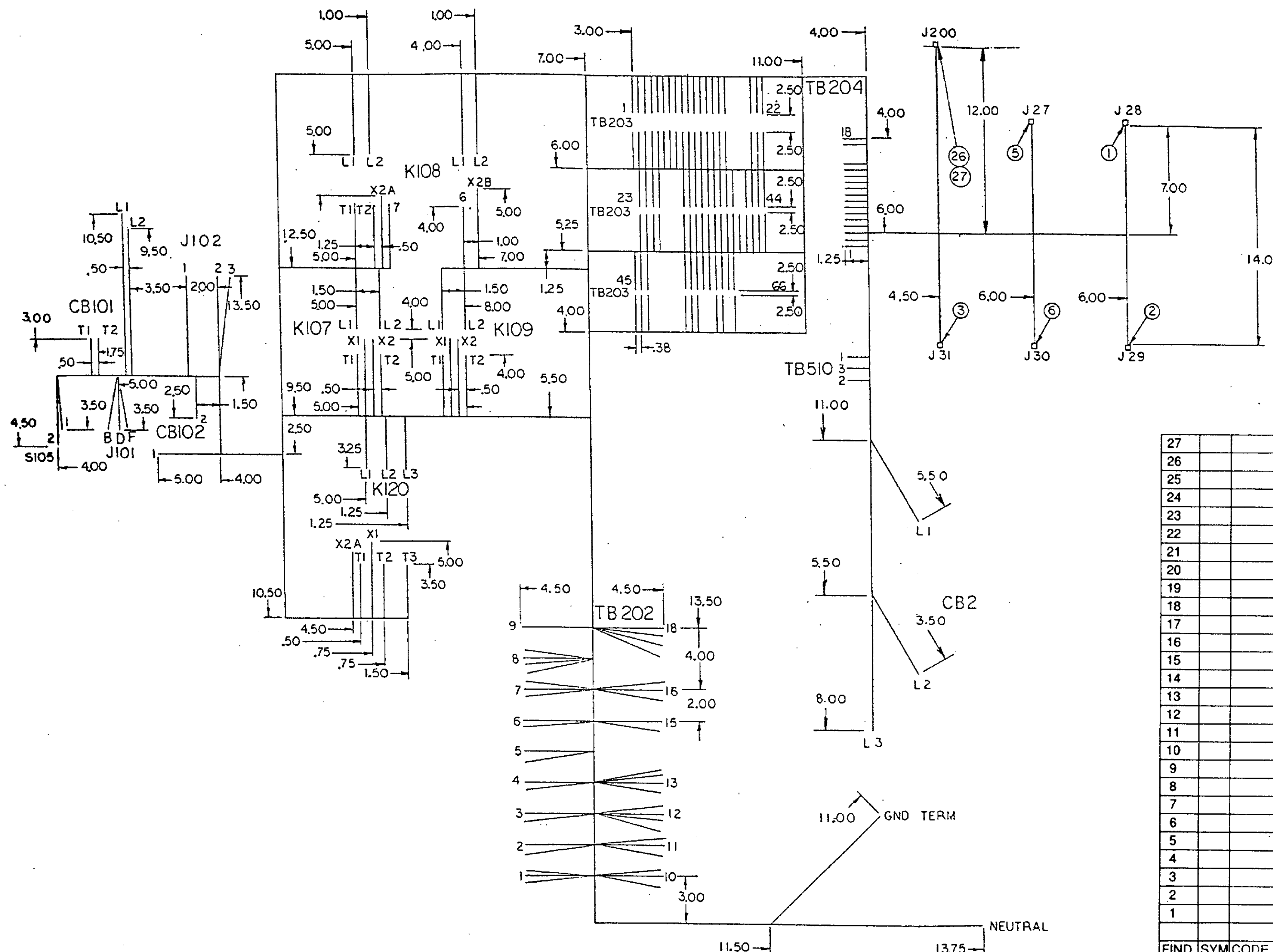


TABLE # 1

WIRE NO.	LETTER DES	LENGTH INCHES	FROM	END PREP	TO	END PREP	MKG COLOR
X104AP2A	A	125.00	TB101-T7	2	TB202-1	4	BLK
X105AP2B	B	145.00	TB101-T8	2	TB202-6	4	BLK
X106AP2C	C	145.00	TB101-T9	2	TB202-7	4	BLK

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
4				MS25036-126	3	TERMINAL LUG	MIL-T-7928	
3				MS3367-1-9	AR	TIE, WRAP	SEE NOTE 2	
2				MS25036-127	3	TERMINAL, LUG	MIL-T-7928	
1				M5086/2-2-9	AR	WIRE, AWG #2	MIL-W-5086/2	
						LIST OF MATERIALS		

FO-4. AC Power Wiring Harness



NOTES:

2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS FIND NOS 15 & 14 LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

3. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

4. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED THREE INCHES.

5. FOR WIRING INFORMATION SEE FO-6 OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
27				MS25251-16	13	PLUG,ENDSEAL,ELEC CONN		
26				MS3102R20-7S	1	CONNECTOR,RECEPTACLE,ELEC		
25			C	71-4924	12	TERMINAL LUG	MIL-T-7928	
24				MS25036-106	14	TERMINAL LUG	MIL-T-7928	
23				MS25036-119	9	TERMINAL LUG	MIL-T-7928	
22				MS25036-107	14	TERMINAL LUG	MIL-T-7928	
21				MS25036-157	19	TERMINAL LUG	MIL-T-7928	
20				MS25036-120	21	TERMINAL LUG	MIL-T-7928	
19				MS25036-156	3	TERMINAL LUG	MIL-T-7928	
18				MS25036-154	9	TERMINAL LUG	MIL-T-7928	
17				MS25036-153	96	TERMINAL LUG	MIL-T-7928	
16				SN60WRAP2	AR	SOLDER	QQ-S-571	SEE NOTE 3
15				MS3367-4-9	AR	TIE WRAP		
14				SN60WRAP2	AR	TIE WRAP		
13				M5086/2-16-9	397	WIRE AWG #16	MIL-W-5086	
12				M5086/2-14-9	15	WIRE AWG #14	MIL-W-5086	
11				M5086/2-12-9	51	WIRE AWG #12	MIL-W-5086	
10				M5086/2-10-9	53	WIRE AWG #10	MIL-W-5086	
9				M5086/2-8-9	15	WIRE AWG #8	MIL-W-5086	
8				M5086/2-6-9	142	WIRE AWG #6	MIL-W-5086	
7				M5086/2-4-9	4	WIRE AWG #4	MIL-W-5086	
6			C	76-11383	1	CONNECTOR		
5				MS3102R32-7S	1	CONNECTOR		
4				MS25036-123	1	TERMINAL LUG	MIL-T-7928	
3				MS3102R24-28S	1	CONNECTOR		
2				MS3102E28-10S	1	CONNECTOR		
1				MS3102E32-17S	1	CONNECTOR		

LIST OF MATERIALS

FO-5. External Power Box Harness Assembly (Sheet 1 of 2)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P62AA16	16	33.00	RED	TB203-53	17	TB204-17	24
P62AB16	16	41.00	RED	TB203-53	17	J31-W	SOLDER
P61AA16	16	31.00	RED	TB203-56	17	TB204-5	24
P61AB16	16	40.00	RED	TB203-56	17	J31-M	SOLDER
P55BR4N	4	44.00	RED	TB202-18	4	GND TERM	SOLDER
P55GD12N	12	45.00	RED	J27-P	SOLDER	TB203-61	25
P59F16	16	30.00	RED	TB203-57	17	TB204-6	24
P59T16	16	39.00	RED	TB203-57	17	J31-N	SOLDER
P56M16	16	43.00	RED	TB203-47	17	J31-X	SOLDER
X101D12A	12	40.00	BLACK	CB2-T1	21	TB203-32	25
X101P16A	16	43.00	BLACK	TB203-32	17	J27-A	SOLDER
X102D12B	12	44.00	BLACK	CB2-T2	21	TB203-32	25
X102P16B	16	42.00	BLACK	TB203-33	17	J27-I	SOLDER
X103D12C	12	46.00	BLACK	CB2-T3	21	TB203-40	25
X103P16C	16	42.00	BLACK	TB203-34	17	J27-C	SOLDER
X104AB6A	6	50.00	BLACK	TB202-1	20	K120-L2	SOLDER
X104AD16A	16	97.00	BLACK	TB202-1	18	J27-D	SOLDER
X104AC10A	10	55.00	BLACK	TB202-1	21	TB203-40	25
X104AA16A	16	62.00	BLACK	TB203-40	17	K120-X1	22
X105AA6B	6	39.00	BLACK	TB202-6	20	K120-L2	SOLDER
X105AB10B	10	47.00	BLACK	TB202-6	21	TB203-41	25
X105AC16B	16	40.00	BLACK	TB203-41	17	J27-E	SOLDER
X106M10C	10	46.00	BLACK	TB203-42	25	TB202-7	21
X106X16C	16	62.00	BLACK	TB203-42	17	K108A-7	22
X106Y6C	6	55.00	BLACK	TB202-7	20	K108B-L1	SOLDER
X106AA6C	6	35.00	BLACK	TB202-7	20	K120-L3	SOLDER
X106AC16C	16	39.00	BLACK	TB203-42	17	J27-F	SOLDER
X110MION	10	36.00	BLACK	TB203-59	25	TB202-A	21
X110N6N	6	45.00	BLACK	TB202-8	20	NEUTRAL-LO	SOLDER
X110P6N	6	52.00	BLACK	TB202-8	20	K108B-L2	SOLDER
X110R16N	16	34.00	BLACK	K108B-L2	SOLDER	K108B-X2	22
GND	12	52.00	RED	J102-3	19	TB202-18	21
X110T14N	14	31.00	BLACK	TB203-58	17	TB204-1	24
X110Z16N	16	53.00	BLACK	TB203-58	17	K120-X2(OL)	22
X110BA12N	12	82.00	BLACK	TB202-8	21	J27-T	SOLDER
X157A6A	6	67.00	BLACK	TB202-5	20	K120-T1	SOLDER
X157M6A	6	96.00	BLACK	TB202-5	20	J28-A	SOLDER
X158A6B	6	67.00	BLACK	TB202-4	20	K120-T2	SOLDER
X158M6B	6	98.00	BLACK	TB202-4	20	J28-B	SOLDER
X159A6C	6	67.00	BLACK	TB202-3	20	K120-T3	SOLDER
X159M6C	6	96.00	BLACK	TB202-3	20	J28-C	SOLDER
X170A6	6	45.00	BLACK	CB101-L2	SOLDER	K107-L2	23
X171A6	6	38.00	BLACK	TB202-15	20	K107-T2	23
X171P12	12	93.00	BLACK	TB202-15	21	J29-F	SOLDER
X171B6	6	35.00	BLACK	K107-T2	23	K109-L2	23
X172B6	6	43.00	BLACK	K107-T1	23	K109-L1	23
X175A16	16	43.00	BLACK	TB202-2	18	K109-X1	22
X175P16	16	100.00	BLACK	TB202-2	18	J29-A	SOLDER
GND	14	30.00	RED	TB204-2	24	TB203-60	17
X176A16	16	34.00	BLACK	S105-2	22	K107-X1	22
P99PA16	16	40.00	RED	TB204-12	17	TB510-1	24
P55PA16	16	40.00	RED	TB204-18	17	TB510-2	24
P41PA16	16	40.00	RED	TB204-11	17	J27-0	24
P99DB16	16	40.00	RED	TB510-1	17	J27-0	24

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
X177A6	6	9.00	BLACK	J101-B	SOLDER	CB101-T1	SOLDER
X178A6	6	9.00	BLACK	J101-D	SOLDER	CB101-T2	SOLDER
X179A6	6	70.00	BLACK	TB202-12	20	J101-F	SOLDER
X179P6	6	99.00	BLACK	TB202-12	20	J29-D	SOLDER
X179B6	6	67.00	BLACK	TB202-12	20	K108A-L2	SOLDER
X179C16	16	45.00	BLACK	TB202-12	18	K107-X2	22
X179D16	16	32.00	BLACK	K107-X2	22	K108A-X2	22
X179E16	16	35.00	BLACK	K108A-X2	22	K109-X2	22
X180A6	6	72.00	BLACK	TB202-13	20	CB101-L1	SOLDER
X180B6	6	66.00	BLACK	TB202-13	20	K108A-L1	SOLDER
X180C6	6	63.00	BLACK	TB202-13	20	K107-L1	23
X181A16	16	71.00	BLACK	TB202-11	18	S105-1	22
X181B16	16	51.00	BLACK	TB202-11	18	K108B-6	22
X182A6	6	83.00	BLACK	TB202-16	20	K108A-T2	SOLDER
X182B10	10	56.00	BLACK	TB202-16	21	J102-2	19
X182P12	12	85.00	BLACK	TB202-16	21	J27-U	SOLDER
X183P12	12	94.00	BLACK	TB202-10	21	J27-V	SOLDER
X183A6	6	92.00	BLACK	TB202-10	20	K108A-T1	SOLDER
X183B10	10	65.00	BLACK	TB202-10	21	CB102-1	SOLDER
X184A10	10	23.00	BLACK	CB102-2	SOLDER	J102-1	19
X150PA10A	10	64.00	BLACK	CB2-L1	21	TB203-35	25
X151PA10B	10	67.00	BLACK	CB2-L2	21	TB203-36	25
X152PA10C	10	70.00	BLACK	CB2-L3	21	TB203-37	25
X360A16	16	36.00	BLACK	TB203-54	17	TB204-7	24
X360AA16	16	40.00	BLACK	TB203-54	17	J31-K	SOLDER
X361A16	16	35.00	BLACK	TB203-55	17	TB204-8	24
X361AA16	16	40.00	BLACK	TB203-55	17	J31-L	SOLDER
X369A14	14	41.00	BLACK	TB203-46	17	TB204-4	24
X370A14	14	41.00	BLACK	TB203-45	17	TB204-3	24
X125A16	16	21.00	BLACK	TB203-21	17	TB204-9	24
X125V16	16	33.00	BLACK	TB203-21	17	J30-W	SOLDER
X128A16	16	20.00	BLACK	TB203-22	17	TB204-10	24
X128R16	16	34.00	BLACK	TB203-22	17	J27-k	SOLDER
P55BG16N	16	60.00	BLACK	TB202-18	17	TB204-18	24
P55GTION	10	34.00	BLACK	TB202-18	18	TB203-61	25
X173P8	8	82.00	BLACK	K109-T2	21	J29-B	SOLDER
X174P8	8	83.00	BLACK	K109-T1	23	J29-E	SOLDER
X107R16	16	43.00	BLACK	TB203-7	23	J30-A	SOLDER
X107S16	16	40.00	BLACK	TB203-7	17	J27-G	SOLDER
X108R16	16	43.00	BLACK	TB203-9	17	J30-B	SOLDER
X108S16	16	40.00	BLACK	TB203-9	17	J27-H	SOLDER
X109R16	16	43.00	BLACK	TB203-10	17	J30-C	SOLDER
X109S16	16	39.00	BLACK	TB203-10	17	J27-J	SOLDER
X111R16	16	44.00	BLACK	TB203-8	17	J30-D	SOLDER
X111S16	16	40.00	BLACK	TB203-8	17	J27-K	SOLDER
X112R16	16	42.00	BLACK	TB203-11	17	J30-E	SOLDER
X112S16	16	39.00	BLACK	TB203-11	17	J27-L	SOLDER
X113R16	16	40.00	BLACK	TB203-12	17	J30-F	SOLDER
X113S16	16	38.00	BLACK	TB203-12	17	J27-M	SOLDER
X114R16	16	40.00	BLACK	TB203-15	17	J30-G	SOLDER
MODIO2	16		BLACK	TB203-17	17	J31-p	SOLDER
MODIO7	16		BLACK	TB203-40	17	TB204-12	17
MODI58	16		BLACK	TB203-17	17	TB204-11	17

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
X114S16	16	37.00	BLACK	TB203-15	17	J27-N	SOLDER
X115R16	16	41.00	BLACK	TB203-13	17	J30-H	SOLDER
X115S16	16	38.00	BLACK	TB203-13	17	J27-W	SOLDER
X116R16	16	41.00	BLACK	TB203-14	17	J30-J	SOLDER
X116S16	16	37.00	BLACK	TB203-14	17	J27-X	SOLDER
X117J16	16	40.00	BLACK	TB203-16	17	J30-K	SOLDER
X117H16	16	36.00	BLACK	TB203-16	17	J27-Y	SOLDER
X118R16	16	45.00	BLACK	TB203-2	17	J30-N	SOLDER
X118S16	16	41.00	BLACK	TB203-2	17	J27-Z	SOLDER
X119R16	16	46.00	BLACK	TB203-1	17	J30-P	SOLDER
X119S16	16	43.00	BLACK	TB203-1	17	J27-a	SOLDER
X120R16	16	45.00	BLACK	TB203-3	17	J30-R	SOLDER
X120S16	16	41.00	BLACK	TB203-3	17	J27-b	SOLDER
X121R16	16	45.00	BLACK	TB203-4	17	J30-S	SOLDER
X121S16	16	40.00	BLACK	TB203-4	17	J27-c	SOLDER
X122R16	16	45.00	BLACK	TB203-5	17	J30-T	SOLDER
X122S16	16	40.00	BLACK	TB203-5	17	J27-d	SOLDER
X123R16	16	44.00	BLACK	TB203-6	17	J30-U	SOLDER
X123S16	16	40.00	BLACK	TB203-6	17	J27-e	SOLDER
X124R16	16	38.00	BLACK	TB203-20	17	J30-V	SOLDER
X124S16	16	35.00	BLACK	TB203-20	17	J27-f	SOLDER
X125R16	16	34.00	BLACK	TB203-21	17	J27-g	SOLDER
X126R16	16	43.00	BLACK	TB203-44	17	J30-Y	SOLDER
X126S16	16	37.00	BLACK	TB203-44	17	J27-h	SOLDER
X127R16	16	44.00	BLACK	TB203-43	17	J30-Z	SOLDER
X127S16	16	38.00	BLACK	TB203-43	17	J27-j	SOLDER
D131R16	16	50.00	BLACK	TB203-24	17	J30-e	SOLDER
D131S16	16	39.00	BLACK	TB203-24	17	J31-A	SOLDER
D137R16	16	50.00	BLACK	TB203-25	17	J30-f	SOLDER
D137S16	16	39.00	BLACK	TB203-25	17	J31-B	SOLDER
D133R16	16	52.00	BLACK	TB203-26	17	J30-g	SOLDER
D133S16	16	38.00	BLACK	TB203-26	17	J31-C	SOLDER
D134S16	16	49.00	BLACK	TB203-27	17	J30-h	SOLDER
D138R16	16	50.00	BLACK	TB203-28	17	J30-d	SOLDER
D138S16	16	37.00	BLACK	TB203-28	17	J31-Z	SOLDER
D134R16	16	38.00	BLACK	TB203-27	17	J31-D	SOLDER
X152PC16C	16	41.00	BLACK	TB203-37	17	J30-c	SOLDER
X152PD16C	16	33.00	BLACK	TB203-37	17	J200-G	SOLDER
X151PC16B	16	33.00	BLACK	TB203-36	17	J200-B	SOLDER
X150PD16A	16	33.00	BLACK	TB203-35	17	J200-A	SOLDER
X303R16	16	44.00	BLACK	TB203-39	17	J30-a	SOLDER
X303S16	16	32.00	BLACK	TB203-39	17	J200-E	SOLDER
P140CT12	12	81.00	RED	TB202-9	17	J27-R	SOLDER
X151PD16B	16	33.00	BLACK	TB203-36	17	J200-H	SOLDER
X369BP16	16	44.00	BLACK	TB203-46	17	J31-R	SOLDER
X370BP16	16	44.00	BLACK	TB203-45	17	J31-S	SOLDER
X180R16	16	82.00	BLACK	TB202-13	17	J31-H	SOLDER
X181R16	16	87.00	BLACK	TB202-11	17	J31-J	SOLDER
X304R16	16	45.00	BLACK	TB203-38	17	J30-b	SOLDER
X304S16	16	32.00	BLACK	TB203-38	17	J31-T	SOLDER

FO-6. External Power Box Harness Assembly (Sheet 2 of 2)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
K1B16	16	23	RED	J5-I	SOLDER	TB20-17	9
K1F16	16	33	RED	TB20-17	9	J26-A	SOLDER
K4B16	16	43	RED	TB20-13	9	TB29-12	16
K4F16	16	30	RED	TB20-13	9	J26-B	SOLDER
K5B16	16	45	RED	S22-2	10	TB21-5	9
K5E16	16	30	RED	TB21-5	9	J5-f	SOLDER
K5F16	16	37	RED	TB21-5	9	TB9-9	16
K6A16	16	45	RED	TB20-12	9	TB9-7	16
K6B16	16	39	RED	TB20-12	9	K1-7	10
K6F16	16	29	RED	TB20-12	9	J26-j	SOLDER
K10A16	16	103	BLACK	TB26-5	9	A106-16	10
K10F16	16	61	BLACK	TB26-5	9	J26-C	SOLDER
K11A16	16	102	BLACK	TB26-6	9	A106-17	10
K11F16	16	62	BLACK	TB26-6	9	J26-D	SOLDER
L20D16	16	69	RED	TB9-2	16	J5-B	SOLDER
E30B16	16	39	RED	TB22-1	9	J5-j	SOLDER
E30F16	16	48	RED	TB22-1	9	J26-b	SOLDER
E31B16	16	41	RED	TB22-2	9	J5-k	SOLDER
E31F16	16	48	RED	TB22-2	9	J26-c	SOLDER
E32B16	16	41	RED	TB22-3	9	J5-m	SOLDER
E32F16	16	49	RED	TB22-3	9	J26-d	SOLDER
E33B16	16	41	RED	TB22-4	9	J5-n	SOLDER
E33F16	16	50	RED	TB22-4	9	J26-e	SOLDER
P36A16	16	45	RED	TB20-8	9	TB9-17	16
P36F16	16	31	RED	TB20-8	9	J26-E	SOLDER
P37A16	16	17	RED	TB9-3	16	TB9-18	16
P37B16	16	47	RED	TB20-7	9	TB9-18	16
P37C16	16	44	RED	TB20-7	9	K50-3	10
P40A16	16	63	RED	S20-2	10	J5-C	SOLDER
P62DA16	16	21	RED	TB20-9	10	J31-W	SOLDER
P41D16	16	25	RED	TB20-19	9	J5-A	SOLDER
P41H16	16	86	RED	TD3-2	16	S22-1	10
P41N16	16	42	RED	TB20-19	9	TB9-8	16
P41T16	16	16	RED	TB9-8	16	TB9-20	16
P41AA16	16	14	RED	TB9-20	16	TD3-2	16
P41JT16	16	26	RED	TB20-1	9	J26-T	SOLDER
P42D16	16	41	RED	TB21-17	9	TB9-21	16
P43A16	16	43	RED	TB20-6	9	K50-1	10
P43B16	16	45	RED	TB20-6	9	TB9-15	16
P44A16	16	80	RED	TB20-3	9	A106-12	10
P45A16	16	37	RED	TB9-10	16	TB21-6	9
P45F16	16	38	RED	TB21-6	9	J26-n	SOLDER
P46E16	16	48	RED	TB20-5	9	TB9-19	16
P46F16	16	19	RED	TB20-5	9	J5-b	SOLDER
P46G16	16	14	RED	TB9-19	16	TD3-3	16
P364B16	16	28	RED	TB20-4	9	J26-G	SOLDER
P47A16	16	16	RED	TB9-16	16	TD3-1	16
P48A16	16	41	RED	TB20-20	9	TB9-6	16
P48B16	16	54	RED	TB20-20	9	TD1-2	16
P48F16	16	35	RED	TB20-20	9	J26-F	SOLDER
P141C12	12	69	RED	TB21-20	11	SHUNT-2	19
P57F16	16	32	RED	TB20-16	9	J26-f	SOLDER
P57A16	16	53	RED	TB20-16	9	TB9-33	16
P50516	16	21	RED	TB20-11	9	J5-K	SOLDER
P50U16	16	52	RED	TB20-11	9	S21-1	10
P61CD16	16	21	RED	TB20-10	9	J31-M	SOLDER
P51A16	16	47	RED	TB20-14	9	TB9-1	16
P51H16	16	32	RED	TB20-14	9	J26-k	SOLDER
P36D16	16	18	RED	TB9-32	16	TB9-17	16
P52E16	16	23	RED	TB20-15	9	J5-a	SOLDER
P41JL16	16	12	RED	TB20-19	9	TB20-1	9
P55WG16	16	6	RED	WIRE NUT	STRIP	A106 GND	13
P41PC16	16	72	RED	TB24-18	9	J27-O	SOLDER
P99PD16	16	72	RED	TB24-17	9	J27-S	SOLDER
P41PD16	16	55	RED	TB24-18	9	J6-V	SOLDER
P99PE16	16	55	RED	TB24-17	9	J6-U	SOLDER
MOD160	16	120	RED	S21-11	10	J5-w	SOLDER
MOD159	16	120	RED	S21-10	10	J5-x	SOLDER

NOTES:

2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS (FIND NO 18) LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

3. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQ 5 OF MIL-STD-454.

4. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED THREE INCHES.

5. FOR WIRING INFORMATION SEE FO-5, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

6. MARK SHRINK SLEEVING (FIND NO 32 OR 34) WITH SHIELDED CABLE NUMBERS (SEE CABLE LIST). ASSEMBLE SLEEVING ON RESPECTIVE CABLES AND SHRINK SEE NOTE 9.

7. STRIP INSULATION LEAVING APPROX. .25 BARE WIRE EXPOSED FOR SOLDERING OR LUGGING, WITH THE EXCEPTION OF THE SHIELDS FROM CABLE NO 1,2,4,9,13 & 14. AT END 1 AND ONE END OF WIRE P55WG1GN, THESE SHOULD BE STRIPPED BACK APPROX .75 INCHES TO FIT INTO WIRE NUT (FIND NO 36).

8. APPLY (1) INCH LONG SHRINK SLEEVING (FIND NO 22 OR 33) TO COVER APPROX A HALF INCH OF JACKET AND THE OTHER HALF INCH OVER THE WIRE(S) AND SHRINK. SEE NOTE 9.

9. APPLY HEAT (300 DEGREES F) FOR 3 TO 5 SECONDS.

10. STRIP BACK CABLE JACKET TAKING CARE NOT TO DAMAGE SHIELD OR CONDUCTORS (SEE CABLE LIST) FOR LENGTH TO STRIP JACKET BACK.

11. TWIST SHIELD TO FORM WIRE, COVER WITH FIND NO 33. SHRINK SLEEVING AS IN NOTE 9.

12. DO NOT BRING SHIELD OUT OF JACKET (DEAD END) APPLY SHRINK SLEEVING AS IN NOTE 8.

13. CONNECT SHIELD ENDS WITH FIND NO 7 & 26 THEN COVER WITH FIND NO 30 THREE INCHES LONG SHRINK PER NOTE 9. INSURE ALL SHIELDS ARE CONNECTED PRIOR TO THIS STEP OR DELAY UNTIL LATER ASSEMBLY STEP.

14. INSTALL NYLON FILLER PLUGS (FIND NO 37 & 38) IN UNUSED OPENINGS OF CONNECTOR BUSHING.

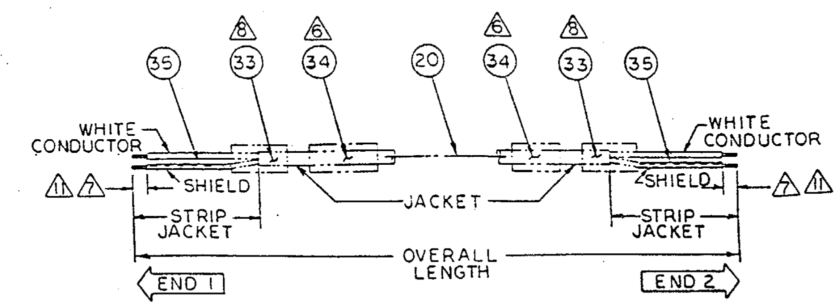
40				MS3102R12S-3S	3	CONNECTOR J104, J105, J106		
39				MS3102R10SL-3S	3	CONNECTOR J107, J108, J109		
38				MS25251-16	16	PLUG, END SEAL		
37				MS25251-12	14	PLUG, END SEAL		
36			B	76-11119	1	CONNECTOR WIRE NUT		
35				M23053/5	A/R	INSUL SLVG, HT, SHRINKABLE .063	MIL-1-23053/5	CL1
34				M23053/5	A/R	INSUL SLVG, HT, SHRINKABLE .125WHT	MIL-1-23053/5	
33				M23053/5	A/R	INSUL SLVG, HT, SHRINKABLE .125BLK	MIL-1-23053/5	
32				M23053/5	A/R	INSUL SLVG, HT, SHRINKABLE .25WHT	MIL-1-23053/5	CL1
31								
30				M23053/5	A/R	INSUL SLVG, HT, SHRINKABLE .38WHT	MIL-1-23053/5	CL1
29				MS25036-102	6	LUG		
28				M5086/2-18-9	A/R	WIRE, AWG #18	MIL-W-5086/2	
27				MS25036-109	1	LUG		
26			C	69-561-2	10	HEX NUT #6-32		
25								
24								
23								
22				M23053/5	A/R	INSUL SLVG, SHRINKABLE .25 ID BLK	MIL-1-23053/5	CL1
21			B	76-11253	48'	CABLE SHIE!.DED, 2 CNDCT		
20			B	76-11333	40'	CABLE, SHIELDED, 1 CNDCT		
19				MS25036-157	2	LUG		
18				MS3367-4-9	A/R	STRAP, SELF-LOCKING		
17				SN60WRAP2	A/R	SOLDER	QQ-S-571	SEE NOTE 3
16				MS25036-106	58	LUG		
15				MS25036-113	2	LUG		
14				MS25036-112	5	LUG		
13				MS25036-108	3	LUG		
12				MS25036-156	5	LUG		
11			B	71-4924	25	LUG		
10				MS25036-107	82	LUG		
9				MS25036-153	257	LUG		
8				M5086/2-12-9	A/R	WIRE, AWG #12	MIL-W-5086/2	
7			D	69-662-18	10	SCR & CAPT WASH ASSY		
6				M5086/2-16-9	A/R	WIRE, AWG 16	MIL-W-5086/2	
5				MS3102R24-28S	1	CONNECTOR, J31		
4				MS3102R32-7S	1	CONNECTOR, J27		
3				MS3102R36-7P	1	CONNECTOR, J26		
2				MS3102R32-7P	1	CONNECTOR, J6		
1				MS3102R36-7S	1	CONNECTOR, J5		
FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL

LIST OF MATERIALS

FO 7. AC-DC Control Box Harness Assembly (Sheet 1 of 5)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P52F16	16	53	RED	TB20-15	9	TB9-31	16
P53D16	16	28	RED	TB21-2	9	J5-p	SOLDER
P53J16	16	36	RED	TB21-2	9	J26-V	SOLDER
P54B16	16	29	RED	TB21-3	9	J5-c	SOLDER
P54F16	16	37	RED	TB21-3	9	J26-X	SOLDER
P55AG16N	16	45	RED	TB22-14	9	J5-T	SOLDER
P55AH16N	16	49	RED	TB22-14	9	TB9-13	16
P55AJ16N	16	40	RED	TB22-15	9	K1-8	10
P55AK16N	16	8	RED	K1-8	10	K50-8	10
P55AL16N	16	62	RED	K50-8	9	A106-13	10
P55AM16N	16	64	RED	TB22-16	9	TD1-4	16
P55AN16N	16	24	RED	P5-6	16	K20-B	13
P55AP12N	12	80	RED	TB22-17	11	BC1-(-)	14
P55AR16N	16	52	RED	TB22-14	9	P4-6	16
P55AS16N	16	27	RED	P4-6	16	P5-6	16
P55AT16N	16	10	RED	TD1-4	16	TD3-4	16
P55AU12N	12	58	RED	TB22-16	11	J27-P	SOLDER
JUMPER	16	5	RED	TB20-1	9	TB20-3	9
P55BT16N	16	55	RED	TB22-15	9	J26-g	SOLDER
P56A16	16	49	RED	TB20-2	9	TB9-22	16
P56B16	16	45	RED	TB20-2	9	K50-2	10
JUMPER	16	4	RED	K50-2	10	K50-4	10
P56C16	16	6	RED	K50-4	10	K1-4	10
P56T16	16	27	RED	TB20-2	9	J26-H	SOLDER
P56F16	16	6	RED	TB9-22	16	TB9-14	16
P58A16	16	37	RED	TB21-7	9	TB9-11	16
P58F16	16	40	RED	TB21-7	9	J26-W	SOLDER
P59D16	16	32	RED	TB21-9	9	J5-F	SOLDER
P59H16	16	32	RED	TB21-9	9	J31-N	SOLDER
P64F16	16	59	RED	K50-11	10	J5-v	SOLDER
P65E16	16	31	RED	TB21-8	9	J5-H	SOLDER
P66E16	16	40	RED	TB21-10	9	TB9-25	16
P66F16	16	32	RED	TB21-10	9	J5-N	SOLDER
X182L12	12	77	BLK	TB26-12	11	BC1-(AC)	14
X183L12	12	78	BLK	TB26-11	11	BC1-(AC)	14
X183S12	12	66	BLK	TB26-11	11	J27-V	SOLDER
X369C12	12	75	BLK	TB9-28	11	TB26-22	11
X369G16	16	60	BLK	TB26-22	9	J31-R	SOLDER
P69F16	16	33	RED	TB21-12	9	K50-5	10
P55GG16M	16	6	RED	TB22-17	9	GND STUD	9
P69G16	16	34	RED	TB21-12	9	J5-g	SOLDER
P70E16	16	32	RED	TB21-11	9	J5-d	SOLDER
P70F16	16	36	RED	TB21-11	9	K50-7	10
P71E16	16	39	RED	TB21-13	9	P4-4	16
P71F16	16	33	RED	TB21-13	9	U5-L	SOLDER
P72E16	16	40	RED	TB21-14	9	P4-5	16
P72F16	16	33	RED	TB21-14	9	J5-M	SOLDER
P73E16	16	32	RED	TB21-15	9	P5-5	16
P73F16	16	34	RED	TB21-15	9	J5-P	SOLDER
P74E16	16	33	RED	TB21-16	9	P5-4	16
P74F16	16	34	RED	TB21-16	9	J5-R	SOLDER
P75A16	16	86	RED	S21-2	10	TB9-37	16
P56S16	16	44	RED	TB22-33	9	K1-4	10
P56R16	16	45	RED	TB22-33	9	J31-X	SOLDER
Q80B12	12	19	RED	TB21-1	11	K20-2	15
Q80K16	16	49	RED	K20-2	27	J26-m	SOLDER
Q80H16	16	28	RED	TB21-1	9	J5-r	SOLDER
Q80J12	12	38	RED	TB21-1	11	J26-t	SOLDER
Q81A16	16	21	RED	TB21-4	9	K20-A	13

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
Q81F16	16	39	RED	TB21-4	9	J26-Y	SOLDER
Q83A16	16	32	RED	TD1-1	16	TB9-4	16
X101E16A	16	44	BLK	TB25-12	9	J6-K	SOLDER
X101L16A	16	55	BLK	TB25-12	9	J27-A	SOLDER
X102E16B	16	42	BLK	TB25-10	9	J6J	SOLDER
X102L16B	16	54	BLK	TB25-10	9	J27-I	SOLDER
X103E16C	16	43	BLK	TB25-11	9	J6-I	SOLDER
X103L16C	16	54	BLK	TB25-11	9	J27-C	SOLDER
X104J16A	16	36	BLK	TB24-20	9	J6-L	SOLDER
X104K16A	16	62	BLK	TB24-20	9	VR101-E1	9
X104L16A	16	55	BLK	VR101-E1	9	A106-1	10
X106M16C	16	55	BLK	VR101-E3	9	A106-3	10
X104P16A	16	72	BLK	TB24-20	9	TB9-24	16
X104T16A	16	47	BLK	TB24-20	9	J27-D	SOLDER
X105J16B	16	37	BLK	TB24-22	9	J6-Z	SOLDER
X105K16K	16	106	BLK	TB24-22	9	A106-2	10
X105L16B	16	55	BLK	A106-2	10	VR101-E2	9
X105M16B	16	37	BLK	TB24-22	9	J6-M	SOLDER
X105T16B	16	40	BLK	TB24-22	9	J27-E	SOLDER
X106V16C	16	37	BLK	TB24-21	9	J6-b	SOLDER
X106K16C	16	37	BLK	TB24-21	9	J6-N	SOLDER
X106L16C	16	104	BLK	TB24-21	9	A106-3	10
X106T16C	16	40	BLK	TB24-21	9	J27-F	SOLDER
X182K12	12	37	BLK	TB26-12	11	J103-2	12
X182S12	12	66	BLK	TB26-12	11	J27-U	SOLDER
X370C12	12	68	BLK	TB9-26	11	TB26-21	11
X370G16	16	60	BLK	TB26-21	9	J31-S	SOLDER
X107B16	16	47	BLK	TB25-18	9	J6-A	SOLDER
X107D16	16	57	BLK	TB25-18	9	J27-G	SOLDER
X108B16	16	44	BLK	TB25-13	9	J6-g	SOLDER
X108D16	16	55	BLK	TB25-13	9	J27-H	SOLDER
X109B16	16	44	BLK	TB25-14	9	J6-h	SOLDER
X109D16	16	56	BLK	TB25-14	9	J27-J	SOLDER
X110AA16N	16	28	BLK	TB24-4	9	J6-S	SOLDER
X110AC12N	12	25	BLK	TB24-4	11	TB26-18	SOLDER
GND	12	22	RED	GND STD	12	J103-GND	11
X110AH12N	12	62	BLK	TB26-19	11	J27-T	SOLDER
X111B16	16	45	BLK	TB25-15	9	J6-W	SOLDER
X111G16	16	56	BLK	TB25-15	9	J27-K	SOLDER
X112B16	16	47	BLK	TB25-16	9	J6-X	SOLDER
X112G16	16	56	BLK	TB25-16	9	J27-L	SOLDER
X113B16	16	46	BLK	TB25-17	9	J6-d	SOLDER
X113G16	16	57	BLK	TB25-17	9	J27-M	SOLDER
X114C16	16	48	BLK	TB25-22	9	J6-B	SOLDER
X114G16	16	58	BLK	TB25-22	9	J27-N	SOLDER
X115C16	16	52	BLK	TB26-2	9	J6-C	SOLDER
X115G16	16	62	BLK	TB26-2	9	J27-W	SOLDER
X116C16	16	50	BLK	TB26-1	9	J6-D	SOLDER
X116G16	16	61	BLK	TB26-1	9	J27-X	SOLDER
X117C16	16	48	BLK	TB25-21	9	J6-E	SOLDER
X117G16	16	59	BLK	TB25-21	9	J27-Y	SOLDER
X118A16	16	110	BLK	TB25-4	9	A106-5	10
X118G16	16	52	BLK	TB25-4	9	J27-Z	SOLDER
X119A16	16	110	BLK	TB25-5	9	A106-4	10
X119G16	16	52	BLK	TB25-5	9	J27-a	SOLDER
X120A16	16	109	BLK	TB25-6	9	A106-7	10
X120G16	16	52	BLK	TB25-6	9	J27-b	SOLDER
X121A16	16	110	BLK	TB25-7	9	A106-6	10



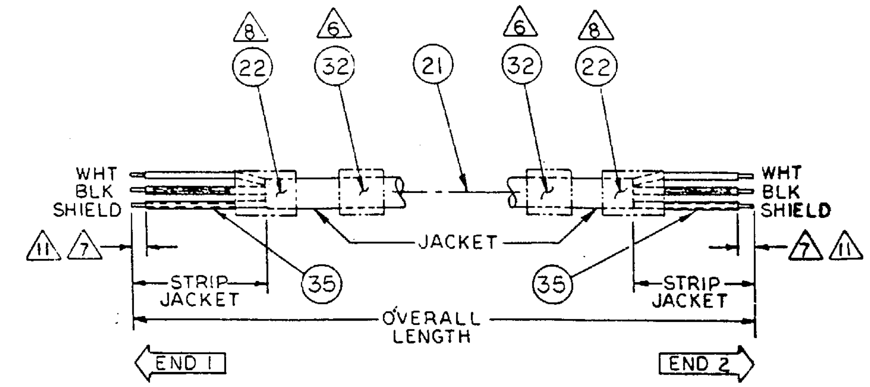
SINGLE CONDUCTOR SHIELDED CABLE ASSEMBLIES

			END 1		INCHES	END 2		INCHES	INCHES/CABLE		
CABLE NO.	COND	LG INCHES	TERM	FROM	STRIP JACK	TERM	TO	STRIP JACK	35	33	34
10	WHITE	75	16	B4-1	3	10	S21-7	3	6	2	4
	SHIELD		10	CBL 12		10	CBL 3 & 11				
11	WHITE	66	9	TB24-11	3	10	S21-8	3	6	2	4
	SHIELD		10	CBL 2 & 12		10	CBL 10 & 3				
12	WHITE	74	9	TB24-10	3	16	B4-3	3	6	2	4
	SHIELD		10	CBL 2 & 11		10	CBL 10				
13	WHITE	102	10	A106-10	5	10	S106-1	3	8	2	4
	SHIELD		STRIP	WIRE NUT		10	CBL 15				
14	WHITE	130	10	A106-11	5	9	TB26-9	3	8	2	4
	SHIELD		STRIP	WIRE NUT		10	CBL 15 & 1415				
15	WHITE	56.5	10	S106-3	3	9	TB24-9	3	8	2	4
	SHIELD		10	CBL 13 & 15		10	CBL 14 & 1415				
					10			10	7	8	

FO 8. AC-DC Control Box Harness Assembly (Sheet 2 of 5)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
X121G16	16	52	BLK	TB25-7	9	J27-c	SOLDER
X122A16	16	108	BLK	TB25-8	9	A106-9	10
X122G16	16	53	BLK	TB25-8	9	J27-d	SOLDER
X123A16	16	110	BLK	TB25-9	9	A106-8	10
X123G16	16	53	BLK	TB25-9	9	J27-e	SOLDER
X124A16	16	29	BLK	TB24-6	9	J6-j	SOLDER
X124C16	16	60	BLK	TB24-6	9	R104-1	10
X124D16	16	59	BLK	TB24-6	9	VR101-1	9
X124E16	16	58	BLK	R104-1	9	R116-1	10
X124G16	16	41	BLK	TB24-6	9	J27-f	SOLDER
X125B16	16	63	BLK	TB24-5	9	R104-2	10
X125G16	16	41	BLK	TB24-5	9	J27-g	SOLDER
X126C16	16	47	BLK	TB25-20	9	J6-e	SOLDER
X126G16	16	58	BLK	TB25-20	9	J27-h	SOLDER
X127E16	16	47	BLK	TB25-19	9	J6-f	SOLDER
X127G16	16	58	BLK	TB25-19	9	J27-j	SOLDER
X128B16	16	47	BLK	TB26-4	9	J106-B	SOLDER
X128C16	16	45	BLK	TB26-4	9	J105-B	SOLDER
X128D16	16	34	BLK	TB26-4	9	J104-B	SOLDER
X128G16	16	57	BLK	TB26-4	9	J27-k	SOLDER
X129G16	16	58	BLK	R116-2	10	J6-k	SOLDER
X183K12	12	39	BLK	TB26-11	11	CB103-1	SOLDER
X185A12	12	23	BLK	CB103-2	SOLDER	J103-1	12
X129A16	16	32	BLK	VR101-2	10	R116-2	10
X129C16	16	48	BLK	TB26-3	9	J106-A	SOLDER
X129D16	16	45	BLK	TB26-3	9	J105-A	SOLDER
X129E16	16	36	BLK	TB26-3	9	J104-A	SOLDER
X129F16	16	69	BLK	TB26-3	9	VR101-2	9
D130A16	16	60	BLK	VR101-3	9	TB24-14	9
D130B16	16	58	BLK	TB24-14	9	S21-4	10
D131A16	16	60	BLK	TB24-12	9	VR101-4	9
D131G16	16	33	BLK	TB24-12	9	J31-A	SOLDER
D137G16	16	65	BLK	S21-6	10	J31-B	SOLDER
D133A16	16	60	BLK	TB24-15	9	VR101-(+)	9
D133G16	16	34	BLK	TB24-15	9	J31-C	SOLDER
D134A16	16	61	BLK	TB24-16	9	VR101-(-)	9
D134G16	16	35	BLK	TB24-16	9	J31-D	SOLDER
D135A16	16	27	BLK	VR101-6	9	P5-3	16
D136A16	16	26	BLK	VR101-7	9	P5-1	16
P140A12	12	67	RED	TB21-19	11	SHUNT-1	19
P140H12	12	47	RED	TB21-19	11	J27-R	SOLDER
P141A12	12	59	RED	TB21-20	11	BC1-(+)	14
P141B12	12	28	RED	TB21-20	11	S20-1	11
P142B16	16	57	RED	SHUNT-3	12	J5-r	SOLDER
P143B16	16	59	RED	SHUNT-4	12	J5-s	SOLDER

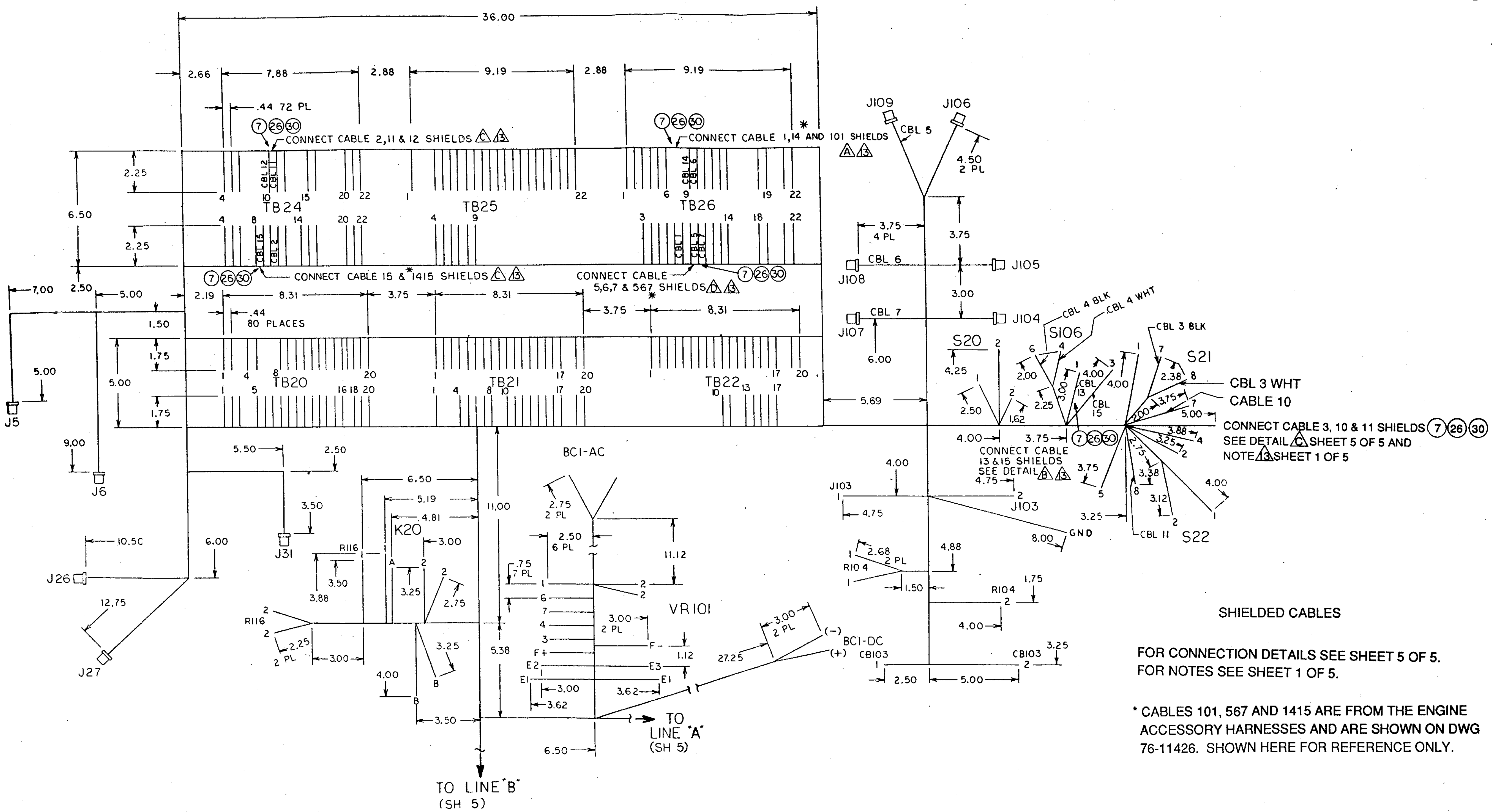
WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P200D16	16	48	RED	TB22-5	9	J5-U	SOLDER
P200F16	16	51	RED	TB22-5	9	J26-R	SOLDER
P201D16	16	41	RED	TB22-6	9	J5-V	SOLDER
P201F16	16	50	RED	TB22-6	9	J26-N	SOLDER
P202D16	16	41	RED	TB22-7	9	J5-W	SOLDER
P202F16	16	51	RED	TB22-7	9	J26-L	SOLDER
P203D16	16	42	RED	TB22-8	9	J5-X	SOLDER
P203F16	16	53	RED	TB22-8	9	J26-Z	SOLDER
P204D16	16	43	RED	TB22-9	9	J5-Y	SOLDER
P364D16	16	18	RED	TB20-4	9	J5-t	SOLDER
P62DB16	16	21	RED	TB20-9	9	J5-u	SOLDER
P62DC16	16	37	RED	TB20-9	9	K50-12	10
P45R16	16	39	RED	TB21-6	9	J26-n	SOLDER
P35C16	16	33	RED	TB20-18	9	J26-p	SOLDER
P35E16	16	33	RED	TB20-18	9	J26-r	SOLDER
P35F16	16	28	RED	TB20-18	9	J26-s	SOLDER
P40S16	16	67	RED	S20-2	10	J6-P	SOLDER
P41AS16	16	23	RED	TB20-1	9	J6-R	SOLDER
P204F16	16	51	RED	TB22-9	9	J26-K	SOLDER
P210K16	16	43	RED	TB22-10	9	J5-z	SOLDER
P210T16	16	52	RED	TB22-11	9	J26-J	SOLDER
P211D16	16	44	RED	TB22-12	9	J5-e	SOLDER
P211F16	16	52	RED	TB22-12	9	J26-M	SOLDER
X304D16	16	38	BLK	TB25-1	9	J6-Y	SOLDER
X304G16	16	40	BLK	TB25-1	9	J31-T	SOLDER
X180F16	16	61	BLK	TB26-13	9	K1-1	10
X180G16	16	58	BLK	TB26-13	9	J31-H	SOLDER
X181F16	16	62	BLK	TB26-14	9	K1-Z	10
X181G16	16	57	BLK	TB26-14	9	J31J	SOLDER
P140C12	12	26	RED	TB21-9	11	K20-1	15
P50ZZ16	16	38	RED	TB20-11	9	K1-3	10
X360F16	16	47	BLK	TB22-19	9	J5-D	SOLDER
X360S16	16	50	BLK	TB22-19	9	J31-K	SOLDER
X361F16	16	48	BLK	TB22-20	9	J5-G	SOLDER
X361S16	16	48	BLK	TB22-20	9	J31-L	SOLDER
P42C16	16	34	RED	TB21-17	9	J5-E	SOLDER
P93H16	16	79	RED	TB9-39	16	J5-S	SOLDER
P94H16	16	77	RED	TB9-35	16	J5-J	SOLDER
P21OU16	16	49	RED	TB22-10	9	J26-P	SOLDER
P21OV16	16	52	RED	TB22-10	9	J26-S	SOLDER
P21OW16	16	49	RED	TB22-11	9	J26-a	SOLDER
P50CE16	16	29	RED	TB20-11	9	J26-V	SOLDER
P55BU12	12	47	RED	K20-B	14	J26-u	SOLDER
P61R16	16	26	RED	TB20-10	9	J5-z	SOLDER
D138G16	16	64	BLK	S21-5	10	J31-z	SOLDER



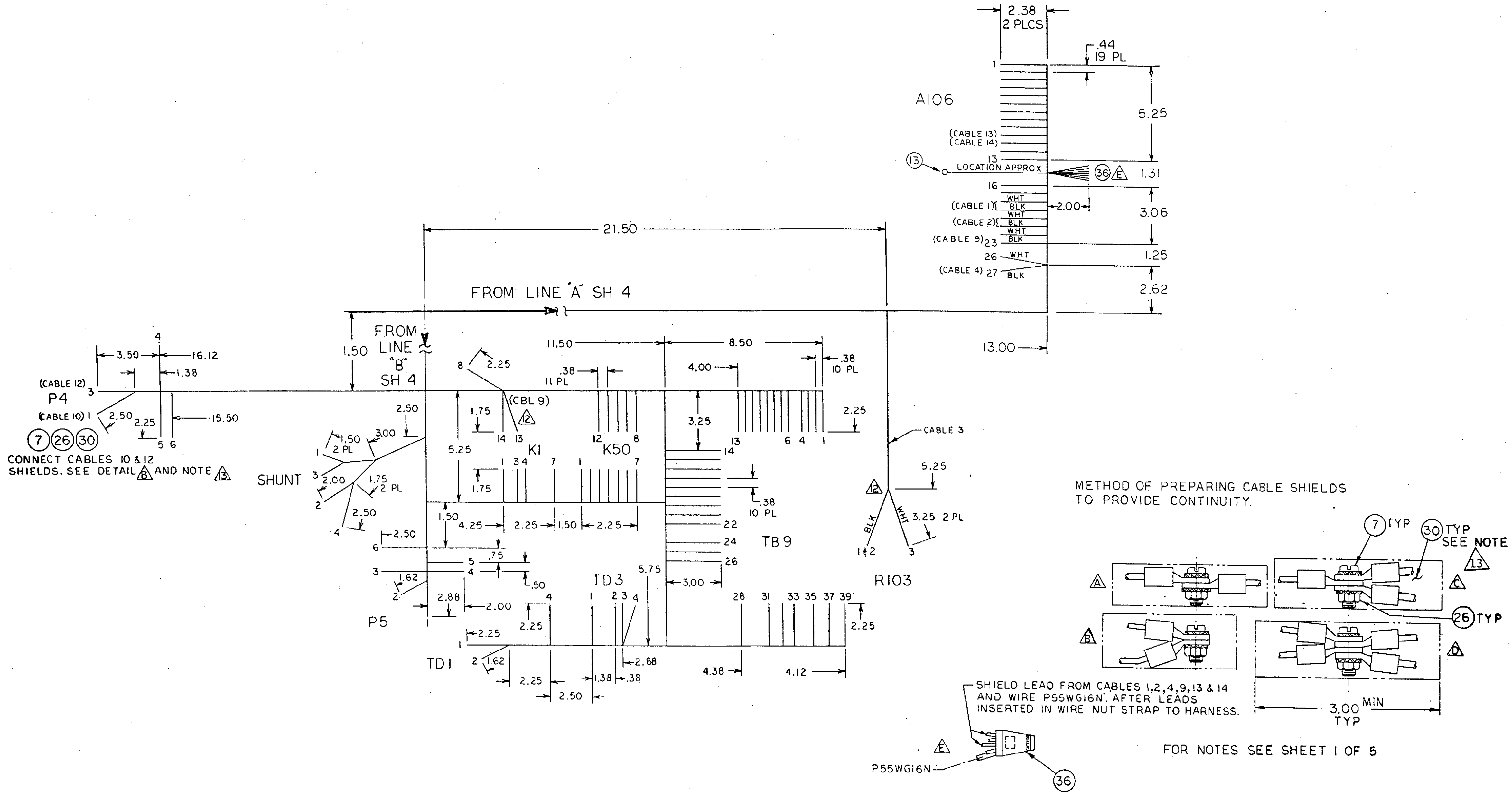
TWISTED TWO CONDUCTOR SHIELDED CABLE ASSEMBLIES

			END 1		INCHES	END 2		INCHES	INCHES/CABLE		
CABLE NO.	COND	LG INCHES	TERM	FROM	STRIP JACK	TERM	TO	STRIP JACK	35	22	32
1	WHITE	98	10	A106-18	5	9	TB26-7	3	8	2	4
	BLACK		10	A106-19		9	TB26-8				
	SHIELD		STRIP	WIRE NUT		29	CBL101				
2	WHITE	93	10	A106-20	5	9	TB24-11	3	8	2	4
	BLACK		10	A106-21		9	TB24-10				
	SHIELD		STRIP	WIRE NUT		29	CBL 11&12				
3	WHITE	97	SOLDER	R103-3	5	10	S21-8	3	3	2	4
	BLACK		SOLDER	R103-1		10	S21-7				
	SHIELD		NONE	DEAD END	12	29	CBL 10&11				
4	WHITE	98	10	A106-26	5	10	S106-4	3	5	2	4
	BLACK		10	A106-27		10	S106-6				
	SHIELD		STRIP	WIRE NUT		NONE	DEAD END	12			
5	WHITE	39	9	TB26-9	3	SOLDER	J109-A	3	6	2	4
	BLACK		9	TB26-10		SOLDER	J109-B				
	SHIELD		29	CBL 567,7&6		SOLDER	J109-C				
6	WHITE	43.5	9	TB26-9	3	SOLDER	J108-A	3	6	2	4
	BLACK		9	TB26-10		SOLDER	J108-B				
	SHIELD		29	CBL 567,7&6		SOLDER	J108-C				
7	WHITE	33	9	TB26-9	3	SOLDER	J107-A	3	6	2	4
	BLACK		9	TB26-10		SOLDER	J107-B				
	SHIELD		29	CBL 567,7&6		SOLDER	J107-C				
9	WHITE	55	10	A106-22	5	10	K1-13	3	8	2	4
	BLACK		10	A106-23		10	K1-14	12			
	SHIELD		STRIP	WIRE NUT		NONE	DEAD END				
					10			10	7		8

FO 9. AC-DC Control Box Harness Assembly (Sheet 3 of 5)



FO 10. AC-DC Control Box Harness Assembly (Sheet 4 of 5)



FO-11. AC-DC Control Box Harness Assembly (Sheet 5 of 5)
FP-21/ (FP-22 blank)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
K1A16	16	47.00	RED	TB6-26	8	J5-I	SOLDER
K5A16	16	46.00	RED	TB6-23	8	J5-f	SOLDER
K5C16	16	345.00	RED	TB6-23	8	J4-c	SOLDER
L20A16	16	97.00	RED	TB1-15	10	DS51-2	SOLDER
L20B16	16	78.00	RED	TB1-15	10	J5-B	SOLDER
L20C16	16	61.00	RED	TB1-15	10	J4-Z	SOLDER
L21A16	16	64.00	RED	S11-2	9	DS2-R	8
L21B16	16	74.00	RED	DS2-R	8	DS3-R	8
L21C16	16	53.00	RED	DS3-R	8	DS4-R	8
L21D16	16	29.00	RED	DS4-R	8	DS5-R	8
L21E16	16	120.00	RED	DS5-R	8	DS10-R	8
L21F16	16	13.00	RED	DS10-R	8	DS11-R	8
L23A16	16	72.00	BLACK	TB3-14	10	M110-3	11
L23B16	16	46.00	BLACK	TB3-14	10	T101-X1	9
L23C16	16	35.00	BLACK	M110-3	11	DS101-R	8
L23D16	16	39.00	BLACK	DS101-R	8	M109-3	11
L23F16	16	68.00	BLACK	TB3-14	10	J2-V	SOLDER
L24A16	16	75.00	BLACK	TB3-13	10	DS102-R	8
L24B16	16	37.00	BLACK	DS102-R	8	M109-1	11
L24D16	16	54.00	BLACK	TB3-13	10	K23-10	9
L24E16	16	65.00	BLACK	TB3-13	10	J2-W	SOLDER
L25A16	16	52.00	BLACK	TB3-15	10	K23-12	9
L25C16	16	40.00	BLACK	M109-4	11	DS101-L	8
L25D16	16	66.00	BLACK	TB3-15	10	J2-Y	SOLDER
L26A16	16	52.00	BLACK	TB3-16	10	T102-X2	9
L26C16	16	36.00	BLACK	M109-2	11	DS102-L	8
L26D16	16	69.00	BLACK	TB3-16	10	J2-X	SOLDER
JUMPER	16	5.00		T101-H3	9	T101-H1	9
JUMPER	16	5.00		T101-H2	9	T101-H4	9
L27A16	16	49.00	BLACK	TB3-17	10	T101-X2	9
L27B16	16	67.00	BLACK	TB3-17	10	J2-Z	SOLDER
L27C16	16	53.00	BLACK	TB3-17	10	K23-9	9
L27D16	16	90.00	BLACK	K23-9	9	M110-4	11
L28A16	16	19.00	BLACK	K23-11	9	T102-X1	9
E30A16	16	73.00	RED	M1 -(SEND)	11	J5-j	SOLDER
E31A16	16	67.00	RED	M2 -(SEND)	11	J5-k	SOLDER
E32A16	16	75.00	RED	M3 -(SEND)	11	J5-m	SOLDER
E33A16	16	74.00	RED	M4 -(SEND)	11	J5-n	SOLDER
P40C16	16	122.00	RED	CB1-1	SOLDER	J5-C	SOLDER
P40D16	16	136.00	RED	CB1-1	SOLDER	M20-(+)	12
P41AF16	16	74.00	RED	S13-3	9	TB6-18	8
P41R16	16	96.00	RED	CB1-2	SOLDER	TB1-20	10
P41B16	16	80.00	RED	TB1-20	10	J5-A	SOLDER
P41C16	16	65.00	RED	TB1-20	10	J4-A	SOLDER

NOTES:

2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS (FIND NOS 14 & 15) LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

3. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

4. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED THREE INCHES.

5. FOR WIRING INFORMATION SEE FO-7, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

6. MARK SHRINK SLEEVING, FIND NO. 20, WITH SHIELD CABLE NUMBER, SEE CABLE LIST, ASSEMBLE ON RESPECTIVE CABLE AND SHRINK PER NOTE 7.

7. APPLY HEAT (300 DEGREES F) FOR 3 TO 5 SECONDS.

8. STRIP INSULATION LEAVING APPROX. .25 BARE WIRE EXPOSED FOR SOLDERING OR LUGGING.

9. STRIP BACK CABLE JACKET TAKING CARE NOT TO DAMAGE SHIELD OR CONDUCTORS. SEE CABLE LIST FOR LENGTH TO STRIP JACKET BACK.

10. TWIST SHIELD TO FORM WIRE COVER WITH FIND NO. 22 AND SHRINK PER NOTE 7.

11. APPLY (1) INCH LONG SLEEVING, FIND NO. 21, TO COVER APPROX. A HALF INCH OF JACKET AND THE OTHER HALF INCH OVER THE WIRES AND SHRINK PER NOTE 7.

12. DO NOT BRING SHIELD OUT OF JACKET (DEAD END) APPLY SHRINK SLEEVING AS IN NOTE 11.

13. CONNECT SHIELD ENDS WITH FIND NO. 9 & 26, THEN COVER WITH FIND NO. 23 (3) INCHES LONG, SHRINK PER NOTE 7. INSURE ALL SHIELDS ARE CONNECTED PRIOR TO THIS STEP OR DELAY UNTIL LATER ASSY STEP.

14. RED WIRE IS USED ON CABLE 104 ONLY.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
26				MS3102R20-7S	1	CONNECTOR, RECEPTACLE, ELEC		
25			C	69-561-2	1	NUT & CAPT WASH ASSY		
24			D	69-662-18	1	SCREW & CAPT WASH ASSY		
23				M23053/5	A/R	INSUL, SLVG, BLK, .375 ID	MIL-I-23053/5	CL1
22				M23053/5	A/R	INSUL, SLVG, BLK, .06 ID	MIL-I-23053/5	CL1
21				M23053/5	A/R	INSUL, SLVG, BLK, .25 ID	MIL-I-23053/5	CL1
20				M23053/5	A/R	INSUL, SLVG, WHT, .25 ID	MIL-I-23053/5	CL1
19			B	77-11018	A/R	CABLE, SHIELD	3 COND	SEE NOTE 6
18			B	76-11253	A/R	CABLE, SHIELD	2 COND	SEE NOTE 6
17			B	76-11119	6	WIRE NUT		
16			B	76-11317	2	LUG, CRIMP		
15				MS3367-1-9	A/R	TIE WRAP		
14				MS3367-4-9	A/R	TIE WRAP		
13				SN60WRAP 2	A/R	SOLDER	QQ-S-571	SEE NOTE 3
12				MS25036-154	16	TERMINAL LUG	MIL-T-7928	
11				MS25036-108	25	TERMINAL LUG	MIL-T-7928	
10				MS25036-153	278	TERMINAL LUG	MIL-T-7928	
9				MS25036-107	186	TERMINAL LUG	MIL-T-7928	
8				MS25036-106	174	TERMINAL LUG	MIL-T-7928	
7				M5086/2-16-9	A/R	WIRE, AWG #16	MIL-W-5086/2	
6				MS3102R20-29S	1	CONNECTOR		
5				MS3102R28-20S	1	CONNECTOR		
4				76-11388	1	CONNECTOR		
3				76-11387	1	CONNECTOR		
2				MS3102R32-7P	1	CONNECTOR		
1				MS3102R36-7S	1	CONNECTOR		

LIST OF MATERIALS

FO-12. Control Box Harness Assembly (Sheet 1 of 8)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P55H16N	16	13.00	RED	DS10-L	8	DS11-L	8
P55J16N	16	33.00	RED	DS11-L	8	DS1-1	SOLDER
P55K16N	16	8.00	RED	DS1-1	SOLDER	DS51-1	SOLDER
P55L16N	16	132.00	RED	DS51-1	SOLDER	DS50-1	SOLDER
P55M16N	16	39.00	RED	DS50-1	SOLDER	DS7-1	SOLDER
P55N16N	16	31.00	RED	DS7-1	SOLDER	DS6-1	SOLDER
JUMPER	16	9.00	RED	K103-2-4	9	K103-1-4	9
P55R16N	16	46.00	RED	DS6-1	SOLDER	DS41-1	SOLDER
P55S16N	16	17.00	RED	DS41-1	SOLDER	DS42-1	SOLDER
P55T16N	16	126.00	RED	DS42-1	SOLDER	M5-(-)	9
P55U16N	16	62.00	RED	TB1-11	10	K114-(2)	9
P55V16N	16	8.00	RED	S49-1	9	S50-1	9
P55W16N	16	8.00	RED	S50-1	9	S51-1	9
P55X16N	16	57.00	RED	TB1-11	10	K23-8	9
P55Y16N	16	42.00	RED	K23-8	9	TB10-6	8
P55AA16N	16	4.00	RED	TD2-4	8	TB10-6	8
P55AB16N	16	14.00	RED	CLK-3	9	S49-1	9
P55AC16N	16	91.00	RED	TB1-9	10	S14-2	9
P55AD16N	16	14.00	RED	CLK-9	9	S52-1	9
P55AE16N	16	63.00	RED	TB1-9	10	J3-L	SOLDER
P55AF16N	16	12.00	RED	M5-(-)	9	M20-(-)	12
P59B16	16	70.00	RED	TB2-6	10	J5-F	SOLDER
P59C16	16	55.00	RED	TB2-6	10	J4-D	SOLDER
JUMPER	16	4.00	RED	S3-2	9	S3-6	9
P60A16	16	77.00	RED	TB2-5	10	S3-3	9
P50AB16	16	58.00	RED	TB1-7	10	J4-E	SOLDER
P60C16	16	54.00	RED	TB2-4	10	J4-F	SOLDER
P61C16	16	50.00	RED	TB2-3	10	TB6-2	8
P65T16	16	20.00	RED	TB6-20	8	TB6-7	8
P65A16	16	51.00	RED	TB2-2	10	TB6-7	8
P65B16	16	69.00	RED	TB2-2	10	J5-H	SOLDER
P62C16	16	54.00	RED	J5-u	SOLDER	K111-8	9
P66A16	16	51.00	RED	TB2-1	10	TB6-8	8
P66B16	16	66.00	RED	TB2-1	10	J5-N	SOLDER
P60S16	16	68.00	RED	TB2-5	10	J5-O	SOLDER
P67A16	16	70.00	RED	TB2-7	10	S8-6	9
P67B16	16	55.00	RED	TB2-7	10	J4-H	SOLDER
P67C16	16	54.00	RED	TB2-8	10	J4-I	SOLDER
P67D16	16	70.00	RED	TB2-8	10	S8-2	9
P67E16	16	59.00	RED	TB2-8	10	K23-5	9
P68A16	16	55.00	RED	TB2-9	10	J4-J	SOLDER
P68B16	16	71.00	RED	TB2-9	10	S8-3	9
P99PI16	16	90.00	RED	TB1-3	10	DS6-2	SOLDER
P99PH16	16	52.00	RED	TB1-3	10	J4-G	SOLDER
P99PG16	16	74.00	RED	TB1-3	10	J6-U	SOLDER
P41PF16	16	74.00	RED	TB1-19	10	J6-V	SOLDER

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P41E16	16	43.00	RED	TB1-18	10	TB10-4	8
P41F16	16	94.00	RED	TB1-18	10	S11-1	9
P41G16	16	58.00	RED	S11-1	9	S12-1	9
P41AE16	16	12.00	RED	TB6-5	8	TB6-10	8
P41J16	16	24.00	RED	S13-8	9	S12-1	9
P41K16	16	118.00	RED	S2-1	9	S8-5	9
P41L16	16	30.00	RED	S8-5	9	S7-5	9
P41M16	16	126.00	RED	S7-5	9	S1-2	9
P41P16	16	68.00	RED	TB1-19	10	J3-A	SOLDER
P41R16	16	42.00	RED	TB1-19	10	TB10-1	8
P41S16	16	62.00	RED	TB1-19	10	K103-2-4	9
P41U16	16	108.00	RED	TB1-17	10	S2-1	9
P41V16	16	64.00	RED	TB1-17	10	TB6-5	8
P42A16	16	36.00	RED	TB1-2	10	TB10-5	8
P42B16	16	72.00	RED	TB1-2	10	J5-E	SOLDER
P46B16	16	14.00	RED	S52-3	10	CLK-3	8
P364E16	16	32.00	RED	TB4-11	10	TD2-2	8
P50A16	16	74.00	RED	TB1-5	10	J5-K	SOLDER
JUMPER	16	6.00	RED	S13-9	9	S13-3	9
JUMPER	16	6.00	RED	S13-8	9	S13-9	9
P50B16	16	58.00	RED	TB1-5	10	J4-C	SOLDER
P50C16	16	62.00	RED	TB1-6	10	J3-E	SOLDER
P50D16	16	95.00	RED	TB1-6	10	S5-1	9
P50E16	16	80.00	RED	S3-5	9	TB1-7	9
P50F16	16	30.00	RED	S5-1	9	S6-1	9
P50G16	16	44.00	RED	TB1-6	10	TB6-24	8
P50H16	16	90.00	RED	TB1-5	10	R1	11
P50J16	16	17.00	RED	R1	11	R2	11
P50K16	16	19.00	RED	R2	11	R3	11
P50L16	16	20.00	RED	R3	11	M4-(+)	11
P50M16	16	23.00	RED	M4-(+)	11	M5-(+)	9
P50N16	16	31.00	RED	M5-(+)	9	K114-1	9
P55GB16N	16	9.00	RED	TB1-9	10	GND STUD	10
P52A16	16	95.00	RED	TB1-4	10	S2-2	9
P52B16	16	56.00	RED	TB1-4	10	J4-b	SOLDER
P52C16	16	73.00	RED	TB1-4	10	J5-a	SOLDER
P53A16	16	77.00	RED	TB1-14	10	J5-p	SOLDER
P83A16	16	95.00	RED	TB1-13	10	S9-1	9
P54R16	16	75.00	RED	S9-2	9	J5-c	SOLDER
P55A16N	16	75.00	RED	TB1-10	10	J5-t	SOLDER
P55B16N	16	59.00	RED	TB1-10	10	J4-a	SOLDER
P55C16N	16	95.00	RED	TB1-10	10	DS2-L	8
P55D16N	16	74.00	RED	DS2-L	8	DS3-L	8
P55E16N	16	52.00	RED	DS3-L	8	DS4-L	8
P55F16N	16	29.00	RED	DS4-L	8	DS5-L	8
P55G16N	16	120.00	RED	DS5-L	8	DS10-L	8

FO-13. Control Box Harness Assembly (Sheet 2 of 8)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P68C16	16	59.00	RED	TB2-9	10	K23-7	9
P68D16	16	14.00	RED	S8-3	9	DS7-2	SOLDER
JUMPER	16	5.00	RED	K23-7	9	K23-6	9
P69A16	16	87.00	RED	TB2-11	10	S7-6	9
P69B16	16	55.00	RED	TB2-11	10	J4-T	SOLDER
P69C16	16	55.00	RED	TB2-10	10	J4-S	SOLDER
P69D16	16	85.00	RED	TB2-10	10	S7-2	SOLDER
P69E16	16	71.00	RED	TB2-10	10	J5-4	SOLDER
P70A16	16	87.00	RED	TB2-12	10	S7-3	9
P70B16	16	12.00	RED	S7-3	9	DS50-2	SOLDER
P70C16	16	72.00	RED	TB2-12	10	J5-d	SOLDER
P70D16	16	56.00	RED	TB2-12	10	J4-R	SOLDER
P71A16	16	93.00	RED	TB2-14	10	S5-2	9
P71B16	16	57.00	RED	TB2-14	10	J4-K	SOLDER
P71C16	16	73.00	RED	TB2-14	10	J5-L	SOLDER
P72A16	16	94.00	RED	TB2-13	10	S5-3	9
P72B16	16	58.00	RED	TB2-13	10	J4-L	SOLDER
P72C16	16	73.00	RED	TB2-13	10	J5-M	SOLDER
P73A16	16	97.00	RED	TB2-16	10	S6-2	9
P73B16	16	57.00	RED	TB2-16	10	J4-M	SOLDER
P73C16	16	74.00	RED	TB2-16	10	J5-P	SOLDER
P74A16	16	95.00	RED	TB2-15	10	S6-3	9
P74B16	16	58.00	RED	TB2-15	10	J4-N	SOLDER
P74C16	16	74.00	RED	TB2-15	10	J5-R	SOLDER
P76A16	16	101.00	RED	K103-2-5	9	DS42-2	SOLDER
P77A16	16	111.00	RED	K103-1-5	9	DS41-2	SOLDER
P78A16	16	58.00	RED	TB2-18	10	J4-Y	SOLDER
P78B16	16	56.00	RED	TB2-18	10	TB6-12	8
P78C16	16	10.00	RED	TB2-18	10	FC1-2	10
P78D16	16	6.00	RED	A1-2	16	FC1-2	10
P78E16	16	76.00	RED	TB6-12	8	S13-7	9
P78F16	16	92.00	RED	TB2-17	10	S14-1	9
P78G16	16	59.00	RED	TB2-17	10	J4-X	SOLDER
Q80A16	16	77.00	RED	TB1-12	10	J5-h	SOLDER
Q80C16	16	96.00	RED	TB1-12	10	DS1-2	SOLDER
P90A16	16	86.00	RED	TB3-1	10	S1-3	9
P90B16	16	81.00	RED	S1-5	9	J4-V	SOLDER
P90D16	16	29.00	RED	TB3-2	10	TB10-2	8
P91A16	16	96.00	RED	TB2-20	10	S1-6	9
P91B16	16	60.00	RED	TB2-20	10	J4-U	SOLDER
P91C16	16	59.00	RED	TB2-19	10	J4-W	SOLDER
P91D16	16	40.00	RED	TB2-19	10	TB10-3	8
P93B16	16	62.00	RED	TB4-13	10	J2-A	SOLDER

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P94B16	16	62.00	RED	TB4-14	10	J2-C	SOLDER
X101A16A	16	59.00	BLACK	TB4-5	10	J6-K	SOLDER
X101B16A	16	62.00	BLACK	TB4-5	10	J2-M	SOLDER
X101C16A	16	91.00	BLACK	TB4-5	10	S101-12	10
X102A16B	16	60.00	BLACK	TB4-6	10	J6-J	SOLDER
X102B16B	16	60.00	BLACK	TB4-6	10	J2-K	SOLDER
X102C16B	16	92.00	BLACK	TB4-6	10	S101-23	10
X103A16C	16	60.00	BLACK	TB4-7	10	J6-I	SOLDER
X103B16C	16	62.00	BLACK	TB4-7	10	J2-L	SOLDER
X103C16C	16	93.00	BLACK	TB4-7	10	S101-14	10
JUMPER	16	4.00		S1-3	9	S1-5	9
P87A16	16	4.00	RED	TD2-1	8	TB10-8	8
X104A16A	16	62.00	BLACK	TB3-6	10	J6-L	SOLDER
X104B16A	16	19.00	BLACK	TB3-6	10	A107-V1	8
X104C16A	16	27.00	BLACK	A107-V1	8	T103-2	8
X104D16A	16	64.00	BLACK	TB3-6	10	J2-R	SOLDER
X104F16A	16	89.00	BLACK	K112-6	9	S103-14	9
X104G16A	16	37.00	BLACK	K112-6	9	A103-1	9
X104H16A	16	40.00	BLACK	T103-2	8	A103-1	9
X105A16B	16	62.00	BLACK	TB3-7	10	J6-M	SOLDER
X105B16B	16	20.00	BLACK	TB3-7	10	A107-V2	8
X105C16B	16	34.00	BLACK	J6-z	SOLDER	T101-H1	9
X105D16B	16	80.00	BLACK	TB3-7	10	S103-24	9
X105E16B	16	63.00	BLACK	TB3-7	10	J2-S	SOLDER
X105F16B	16	26.00	BLACK	T103-3	8	A107-V2	8
X106A16C	16	64.00	BLACK	TB3-8	10	J6-N	SOLDER
X106B16C	16	21.00	BLACK	TB3-8	10	A107-V3	8
X106C16C	16	30.00	BLACK	TB3-8	10	K111-1	9
X106D16C	16	21.00	BLACK	K111-1	9	K102-1	9
X106E16C	16	92.00	BLACK	K102-1	9	CLK-1	8
X106F16C	16	55.00	BLACK	CLK-1	8	S103-34	9
X106G16C	16	64.00	BLACK	TB3-8	10	J2-T	SOLDER
X106H16C	16	31.00	BLACK	J6-b	SOLDER	T101-H4	9
X106J16C	16	25.00	BLACK	T103-4	8	A107-V3	8
X107A16	16	54.00	BLACK	J6-A	SOLDER	A107-L1	8
X108A16	16	54.00	BLACK	J6-g	SOLDER	A107-L2	8
X109A16	16	52.00	BLACK	J6-h	SOLDER	A107-L3	8
X110A16N	16	64.00	BLACK	TB3-9	10	J6-S	SOLDER
X110B16N	16	20.00	BLACK	TB3-9	10	A107-N1	8
X110C16N	16	40.00	BLACK	T103-1	8	A103-2	9
X110D16N	16	32.00	BLACK	A103-2	9	K111-2	9
X110E16N	16	21.00	BLACK	K111-2	9	K102-2	9
X110F16N	16	8.00	BLACK	K102-2	9	K112-7	9
X110G16N	16	91.00	BLACK	K112-7	9	CLK-2	8
JUMPER	16	8.00	BLACK	A107-N1	8	A107-N2	8
JUMPER	16	8.00	BLACK	A107-N2	8	A107-N3	8
X110J16N	16	25.00	BLACK	A107-N3	8	T103-1	8

FO-14. Control Box Harness Assembly (Sheet 3 of 8)
FP-27/ (FP-28 blank)

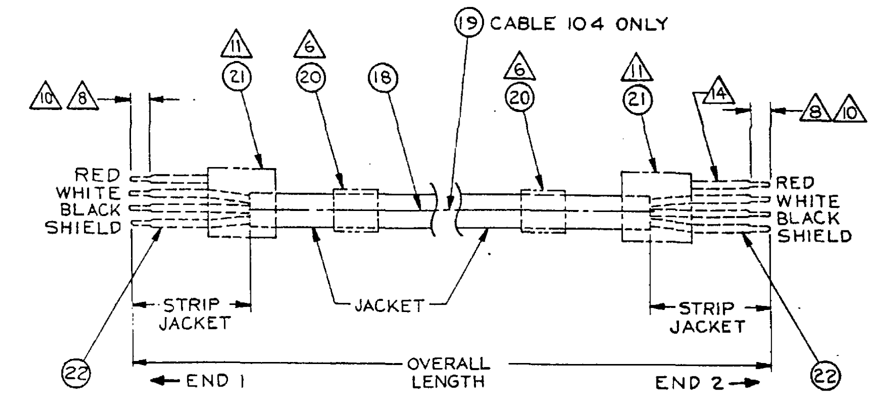
WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
X110L16N	16	60.00	BLACK	TB3-9	10	J2-U	SOLDER
X111A16	16	43.00	BLACK	J6-W	SOLDER	K114-A1	9
X112A16	16	44.00	BLACK	J6-X	SOLDER	K114-B1	9
X113A16	16	45.00	BLACK	J6-d	SOLDER	K114-C1	9
X114A16	16	58.00	BLACK	TB4-4	10	J6-B	SOLDER
X114B16	16	59.00	BLACK	TB4-4	10	J2-D	SOLDER
X115A16	16	57.00	BLACK	TB4-1	10	J6-C	SOLDER
X115B16	16	58.00	BLACK	TB4-1	10	J2-E	SOLDER
X116A16	16	57.00	BLACK	TB4-2	10	J6-D	SOLDER
X116B16	16	56.00	BLACK	TB4-2	10	J2-F	SOLDER
X117A16	16	58.00	BLACK	TB4-3	10	J6-E	SOLDER
X117B16	16	57.00	BLACK	TB4-3	10	J2-G	SOLDER
X124B16	16	35.00	BLACK	K23-13	9	J6-j	SOLDER
X126A16	16	64.00	BLACK	TB3-10	10	J6-e	SOLDER
X126B16	16	34.00	BLACK	TB3-10	10	K112-1	9
X127A16	16	64.00	BLACK	TB3-11	10	J2-b	SOLDER
X127B16	16	70.00	BLACK	TB3-11	10	M110-2	11
X127C16	16	64.00	BLACK	TB3-12	10	J6-f	SOLDER
X127D16	16	65.00	BLACK	TB3-12	10	J2-a	SOLDER
P142A16	16	78.00	RED	M21-(-)	12	J5-r	SOLDER
P143A16	16	76.00	RED	M21-(+)	12	J5-s	SOLDER
X150A16A	16	61.00	BLACK	TB4-8	10	J2-J	SOLDER
X150B16A	16	63.50	BLACK	TB4-8	10	J201-A	SOLDER
X150C16A	16	96.00	BLACK	TB4-8	10	S101-16	10
X150D16A	16	62.00	BLACK	S101-16	10	S103-12	9
X151A16B	16	64.50	BLACK	TB4-9	10	J201-B	SOLDER
X151B16B	16	61.00	BLACK	TB4-9	10	J2-I	SOLDER
X151C16B	16	93.00	BLACK	TB4-9	10	S101-27	10
X151D16B	16	60.00	BLACK	S101-27	10	S103-22	9
X152A16C	16	64.50	BLACK	TB4-10	10	J201-G	SOLDER
X129A16	16	35.00	BLACK	K23-14	9	J6-k	SOLDER
X326B16	16	76.00	BLACK	K112-2	9	M110-1	11
X152B16C	16	61.00	BLACK	TB4-10	10	J2-H	SOLDER
X152C16C	16	94.00	BLACK	TB4-10	10	S101-18	10
X152D16C	16	61.00	BLACK	S101-18	10	S103-32	9
X153A16	16	101.00	BLACK	S103-11	9	K103-1-1	9
X153B16	16	9.00	BLACK	K103-1-1	9	K103-2-1	9
X154A16	16	101.00	BLACK	S103-21	9	K103-1-3	9
X154B16	16	9.00	BLACK	K103-1-3	9	K103-2-2	9
X155A16	16	100.00	BLACK	S103-31	9	K103-1-2	9
X155B16	16	10.00	BLACK	K103-1-2	9	K103-2-3	9
P200A16	16	33.00	RED	TB6-28	8	J4-f	SOLDER
P200B16	16	46.00	RED	TB6-28	8	J5-U	SOLDER
P220C16	16	92.00	RED	TB6-21	8	TB7-1	8
P201A16	16	49.00	RED	TB6-36	8	J1-A	SOLDER
P201B16	16	48.00	RED	TB6-36	8	J5-V	SOLDER
P221C16	16	100.00	RED	TB6-14	8	TB7-2	8
P202A16	16	50.00	RED	TB6-37	8	J1-B	SOLDER
P202B16	16	49.00	RED	TB6-37	8	J5-W	SOLDER
P222C16	16	100.00	RED	TB6-13	8	TB7-3	8

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P203A16	16	48.00	RED	TB6-34	8	J1-C	SOLDER
P203B16	16	47.00	RED	TB6-34	8	J5-X	SOLDER
P223C16	16	115.00	RED	TB6-4	8	TB7-4	8
P204A16	16	48.00	RED	TB6-32	8	J1-D	SOLDER
P204B16	16	47.00	RED	TB6-32	8	J5-Y	SOLDER
P224C16	16	118.00	RED	TB6-6	8	TB7-5	8
P205A16	16	46.00	RED	TB6-31	8	J1-E	SOLDER
P225B16	16	70.00	RED	TB6-25	8	TB8-1	8
P205C16	16	10.00	RED	TB6-31	8	K102-8	9
P206A16	16	46.00	RED	TB6-29	8	J1-F	SOLDER
P226B16	16	72.00	RED	TB6-19	8	TB8-2	8
P206C16	16	20.00	RED	TB6-29	8	K111-4	9
P207A16	16	47.00	RED	TB6-30	8	J1-G	SOLDER
P227B16	16	69.00	RED	TB6-27	8	TB8-3	8
P207C16	16	18.00	RED	TB6-30	8	K112-5	9
P210Z16	16	72.00	RED	S13-6	9	TB4-18	10
P231A16	16	34.00	RED	TB4-20	10	FC1-1	10
P208A16	16	47.00	RED	TB6-33	8	J1-H	SOLDER
P230B16	16	93.00	RED	TB6-3	8	TB8-4	8
P208C16	16	36.00	RED	TB6-33	8	K114-4	9
P209A16	16	49.00	RED	TB6-35	8	J1-J	SOLDER
P229B16	16	93.00	RED	TB6-1	8	TB8-5	8
P209C16	16	25.00	RED	TB6-35	8	K113-8	9
P210A16	16	40.00	RED	TB6-9	8	J5-Z	SOLDER
P210B16	16	50.00	RED	TB6-9	8	TB3-4	10
P210C16	16	32.00	RED	TB3-4	10	TB10-7	8
P210D16	16	72.00	RED	TB3-5	10	S13-6	9
P210E16	16	50.00	RED	TB3-4	10	J4-d	SOLDER
P210F16	16	33.00	RED	TB10-7	8	K113-7	9
P210G16	16	26.00	RED	K113-7	9	K114-3	9
P210H16	16	26.00	RED	K114-3	9	K112-3	9
P210J16	16	11.00	RED	K112-3	9	K102-7	9
P235A16	16	39.00	RED	TB3-18	10	TB10-9	8
P211B16	16	70.00	RED	TB3-20	10	J5-e	SOLDER
P236A16	16	34.00	RED	TB3-19	10	K111-3	9
P212A16	16	66.00	RED	TB6-22	8	S13-4	9
P213A16	16	74.00	RED	TB6-17	8	S13-5	9
P215A16	16	65.00	RED	TB6-16	8	FC2-1	8
P215B16	16	75.00	RED	TB6-16	8	S13-15	9
P216A16	16	76.00	RED	TB6-15	8	S13-1	9
P216B16	16	50.00	RED	TB6-15	8	TB4-19	10
P217A16	16	89.00	RED	TB6-11	8	S12-2	9
L218A16	16	17.00	RED	TB8-7	8	S13-2	9
X151R16B	16	39.50	BLACK	T102-H1	9	J201-H	SOLDER
X303A16C	16	38.50	BLACK	T102-H4	9	J201-E	SOLDER
X304A16	16	35.00	BLACK	T102-H2	9	J6-Y	SOLDER
D330A16	16	46.00	BLACK	S101-11	10	M101-(+)	12
D331A16	16	48.00	BLACK	S101-21	10	M101-(-)	12
D332A16	16	60.00	BLACK	S101-11	10	M102-(+)	12
D333A16	16	60.00	BLACK	S101-21	10	M102-(-)	12
JUMPER	16	6.00	BLACK	FC2-1	8	FC2-4	8
JUMPER	16	6.00	BLACK	FC2-5	8	A1-1	16

FO-15. Control Box Harness Assembly (Sheet 4 of 8)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
D333B16	16	100.00	BLACK	M102-(-)	12	K113-4	9
JUMPER	16	6.00	-	T102-H2	9	T102-H3	9
D333D16	16	32.00	BLACK	K113-4	9	TB107-4	8
D334A16	16	81.00	BLACK	A103-(+)	9	M103-(+)	12
D335A16	16	81.00	BLACK	A103-(-)	9	M103-(-)	12
D336A16	16	63.00	BLACK	A107-(+)	8	M107-(+)	12
D337A16	16	64.00	BLACK	A107-(-)	8	M107-(-)	12
D338A16	16	50.00	BLACK	A108-(+)	8	M108-(+)	12
D339A16	16	49.00	BLACK	A108-(-)	8	M108-(-)	12
D340A16	16	14.00	BLACK	A107-S1	8	A108-L1	8
D341A16	16	15.00	BLACK	A107-S2	8	A108-L2	8
D342A16	16	15.00	BLACK	A107-S3	8	A108-L3	8
D343A16	16	20.00	BLACK	T103-5	8	A108-V1	8
D344A16	16	19.00	BLACK	T103-7	8	A108-V2	8
D345A16	16	19.00	BLACK	T103-9	8	A108-V3	8
D346A16	16	71.00	BLACK	A108-S1	8	S102-22	10
D347A16	16	70.00	BLACK	A108-S2	8	S102-23	10
D349A16	16	14.00	BLACK	K114-A2	9	K113-1	9
D349B16	16	34.00	BLACK	K113-1	9	TB107-1	8
D350A16	16	15.00	BLACK	K114-B2	9	K113-2	9
D350B16	16	35.00	BLACK	K113-2	9	TB107-2	8
D351A16	16	15.00	BLACK	K114-C2	9	K113-3	9
D351B16	16	33.00	BLACK	K113-3	9	TB107-3	8
D356A16	16	19.00	BLACK	T103-8	8	A108-N2	8
D357A16	16	19.00	BLACK	T103-6	8	A108-N1	8
D358A16	16	19.00	BLACK	T103-10	8	A108-N3	8
X360A16	16	68.00	BLACK	J5-D	SOLDER	TB4-16	10
X360B16	16	56.00	BLACK	TB4-16	10	J3-N	SOLDER
X361A16	16	68.00	BLACK	J5-G	SOLDER	TB4-15	10
X361B16	16	56.00	BLACK	TB4-15	10	J3-P	SOLDER
P364A16	16	65.00	RED	J5-I	SOLDER	TB4-11	10
L218B16	16	34.00	RED	S13-2	9	TB7-6	8
P210AA16	16	65.00	RED	J1-P	SOLDER	TB3-5	10
R400A16	16	120.00	BLACK	J110-1	SOLDER	J2-c	SOLDER
R401A16	16	121.00	BLACK	J110-2	SOLDER	J2-d	SOLDER
P402A16	16	95.00	RED	TB1-17	10	DS50-3	SOLDER
P402C16	16	135.00	RED	DS50-3	SOLDER	DS51-3	SOLDER
P402D16	16	127.00	RED	DS51-3	SOLDER	DS6-3	SOLDER
P402E16	16	30.00	RED	DS6-3	SOLDER	DS7-3	SOLDER
P402F16	16	27.00	RED	DS7-3	SOLDER	DS41-3	SOLDER
P402G16	16	18.00	RED	DS41-3	SOLDER	DS42-3	SOLDER
P144A16	16	15.00	RED	S52-2	9	CLK-4	8
P145A16	16	12.00	RED	S51-2	9	CLK-5	8
P146A16	16	11.00	RED	S50-2	9	CLK-6	8
P147A16	16	14.00	RED	S49-2	9	CLK-7	8
P64A16	16	28.00	RED	K111-7	9	K113-6	9
P64D16	16	54.00	RED	K111-7	9	J5-v	SOLDER
P61T16	16	70.00	RED	TB2-3	10	J5-z	SOLDER
D348A16	16	70.00	BLACK	A108-53	8	S102-24	10

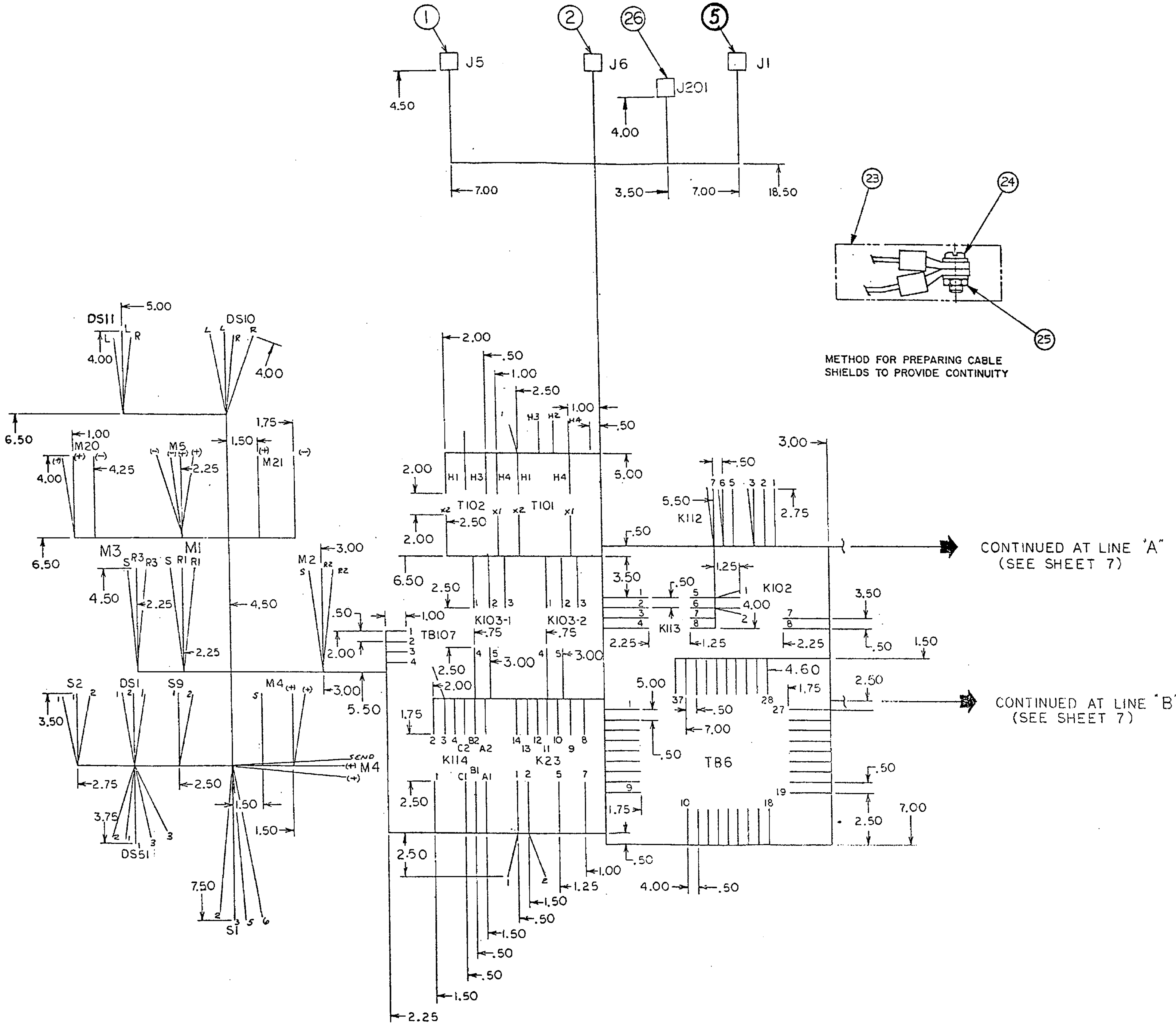
WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P40R16	16	77.00	RED	M20-(+)	12	J6P	SOLDER
P41Z16	16	71.00	RED	TB1-20	10	J6-R	SOLDER
P59AD16	16	36.75	RED	TB2-6	10	K113-5	9



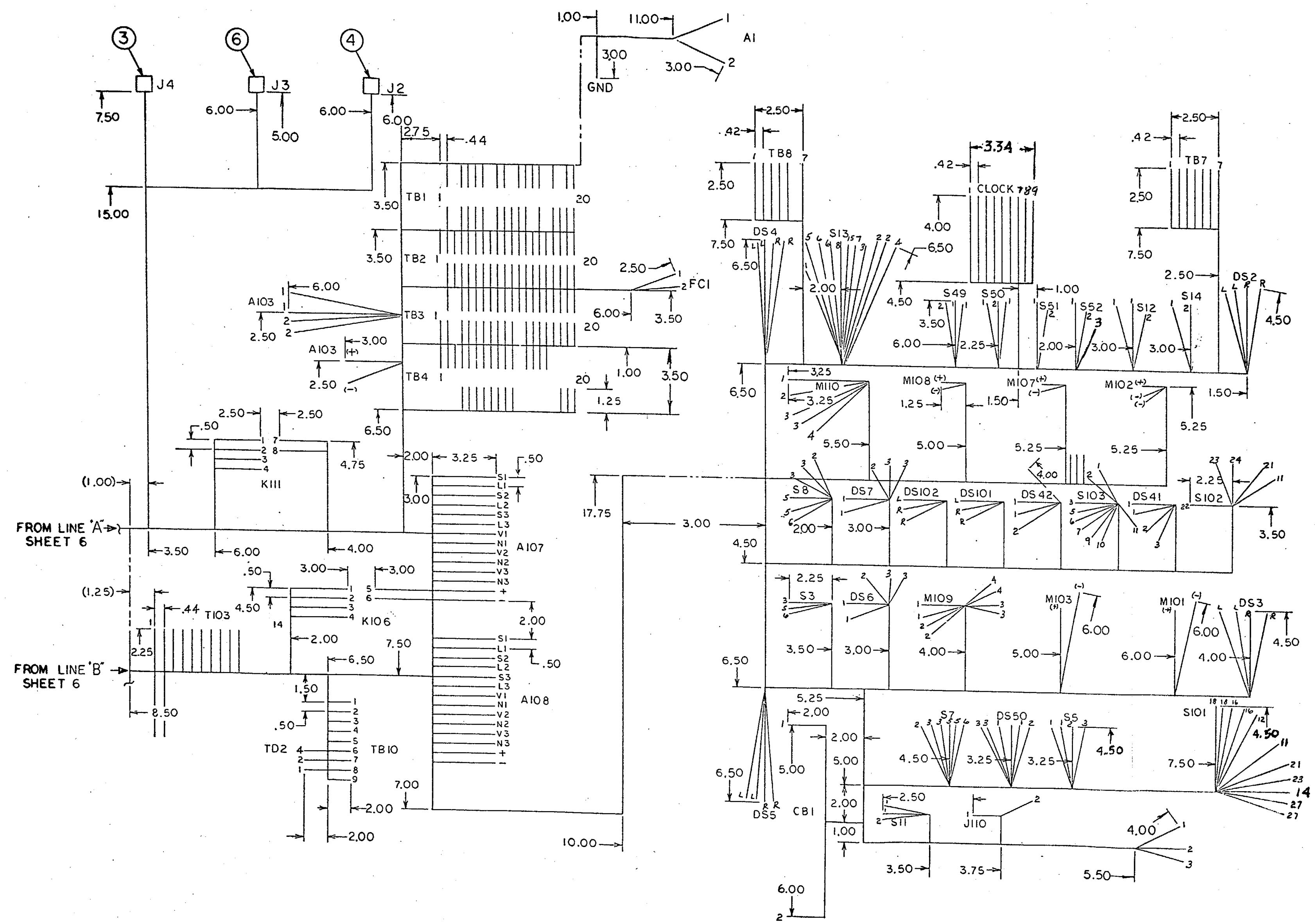
TWISTED TWO CONDUCTOR SHIELD CABLE ASSEMBLIES

			END 1		INCHES	END 2		INCHES	INCHES/CABLE		
CABLE NO.	COLOR	LENGTH INCHES	TERM	FROM	STRIP JACK	TERM	TO	STRIP JACK	22	21	20
102	WHITE	198	9	A106-24	5	9	TBM-3	3	8	2	4
	BLACK		9	A106-20		9	TBM-2				
	SHIELD		17	WIRE NUT		NONE	DEAD END				
103	WHITE	198	9	J3-G	5	9	TBM-2	3	8	2	4
	BLACK		9	J3-F		9	TBM-1				
	SHIELD		9	J3-H		17	DEAD END				
104	WHITE	36	9	TBM-4	5	9	BCR-2	3	8	2	4
	BLACK		9	TBM-1		9	BCR-4				
	RED		9	TBM-3		9	BCR-1				
	SHIELD		17	WIRE NUT		17	DEAD END				
105	WHITE	36	9	SRM-6	5	9	TBM-4	3	8	2	4
	BLACK		9	SRM-5		9	TBM-2				
	SHIELD		17	WIRE NUT		17	DEAD END				
					9			9	8	11	

FO-16. Control Box Harness Assembly (Sheet 5 of 8)
FP-31/ (FP-32 blank)



FO-17. Control Box Harness Assembly (Sheet 6 of 8)
FP-33/ (FP-34 blank)

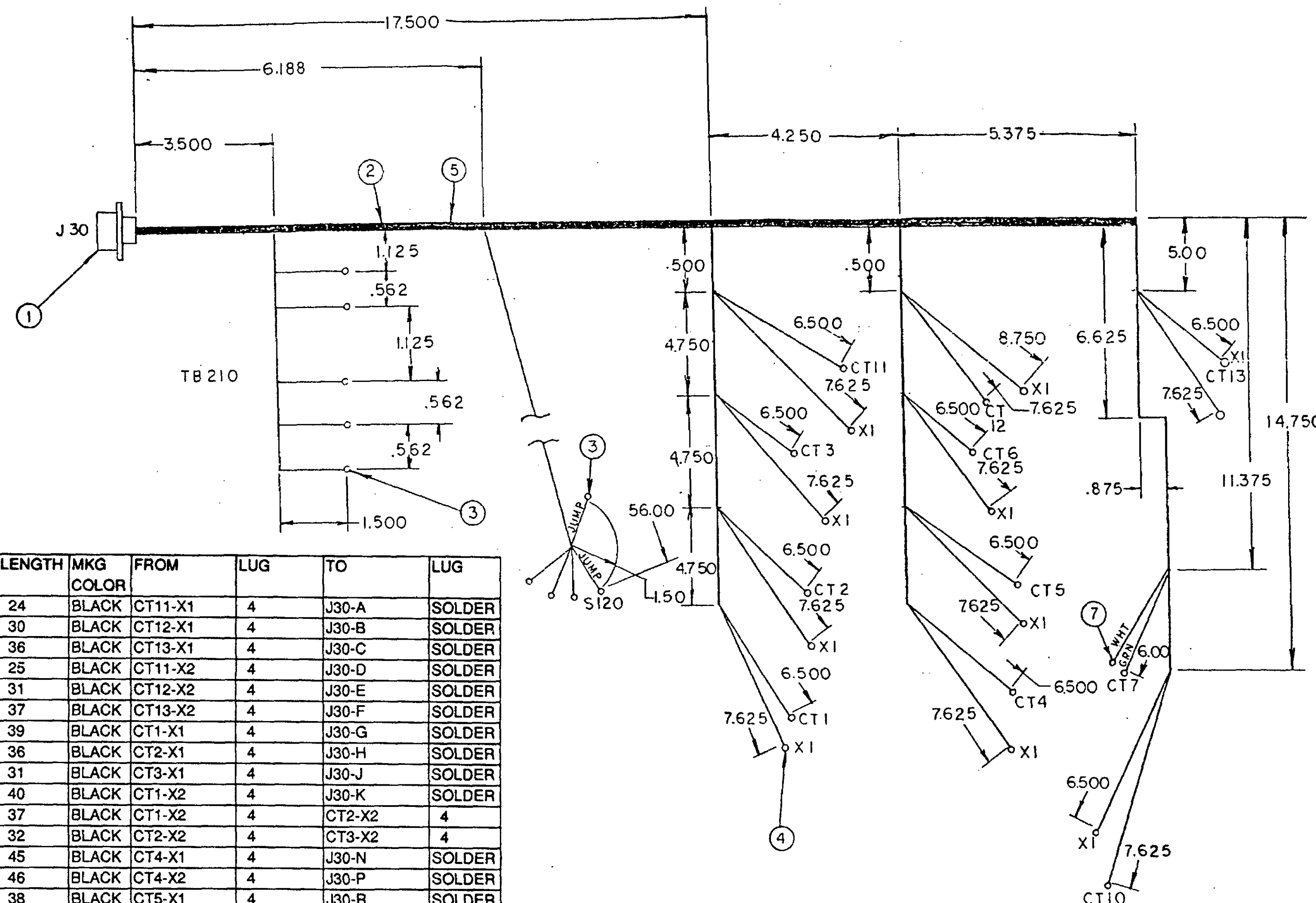


FO-18. Control Box Harness Assembly (Sheet 7 of 8)
FP-35/ (FP-36 blank)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
MOD103	16		RED	K106-5	9	SRM-9	10
MOD104	16		RED	K106-6	9	TB2-3	10
MOD105	16		BLK	K106-1	8	K23-11	9
MOD106	16		BLK	K106-2	8	CR-3	10
MOD107	16		BLK	K106-3	8	M109-4	11
MOD108	16		BLK	K106-4	8	TB3-17	10
MOD109	16		BLK	K23-12	9	SRM-2	10
MOD110	16		BLK	K23-10	9	SRM-3	10
MOD111	16		BLK	TB4-16	10	CR-S	10
MOD112	16		BLK	TB4-16	10	A/M SW22	10
MOD113	16		RED	TB4-13	10	TB4-14	10
MOD114	16		RED	TB3-1	10	A/M SW41	10
MOD115	16		RED	TB3-2	10	A/M SW42	10
MOD116	16		RED	TB3-3	10	BTR-6	10
MOD117	16		RED	TB3-3	10	TB3-9	10
MOD118	16		BLK	TB3-16	10	K106-2	8
MOD119	16		BLK	TB3-3	10	CR-6	10
MOD120	16		BLK	TB3-6	10	CR-1	10
MOD121	16		BLK	TB3-15	10	M109-3	11
MOD122	16		BLK	TB3-16	10	M109-1	11
MOD123	16		RED	TB2-5	10	K106-5	10
MOD124	16		RED	TB2-6	10	S3-2	9
MOD125	16		RED	TB1-6	10	SRM-10	10
MOD126	16		RED	J3-B	SOLDER	A/M SW44	10
MOD127	16		RED	J3-C	SOLDER	BTR-5	10
MOD128	16		RED	J3-D	SOLDER	SRM-9	10
MOD129	16		RED	BTR-6	10	BCR-6	10
MOD130	16		RED	BCR-8	10	SRM-13	10
MOD131	16		RED	BCR-7	10	SRM-12	10
MOD132	16		RED	TB1-3	10	BCR-5	10
MOD133	16		RED	TB1-3	10	J5-u	SOLDER

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
MOD134	16		RED	J3-5	SOLDER	TB1-3	10
MOD135	16		RED	J3-T	SOLDER	81GU-1	10
MOD136	16		RED	J5-J	SOLDER	81GU-4	10
MOD137	16		RED	J5-S	SOLDER	81GU-3	10
MOD138	16		RED	J5-w	SOLDER	81GO-3	10
MOD139	16		RED	J5-x	SOLDER	81GO-4	10
MOD140	16		RED	27/59G-2	10	27/59G-6	10
MOD141	16		RED	27/59G-1	10	81GO-2	10
MOD142	16		RED	27/59G-1	10	CR-6	10
MOD143	16		RED	27/59G-2	10	81GO-2	10
MOD144	16		RED	27/59G-5	10	81GO-7	10
MOD145	16		RED	27/59G-6	10	CR-1	10
MOD146	16		RED	BTR-1	10	A/M SW11	10
MOD147	16		RED	BTR-2	10	S3-2	10
MOD148	16		RED	81G0-1	10	81GU-1	10
MOD149	16		RED	81G0-2	10	81GU-2	10
MOD150	16		RED	81G0-5	10	81GU-6	10
MOD151	16		RED	81GU-5	10	CR-2	10
MOD152	16		RED	CR-2	10	A/M SW21	10
MOD153	16		RED	CR-4	10	SRM-1	10
MOD154	16		RED	SRM-4	10	K106-3	10
MOD155	16		RED	A/M SW14	10	S3-6	10
MOD156	16	12.00	RED	BCR-1	10	BCR-3	10

FO-19. Control Box Harness Assembly (Sheet 8 of 8)
FP-37/ (FP-38 blank)



WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	LUG	TO	LUG
X107AA16	16	24	BLACK	CT11-X1	4	J30-A	SOLDER
X108AA16	16	30	BLACK	CT12-X1	4	J30-B	SOLDER
X109AA16	16	36	BLACK	CT13-X1	4	J30-C	SOLDER
X111AA16	16	25	BLACK	CT11-X2	4	J30-D	SOLDER
X112AA16	16	31	BLACK	CT12-X2	4	J30-E	SOLDER
X113AA16	16	37	BLACK	CT13-X2	4	J30-F	SOLDER
X114AA16	16	39	BLACK	CT1-X1	4	J30-G	SOLDER
X115AA16	16	36	BLACK	CT2-X1	4	J30-H	SOLDER
X116AA16	16	31	BLACK	CT3-X1	4	J30-J	SOLDER
X117AA16	16	40	BLACK	CT1-X2	4	J30-K	SOLDER
X117AB16	16	37	BLACK	CT1-X2	4	CT2-X2	4
X117AC16	16	32	BLACK	CT2-X2	4	CT3-X2	4
X118AA16	16	45	BLACK	CT4-X1	4	J30-N	SOLDER
X119AA16	16	46	BLACK	CT4-X2	4	J30-P	SOLDER
X120AA16	16	38	BLACK	CT5-X1	4	J30-R	SOLDER
X121AA16	16	39	BLACK	CT5-X2	4	J30-S	SOLDER
X122AA16	16	37	BLACK	CT6-X1	4	J30-T	SOLDER
X123AA16	16	38	BLACK	CT6-X2	4	J30-U	SOLDER
X124AA16	16	46	BLACK	CT7-X2	4	J30-V	SOLDER
X125AA16	16	47	BLACK	CT7-X1	7	J30-W	SOLDER
X126AA16	16	50	BLACK	CT10-X2	7	J30-Y	SOLDER
X127AA16	16	51	BLACK	CT10-X1	4	J30-Z	SOLDER
X152PP16	16	65	BLACK	S120-AB-OUT	3	J30-c	SOLDER
X303T16	16	65	BLACK	S120-A-IN	3	J30-a	SOLDER
X304T16	16	65	BLACK	S120-B-IN	3	J30-b	SOLDER
D133T16	16	6	BLACK	TB210-1	3	J30-g	SOLDER
D134T16	16	6	BLACK	TB210-2	3	J30-h	SOLDER
D131T16	16	9	BLACK	TB210-5	3	J30-e	SOLDER
D137T16	16	10	BLACK	TB210-6	3	J30-f	SOLDER
D138T16	16	8	BLACK	TB210-4	3	J30-d	SOLDER
JUMPER	16	3	BLACK	SRO-A-OUT	3	SRO-B-OUT	3
		J30-CA 3102R28-2009-51S					

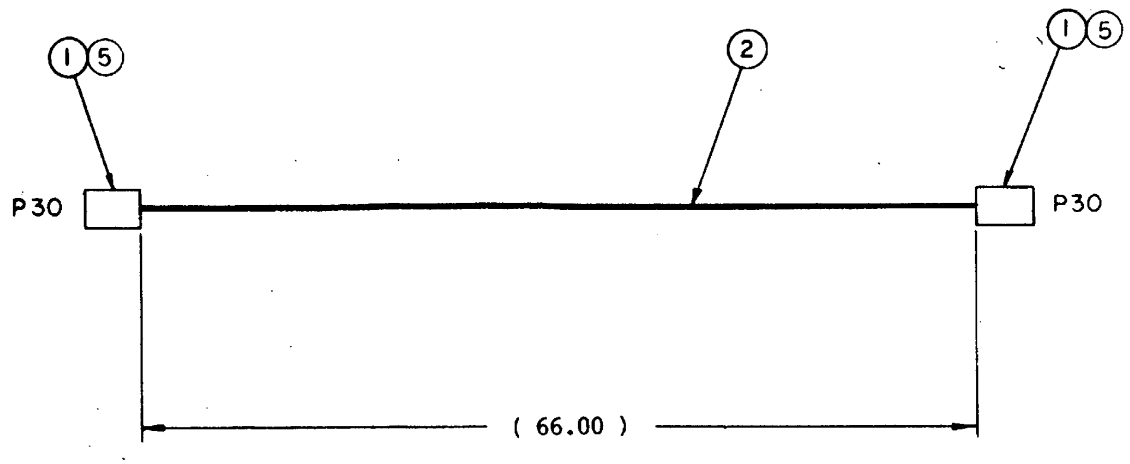
NOTES:

1. INTERPRET DWG PER DOD-STD-100.
2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS. FIND NO. 5 LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED 3 INCHES.
3. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQ. 5 OF MIL-STD-454.
4. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED 6 INCHES.
5. FOR WIRING INFORMATION SEE FO-10 IN TM5-6115-593-12.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
7				MS25036-106	2	LUG		
6				SN60WRAP2	AR	SOLDER	QQ-S-571	SEE NOTE 3
5				MS3367-1-9	AR	STRAP,ADJUSTABLE,TIE		
4				MS25036-108	22	LUG		
3				MS25036-107	10	LUG		
2				M5086/2-16-9	AR	WIRE		
1			C	76-11383	1	CONNECTOR		

LIST OF MATERIALS

FO-20. Reconnection Box Harness Assembly
FP-39/ (FP-40 blank)



WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
X107T16	16	66.00	BLACK	P30-A	SOLDER	P30-A	SOLDER
X108T16	16	66.00	BLACK	P30-B	SOLDER	P30-B	SOLDER
X109T16	16	66.00	BLACK	P30-C	SOLDER	P30-C	SOLDER
X111T16	16	66.00	BLACK	P30-D	SOLDER	P30-D	SOLDER
X112T16	16	66.00	BLACK	P30-E	SOLDER	P30-E	SOLDER
X113T16	16	66.00	BLACK	P30-F	SOLDER	P30-F	SOLDER
X114T16	16	66.00	BLACK	P30-G	SOLDER	P30-G	SOLDER
X115T16	16	66.00	BLACK	P30-H	SOLDER	P30-H	SOLDER
X116T16	16	66.00	BLACK	P30-J	SOLDER	P30-J	SOLDER
X117T16	16	66.00	BLACK	P30-K	SOLDER	P30-K	SOLDER
X118T16	16	66.00	BLACK	P30-N	SOLDER	P30-N	SOLDER
X119T16	16	66.00	BLACK	P30-P	SOLDER	P30-P	SOLDER
X120T16	16	66.00	BLACK	P30-R	SOLDER	P30-R	SOLDER
X121T16	16	66.00	BLACK	P30-S	SOLDER	P30-S	SOLDER
X122T16	16	66.00	BLACK	P30-T	SOLDER	P30-T	SOLDER
X123T16	16	66.00	BLACK	P30-U	SOLDER	P30-U	SOLDER
X124T16	16	66.00	BLACK	P30-V	SOLDER	P30-V	SOLDER
X125T16	16	66.00	BLACK	P30-W	SOLDER	P30-W	SOLDER
X126T16	16	66.00	BLACK	P30-Y	SOLDER	P30-Y	SOLDER
X127T16	16	66.00	BLACK	P30-Z	SOLDER	P30-Z	SOLDER
X303P16	16	66.00	BLACK	P30-a	SOLDER	P30-a	SOLDER
X304P16	16	66.00	BLACK	P30-b	SOLDER	P30-b	SOLDER
X152PB16C	16	66.00	BLACK	P30-c	SOLDER	P30-c	SOLDER
D133EE16	16	66.00	BLACK	P30-g	SOLDER	P30-g	SOLDER
D134EE16	16	66.00	BLACK	P30-h	SOLDER	P30-h	SOLDER
D131EE16	16	66.00	BLACK	P30-e	SOLDER	P30-e	SOLDER
D137EE16	16	66.00	BLACK	P30-f	SOLDER	P30-f	SOLDER
D138EE16	16	66.00	BLACK	P30-d	SOLDER	P30-d	SOLDER

NOTES:

1. ALL WIRES SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING STRAPS FIND NO. 3. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

2. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

3. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.

4. FOR WIRING INFORMATION SEE FO-6, FO-10, AND FO-11, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

5. INSTALL NYLON FILLER PLUGS (5) IN UNUSED OPENINGS OF CONNECTOR BUSHING.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
5				MS25251-16	30	PLUG,END,SEAL		
4				SN60WRAP2	A/R	SOLDER	QQ-S-571	SEE NOTE 3
3				MS3367-4-9	A/R	STRAP,SELF-LOCKING		
2				M5086/2-16-9	A/R	WIRE	MIL-W-5086/2	
1			C	76-11428	2	CONNECTOR (CA3106R28-2009-51P)		

LIST OF MATERIALS

FO-21. Reconnection Harness

WIRE NO.	SIZE (INCHES)	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
K1C16	16	180	RED	P26-A	SOLDER	P11-A	SOLDER
K2A16	16	192	RED	P11-D	SOLDER	P12-A	SOLDER
K3A16	16	108	RED	P12-D	SOLDER	P13-A	SOLDER
K4C16	16	216	RED	P13-D	SOLDER	P26-B	SOLDER
K10B16	16	192	BLACK	P26-C	SOLDER	P112-B	SOLDER
K11B16	16	192	BLACK	P26-D	SOLDER	P112-A	SOLDER
P140AB4	4	170	RED	TB202-9	28	L4-(+)	29
P36B16	16	192	RED	P26-E	SOLDER	P14-A	SOLDER
P48C16	16	192	RED	P26-F	SOLDER	P14-B	SOLDER
P364C16	16	192	RED	P26-G	SOLDER	P14-E	SOLDER
P56E16	16	192	RED	P26-H	SOLDER	P14-D	SOLDER
P210L16	16	192	RED	P26-J	SOLDER	P14-F	SOLDER
P204E16	16	192	RED	P26-K	SOLDER	P14-J	SOLDER
P202E16	16	204	RED	P26-L	SOLDER	P15-C	SOLDER
P211E16	16	204	RED	P26-M	SOLDER	P15-B	SOLDER
P201E16	16	264	RED	P26-N	SOLDER	P12-C	SOLDER
P210M16	16	264	RED	P26-P	SOLDER	P12-B	SOLDER
P200E16	16	216	RED	P26-R	SOLDER	P13-C	SOLDER
P210P16	16	216	RED	P26-S	SOLDER	P13-B	SOLDER
P35K16	16	168	RED	P26-r	SOLDER	P36-B	SOLDER
P41AC16	16	84	RED	P26-T	SOLDER	P19-A	SOLDER
P53F16	16	84	RED	P26-U	SOLDER	P19-B	SOLDER
P50AA16	16	84	RED	P26-V	SOLDER	P19-C	SOLDER
P58B16	16	84	RED	P26-W	SOLDER	P19-D	SOLDER
P54C16	16	108	RED	P26-X	SOLDER	P18-A	SOLDER
Q81C16	16	108	RED	P26-Y	SOLDER	P18-B	SOLDER
P203E16	16	108	RED	P26-Z	SOLDER	P18-D	SOLDER
P210N16	16	108	RED	P26-a	SOLDER	P18-C	SOLDER
E30C16	16	216	RED	P26-b	SOLDER	MT1-1	10
E31C16	16	240	RED	P26-c	SOLDER	MT2-1	10
E32C16	16	222	RED	P26-d	SOLDER	MT3-1	10
E33C16	16	90	RED	P26-e	SOLDER	P20-1	8
P57D16	16	276	RED	P26-f	SOLDER	P21-A	SOLDER
P55BD16N	16	276	RED	P26-g	SOLDER	P21-B	SOLDER
P45B16	16	180	RED	P26-h	SOLDER	P35-A	SOLDER
P35A16	16	222	RED	P26-s	SOLDER	OP3-1	27
K6C16	16	186	RED	P26-j	SOLDER	L1-(+)	10
P51B16	16	168	RED	P26-k	SOLDER	K3-A	10
P55BH16N	16	14	RED	L4-(-)	31	K3-B	10
K8A8	8	14	RED	K3-2	14	L4-(1)	13
P140G8	8	18	RED	L4-(+)	30	K3-1	14
P45D16	16	168	RED	P26-n	SOLDER	P36-A	SOLDER
Q80D12	12	108	RED	P26-t	SOLDER	P22-A	SOLDER
P55BP12	12	96	RED	P26-u	SOLDER	BI-GND	12
P35D16	16	274	RED	P26-p	SOLDER	P35-B	SOLDER
P55FS16N	16	29	RED	BI-GND	10	P24-B	SOLDER
Q80F16	16	108	RED	P26-m	SOLDER	P24-A	SOLDER
P55BJ16N	16	81	RED	L4-(-)	31	OP3-2	27
X173H8	8	300	BLACK	P29-B	SOLDER	TH101-6	13
X174H8	8	296	BLACK	P29-E	SOLDER	TH101-7	13
X179H4	8	300	BLACK	P29-D	SOLDER	TH101-4	13
X171H16	16	410	BLACK	P29-F	SOLDER	TH101-1	11
X175H16	16	265	BLACK	P29-A	SOLDER	TH101-2	11

NOTES:

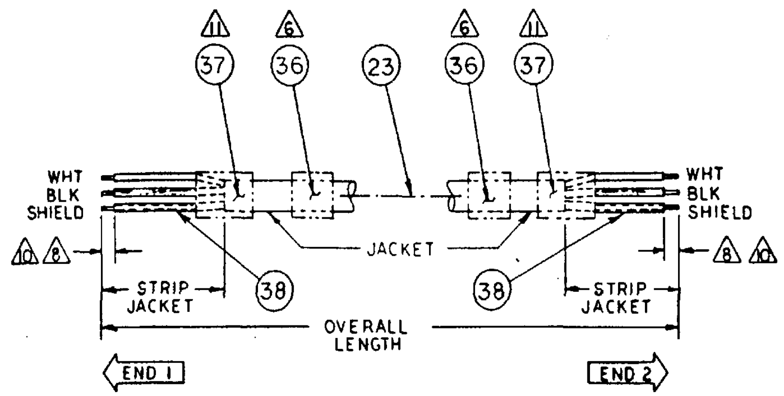
1. INTERPRET DWG PER DOD-STD-100.
2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS FIND NO 20 & 21, LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED THREE INCHES.

NOTES CONTINUED ON SHEET 2.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
39				76-11119	AR	WIRE NUT		
38				M23053/5	AR	INSUL,SLEEVING .06 ID BLK	MIL-1-23053/5	CLI
37				M23053/5	AR	INSUL,SLEEVING .25 ID BLK	MIL-1-23053/5	CLI
36				M23053/5	AR	INSUL,SLEEVING .25 ID WHT	MIL-1-23053/5	CLI
35				MS25251-16	11	PLUG,END,SEAL		
34			B	76-11112	1	PLUG,END,SEAL		
33				MS25251-12	5	PLUG,END,SEAL		
32				M23053/5	3"	INSUL,SLEEVING .375 ID BLK	MIL-1-23053/5	CLI
31				MS25036-155	2	LUG	MIL-T-7928	
30			B	76-11450	1	LUG	MIL-T-7928	
29			B	76-11297	1	LUG	MIL-T-7928	
28				MS25036-123	1	LUG	MIL-T-7928	
27				MS25036-106	6	LUG	MIL-T-7928	
26			C	69-561-2	1	NUT AND CAPT WASHER ASSY		
25			B	76-11412	1	LUG	MIL-T-7928	
24				MS3106R36-7S	1	CONNECTOR,PLUG,ELEC		
23			B	76-11253	630'	CABLE,SHIELDED,2-COND		SEE NOTE 6
22				SN60 WRAP 2	AR	SOLDER	QQ-S-571	SEE NOTE 3
21				MS3367-4-9	AR	STRAP,SELF-LOCKING		
20				MS3367-1-9	AR	STRAP,SELF-LOCKING		
19				M5086/2-16-9	AR	WIRE, AWG #16 COLOR, WHITE	MIL-W-5086/2	
18				M5086/2-12-9	AR	WIRE, AWG #12 COLOR, WHITE	MIL-W-5086/2	
17				M5086/2-8-9	AR	WIRE, AWG #8, COLOR, WHITE	MIL-W-5086/2	
16				M5086/2-4-9	AR	WIRE, AWG #4, COLOR, WHITE	MIL-W-5086/2	
15				MS25036-102	5	LUG	MIL-T-7928	
14				MS25036-117	2	LUG	MIL-T-7928	
13				MS25036-115	5	LUG	MIL-T-7928	
12				MS25036-112	4	LUG	MIL-T-7928	
11				MS25036-153	6	LUG	MIL-T-7928	
10				MS25036-108	8	LUG	MIL-T-7928	
9			D	69-662-18	1	SCR AND CAPT WASHER ASSY		
8				MS27144-2	1	PLUG		
7				MS3106R28-10P	1	CONNECTOR,PLUG,ELEC		
6				MS3106R14S-9S	1	CONNECTOR,PLUG,ELEC		
5				MS3106R12-5S	1	CONNECTOR,PLUG,ELEC		
4				MS3106R18-1S	1	CONNECTOR,PLUG,ELEC		
3				MS3106R10SL-4S	5	CONNECTOR,PLUG,ELEC		
2				MS3106R12S-3S	1	CONNECTOR,PLUG,ELEC		
1				MS3106R14S-2S	6	CONNECTOR,PLUG,ELEC		

LIST OF MATERIALS

FO-22. Engine Accessory Harness (Sheet 1 of 3)



TWISTED TWO CONDUCTOR SHIELD CABLE ASSEMBLIES

			END 1		INCHES	END 2		INCHES	INCHES/CABLE		
CABLE NO.	COND	LG INCHES	TERM	FROM	STRIP JACK	TERM	TO	STRIP JACK	38	37	36
101	WHITE	198	11	TB26-7	3	SOLDER	J113-B	3	3	2	4
	BLACK		11	TB26-8		SOLDER	J113-A				
	SHIELD		15	CBL-1		NONE	DEAD END	12			
567	WHITE	228	27	TB510-5	3	11	TB26-9	3	6	2	4
	BLACK		27	TB510-6		11	TB26-10				
	SHIELD		15	CBL 14 & 15		15	CBL 5,6 & 7				
1415	WHITE	204	11	TB24-8	3	27	TB510-4	3	6	2	4
	BLACK		11	TB24-9		27	TB510-3				
	SHIELD		15	CBL 14 & 15		15	CBL 5,6 & 7				
					9			9	8	11	

NOTES CONTINUED

5. FOR WIRING INFORMATION SEE FO-3, FO-4 AND FO-11 IN TM5-6115-593-12.

6. MARK SHRINK SLEEVING (FIND ITEM 36) WITH SHIELD CABLE NUMBER SEE CABLE LIST, ASSEMBLE ON RESPECTIVE CABLE AND SHRINK PER NOTE 7.

7. APPLY HEAT (300 DEGREES F) FOR 3 TO 5 SECONDS.

8. STRIP INSULATION LEAVING APPROX .25 BARE WIRE EXPOSED FOR SOLDERING OR LUGGING.

9. STRIP BACK CABLE JACKET TAKING CARE NOT TO DAMAGE SHIELD OR CONDUCTORS. SEE CABLE LIST FOR LENGTH TO STRIP JACKET BACK.

10. TWIST SHIELD TO FORM WIRE COVER WITH FIND NO. 38 AND SHRINK PER NOTE 7.

11. APPLY (1) INCH LONG SLEEVING (FIND NO. 37) TO COVER APPROX A HALF INCH OF JACKET AND THE OTHER HALF INCH OVER THE WIRES AND SHRINK PER NOTE 7.

12. DO NOT BRING SHIELD OUT OF JACKET (DEAD END) APPLY SHRINK SLEEVING AS IN NOTE 11.

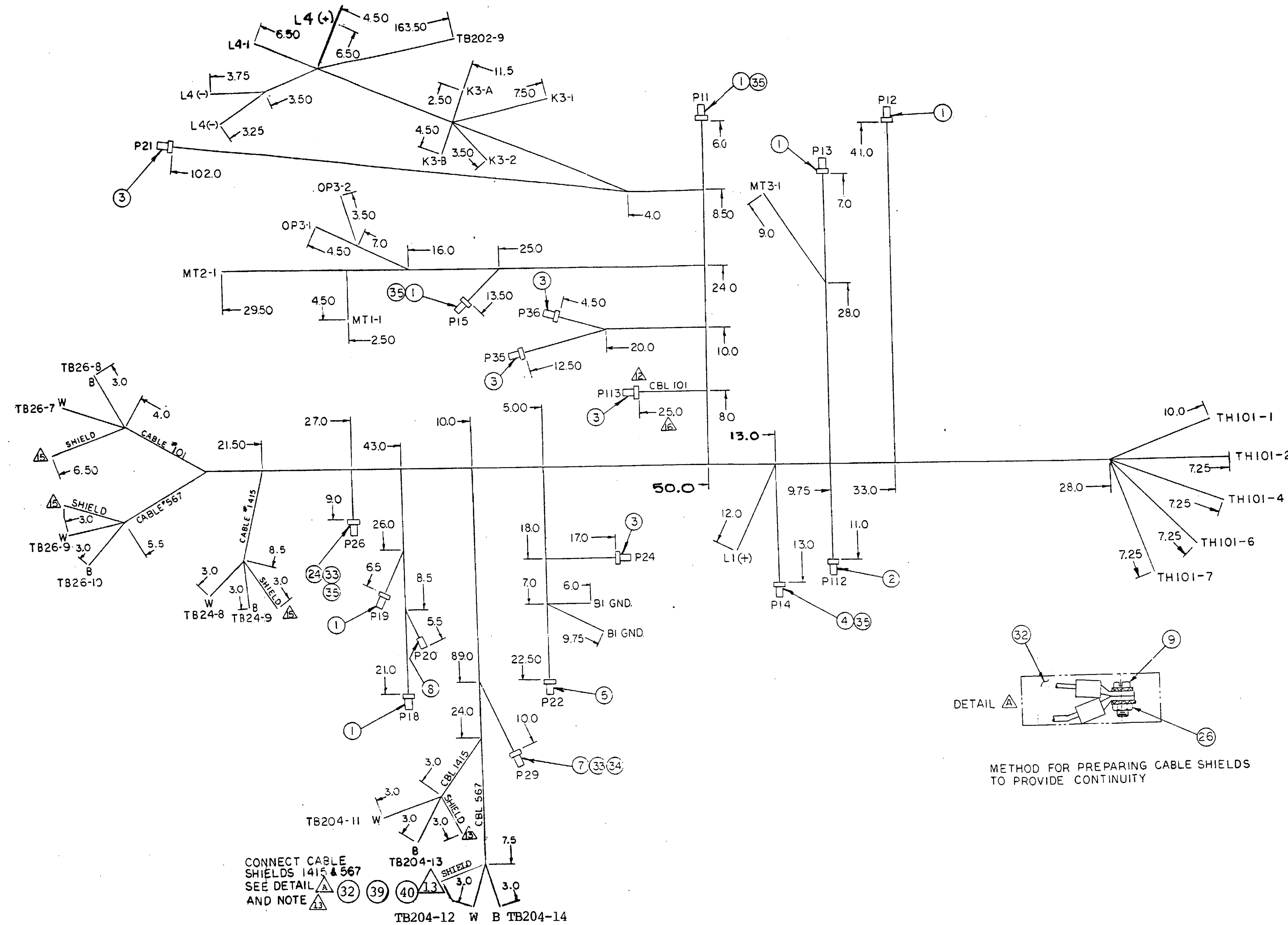
13. CONNECT SHIELD ENDS WITH FIND NO. 9 & 26, THEN COVER WITH FIND NO. 32 (3) INCHES LONG, SHRINK PER NOTE 7. INSURE ALL SHIELDS ARE CONNECTED PRIOR TO THIS STEP OR DELAY UNTIL LATER ASSY STEP.

14. INSTALL NYLON FILLER PLUGS (33, 34 & 35) IN UNUSED OPENINGS OF CONNECTOR BUSHING.

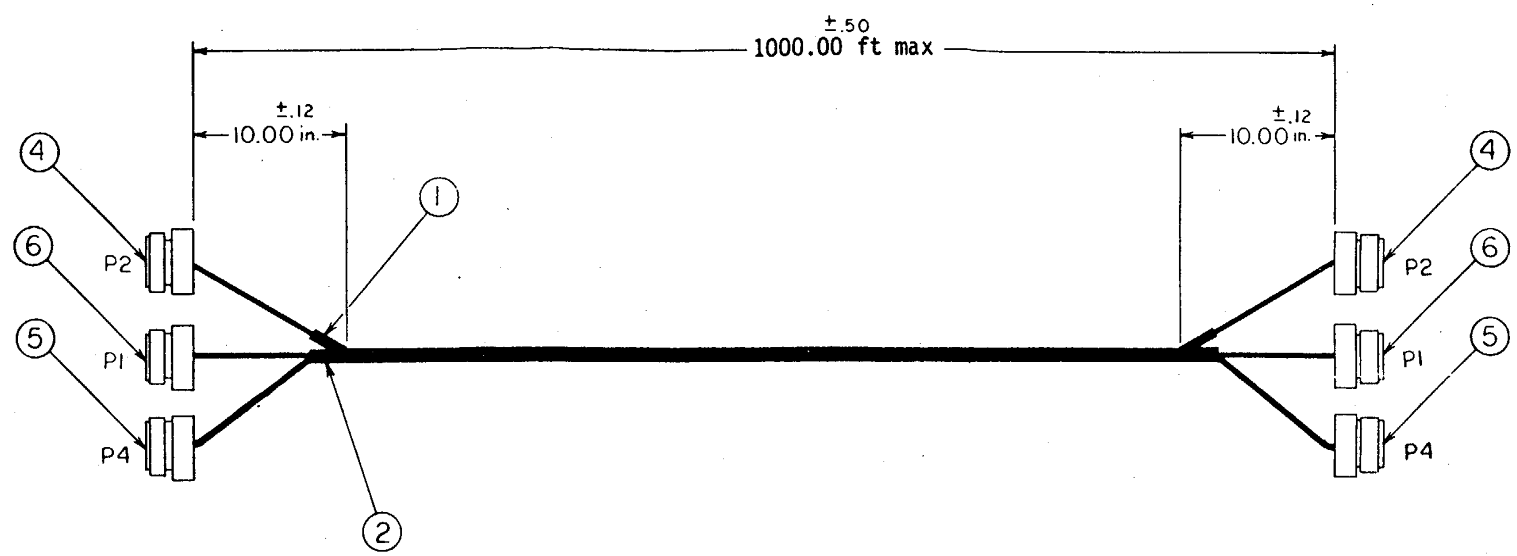
15. THESE CONNECTIONS MADE IN AC/DC BOX, SEE FO-5 IN TM5-6115-593-12.

16. MAGNETIC PICKUP LOCATION VARIES.

FO-23. Engine Accessory Harness (Sheet 2 of 3)



FO-24. Engine Accessory Harness (Sheet 3 of 3)



7				SN60WRAP2	AR	SOLDER	QQ-S-571	
6				MS3106R28-20P	2	CONNECTOR, ELEC		
5			C	76-11403	2	CONNECTOR, ELEC		
4			C	76-11404	2	CONNECTOR, ELEC		
3				MS3367-2-9	AR	TIE WRAP		
2			B	76-11027	1	CABLE, 37 CONDUCTOR		
1			C	76-11029	1	CABLE, 25 CONDUCTOR		
FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
LIST OF MATERIALS								

NOTES:

1. WIRES SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING STRAPS FIND NO. 3 LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED SIX INCHES.

2. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

3. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.

4. FOR INTERCONNECTION DIAGRAM SEE FO-14, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

FO-25. Remote Control Cable Assembly (Sheet 1 of 2)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
ONE	14	AS REQ.	BLACK	P4-A	SOLDER	P4-A	SOLDER
TWO	14	AS REQ.	WHITE	P4-C	SOLDER	P4-C	SOLDER
THREE	14	AS REQ.	RED	P4-D	SOLDER	P4-D	SOLDER
FOUR	14	AS REQ.	GREEN	P4-E	SOLDER	P4-E	SOLDER
FIVE	14	AS REQ.	ORANGE	P4-F	SOLDER	P4-F	SOLDER
SIX	14	AS REQ.	BLUE	P4-G	SOLDER	P4-G	SOLDER
SEVEN	14	AS REQ.	WHT,BLK,TR	P4-H	SOLDER	P4-H	SOLDER
EIGHT	14	AS REQ.	RED,BLK,TR	P4-I	SOLDER	P4-I	SOLDER
NINE	14	AS REQ.	GRN,WHT,TR	P4-J	SOLDER	P4-J	SOLDER
TEN	14	AS REQ.	ORN,BLK,TR	P4-K	SOLDER	P4-K	SOLDER
ELEVEN	14	AS REQ.	BLUE,BLK,TR	P4-L	SOLDER	P4-L	SOLDER
TWELVE	14	AS REQ.	BLK,WHT,TR	P4-M	SOLDER	P4-M	SOLDER
THIRTEEN	14	AS REQ.	RED,WHT,TR	P4-N	SOLDER	P4-N	SOLDER
FOURTEEN	14	AS REQ.	GRN,WHT,TR	P4-R	SOLDER	P4-R	SOLDER
FIFTEEN	14	AS REQ.	BLUE,WHT,TR	P4-S	SOLDER	P4-S	SOLDER
SIXTEEN	14	AS REQ.	BLK,RED,TR	P4-T	SOLDER	P4-T	SOLDER
SEVENTEEN	14	AS REQ.	WHT,RED,TR	P4-U	SOLDER	P4-U	SOLDER
EIGHTEEN	14	AS REQ.	ORN,RED,TR	P4-V	SOLDER	P4-V	SOLDER
NINETEEN	14	AS REQ.	BLUE,RED,TR	P4-W	SOLDER	P4-W	SOLDER
TWENTY	14	AS REQ.	RED,GRN,TR	P4-X	SOLDER	P4-X	SOLDER
TWENTY-ONE	14	AS REQ.	ORN,GRN,TR	P4-Y	SOLDER	P4-Y	SOLDER
TWENTY-TWO	14	AS REQ.	BLACK	P4-Z	SOLDER	P4-Z	SOLDER
TWENTY-THREE	14	AS REQ.	WHITE	P4-a	SOLDER	P4-a	SOLDER
TWENTY-FOUR	14	AS REQ.	RED,WHT,TR	P4-b	SOLDER	P4-b	SOLDER
TWENTY-FIVE	14	AS REQ.	GREEN	P4-c	SOLDER	P4-c	SOLDER
TWENTY-SIX	14	AS REQ.	ORANGE	P4-d	SOLDER	P4-d	SOLDER
TWENTY-SEVEN	14	AS REQ.	BLUE	P4-f	SOLDER	P4-f	SOLDER
TWENTY-EIGHT	14	AS REQ.	WHITE	P1-A	SOLDER	P1-A	SOLDER
TWENTY-NINE	14	AS REQ.	RED,BLK,TR	P1-B	SOLDER	P1-B	SOLDER
THIRTY	14	AS REQ.	GRN,BLK,TR	P1-C	SOLDER	P1-C	SOLDER
THIRTY-ONE	14	AS REQ.	ORN,BLK,TR	P1-D	SOLDER	P1-D	SOLDER
THIRTY-TWO	14	AS REQ.	BLUE,BLK,TR	P1-E	SOLDER	P1-E	SOLDER
THIRTY-THREE	14	AS REQ.	BLK,WHT,TR	P1-F	SOLDER	P1-F	SOLDER
THIRTY-FOUR	14	AS REQ.	RED,WHT,TR	P1-G	SOLDER	P1-G	SOLDER
THIRTY-FIVE	14	AS REQ.	GRN,WHT,TR	P1-H	SOLDER	P1-H	SOLDER
THIRTY-SIX	14	AS REQ.	BLUE,WHT,TR	P1-J	SOLDER	P1-J	SOLDER
THIRTY-SEVEN	14	AS REQ.	BLK,RED,TR	P1-P	SOLDER	P1-P	SOLDER

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
	14	AS REQ.	BLACK	P2-A	SOLDER	P2-A	SOLDER
	14	AS REQ.	WHITE	P2-C	SOLDER	P2-C	SOLDER
	14	AS REQ.	RED	P2-D	SOLDER	P2-D	SOLDER
	14	AS REQ.	GREEN	P2-E	SOLDER	P2-E	SOLDER
	14	AS REQ.	ORANGE	P2-F	SOLDER	P2-F	SOLDER
	14	AS REQ.	BLUE	P2-G	SOLDER	P2-G	SOLDER
	14	AS REQ.	WHT-BLK	P2-H	SOLDER	P2-H	SOLDER
	14	AS REQ.	RED-BLK	P2-I	SOLDER	P2-I	SOLDER
	14	AS REQ.	GRN-BLK	P2-J	SOLDER	P2-J	SOLDER
	14	AS REQ.	ORN-BLK	P2-K	SOLDER	P2-K	SOLDER
	14	AS REQ.	BLUE-BLK	P2-L	SOLDER	P2-L	SOLDER
	14	AS REQ.	BLK-WHT	P2-M	SOLDER	P2-M	SOLDER
	14	AS REQ.	RED-WHT	P2-R	SOLDER	P2-R	SOLDER
	14	AS REQ.	GRN-WHT	P2-S	SOLDER	P2-S	SOLDER
	14	AS REQ.	BLUE-WHT	P2-T	SOLDER	P2-T	SOLDER
	14	AS REQ.	BLK-RED	P2-U	SOLDER	P2-U	SOLDER
	14	AS REQ.	WHT-RED	P2-V	SOLDER	P2-V	SOLDER
	14	AS REQ.	ORN-RED	P2-W	SOLDER	P2-W	SOLDER
	14	AS REQ.	BLUE-RED	P2-X	SOLDER	P2-X	SOLDER
	14	AS REQ.	RED-GRN	P2-Y	SOLDER	P2-Y	SOLDER
	14	AS REQ.	ORN-GRN	P2-Z	SOLDER	P2-Z	SOLDER
	14	AS REQ.	BLK-WHT-RED	P2-a	SOLDER	P2-a	SOLDER
	14	AS REQ.	WHT-BLK-RED	P2-b	SOLDER	P2-b	SOLDER
	14	AS REQ.	RED-BLK-WHT	P2-c	SOLDER	P2-c	SOLDER
	14	AS REQ.	GRN-BLK-WHT	P2-d	SOLDER	P2-d	SOLDER

FO-26. Remote Control Cable Assembly (Sheet 2 of 2)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
K5BB16	16	114	RED	S22-2	5	J4-c	SOLDER
L20BB16	16	112	RED	DS51-2	SOLDER	J4-Z	SOLDER
L21BB16	16	53	RED	S4-2	5	DS2-R	6
L21BC16	16	39	RED	DS2-R	6	DS3-R	6
L21BD16	16	60	RED	DS3-R	6	DS4-R	6
L21BE16	16	36	RED	DS4-R	6	DS5-R	6
L23BB16	16	57	BLK	TB30-1	6	J2-V	SOLDER
L23BC16	16	72	BLK	TB30-1	6	M110-3	7
L23BD16	16	70	BLK	M110-3	7	M109-3	7
L23BE16	16	60	BLK	M109-3	7	DS101-R	6
L24BB16	16	56	BLK	TB30-2	6	J2-W	SOLDER
L24BC16	16	51	BLK	TB30-2	6	M109-1	7
L24BD16	16	63	BLK	M109-1	7	DS102-R	6
L25BB16	16	56	BLK	TB30-4	6	J2-Y	SOLDER
L25BC16	16	50	BLK	TB30-4	6	M109-4	7
L25BD16	16	58	BLK	M109-4	7	DS101-L	6
L26BB16	16	57	BLK	TB30-3	6	J2-X	SOLDER
L26BC16	16	50	BLK	TB30-3	6	M109-2	7
L26BD16	16	62	BLK	M109-2	7	DS102-L	6
L27BB16	16	127	BLK	M110-4	7	J2-Z	SOLDER
P41BB16	16	56	RED	TB30-8	6	J4-A	SOLDER
P41BC16	16	55	RED	TB30-8	6	S4-1	5
P41BD16	16	51	RED	S4-1	5	S1-2	5
P41BE16	16	58	RED	TB30-8	6	S22-1	5
P41BF16	16	58	RED	S22-1	5	S2-1	5
P50BB16	16	56	RED	TB30-9	6	J4-C	SOLDER
P50BC16	16	69	RED	TB30-9	6	S6-1	5
P50BD16	16	13	RED	S6-1	5	S5-1	5
P50BE16	16	27	RED	S5-1	5	S3-5	5
P50BF16	16	50	RED	TB30-9	6	K115-4	5
P52BB16	16	111	RED	S2-2	5	J4-b	SOLDER
P55BB16N	16	52	RED	TB30-13	6	J4-a	SOLDER
P55BC16N	16	57	RED	TB30-13	6	DS2-L	6
P55BM16N	16	48	RED	DS7-1	SOLDER	DS51-1	SOLDER
L218T16	16	27	RED	S13-2	5	TB7-6	6
P55BD16N	16	38	RED	DS2-L	6	DS3-L	6
P55BE16N	16	60	RED	DS3-L	6	DS4-L	6
P55BF16N	16	38	RED	DS4-L	6	DS5-L	6
P55BG16N	16	28	RED	DS5-L	6	DS50-1	SOLDER
P55BH16N	16	20	RED	DS50-1	SOLDER	DS52-1	SOLDER
P55BJ16N	16	7	RED	DS52-1	SOLDER	DS6-1	SOLDER
P55BK16N	16	65	RED	DS6-1	SOLDER	DS7-1	SOLDER
P59BB16	16	113	RED	S3-2	5	J4-D	SOLDER
P60BB16	16	113	RED	S3-3	5	J4-F	SOLDER
P66BB16	16	109	RED	DS6-2	SOLDER	J4-G	SOLDER
P67BB16	16	124	RED	S8-5	5	J4-H	SOLDER
P67CC16	16	124	RED	S8-6	5	J4-I	SOLDER
JUMPER	16	6	-	S8-6	5	S8-2	5
P68BB16	16	14	RED	S8-3	5	DS7-2	SOLDER
P68BC16	16	120	RED	DS7-2	SOLDER	J4-J	SOLDER

NOTES:

1. INTERPRET DWG PER DOD-STD-100.
2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS (FIND NO. 11). LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED 3 INCHES.
3. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQ 5 OF MIL-STD-454.
4. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED 3 INCHES.
5. FOR WIRING INFORMATION SEE FO-9 IN TM5-6115-593-12.

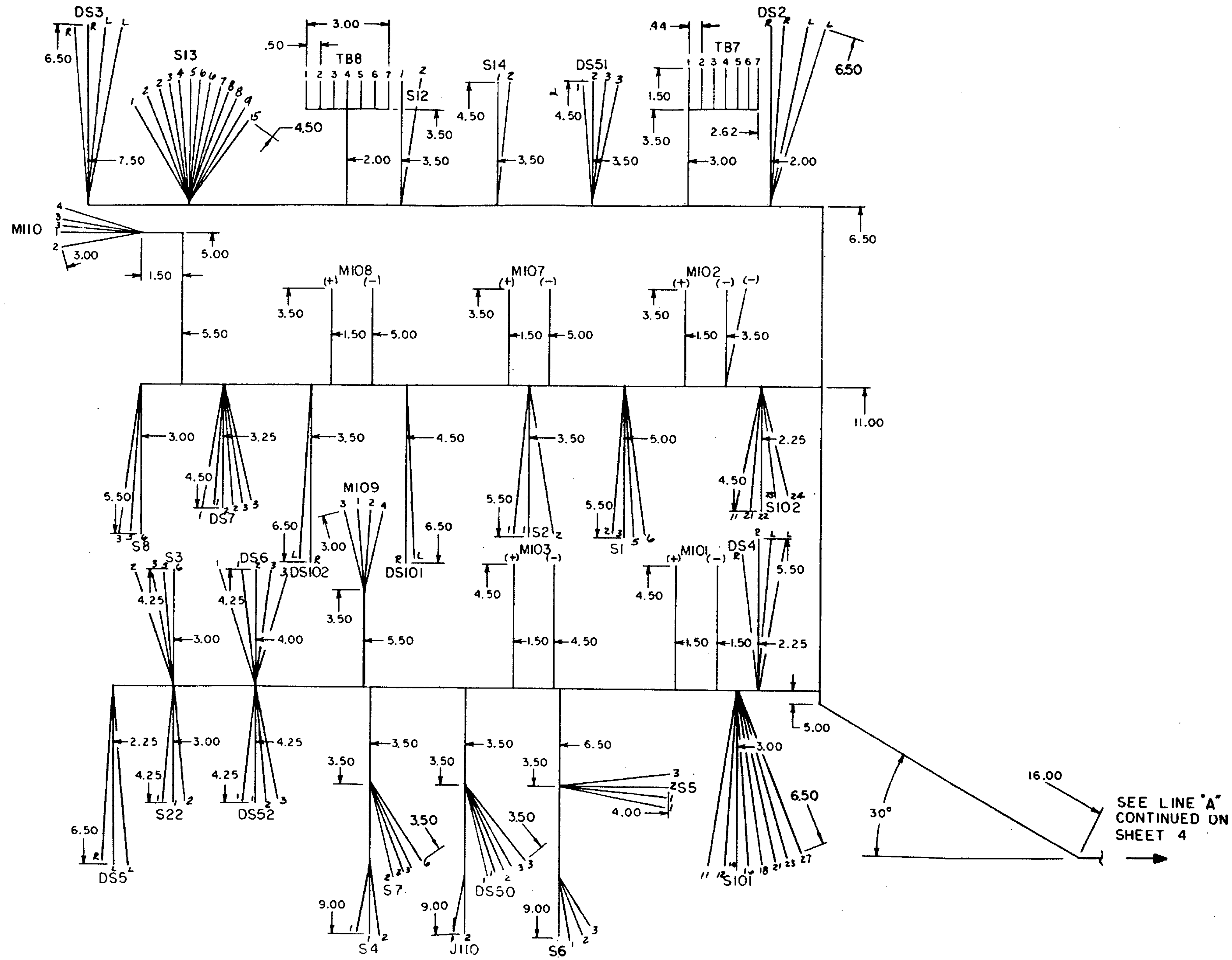
FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
12			B	76-11317	2	LUG,PUSH ON		
11				MS3367-4-9	AR	WRAP,TIE		
10				SN60WRAP2	AR	SOLDER	QQ-S-571	SEE NOTE 2
9				MS25036-153	16	LUG		
8				MS25036-154	12	LUG		
7				MS25036-108	13	LUG		
6				MS25036-106	148	LUG		
5				MS25036-107	72	LUG		
4				5086/2-16-9	AR	WIRE, #16 AWG	MIL-W-5086/2	
3			C	76-11388	1	CONNECTOR		
2			C	76-11387	1	CONNECTOR		
1				MS3102R28-20S	1	CONNECTOR		

LIST OF MATERIALS

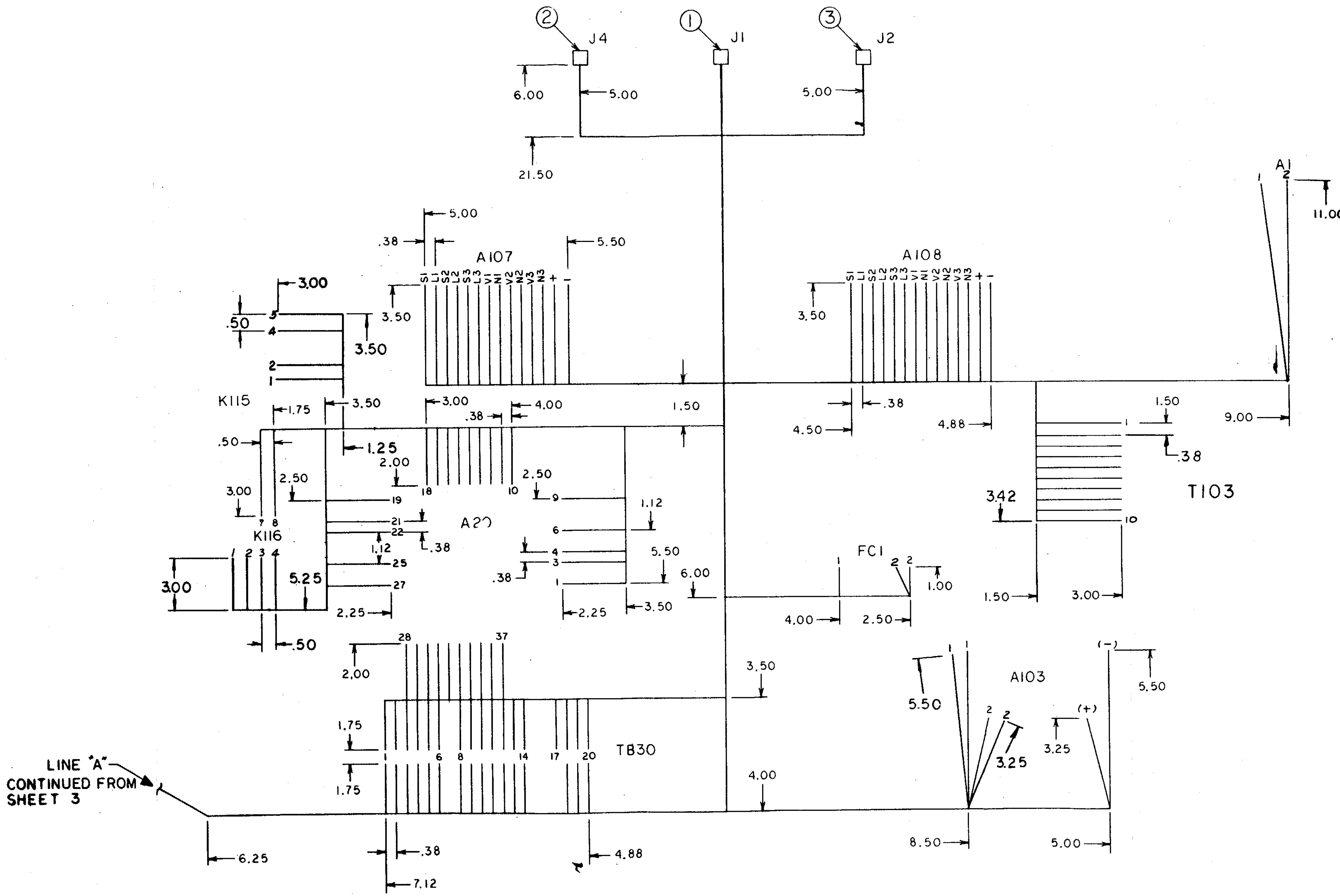
FO-27. Remote Control Box Harness Assembly (Sheet 1 of 4)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P69BB16	16	104	RED	S7-5	5	J4-T	SOLDER
P69CC16	16	104	RED	S7-2	5	J4-S	SOLDER
JUMPER	16	6	-	S7-2	5	S7-6	5
P70BB16	16	53	RED	TB30-10	6	S7-3	5
P70BC16	16	19	RED	S7-3	5	DS50-2	SOLDER
P70BD16	16	54	RED	TB30-10	6	J4-R	SOLDER
P71BB16	16	99	RED	S5-2	5	J4-K	SOLDER
P72BB16	16	99	RED	S5-3	5	J4-L	SOLDER
P73BB16	16	101	RED	S6-2	5	J4-M	SOLDER
P74BB16	16	101	RED	S6-3	5	J4-N	SOLDER
P78BB16	16	53	RED	TB30-11	6	J4-Y	SOLDER
P78BC16	16	64	RED	TB30-11	6	S14-1	5
P78BD16	16	29	RED	TB30-11	6	TB6-12	6
P78BE16	16	20	RED	TB30-12	6	FC1-2	9
P78BF16	16	51	RED	FC1-2	9	A1-2	12
P78BG16	16	59	RED	TB30-12	6	S13-7	5
P90BB16	16	108	RED	S1-3	5	J4-V	SOLDER
P91BB16	16	108	RED	S1-6	5	J4-W	SOLDER
P92BB16	16	108	RED	S1-5	5	J4-U	SOLDER
P93BB16	16	55	RED	K116-7	5	J2-A	SOLDER
P94BB16	16	54	RED	K116-8	5	J2-C	SOLDER
P95BB16	16	111	RED	S3-6	5	J4-E	SOLDER
L96BB16	16	24	RED	K115-5	5	K116-3	5
L97BB16	16	101	RED	K116-4	5	DS52-2	SOLDER
X101BB16A	16	92	BLK	S101-12	9	J2-M	SOLDER
X102BB16B	16	92	BLK	S101-23	9	J2-K	SOLDER
X103BB16C	16	92	BLK	S101-14	9	J2-L	SOLDER
X104BB16A	16	45	BLK	A107-V1	6	J2-R	SOLDER
X104BC16A	16	29	BLK	A107-V1	6	T103-2	6
X105BB16B	16	45	BLK	A107-V2	6	J2-S	SOLDER
X105BC16B	16	29	BLK	A107-V2	6	T103-3	6
X106BB16C	16	55	BLK	TB30-6	6	J2-T	SOLDER
X106BC16C	16	29	BLK	A107-V3	6	T103-4	6
X110BB16N	16	55	BLK	TB30-5	6	J2-U	SOLDER
X110BC16N	16	34	BLK	TB30-5	6	A107-N2	6
X110BD16N	16	25	BLK	A107-N3	6	T103-1	6
X110BE16N	16	27	BLK	TB30-5	6	A103-2	6
X106BD16C	16	39	BLK	TB30-6	6	A107-V3	6
X106BE16C	16	32	BLK	TB30-6	6	A103-1	6
X106BF16C	16	57	BLK	A103-1	6	K115-2	5
X106BG16C	16	24	BLK	K115-2	5	K116-2	5
X110BF16N	16	55	BLK	A103-2	6	K115-1	5
X110BG16N	16	26	BLK	K115-1	5	K116-1	5
X114BB16	16	46	BLK	A107-L1	6	J2-D	SOLDER
X115BB16	16	45	BLK	A107-L2	6	J2-E	SOLDER
X116BB16	16	44	BLK	A107-L3	6	J2-F	SOLDER
X117BB16	16	11	BLK	S102-21	9	M102-(-)	8
X117BC16	16	102	BLK	M102-(-)	8	J2-G	SOLDER
X127BB16	16	104	BLK	M110-2	7	J2-a	SOLDER
X150BB16A	16	93	BLK	S101-16	9	J2-J	SOLDER
X151BB16B	16	93	BLK	S101-27	9	J2-I	SOLDER
X152BB16C	16	93	BLK	S101-18	9	J2-H	SOLDER
X160BB16	16	128	BLK	M110-1	7	J2-b	SOLDER
P214CB16	16	74	RED	S13-6	5	TB30-18	6
P200BB16	16	58	RED	TB6-28	6	J4-f	SOLDER
P220BC16	16	96	RED	TB6-21	6	TB7-1	6
P201BB16	16	50	RED	TB6-36	6	J1-A	SOLDER
P221BC16	16	90	RED	TB6-14	6	TB7-2	6
P202BB16	16	50	RED	TB6-37	6	J1-B	SOLDER
P222BC16	16	90	RED	TB6-13	6	TB7-3	6
P203BB16	16	51	RED	TB6-34	6	J1-C	SOLDER
P223BC16	16	90	RED	TB6-4	6	TB7-4	6
P204BB16	16	52	RED	TB6-32	6	J1-D	SOLDER
P224BC16	16	90	RED	TB6-6	6	TB7-5	6
P205BB16	16	52	RED	TB6-31	6	J1-E	SOLDER
P225BC16	16	113	RED	TB6-25	6	TB8-1	6
P206BB16	16	52	RED	TB6-29	6	J1-F	SOLDER
P226BC16	16	107	RED	TB6-19	6	TB8-2	6
P207BB16	16	52	RED	TB6-30	6	J1-G	SOLDER
P227BC16	16	111	RED	TB6-27	6	TB8-3	6
P208BB16	16	51	RED	TB6-33	6	J1-H	SOLDER
P230BC16	16	101	RED	TB6-3	6	TB8-4	6
P209BB16	16	51	RED	TB6-35	6	J1-J	SOLDER
P229BC16	16	101	RED	TB6-1	6	TB8-5	6
P214BB16	16	44	RED	TB6-9	6	J4-d	SOLDER
P41BJ16	16	101	RED	TB30-14	5	S13-8	5
P41BK16	16	14	RED	S13-8	5	S12-1	5
P41BM16	16	35	RED	TB30-14	6	TB6-10	6
P41BP16	16	9	RED	TB6-10	6	TB6-18	6
P212BB16	16	110	RED	TB6-22	6	S13-4	5
P213BB16	16	104	RED	TB6-17	6	S13-5	5
P214AB16	16	98	RED	S13-6	5	TB6-9	6
P215BB16	16	48	RED	TB6-16	6	A1-1	12
P216BB16	16	34	RED	TB6-15	6	TB30-19	6
P216BC16	16	103	RED	TB6-15	6	S13-1	5
P217BB16	16	95	RED	S12-2	5	TB6-11	6
L218BB16	16	14	RED	S13-2	5	TB8-7	6
P228BB16	16	118	RED	S14-2	5	J4-X	SOLDER
P41BG16	16	104	RED	TB6-18	6	S13-3	5
P231B16	16	17	RED	TB30-20	6	FC1-1	9
D330BB16	16	14	BLK	S101-11	9	M101-(+)	8
D331BB16	16	13	BLK	S101-21	9	M101-(-)	8
D332BB16	16	30	BLK	S102-11	9	M102-(+)	8
D334BB16	16	67	BLK	A103-(+)	5	M103-(+)	8
D335BB16	16	67	BLK	A103-(-)	5	M103-(-)	8
D336BB16	16	86	BLK	A107-(+)	6	M107-(+)	8
D337BB16	16	82	BLK	A107-(-)	6	M107-(-)	8
D338BB16	16	96	BLK	A108-(+)	6	M108-(+)	8
D339BB16	16	95	BLK	A108-(-)	6	M108-(-)	8
D340BB16	16	24	BLK	A107-S1	6	A108-L1	6
D341BB16	16	24	BLK	A107-S2	6	A108-L2	6
D342BB16	16	24	BLK	A107-S3	6	A108-L3	6
D343BB16	16	15	BLK	T103-5	6	A108-V1	6
D344BB16	16	15	BLK	T103-7	6	A108-V2	6
D345BB16	16	15	BLK	T103-9	6	A108-V3	6
D346BB16	16	75	BLK	A108-S1	6	S102-22	9
D347BB16	16	76	BLK	A108-S2	6	S102-23	9
D348BB16	16	77	BLK	A108-S3	6	S102-24	9
D356BB16	16	17	BLK	T103-8	6	A108-N2	6
D357BB16	16	17	BLK	T103-6	6	A108-N1	6
D358BB16	16	16	BLK	T103-10	6	A108-N3	6
R400AA16	16	105	BLK	J2-c	SOLDER	J110-1	SOLDER
R401AA16	16	105	BLK	J2-d	SOLDER	J110-2	SOLDER
JUMPER	16	8	-	A107-N1	6	A107-N2	6
P210BC16	16	46	RED	J1-P	SOLDER	TB30-17	6
P215BC16	16	102	RED	TB6-16	6	S13-15	5
JUMPER	16	8	-	TB30-13	6	GND STUD	5
P402AA16	16	49	RED	S2-1	5	DS50-3	SOLDER
P402AB16	16	51	RED	DS50-3	SOLDER	DS51-3	SOLDER
P402AC16	16	60	RED	DS51-3	SOLDER	DS6-3	SOLDER
P402AD16	16	65	RED	DS6-3	SOLDER	DS7-3	SOLDER
P402AE16	16	65	RED	DS7-3	SOLDER	DS52-3	SOLDER
JUMPER	16	7	-	A107-N1	6	A107-N3	6
P210BB16	16	86	RED	TB30-17	6	S13-9	5
P41BT16	16	9	RED	TB30-14	6	TB30-8	6

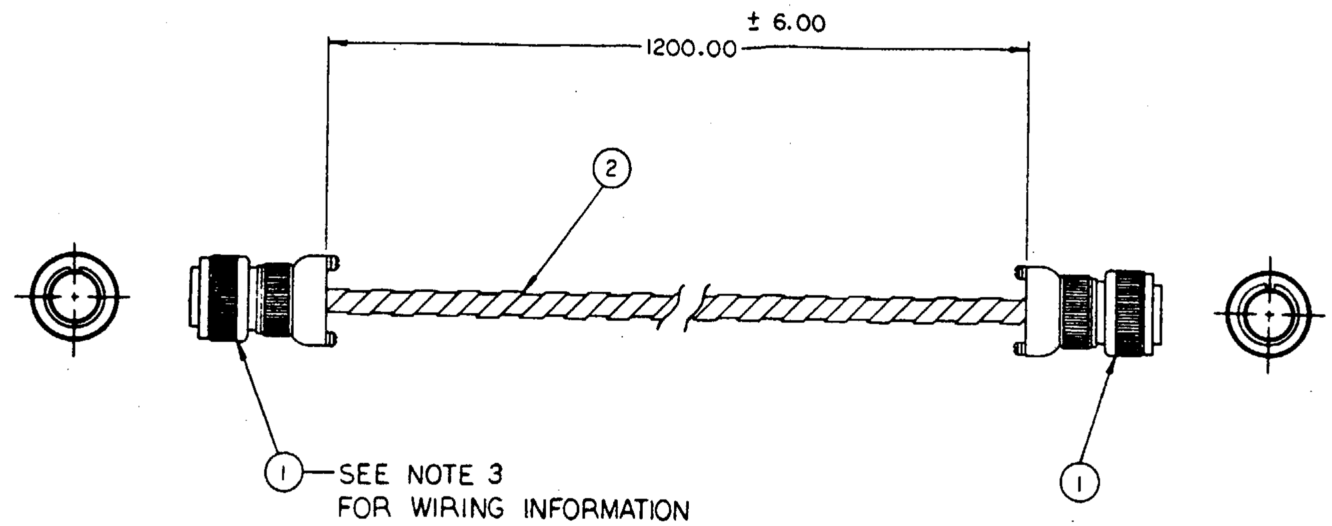
FO-28. Remote Control Box Harness Assembly (Sheet 2 of 4)



FO-29. Remote Control Box Harness Assembly (Sheet 3 of 4)



FO-30. Remote Control Box Harness Assembly (Sheet 4 of 4)
FP-59/(FP-60 blank)



NOTES:

1. MARK ITEM PER MIL-STD-130.

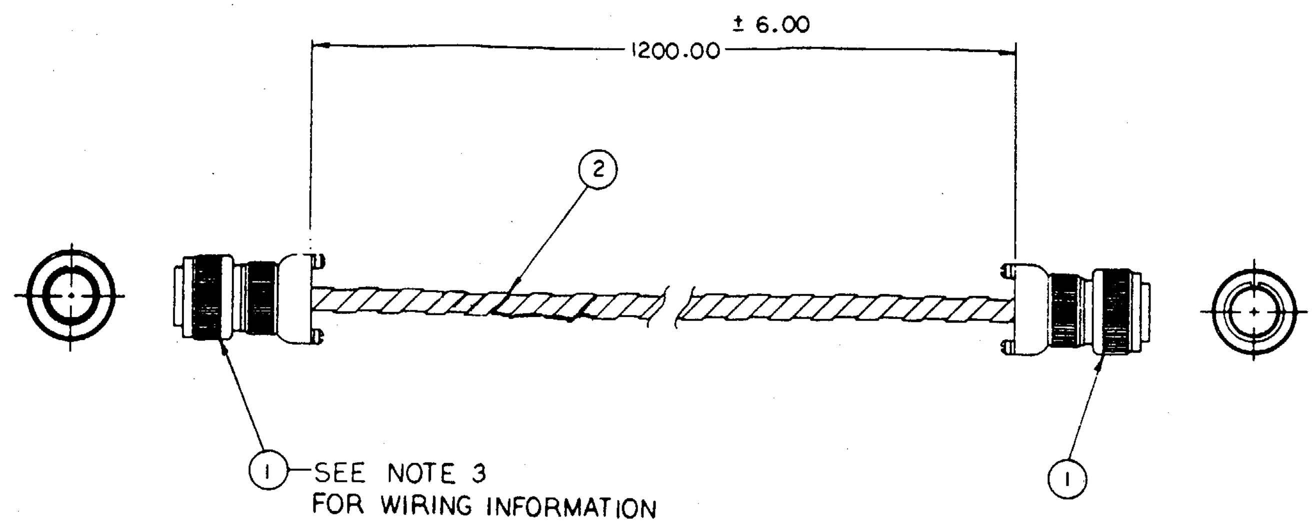
2. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

3. WIRING TERMINATION: BLACK WIRE TO PIN "A" ON BOTH CONNECTORS WHITE WIRE TO PIN "B" ON BOTH CONNECTORS & SHIELD TO PIN "C" ON ONE CONNECTOR ONLY.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
3				SN60WRAP2	AR	SOLDER	QQ-S-571	SEE NOTE 2
2				76-11253	1	CABLE, SHIELDED		
1			B	MS3106RIOSL-3P	2	CONNECTOR, PLUG, ELEC		

LIST OF MATERIALS

FO-31. Paralleling Cables, Governor Control



NOTES:

1. MARK ITEM PER MIL-STD-130.

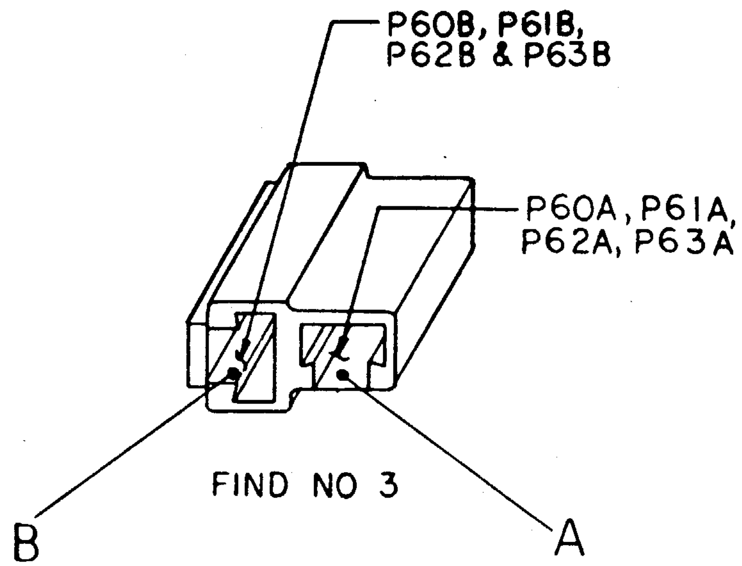
2. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

3. WIRING TERMINATION: BLACK WIRE TO PIN "A" ON BOTH CONNECTORS WHITE WIRE TO PIN "B" ON BOTH CONNECTORS.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
3				SN60WRAP2	AR	SOLDER	QQ-S-571	SEE NOTE 2
2			B	76-11253	1	CABLE, SHIELDED		
1				MS3106R12S-3P	2	CONNECTOR		

LIST OF MATERIALS

FO-32. Paralleling Cables, Voltage Regulator



NOTES:

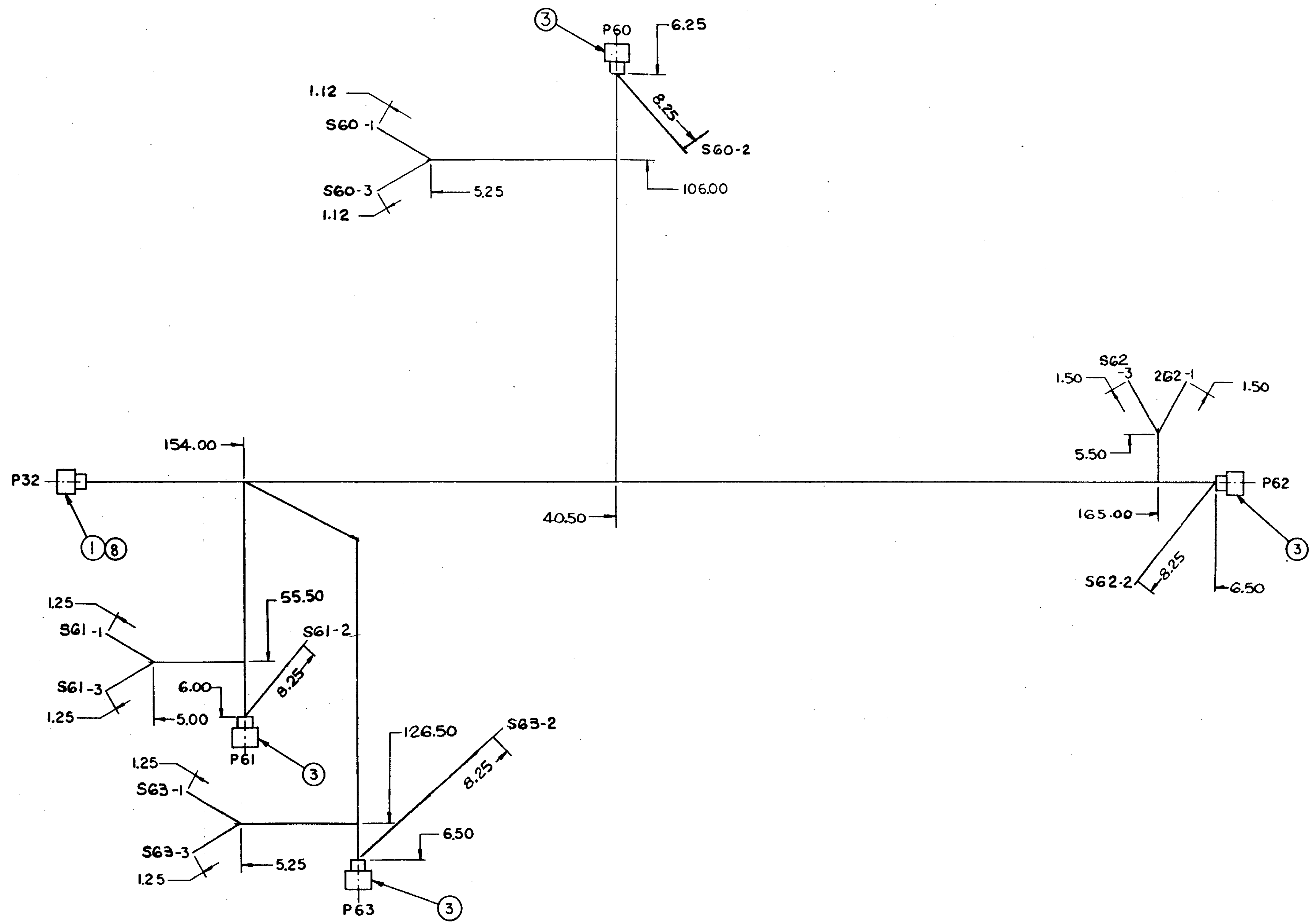
1. ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS FIND NO. 4 LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
2. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
3. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED THREE INCHES.
4. FOR WIRING INFORMATION SEE FO-11, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.
5. INSTALL NYLON FILLER PLUGS (8) IN UNUSED OPENINGS OF CONNECTOR BUSHING.
6. DESIGNATORS A & B DO NOT APPEAR ON PART REFER TO FIND NO. 3 FOR ORIENTATION OF PLUG ENDS.

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P187B16	16	378.00	RED	P32-L	SOLDER	S63-3	2
P188B16	16	378.00	RED	P32-M	SOLDER	S63-1	2
P190B16	16	300.00	RED	P32-A	SOLDER	P60-A	7
P191B16	16	300.00	RED	P32-B	SOLDER	S60-3	2
P192B16	16	300.00	RED	P32-C	SOLDER	S60-1	2
P193B16	16	228.00	RED	P32-D	SOLDER	P61-A	7
P194B16	16	228.00	RED	P32-E	SOLDER	S61-3	2
P195B16	16	228.00	RED	P32-F	SOLDER	S61-1	2
P196B16	16	366.00	RED	P32-G	SOLDER	P62-A	7
P197B16	16	366.00	RED	P32-H	SOLDER	S62-3	2
P198B16	16	366.00	RED	P32-J	SOLDER	S62-1	2
P199B16	16	378.00	RED	P32-K	SOLDER	P63-A	7
P460A16	16	8.00	RED	S60-2	2	P60-B	7
P461A16	16	8.00	RED	S61-2	2	P61-B	7
P462A16	16	8.00	RED	S62-2	2	P62-B	7
P463A16	16	8.00	RED	S63-2	2	P63-B	7

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
8				MS25251-16	5	PLUG, END SEAL		
7			B	76-11010	8	TERMINAL		
6				SN60WRAP2	AR	SOLDER	QQ-S-571	SEE NOTE 2
5				M5086/2-16-9	AR	WIRE, 16 AN, COLOR, WHITE		
4				MS3367-4-9	AR	STRAP, SELF-LOCKING		
3			B	76-11443	4	CONNECTOR		
2				MS25036-107	12	TERMINAL LUG		
1				MS3106R20-29P	1	CONNECTOR,PLUG,ELEC		

LIST OF MATERIALS

FO-33. Louver Harness Assembly (Sheet 1 of 2)



FO-34. Louver Harness Assembly (sheet 2 of 2)

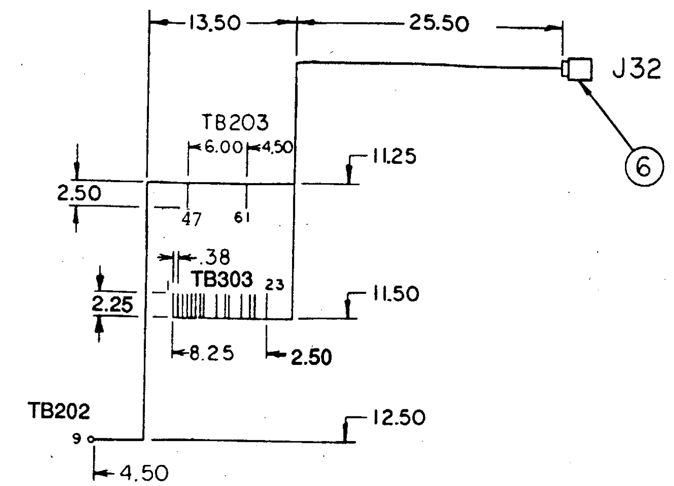
NOTES:

1. ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS FIND NO. 5 LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

2. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

3. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED THREE INCHES.

4. FOR WIRING INFORMATION SEE FO-6, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.



FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
8				M5086/2-12-9	AR	WIRE AWG #12	MIL-W-5086/2	
7			B	71-4924	3	TERMINAL LUG	MIL-T-7928	
6				MS3102R-20-29S	1	CONNECTOR		
5				MS3367-1-9	AR	TIE WRAP		
4				SN60WRAP 2	AR	SOLDER	QQ-S-571	SEE NOTE 2
3				M5086/2-16-9	AR	WIRE AWG #16	MIL-W-5086/2	
2				MS25036-106	14	TERMINAL LUG	MIL-T-7928	
1				MS25036-157	1	TERMINAL LUG	MIL-T-7928	

LIST OF MATERIALS

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P190A16	16	63.00	RED	TB303-1	2	J32-A	SOLDER
P191A16	16	63.00	RED	TB303-2	2	J32-B	SOLDER
P192A16	16	62.00	RED	TB303-5	2	J32-C	SOLDER
P193A16	16	62.00	RED	TB303-7	2	J32-D	SOLDER
P194A16	16	62.00	RED	TB303-8	2	J32-E	SOLDER
P195A16	16	60.00	RED	TB303-11	2	J32-F	SOLDER
P196A16	16	59.00	RED	TB303-13	2	J32-G	SOLDER
P197A16	16	59.00	RED	TB303-14	2	J32-H	SOLDER
P198A16	16	58.00	RED	TB303-17	2	J32-J	SOLDER
P199A16	16	58.00	RED	TB303-19	2	J32-K	SOLDER
P187A16	16	58.00	RED	TB303-20	2	J32-L	SOLDER
P188A16	16	56.00	RED	TB303-23	2	J32-M	SOLDER
P140CR12	12	65.00	RED	TB303-4	7	TB202-9	1
P56N16	16	37.00	RED	TB303-3	2	TB203-47	2
P55BA12	12	32.00	RED	TB303-6	7	TB203-61	7

FO-35. Louver Control Harness (External Power Box)

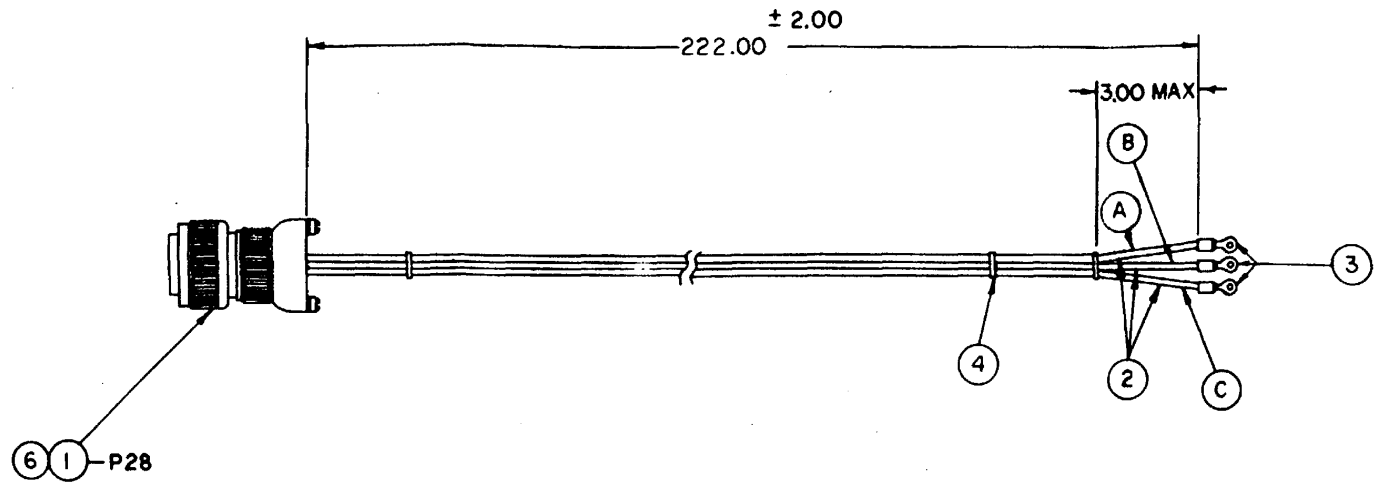


TABLE * 1

WIRE NO.	LETTER DES	FROM	END PREP	TO	END PREP	MKG COLOR
X157B6A	A	P28-A	SOLDER	B102-T1	3	BLACK
X158B6B	B	P28-B	SOLDER	B102-T2	3	BLACK
X159B6C	C	P28-C	SOLDER	B102-T3	3	BLACK

NOTES:

1. WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS FIND NO. 4 LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

2. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

3. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED THREE INCHES. SEE TABLE #1 FOR WIRE NUMBERING INFORMATION.

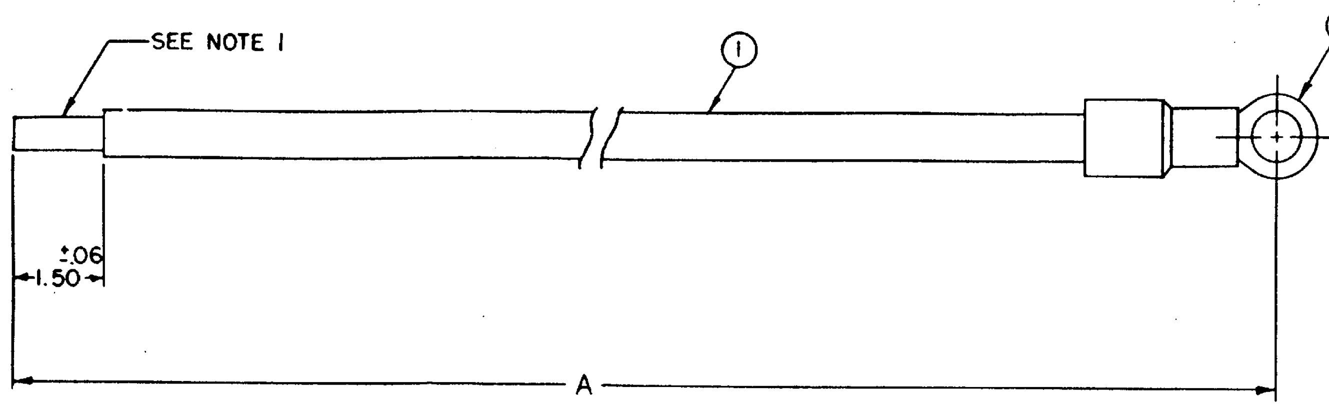
4. FOR WIRING INFORMATION SEE FO-11, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

5. INSTALL NYLON FILLER PLUGS (6) IN UNUSED OPENINGS OF CONNECTOR BUSHING.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
6			B	76-11112	1	PLUG, END SEAL		
5				SN60WRAP2	AR	SOLDER	QQ-S-571	SEE NOTE 2
4				MS3367-1-9	66	STRAP, SELF-LOCKING	MIL-S-23190	
3				MS25036-119	3	TERMINAL, LUG	MIL-T-7928	
2				M5086/2-6-9	AR	WIRE, AWG #6	MIL-W-5086-2	
1				MS3106R32-17P	1	CONNECTOR, PLUG ELEC	MIL-C-5015D	

LIST OF MATERIALS

FO-36. Auxiliary Power Harness



NOTES:

1. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

2. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN WIRE NUMBERS SHALL NOT EXCEED THREE INCHES.
FOR WIRE NUMBERING INFORMATION SEE TABLE #1
76-11434-1 WIRE NUMBERS ARE TO APPEAR IN BLACK
76-11434-2 WIRE NUMBERS ARE TO APPEAR IN BLACK
76-11434-3 WIRE NUMBERS ARE TO APPEAR IN RED

3. SEE FO-6, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL FOR EXTERNAL PWR BOX WIRING DIAG.

TABLE *1

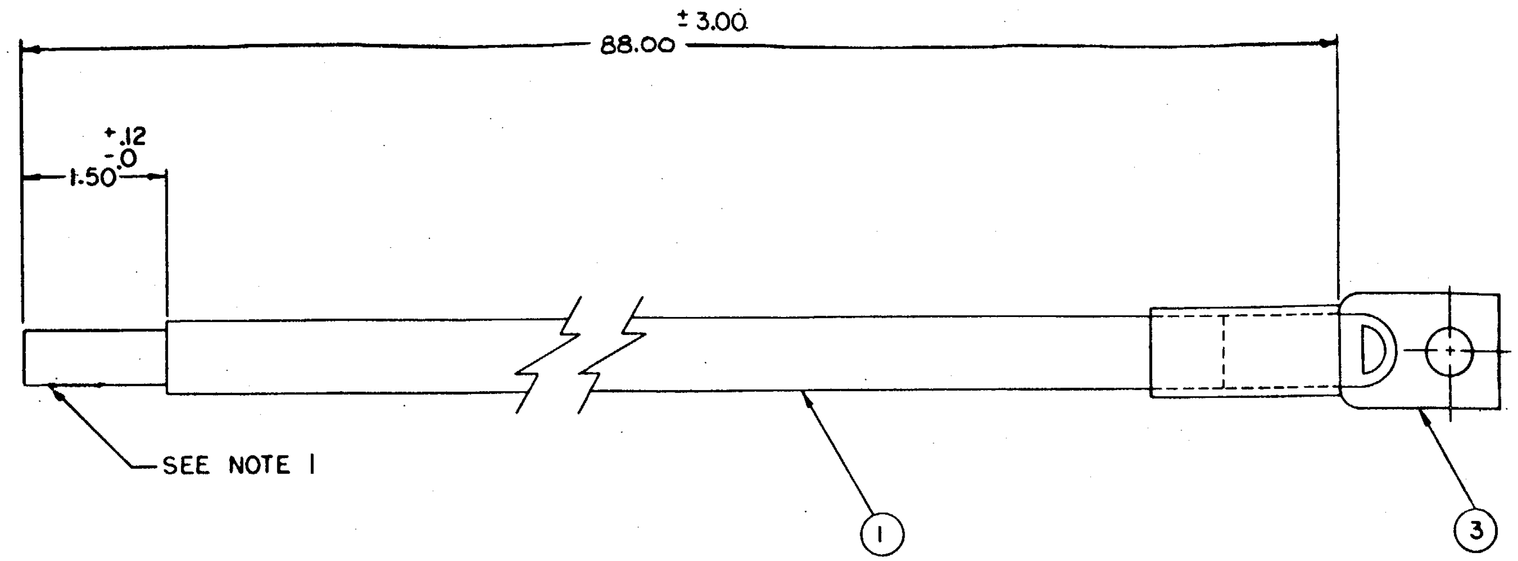
	PART NO.	A DIMENSION	WIRE NO.	FROM	END PREP	TO	END PREP
	76-11434-1	60.00 ± 1.00	X110GS1/ON	GND TERM R	2	NEUT	SOLDER
3	76-11434-2	240.00 ± 3.00	X110GT1/ON	GND TERM L	2	NEUT	SOLDER
4	76-11434-3	120.00 ± 2.00	P55NG1/ON	GND TERM	SOLDER	ENG GND	2

4. SEE FO-11, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL

QTY REQD 1 DASH	QTY REQD 2 DASH	QTY REQD 3 DASH	FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
AR	AR	AR	3				SN60WRAP2	SOLDER	QQ-S-517	SEE NOTE 1
1	1	1	2				MS25036-134	TERMINAL LUG	MIL-T-7928	
AR	AR	AR	1				M5086/2-01-9	WIRE AWG #1/0	MIL-W-5086/2	

LIST OF MATERIALS

FO-37. Electrical Cable Assembly



NOTES:

1. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

2. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT LENGTH BETWEEN WIRE NUMBERS SHALL NOT EXCEED THREE INCHES. FOR WIRE NUMBERING INFORMATION SEE TABLE #1.

3. FOR WIRING INFORMATION SEE FO-6, FO-10, AND FO-11, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

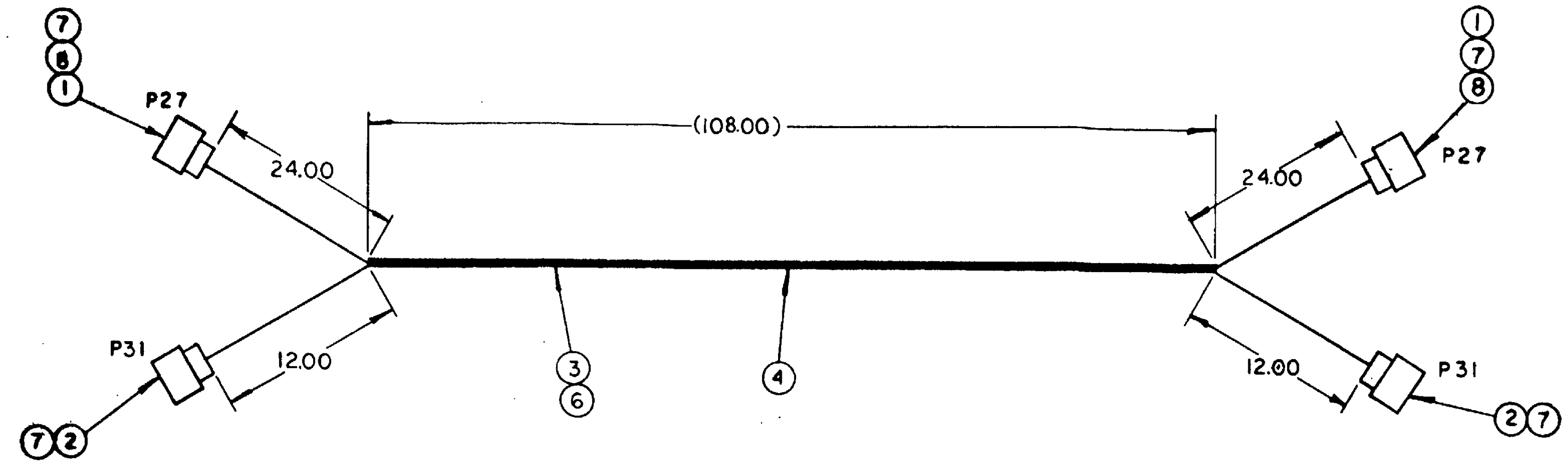
TABLE #1.

WIRE NO.	LENGTH	FROM	END PREP	TO	END PREP	COLOR	PART NO.
X110PN04N		TB101-T12	3	NEUT	SOLDER	BLACK	76-11432-01
X110PR04N		TB101-T11	3	NEUT	SOLDER	BLACK	76-11432-02
X110PS04N		TB101-T10	3	NEUT	SOLDER	BLACK	76-11432-03
X110PP04N		TB101-T11	3	NEUT	SOLDER	BLACK	76-11432-04
X110PT04N		TB101-T10	3	NEUT	SOLDER	BLACK	76-11432-05

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
3				MS25036-140	1	TERMINAL LUG	MIL-T-7928	
2				SN60WRAP2	AR	SOLDER	QQ-S-571	SEE NOTE 1
1				M5086/2-04-9	AR	POWER WIRE AWG #4/0	MIL-W-5086/2	

LIST OF MATERIALS

FO-38. AC Neutral Power Cable



NOTES:

1. WIRES SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING STRAPS, FIND NO. 4, LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED 6 INCHES.
2. SOLDERING SHALL BE DONE IN ACCORDANCE WITH REQ 5 OF MIL-STD-454.
3. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED 6 INCHES.
4. INSTALL NYLON FILLER PLUGS (7 & 8) IN UNUSED OPENINGS OF CONNECTOR BUSHING.
5. SEE FO-6, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.
6. SEE FO-5, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

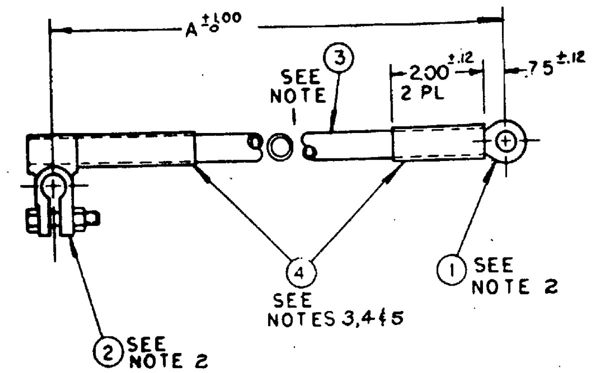
WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	LUG	TO	LUG
P55CC12N	12	156	RED	P27-P	SOLDER	P27-P	SOLDER
P140CC12	12	156	RED	P27-R	SOLDER	P27-R	SOLDER
P62CC16	16	156	RED	P31-W	SOLDER	P31-W	SOLDER
X101CC16A	16	156	BLACK	P27-A	SOLDER	P27-A	SOLDER
X102CC16B	16	156	BLACK	P27-B	SOLDER	P27-B	SOLDER
X103CC16C	16	156	BLACK	P27-C	SOLDER	P27-C	SOLDER
X104CC16A	16	156	BLACK	P27-D	SOLDER	P27-D	SOLDER
X105CC16B	16	156	BLACK	P27-E	SOLDER	P27-E	SOLDER
X106CC16C	16	156	BLACK	P27-F	SOLDER	P27-F	SOLDER
X107CC16	16	156	BLACK	P27-G	SOLDER	P27-G	SOLDER
X108CC16	16	156	BLACK	P27-H	SOLDER	P27-H	SOLDER
X109CC16	16	156	BLACK	P27-J	SOLDER	P27-J	SOLDER
X110CC12N	12	156	BLACK	P27-T	SOLDER	P27-T	SOLDER
X111CC16	16	156	BLACK	P27-K	SOLDER	P27-K	SOLDER
X112CC16	16	156	BLACK	P27-L	SOLDER	P27-L	SOLDER
X113CC16	16	156	BLACK	P27-M	SOLDER	P27-M	SOLDER
X114CC16	16	156	BLACK	P27-N	SOLDER	P27-N	SOLDER
X115CC16	16	156	BLACK	P27-W	SOLDER	P27-W	SOLDER
X116CC16	16	156	BLACK	P27-X	SOLDER	P27-X	SOLDER
X117CC16	16	156	BLACK	P27-Y	SOLDER	P27-Y	SOLDER
X118CC16	16	156	BLACK	P27-Z	SOLDER	P27-Z	SOLDER
X119CC16	16	156	BLACK	P27-a	SOLDER	P27-a	SOLDER
X120CC16	16	156	BLACK	P27-b	SOLDER	P27-b	SOLDER
X121CC16	16	156	BLACK	P27-c	SOLDER	P27-c	SOLDER
X122CC16	16	156	BLACK	P27-d	SOLDER	P27-d	SOLDER
X123CC16	16	156	BLACK	P27-e	SOLDER	P27-e	SOLDER
X124CC16	16	156	BLACK	P27-f	SOLDER	P27-f	SOLDER
X125CC16	16	156	BLACK	P27-g	SOLDER	P27-g	SOLDER
X126CC16	16	156	BLACK	P27-h	SOLDER	P27-h	SOLDER
X127CC16	16	156	BLACK	P27-j	SOLDER	P27-j	SOLDER
X128CC16	16	156	BLACK	P27-k	SOLDER	P27-k	SOLDER
D131CC16	16	132	BLACK	P31-A	SOLDER	P31-A	SOLDER
D137CC16	16	132	BLACK	P31-B	SOLDER	P31-B	SOLDER
D133CC16	16	132	BLACK	P31-C	SOLDER	P31-C	SOLDER
D130CC16	16	132	BLACK	P31-Z	SOLDER	P31-Z	SOLDER

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	LUG	TO	LUG
D134CC16	16	132	BLACK	P31-D	SOLDER	P31-D	SOLDER
X180CC16	16	132	BLACK	P31-H	SOLDER	P31-H	SOLDER
X181CC16	16	132	BLACK	P31-J	SOLDER	P31-J	SOLDER
X182CC12	12	156	BLACK	P27-U	SOLDER	P27-U	SOLDER
X183CC12	12	156	BLACK	P27-V	SOLDER	P27-V	SOLDER
X360CC16	16	132	BLACK	P31-K	SOLDER	P31-K	SOLDER
X361CC16	16	132	BLACK	P31-L	SOLDER	P31-L	SOLDER
P61CC16	16	132	RED	P31-M	SOLDER	P31-M	SOLDER
P59CC16	16	132	RED	P31-N	SOLDER	P31-N	SOLDER
P56CC16	16	132	RED	P31-X	SOLDER	P31-X	SOLDER
X369B16	16	132	BLACK	P31-R	SOLDER	P31-R	SOLDER
X370B16	16	132	BLACK	P31-S	SOLDER	P31-S	SOLDER
X304CC16	16	132	BLACK	P31-T	SOLDER	P31-T	SOLDER
P41PB16	16	156	RED	J27-O	SOLDER	J27-O	SOLDER
P99PC16	16	156	RED	J27-S	SOLDER	J27-S	SOLDER

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
8				MS25251-12	4	PLUG, END, SEAL		
7				MS25251-16	8	PLUG, END, SEAL		
6				M5086/2-12-9	AR	WIRE, AWG #12, WHITE	MIL-W-5086/2	
5				SN60WRAP2	AR	SOLDER	QQ-S-571	SEE NOTE 2
4				MS3367-1-9	AR	STRAP, SELF-LOCKING		
3				M5086/2-16-9	AR	WIRE, AWG #16, WHITE	MIL-W-5086/2	
2				MS3106R24-28P	2	CONNECTOR, PLUG, ELEC		
1				MS3106R32-7P	2	CONNECTOR, PLUG, ELEC		

LIST OF MATERIALS

FO-39. AC-DC Control Cable Assembly



TABULATION		
PART NO.	DIM "A"	MARKINGS
76-11422-01	91.00	P140XX
76-11422-02	101.00	P140H

NOTES:

1. STRIP INSULATION FROM ENDS OF WIRE (FIND NO. 3) .62 LONG AT FIND NO. 1 AND .75 LONG AT FIND NO. 2

2. CRIMP TERMINALS (FIND NO 1 AND 2) ON TO CABLE. ORIENT TERMINALS IN POSITION SHOWN.

3. AFTER PLACING INSULATION (ITEM 4) ON CABLE (FIND NO. 3) APPLY HEAT OF 400 DEGREES F FOR 3-5 SECONDS TO OBTAIN PROPER SHRINKAGE.

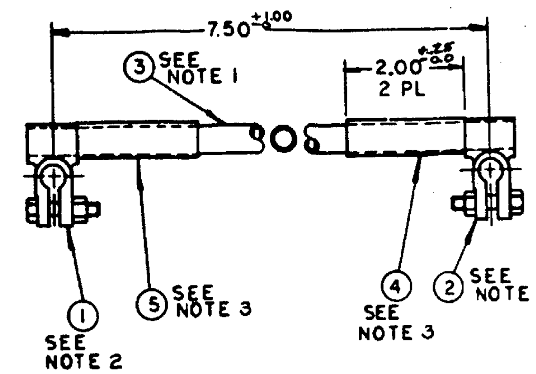
4. MARK ITEM PER MIL-STD-130.

5. STAMP MARKINGS, PER TABLE, ON INSULATION (ITEM 4) USE WHITE EPOXY PER DWG 70-1316.

6. FOR WIRING INFORMATION SEE FO-3, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
4				CLASS I	2	INSUL, SLEEV, 1.50 ID, RED	MIL-1-23053/5	
3				M5756-04	AR	WIRE, ELECTRICAL 4/0	MIL-C-5756B	
2			B	76-11294-01	1	TERM, LUG, BATTERY		
1				MS25036-141	1	TERMINAL, LUG		

LIST OF MATERIALS



PART NO.	76-11423

NOTES:

1. STRIP INSULATION .75 LONG FROM BOTH ENDS OF CABLE (FIND NO. 3).

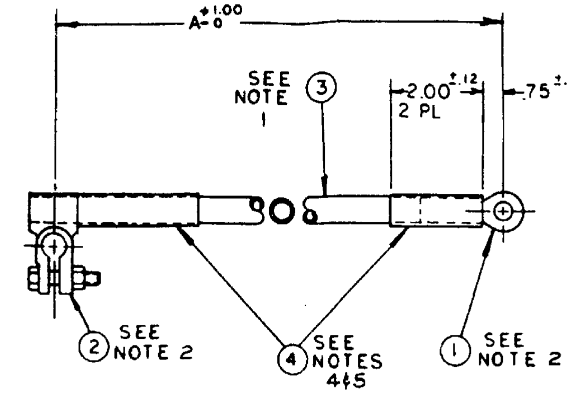
2. CRIMP TERMINALS (FIND NOS 1 & 2) ONTO CABLES. ORIENT TERMINALS IN POSITION SHOWN.

3. BEFORE INSTALLING FIND NOS 1 & 2, PLACE INSULATION (FIND NOS 4 & 5) ON CABLE (FIND NO. 3). AFTER INSTALLING FIND NOS 1 & 2, POSITION FIND NOS 4 & 5 AS SHOWN AND APPLY HEAT OF 400 DEGREES F FOR 3-5 SECONDS TO OBTAIN PROPER SHRINKAGE.

4. MARK ITEM PER MIL-STD-130.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
5				CLASS I	1	INSUL, SLEEV, 1.50 ID, BLK	MIL-1-23053/5	
4				CLASS I	1	INSUL, SLEEV, 1.50 ID, RED	MIL-1-23053/5	
3				M5756-04	A/R	WIRE, ELECTRICAL, 4/0	MIL-C-5756B	
2			B	76-11294-01	1	TERM, LUG BATTERY, POS		
1			B	76-11294-02	1	TERM, LUG BATTERY, NEG		

LIST OF MATERIALS



TABULATION		
PART NO.	DIM "A"	MARKINGS
76-11424-01	81.00	P55XX
76-11424-02	96.00	P55YY

NOTES:

1. STRIP INSULATION FROM ENDS OF WIRE (FIND NO. 3), .62 LONG AT FIND NO. 1 AND .75 LONG AT FIND NO. 2.

2. CRIMP TERMINALS (FIND NO. 1 AND 2) ONTO CABLE. ORIENT TERMINALS IN POSITION SHOWN.

3. AFTER PLACING INSULATION (ITEM 4) ON CABLE (ITEM 3), APPLY HEAT OF 400 DEGREES F FOR 3-5 SECONDS TO OBTAIN PROPER SHRINKAGE.

4. MARK ITEM PER MIL-STD-130.

5. STAMP MARKINGS, PER TABLE, ON INSULATION (ITEM 4). USE WHITE EPOXY INK PER DWG 70-1316.

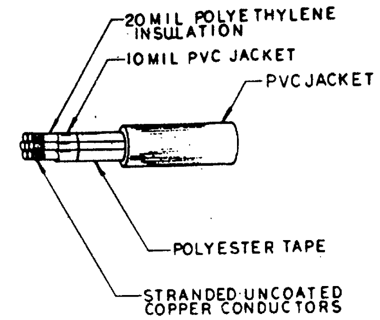
6. FOR WIRING INFORMATION SEE FO-3, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

FIND NO	SYM	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
4				CLASS I	2	INSUL, SLEEVING, 1.50 ID, BLK	MIL-1-23053/5	
3				M5756-04	A/R	WIRE, ELECTRICAL, 4/0	MIL-C-5756B	
2			B	76-11294-02	1	TERM LUG BATTERY		
1				MS25036-141	1	TERMINAL LUG		

LIST OF MATERIALS

FO-40. Battery Cables

SUGGESTED SOURCE OF SUPPLY	
VENDOR PIN	VENDOR
DTC CONTROL CABLE SPECIAL SEE NOTE 4	DELCO WIRE & CABLE CO. 257-269 RITTENHOUSE CIRCLE KEYSTONE INDUSTRIAL PARK, BRISTOL, PA 19007 CODEIDENT 54387
CT-B SPEC 3005-25-14 CONTROL CABLE SEE NOTE 4	CYPRUS WIRE & CABLE CO. PO BOX 2332-60 NEW YORK AVE. FRAMINGHAM, MASS. 01701

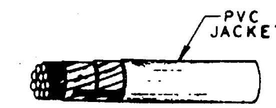


CT B SPEC 3005 CABLE: WIRE SIZE: AWG #14 7 STRAND AT .0242
CABLE DIM: .99 NOM. DIA., - 605 #/1,000 FT
(VENDOR-CYPRUS)

NOTES:

1. DTC CONTROL CABLE: SPECIFICATIONS:
   A) COPPER CONDUCTOR STRANDED 90 DEGREES C HEAT RESISTANT PVC INSULATION, COLOR CODED.
   B) CLEAR EXTRUDED NYLON JACKET.
   C) NON-HYGROSCOPIC SEPARATOR OVER CABLED CONDUCTORS.
   D) 90 DEGREES C ABRASION RESISTANT PVC JACKET.
   E) OIL AND CHEMICAL RESISTANT, RESIST OIL, GREASES, ALCOHOL, DILUTE ACIDS, ALKALIS, AND PETROLEUM SOLVENTS.
   F) FULLY COLOR CODED.
2. WIRE SIZE: AWG #14-19 STRAND AT .0147
   CABLE DIM: .90 NOM DIA-500 #11,000 FT
   (VENDOR-DELCO)
3. MULTIPLE CONDUCTOR CABLE 600 VOLT 90 DEGREES C RATED WIRE.
4. EACH CONDUCTOR MUST BE INDIVIDUALLY DISTINGUISHABLE ONE FROM ANOTHER. USING COLORS PER TABLE 5.1 OF IPCEA SPEC S61-402 DATED SEPT 1973 USE FIRST 25 COLORS ONLY.
5. MARK PER MIL STD 130.

SUGGESTED SOURCE OF SUPPLY	
VENDOR PIN	VENDOR
LG 443460	TRIANGLE WIRE & CABLE CO. PO BOX 711 NEW BRUNSWICK, NJ CODE IDENT 78799
SPEC 3005-37-14 TYPE CT-B	CYPRUS WIRE & CABLE CO. PO BOX 2332 60 NEW YORK AVE. FRAMINGHAM, MASS. CODE IDENT



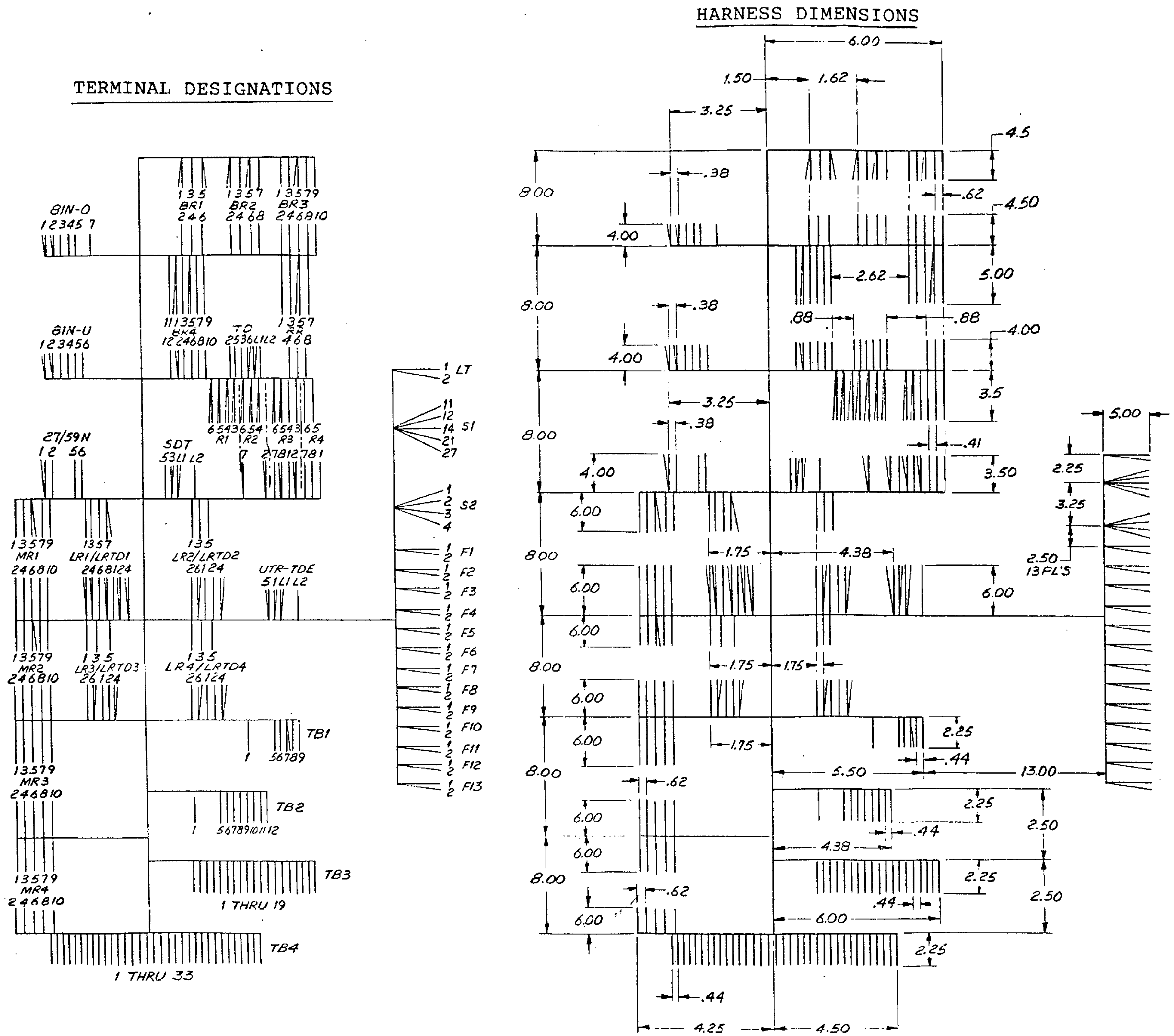
WIRE NO.	CONDUCTOR COLOR CODE
ONE	BLK
TWO	WHT
THREE	RED
FOUR	GRN
FIVE	ORN
SIX	BLUE
SEVEN	WHT BLK TR
EIGHT	RED BLK TR
NINE	GRN BLK TR
TEN	ORN BLK TR
ELEVEN	BLUE BLK TR
TWELVE	BLK WHT TR
THIRTEEN	RED WHT TR
FOURTEEN	GRN WHT TR
FIFTEEN	BLUE WHT TR
SIXTEEN	BLK RED TR
SEVENTEEN	WHT RED TR
EIGHTEEN	ORN RED TR
NINETEEN	BLUE RED TR
TWENTY	RED GRN TR
TWENTY-ONE	ORN GRN TR
TWENTY-TWO	BLK
TWENTY-THREE	WHT
TWENTY-FOUR	RED
TWENTY-FIVE	GRN
TWENTY-SIX	ORN
TWENTY-SEVEN	BLUE
TWENTY-EIGHT	WHT BLK TR
TWENTY-NINE	RED BLK TR
THIRTY	GRN BLK TR

WIRE NO.	CONDUCTOR COLOR CODE
THIRTY-ONE	ORN BLK TR
THIRTY-TWO	BLUE BLK TR
THIRTY-THREE	BLK WHT TR
THIRTY-FOUR	RED WHT TR
THIRTY-FIVE	GRN WHT TR
THIRTY-SIX	BLUE WHT TR
THIRTY-SEVEN	BLK RED TR

NOTES:

1. COLOR CODING OF CABLE: SEE TABLE FOR NUMBERS AND COLOR OF EACH CONDUCTOR IN CABLE.
2. TRIANGLE PWC NA POWER & CONTROL TRAY CABLE, TYPE TC 90 DEGREES C, 600 V.
3. OIL AND CHEMICAL RESISTANT, ALCOHOL & ACID RESISTANT, ALKALIS RESISTANT, & WEATHER RESISTANT.

FO-41. Cables 25- and 37 -Conductor



NOTE:
FOR WIRING INFORMATION SEE FO-13, OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL.

FO-42. ACM Wiring Harness (Sheet 1 of 3)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
X100A	16	60	BLACK	LT-2	2	TB1-1	2
X100B	16	61	BLACK	TB1-5	2	BR3-5	2
X100C	16	24	BLACK	BR2-5	2	BR3-5	2
X100D	16	18	BLACK	BR1-5	2	BR2-5	2
X100E	16	28	BLACK	BR1-5	2	81NO-1	2
X100F	16	23	BLACK	BR4-5	2	81NO-1	2
X100G	16	31	BLACK	BR4-5	2	TD-L1	2
X100H	16	38	BLACK	RR-5	2	TD-L1	2
X100I	16	38	BLACK	81NU-1	2	RR-5	2
X100J	16	38	BLACK	81NU-1	2	27/59N-1	2
X100K	16	40	BLACK	27/59N-1	2	UTR-L1	2
X100L	16	38	BLACK	MR1-5	2	UTR-L1	2
X100M	16	35	BLACK	MR1-5	2	MR2-5	2
X100N	16	33	BLACK	MR2-5	2	MR3-5	2
X100O	16	35	BLACK	MR3-5	2	MR4-5	2
X101A	16	54	BLACK	F1-1	2	TB1-6	2
X102A	16	41	BLACK	81NO-7	2	27/59N-5	2
X103A	16	34	BLACK	81NO-5	2	81NU-6	2
X104A	16	27	BLACK	81NU-5	2	TD-L2	2
X105A	16	31	BLACK	TD-5	2	LR1-7	2
X105B	16	33	BLACK	UTR-1	2	LR1-7	2
X105C	16	34	BLACK	TB1-7	2	UTR-1	2
X105D	16	57	BLACK	S1-11	2	TB1-7	2
X105E	16	3	BLACK	S1-11	2	S1-21	2
X105F	16	17	BLACK	S1-21	2	LT-1	2
X106A	16	41	BLACK	RR-6	2	LR1-8	2
X106B	16	30	BLACK	TB1-8	2	LR1-8	2
X107A	16	57	BLACK	S1-12	2	TB1-9	2
X108A	16	40	BLACK	S1-27	2	UTR-L2	2
X109A	16	35	BLACK	S1-14	2	UTR-5	2
X109B	16	31	BLACK	TB2-1	2	UTR-5	2
X111A	16	56	BLACK	F1-2	2	27/59N-2	2
X111C	16	38	BLACK	81NU-2	2	27/59N-6	2
X111D	16	36	BLACK	81NO-2	2	81NU-2	2
X111E	16	35	BLACK	81NO-2	2	TD-3	2
X112A	16	66	BLACK	S2-3	2	81NU-4	2
X114A	16	72	BLACK	S2-1	2	81NU-3	2
X113A	16	67	BLACK	S2-4	2	81NO-4	2
X115A	16	73	BLACK	S2-2	2	81NO-3	2
X116A	16	28	BLACK	MR1-6	2	MR2-1	2
X117A	16	31	BLACK	MR2-2	2	MR3-1	2
X118A	16	33	BLACK	MR3-2	2	MR4-1	2
X119A	16	75	BLACK	F10-2	2	MR4-2	2
X120A	16	58	BLACK	F10-1	2	TB2-5	2
X121A	16	29	BLACK	MR2-6	2	MR3-3	2
X122A	16	32	BLACK	MR3-4	2	MR4-3	2
X123A	16	59	BLACK	MR1-1	2	MR4-4	2
X124A	16	56	BLACK	F11-2	2	MR1-2	2
X125A	16	58	BLACK	F11-1	2	TB2-6	2
X126A	16	35	BLACK	MR3-6	2	MR4-8	2
X127A	16	45	BLACK	MR1-4	2	MR4-7	2
X128A	16	45	BLACK	MR1-3	2	MR2-4	2
X129A	16	59	BLACK	F12-2	2	MR2-3	2
X130A	16	64	BLACK	F12-1	2	TB2-7	2
X131A	16	60	BLACK	MR1-8	2	MR4-6	2
X132A	16	45	BLACK	MR1-7	2	MR2-8	2

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
X133A	16	47	BLACK	MR2-7	2	MR3-8	2
X134A	16	68	BLACK	F13-2	2	MR3-7	2
X135A	16	68	BLACK	F13-1	2	TB2-8	2
X136A	16	62	BLACK	F2-2	2	BR1-6	2
X141A	16	50	BLACK	F4-1	2	TB2-11	2
X142A	16	49	BLACK	F5-2	2	BR4-6	2
X143A	16	50	BLACK	F5-1	2	TB2-12	2
X144A	16	69	BLACK	TB3-17	2	RR-3	2
X145A	16	61	BLACK	TB3-18	2	RR-4	2
X146A	16	70	BLACK	TB3-19	2	RR-1	2
X147A	16	45	BLACK	TB3-1	2	MR1-9	2
X148A	16	37	BLACK	TB3-2	2	MR1-10	2
X161A	16	62	BLACK	TB3-15	2	BR4-11	2
X162A	16	55	BLACK	TB3-16	2	BR4-12	2
P200A	16	27	BLACK	SDT-L1	2	LR1-6	2
P200B	16	26	BLACK	SDT-L1	2	LR2-6	2
P200C	16	22	BLACK	LR3-6	2	LR2-6	2
P200D	16	18	BLACK	LR4-6	2	LR3-6	2
P200E	16	32	BLACK	TB4-33	2	LR4-6	2
P201A	16	60	BLACK	F6-1	2	TB4-1	2
P202A	16	62	BLACK	F7-1	2	TB4-2	2
P203A	16	65	BLACK	F8-1	2	TB4-3	2
P204A	16	67	BLACK	F9-1	2	TB4-4	2
P211A	16	51	BLACK	F6-2	2	R4-8	2
P212A	16	53	BLACK	F7-2	2	R4-7	2
P213A	16	64	BLACK	F8-2	2	R4-6	2
P214A	16	66	BLACK	F9-2	2	R4-5	2
P215A	16	35	BLACK	R4-1	2	TD-6	2
P215B	16	28	BLACK	TD-6	2	SDT-3	2
P215C	16	34	BLACK	BR4-1	2	SDT-3	2
P215D	16	25	BLACK	BR1-1	2	BR4-1	2
P215E	16	20	BLACK	BR1-1	2	BR2-1	2
P215F	16	26	BLACK	BR2-1	2	BR3-1	2
P216A	16	27	BLACK	BR1-2	2	R1-5	2
P216B	16	36	BLACK	BR2-3	2	R1-5	2
P218A	16	32	BLACK	BR2-4	2	R2-5	2
P218B	16	41	BLACK	BR3-7	2	R2-5	2
P219A	16	43	BLACK	BR3-8	2	R2-2	2
P219B	16	37	BLACK	BR4-9	2	R2-2	2
P220A	16	32	BLACK	BR4-10	2	LR4-5	2
P221A	16	31	BLACK	BR2-2	2	R1-4	2
P221B	16	39	BLACK	BR3-3	2	R1-4	2
P223A	16	29	BLACK	BR4-7	2	R2-4	2
P223B	16	36	BLACK	BR3-4	2	R2-4	2
P224A	16	27	BLACK	BR4-8	2	R2-7	2
P224B	16	27	BLACK	R2-7	2	LR3-5	2
P225A	16	33	BLACK	BR3-2	2	R1-6	2
P225B	16	27	BLACK	BR4-3	2	R1-6	2
P227A	16	21	BLACK	BR4-4	2	R2-6	2
P227B	16	27	BLACK	R2-6	2	LR2-5	2
P228A	16	20	BLACK	BR4-2	2	R1-3	2
P228B	16	25	BLACK	R1-3	2	LR1-5	2
P228C	16	28	BLACK	BR4-2	2	SDT-L2	2

NOTES:

1. INTERPRET DRAWING PER DOD-STD-100.
2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING STRAPS FIND NO. 3. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED THREE INCHES.

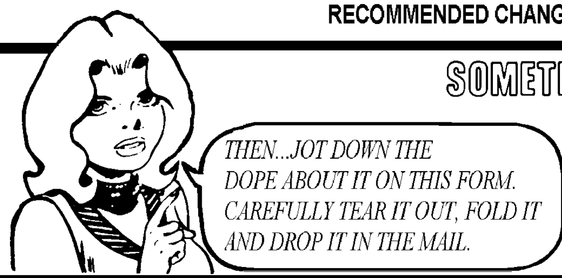
3			MS3367-4-9	A/R	STRAP		
2			MS25036-153	338	LUG		
1			M5086/2-16-9	A/R	WIRE		
FIND NO.	FSCM	DWG SIZE	PART OF IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL

FO-43. ACM Wiring Harness (Sheet 2 of 3)

WIRE NO.	SIZE	LENGTH	MKG COLOR	FROM	END PREP	TO	END PREP
P229A	16	38	BLACK	RR-7	2	TD-2	2
P230A	16	37	BLACK	R3-8	2	RR-8	2
P230B	16	30	BLACK	R3-5	2	SDT-5	2
P230C	16	34	BLACK	R3-2	2	R3-6	2
P231A	16	50	BLACK	TB4-5	2	R3-1	2
P232A	16	49	BLACK	TB4-6	2	R3-7	2
P233A	16	58	BLACK	TB4-7	2	R3-3	2
P234A	16	57	BLACK	TB4-8	2	R3-4	2
P240A	16	34	BLACK	TB4-9	2	LRTD4-1	2
P241A	16	4	BLACK	LRTD4-4	2	LRTD4-3	2
P241B	16	33	BLACK	TB4-10	2	LRTD4-4	2
P242A	16	32	BLACK	TB4-11	2	LRTD4-2	2
P243A	16	33	BLACK	TB4-12	2	LR4-3	2
P244A	16	29	BLACK	TB4-13	2	LR4-2	2
P245A	16	35	BLACK	TB4-14	2	LR4-1	2
P246A	16	32	BLACK	TB4-15	2	LRTD3-1	2
P247A	16	4	BLACK	LRTD3-3	2	LRTD3-4	2
P247B	16	31	BLACK	TB4-16	2	LRTD3-4	2
P248A	16	29	BLACK	TB4-17	2	LRTD3-2	2
P249A	16	34	BLACK	TB4-18	2	LR3-1	2
P250A	16	28	BLACK	TB4-19	2	LR3-2	2
P251A	16	34	BLACK	TB4-20	2	LR3-3	2
P252A	16	39	BLACK	TB4-21	2	LRTD2-1	2
P253A	16	4	BLACK	LRTD2-4	2	LRTD2-3	2
P253B	16	40	BLACK	TB4-22	2	LRTD2-4	2
P254A	16	39	BLACK	TB4-23	2	LRTD2-2	2
P255A	16	45	BLACK	TB4-24	2	LR2-3	2
P256A	16	38	BLACK	TB4-25	2	LR2-2	2
P257A	16	46	BLACK	TB4-26	2	LR2-1	2
P258A	16	40	BLACK	TB4-27	2	LRTD1-1	2
P259A	16	4	BLACK	LRTD1-4	2	LRTD1-3	2
P259B	16	42	BLACK	TB4-28	2	LRTD1-4	2
P260A	16	43	BLACK	TB4-29	2	LRTD1-2	2
P261A	16	48	BLACK	TB4-30	2	LR1-1	2
P262A	16	38	BLACK	TB4-31	2	LR1-2	2
P263A	16	50	BLACK	TB4-32	2	LR1-3	2
JUMPER	16	4	BLACK	27/59N-2	2	27/59N-6	2
JUMPER	16	4	BLACK	LR2-2	2	LR2-4	2
JUMPER	16	4	BLACK	LR4-2	2	LR4-4	2
JUMPER	16	4	BLACK	LR1-2	2	LR1-4	2
JUMPER	16	4	BLACK	LR3-2	2	LR3-4	2
JUMPER	16	4	BLACK	R3-2	2	R3-8	2
JUMPER	16	4	BLACK	R3-6	2	R3-5	2
JUMPER	16	4	BLACK	RR-2	2	RR-4	2

FO-44. ACM Wiring Harness (Sheet 3 of 3)

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS



SOMETHING WRONG WITH PUBLICATION

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER	SIGN HERE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

PIN: 040843-000