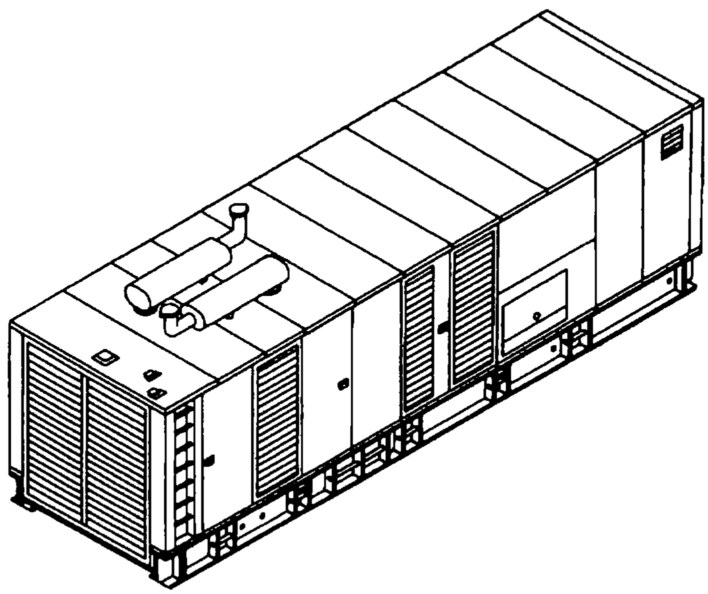
*TM 9-6115-604-34
NAVFAC P-8-633-34

TECHNICAL MANUAL

DIRECT SUPPORT, GENERAL SUPPORT AND DEPOT LEVEL MAINTENANCE MANUAL

GENERATOR SET, DIESEL ENGINE DRIVEN, AIR TRANSPORTABLE SKID MTD., 750 KW, 3 PHASE, 4 WIRE, 2400/4160 AND 2200/3800 VOLTS



DOD MODEL	CLASS	HERTZ	NSN
MEP 208A	PRIME UTILITY	50/60	6115-00-450-5881

DISTRIBUTION STATEMENT A. Approved for public release; distribution Is unlimited.

***This manual supersedes TM5-6115-604-34/NAVFAC P-8-633-34, 15 June 1985, including all changes.**

H E A D Q U A R T E R S, D E P A R T M E N T S O F T H E A R M Y A N D N A V Y
3 0 A U G U S T 1 9 9 6

WARNING

NOISE HAZARD

Operation of this equipment presents a noise hazard to personnel in the area. The noise level exceeds the allowable limits for unprotected personnel. Wear ear muffs or ear plugs which were fitted by a trained professional.

WARNING

Compressed air used for cleaning or drying can create airborne particles that may enter the eyes. Wearing of goggles is required.

WARNING

Cleaning solvent PD-680, type III, or equivalent, is flammable and toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory tract protection is required.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required.

WARNING

Engine must be cold when removing thermostat for testing. Failure to observe this precaution may result in second or third-degree burns.

WARNING

HIGH VOLTAGE

is present when this generator set is in operation.

WARNING

DEATH

or severe burns may result if personnel fall to observe safety precautions. Do not operate this generator set until the ground terminal stud has been connected to a suitable ground. Disconnect the battery ground cable before removing and installing components on the engine or in the electrical control panel system.

Do not attempt to service or otherwise make any adjustments, connections, or reconnections of wires or cables until generator set Is shut down and completely de-energized.

WARNING
DANGEROUS GASES

Batteries generate explosive gas during charging; therefore, utilize extreme caution, do not smoke, or use open flame in vicinity when servicing batteries.

Exhaust discharge contains noxious and deadly fumes. Do not operate generator sets In enclosed areas unless exhaust discharge is properly vented to the outside.

WARNING
LIQUIDS UNDER PRESSURE

are present In the fuel system and in the cooling system of the generator set during operation. Do not expose any part of the body to a high pressure leak in the fuel system of the generator set. Relieve pressure from radiator before removing radiator cap.

WARNING

Always maintain constant metal-to-metal contact between fuel tank filler neck and spout of fuel supply. This will prevent the possibility of sparking caused by static electricity. Do not smoke or use an open flame In the vicinity.

WARNING

Do not use a lifting device with a capacity of less than 45,000 pounds (20,400 kg). Do not allow the generator set to swing while it is suspended. Failure to observe this warning may result in serious injury or death to personnel.

WARNING

Do not operate the generator set in an enclosed area unless the exhaust gases are piped to the outside. Inhalation of exhaust fumes will result in serious injury.

WARNING

Before attempting to connect load cables, make sure generator set is not operating and there is no voltage present.

WARNING

Do not touch exposed electrical connections when DC CONTROL CIRCUIT BREAKER is energized.

WARNING

The muffler and exhaust pipe become extremely hot during operation. Do not handle muffler or exhaust pipe when they are hot.

WARNING

Do not operate the generator set unless it has been properly grounded. Electrical faults (such as leakage paths) in the generator set, feeder lines, or load equipment can cause injury or death by electrocution.

WARNING

Electrolyte contains sulfuric acid which can cause severe burns. It is highly toxic to the skin, eyes, and respiratory tract. Avoid all exposure. Skin, eye, and respiratory protection is required.

WARNING

Drilling operations can create metal chips that may enter the eye. Wearing goggles is required.

WARNING

Do not attempt to remove the radiator cap until the radiator has cooled to a point where there will be no built-up steam pressure. Failure to observe this warning could result in second- or third-degree burns.

For First Aid, Refer to FM21-11

TECHNICAL MANUAL

TM 9-9-6115-604-34

HEADQUARTERS, DEPARTMENTS
OF THE ARMY AND THE NAVY
WASHINGTON, D.C., 30 August 1996

DIRECT SUPPORT, GENERAL SUPPORT, AND DEPOT LEVEL MAINTENANCE MANUAL

GENERATOR SET, DIESEL ENGINE DRIVEN, AIR TRANSPORTABLE SKID MTD., 750 KW, 3 PHASE 4 WIRE, 2400/4160 AND 2200/3800 VOLTS

DOD MODEL	CLASS	HERTZ	NSN
MEP 208A	PRIME UTILITY	50/60	6115-00-450-5881

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 these procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual directly to: Commander, US Army Aviation and Troop Command, ATTN: AMSAT-1-MP, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. You may also submit your recommended changes by E-mail directly to <mpmt*/oavma28@st-louis-emh7.army.mil>. A reply will be furnished directly to you. Instructions for sending an electronic 2028 may be found at the back of this manual immediately preceding the hard copy 2028.

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* This manual supersedes TM 5-6115-604-34/NAVFAC P-8-633-34, 15 June 1985, including all changes.

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CHAPTER 1
INTRODUCTION
SECTION I. GENERAL

1-1. SCOPE. This manual contains instructions for direct support and general support and depot maintenance personnel maintaining the 750 kW diesel engine driven generator set MEP208A. The MEP208A is a 50/60 Hertz (Mode 1), prime utility (Type 1, Class 2A) set and is maintained as authorized by the Maintenance Allocation Chart (MAC). This manual 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 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. (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. Reporting 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 or 2028-2 located in back of manual directly to: Commander, U.S. Army Aviation and Troop Command, ATTN: AMSAT-1-MP, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798.
b. (N) Navy - by letter directly to: Commanding Officer, U.S. Navy, Ship Parts Control Center, ATTN: Code 783, Mechanicsburg, PA 17055.

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

a. (A) Army users shall refer to the Maintenance Allocation Chart (MAC) for tasks and levels of maintenance to be performed. The MAC is located in Appendix C of the Operator and Organizational Maintenance Manual.
b. (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 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 direct and general support and depot maintenance personnel.

a. Identification and Instruction Plates. Refer to the Operator and Organizational Maintenance Manual for the location of identification and instruction plates in the generator set.

b. Torque Data. Table 1-1 lists all components that require special torques. Table 1-2 contains torque values for capscrews. Table 1-3 contains torque values for locknuts and lockscrews.

c. Repair and Replacement Standards. Table 1-4 contains wear data for critical components.

d. Schematics and Wiring Diagrams. FO-1 through FO-12 are the schematic and wiring diagrams for the generator set and auxiliary equipment. Foldouts FO-13 through FO-38 are wiring harness diagrams for the generator set and auxiliary equipment.

e. System Capacities and Detailed Data on Components Table 1-5 gives system capacities for the fuel, cooling, and lubrication systems. This table also provides specifications of components in the generator set applicable to the field, general support, and depot level. Additional tabulated data is contained in the Operator and Organizational Maintenance Manual.

1-8. DIFFERENCES BETWEEN MODELS. Not Applicable.

1-9. (A) REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR). EIR will be prepared using DA Form 2407, Maintenance Request. Instructions for preparing EIRs are provided in DA Pam 738-750, The Army Maintenance Management System. EIRs should be mailed directly to: Commander, U.S. Army Aviation and Troop Command, ATTN: AMSAT-1-MDO, 4300 Goodfellow Boulevard, St Louis, MO 631201798. A reply will be furnished directly to you.

Table 1-1. Special Torque Data

DESCRIPTION	FIG. NO.	Ref. NO.	POUND-INCHES (NEWTON-METERS) MIN	MAX	POUND-FEET (NEWTON-METERS) MIN	MAX
COOLING SYSTEM						
Water header (oil cooler cover) capscrews	Figure 8-2	2, 3			25 (2.8)	30 (3.4)
ENGINE						
Aftercooler cover capscrews (Special sequence, see Figure 9-79)	Figure 9-78	27			25 (2.8)	30 (3.4)
Aftercooler crossover housing and connection capscrews	Figure 9-78	1			30 (3.4)	35 (4.0)
Aftercooler housing-to-plate capscrews	Figure 9-78	34			40 (4.5)	50 (5.6)
Aftercooler outlet adapter and housing screws	Figure 9-78	11, 13, 19 and 24			30 (3.4)	35 (4.0)
Aftercooler support screws	Figure 9-78	36, 37			90 (10.2)	110 (12.4)
Aftercooler support plate hexagon head screws	Figure 9-78 (4.5)	31 (5.6)			40	50
Barring device capscrews	Figure 9-62	15			90 (10.2)	110 (12.4)
Cam follower cover capscrews	Figure 9-13	3,4			30 (3.4)	35 (4.0)
Cam follower shaft capscrews	Figure 9-13	9			29 (3.3)	31 (3.5)
Camshaft rear cover capscrews	Figure 9-15	19			30 (3,4)	35 (4.0)
Camshaft thrust plate capscrews	Figure 9-15	25			30 (3.4)	35 (4,0)
Connecting rod bolts (Special procedure see paragraph 9-20 and Table 9-3)	Figure 9-24	1			210 (23.7)	220 (24.9)
Crankcase breather capscrews	Figure 9-24	44			20 (2.3)	30 (3.4)
Crankshaft counterweight capscrews	Figure 9-38	2			200 (22.6)	210 (23.7)
Crankshaft pipe plugs	Figure 9-38	1			5 (0.6)	7 (0.8)

Table 1-1. Special Torque Data (Continued)

DESCRIPTION	FIG. NO.	Ref. NO.	POUND-INCHES (NEWTON-METERS) MIN	MAX	POUND-FEET (NEWTON-METERS) MIN	MAX
ENGINE (CONT)						
Crankshaft seal retainer capscrews, rear	Figure 9-62	25			20 (2.3)	25 (2.8)
Crankshaft thrust bearing retainer capscrews	Figure 9-24	35			30 (3.4)	35 (4.0)
Crankshaft thrust bearing plate capscrews	Figure 9-24	24			20 (2.3)	25 (2.8)
Crosshead adjusting screw locknut using ST-669	Figure 9-1	9			22 (2.5)	26 (2.9)
True torque					25 (2.8)	35 (4.0)
Cylinder head capscrews (Special procedure see paragraph 9-10 and Figure 9-12)						
Cylinder head pipe plug						
Size 1/8					5 (0.6)	10 (1.1)
3/8					35 (4.0)	45 (5.1)
1/2					60 (6.8)	70 (7.9)
314					65 (7.3)	75 (8.4)
1					135 (15.2)	145 (16.4)
Exhaust manifold capscrews	Figure 9-82	1			40 (4.5)	45 (5.1)
Flywheel capscrews (Special Sequence see paragraph 9-34 and Figure 9-63)	Figure 9-62	1			360 (40.7)	380 (42.9)
Flywheel housing (Special procedure see paragraph 9-35)	Figure 9-62	6, 7			260 (29.4)	270 (30.5)
Front engine support	Figure 2-4				200 (22.6)	220 (24.9)
Front engine support base	Figure 2-4				200 (22.6)	220 (24.9)
Front (timing) gear cover screws	Figure 9-15 and 3	1, 2,			45 (5.1)	50 (5.6)
Front gear housing capscrews	Figure 9-15	45			45 (5.1)	55 (6.2)
Front gear housing hole cover	Figure 9-15	50, 51			45 (5.1)	55 (6.2)
Inspection hole cover capscrews	Figure 9-13	3 and 4			30 (3.1)	35 (4.0)

Table 1-1. Special Torque Data (Continued)

DESCRIPTION	FIG. NO.	Ref. NO.	POUND-INCHES (NEWTON-METERS) MIN	MAX	POUND-FEET (NEWTON-METERS) MIN	MAX
ENGINE (CONT)						
Intake manifold air balance connection capscrews (Special sequence, see paragraph 943 and Figure 9-80A)	Figure 9-78	1,41			30 (3.4)	35 (4.0)
Intake manifold capscrews (Special sequence. see Figure 9-81)	Figure 9-78	44			30 (3.4)	35 (4.0)
Intake manifold crossover housing capscrews (Special sequence see paragraph 9-43)	Figure 9-78	1			30 (3.4)	35 (4.0)
Lifting bracket capscrews	Figure 9-24	40			190 (21.5)	200 (22.6)
Main bearing capscrews (Special procedure, see paragraph 9-34 and Table 9-4)						
Main bearing side lock capscrews (Special procedure, see paragraph 9-34 and Table 94)						
Oil Pan Capscrews	Figure 9-68	6			32 (3.6)	38 (4.3)
Oil pan adapter capscrew (Special sequence, see paragraph 9-38 and Figure 966)	Figure 9-68	18,19			32 (3.6)	38 (4.3)
Oil pan adapter cover capscrews	Figure 9-68	16			32 (3.6)	38 (4.3)
Piston cooling nozzle capscrews	Figure 9-24	37	60 (6.8)	95 (10.7)		
Rear engine support	Figure 2-4				200 (22.6)	220 (22.6)
Rear gear housing capscrews	Figure 9-62	30			60 (6.8)	70 (7.9)
Rocker arm adjusting screw locknut	Figure 9-2	15				
Using ST-669					30 (3.4)	35 (4.0)
True torque					40 (4.5)	45 (5.1)
Rocker arm housing attaching capscrews	Figure 9-2	18			60 (6.8)	70 (7.9)
Rocker arm cover attaching screws	Figure 9-2	1, 3			30 (3-4)	35 (4.0)

Table 1-1. Special Torque Data (Continued)

DESCRIPTION	FIG. NO.	Ref. NO.	POUND-INCHES (NEWTON-METERS) MIN	MAX	POUND-FEET (NEWTON-METERS) MIN	MAX
ENGINE (CONT)						
Rocker arm shaft attaching capscrews	Figure 9-2	8, 9			60 (6.8)	70 (7.9)
Thrust bearing retainer capscrews	Figure 9-24	35			30 (3.4)	35 (4.0)
Thrust bearing retainer plate capscrews	Figure 9-24	24			20 (2.3)	25 (2.8)
Timing gear idler shaft capscrew and bolt	Figure 9-15	33, 39			175 (19.8)	180 (20.3)
Turbocharger, back-plate-to-center housing bolt	Figure 9-70	15	90 (10.2)	110 (12.4)		
Turbocharger center housing to turbine housing bolt	Figure 9-70	4	100 (11.3)	110 (12.4)		
Turbocharger retension strap capscrews					40 (4.5)	45 (5.1)
Turbocharger, turbine shaft locknut (Special procedure, see Figure 9-77)						
Turbocharger Vee band locknut	Figure 9-70	1	40 (4.5)	60 (6.8)		
Vibration damper capscrews (Special procedure, see paragraph 9-34 and Figure 9-60)	Figure 9-59	1			360 (40.7)	380 (42.9)
FUEL SYSTEM						
Accessory drive to front gear cover capscrews.	Figure 6-36 and 15	13, 14			45 (5.1)	55 (6.2)
Ether jets	Figure 9-78	6	75 (8.5)	85 (9.6)		
Ether lines	--	--	40 (4.5)	50 (5.6)		
Fuel Injection Pump						
Actuator to housing capscrews (Special sequence, see paragraph 6-11 and Figure 6-6)	Figure 6-5	1		75 (8.5)		
Damper body to plate capscrews	Figure 6-7	1			9 (1.0)	11 (1.24)
Damper to gear pump capscrews	Figure 6-5	7			11 (1.24)	13 (1.5)
Front cover to accessory drive mounting capscrews	Figure 6-5	33			40 (4.5)	45 (5.1)

Table 1-1. Special Torque Data (Continued)

DESCRIPTION	FIG. NO.	Ref. NO.	POUND-INCHES (NEWTON-METERS) MIN	MAX	POUND-FEET (NEWTON-METERS) MIN	MAX
FUEL SYSTEM (CONT)						
Front cover drive coupling capscrew	Figure 6-12	20			5 (0.6)	
Front cover to housing mounting capscrews	Figure 6-5 and 22	20, 21,			9 (1.0)	11 (1.2)
Front cover male connector	Figure 6-12	12			35 (4.0)	45 (5.1)
Gear pump cover to body capscrew	Figure 6-8	1			11 (1.2)	13 (1.5)
Gear pump to housing capscrews	Figure 6-5	12			11 (1.2)	13 (1.5)
Housing throttle stop hexagonal nuts	Figure 6-11	54	70 (7.9)	90 (10.2)		
Shutoff valve housing to coil assembly capscrews	Figure 6-10	6	25 (2.8)	30 (3.4)		
Shutoff valve to housing mounting capscrews	Figure 6-5	16			9 (1.0)	11 (1.2)
Shutoff valve pipe plugs	Figure 6-10	4				
1/8 inch (3.18 mm)					5 (0.6)	8 (0.9)
1/4 inch (6.35 mm)					25 (34)	30 (41)
Solenoid base subassembly	Figure 6-2	8	150 (16.9)	200 (22.6)		
Solenoid valve screw	Figure 6-2	1	100 (11.3)	120 (13.6)		
Spring pack cover to housing capscrews (lower governor)	Figure 6-5	37			9 (1.0)	11 (1.2)
Spring pack cover to housing capscrews (upper governor)	Figure 6-5	42			9 (1.0)	11 (1.2)
Fuel injector damp (hold-down) capscrews	Figure 6-21	19	120 (13.6)	165 (18.6)		
Fuel injector cup retainer Using ST-1072, Crowfoot wrench	Figure 6-21	12			70 (7.9)	
Fuel injector delivery orifice	Figure 6-21	10	8 (0.9)	10 (1.1)		
Fuel manifold fuel block connection capscrews	Figure 6-35	6	40 (4.5)	45 (5.1)		
Fuel manifold socket head capscrews	Figure 6-35	25	40 (4.5)	45 (5.1)		

Table 1-1. Special Torque Data (Continued)

DESCRIPTION	FIG. NO.	Ref. NO.	POUND-INCHES (NEWTON-METERS) MIN	MAX	POUND-FEET (NEWTON-METERS) MIN	MAX
GENERATOR						
Generator armature mounting capscrew	Figure 5-1	12			95 (10.7)	
Generator drive disks to drive hub capscrews (Special sequence, see Figure 5-7)	Figure 5-1	20			216 (24.4)	
Generator drive disks- to-flywheel capscrews	Figure 2-4	--			112 (12.7)	
Generator machining adapter to flywheel housing capscrews	Figure 2-4	--			50 (5.6)	
Generator machining adapter to main stator and frame assembly capscrews	Figure 5-1	26			60 (6.8)	
Generator rectifier mounting nut	Figure 5-1	35 and 36	20 (2.3)	30 (3.4)		
Generator support mounting capscrews	Figure 2-4	--			850 (96.0)	
Generator stator mounting capscrews	Figure 5-1	8			60 (6.8)	
LUBRICATION SYSTEM						
Oil connection to cylinder block capscrews	Figure 8-4	14			30 (3.4)	35 (4.0)
Oil cooler cover to cylinder block capscrews	Figure 8-2	2 and 3			25 (2.8)	30 (3.4)
Oil cooler element locknut	Figure 8-2	1			40 (4.5)	45 (5.1)
Oil pump assembly to cylinder block capscrews	Figure 8-4	24			70 (7.9)	75 (8.4)
Oil pump cover to body capscrews	Figure 84	37			30 (3.4)	35 (4.0)
Oil suction tube to oil pump capscrews	Figure 8-4	7			30 (3.4)	35 (4.0)
Oil transfer tube to oil pump and oil connection capscrews	Figure 8-4 21	16 and			30 (3.4)	35 (4.0)
Piston cooling nozzle capscrew	Figure 9-24	37			5 (0.6)	8 (0.9)
Pressure relief housing to cover capscrews	Figure 8-4	21			30 (3.4)	35 (4.0)

Table 1-1. Special Torque Data (Continued)

DESCRIPTION	FIG. NO.	Ref. NO.	POUND-INCHES (NEWTON-METERS) MIN	MAX	POUND-FEET (NEWTON-METERS) MIN	MAX
STARTER MOTOR						
Starter drive housing internal housing bolts	Figure 4-3	20			13 (1.5)	17 (1.9)
Starter drive housing socket head screws	Figure 4-3	19			13 (1.5)	17 (1.9)
Starter terminal lead hexagonal nut	Figure 4-3	38	16 (1.8)	30 (3.4)		

Table 1-2. Capscrew Markings and Torque Values

SAE GRADE NUMBER		1 or 2	5	6 or 7	8
CAPSCREW BODY-SIZE INCHES-THREAD		**POUND-FEET (NEWTON-METERS)**	**POUND-FEET (NEWTON-METERS)**	**POUND-FEET (NEWTON-METERS)**	**POUND-FEET (NEWTON-METERS)**
1/4	- 20	5	8	10	12
		(7)	(11)	(14)	(16)
- 28	6	10	12	14	
		(8)	(14)	(16)	(19)
5/16	-18	11	17	19	24
		(15)	(23)	(26)	(33)
-24	1 3	1 9	24	27	
		(18)	(26)	(33)	(37)
3/8	-16	1 8	31	34	44
		(24)	(42)	(46)	(60)
-24	20	35	43	49	
		(27)	(47)	(58)	(66)
7/16	-14	28	49	55	70
		(38)	(66)	(75)	(95)
- 20	30	55	69	78	
		(41)	(75)	(94)	(106)
1/2	-13	39	75	85	105
		(53)	(102)	(115)	(142)
- 20	41	85	105	120	
		(56)	(115)	(142)	(163)
9/16	- 12	51	110	120	155
		(69)	(149)	(163)	(210)
-18	55	120	150	170	
		(75)	(163)	(203)	(230)
5/8	-11	83	150	167	210
		(113)	(203)	(226)	(285)
-18	95	170	209	240	
		(129)	(230)	(283)	(325)
3/4	-10	105	270	280	375
		(142)	(366)	(380)	(508)
-16	115	295	350	420	
		(156)	(400)	(475)	(569)
7/8	- 9	160	395	440	605
		(217)	(536)	(597)	(820)
-14	175	435	550	675	
		(237)	(590)	(746)	(915)
1	-8	235	590	660	910
		(319)	(800)	(895)	(1234)
- 14	250	660	825	990	
		(339)	(895)	(1119)	(1342)

Table 1-2. Capscrew Markings and Torque Values (Continued)

Standard pipe plug torque using sealing compound MIL-S-45180	NPTF SIZE	POUND-FEET (NEWTON-METERS) MIN	MAX
	1/8	10 (14)	12 (16)
	1/4	14 (19)	16 (22)
	3/8	18 (24)	22 (30)
	1/2	23 (31)	27 (37)
	3/4	33 (45)	37 (50)
	1	75 (102)	84 (115)
	1 1/4	95 (129)	105 (143)
	1 1/2	110 (149)	130 (176)
Standard tubing nuts and fittings	**TUBE-SIZE**	**POUND-FEET (NEWTON-METERS) MIN**	**MAX**
	OD		
	1/8	6.3 (8.5)	7.1 (9.6)
	3/16	7.9 (10.6)	8.8 (11.9)
	1/4	11 (15)	13 (17)
	5/16	14 (19)	16 (22)
	3/8	23 (31)	25 (34)
	1/2	38 (52)	41 (56)
	5/8	54 (73)	58 (79)
	3/4	75 (102)	83 (113)

Table 1-2. Capscrew Markings and Torque Values (Continued)

NOTE

1. **Use the torque values listed above when specific torque values are not available.**
2. **Do not use above values in place of those specified in other sections of this manual.**
3. **The above is based on use of clean, dry threads.**
4. **Reduce torque by 10 percent when engine oil is used as a lubricant.**
5. **Reduce torque by 20 percent if new plated capscrews are used.**
6. **Capscrews threaded into aluminum may require reductions in torque of 30 percent or more of Grade 5 capscrews torque and must attain two capscrew diameters of thread engagement.**

Table 1-3. Prevailing Torque of Locknuts and Lockscrews

SIZE		1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4
Nuts, and all metal bolts	pounds-inches	4.0	5.0	12	15	20	27	34	51
	newton-meters	0.45	0.56	1.4	1.7	2.3	3.1	4.0	5.8
Nylon insert Adhesive, or nylon coated bolts	pounds-inches	4.0	5.0	9.0	12	15	22	28	43
	newton-meters	0.45	0.46	1.0	1.4	1.7	2.5	3.2	4.9

NOTE

1. **Clean dirt and other foreign material off of bolt and nut.**
2. **Discard bolts or nuts that show thread damage or signs of overtightening.**
3. **Assemble the nut and bolt so that the self-locking insert has fully engaged the threads.**
4. **Using a pound-inch torque wrench, check the torque required to turn the nut or bolt.**
5. **Replace bolts or nuts that do not have the minimum torque given in the chart, above.**

Table 1-4. Repair and Replacement Standards

			DIMENSIONAL DATA INCH (mm)		
DESCRIPTION	FIG. NO.	REF. NO.	MIN	MAX	WEAR LIMIT
COOLING SYSTEM WATER PUMP					
Body inner bearing bore	Figure 7-1	13	2.4408 (61,996)	2.4413 (62,009)	2.4493 (62,212)
Body oil seal bore	Figure 7-1	13	1.398 (38.05)	1.500 (38.10)	
Body outer bearing bore	Figure 7-1	13	2.8345 (71.996)	2.8351 (72.012)	2.8431 (72.215)
Impeller bore	Figure 7-1	3	0.9815 (24.930)	0.9826 (24.958)	
Impeller depth in body	Figure 7-1	13	3.448 (87.58)	3.452 (87.68)	
Shaft diameter impeller end and seat location	Figure 7-1	12	0.9838 (24.898)	0.9843 (25.001)	
Shaft diameter, inner and outer bearing	Figure 7-1	12	1.1810 (29.997)	1.1814 (30.008)	
Shaft diameter, oil seal	Figure 7-1	12	0.997 (25.32)	1.003 (25.48)	
Shaft and impeller, minimum press fit	Figure 7-1	3, 12	-0.001 (-0.03)		
WATER PUMP DRIVE UNIT					
Bushing inside diameter	Figure 7-1	28	1.751 (44.48)	1.754 (44.55)	1.755 (44.58)
Shaft end clearance, assembled	---	---	0.002 (0.05)	0.012 (0.30)	
Shaft outside diameter, bushing area	Figure 7-1	25	1.7485 (44.412)	1.749 (44.42)	1.748 (44.40)
ENGINE CAM FOLLOWERS					
Shaft diameter	Figure 9-13	14	0.8735 (22.187)	0.8740 (22.200)	0.873 (22.17)
Follower shaft hole, inside diameter			0.875 (22.23)	0.876 (22.25)	0.877 (22.28)
Cam roller	Figure 9-13	18,20			
Inside diameter			0.754 (19.15)	0 755 (19.18)	0.756 (19.20)
Outside diameter			1.624 (41.25)	1.625 (41.28)	1.622 (41.20)

Table 1-4. Repair and Replacement Standards (Continued)

			DIMENSIONAL DATA INCH (mm)		
DESCRIPTION	**FIG. NO.**	**REF. NO.**	**MIN**	**MAX**	**WEAR LIMIT**
ENGINE (CONT)					
CAM FOLLOWERS (CONT)					
Cam roller pin, outside diameter	Figure 9-13	17, 19	0.7505 (19.063)	0.7510 (19.075)	0.748 (19.00)
Roller-to-pin clearance			0.003 (0.08)	0.0045 (0.114)	
Roller-to-follower side clearance	---	---	0.009 (0.23)	0.024 (0.61)	
CAMSHAFT					
Bushing, installed inside diameter	Figure 9-15	28	3.0000 (76.200)	3.0015 (76.238)	3.0035 (76.289)
End clearance	Figure 9-15	26, 27	0.006 (0.15)	0.013 (0.33)	
Gear backlash	Figure 9-15	29, 30	0.003 (0.08)	0.012 (0.30)	0.020 (0.51)
Journal Diameter	Figure 9-15	26, 27	2.996 (76.10)	2.997 (76.12)	2.995 (76.07)
Thrust bearing thickness	Figure 9-15	32	0.368 (9.35)	0.372 (9.45)	0.361 (9.17)
CONNECTING RODS					
Crankpin bore inside diameter	Figure 9-26	B	4.5017 (114.343)	4.5027 (114.369)	
Piston pin bushing inside diameter	Figure 9-26	A	2.4010 (60.985)	2.4015 (60.998)	2.4025 (61.024)
Piston pin clearance in bushing			0.0020 (0.051)	0.0030 (0.076)	0.0045 (0.114)
CRANKSHAFT					
Main journal diameter	Figure 9-41	---	6.498 (165.05)	6.500 (165.10)	6.497 (165.02)
Rod journal diameter	Figure 9-41	---	4.2485 (107.912)	4.2500 (107.950)	4.2460 (107.848)
Main and rod journal out-of-round	Figure 9-41	---			0.002 (0.05)
Main and rod journal taper	Figure 9-41	---			0.0005 (0.013)
Thrust flange thickness	Figure 9-51	T	0.498 (12.65)	0.502 (12.75)	0.493 (12.52)
Main bearing shell thickness, std	Figure 9-24	19, 20 22, 23	0.1700 (4.318)	0.1707 (4.336)	0.1685 (4.280)

Table 1-4. Repair and Replacement Standards (Continued)

			DIMENSIONAL DATA INCH (mm)		
DESCRIPTION	**FIG. NO.**	**REF. NO.**	**MIN**	**MAX**	**WEAR LIMIT**
ENGINE (CONT)					
CRANKSHAFT (CONT)					
Rod-bearing shell thickness, std	Figure 9-24	11	0.1237 (3.142)	0.1242 (3.155)	0.1222 (3.104)
Thrust bearing thickness, std	Figure 9-24	26	0.1915 (4.864)	0.1945 (4.940)	(see crank-shaft end clearance)
Main bearing journal clearance	---	---	0.0036 (0.091)	0.0075 (0.191)	0.0095 (0.241)
Rod bearing journal clearance	---	---	0.0025 (0.089)	0.0065 (0.165)	0.0090 (0.229)
End clearance	---	---	0.005 (0.13)	0.015 (0.38)	0.020 (0.51)
CYLINDER BLOCK					
Camshaft bushing bore	Figure 9-24	58	3.1875 (80.963)	3.1885 (80.988)	3.1895 (81.013)
Height from installed alignment bar	Figure 9-58	A	15.581 (395.76)	15.5835 (395.821)	15.171 (385.34)
Liner counterbore depth	Figure 9-56	A	0.721 (18.31)	0.723 (18.36)	0.782 (19.86)
Liner bore, top	Figure 9-56	B	74.915 (190.284)	7.4935 (190.335)	
Liner bore, secondary	Figure 9-56	C	7.155 (181.74)	7.157 (181.79)	
Liner bore, lower diameter	Figure 9-57	---	6.982 (177.34)	6.984 (177.39)	
Liner bore, lower concentricity	Figure 9-57	---		0.005 (0.13)	
Liner-to-block clearance, lower bore	Figure 9-36	---	0.002 (0.05)	0.006 (0.15)	
Liner inside diameter	Figure 9-24	27	6.2495 (158.737)	6.2510 (158.775)	6.2550 (158.877)
Main bearing bore	Figure 9-24	58	6.8450 (173.864)	6.8460 (173.888)	6.8465 (173.901)
CYLINDER HEAD AND VALVES					
Crosshead guide bore in cylinder head, inside diameter	Figure 9-1	7	0.4315 (10.960)	0.4325 (10.986)	
Crosshead guide outside diameter	Figure 9-8	B	0.433 (11.00)	0.4335 (11.011)	0.432 10.97)

Table 1-4. Repair and Replacement Standards (Continued)

			DIMENSIONAL DATA INCH (mm)		
DESCRIPTION	FIG. NO.	REF. NO.	MIN	MAX	WEAR LIMIT
ENGINE (CONT)					
CYLINDER HEAD AND VALVES (CONT)					
Crosshead guide installed height	Figure 9-8	A	2.350 (59.69)	2.370 (60.20)	
Cylinder head thickness	Figure 9-1	7	4.745 (120.52)	34.755 (120.78)	4.715 (119.76)
Injector seal seat thickness	Figure 9-1	18	0.0135 (0.343)	0.0165 (0.419)	
Injector tip protrusion	Figure 9-6	---	0.090 (2.29)	0.110 (2.79)	
Valve stem diameter	Figure 9-3	B	0.4945 (12.560)	0.4955 (12.586)	0.4935 (12.535)
Valve rim thickness	Figure 9-3	A	0.105 (12.67)		
Valve and seat angle	Figure 9-9	---	30 degrees	30 degrees	
Valve guide installed height	Figure 9-8	D	1.375 (34.93)	1.390 (35.31)	
Valve guide inside diameter	Figure 9-8	C	0.4972 (12.629)	0.4980 (12.649)	0.4996 (12.690)
Valve guide outside diameter	Figure 9-1	25	0.8456 (21.378)	0.8461 (21.491)	
Valve guide bore in cylinder head, inside diameter	Figure 9-1	7	0.8435 (21.415)	0.8445 (21.450)	
Valve seat insert counter-bore depth in cylinder head	Figure 9-1	7			
intake			0.512 (13.00)	0.517 (13.13)	
exhaust			0.492 (12.50)	0.497 (12.62)	
Valve seat insert bore in cylinder head, inside diameter	Figure 9-1	7	2.377 (60.38)	2.378 (60.40)	
Valve seat insert, standard outside diameter	Figure 9-1	26	2.3805 (60.465)	2.3815 (60.490)	
Valve seat runout TIR	Figure 9-1	26		0.002 (0.05)	
Valve spring free length	Figure 9-1	3	3.349 (85.06)		

Table 1-4. Repair and Replacement Standards (Continued)

			DIMENSIONAL DATA INCH (mm)		
DESCRIPTION	FIG. NO.	REF. NO.	MIN	MAX	WEAR LIMIT
ENGINE (CONT)					
CYLINDER HEAD AND VALVES (CONT)					
Valve spring installed length	Figure 9-1	3		2.470 (62.74)	
Valve spring load at installed length	Figure 9-1	3	170.8 lb (77.5 kg)	294 lb (133.4 kg)	
FLYWHEEL					
Face runout per each 1 inch (25.4 mm) of radius	Figure 9-64	B		0.0005 (0.013)	
Pilot bore runout TIR	Figure 9-64	A		0.005 (0.13)	
Static unbalance of flywheel and ring gear assembly	Figure 9-62	3, 5		2 ounce-inch (144 mg.m)	
PISTONS					
Pin bore at 700F (21OC)	Figure 9-24	10	2.3985 (60.922)	2.3989 (60.932)	2.3990 (60.935)
Pin fit in bore	---	---	-0.0005 (-0.013)	-0.0001 (-0.003)	+0.0002 (+0.005)
Piston pin outside diameter	Figure 9-24	9	2.3988 (60.930)	2.3990 (60.938)	2.3980 (60.909)
Piston ring end gap (Special procedure see Figure 9-30)	Figure 9-30	---			
Skirt clearance in liner	---	---	0.0105 (0.267)	0.0130 (0.330)	0.0180 (0.457)
Skirt diameter 70°F (21°C)	Figure 9-24	10	6.2380 (158.445)	6.2390 (158.471)	6.2370 (158.420)
ROCKER ARMS AND CROSSHEADS					
Crosshead, clearance between valve spring retainer	Figure 9-1	8	0.025 (0.064)		
Crosshead, guide bore	Figure 9-1	8	0.434 (11.02)	0.436 (11.07)	0.440 (11.18)
Rocker arm bushing, inside diameter	Figure 9-2	27, 28	1.3735 (34.887)	1.3765 (34.963)	1.3775 (34.990)
Rocker arm end clearance, installed	---	- --	0.014 (0.36)	0.034 (0.86)	
Rocker arm shaft, outside diameter	Figure 9-2	11	1.3720 (34.849)	1.3725 (34.862)	1.3710 (34.823)

Table 1-4. Repair and Replacement Standards (Continued)

DESCRIPTION	FIG. NO.	REF. NO.	DIMENSIONAL DATA INCH (mm) MIN	MAX	WEAR LIMIT
ENGINE (CONT)					
TIMING GEARS					
Gear backlash	Figure 9-16 Figure 9-20	--- ---	0.003 (0.08)	0.012 (0.30)	0.020 (0.51)
Gear end clearance	Figure 9-16 Figure 9-19	--- ---	0.005 (0.13)	0.011 (0.28)	0.018 (0.46)
Idler gear bushings, inside diameter	Figure 9-15	42	1.8755 (47.638)	1.8765 (47.663)	1.8785 (47.714)
Idler shafts, outside diameter	Figure 9-15	35, 41	1.8735 (47.587)	1.8740 (47.600)	1.8720 (47.549)
Thrust bearing thickness	Figure 9-15	38	0.092 (2.34)	0.095 (2.41)	0.088 (2.24)
TURBOCHARGERS					
Bearing, inside diameter	Figure 9-70	22	0.6268 (15.921)	0.6272 (15.941)	
Bearing, outside diameter	Figure 9-70	22	0.9782 (24.846)	0.9787 (24.859)	
Bearing, radial clearance	Figure 9-70	22	0.003 (0.08)	0.007 (0.18)	
Center housing bearing bore	Figure 9-70	18		0.9830 (24.968)	0.9835 (24.981)
Shaft, outside diameter	Figure 9-74	---	0.6250 (18.875)	0.6254 (15.885)	0.6245 (15.862)
Thrust bearing thickness	Figure 9-70	20	0.090 (2.29)	0.092 (2.34)	
Total end clearance	- - -	---	Q.00 (0.10)	0.009 (0.23)	
VIBRATION DAMPER					
Face runout per each 1 inch (25.4 mm) of damper diameter at point of measurement	Figure 9-59	4		0.002 (0.05)	
Radial runout per each 1 inch (25.4 mm) of damper diameter	Figure 9-59	4		0.001 (0.03)	
Thickness, measured 0.125 inch (3.18 mm) from edge	Figure 9-59	4		2.574 (65.38)	
Thickness variation	Figure 9-59	4		0.010 (2.54)	

Table 1-4. Repair and Replacement Standards (Continued)

			DIMENSIONAL DATA INCH (mm)		
DESCRIPTION	FIG. NO.	REF. NO.	MIN	MAX	WEAR LIMIT
FUEL SYSTEM ACCESSORY DRIVE					
Bushing inside diameter	Figure 6-36	10	1.316 (33.43)	1.319 (33.50)	1.320 (33.53)
Drive gear end clearance	Figure 6-36	6	0.002 (0.04)	0.012 (0.30)	
Shaft outside diameter	Figure 6-36	9			
at gear end			1.3765 (34.963)	1.377 (34.98)	
at bearing contact area			1.3115 (33.312)	1.312 (33.32)	1.310 (33.27)
FUEL INJECTION PUMP					
Fuel Pump Assembly	Figure 6-11	37			
Governor spring (upper governor)					
free length			1.308 (33.22)	1.328 (33.73)	
load at 1.12 inches (28.45 mm)			6.47 lb (2.98 kg)	8.03 lb (3.64 kg)	
High speed governor spring (lower governor)	Figure 6-11	12			
free length		12	1.227 (31.17)	1.247 (31.67)	
bad at 1.0 inch (25.4 mm)			12.75 lb (5.78 kg)	13.81 lb (6.26 kg)	
Idling spring (lower governor)	Figure 6-11	17			
free length			1.015 (25.78)	1.035 (26.29)	
load at 0.955 inch (24.26 mm)			0.69 lb (0.31 kg)	0.85 lb (0.39 kg)	
Idling spring (upper governor)	Figure 6-11	40			
free length			0.335 (8.50)		
load at 0.265 inches (6.70mm)			0.28 lb. (0.13 kg)	0.36 lb. (0.16 kg)	
Sleeve bearing, inside diameter	Figure 6-11	80	0.7495 (19.037)	0.7505 (19.063)	0.7525 (19.114)

Table 1-4. Repair and Replacement Standards (Continued)

DESCRIPTION	FIG. NO.	REF. NO.	DIMENSIONAL DATA INCH (mm) MIN	MAX	WEAR LIMIT
FUEL SYSTEM (CONT)					
FUEL INJECTION PUMP (CONT)					
Throttle shaft (upper governor), bushings inside diameter	Figure 6-11	31	0.560 (14.22)	0.563 (14.30)	
Gear Pump					
Cover and housing bushing inside diameter	Figure 6-8	9	0.5013 (12.733)	0.5016 (12.741)	
Gear protrusion from housing	Figure 6-8	7,10, 13	-0.0001 (-0.003)	+0.0005 +(0.013)	
Gear tooth flank clearance	Figure 6-8	10 13	0.006 (0.15)	0.010 (0.25)	
Gearwidth	Figure 6-8	10,13	1.2483 (31.707)	1.2486 (31.714)	
Housing, gear bore depth	Figure 6-8	7	1.2482 (31.704)	1.2485 (31.712)	
Shafts, outside diameter	Figure 6-8	11,12	0.4998 (12.695)	0.5001 (12.703)	
Shafts, protrusion from housing 12	Figure 6-8	7,11, 12	2.370 (60.2)	2.412 (61.3)	
Mainshaft, Cover, and Governor					
Gear backlash	Figure 6-12	9, 28, 34, 44	0.005 (0.13)	0.009 (0.23)	
Idler gear to bushing end clearance	Figure 6-12	34, 35	0.002 (0.05)	0.007 (0.18)	
Idler shaft bushing inside diameter	Figure 6-12	35		0.507 (12.88)	
Shaft bushing, inside diameter	Figure 6-12	10, 45		0.504 (12.80)	
Sleeve bearing, inside diameter	Figure 6-12	16	0.3963 (10.066)	0.3970 (10.084)	
Tachometer drive shaft, outside diameter	Figure 6-12	13	0.3950 (10.033)	0.3955 (10.046)	
Tachometer driven gear inside diameter	Figure 6-12	17		0.3948 (10.028)	
Tachometer driven gear to sleeve bearing end clearance	Figure 6-12	16,17	0.002 (0.05)	0.005 (0.13)	

Table 1-4. Repair and Replacement Standards (Continued)

DESCRIPTION	FIG. NO.	REF. NO.	DIMENSIONAL DATA INCH (mm) MIN	MAX	WEAR LIMIT
FUEL SYSTEM (CONT)					
FUEL INJECTION PUMP (CONT)					
Mainshaft, Cover, and Governor (cont)					
Weight assist spring	Figure 6-12	3			
free length			0.574 (14.58)	0.594 (15.09)	
load at 0.325 inch (8.26 rmm)			3.30 lb (1.50 kg)	3.70 lb (1.68 kg)	
FUEL INJECTORS					
Spring, load at 2.40 inches (61.0 mm)	Figure 6-21	4	129.00 lb (58.51 kg)	149.75 lb (67.93 kg)	
GENERATOR					
Exciter air gap	Figure 2-11	---	0.010 (0.25)		
LUBRICATION SYSTEM					
OIL PUMP					
Bushings, inside diameter	Figure 8-7	1	1.5025 (38.163)	1.504 (38.201)	1.505 (38.227)
Idler and drive shafts, outside diameter	Figure 8-7	2	1.4995 (38.087)	1.500 (38.10)	1.4993 (38.082)
Drive shaft, end clearance	Figure 8-7	3	0.004 (0.10)	0.007 (0.18)	
Drive shaft, protrusion from gear	Figure 8-7	4	2.460 (62.48)	2.480 (62.99)	
Idler shaft, protrusion from gear	Figure 8-7	5	1.280 (32.51)	1.300 (33.02)	
Drive gear-to-crankshaft gear backlash	Figure 8-4	43	0.003 (0.08)	0.012 (0.30)	
STARTER MOTOR					
Armature shaft runout TIR	Figure 4-3	64		0.005 (0.13)	
Commutator runout TIR	Figure 4-3	64		0.005 (0.13)	
Starter motor, bushing clearance	Figure 4-3	24, 33, 46	0.0015 (0.038)	0.003 (0.08)	0.005 (0.13)
Starter motor, pinion clearance	Figure 4-7	---	0.328 (8.31)	0.390 (9.91)	

Table 1-5. System Capacities and Detailed Data on Components Generator Set Manufacturer

Generator Set Manufacture
Model Mode
MEP208A 50/60 Hertz
Operating Temperature Range:
Voltage Output:
50 Hz:
60 Hz:
Power Factor:
Capacities:
Fuel System:
Tank:
Lines:
Cooling System:
Radiator:
Engine Block:
Hoses:
Lubricating Oil:
Crankcase:
Full:
Low:
Filters:
Dimensions:
Overall Length:
Overall Width:
Overall Height
(without mufflers):
Net weight (dry):
Net weight (wet):
Engine:
Manufacturer.
Model:
Type:

Number of Cylinders:
Displacement:
Engine Power Output (BHP):

Dynamics Corporation of
America, Fermont Division
Class
Prime Utility
-25° to +125°F (-31° to +51°C)

2200/3800 volts, 3 phase, 4 wire
2400/4160 volts, 3 phase, 4 wire
0.8

133.6 gallons (505.7 liters)
130 gallons (492 liters)
3.6 gallons (13.6 liters)
91.3 gallons (345.6 liters)
51.8 gallons (196.1 liters)
31.25 gallons (118.28 liters)
8.25 gallons (32.2 liters)
36 gallons (136 liters)

30 gallons (113 liters)
23 gallons (87 liters)
6 gallons (22 liters)

330 inches (8382 mm)
96.00 inches (2438 mm)

100.00 inches (2540 mm)
37,500 pounds (17,045.5 kg)
39,600 pounds (18,000 kg)

Cummins Engine Company, Inc.
KTA-2300G
Four stroke cycle, 60° Vee,
turbocharged and aftercooled
12
2300 cubic inches (37.7 liters)
1235 at 1800 rpm
1030 at 1500 rpm

Table 1-5. System Capacities and Detailed Data on Components (Continued)

AC ELECTRICAL POWER GENERATION AND CONTROL SYSTEM	
Switchgear Circuit Breaker	
Drawing Number:	80-7365
Voltage Rating:	120/140 V ac
Number of Poles:	2
Current Rating:	15 amperes
Operating Temperature:	-25° to +125°F (-31° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Humidity Conditions:	To 100%
Specifications:	Per Federal Specification WC-375/6 UL listed
Interrupting Capacity:	10,000 amperes
Wire Size:	No. 1 to 300 mcm
Manufacturer:	General Electric Company
Part Number:	THQEZ1 1 5WL
FSCM:	28432
Generator	
Drawing Number:	80-7543
Specifications:	MIL-G-82058C, ANSI C50.10, ANSI C50.12, NEMA MG1
Mechanical Characteristics:	Synchronous rotating field, brushless, air-cooled, self-ventilated
Weight:	5700 pounds (2590 kg)
Phase:	3
Frequency:	50/60 Hz
Poles:	4
Speed:	1500/1800 rpm
Duty:	Continuous
Overload:	2 hour overload at 100% of the 60 Hz rating from -25° to 125°F (-31° to 51°C) and at altitudes from sea level to 1500 feet (457 m)
Temperature Rise:	95 degrees by resistance
Ambient Temperature:	-21.5° to +125°F (-29° to 51°C)
Enclosure:	Open drip proof
Efficiency:	94.4%
Rating:	62.5/750 kW
Power Factor:	0.8 lagging

Table 1-5. System Capacities and Detailed Data on Components (Continued)

AC ELECTRICAL POWER GENERATION AND CONTROL SYSTEM (CONTINUED)

Output Voltage:	With operating voltage selector in 2400 volt connection
	position:
	A. At 60 Hz: 2160 to 2640 volts
	B. At 50 Hz: 1980 to 2420 volts
	With operating voltage selector in
	2400/4160 volt connection position:
	A. At 60 Hz: 3750 to 4575 volts
	B. At 50 Hz: 3420 to 4180 volts
	Marathon Electric
	SS511352
	38151
Manufacturer:	
Part Number:	80-7546
FSCM:	
Voltage Regulator	120/203/240/416/430/600 V ac
Drawing Number:	Less than 10 VA per line
Sensing Terminals (El, E2 and E3):	
Voltage:	240 V ac
Burden:	1680
Input Power (Terminals 3 and 4):	
Voltage:	125Vdcat7A
VA (maximum continuous):	180 V dc at 1OA
Output Field Power	18 ohms
(Terminals F+ and F-):	50/60 Hz
Maximum Continuous:	Less than ±1.4%
Maximum Forcing:	Less than 17 milliseconds
DC Field Resistance (minimum):	MIL-STD-461, Class III B,
Frequency:	conducted or radiated
Voltage Regulation:	±10% of nominal voltage
Response Time:	-67° to ±158° F (-55° to +70°C)
EMI (Electromagnetic	-85° to ±212° F (-65° to +10°C)
Interference):	Less than ±1.2% for 122° F (50°C)
Voltage Adjust Range:	temperature change (after 20 minutes
Ambient Operating Temperature:	warm-up)
Storage Temperature:	Less than 60 watts
Temperature Coefficient:	Withstands 1.3 G's from 5 to 26 Hz, 0.036 inch
	displacement from 26 to 52 Hz and 5 G's from
Power Dissipation:	52 to 260 Hz
Vibration:	

Table 1-5. System Capacities and Detailed Data on Components (Continued)

AC ELECTRICAL POWER GENERATION AND CONTROL SYSTEM (CONTINUED)

Manufacturer:	Basler Electric Company
Part Number:	9059700-106
Model Number:	SR8F3
FSCM:	97520
Load Circuit Breaker Assembly	
Drawing Number:	80-7458
Mechanical Characteristics:	Circuit breaker per NEMA SG-4,
	vacuum draw out type, vacuum rated
Trip Coil:	1200 amperes continuous, 4.16 kV
Closing Coil:	and 250 mA interrupting
Manual Operation:	24 V dc nominal (18 to 30 V), 30 amperes maximum
	120 V ac, 50/60 Hz, 6 amperes maximum
Operating Temperature:	Via operating (crank) handle furnished for closing,
Storage Temperature:	tripping, charging, and drawing out circuit breaker
Humidity Conditions:	-25° to +125°F (-31° to 51°C)
Manufacturer:	-65° to +155°F (-53° to 68°C)
Part Number:	To 100%
FSCM:	Howe-Yin, Inc.
Surge Capacitor	HVDS-0525-01
Drawing Number:	05464
Number of Poles:	
Voltage Rating:	80-7413
Operating Temperature:	3
Storage Temperature:	4800 V ac
Humidity Conditions:	-25° to +125° F (-31° to 51° C)
Manufacturer:	-65° to +155° F (-53° to 68° C)
Part Number:	To 100%
FSCM:	Westinghouse
Power Relay	1 N02180A01
Drawing Number:	89946
Contacts:	
Coil Input:	80-7845
Terminals:	SPDT 0.312 dia silver
Rating:	50/60 Hz
Coil Data:	Screw type
Coil Resistance:	120 V ac, 25 amperes at 277 V ac, 1 hp at 120/240 V ac
Current:	DC resistance - 290 ohms ±15% at 77° F (25°C)
Voltage:	63,800 ohms maximum with suppression
Electrical Life:	85 milliamperes
	600 V ac maximum
	10, 000 operation at rated load 77°F (25°C)

Table 1-5. System Capacities and Detailed Data on Components (Continued)

AC ELECTRICAL POWER GENERATION AND CONTROL SYSTEM (CONTINUED)	
Contact Snap Action Switch:	Rated at 77°F (25°C) 5 amperes at #120 V ac, 60 Hz
Operation:	AC-85% of nominal voltage at 77°F (25°C)
Power:	9.8 volt amperes at 77°F (25°C)
Duty:	Continuous
Operating Temperature:	-25° to +125°F (-31° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Humidity Conditions:	To 100%
Initial Insulation Resistance:	100 megohms minimum
Insulating Material:	Molded phenolic
Initial Breakdown Voltage:	2000 volts rms between all elements and ground (minimum)
Manufacturer:	Potter and Brumfield
Part Number:	PRD5AY01 20V
FSCM:	77342
Time Delay Relay	
Drawing Number:	80-7842
Operating Voltage:	24Vdc+10 to 15%Vdc
Timing Ranges:	16.7 K ±10% ohms/sec; 2 to 60 minutes calibrated within +10% to #-1 % of value at 68° F (20°C)
Repeat Accuracy:	±1%
Temperature Variation:	±5%
Voltage Variation:	±0.25%
Overall Accuracy:	±5.25%
Output DPDT:	10 amperes resistive rating
Temperature Range:	-22° to 149°F (-30° to 65°C)
Storage Temperature:	-40° to 185°F (-40° to 85°C)
Mounting/Terminals:	Nylon case with 8-pin phenolic base
Mechanical Life:	50 million cycles
Transient Duration:	Less than 0.1 millisecond 1000 volts at 24 V dc; less than 1 millisecond 240 volts at 24 V dc
Current Drain at 24 V dc and 68°F (20°C):	75 milliamperes
Dielectric:	1000 V ac between terminals and case, and between mutually isolated contacts
Manufacturer:	Agastat
Part Number:	SSC1201A
FSCM:	90403

Table 1-5. System Capacities and Detailed Data on Components (Continued)

AC ELECTRICAL POWER GENERATION AND CONTROL SYSTEM (CONTINUED)	
Reverse Power Relay	
Drawing Number:	80-7797
Line Voltage:	120 volts line-to-line, 3 phase, 3 wire, 50/60 Hz
Current Requirements:	0 to 5 amperes ac maximum
Trip Adjustment:	Screwdriver adjustable 4% to 20% of the 5 ampere rating; factory set at 0.5 amperes
Output Contacts:	One set normally closed, one set normally open
Contact Rating:	5 amperes resistive at 120 V ac or 28 V dc
Operating Temperature:	-25° to +125°F (-31° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Manufacturer:	Wilmar Electronics Incorporated
Part Number:	710TDX
FSCM:	25248
Synchro Check Relay	
Drawing Number;	80-7796
Sensing Voltage:	120 V ac ±15%
Line Frequency:	50 to 500 Hz
Time Delay:	Fixed at 110 milliseconds
Contact Rating:	5 amperes at 120 V ac or 28 V dc (resistive)
Phase Angle Adjustment Range:	6 to 18 electrical degrees
Factory Setting:	10 degrees
Operating Temperature:	-25° to +125°F (-30° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Manufacturer:	Wilmar Electronics, Incorporated
Part Number:	1810DB-6X
FSCM:	25248
Undervoltage Relay	
Drawing Number:	80-7795
Nominal Voltage:	208 V ac, 3 phase, 3 wire, 50/60 Hz
Type Sensing:	Lowest of the 3 phase input
UN Adjustment Range:	145 to 208 V ac
Factory Setting:	177V ac
Operating Temperature:	-25° to +125°F (-31° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Contact Rating:	5 amperes at 120 V ac or 28 V dc (resistive)
Manufacturer:	Wilmar Electronics, Incorporated
Part Number:	401-65X
FSCM:	25248

Table 1-5. System Capacities and Detailed Data on Components (Continued)

AC ELECTRICAL POWER GENERATION AND CONTROL SYSTEM (CONTINUED)	
Overvoltage Relay	80-7794
Drawing Number:	208 V ac, 3 phase, 3 wire, 50/60 Hz
Nominal Voltage:	Highest of the 3-phase input
Type Sensing:	208 to 260 V ac
O/V Adjustment Range:	239 V ac
Factory Setting:	-25° to +125°F (-31° to 51°C)
Operating Temperature:	-65° to +155°F (-53° to 68°C)
Storage Temperature:	5 amperes at 120 V ac or 28 V dc (resistive)
Contact Rating:	Wilmar Electronics, Incorporated
Manufacturer:	301 -38C
Part Number:	25248
FSCM:	
Crank Timer Relay	80-7658
Drawing Number:	24 V dc
Nominal Voltage:	
Voltage Limits:	7 to 30 V dc
Pin 4:	24 ± 10% V dc
Pin A:	
Timing Data:	15 ± 5% seconds
On Time:	15 ± 5% seconds
Off Time:	Operate 20 ± 5% seconds
Delay:	
Switching Data,	100 milliamperes at 12 V dc
Semiconductor Method:	200 milliamperes at 12 V dc
Pin 7:	100 milliamperes at 12 V dc
Pin 9:	-25° to +125°F (-31° to 51°C)
Pin B:	-5° to +155°F (-53° to 68°C)
Operating Temperature:	Dynamics Corporation of America,
Storage Temperature:	Potter and Brumfield
Manufacturer:	CZ639
	89265
Part Number:	
FSCM:	80-7436
Ground Fault Relay	199 V ac, 10 seconds at 360 V ac
Drawing Number:	16 minimum, 64 maximum; 50/60 Hz
Voltage Rating:	2 normally open
Tap Range Volts:	30 amperes at 250 V dc, 5 amperes continuous
Contacts:	-25° to +125°F (-31° to 51°C)
Current Rating:	-65° to +155°F (-53° to 68°C)
Operating Temperature:	
Storage Temperature:	

Table 1-5. System Capacities and Detailed Data on Components (Continued)

AC ELECTRICAL POWER GENERATION AND CONTROL SYSTEM (CONTINUED)	
Humidity Conditions:	To 100%
Manufacturer:	General Electric
Part Number:	121AV52D1A
FSCM:	03497
Overcurrent Relay	
Drawing Number:	80-7395
Type:	3 phase
Frequency:	50/60 Hz
Current Taps:	4, 5, 6, 7, 8, 10, and 12 amperes
Pickup Range:	4 to 12 amperes
Operating Temperature:	-25° to +125°F (-31° to 51°C)
Storage Temperature:	-65° to +155°F (53° to 68°C)
Humidity Conditions:	To 100%
Manufacturer:	Brown Boveri Electric
Part Number:	223T1394
FSCM:	36137
Type BF Relay	
Drawing Number:	80-7894
Rating:	120 V ac, 110 V ac, 10 amperes continuous, 50/60 Hz; amperes make 60; amperes break 6; volt amperes make 7200; volt amperes break 720
Contact Material:	Silver alloy
Contacts:	2 normally open, 2 normally closed
Terminals:	Captive clamp
Number of Poles:	2
Coil Data:	
Pickup Time:	11 to 18 milliseconds ac
Dropout Time:	11 to 18 milliseconds ac
Operating Temperature:	-25° to +125°F (-31° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Humidity Conditions:	To 100%
AC Rating:	NEMA A300
DC Rating:	NEMA N300
Manufacturer:	Westinghouse Electric
Part Number:	BF22F
FSCM:	89946
Relay Socket	
Drawing Number:	69-658
Voltage Breakdown:	3500 V dc
Contact Rating:	10 amperes
Insulation:	Per MIL-M-14, Type GD1 -30

Table 1-5. System Capacities and Detailed Data on Components (Continued)

AC ELECTRICAL POWER GENERATION AND CONTROL SYSTEM (CONTINUED)	
Number of Contacts:	8
Mating Pin Size:	0.050 dia
Mounting Hardware:	Furnished with socket relay
Contact:	Copper alloy-gold flashed over silver plate
Manufacturer:	Viking Industries, Inc.
Part Number:	V88/1FA11-80
FSCM:	05574
Pin Socket	
Drawing Number:	80-7660
Rating:	250 V ac, 10 amperes
Connection Wire Size:	12 AWG
Operating Temperature:	-25° to +125°F (-31° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Humidity Conditions:	To 100%
Manufacturer:	Curtis Industries, Inc.
Part Number:	RS8
FSCM:	73631
Socket	
Drawing Number:	80-7376
Material:	Glass filled polyester
Rating:	10 amperes at 277 V ac
Mechanical Characteristics:	0.187 inch (4.62 mm) quick connect terminal base
Operating Temperature:	-25° to +125°F (-31° to 51° C)
Storage Temperature:	-65° to +155°F (-53° to 68° C)
Humidity Conditions:	To 100%
Manufacturer:	Potter Brumfield
Part Number:	27E121, Type KV
FSCM:	77342
Plug Connector	
Drawing Number:	80-7370
Voltage Rating:	600 V ac, 250 V dc
Current Rating:	1 00 amperes
Number of Poles:	3
Terminals:	2
Operating Temperature:	-25° to +125°F (-30° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Humidity Conditions:	To 100%
Manufacturer:	Crouse-Hinds Company
Part Number:	APJ1 0387S22
FSCM:	15235

Table 1-5. System Capacities and Detailed Data on Components (Continued)

AC ELECTRICAL POWER GENERATION AND CONTROL SYSTEM (CONTINUED)	
Switch	
Drawing Number:	80-7948
Rating:	120/277 V ac, 15 amperes
Operating Temperature:	-25° to +125°F (-31° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Humidity Conditions:	To 100%
Contacts:	Solid silver, cadmium oxide
Terminals:	Binding head screws suitable for accepting wires up to No. 10 AWG
Manufacturer:	Harvey Hubbell
Part Numbers:	1201 1203
Number of Poles:	One 3 way
FSCM:	74545
Terminator Elbow	
Drawing Number:	80-7389
Voltage (Maximum):	8.3 kV rms phase to ground; 14.4 kV rms phase to phase
Withstand:	
Voltage Impulse:	95 kV crest, 1.2 x 50 ms wave
AC:	60 Hz 1 minute, 34 kV rms
DC:	15 minutes, 53 Kv
Minimum Corona:	11 Kv rms
Continuous Current:	200 A
Switching Current:	Per ANSI 386-1977; circuit for 10 switching operations; 200 A at 14.4 Kv phase to phase
Fault Closure:	Per ANSI 386-1977; circuit at 14.4 Kv - 10,000 A rms symmetrical for 10 cycles or 15,000 A at 8.3 Kv phase to ground rms symmetrical for 4 cycles (when used with comparably rated bushing)
Operating Temperature:	-25° to +125°F (-31° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Humidity Conditions:	To 100%
Manufacturer:	RTE Corporation
Part Number:	260459B61 M
FSCM:	96207
FUEL SYSTEM	
Fuel Injectors:	
Type:	PT-Type D
Flow:	118 cc

Table 1-5. System Capacities and Detailed Data on Components (Continued)

FUEL SYSTEM (CONTINUED)	
Manufacturer:	Cummins Engine Co,. Inc.
Part Number:	3016676
FSCM:	15434
Fuel Infection Pump:	
Type:	PT(Type G)VS-EFC (Electronic Fuel Control)
Fuel Rate:	426 to 444 lbs/hr. (192 to 200 kg/hr.)
Fuel Rail Pressure:	(176 to 194 psi (1214 to 1338 kPa) at 1800 rpm
Lower Throttle Shaft Rotation:	Counterclockwise to open
Upper Throttle Shaft Rotation:	Clockwise to open
Lower Governor Cutoff Speed:	2010 to 2040 rpm
Upper Governor Cutoff Speed:	1910 to 1940 rpm
Throttle Leakage:	110 cc/min. at 1800 rpm
Idle Speed Flow:	310 ±15 cc/min. at 600 rpm
Throttle Travel (Rotation):	27° to 29° degrees
Calibration Pressure:	185 psi (1276 kPa)
Calibration Flow:	1275 lbs/hr (575 kg/hr)
Check Point Pressure:	137 to 143 psi (945 to 986 kPa)
Check Point Flow:	1080 lbs/hr (486 kg/hr)
Manufacturer:	Cummins Engine Co., Inc.
Part Number:	3201699-11741
FSCM:	15434
Load Sharing Panel	
Drawing Number:	80-7609
Specification:	MIL-G-82058
Power Supply:	24 V dc at 0.25 ampere
Signal Inputs:	120/240 V, 50/60 Hz line-to-line
Performance:	Isochronous or droop parallel or single unit control
Load Sharing:	Adjustable to 10%
Droop:	Adjustable to 100%
Mounting:	Any position
Operating Temperature:	-25° to +125°F (-31° to 51°C)
Storage Temperature:	-65° to +155°F (-53° to 68°C)
Manufacturer:	American Bosch
Part Number:	LS674A
FSCM:	01843
LUBRICATION SYSTEM	
Oil Pump:	
Manufacturer:	Cummins Engine Co., Inc.
Part Number:	AR-1 2388
FSCM:	15434

Table 1-5. System Capacities and Detailed Data on Components (Continued)

CONTROLS, INSTRUMENTS, AND SWITCHGEAR	
Watt Transducer	80-7384
Drawing Number:	2-1/2
Element:	Balanced (±5%)
Voltage:	Unrestricted
Load:	3 phase, 4 wire
Connection:	1500
Cal. Watts:	0 to 3000
Watt Input Range:	120V
Potential Input (Nominal):	0.1 Vat 120V
Potential Burden:	175 V
Potential Overload (Continuous):	0 to 150V
Potential Range:	5A
Current Input (Nominal):	0 to 10A
Current Range:	15 A
Overload (Continuous):	50 A
Overload (10 s/h):	400 A
Overload (1 s/h):	0.2Vaat5A
Burden/Element:	
Output (Full Scale)	± 1 mAdc
Rated Output (RO):	±(0.2% reading +0.01% RO)
Accuracy:	0 to 10 kilohms
Load Resistance, RL:	11.0 volts minimum
Compliance:	Less than 0.5% of RO
Output Ripple Peak:	Less than 400 ms
Response Time (to 99%):	50/60 Hz
Frequency:	Lagging 0.5 to leading 0.5
Power Factor:	-25° to 158°F (-32° to + 70°C)
Operating Temperature:	±0.005%/±0.00050%/ C
Temperature Influence (Maximum):	-65° to +155°F (-53° to 68°C)
Storage Temperature:	To 1 00%
Humidity Conditions:	±0.1% RO maximum
Stability (per Year):	1800 V rms at 60 Hz
Dielectric Test:	Complete input/output/power/supply/case
Isolation:	Withstands IEEE STD 472 SWC test
Surge:	None ever required
Calibration Adjustment:	Scientific Columbus
Manufacturer:	XL31 K421/2A2
Part Number:	24561
FSCM:	

Table 1-5. System Capacities and Detailed Data on Components (Continued)

CONTROLS, INSTRUMENTS, AND SWITCHGEAR (CONTINUED)

Power Factor Transducer
- Drawing Number: 80-7382
- Output, Linear to Phase Angle: 0 to ±0.5 mA
- Output Load Required: 0 to 10 K ohms
- Power System: 3 phase, 4 wire
- Power Factor Range: 0.5 lag to 0.5 lead
- Phase Angle Range: 0 to ± 60 degrees
- Accuracy Rating:
  - At 77°F (25°C): ±0.01 pf from 0.8 pf to 0.8 pf; ±0.02 pf from 0.8 pf to 0.8 pf
  - At -13°to 140°F(-25° to+60°C): ±0.025 pf from 0.5 pf to 0.5 pf; ±0.4 pf from 0.5 pf to 0.5 pf
- Operating Temperature: -25° to +125°F (-31° to 51°C)
- Storage Temperature: -65° to +155°F (-53° to 68°C)
- Humidity Conditions: To 100%
- Manufacturer: Scientific Columbus
  - Part Number: PF-34A4
  - FSCM: 24561

Frequency Transducer
- Drawing Number: 80-7360
- Linearity: 2% of span
- Voltage Range (120 V):

Hz Range	Load Resistance	DC Output		
45 to 55	3000 ohms	1.5	0	1.5
48 to 52	1200 ohms	0.6	0	0.6
55 to 64	3000 ohms	1.5	0	1.5
58 to 62	1200 ohms	0.6	0	0.6
59 to 61	600 ohms	0.3	0	0.3

- Voltage Influence (120 V): Zener regulated; 100 to 140 V ac ±2% of span
- Insulation Ground: 2600 V
- Loss: 3.6 V a
- Operating Temperature: -25° to +125°F (-31° to 51°C)
- Storage Temperature: -65° to +155°F (-53° to 68°C)
- Humidity Conditions: To 100%
- Manufacturer: Westinghouse Corporation
  - Part Number: VC-841
  - FSCM: 88416

Current Transducer
- Drawing Number: 80-7383
- Full Scale Current: 5 amperes
- Burden: 0.25Va
- Overload: 10 amperes continuous, 250 A for 1 second

Table 1-5. System Capacities and Detailed Data on Components (Continued)

CONTROLS, INSTRUMENTS, AND SWITCHGEAR (CONTINUED)	
Frequency Range (Nominal):	50/60 Hz
Maximum Temperature	
Effects on Accuracy:	
Accuracy at 77°F (25°C)	±0.5%
(% RO at Nominal Frequency):	
Output at Rated Input (DC):	±0.25%
Output Load Required:	1 mA
Ripple (Peak):	O to 10 K ohms
Response Time:	Less than or equal to 0.25%
Dielectric Test:	400 rms
Operating Temperature:	1500 rms
Storage Temperature:	-25° to +125°F (-31° to 51°C)
Humidity Conditions:	-65° to +155°F (-53° to 68°C)
Manufacturer:	To 100%
Part Number:	Scientific Columbus
FSCM:	4044, CT510A2
Synchronizer	24561
Drawing Number:	
DC Power Supply Voltage Input:	80-7408
DC Power Supply Current Input:	11 to 30 V dc
AC Voltage Input (Main and General):	110 mA
AC Current Input:	50 to 50 V rms; 3 ranges
Alternator Frequency:	Less than 2 mA
Breaker Closure Relay:	30 to 100 Hz
Breaker Closure Angle (Window):	Normally open (1250 V a); dual 5 amperes at 30 volts
Phase Error Adjustment Range:	±6 (continuously adjustable from ±30 to 0)
Speed Capture Range:	±10
Operating Temperature Range:	±4 (based on 3250 Hz magnetic pickup signal)
Weight:	-40° to 158° F (-40° to 70° C)
Vibration:	2.1 pounds (0.95 kg)
Shock:	5 G at 5 Hz to 300 Hz
Dead Bus Voltage Sensing	20 G's any plane
Adjustment:	
Voltage Matching:	60 to 90% rating
Operating Temperature:	Compatible with VMA671
Storage Temperature:	-25° to +125°F (-31° to 51°C)
Humidity Conditions:	-65° to +155°F (-53° to 68°C)
Manufacturer:	To 100%
Part Number:	American Bosch Division
FSCM:	SY671 Y
	01843

CHAPTER 2

GENERAL MAINTENANCE INSTRUCTIONS

SECTION I. REPAIR PARTS, SPECIAL TOOLS, TEST MEASUREMENT AND DIAGNOSTIC EQUIPMENT (TMDE), AND SUPPORT EQUIPMENT

2-1. REPAIR PARTS. Repair parts and equipment are tested and illustrated in TM 9-6115-604-24P, the Repair Parts and Special Tools List for the generator set.

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

2-3. FABRICATED TOOLS AND EQUIPMENT. Refer to Table 2-2.

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

		Reference			
Item	**NSN or Reference No.**	**Fig. No.**	**Para No.**	**Use**	**Fig.**
Stopwatch	403.201		5-34 5-35 5-36	Testing over/under voltage relays K110/ K111 and overcurrent relay K114.	--
Counterboring Tool, Water Hole	ST-1010 (15434)	--	9-11	Sleeving water holes.	--
Tester, Hydrostatic	ST-1012 (15434)	Figure 9-5	9-8	Testing cylinder heads. Requires 3375070 adapter plates and 3375071 packings.	--
Driver, Rear Seal/ Wear	ST-1093 (15434)	--	9-33	Installing rear wear ring and crankshaft seal. Also to align seal retainer.	--
Manometer	ST-1111-3 (15434)	Figure 12-1	12-3	For use with 3375767 manometer.	--
Puller, Main Bearing Cap	ST-1116 (15434)	--	9-22	Removing main bearing caps.	--
Driver, Valve Seat Insert Staking	ST-1122 (15434)	--	9-11	Installation of valve seat inserts.	--
Guide, Head, Dowel Pin	ST-1134 (15434)	--	9-11	Removing dowel pins and cross-head guides.	--
Magnetic Crack Detector	ST-1166 (15434)	--	9-8	Testing for surface cracks in cylinder head.	--
Counterbore Tool, Liner	ST-1168 (15434)	--	9-31	Repairing liner counterbore in cylinder block.	--
Bore Tool, Main Bearing	ST-1177 (15434)	--	9-31	Boring main bearing bores.	--
Crankshaft Hardness Tester	ST-1196 (15434)	--	9-28	Testing crankshaft hardness.	--
Plate, Puller	ST-1209 (15434)	--	9-24	For use with 3375629 cylinder liner puller.	--
Driver Set, Camshaft Bushing	ST-1228 (15434)	Figure 9-18	9-16	Removing and installing camshaft bushings.	--

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

Item	NSN or Reference No.	Reference Fig. No.	Reference Para No.	Use	Fig.
Block Weight Carrier	ST-1231 (15434)	--	6-12	Removing and installing weight carrier.	--
Checking Tool, Plunger	ST-1241 (15434)	--	6-12	Checking fuel pump governor weight plunger protrusion.	--
Puller, Coupling Half	ST-1249 (15434)	--	6-12	Disassembling fuel pump.	--
Gage, Concentricity	ST-1252 (15434)	Figure 9-57	9-31	Checking concentricity of cylinder block lower liner bore.	--
Vacuum Tester, Valve	ST-1257 (15434)	Figure 9-11	9-9	Checking valve and seat sealing in cylinder head.	--
Seal	ST-1257-36 (15434)	--	9-9	Exhaust Valve Seal.	--
Seal	ST-1257-37 (15434)	--	9-9	Intake valve seal.	--
Cup	ST-1257-38 (15434)	--	9-9	Sealing intake and exhaust valves.	--
Spacer, Crosshead Guide	ST-1264 (15434)	--	9-11	Installing valve crosshead guide.	--
Driver, Valve Guide, Tapered Top	ST-1265 (15434)	--	9-11	Installing valve guide.	--
Clamp, Cylinder Liner	ST-1267 (15434)	Figure 9-34	9-24	Clamping cylinder liner for protrusion checking.	--
Expander, Piston Ring	ST-1269 (15434)	--	9-20	Removing and installing piston rings.	--
Block, Roller Pin followers.	ST-1283 (15434)	Figure 9-14	9-14	Disassembling and assembling cam	--
Mandrel	ST-1284 (15434)	--	9-13	Removing and Installing rocker lever bushings.	--
Driver, Connecting Rod Bushing	ST-1285 (15434)	Figure 9-28	9-19	Removing and installing piston pin bushings.	--
Valve Seat Insert Staking Tool	ST-1288 (15434)	--	9-11	Installing valve seat inserts.	--
Stand, Injector Assembly	ST-1 298 (15434)	--	6-15	Repairing fuel injectors.	--
Mandrel Set, Locating	ST-1305 (15434)	--	9-19	Checking connecting rod alignment.	--
Counterbore Tool, Cylinder Block	ST-1309 (15434)	--	9-31	Resurfacing cylinder liner counterbore.	--
Cutter Set, Valve Seat Insert	ST-1310 (15434)	--	9-11	Installing new valve seat inserts.	--

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

		Reference			
Item	NSN or Reference No.	Fig. No.	Para No.	Use	Fig.
Pilot, Camshaft	ST-1313 (15434)	--	9-15	Removing and installing camshaft.	--
Driver, Valve Guide Flat Top	ST-1315 (15434)	--	9-11	Installing valve guide.	--
Driver, Water Tube	ST-1319 (15434)	--	9-5	Removing and installing water transfer tubes.	--
Extractor, Valve Seat	ST-1323 (15434)	--	9-11	Removing valve seat inserts.	--
Dial Gage Attachment	ST-1325 (15434)	Figure 9-64	9-35	Checking flywheel and housing runout.	--
Puller, Tachometer Drive	ST-1326 (15434)	--	6-12	Removing tachometer drive from fuel pump.	--
Arbor, Expanding	ST-1331 (15434)	--	9-20	Checking connecting rod alignment.	--
Tool Kit, Valve Seat Insert	ST-257 (15434)	--	9-11	Cutting valve seat insert counterbores.	--
Vise, Ball Joint	ST-302 (15434)	--	6-11	Repairing and rebuilding fuel pump.	--
Pulley Assembly Tool	ST-386 (15434)	--	9-33	Installing accessory drive pulley.	--
Compressor, Valve Spring	ST-448-6 (15434)	--	9-6	Removing and installing valve springs.	--
Fixture, Reaming	ST-490 (15434)	--	6-12	Reaming fuel pump mainshaft bushing.	--
Gage, Piston Ring Groove Wear	ST-560	--	9-20	Measuring wear of piston ring groove.	--
Fixture, Rod Checking	ST-561 (15434)	--	9-19	Checking connecting rod alignment.	--
Front Gear Cover Bushing Mandrel	ST-598 (15434)	--	9-18	Installing and removing bushings in front gear cover.	--
Standard Puller	ST-647 (15434)	--	9-31	All purpose puller.	--
Valve Facing Machine	ST-684 (15434)	--	9-9	Refacing valves.	--
Valve Seat Grinding Machine	ST-685 (15434)	--	9-9	Refacing valve seats.	--
Eccentrimeter	ST-685-4 (15434)	--	9-9	Checking valve seat concentricity.	--
Puller, Weight Carrier	ST-709 (15434)	--	6-12	Disassembling weight carriers.	--
Connecting Rod Chamfering Tool	ST-861 (15434)	Figure 9-27	9-19	Cutting chamfer for connecting rod bushing installation.	--

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

Item	NSN or Reference No.	Reference Fig. No.	Reference Para No.	Use	Fig.
Brush	ST-876 (15434)	--	9-7	Cleaning fuel passages in cylinder head.	
Wrench, Injector Cup	ST-995 (15434)	--	6-16	Repairing fuel injectors.	--
Cutter, Thrust Surface	3375053 (15434)	--	9-31	Refinishing cylinder block thrust bearing surface. Use with ST-11 77.	--
Main Bearing Bore Kit	3375059 (15434)	Figure 9-58	9-31	Checking main bearing bore alignment.	--
Plate, Adapter	3375070 (15434)	--	9-8	Adapting cylinder head to ST-1012.	--
Packing Set	3375071 (15434)	--	9-8	Sealing cylinder head. Use with 3375070.	--
Pin, Guide	3375098 (15434)	--	9-19	Removing connecting rod.	--
Mounting Plate, Fuel Pump	3375133 (15434)	--	6-11	Assembling and disassembling fuel pump	--
Driver	3375172 (15434)	--	6-12	Assembling fuel pump.	--
Driver, Seal	3375173 (15434)	--	6-12	Assembling fuel pump.	--
Driver, Seal	3375174 (15434)	--	6-12	Assembling fuel pump.	--
Valve Spring Tester	3375182 (15434)	--	9-5	Testing valve spring tension.	--
Installing Tool, Throttle Shaft Ball	3375204 (15434)	--	6-12	Assembling fuel pump.	--
Lube Oil Pump Bushing Boring Tool	3375206 (15434)	--	8-13	Boring lube oil pump bushing.	--
Gage, Fillet Ball	3375241 (15434)	Figure 9-52	9-28	Checking fillet radius of crank-shaft journals.	--
Gage, Fillet Ball	3375242 (15434)	Figure 9-52	9-28	Checking fillet radius of crankshaft journals.	--
Water Pump Carbide Seal Mandrel	3375256 (15434)	--	7-4	Installing carbide seal, water pump.	--
Puller Assembly	3375265 (15434)	--	7-2	Removing water pump pulley and impeller.	--
Water Pump Bearing Mandrel	3375318 (15434)	--	7-4	Installing water pump bearings.	--

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

Item	NSN or Reference No.	Reference Fig. No.	Reference Para No.	Use	Fig.
Water Pump Seal Mandrel	3375319 (15434)	--	7-4	Installing front water seals.	--
Water Pump Bearing Separator	3375326 (15434)	--	7-2	Removing water pump bearings from shaft.	--
Injector Leakage Tester	3375375 (15434)	Figure 6-18	6-14	Measuring fuel leakage in fuel injectors.	--
Injector Link	3375398 (15434)	--	6-19	For use with 3375375 injector leakage tester.	--
Test Stand Kit, Injector	3375410 (15434)	Figure 6-20	6-14	Testing and calibration of fuel injectors.	--
Cylinder Liner Installation Tool	3375422 (15434)	--	9-24	Installing cylinder liners.	--
Bridge Assembly	3375423 (15434)	--	9-24	For use with 3375422 cylinder liner installation tool.	--
Plate, Liner Installation	3375424 (15434)	--	9-24	For use with 3375422 cylinder liner installation tool.	--
Compressor, Ring	3375432 (15434)	--	9-21	Installing piston connecting rod assemblies in cylinder	--
Adapter Pot	3375440 (15434)	--	6-14	For use with 3375375 injector leakage tester.	--
Pilot, Drill	3375497 (15434)	--	9-33	For use with 3375786.	--
Injection Timing Fixture	3375522 (15434)	Figure 9-21	9-18	Checking injection timing.	--
Puller, Cylinder Liner	3375629 (15434)	--	9-24	Removing cylinder liners.	--
Tachometer, Digital	3375631 (15434)	--	13-15	Measuring engine speed from tachometer drive in fuel pump.	--
Test Stand, Fuel Pump	3375698 (15434)	Figure 6-14	6-13	Calibrating fuel pump.	--
Engine Blow-By Tool	3375767 (15434)	Figure 12-1	12-3	Measures engine blowby.	--
Oil Seal Puller/ Installer	3375786 (15434)	--	9-33	Removing and installing crankshaft seal.	--
Liner Counterbore Salvage Tool	3375820 (15434)	--	9-31	Adapter for ST-11 68.	--
Puller Assembly	3375834 (15434)	--	9-18	Removing crankshaft gear.	--
Jaw, Puller	3375835 (15434)	--	9-18	For use 3375834 puller assembly.	--

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

		Reference			
Item	NSN or Reference No.	Fig. No.	Para No.	Use	Fig.
Valve Guide Arbor Set	3375946 (15434)	--	9-9	For use with ST-685.	--
Stand, Engine Rebuild	3375955 (15434)	--	9-27	Assembling and disassembling engine.	--
Driver, Pressure Valve	3375959 (15434)	--	6-12	Assembling fuel pump.	--
Idle Speed Adjusting Tool	3375981 (15434)	--	6-13	Calibrating fuel pump.	--
Puller, Injector	3376000 (15434)	--	6-15	Removing injectors.	--
Dial Indicator	3376050 (15434)	Figure 9-19	9-18	Measuring camshaft end clearance.	--
Cutter Assembly	3376219 (15434)	--	9-31	For use with ST-11 68.	--
Block, Gage	3376220 (15434)	Figure 9-6	9-8	Measuring injector tip protrusion and cylinder liner protrusion.	--
Counterbore Repair Sleeve	3376222 (15434)	--	9-31	For use with 3375820.	--
Driver, Sleeve	3376223 (15434)	--	9-31	For use with ST-1168.	--
Plate, Guide	3376224 (15434)	--	9-31	For use with ST-11 68.	--
Shaft, Sleeve Driver	3376226 (15434)	--	9-31	For use with ST-11 68.	--
Camshaft Bore Salvage Kit	3376345 (15434)	--	9-31	For use with ST-i 177.	--
Bushing, Camshaft Repair	3376347 (15434)	--	9-31	For use with ST-I 177.	--
Spray Tester, Injector Cup	3376350 (15434)	Figure 6-19	6-14	Checking injector cup spray pattern.	--
Kit, Cam Gear Puller	3376400 (15434)	--	6-15	Removing camshaft gear.	--
Governor Plug Tool	3376457 (15434)	--	6-10	Assembling and disassembling fuel pump.	--
Soldering Iron	3439-00-223-2528	--	5-29	Repair of relay panel assemblies.	--
Wrench, Torque	5120-00-640-6364	--	9-10	Tightening cylinder head capscrews.	--
Megohmmeter	6625-00-643-1030	--	5-26	Testing surge suppressor capacitor.	--
Grounding Stick	T6000891 (17438)	--	5-26	Discharging residual voltage from components.	--

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

Item	NSN or Reference No.	Reference Fig. No.	Reference Para No.	Use	Fig.
Tool Kit, Electronic	K600 (27596)		5-31	Repairs of protective relays.	--
Power Supply, 0-10 V ac Variable	621 3A (28480)		5-33	Testing reverse power relay K109.	--
Fixture, Lifting	D-511856 (38151)		5-16	Installing and removing generator G1 rotor.	--
Spanner, Adjust-able 3 Inch	383 (96645)		6-19	Repair of fuel tank.	--
Power Supply, 24 V dc	PUC50-2 (98380)		5-29	Testing time delay relay K23.	--
Overtravel Adjusting tool	T1	Figure 5-20	5-22	Adjusting load circuit breaker CB101 return spring overtravel.	--
Heat Gun	300X (60903)		5-4	Drying generator gland components.	--

Table 2-2. Fabricated Tools and Equipment

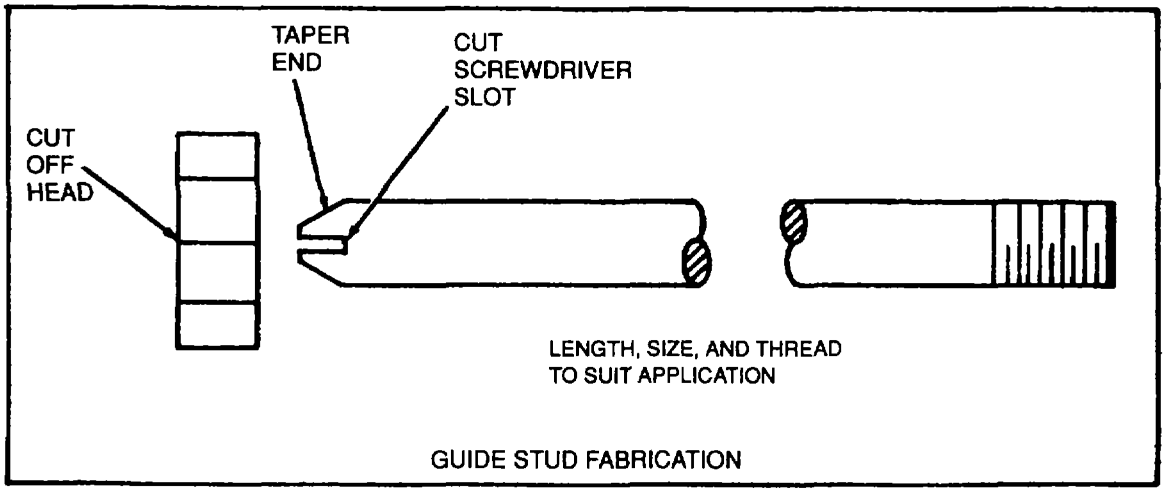
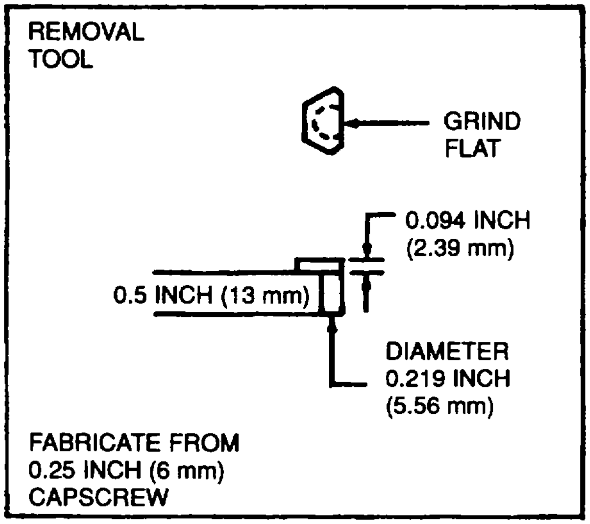
DESCRIPTION

Guide Studs, front gear cover (2 required) Fabricate from capscrew, part number 110266, or equivalent
Guide Studs, front gear housing (2 required) Fabricate from capscrew, part number 103009, or equivalent
Guide Studs, flywheel installation (2 required) Fabricate from capscrew, part number 3023536, or equivalent
Guide Studs, flywheel housing installation (2 required) Fabricate from capscrew, part number 205556, or equivalent

Table 2-2. Fabricated Tools and Equipment (Continued)

DESCRIPTION
Guide Studs, rear gear housing installation (2 required) Fabricate from capscrew, part number 106069, or equivalent
Guide Studs, vibration damper installation (2 required) Fabricate from capscrew, part number 3023539, or equivalent
Guide Studs, oil pan installation (10 required) Fabricate from capscrew, 7/16", 14 thread, approximately 3" long
Guide Studs, thermostat housing support (2 required) Fabricate from support capscrew, part number 205669, or equivalent
Guide Studs, aftercooler cover installation (2 required) Fabricate from capscrew, part number 3012475, or equivalent
Guide Studs, intake manifold installation (6 required) Fabricate from capscrew, part number S149, or equivalent.

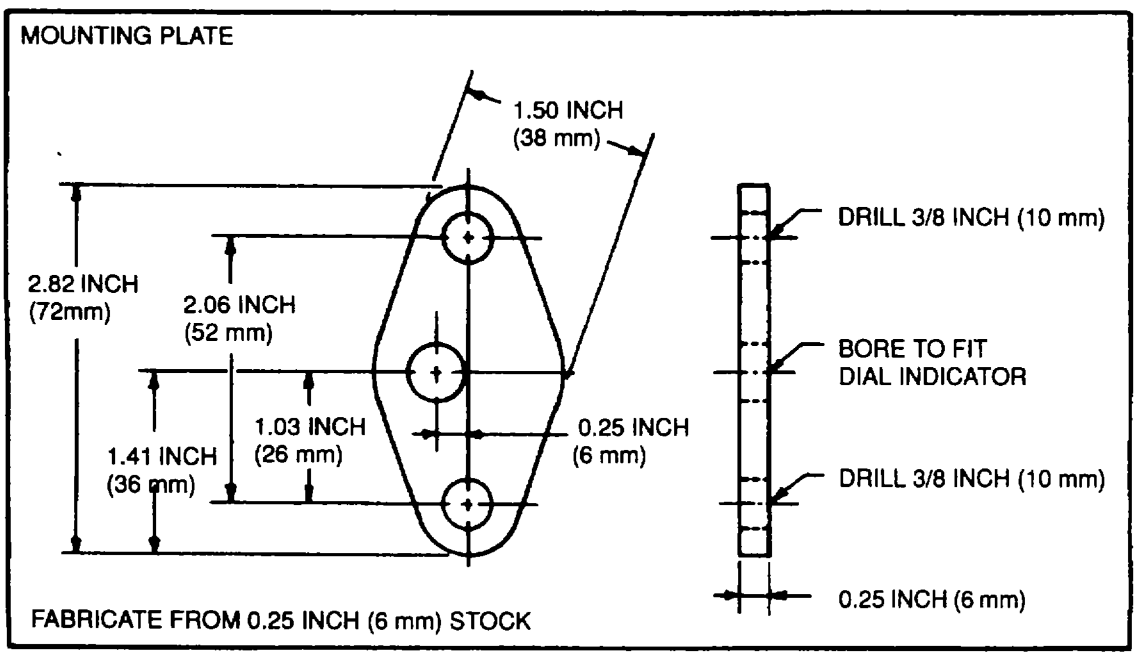
Table 2-2. Fabricated Tools and Equipment (Continued)

DESCRIPTION
Main Bearing Removal Tool



Fabricate from 1/4 inch capscrew (6 mm)

Dial Indicator Mounting Plate



Fabricate from 1/4 inch (6 mm) stock

SECTION II. TROUBLESHOOTING

2-4. GENERAL.

a. Table 2-3 and Table 2-4 contain 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 inspections or tests which will help you to determine probable causes and corrective actions to take. You should perform the inspections/tests and corrective actions in the order listed.

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

Table 2-3. Engine Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. ENGINE CRANKS BUT WILL NOT START.

Step 1. Check fuel pump operation in accordance with paragraph 6-8.
Repair or replace as necessary.

Step 2. Check for proper injector adjustment in accordance with paragraph 6-17.
Adjust.

Step 3. Check injector operation in accordance with paragraph 6-17.
Repair or replace as necessary.

2. ENGINE SHUTS DOWN SOON AFTER STARTING.

Step 1. Check fuel pump for proper adjustment in accordance with paragraph 6-9.
Adjust fuel pump.

Step 2. Check injector flow in accordance with paragraph 6-17.
Adjust fuel injectors.

3. ENGINE SHUTS DOWN AND WILL NOT RESTART.

Step 1. Check fuel pump operation in accordance with paragraph 6-8.
Repair as necessary.

Step 2. Check fuel pump for proper calibration in accordance with paragraph 6-11.
Calibrate as necessary.

4. ENGINE RUNS ERRATICALLY OR MISFIRES.

Step 1. Check compression of all cylinders.
Repair as necessary.

Step 2. Check turbochargers in accordance with the Operator and Organizational Maintenance Manual.
Repair as necessary.

Table 2-3. Engine Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

4. ENGINE RUNS ERRATICALLY OR MISFIRES (CONTINUED).

Step 3. Check cylinder head assemblies and gasket in accordance with paragraphs 9-4 through 9-9.
Repair or replace as necessary.

Step 4. Check injector operation in accordance with paragraph 6-17.
Repair or replace as necessary.

Step 5. Check gear pump on fuel pump for worn gears in accordance with paragraph 6-10.
Repair or replace as necessary.

Step 6. Check camshaft lobes for wear in accordance with paragraph 9-15.

5. ENGINE EXHAUST EXCESSIVELY BLACK.

Step 1. Remove and inspect injectors in accordance with paragraph 6-15 and test in accordance with paragraph 6-17.
Repair or replace as necessary.

Step 2. Check fuel pump for proper calibration in accordance with paragraph 6-11.
Calibrate.

Step 3. Check cylinder head assemblies and gasket in accordance with paragraphs 9-4 through 9-9.
Repair as necessary.

Step 4. Check camshaft lobes for wear in accordance with paragraph 9-15.
Replace as necessary.

Step 5. Check the aftercooler for clogging or defects in accordance with paragraph 9-42.

Repair or replace as necessary.

6. ENGINE EXHAUST EXCESSIVELY WHITE OR BLUE.

Step 1. Check and test injectors in accordance with paragraph 6-17.
Repair and adjust as necessary.

Step 2. Check camshaft and bushings for wear in accordance with paragraphs 9-15 and 9-16.
Replace parts as necessary.

Step 3. Check cylinder head assemblies and gasket in accordance with paragraphs 9-4 through 9-9.
Repair or replace as necessary.

Step 4. If oil consumption is high, check for worn rings or liners by removing the exhaust manifolds and checking for oily or carboned parts in accordance with paragraph 9-12.

Repair as necessary.

Table 2-3. Engine Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

6. ENGINE EXHAUST EXCESSIVELY WHITE OR BLUE (CONTINUED).

Step 5. Check aftercooler for internal cracks or defects in coolant passages and test in accordance with paragraph 9-42.

Repair or replace as necessary.

7. GENERATOR OUTPUT FREQUENCY CANNOT BE MAINTAINED.

Check electronic speed control for proper adjustment.

Adjust as necessary.

8. HARD STARTING

Step 1. Check intake and exhaust manifolds for possible seal leaks in accordance with the Operator and Organizational Maintenance Manual.

Replace seals.

Step 2. Check fuel pump operation in accordance with paragraph 6-8.
Repair or replace as necessary.

Step 3. Check injector operation in accordance with paragraph 6-17.
Repair or replace as necessary.

Step 4. Check injector lobes on camshaft in accordance with paragraph 9-15.
If lobes are worn, replace camshaft.

Step 5. If oil consumption is high, check for worn rings or liners by removing the exhaust manifolds and checking for oily or carboned parts in accordance with paragraph 9-12.

Repair as necessary.

9. LOW POWER OR LOSS OF POWER.

Perform all tests and inspections listed for MALFUNCTIONS 2, 5, 6, 7, and 9 of this manual.

Correct as specified.

10. CANNOT REACH GOVERNED RPM.

Step 1. Fuel pump may not be properly calibrated. Check in accordance with paragraph 6-11.
Calibrate.

Step 2. Check and test injector flow in accordance with paragraph 6-17.
Adjust.

Step 3. Check cylinder head pressure for possibility of gasket blow-by.
Replace gasket if necessary.

Table 2-3. Engine Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

10. CANNOT REACH GOVERNED RPM (CONTINUED).

Step 4. Check governor and actuator operation in accordance with paragraphs 6-23 and 6-11 respectively.
Repair or replace as necessary.

11. EXCESSIVE FUEL CONSUMPTION.

Step 1. Check and test fuel injector flow in accordance with paragraph 6-17.
Correct as necessary.

Step 2. Check fuel pump calibration in accordance with paragraph 6-11.
Calibrate as necessary.

12. EXCESSIVE OIL CONSUMPTION.

Step 1. Check for external oil leaks.
Repair as necessary.

Step 2. Check cylinder compression for gasket blow-by, leakage, or worn piston rings.
Repair as necessary.

13. CRANKCASE SLUDGE.

Check for internal water leaks. Check head gaskets, cylinder heads, liner packing, and cylinder block in accordance with Chapter 9.

Repair as necessary.

14. DILUTION (CRANKCASE).

Step 1. Check cylinder head assemblies and gaskets for leaks in accordance with paragraphs 9-4 and 9-8.
Repair as necessary.

Step 2. Check and test injectors in accordance with paragraph 6-17.
Repair as necessary.

Step 3. Check fuel pump calibration in accordance with paragraph 6-11.
Calibrate.

15. LOW OIL PRESSURE.

Step 1. Check oil pump in accordance with paragraph 8-12.
Repair or replace as necessary.

Step 2. Check for high oil temperature.
Clean oil cooler in accordance with paragraph 8-6. Flush water passages.

Table 2-3. Engine Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

15. LOW OIL PRESSURE (CONTINUED).

Step 3. Check crankshaft bearing clearances in accordance with paragraphs 9-21 and 9-22.

Replace bearings as necessary.

16. COOLANT TEMPERATURE TOO HIGH.

Check radiator in accordance with the Operator and Organizational Maintenance Manual.

Repair or replace radiator.

17. OIL TEMPERATURE TOO HIGH.

Step 1. Check lube oil cooler for restriction in accordance with paragraph 8-6.
Clear all foreign matter from oil cooler.

Step 2. Check oil pump assembly in accordance with paragraph 8-12.
Repair or replace as necessary.

18. FUEL KNOCKS (COMBUSTION NOISE).

Check fuel injectors in accordance with paragraphs 6-15 and 6-17.

Repair, clean, and adjust injectors as required.

19. EXCESSIVE CRANKCASE PRESSURE.

Check in accordance with MALFUNCTION 12, Step 2.

Table 2-4. Electrical Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. ANNUNCIATOR PANEL INDICATOR LAMPS FAIL TO LIGHT WHEN ANNUNCIATOR TEST PUSHBUTTON IS PRESSED.

Check all components associated with annunciation alarm system in accordance with paragraphs 10-1 and 10-2.

Repair as necessary.

2. LOAD CIRCUIT BREAKER CB101 FAILS TO CLOSE.

Step 1. Verify that switch gear circuit breaker CB123 is ON.

Set to ON as necessary.

Step 2. Test load circuit breaker CB101 in accordance with paragraph 5-19.

Repair as necessary.

Table 2-4. Electrical Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

2. LOAD CRCUIT BREAKER CB101 FAILS TO CLOSE (CONTINUED).

Step 3. Check and test circuit breaker trip relay K30 in accordance with paragraph 5-30 and check wiring using FO-7.

Repair or replace as necessary.

Step 4. Check and test synchro check relay K116 in accordance with paragraph 5-38.

Repair or replace as necessary.

3. GENERATOR G1 DOES NOT PRODUCE VOLTAGE.

WARNING
Lethal static charges may be on generator G1 lines T1, T2, T3, L1, L2, or L3 when generator set is shut down. Using an insulated (fiberglass) rod with a ground metal tip, discharge generator leads to ground prior to working on them.

Step 1. Shut down generator set. Park load cables and remove rear access panel to cabinet B. Refer to Figure 10-3. Discharge generator G1 leads T1, T2, T3, L1, L2, and L3 to ground using an insulated (fiberglass) rod with grounded metal tip.

Step 2. Check lead connections to lightning arresters E101, E102, and E103 and surge suppression capacitor C101 for security.

Correct as necessary.

Step 3. Install rear access panel to cabinet B. Check contact set 46 (field flashing) of crank relay K3 for proper connection to battery positive in accordance with paragraph 5-28.

Replace crank relay K3 as necessary.

Test voltage regulator VR101 in accordance with paragraph 5-13.

If voltage regulator VR101 passes bench test but fails on equipment test, check all wiring to voltage regulator VR101 and repair or replace as necessary.

Check crank relay K3, contact set 4-6 (field flashing) for proper connection to battery positive. Refer to paragraph 5-28 for relay K3 test procedure. Replace K3 if defective.

Step 4. Remove louvered cover from conduit box and inspect and test the rotating rectifier assembly in accordance with paragraph 5-6.

Clean or repair in accordance with paragraph 57, step b.

If necessary, repair the rotating rectifier assembly in accordance with paragraph 5-7, step b.

Step 5. Test generator G1 in accordance with paragraph 56.

If necessary, dry the generator in accordance with paragraph 5-4 or repair the generator in accordance with paragraph 57.

Table 2-4. Electrical Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

4. GENERATOR G1 PRODUCES LOW VOLTAGE.

Troubleshoot in accordance with MALFUNCTION 3, above.

Correct as specified.

5. GENERATOR G1 PRODUCES HIGH VOLTAGE.

WARNING

Lethal static charges may be on generator G1 lines T1, T2, T3, L1, L2, or L3 when generator set is shut down. Using an Insulated (fiberglass) rod with a ground metal tip, discharge generator leads to ground prior to working on them.

Step 1. Shut down generator set. Remove rear panel to Cabinet B. Refer to Figure 10-3. Discharge generator G1 leads T1, T2, T3, L1, L2, and L3 to ground using an insulated (fiberglass) rod with grounded metal tip.

Step 2. Troubleshoot in accordance with MALFUNCTION 3, steps 3-5 above.

Correct as specified.

6. GENERATOR G1 VOLTAGE FLUCTUATES,

Step 1. Adjust stability of voltage regulator VR101 by adjusting rheostat VR101R11 clockwise for increased stability.

If voltage regulator VR101 cannot be adjusted, test in accordance with paragraph 5i 3. Repair or replace as necessary.

Step 2. Adjust OPERATION POINT ADJUSTMENT on CURRENT BOOST SYSTEM A101 clockwise.

If problem persists, troubleshoot in accordance with MALFUNCTION 1, above.

Step 3. Check parallel cable assemblies in accordance with the Operator and Organizational Maintenance Manual. Repair or replace as necessary.

7. GENERATOR G1 VOLTAGE RECOVERY SLOW WITH LOAD CHANGES.

Step 1. Adjust stability of voltage regulator VR101 by adjusting rheostat VR101R11 counterclockwise to decrease response time to load changes.

If voltage regulator VR101 cannot be adjusted, go to Step 3, below.

Step 2. Adjust OPERATION POINT ADJUSTMENT on CURRENT BOOST SYSTEM Al01 counter clockwise.

If adjustment cannot be made, go to Step 3, below.

Step 3. Test voltage regulator VR101 in accordance with paragraph 5-13.

If voltage regulator passes bench test, but fails on equipment test, replace CURRENT BOOST SYSTEM Al 01.

Table 24. Electrical Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

8. PARALLELED GENERATOR SETS DO NOT DIVIDE LOAD EQUALLY IN PARALLEL ISOCHRONOUS MODE

Step 1. Test bad sharing panel Al 04 in accordance with paragraph 6-23.

WARNING
Lethal static charges may be on generator G1 lines T1, T2, T3, L1, L2, or L3 when generator set is shut down. Using an insulated (fiberglass) rod with a ground metal tip, discharge generator leads to ground prior to working on them.

Step 2. Shut down generator set. Park load cables. Remove rear access panel to Cabinet B. Refer to Figure 10-3. Discharge generator G1 leads T1, T2, T3, L1, L2, and L3 to ground using an insulated (fiberglass) rod with grounded metal tip.

Step 3. Refer to Figure 10-3. Make sure line T2 and not T1, T3, or TO is running through current transformer CT114.

Correct as necessary

Step 4. Check wiring connections to current transformer CT114 terminals against FO-9. Be sure leads are not reversed.

Tighten connections.

Step 5. Test current transmitter CT114 in accordance with the Operator and Organizational Maintenance Manual.

Replace if necessary in accordance with paragraphs 5-7 and 5-9.

SECTION III. GENERAL MAINTENANCE

2-5. GENERAL This section contains general in on repair practices such as cleaning, connecting and disconnecting wires, soldering, and welding.

WARNING
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.

WARNING
Dry cleaning solvent, PD-680, type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid Injury to personnel.

2-6. CLEANING. Components may be cleaned with low pressure compressed air, then wiped dean with a dry, lint-free cloth. Components may also be cleaned with a cloth dampened in dry cleaning solvent P-D-680, Type II, or equivalent.

2-7. WIRING Tag all wires and cables during removal procedures 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 gage. Never use replacement wire with a higher gage number (smaller diameter).

WARNING

To avoid Injury to personnel, do not breathe fumes generated by soldering. Remove rings and watches while soldering. Eye protection is required to avoid Injury to personnel.

2-8. 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 first determining its proper setting. Repeat prior to reenergizing the equipment.

WARNING

Welding operations produce heat, highly toxic fumes, and Injurious radiation, metal slag, and airborne particles. Welding with goggles, the proper tinted lenses, apron or jacket, and welders gloves are required to avoid Injury to personnel.

2-9. WELDING. Proper preparation is an important factor in welding. Edges to be joined must be dean. 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, steps shall be taken to make certain that the finished job will be in correct alignment

2-10. EXPANSION PLUG REPLACEMENT.

a. Drive a tapered punch through the center of the defective expansion plug and use the punch to pry out the plug.

b. Clean the hole thoroughly using a hand wire brush to remove any rust or scale.

c. Coat the outer diameter of the new expansion plug with sealant MIL-S45180.

d. Using a bushing driver that fits the inner and outer diameters of the expansion plug, drive the plug into the hole until it is recessed approximately 0.062 inch (1 .57mm).

2-11. HEUCAL INSERT REPLACEMENT.

a. Using a sharp scratch-awl, lift the end of the insert, and remove it using needle nose pliers (A, Figure 2-1).

b. Using special insert tap of the proper size as listed in MS-33537 (Standard Dimensions for Insert, Screw Thread, Helical Coil, Coarse and Fine Thread), repair any thread damage caused by removal (B, Figure 2-1).

c. Using the installing tool, screw in the new insert to a depth of 3/4 to 1 1/2 threads below the edge of the hole (C, Figure 2-1).

d. Using the break off tool, remove the driving tang form the insert (D, Figure 2-1).

2-12. THREADED HOLE REPAIR.

a. Drill out the damaged threads using the correct drill size for a helical insert as listed in MS-33537 (Standard Dimensions for Insert, Screw Thread, Helical Coil, Coarse and Fine Thread).

b. Tap the hole to the proper size for the insert as listed in MS 33537 (Standard Dimensions for Insert, Screw Thread, Helical Coil, Coarse and Fine Thread).

c. Install the insert in accordance with paragraph 2-11, steps c and d, above.

2-13. SHEET METAL REPAIR.

a. Repair cracks and tears in sheet metal by welding in accordance with paragraph 2-9.

b. Remove small dents using body hammers and dollies.

c. Remove surface scratches using abrasive paper P-P-101.

d. Treat and paint the repaired surface in accordance with MIL-T-704, Type A. Paint must be in accordance with FED-STD-595.

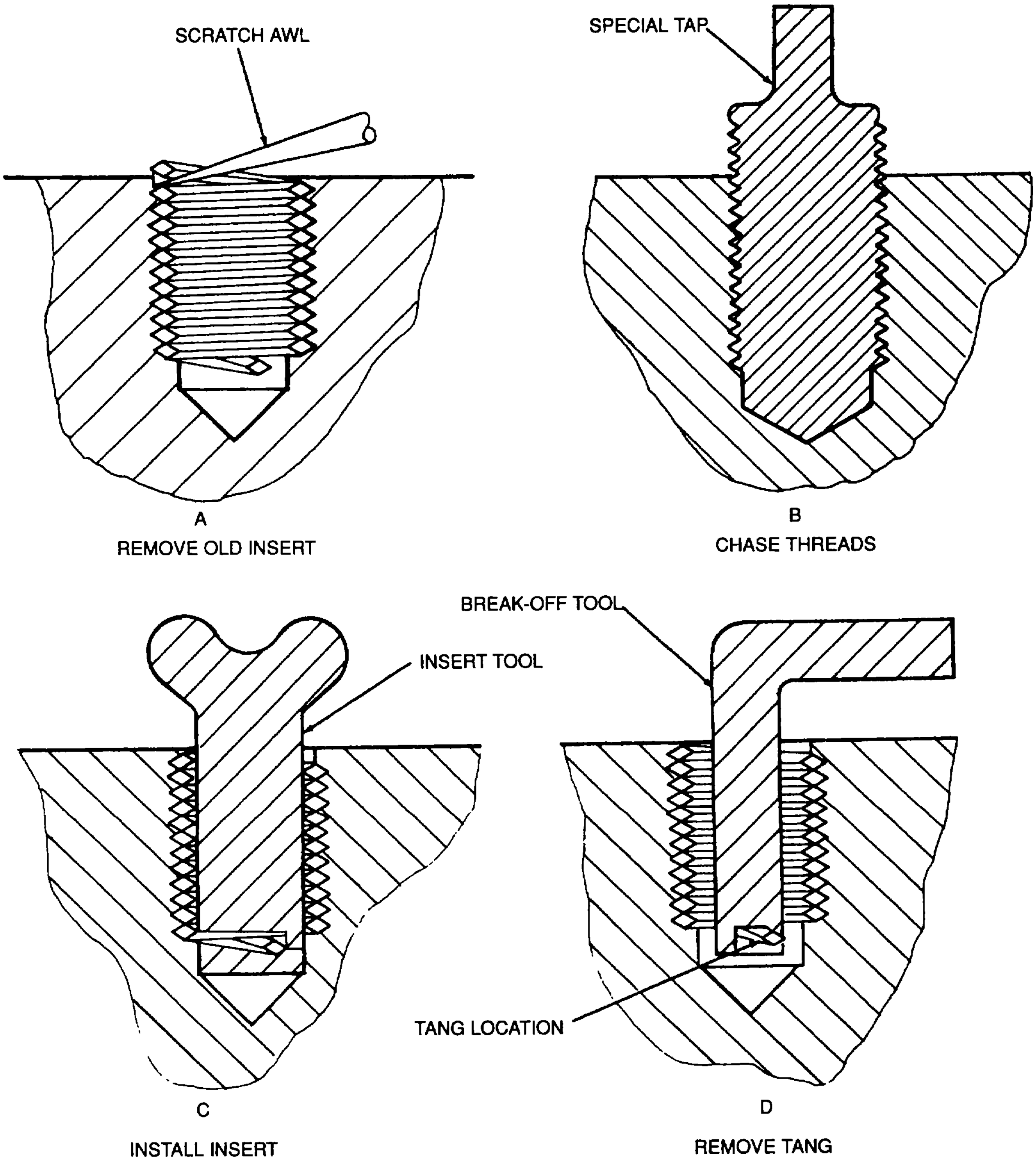


Figure 2-1. Removing and Installing Helical Coil Thread Inserts

SECTION IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS

2-14. GENERAL. This section contains removal and installation procedures for the engine, generator G1,fuel tank and load circuit breaker CB101.

2-15. ENGINE REMOVAL AND INSTALLATION.

a. Remove. The engine is removed through the front of the generator set using an overhead crane or hoist, rated for 15,000 pounds (6800 kg) with a minimum height clearance of 124 inches (3175 mm). Proceed as follows

(1) Disconnect load cables from output terminals, place on safety stands and tag output terminal to ensure generator set is not connected to load bus during generator removal.

(2) Set maintenance lockout switch to MAINTENANCE and safety tag.

(3) Disconnect cable from UTILITY POWER receptacle and safety tag UTILITY POWER receptacle to ensure cable is not connected during engine removal.

(4) Remove batteries in accordance with paragraph 3-9 of the Operator and Organizational Maintenance Manual.

(5) Drain the cooling and lubrication systems in accordance with paragraphs 3-3 and 3-12 of the Operator and Organizational Maintenance Manual.

(6) Disconnect the oil prelube hoses and bypass filter hose from the engine block, and oil pan in accordance with paragraphs 4-65 and 4-71 of the Operator and Organizational Maintenance Manual.

(7) Disconnect the oil drain valve and hose from the oil pan in accordance with paragraph 4-67 of the Operator and Organizational Maintenance Manual.

(8) Disconnect the hoses from the crankcase breathers.

(9) Disconnect the radiator hoses to the water pump, thermostat housings, and aftercooler in accordance with paragraphs 4-54, 4-55, and 4-57 of the Operator and Organizational Maintenance Manual.

(10) Disconnect the coolant preheater hoses from the water pump and cylinder head (coolant transfer tubes) in accordance with paragraph 4-61 of the Operator and Organizational Maintenance Manual.

(11) Disconnect the ether installation from the engine in accordance with paragraph 450 of the Operator and Organizational Maintenance Manual.

(12) Disconnect the fuel lines from the fuel filters, fuel return port on the cylinder block, and clamps holding the lines to the engine in accordance with paragraphs 4-47 and 4-48 of the Operator and Organizational Maintenance Manual.

(13) Disconnect the EMERGENCY SHUTDOWN cable from the engine emergency manual fuel shut off valve and from the cable clamps securing the cable to the engine in accordance with paragraph 4-51 of the Operator and Organizational Maintenance Manual.

(14) Remove the engine wiring harness in accordance with paragraph 4-22 of the Operator and Organizational Maintenance Manual.

(15) Remove the ac and dc lights and conduits above the engine in accordance with figure 3-9 and paragraph 4-35 of the Operator and Organizational Maintenance Manual.

(16) Remove radiator shutter and radiator in accordance with paragraph 4-55 of the Operator and Organizational Maintenance Manual. Remove fan and pulley guards in accordance with paragraph 4-59 of the Operator and Organizational Maintenance Manual.

(17) Remove the mufflers in accordance with paragraph 4-86 of the Operator and Organizational Maintenance Manual.

(18) Remove the exhaust system components that connect the mufflers to the turbocharger outlets in accordance with paragraph 3-15 of the Operator and Organizational Maintenance Manual.

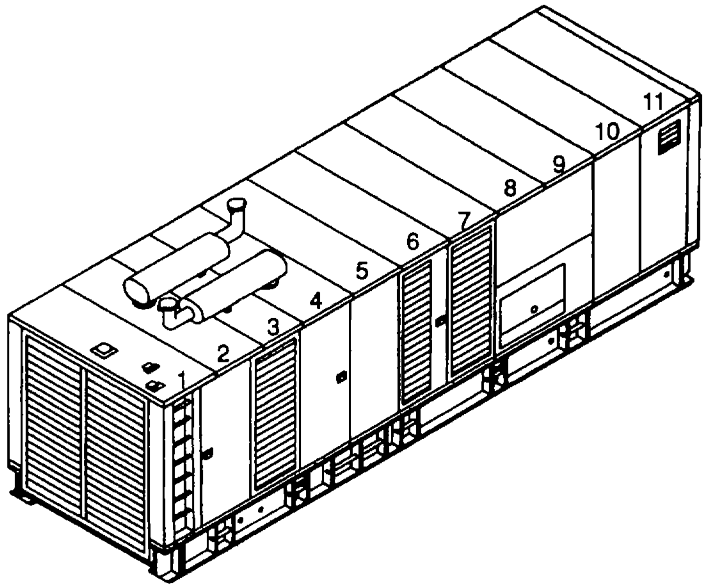


Figure 2-2. Removal of Roof Panels

(19) Remove roofing panels 1 through 4 (see Figure 2-2) above the engine in accordance with paragraph 4-13 of the Operator and Organizational Maintenance Manual and Figure 4-12.

(20) Remove the air cleaner assemblies in accordance with paragraph 4-74 of the Operator and Organizational Maintenance Manual.

(21) Remove the cover and screen from the adapter between the generator and engine. See Figure 2-3.

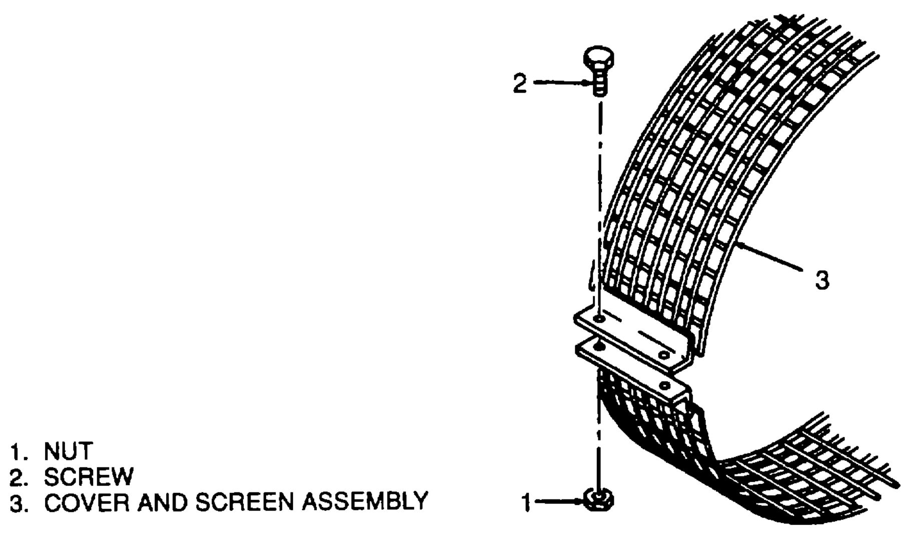
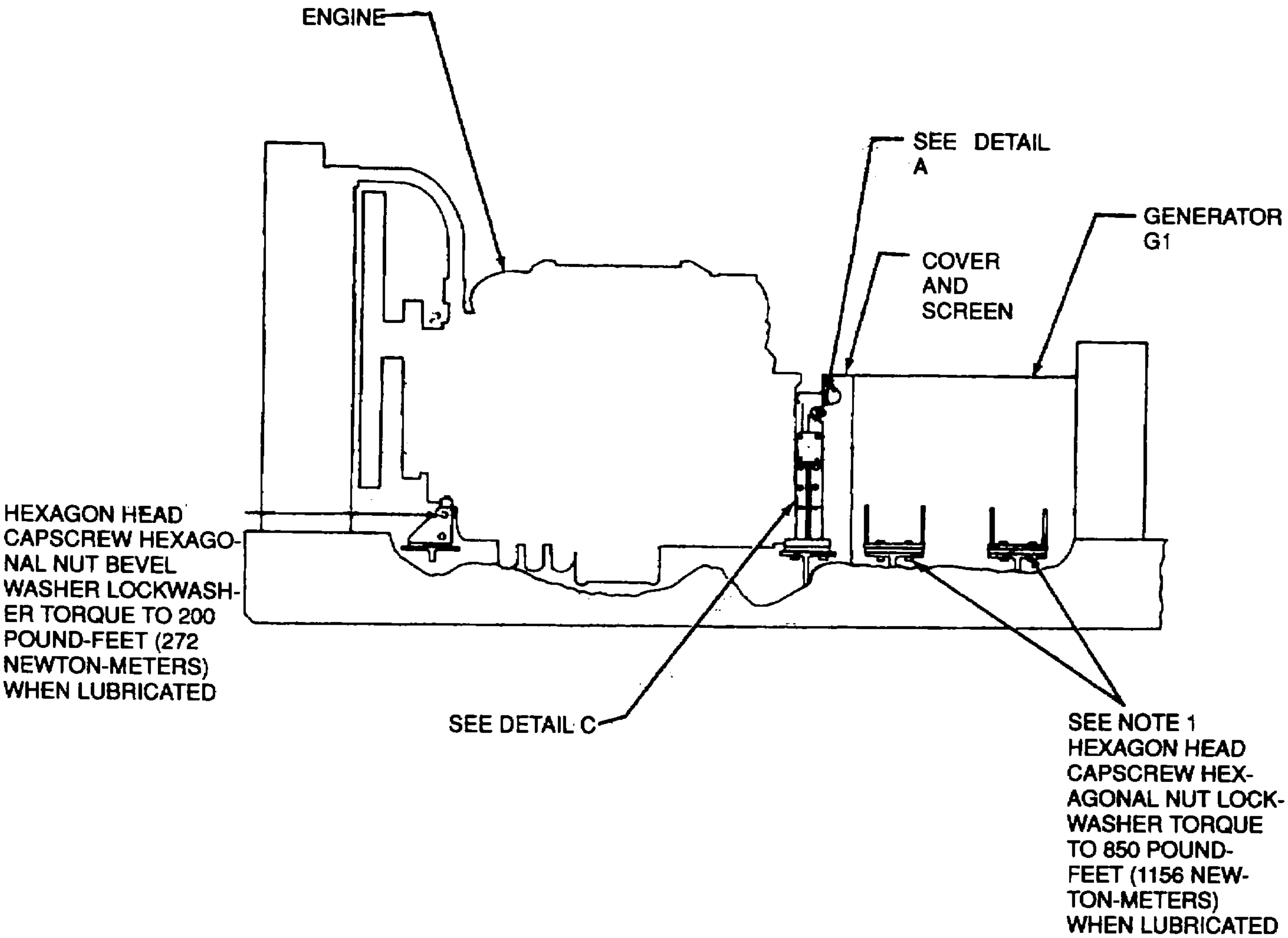


Figure 2-3. Removal of Cover and Screen

(22) See Figure 2-4, detail B. Bend back the corners of the locking plates and remove hexagon head capscrews to disconnect the generator drive discs from the engine flywheel.

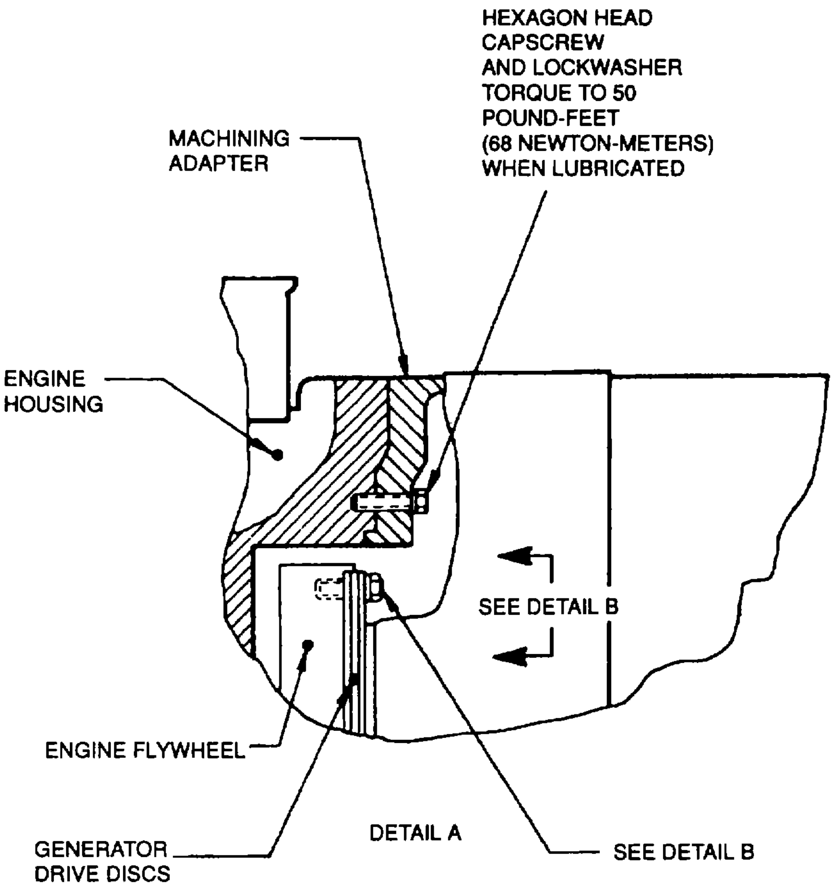
(23) See Figure 2-4, detail B. Remove the hexagon head capscrews and washers securing the adapter to the flywheel housing. Start with the screws nearest the 12 o'clock position and work back and forth around the circle down to the 6 o'clock position.



NOTES:

1. ADD OR REMOVE SHIMS (DETAIL D) IN ACCORDANCE WITH PARAGRAPH 2-15.
2. BEND CORNER OF LOCKING PLATE AGAINST FLAT SIDE OF HEXAGON HEAD CAPSCREW TO LOCK SCREW IN PLACE.

Figure 2-4. Engine and Generator G1, Removal, Installation, and Alignment (Sheet 1 of 4)



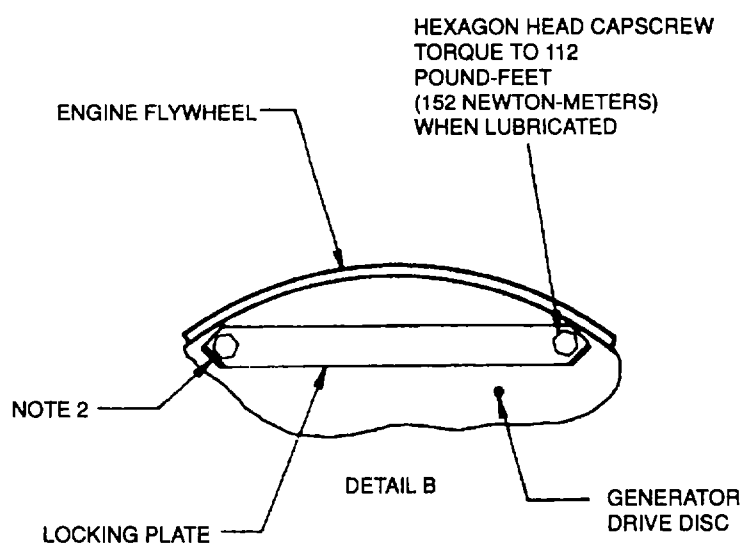


Figure 2-4. Engine and Generator G1, Removal, Installation, and Alignment (Sheet 2 of 4)

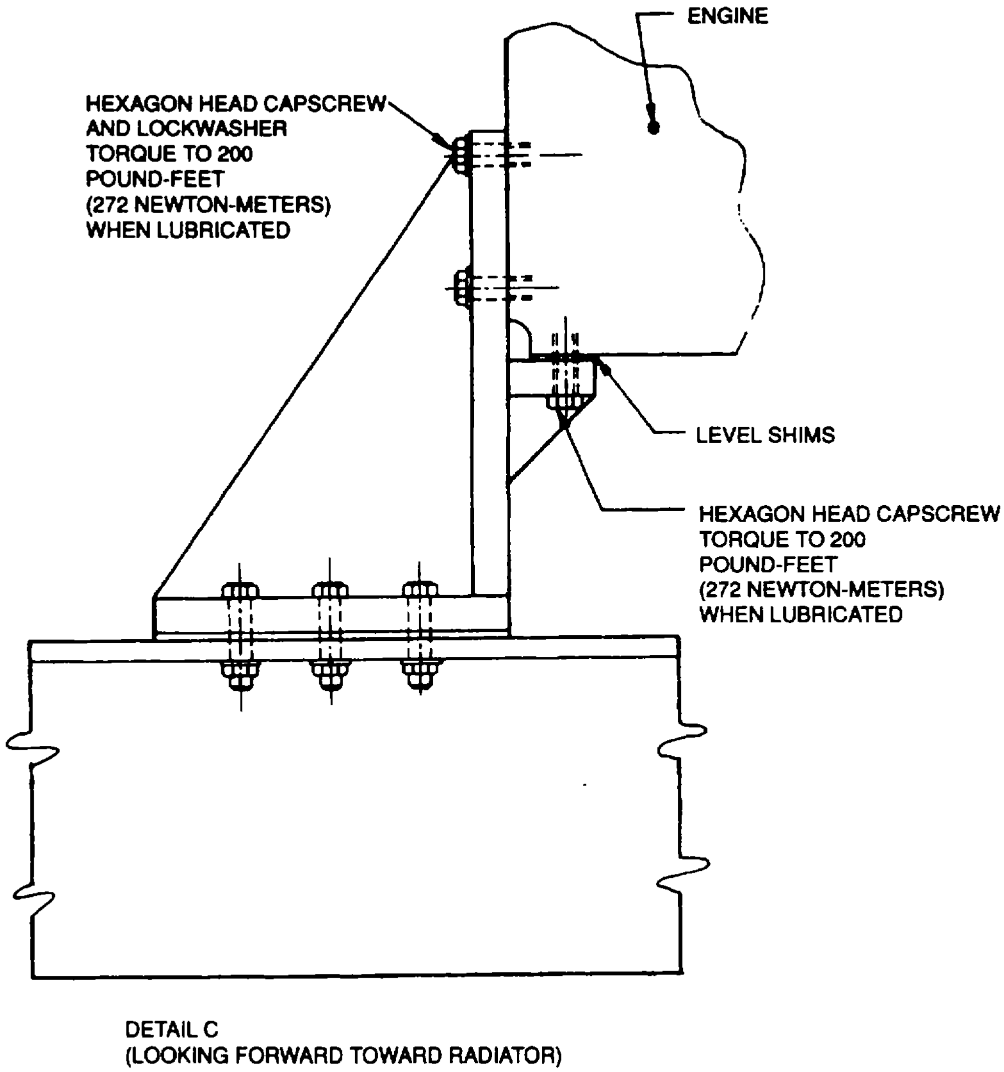


Figure 2-4. Engine and Generator G1, Removal, Installation, and Alignment (Sheet 3 of 4)

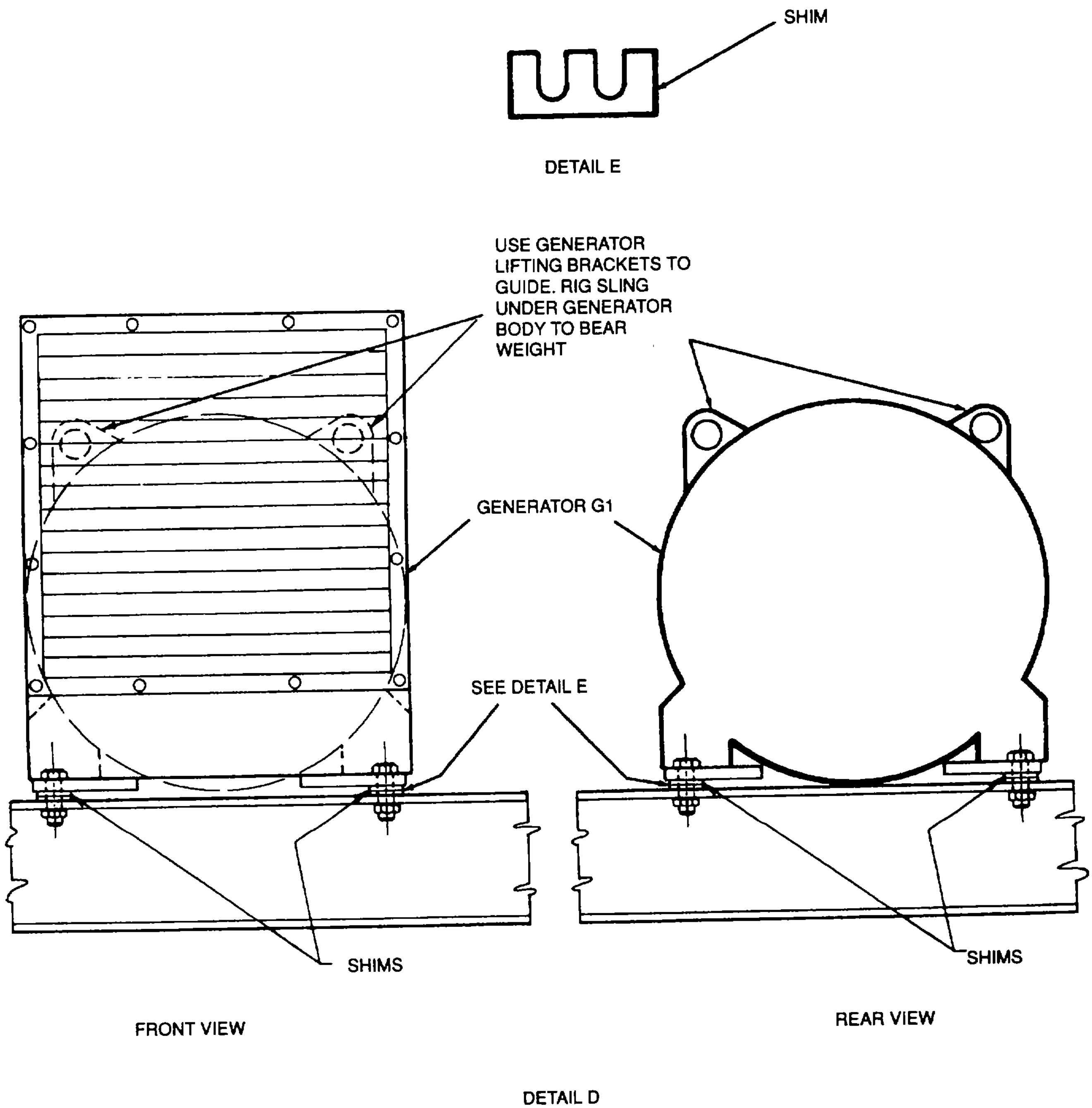


Figure 2-4. Engine and Generator G1, Removal, Installation, and Alignment (Sheet 4 of 4)

WARNING

Use of slings, chains, or lifting hoists not rated for the weight of the engine assembly may result In Injury to personnel and damage to equipment. Lifting gear must be rated for 15,000 pounds (6300 kg), minimum.

(24) Rig the engine assembly for lifting. See Figure 2-5 and Figure 2-6. There are four lifting brackets mounted to the cylinder block between the cylinder head assemblies. Using locking lifting hooks on the brackets, actuate the hoist enough to take the slack out of the lifting chains, but do not lift the engine at this time.

(25) Prepare an engine rebuild stand (3375955 or equivalent) for receipt of the engine.

WARNING

To minimize potential falling hazard, dear the area of personnel and other equipment when attempting to lift heavy equipment.

(26) See Figure 2-5. Remove hexagon head capscrews (16), lockwashers (17), hexagon head capscrews (14), lockwashers (15), and hexagonal nuts (10), lockwashers (12), and hexagonal nuts (13) securing the engine to the rear and front engine supports (6 and 1). Hoist engine so that engine is free of front and rear engine mounts.

(27) Remove hexagonal nuts (5), lockwashers (4) and hexagon head capscrews (2) and bevel washers (3) to remove front engine support (1).

(28) Move hoist slowly in forward direction until engine flywheel housing dears generator flex plates and hub.

CAUTION

Take care when moving hoist In forward direction so that engine oil pan does not contact skid ban cross member on which front engine support is mounted.

(29) Raise hoist until engine oil pan dears skid base cross member and move in forward direction until engine is dear of generator set, and secure on engine rebuild stand. Install suitable protection over engine flywheel housing, conduit box, and all other exposed equipment to protect from the elements.

b. Install. This procedure covers installation and alignment of the engine.

(1) Remove hexagonal nuts (9, Figure 2-5), lockwashers (8) and hexagon head capscrews (7) securing rear engine supports (6) to skid base and remove from mounting pads for future use.

(2) Remove the ac and dc conduit above the generator in accordance with paragraph 4-35 of the Operator and Organizational Maintenance Manual. Do not remove ac/dc lights.

(3) Remove roof panels 5 and 6 (see Figure 2-2) above the generator in accordance with paragraph 4-13 of the Operator and Organizational Maintenance Manual.

(4) Remove conduit box cover from rear of generator. See Figure 2-7.

(5) Remove capscrews (5, Figure 2-8) and lockwashers (6), and remove generator cable exit enclosure (4).

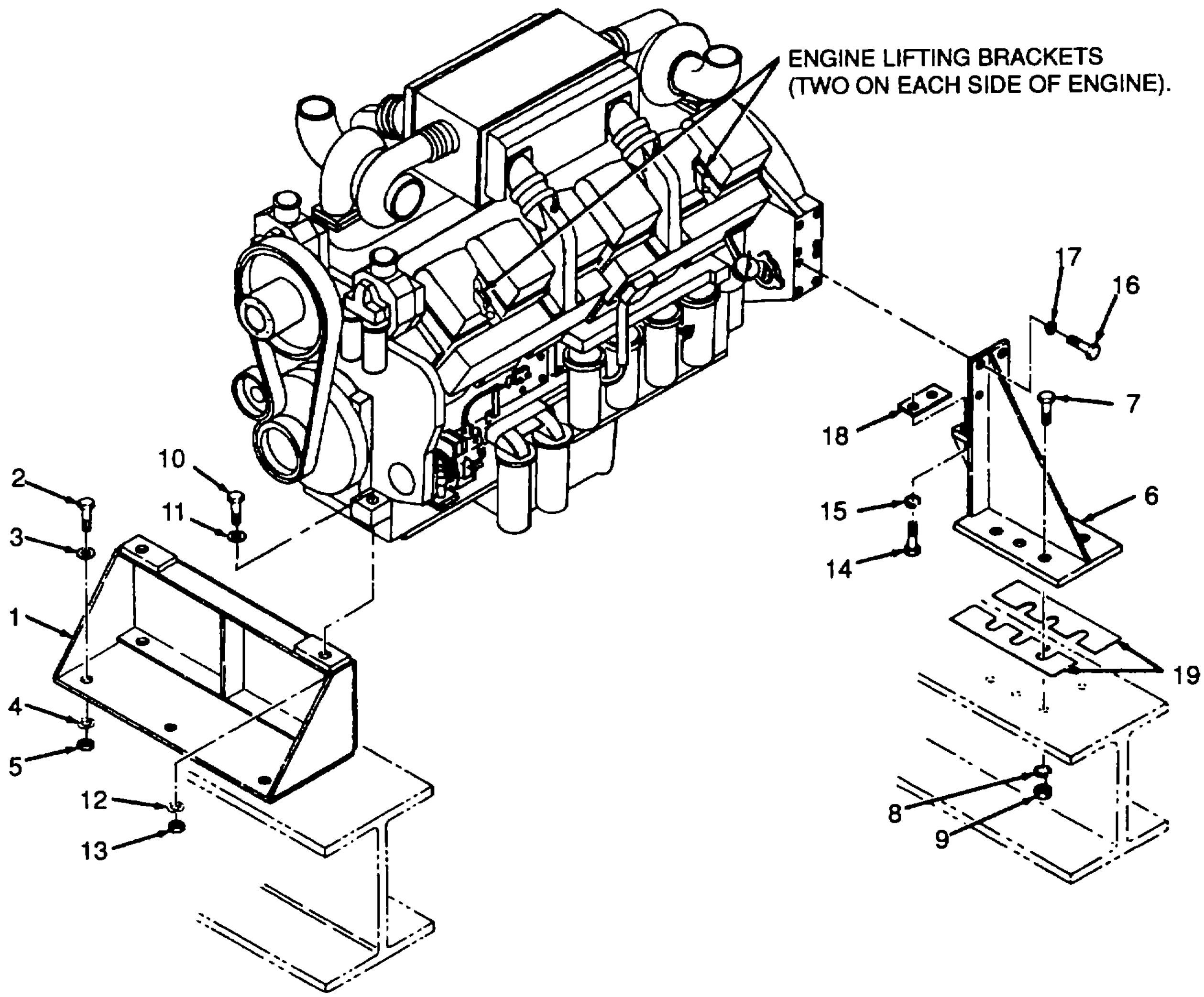
(6) Disconnect cannon plug on battery charger BC1.

(7) Rig overhead crane or hoist with minimum load capacity of 6,000 pounds (2722 K) and minimum height clearance of 150 inches (3810 mm). See Figure 2-9 and connect the lifting rig to lifting lugs on generator housing. Take up slack from hoist but do not lift generator at this time.

(8) See Figure 2-4. Remove the hexagon head capscrews, hexagonal nuts, and lockwashers from the generator mounting feet.

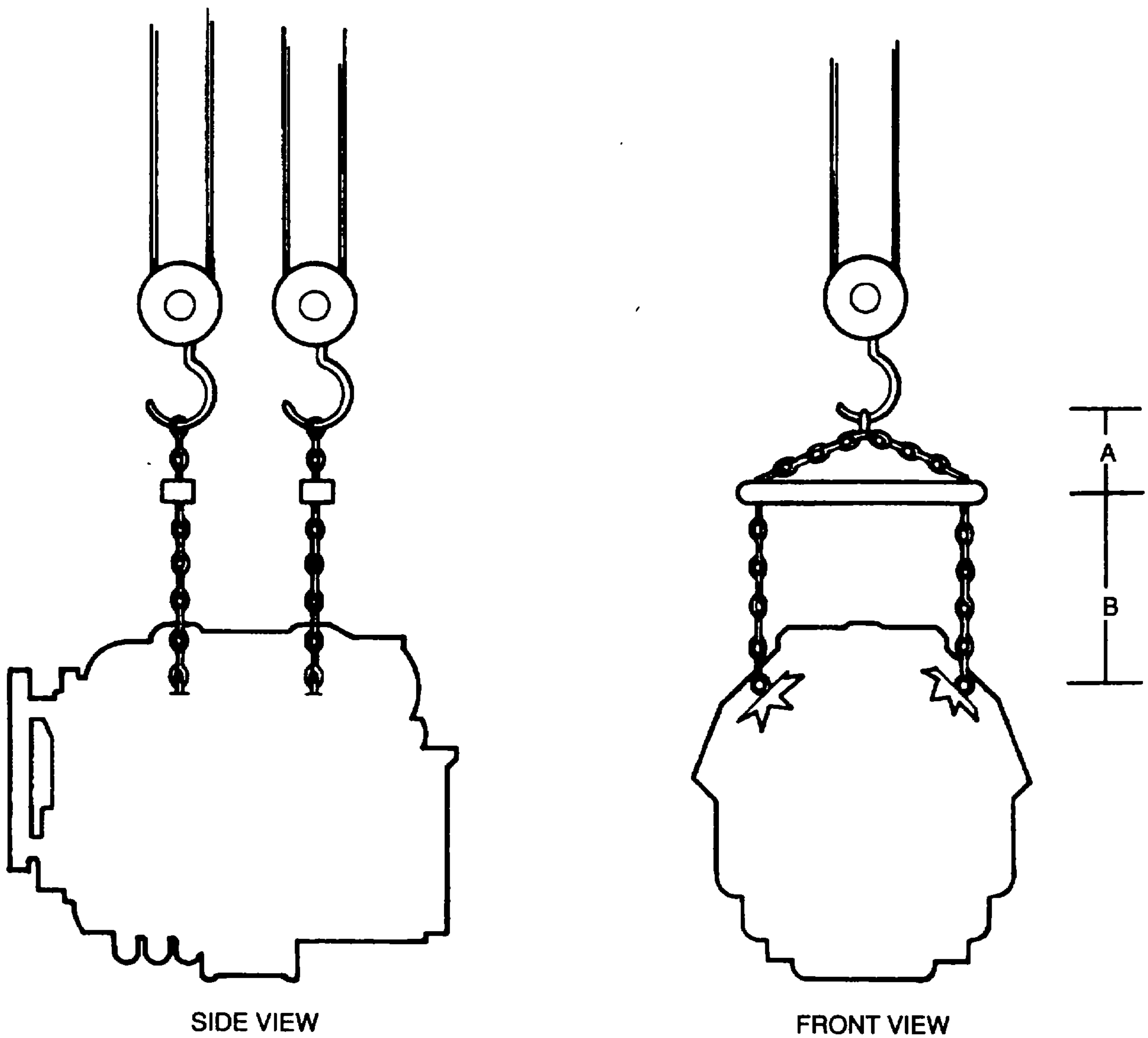
WARNING

Use of chains and hoists not rated for the weight of the generator may result In Injury to personnel or damage to equipment



1. FRONT ENGINE SUPPORT
2. HEXAGON HEAD CAPSCREW
3. BEVEL WASHER
4. LOCKWASHER
5. HEXAGONAL NUT
6. REAR ENGINE SUPPORT
7. HEXAGON HEAD CAPSCREW
8. LOCKWASHER
9. HEXAGONAL NUT
10. HEXAGON HEAD CAPSCREW
11. BEVEL WASHER
12. LOCKWASHER
13. HEXAGONAL NUT
14. HEXAGON HEAD CAPSCREW
15. LOCKWASHER
16. HEXAGON HEAD CAPSCREW
17. LOCKWASHER
18. SHIM
19. SHIM

Figure 2-5. Engine and Generator G1, Alignment



A = APPROXIMATELY 16 INCHES (406 mm)
B = APPROXIMATELY 24 INCHES (610 mm)

Figure 2-6. Engine, Lifting

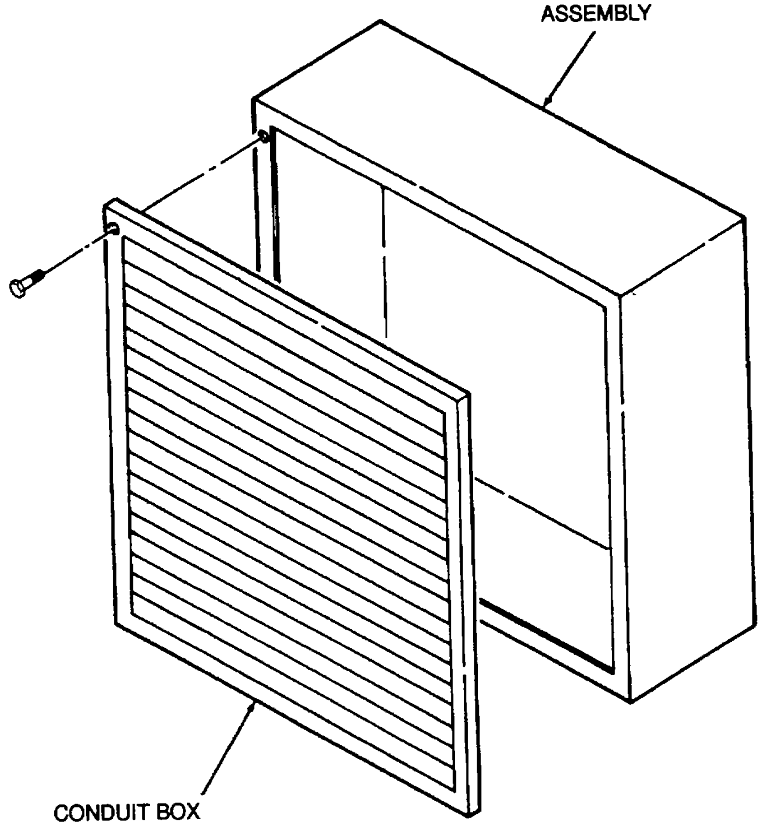


Figure 2-7. Removal of Conduit Box Cover Assembly

CAUTION

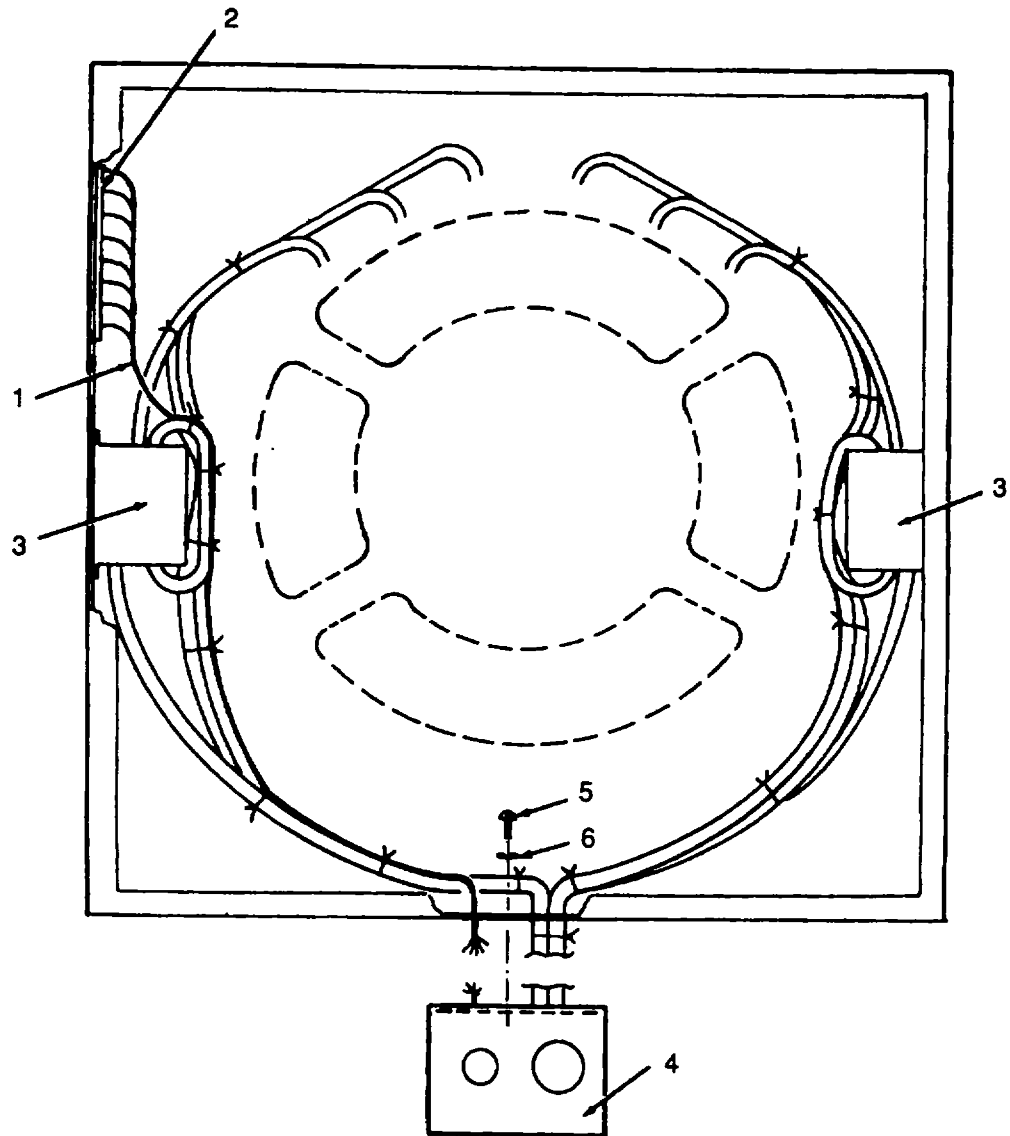
Take care when lifting generator, as there is enough slack In generator cables and wiring to remove generator without disconnecting cables and wiring, providing the generator is not lifted and moved beyond limits stated In paragraph 2-15b(9).

(9) Lift generator approximately 0. 500 inches (12.7mm) or until generator feet dear generator mounting pads, and move in rearward direction 6 inches (152.4 mm) and lower to generator mounting pads.

WARNING

Use of slings, chains, or lifting hoists not rated for the weight of the engine assembly may result Injury to personnel and failing damage to equipment. Lifting gear must be rated for 15,000 pounds (680O kg), minimum.

(10) See Figure 2-5 and Figure 2-6. Rig the engine assembly for lifting. There are four lifting brackets mounted to the cylinder block between the cylinder head assemblies. Use locking lifting hooks on the brackets. Actuate the hoist enough to take the slack out of the lifting chassis, but do not lift the engine at this time.



1. AC WIRING HARNESS
2. TERMINAL BOARD
3. TRANSFORMERS
4. CABLE EXIT ENCLOSURE
5. CAPSCREW
6. LOCKWASHER

Figure 2-8. Conduit Box Assembly

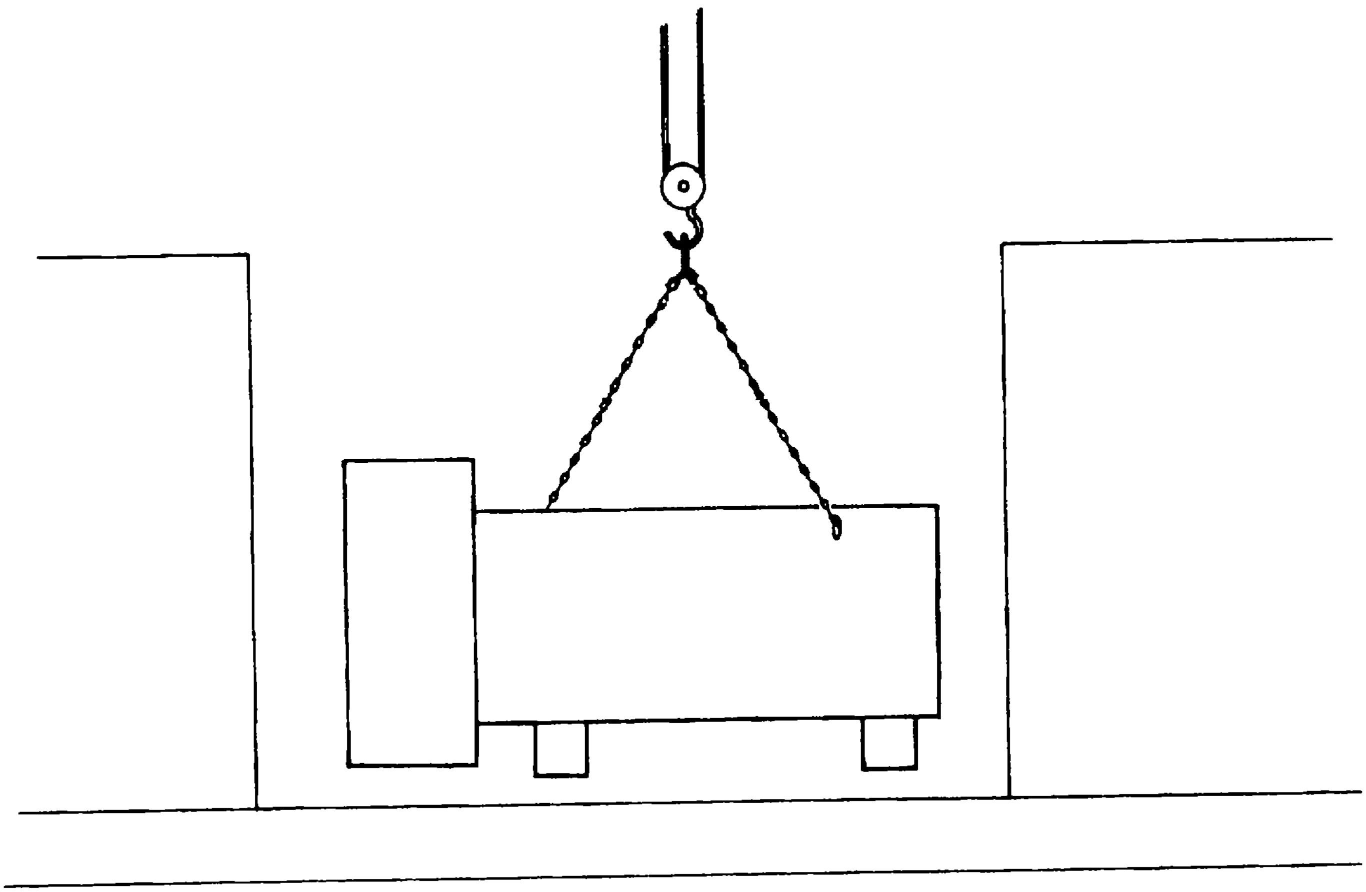


Figure 2-9. Generator G1, Lifting

(11) Remove mounting bolts securing engine to rebuild stand (3375955 or equivalent).

WARNING

To minimize potential falling damage, clear the area of personnel and other equipment when attempting to lift heavy equipment.

(12) Hoist engine from rebuild stand and install through the front of the generator set and position engine over front and rear engine mounting holes.

(13) Install front engine support to skid base with hexagon capscrews (2, Figure 2-5), bevel washers (3), lockwashers (4), and hexagonal nuts (5). Hand tighten only at this time.

(14) Lower engine to mate front engine support (1) with engine trunnion and install hexagon capscrews (10), bevel washers (11), lockwashers (1 2), and hexagonal nuts (13). Hand tighten only at this time.

(15) Install rear engine supports (6) to engine using hexagonal head capscrews (14) and lockwashers (15). Tighten, but do not torque.

(16) Lower engine as necessary to align rear engine mounting supports to skid base and install hexagon capscrews (7), washers (8), and hexagonal nuts (9). Leave hand tight.

(17) Install hexagon head capscrews (16) and lockwashers (17). Verify that hexagon head capscrews (16) have sufficient clearance to be freely turned by hand. If the hexagon head capscrews freely turn, it indicates that the engine is resting on the engine mount and not being suspended on the hexagon head capscrews (16). If the engine is resting on mounts, proceed directly to step (18), below. Otherwise, correct the problem by shimming in accordance with the following steps:

(a) Remove all hardware (14 through 17) retaining engine to rear engine supports (6).

(b) Raise the engine slightly to allow installation of shims (18) in 0.015 increments between engine and rear engine support.

(c) Install hexagon head capscrews (14) and lockwashers (15). Tighten, but do not torque.

(d) Install hexagon head capscrews (16) and lockwashers (17). Verify that hexagon head capscrews (16) have sufficient clearance to be freely turned by hand. If not, repeat steps (a) through (c), above, until engine is properly shimmed to rear engine supports (6).

(18) If hexagon head capscrews (16) are free, torque hardware (14 and 16) to 200 pound-feet (272 newton-meters).

(19) Remove all hexagonal nuts (9) and lockwashers (8) securing rear engine supports (6) to skid base.

(20) Raise the rear of the engine and insert 1/2 inch (12 mm) spacer blocks between the skid base and the rear engine supports (6). Lower the engine until the supports rest on the spacer blocks.

(21) Install two lineup studs in the flywheel for generator drive plate (flexible discs) alignment at the 3 and 9 o'clock positions.

WARNING

Use of slings, chains, or lifting hoists not rated for the weight of the engine assembly may result In Injury to personnel and falling damage to equipment.

(22) Rig the generator for lifting with a hoist or overhead crane rated for a minimum of 6,000 pounds (2722 kg) and a minimum height clearance of 150 inches (3816 mm) (See Figure 2-9). There are two lifting brackets welded to the top of the generator. Use locking lifting hooks on the brackets and raise the hoist to remove slack from the slings and lifting chains, but do not lift generator at this time.

WARNING

To minimize potential failing damage, clear the area of personnel and other equipment when attempting to lift heavy equipment.

CAUTION

Take care when lifting generator, as there is enough slack In generator cables and wiring to remove generator without disconnecting cables and wiring, providing the generator is not lifted and moved beyond limits stated In paragraph 2-15b(9).

NOTE

This task requires two people.

(23) Lift generator approximately 0.500 inches (12.7 mm) or until generator feet clear generator mounting pads. Slowly move generator towards engine and guide the drive plate (flexible discs)to the lineup studs installed in the flywheel in step (7), above. This will require manual alignment while generator is suspended on lifting device. Generator adapter ring must be properly seated in flywheel housing before proceeding to next step.

(24) See Figure 2-4, detail A Install all the hexagon head capscrews and lockwashers securing the generator adapter to the engine flywheel housing. Torque the capscrews on the lower half of the adapter to 50 pound-feet (68 newton-meters). Leave the upper half of the bolt circle finger tight

(25) Using feeler gages, check the gap between the adapter and flywheel housing at the top of the ring. If the gap is greater than 0.015 inch (0.38 mm), alternately torque to 50 pound-feet the bolts on the top half of the ring, starting at the points farthest from 12 o'clock position until a maximum gap of 0.015 inch (0.38 mm) is obtained. If a gap of 0.015 inch (0.38 mm) cannot be achieved, the generator adapter ring or drive plates may not be properly aligned and seated. Remove all hexagon head capscrews and lockwashers securing generator adapter to engine flywheel housing, and repeat procedures described in paragraph 2-15b(22) through (25).

(26) Raise both engine and generator assembly and remove the 1/2 inch (13 mm) spacer blocks from beneath the rear engine supports (6, Figure 2-5). Lower the engine and generator assembly to the skid base mounting pads. Relieve all crane and sling tension.

(27) Using feeler gages, check the gap at the 12 o'clock position of the adapter to flywheel housing mating area. If the gap is decreased to a dimension greater than 0 but less than 0.015 inch (0.38 mm), proper alignment has been attained and proceed directly to step (30), below. If the gap is 0, longitudinal preload is assumed and shimming will be required between the rear engine supports (6, Figure 2-5) and the skid base. Proceed as follows:

   (a) Raise the engine and generator assemblies and install 0.015 inch (0.38 mm) shims (19) between both rear engine supports (6) and the skid base. Lower the engine and generator assemblies and check the adapter to flywheel housing gap as described in step (25), above.

   (b) As require, shim both rear engine supports in equal increments of 0.005 inches (0.127 mm) until a maximum gap of 0.015 inches (0.38mm) is obtained.

(28) Using feeler gages, check the two rear engine supports and four generator mounting pads for clearance to the skid base. If clearance is O to 0.010 inches (0.025 mm), proceed directly to step (30), below. If clearance is greater than 0.010 inches (0.025 mm) shims must be installed to reduce the clearance to an acceptable limit of less than 0.010 inches (0.025mm). Proceed as follows: NOTE The shimming procedure will require the raising and lowering of engine and generator assemblies until acceptable clearance is attained.

   (a) Install shims (19, Figure 2-5) beneath rear engine supports until acceptable clearance is attained. Shim equally at both mounts.
   (b) See Figure 2-4, detail D. Add shims beneath generator feet until acceptable clearance is attained. Shim equally at all four mounts.

(29) After attaining acceptable clearances, remove lifting slings for both engine and generator assemblies.

(30) See Figure 2-5 and install lockwashers (8) and hexagonal nuts (9) securing rear engine mounts to skid base. Torque to 200 pound-feet (271 newton-meters) hexagonal nuts (9) and capscrews (7) on rear engine mounts and hexagonal nuts (13) and capscrews (10) on front engine support.

(31) See Figure 2-4. Install hexagon head capscrews, hexagonal nuts, and lockwashers to secure the generator to the skid base and torque in two stages, as follows:

   (a) Beginning with the two rear feet then the two front feet, torque to 600 pound-feet (813 newton-meters).

   (b) Using feeler gage, check the gap at the top of the adapter to engine mating surface. If the gap is not within the acceptable limit of 0 to 0.015 inches (0.38 mm), the shimming procedure must be repeated until an acceptable limit is attained; add shims beneath rear engine supports or generator mounting feet as required.
   (c) If the gap is within the acceptable limit of 0 to 0.015 inches (0.38 mm), apply the final torque of 850 pound-feet (1156 newton meters) to the hexagon head capscrews securing the generator mounting feet.

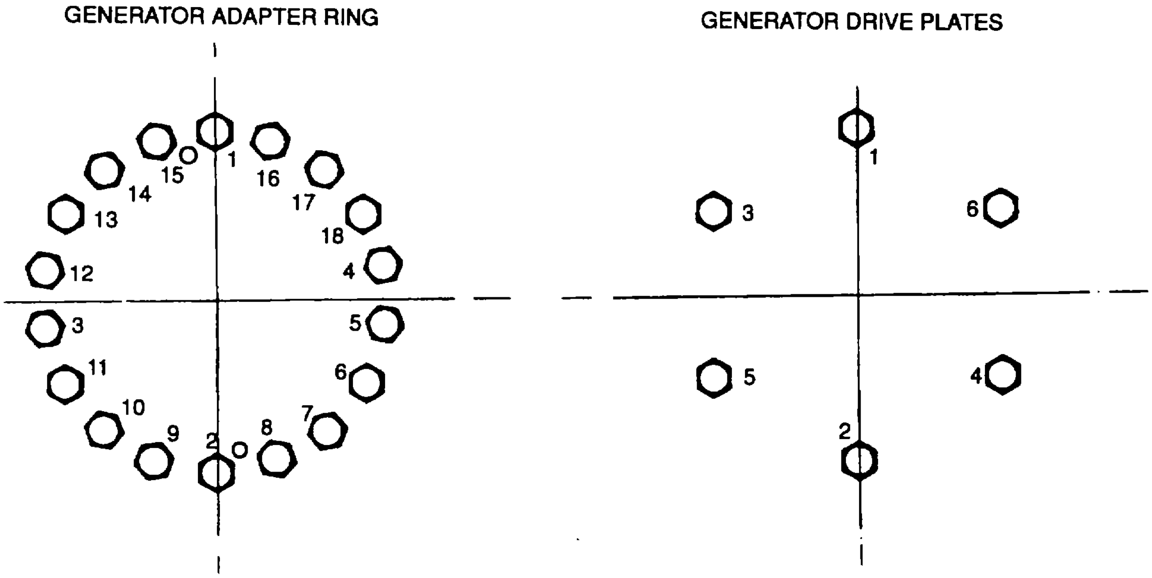


Figure 2-10. Generator G1, Torque Sequence of Adapter Ring and Drive Plates (Flexible Discs)

(32) Check the gap at the 12 o'clock position of the adapter. If it is still within the acceptable limit of 0 to 0.015 inches (0.38 mm), loosen the hexagon head capscrews and lockwashers, securing the generator adapter to engine flywheel housing and torque capscrews to 50 pound-feet (68 newton-meters) in accordance with Figure 2-10.

(33) See Figure 2-4, detail B. Install hexagon head capscrews and locking plates to secure the generator drive discs to the engine flywheel. Torque the capscrews to 112 pound-feet (152 newton-meters) in accordance with Figure 2-10 and bend a locking plate corner to a flat side of each screw. After installing at least two hexagon head capscrews remove the guide pins that were used to pilot the generator to the engine.

(34) See Figure 2-3. Install and secure cover and screen on generator adapter.

(35) See Figure 2-11 and check the exciter air gap (gap between exciter armature and stator) by inserting a 0.010 inch (0.25 mm) feeler gage in the gap and rotating it around the armature diameter to ensure that a minimum air gap of 0.010 inch (0.25 mm) is available. If the feeler gage cannot be rotated one full revolution, then check for a "cocked' exciter stator or loose stator mounting capscrews. Refer to Chapter 5 as necessary.

(36) Using the barring mechanism built into the engine flywheel housing, (see figure 3-2 of the Operator and Organizational Maintenance Manual), bar the engine-generator assembly through at least one full revolution to verify engine-generator freedom of rotation. If binding is discovered, then the alignment procedure was performed incorrectly or the engine or generator or both have been improperly assembled.

(37) Check the exciter air gap again in accordance with step (35), above.

(38) Install generator cable exit enclosure (4, Figure 2-8) with hexagon head capscrews (5) and lockwashers (6).

(39) Install conduit box cover on rear of generator. See Figure 2-7.

(40) Install the air cleaner assemblies in accordance with paragraph 4-74 of the Operator and Organizational Maintenance Manual.

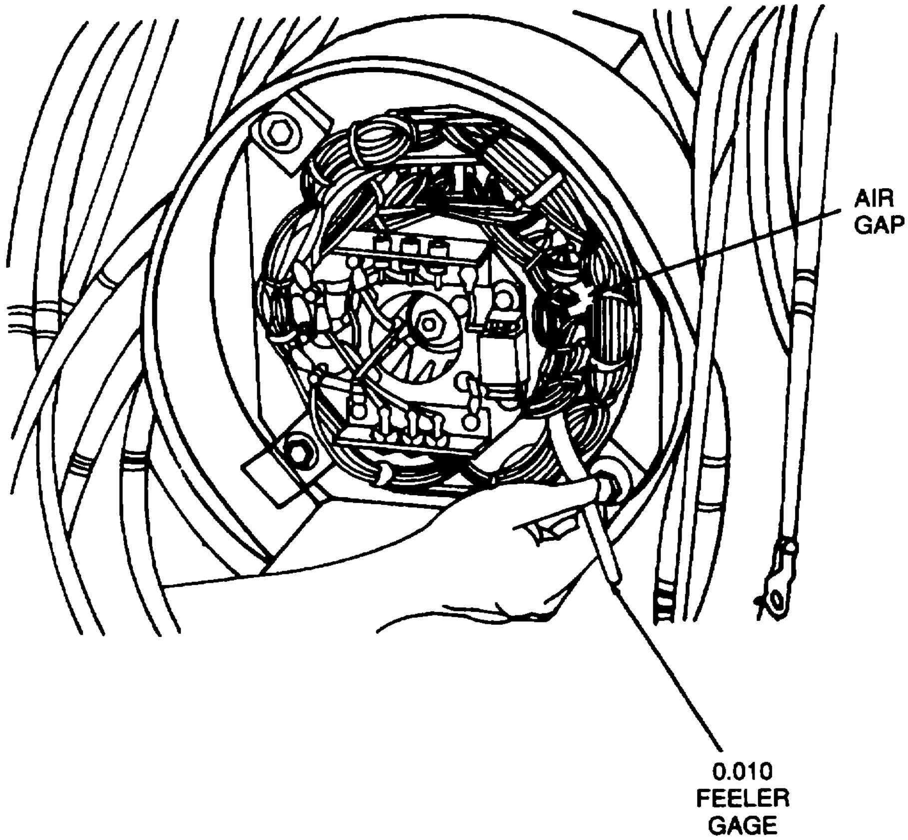


Figure 2-11. Generator G1, Checking Exciter Air Gap

(41) Install roof panels 5 and 6 (see Figure 2-2) over generator in accordance with paragraph 4-17 of Operator and Organizational Maintenance Manual.

(42) Install ac and dc conduit above generator in accordance with paragraph 4-35 of the Operator and Organizational Maintenance Manual.

(43) Install roof panels 1 through 4 (see Figure 2-2) above the engine in accordance with paragraph 4-17 of the Operator and Organizational Maintenance Manual and figure 4-12.

(44) Install the exhaust system components that connect the mufflers to the turbocharger outlets in accordance with paragraph 3-15 of the Operator and Organizational Maintenance Manual.

(45) Install the mufflers in accordance with paragraph 4-86 of the Operator and Organizational Maintenance Manual.

(46) Install radiator shutter and radiator in accordance with paragraph 4-55 of the Operator and Organizational Maintenance Manual.

(47) Install fan and pulley guards in accordance with paragraph 4-59 of the Operator and Organizational Maintenance Manual.

(48) Install the ac and dc lights and conduits above the engine in accordance with paragraph 4-35 of the Operator and Organizational Maintenance Manual.

(49) Reconnect the engine wiring harness in accordance with paragraph 4-22 of the Operator and Organizational Maintenance Manual.

(50) Reconnect the EMERGENCY SHUTDOWN cable to the engine emergency manual shut off valve and secure-the cable to the engine in accordance with paragraph 4-51 of the Operator and Organizational Maintenance Manual.
(51) Reconnect the fuel lines to the fuel filters, fuel return port on the cylinder block, and damps holding the lines to the engine in accordance with paragraphs 4-47 and 4-48 of the Operator and Organizational Maintenance Manual.
(52) Reconnect the ether installation to the engine in accordance with paragraph 4-50 of the Operator and Organizational Maintenance Manual.
(53) Reconnect the coolant preheater hoses to the water pump and cylinder head (coolant transfer tubes) in accordance with paragraph 4-61 of the Operator and Organizational Maintenance Manual.
(54) Reconnect the radiator hoses to the water pump, thermostat housings, and aftercooler in accordance with paragraphs 4-54, 4-55, and 4-57 of the Operator and Organizational Maintenance Manual.
(55) Reconnect the hoses to the crankcase breathers.
(56) Reconnect the oil drain valve and hose to the oil pan in accordance with paragraph 4-67 of the Operator and Organizational Maintenance Manual.
(57) Reconnect the oil prelube hoses and bypass filter hose to the engine block, and oil pan in accordance with paragraphs 4-65 and 4-71 of the Operator and Organizational Maintenance Manual.
(58) Fill the cooling and lubrication systems in accordance with paragraphs 3-3 and 3-12 of the Operator and Organizational Maintenance Manual.
(59) Install the batteries in accordance with paragraph 3-9 of the Operator and Organizational Maintenance Manual.
(60) Reconnect cable from UTILITY POWER receptacle and remove safety tag.
(61) Set maintenance lockout switch to OPERATE and remove safety tag.
(62) Install load cables and remove and discard tags.

2-16. GENERATOR G1 REMOVAL AND INSTALLATION

a. Remove. The generator is removed by lifting it through the top of the generator set. An overhead crane or hoist rated for 6.000 pounds (2,722 kg) should be used. Minimum height clearance needed for lifting the generator free of the generator set is 150 inches (3810 mm).

(1) Disconnect load cables from output terminals, place on safety stands and tag output terminal to ensure generator set is not connected to load bus during generator removal.
(2) Set maintenance lockout switch to MAINTENANCE and safety tag.
(3) Disconnect cable from UTILITY POWER receptacle and safety tag UTILITY POWER receptacle to ensure cable is not connected during generator removal.
(4) Remove batteries in accordance with paragraph 3-9 of the Operator and Organizational Maintenance Manual.
(5) Remove the conduit box cover assembly from the conduit box assembly. See Figure 2-7. Remove hexagon head capscrews (5, Figure 2-8) and lockwashers (6) securing generator cable exit endosure (4) to generator cabinet.
(6) Remove the cover from the rear of cabinet B. See Figure 2-12 and paragraph 4-18 of the Operator and Organizational Maintenance Manual.
(7) Disconnect the generator power leads (1, Figure 2-13) from the terminal posts (2) on the back of the load circuit breaker CB101 receptacles.
(8) Disconnect the generator ground leads (3) from the insulated standoff (4).

NOTE

Before moving the generator power leads, generator ground leads, or wiring harness, the tiewraps which fasten them to other wiring must be removed.

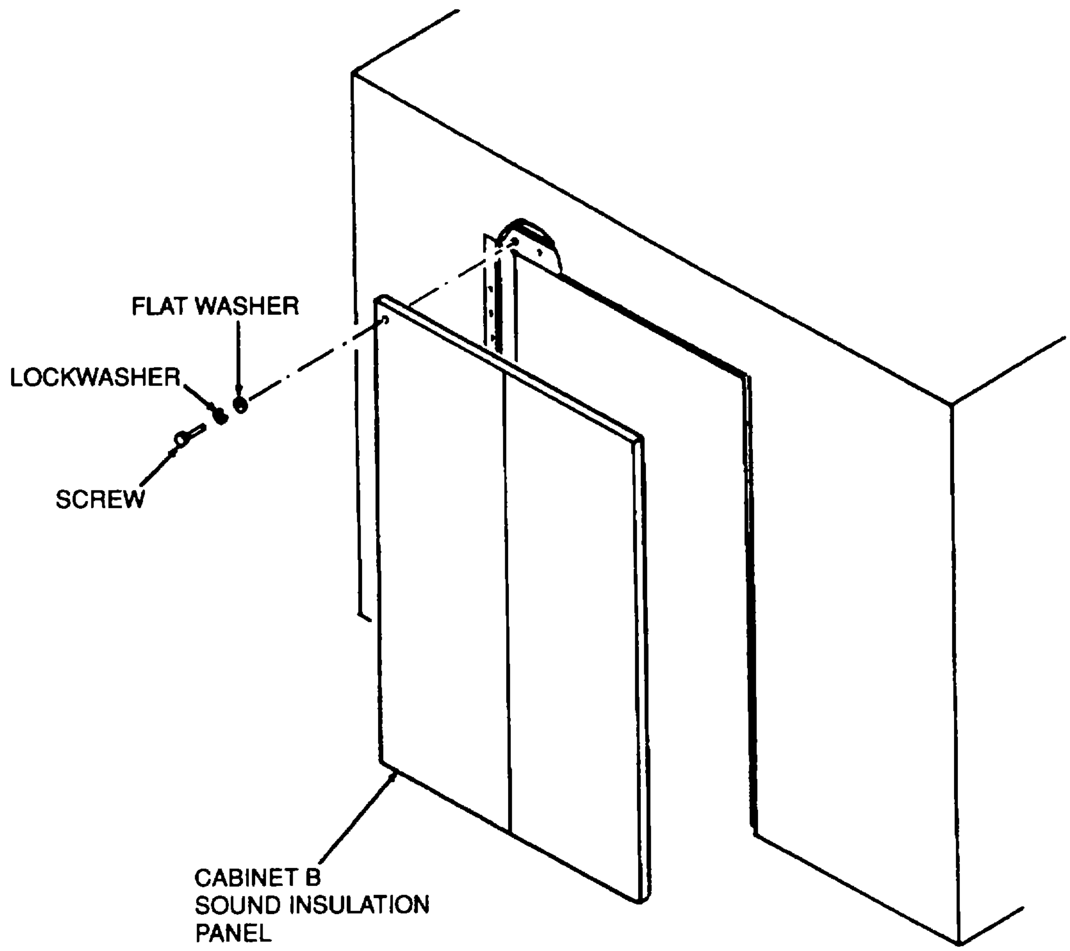


Figure 2-12. Removal of Cabinet B Rear Cover

(9) Working from the conduit box assembly (see Figure 2-14), pull the generator power and ground leads through the conduit that connects cabinet B and the conduit box assembly. Coil the leads up and lay them in the bottom of the conduit box assembly.

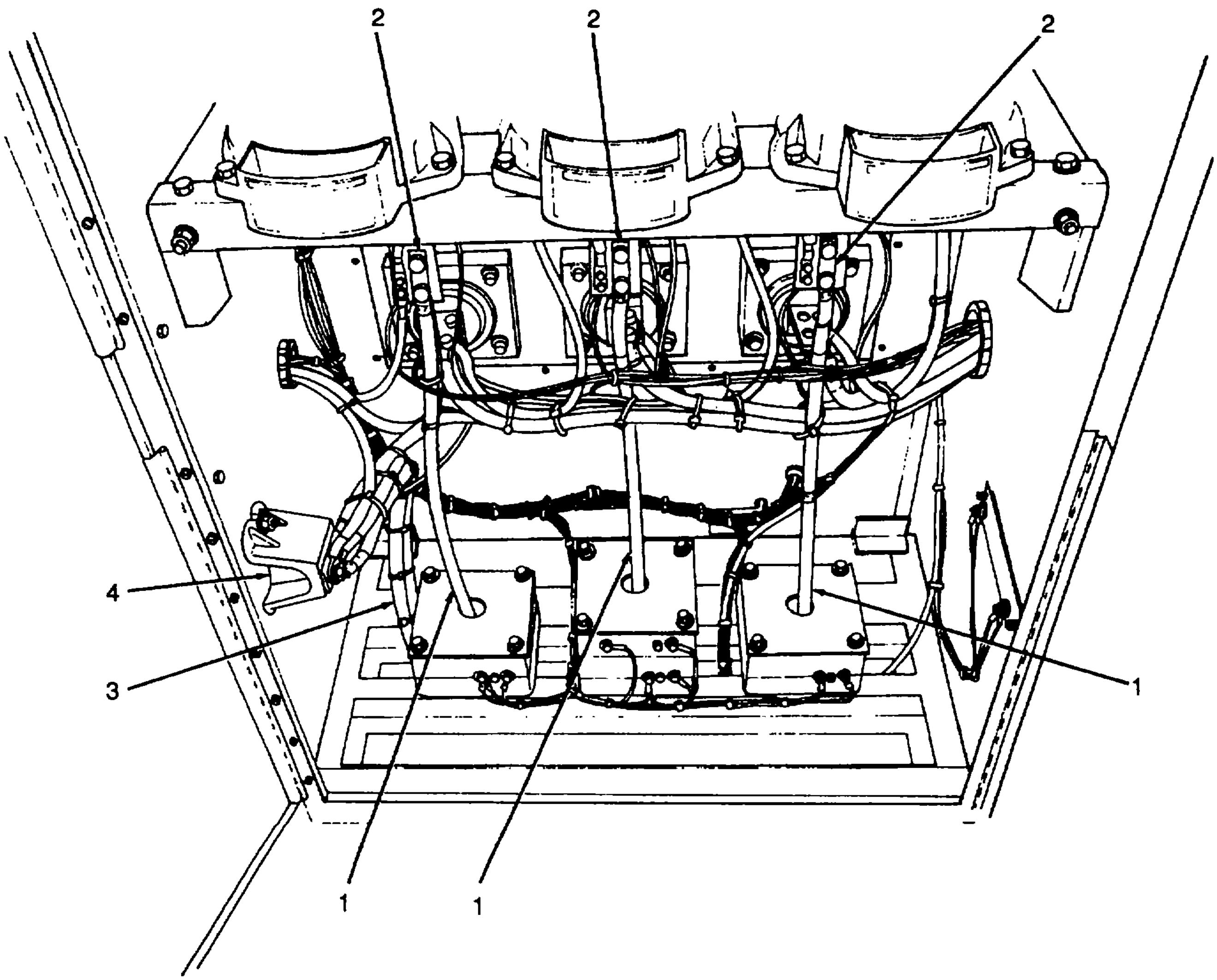
(10) Disconnect the ac wiring harness (1, Figure 2-8) from the terminal board (2) and the two transformers (3) located in the conduit box assembly. Coil up the wiring harness and lay it in the cable exit enclosure (4) located underneath the conduit box assembly.

(11) Remove battery charger in accordance with paragraph 4-20 of the Operator and Organizational Maintenance Manual.

(12) Remove the ac and dc lights and conduits above the generator in accordance with paragraph and 4-35 of the Operator and Organizational Maintenance Manual.

(13) Remove roof panels 5, 6, and 7 (see Figure 2-2) above the generator in accordance with paragraph 4-13 of the Operator and Organizational Maintenance Manual.

(14) Remove air cleaner assembly in accordance with paragraph 4-74 of the Operator and Organizational Maintenance Manual.



1. POWER LEADS
2. TERMINAL POSTS
3. GROUND LEADS
4. INSULATED STANDOFF

Figure 2-13. Generator G1, Ground and Power Leads Installation

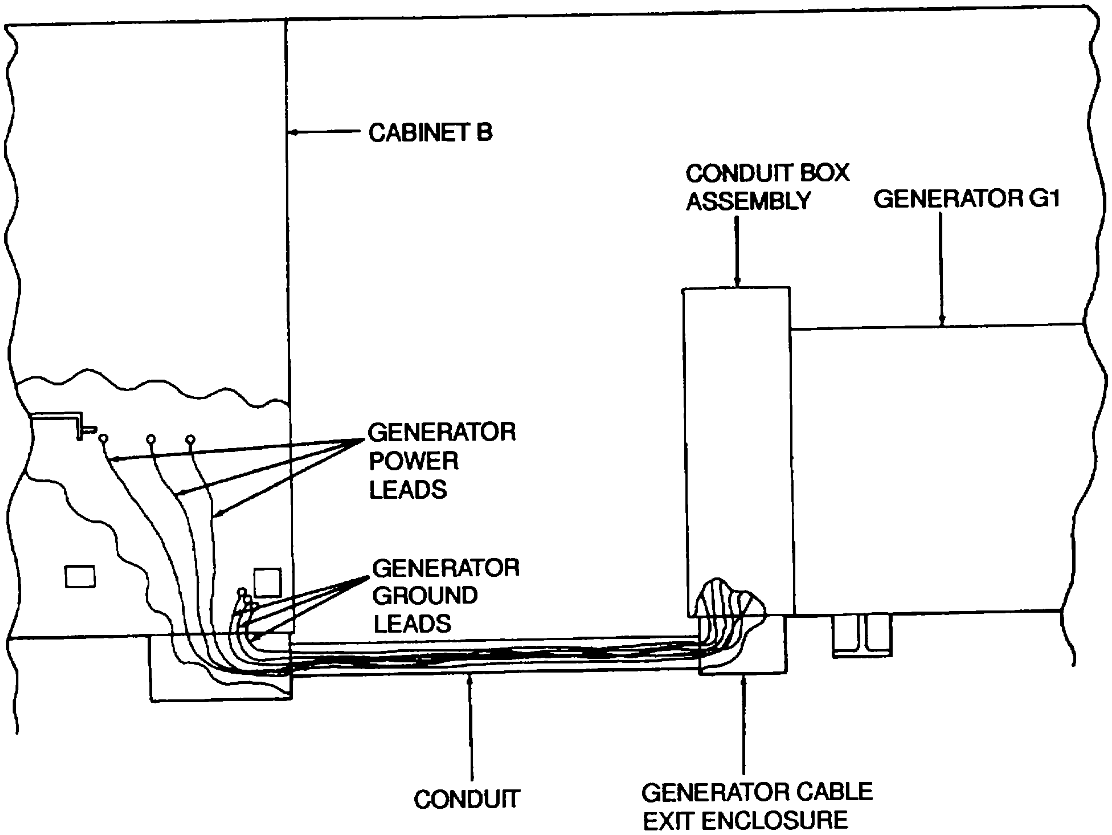


Figure 2-14. Generator, Ground and Power Leads Routing

(15) Remove the cover and screen assembly (3, Figure 2-3) by removing nuts (1) and screws (2).

(16) See Figure 2-4, detail B. Bend back the corners of the locking plates and remove the hexagon head capscrews to disconnect the generator drive discs from the engine flywheel. Remove hexagon head capscrews from the 3 and 9 o'clock positions first and install guide pins before removing remaining hexagon head capscrews.

NOTE
Locking plates should be replaced and not reused.

(17) See Figure 2-4. Remove the hexagon head capscrews, hexagonal nuts, and lockwashers from the generator mounting feet.

WARNING
Use of chains and hoists not rated for the weight of the generator may result in Injury to personnel or damage to equipment

(18) See Figure 2-9. Connect the lifting rig to the lifting lugs on the generator housing and connect the lifting rig to the hoist and take up slack from lifting device, but do not lift generator at this time.

(19) See Figure 2-4, detail A. Remove the hexagon head capscrews and washers securing the adapter to the flywheel housing. Start with the screws nearest the 12 o'clock position and work back and forth around the circle down to the 6 o'clock position.

(20) Lift generator slowly so that generator mounting feet are free from skid base mounting pads. Move generator slowly in rearward direction until generator flex plates and rotor hub dear engine flywheel housing.

(21) Hoist the generator out of the generator set and set it on the floor or a pallet.

(22) Install suitable protection over engine flywheel housing, conduit box, and all other exposed equipment to protect from the elements.

b. Install. This procedure is for installation and alignment of the generator.

(1) Remove the mufflers in accordance with paragraph 4-86 of the Operator and Organizational Maintenance Manual.

(2) Prepare the generator set by removing roof panel 4 (see Figure 2-2 and paragraph 413 of the Operator and Organizational Maintenance Manual), over the rear of engine compartment, removing all tools and equipment from the engine and generator bays, and positioning over rear of engine an overhead hoist or crane rated for 15,000 pounds (6800 kg).

(3) Rig the engine assembly for lifting. There are two lifting brackets at the rear of the engine mounted to the cylinder block between the cylinder head assemblies. Use locking lifting hooks on the brackets. Actuate the hoist enough to take the slack out of the lifting device, but do not lift the engine at this time.

(4) Loosen hexagonal nuts (13, Figure 2-5), securing front of engine to front engine support.

(5) Remove hexagonal nuts (9, Figure 2-5) and washers (8), retaining rear engine supports (6), to skid base.

(6) Raise the rear of the engine and place 1/2 inch (12 mm) spacer blocks between the skid base and the rear engine supports (6, Figure 2-5). Lower the engine until the supports rest on the spacer blocks.

NOTE

The purpose of the 112 inch (12 mm) spacer blocks is (1) to eliminate interference between the generator and the skid base during preliminary assembly and (2) to allow sufficient clearance to establish an 0.015 inch (0.38mm) (approximate) gap between the flywheel housing and the generator S.AE. flange (adapter) for preload condition checking.

(7) Install two lineup studs in the flywheel for generator drive plate (flexible discs) alignment at the 3 and 9 o'clock positions.

WARNING

Use of sling, chins, or lifting hoists not rated for the weight of the engine assembly may result In Injury to personnel and falling damage to equipment.

(8) Rig the generator for lifting (see Figure 2-9), with a hoist or overhead crane rated for a minimum of 6,000 pounds (2722 kg) and a minimum height clearance of 150 inches (3810 mm). There are two lifting brackets welded to the top of the generator. Use locking lifting hooks on the brackets and raise the hoist to remove slack from the slings and lifting chains, but do not lift generator at this time.

WARNING

To minimize potential falling damage, clear the area of personnel and other equipment when attempting to lift heavy equipment.

NOTE

This task requires two people.

(9) Hoist generator into the generator set through the roof, piloting the drive plate (flexible discs) to the lineup studs installed in the flywheel in step (7), above. This will require manual alignment while generator is being suspended on lifting device. Generator adapter ring must be properly seated in flywheel housing before proceeding to next step.

(10) See Figure 24, detail A. Install all the hexagon head capscrews and lockwashers securing the generator adapter to the engine flywheel housing. Torque the capscrews on the lower half of the adapter to 50 pound-feet (68 newton-meters). Leave the upper half of the bolt circle finger tight

(11) Using feeler gages, check the gap between the adapter and flywheel housing at the top of the ring. If the gap is greater than 0.015 inch (0.38 mm), alternately torque to 50 pound-feet (68 newton-meters) the bolts on the top half of the ring, starting at the points farthest from 12 o'clock position until a maximum gap of 0.015 inch (0.38 mm) is obtained. If a gap of 0.015 inch (0.38 mm) cannot be achieved, the generator adapter ring or drive plates may not be properly aligned and seated. Remove all hexagon head capscrews and lockwashers securing generator adapter to engine flywheel housing, and repeat procedures described in paragraph 2-1 5b(22) through (25).

(12) Raise both engine and generator assembly and remove the 1/2 inch (13 mm) spacer blocks from beneath the rear engine supports (6, Figure 2-5). Lower the engine and generator assembly to the skid base mounting pads. Relieve all crane and sling tension.

(13) Using feeler gages, check the gap at the 12 o'clock position of the adapter to flywheel housing mating area. If the gap is decreased to a dimension greater than 0 but less than 0.015 inch (0.38 mm), proper alignment has been attained and proceed directly to step (18), below. If the gap is 0, longitudinal preload is assumed and shimming will be required between the rear engine supports (6) and the skid base. Proceed as follows:

(a) Raise the engine and generator assemblies and install 0.015 inch (0.38 mm) shims (19) between both rear engine supports (6) and the skid base. Lower the engine and generator assemblies and check the adapter to flywheel housing gap as described in step (13), above.

(b) As require, shim both rear engine supports in equal increments of 0.005 inch (0.127 mm) until a maximum gap of 0.015 inch (0.38 mm) is attained.

(14) Using feeler gages, check the two rear engine supports and four generator mounting pads for clearance to the slid base. If clearance is 0 to 0.010 inches (0.25 mm), proceed directly to step (15), below. If clearance is greater than 0.010 inches (0.25 mm), shims must be installed to reduce the clearance to an acceptable limit of less than 0.010 inches (0.25 mm). Proceed as follows:

NOTE

The shimming procedure will require the raising and lowering of engine and generator assemblies until acceptable clearance is attained.

(a) Install shim (19, Figure 2-5) beneath rear engine supports until acceptable clearance is attained. Shim equally at both mounts.

(b) See Figure 2-4, detail D. Add shims beneath generator feet until acceptable clearance is attained. Shim equally at all four mounts.

(15) After attaining acceptable clearances, remove lifting slings for both engine and generator assemblies.

(16) Install lockwashers (8, Figure 2-5) and hexagonal nuts (9) securing rear engine mounts to skid base.

(17) Torque hexagonal nuts (9 and 13) and capscrews (7 and 10) to 200 pound-feet (271 newton-meters) on both rear engine mounts and front engine support

(18) See Figure 24. Install hexagon head capscrews, hexagonal nuts, and lockwashers to secure the generator to the skid base and torque in two stages, as follows: (a) Beginning with the two rear feet then the two front feet, torque to 600 pound-feet (813 newton-meters).

(b) Using feeler gage, check the gap at the top of the adapter to engine mating surface. if the gap is not within the acceptable limit of 0 to 0.015 inch (0.38 mm), the shimming procedure must be repeated until an acceptable limit is attained. Add shims beneath rear engine supports or generator mounting feet as required.

(c) If the gap is within the acceptable limit of 0 to 0.015 inch (0.38 mm), apply the final torque of 850 pound-feet (1156 newton-meters) to the hexagon head capscrews securing the generator mounting feet.

(19) Check the gap at the 12 o'clock position of the adapter. ' it is still within the acceptable limit of O to 0.015 inch (0.38 mm), loosen the hexagon head capscrews and lockwashers securing the generator adapter to engine flywheel housing and torque capscrews to 50 pound-feet (68 newton-meters) in accordance with Figure 2-10.

(20) See Figure 2-4, detail B. Install hexagon head capscrews and locking plates to secure the generator drive discs to the engine flywheel. Torque the capscrews to 112 pound-feet (152 newton-meters) in accordance with Figure 2-10 and bend a loading plate corner to a flat side of each screw. After installing at least two hexagon head capscrews and one locking plate, remove the guide pins that were used to pilot the generator to the engine.

(21) Install cover and screen assembly (3, Figure 2-3) with nuts (1) and screws (2).

(22) See Figure 2-11 and check the exciter air gap (gap between exciter armature and stator) by inserting a 0.010 inch (0.25 mm) feeler gage in the gap and rotating it around the armature diameter to ensure that a minimum air gap of 0.010 inch (0.25 mm) is available. I the feeler gage cannot be rotated one full revolution, then check for a “cocked" exciter stator or loose stator mounting capscrews. Refer to Chapter 5 as necessary.

(23) Using the barring mechanism built into the engine flywheel housing, (see Figure 3-2 of the Operator and Organizational Maintenance Manual), bar the engine generator assembly through at least one full revolution to verify engine-generator freedom of rotation.

NOTE

If binding is discovered, then the alignment procedure was performed incorrectly or the engine or generator or both have been improperly assembled.

(24) Check the exciter air gap again in accordance with step (22), above.

(25) Make electrical connections to strip heaters H109 and H110. Refer to paragraph 5-4 and dry the generator set as required.

NOTE

Utility power must be available to dry the generator when installed in the generator set.

(26) Reinstall air cleaner assembly in accordance with paragraph 4-74 of the Operator and Organizational Maintenance Manual.

(27) Reinstall the roof panels and ac and dc lights and conduit above the engine and generator in accordance with paragraphs 4-13 and 4-35 of the Operator and Organizational Maintenance Manual.

(28) Reinstall the battery charger in accordance with paragraph 4-20 of the Operator and Organizational Maintenance Manual.

(29) Reconnect the ac wiring harness (1, Figure 2-8) to the terminal board (2) and the two transformers (3).

(30) Refer to Figure 2-14. Feed the generator leads through the conduit that runs between cabinet B and the conduit box assembly.

(31) Reconnect the generator ground leads (3, Figure 2-13) to the insulated standoff (4).

(32) Reconnect the generator power leads (1) to terminal posts (2) on the back of the load circuit breaker CB1 01 receptacles.

(33) See Figure 2-12 and paragraph 4-18 of the Operator and Organizational Maintenance Manual. Reinstall the cover on the rear of cabinet B.

(34) See Figure 2-8 and install generator cable exit enclosure (4) to generator cabinet with capscrews (5) and lockwashers (6).

(35) See Figure 2-7 and reinstall the conduit box cover assembly.

(36) Reinstall batteries in accordance with paragraph 39 of the Operator and Organizational Maintenance Manual.

(37) Refer to Chapter 13 and perform applicable set tests and inspections after repair or overhaul.

2-17. LOAD CIRCUIT BREAKER CB1O1 REMOVAL AND INSTALLATION. Special tools are required to accomplish load circuit breaker CB101 removal or installation. These tools (crank or ramps) are supplied with the generator set. See Figure 2-15 for their locations.

NOTE

Load circuit breaker CB101 removal or installation will require two or more persons.

a. Remove. This procedure requires use of a forklift with tongs a minimum 42 inches (1067 mm) in length, 4 inches (107 mm) in width, and 1.50 inches (38 mm) thick.

(1) Remove the ramps from the generator compartment as follows:

(a) Open access doors as required.

(b) See Figure 2-15, detail A, and remove screws, lockwashers, and channels to remove ramps.

(2) See Figure 2-15, details B and C. Open control room door and cabinet B bottom compartment. Remove lip flange at base of cabinet B by removing screws, bevel washers and nuts to gain access to ramp alignment pins.

(3) Hook the end of each ramp removed in step (1), above, on alignment pins at base of cabinet B. Note that the ramps when installed will be lying on the floor angled slightly towards the left side of the control room door.

(4) Remove racking handle from storage at left side of load circuit breaker CB1 01 and attach to racking crank on circuit breaker panel. With racking handle, turn racking crank counterclockwise until load circuit breaker CB1 01 moves as far outwards as it will go. Then remove racking handle and restore to storage position at left of circuit breaker compartment.

(5) See Figure 2-15, detail B. Locate Kirk-key interlock at lower right side of circuit breaker compartment. Turn the load circuit breaker Kirk-key interlock and remove key.

(6) See Figure 2-15, detail C. With Kirk-key interlock key removed in step (5), above, unlock the main disconnect switch S120 Kirk-key interlock. Pull main disconnect switch S120 handle downwards to OPEN position.

(7) Adjust forklift tongs until they are approximately 8 inches (203 mm) apart at the center. Maneuver forklift until tongs are halfway inside the control room, in between and parallel with the load circuit breaker ramp channels. Adjust forklift tongs until they are flush against the control room floor and centered between the two ramp channels. Position piece of plywood or similar buffer material on forklift tongs to prevent damage to load circuit breaker CB1 01 underside when lifting.

(8) Locate release latch at bottom right side of load circuit breaker CB101. Pull latch upwards and slightly lift circuit breaker front and pull out of cabinet until front circuit breaker rollers are engaged on the ramp channels. Roll load circuit breaker CB101 out of cabinet and onto ramps. Slightly lift rear end to allow rear circuit breaker rollers to engage the ramp channels. Two persons are required to roll the load circuit breaker CB101 assembly out of the cabinet (9) Roll load circuit breaker CB101 on ramp channels into position above forklift tongs. Maneuver forklift, if needed, to ensure load circuit breaker CB101 underside is fully supported. Slightly lift load circuit breaker CB011 and secure to the forklift tongs.

CAUTION

Do not tilt forklift tongs backwards when removing load circuit breaker CB101 as this may cause damage.

(10) Carefully remove load circuit breaker CB1 01 from the generator set.

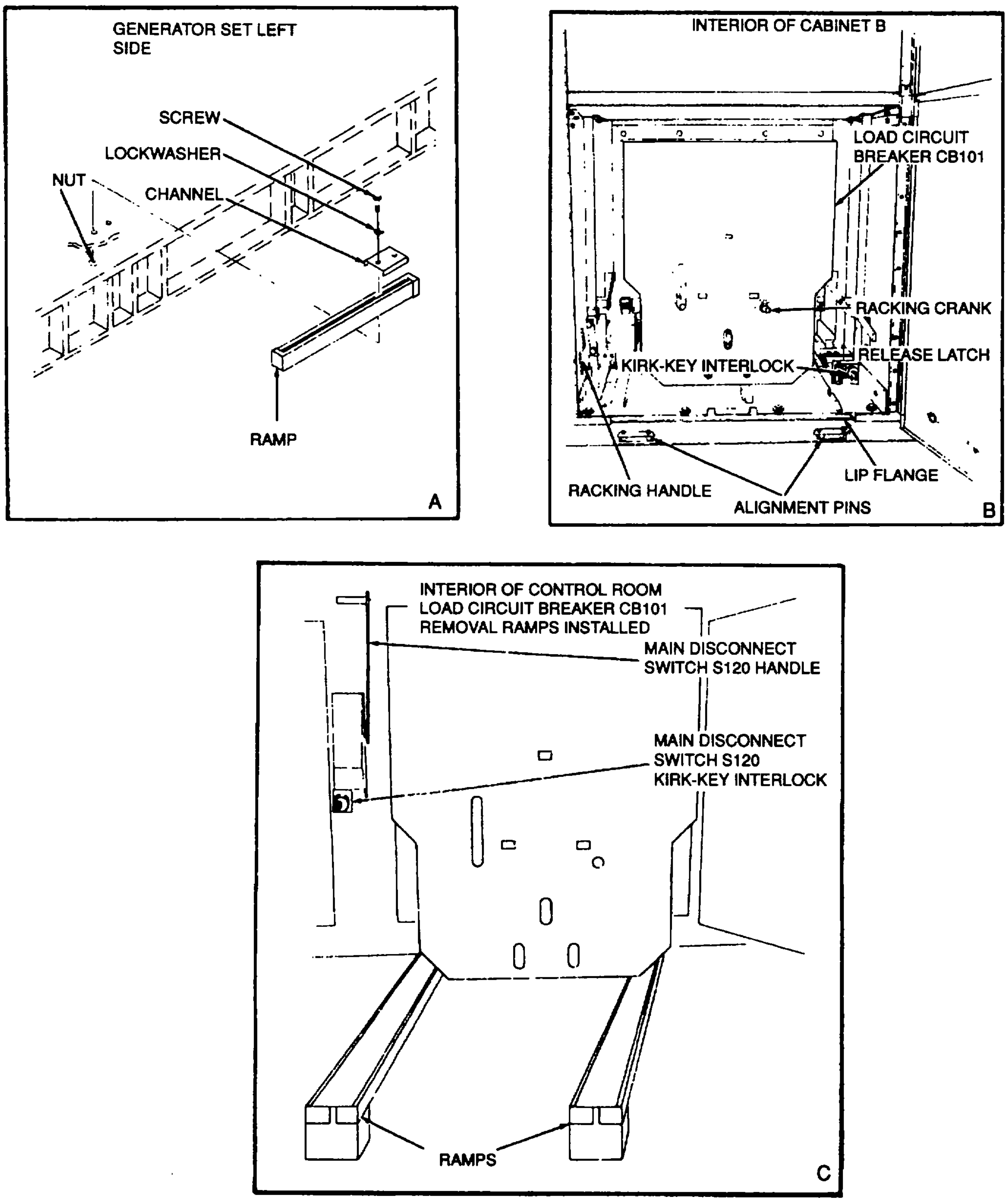


Figure 2-15. Load Circuit Breaker CB101, Removal and Installation

b. Install. See Figure 2-15. Use a forklift and proceed as follows:

(1) Prepare the generator set for load circuit breaker CB1 01 installation as follows:

(a) Open the control room and bottom cabinet B doors.

(b) Clear the control room and interior of cabinet B of any objects that will obstruct the installation of load circuit breaker CB1 01. Remove the lip flange (if reinstalled) from the base of cabinet B by removing screws, bevel washers, and nuts. Remove racking handle from storage position.

(c) Position buffered forklift tongs approximately 8 inches (203 mm) apart. Slightly and carefully lift load circuit breaker CB1 01 with its front panel facing the forklift operator. Ensure that the circuit breaker underside is fully seated and centered on the buffered forklift tongs. Secure load circuit breaker CB1 01 to the forklift tongs before maneuvering the forklift for installation.

(d) Maneuver load circuit breaker CB1 01 through the control room door until circuit breaker rollers are aligned with the circuit breaker ramp channels installed in step a(3), above. Then lower load circuit breaker CB101 until all rollers engage the ramp channels.

(e) Slightly lift rear end of load circuit breaker CB1 01 assembly to allow entry into the compartment, ensuring that both rear rollers are within the guide rails on either side of compartment floor. Slightly lift front end of load circuit breaker CB1 01 and push circuit breaker inside compartment until the release latch on the lower right side of circuit breaker snaps back into the guide rail slot.

(f) See Figure 2-15, detail C. Pull main disconnect switch S120 handle upwards to the CLOSED position. Lock main disconnect switch Kirk-key interlock and remove key.

(g) Install key removed in step (g), above, on load circuit breaker CB1 01 Kirk-key interlock and unlock

(h) Lift release latch at bottom right side of load circuit breaker CB1 01 and push circuit breaker into cabinet at the same time step 0i), below, is being performed.

(i) With racking handle, turn racking crank on circuit breaker panel clockwise until load circuit breaker CB1 01 is as far in as it will go. (Indicated by free movement of racking handle.) (1) Remove racking handle and replace in storage position at left side of compartment (k) Install lip flange at base of cabinet B and secure with screws, bevel washers, and nuts. Close compartment door.

2-18. FUEL TANK REMOVAL AND INSTALLATION.

a. Remove.

WARNING

Fuel used In the following operations Is flammable and toxic to the skin, eyes, and respiratory tract. Use In an adequately ventilated area. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

WARNING

The fuel tank, even when empty, may contain explosive fumes and vapors. Do not remove tank In the vicinity of any source of Intense heat. Smoking Is prohibited within 50 feet (15.24 meters) of the work area. Failure to heed this warning may result In death or serious Injury.

NOTE

Fuel tank removal and installation will require two or more persons.

(1) Turn FUEL PUMP switch S8 on generator control cabinet C to OFF position.

(2) Open the fuel drain valve (34, Figure 2-16), and drain fuel into dean suitable container.

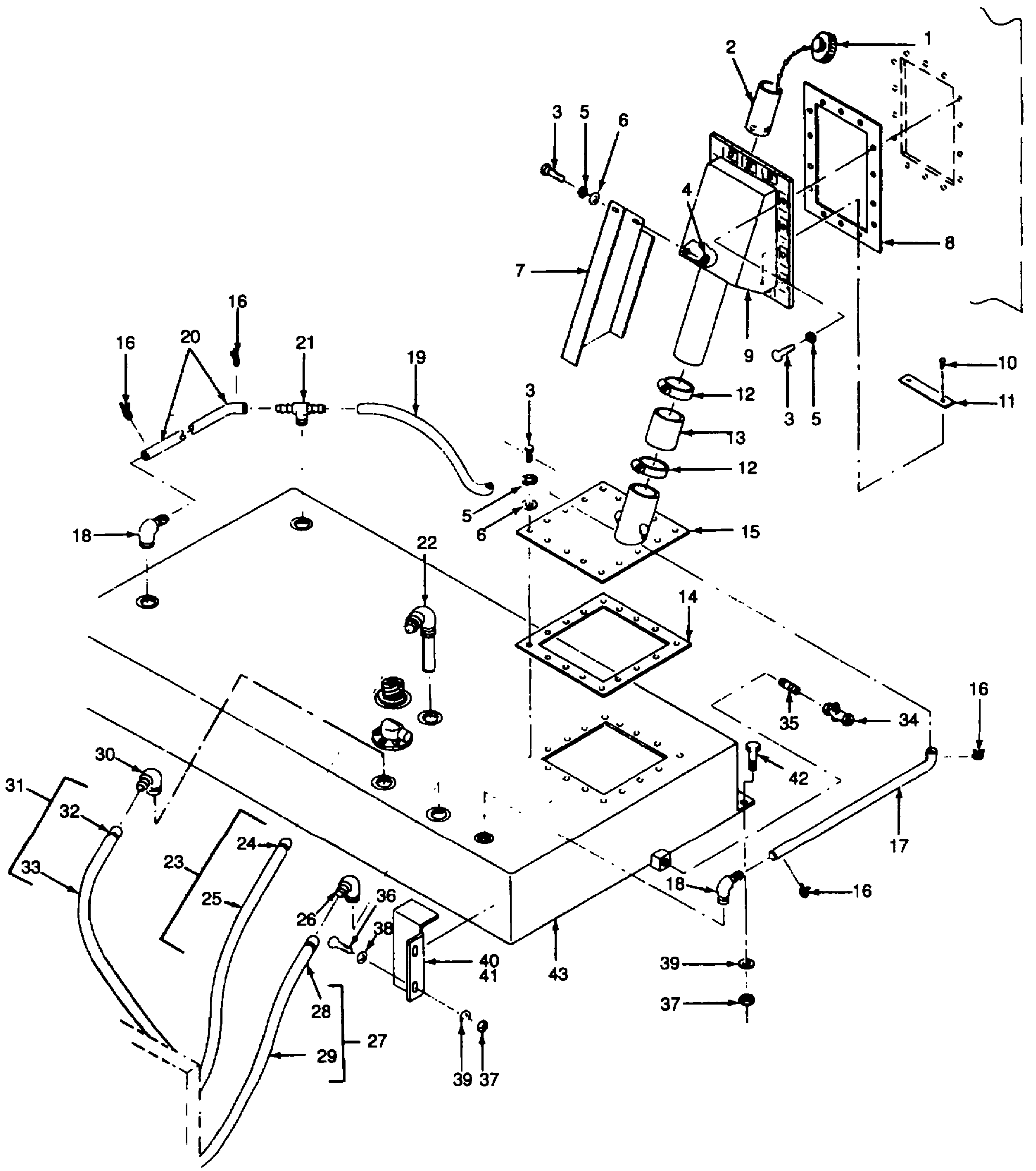


Figure 2-16. Fuel Tank, Exploded View (Sheet 1 of 2)

1.	FUEL TANK CAP	23.	FUEL SUCTION HOSE ASSEMBLY
2.	ELEMENT STRAINER	24.	STRAIGHT ADAPTER
3.	HEXAGON HEAD CAPSCREW	25.	HOSE
4.	HEXAGONAL NUT	26.	ELBOW
5.	LOCKWASHER	27.	FUEL RETURN HOSE ASSEMBLY
6.	FLAT WASHER	28.	STRAIGHT ADAPTER
7.	FUEL FILL GUARD	29.	HOSE
8.	FUEL FILL GASKET	30.	ELBOW
9.	FILLER NECK AND HOUSING	31.	FUEL TRANSFER HOSE ASSEMBLY
10.	RIVET	32.	STRAIGHT ADAPTER
11.	FUEL TANK IDENTIFICATION PLATE	33.	HOSE
12.	HOSE CLAMP	34.	DRAIN VALVE
13.	FUEL FILL HOSE	35.	PIPE NIPPLE
14.	COVER GASKET	36.	HEXAGON HEAD CAPSCREW
16.	SPRING CLAMP	37.	HEXAGONAL NUT
17.	VENT HOSE	38.	FLAT WASHER
18.	ELBOW	39.	LOCKWASHER
19.	VENT HOSE	40.	RETAINER
20.	VENT HOSE	41.	RETAINER
21.	TEE FITTING	42.	HEXAGON HEAD SCREW
22.	FUEL SUCTION TUBE ASSEMBLY	43.	FUEL TANK

Figure 2-16. Fuel Tank, Exploded View (Sheet 2 of 2)

(3) Remove hexagon head capscrews (3), lockwashers (5), flat washers (6), and hexagonal nuts (4), and remove fuel fill guard (7).

(4) Loosen the hose clamps (12), and slide the fuel fill hose (13) up the filler neck (9).

(5) Remove the control room fire extinguisher and bracket in accordance with the Operator and Organizational Maintenance Manual.

(6) Remove hexagon head capscrews (1, Figure 2-17), hexagonal nuts (2), and lockwashers (3), and remove the rear door stop plate (4). Remove the floor mat (9).

(7) Remove the machine screws (5), and remove the floor plates (6) from the skid base.

(8) Remove the screws (7), and remove the cover plates (8) from the skid base.

(9) Remove the spring clamps (16, Figure 2-16), vent hoses (17,19, and 20), and remove the elbows (18) and tee fitting (21).

(10) Remove the hexagon head capscrews (3), lockwashers (5), flat washers (6), and remove the fill pipe (15). Remove and discard the cover gasket (14).

(11) Remove the fuel quantity transmitter MT4 and fuel level switches FL1 through FL4 assembly in accordance with the Operator and Organizational Maintenance Manual.

(12) Remove the drain valve (34) and pipe nipple (35).

(13) Disconnect the fuel suction hose assembly (23), fuel return hose assembly (27), and fuel transfer hose assembly (31). Cap the ends of the hoses to prevent contamination.

(14) Remove the fuel suction tube assembly (22), and elbows (26 and 30).

(15) Remove the nuts (37), lockwashers (39), capscrews (36), flat washers (38), and retainers (40 and 41). Inspect webbing on retainers (40 and 41). Replace webbing if necessary.

(16) Remove the nuts (37), lockwashers (39), and capscrews (42) securing the tank flange to the skid base.

(17) See Figure 2-18. Remove the fuel tank through the opening in the rear of the skid base.

b. Install.

(1) See Figure 2-18. Slide the fuel tank (43, Figure 2-16) through the opening in the rear of the skid base, and align the screw holes in the fuel tank flange and skid base.

(2) Install the capscrews (42) through the fuel tank flange and skid base, and install the lockwashers (39) and hexagonal nuts (37) finger tight.

(3) Install the retainers (40 and 41), flat washers (38), capscrews (36), lockwashers (39), and install the nuts (37) finger tight.

(4) Check that the fuel tank (43) is positioned properly, and tighten the hexagon head capscrews (36 and 42) and hexagonal nuts (37).

CAUTION

To avoid fuel contamination, do not use liquid or paste sealers on pipe threads.

(5) Wrap the pipe threads of the elbows (30 and 26) and fuel suction tube assembly (22) with anti-seize tape MIL-T-27730, and install them in the fuel tank (43).

(6) Connect the fuel transfer hose assembly (31), fuel return hose assembly (27), and fuel suction hose assembly (23).

(7) Wrap the threads of the pipe nipple (35) with anti-seize tape MIL-T-27730, and install the nipple and drain valve (34) in the fuel tank (43).

(8) Install the fuel quantity transmitter MT4 and fuel level switches FL1 through FL4 assembly in accordance with the Operator and Organizational Maintenance Manual.

(9) Using a new cover gasket (14), install the fill pipe (15), lockwashers (5), flat washers (6), and capscrews (3). Tighten the hexagon head capscrews in accordance with Table 1-2.

(10) Wrap the pipe threads of the tee fitting (21) and elbows (18) with ant-seize tape MIL-T-27730, and install in the fuel tank (43).

(11) Install the vent hoses (17, 19, and 20) using the spring damps (16).

(12) Install the cover plates (8, Figure 2-17) on the skid base with the screws (7).

(13) Install the floor plates (6) on the skid base with the machine screws (5). Install the floor mat (9).

(14) Install the rear door stop plate (4) with the hexagon head capscrews (1), hexagonal nuts (2), and lockwashers (3).

(15) Install the control room fire extinguisher and bracket in accordance with the Operator and Organizational Maintenance Manual.

(16) Slide the fuel fill hose (13, Figure 2-16) down over fill pipe (15) and secure with hose damps (12).

(17) Install fuel fill guard (7) and secure with hexagon head capscrews (3), lockwashers (5), flat washers (6), and hexagonal nuts (4).

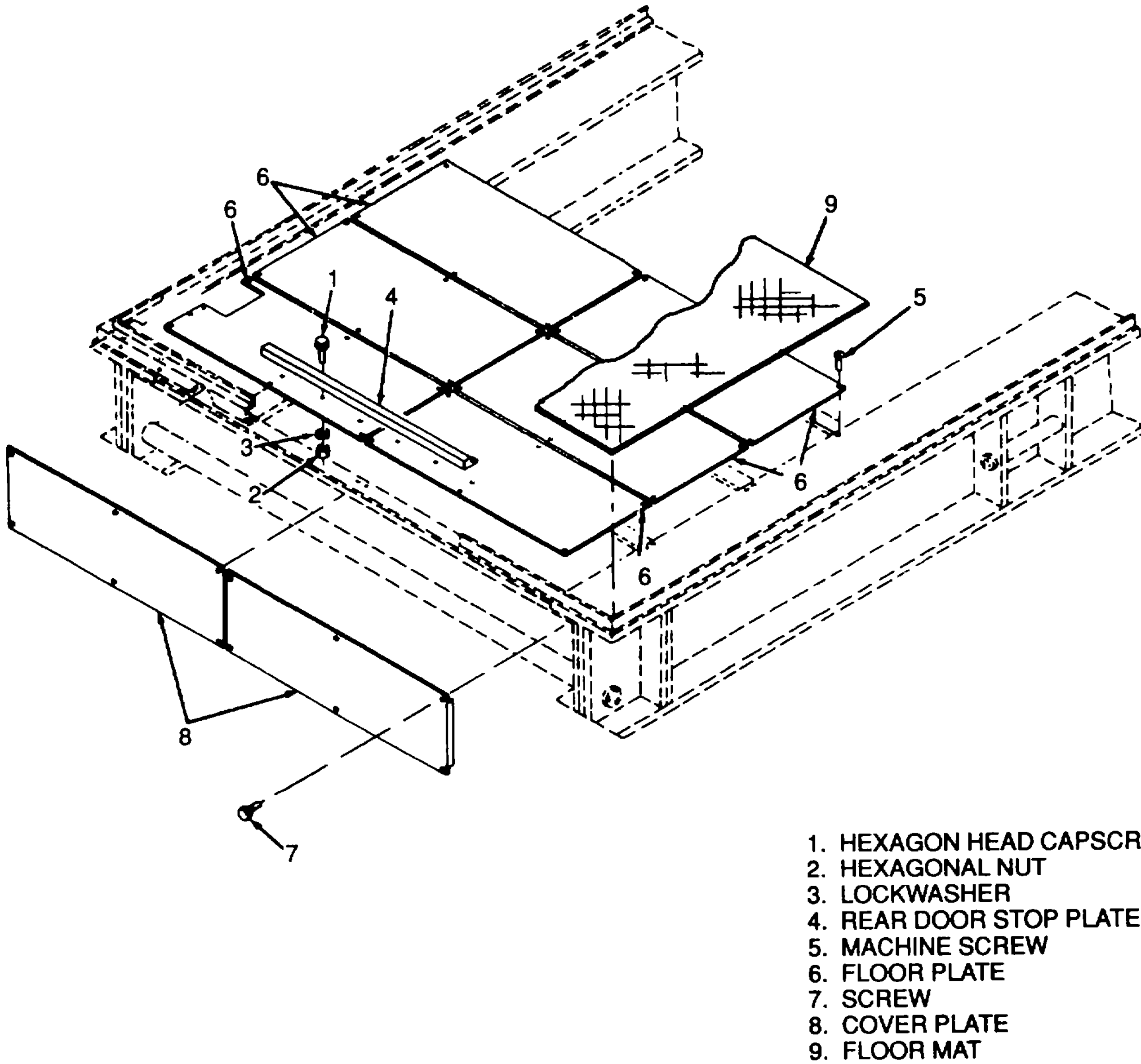
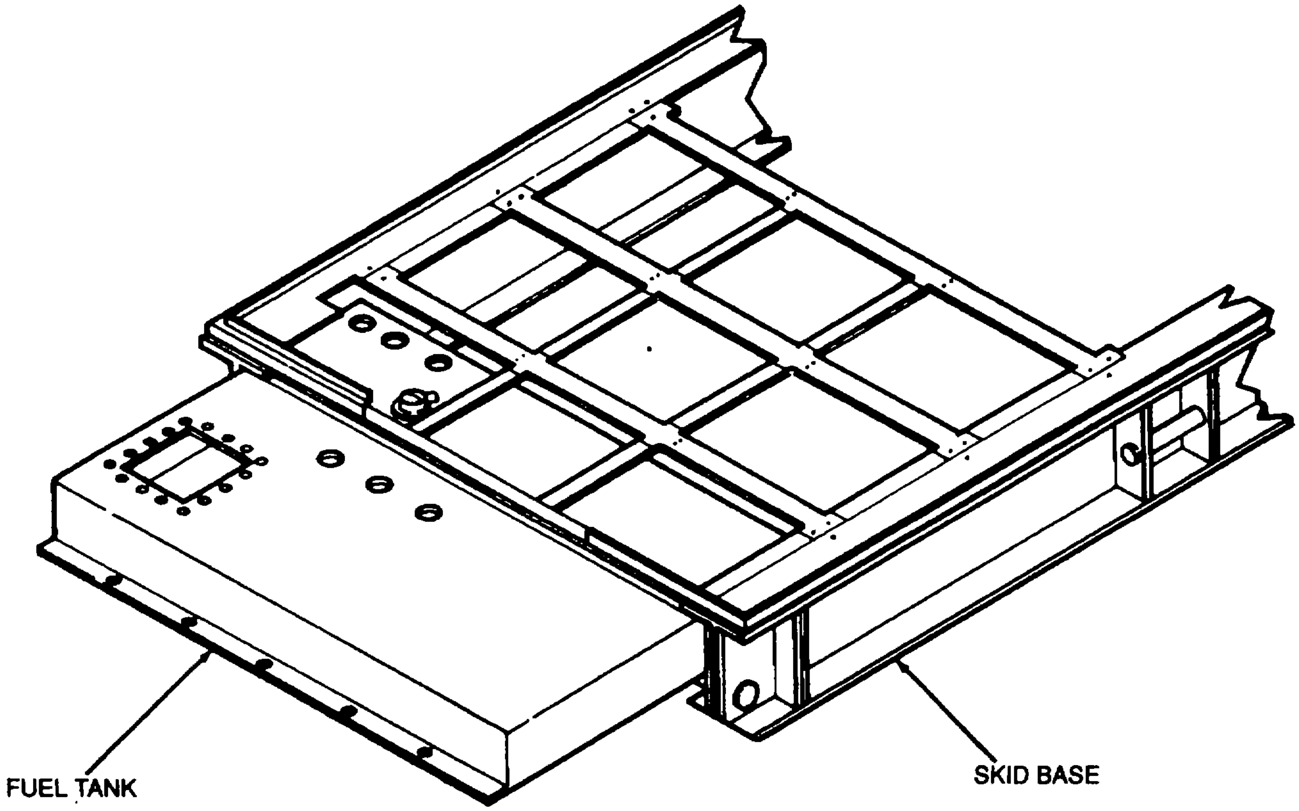


Figure 2-17. Fuel Tank, Removal and Installation of Floor Plates and Cover Plates



REMOVE AND INSTALL THE FUEL TANK THROUGH THE OPENING IN THE REAR OF THE SKID BASE.

Figure 2-18. Fuel Tank, Removal and Installation

CHAPTER 3

MAINTENANCE OF SKID BASE

SECTION I. REPAIR

3-1. GENERAL. The skid base is a welded, integral assembly. Repair minor cracks or breaks by welding in accordance with MIL-STD-1 261, Class 1. Remove and replace severely damaged structural components. Treat and paint in accordance with MIL-T-704, Type A.

CHAPTER 4

MAINTENANCE OF DC ELECTRICAL AND CONTROL SYSTEM

SECTION I. WIRING HARNESS OVERHAUL

4-1. GENERAL. Electrical interconnection of control devices and indicators is accomplished through wiring harnesses. Wires in the harness are bundled and secured to prevent unnecessary movement and chafing.

4-2. WIRING HARNESS OVERHAUL. If 30 percent of the wires in a harness are defective, the harness must be overhauled. FO-1 3 through FO-38 are wiring harness fabrication drawings. These drawings specify the length and gage of every wire used in each harness, as well as the termination points, lugs, or connectors, and wire marking data. The harness drawings also provide routing information for each harness. The following is a list of the dc wiring harnesses with a functional description of each.

NOTE
The harness that are combination ac and dc are listed in Chapter 5.

a. Cabinet A Interconnect Harness (80-7897). Refer to FO-1 3. Interconnects all meters, relays, and other electrical components located in cabinet A.

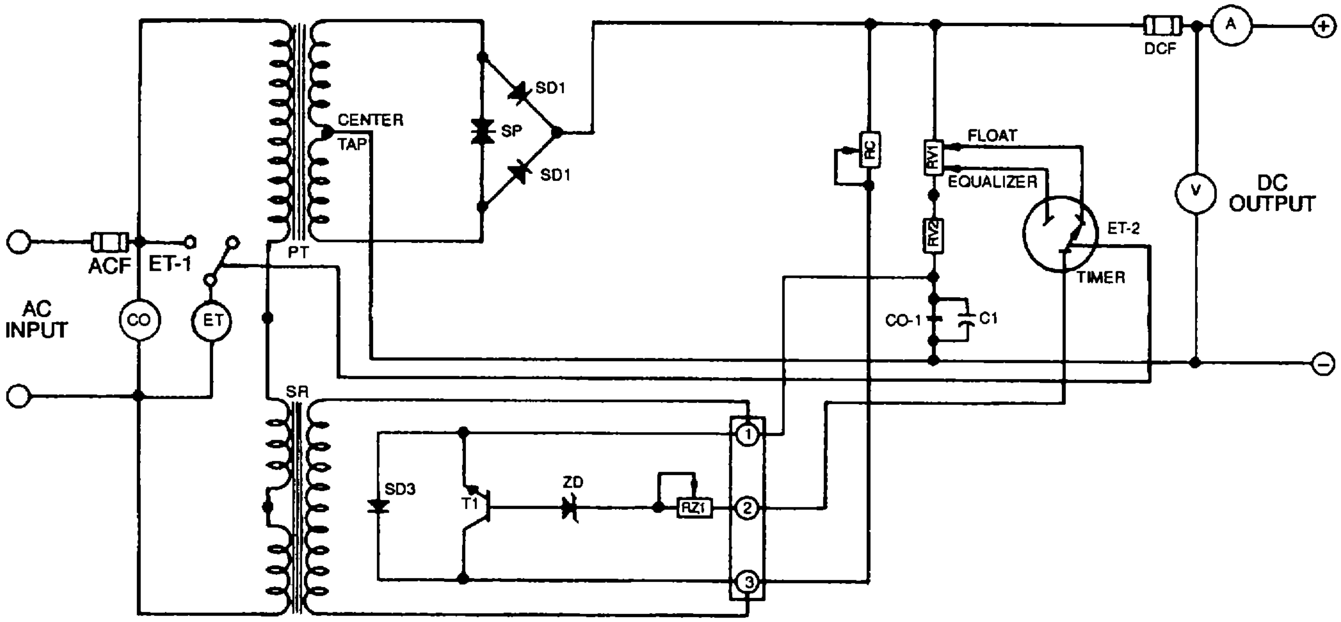
b. Fuel Monitor Harness (80-7920). Refer to FO-1 4. Interconnects the floats in the fuel tank with fuel level gage M4, fuel transfer pump, and annunciator alarm system.

SECTION II. BATTERY CHARGER BC1 REPAIR

4-3. GENERAL. Refer to Figure 4-1. The battery charger BC1 is designed to maintain the generator set batteries BT1 through BT4 in a fully charged condition at all times. The battery charger BC1 receives 120 V ac current from the generator set ac electrical system and is protected by BATTERY CHARGER circuit breaker DP2CB116. An ac input fuse ACF protects the internal circuitry of the primary system. A power transformer PT steps down the 120 V ac current to 24 V ac and a set of diodes SD1 converts this ac current to dc. This 24 V dc current is then applied directly to the generator set batteries BT1 through BT4. A dc output fuse DCF, located after the diodes SD1, protects the system. An ammeter A, located just ahead of the generator set batteries BT1 through BT4, measures the output rate of the battery charger BC1. A dc voltmeter V, installed across the positive and negative output from the leads battery charger BC1, measures the voltage of the generator set batteries BT1 through BT4. The equalizer timer ET, placed between the current sensing circuitry of the battery charger BC1 and the resistor RV1, is used to manually select the rate of charge (float or equalizer) and the charging duration. The current sensing circuitry of the battery charger BC1 continually senses battery and load conditions and provides the appropriate output rate.

As the generator set batteries BT1 through BT4 approach an optimum preselected voltage, the battery charger BC1 equalizer output rate tapers to the float output rate, which maintains the generator set batteries BT1 through BT4 in a fully charged condition. If the equalizer timer ET has been manually set to the equalizer rate, it will automatically select the float rate once it times out, and control of the charging rate is returned to the current sensing circuitry. The saturable reactor assembly SR operates with the current sensing circuitry of the battery charger BC1 to determine the rate of charge, and helps to compensate for line voltage variations of +l 0 percent.

4-4. REMOVAL OF BATTERY CHARGER BC1. Remove battery charger BC1 in accordance with paragraph 4-20 of the Operator and Organizational Maintenance Manual.



REFERENCE
DESIGNATOR

A	AMMETER
ACF	AC INPUT FUSE
C1	CAPACITOR
CO, CO-1	CUT OUT RELAY
DCF	DC OUTPUT FUSE
PT	POWER TRANSFORMER
SR	SATURABLE REACTOR ASSEMBLY
SD1, SD2, SD3	SILICONE DIODE
T1	TRANSISTOR
ZD	ZENER DIODE
RZ1	ZENER RESISTOR
RC	COLLECTOR RESISTOR
RV1, RV2	VOLTAGE DIVIDER RESISTOR
V	VOLTMETER

Figure 4-1. Battery Charger BC1, Schematic

4-5. BATTERY CHARGER BC1 DISASSEMBLY

NOTE
When necessary, remove components that have been soldered in place by unsoldering.

a. Tag and disconnect wiring.

b. Remove the front cover (3, Figure 42) from the enclosure (6), and remove the nameplate (2), if necessary, by removing the rivets (1).

c. Remove the hexagon head screws (11) and flat washers (10), and remove the resistor (8) from the enclosure (6). Remove the retaining clip (44).

d. Remove the hexagon head screws (12), and remove the resistor (9) from the enclosure (6).

e. Remove the hexagon head screws (4) and lockwashers (5), and separate the enclosure rear panel (7) from the enclosure (6).

f. Remove the screws (13), and remove the fuse board (14) from the transformer (24). Remove the output fuse (15) and the input fuse (16) from the fuse board (14). Remove the fuse holders (45 and 46).

g. Remove the hexagonal nut (19) and lockwasher (18), and remove the cut out relay (21) from the bracket (20). Remove the fixed capacitor (22).

h. Remove the hexagon head screw (17), and remove the bracket (20) from the enclosure rear panel (7).

i. Remove the hexagon head screws (23), and remove the transformer (24) from the enclosure rear panel (7).

j. Remove the hexagon head screws (25), hexagonal nuts (26), lockwashers (27), and flat washers (28), and remove the reactor assembly (29) from the enclosure rear panel (7).

k. Remove the capscrews (30), and remove the terminal board (31) from the enclosure rear panel (7). Remove the screw and captive washer assemblies (32), and remove the zener resistor (33) from the terminal board (31). Remove the round head screws (34), and remove the transistor (35) from the terminal board (31). Remove the diode (43) and the zener diode (47) from the terminal board.

l. Remove the capscrews (36), and remove the heatsink (37) from the enclosure rear panel (7). Remove the silicone diodes (38) from the heatsink (37).

4-6. CLEANING, INSPECTION, AND REPAIR OF BATTERY CHARGER BC1. Disassemble battery charger BC1 in accordance with paragraph 4-5, and reassemble after repair in accordance with paragraph 4-7. Refer to Figure 4-2.

a. Inspect the battery charger BC1 for signs of corrosion, loose electrical connections, worn or broken wiring, poor or broken soldered connections. Clean corroded components. Tighten loose electrical connections, and repair worn wiring and poorly or broken soldered connection in accordance with MIL-STD4, Requirement 5. Replace broken wires as necessary.

b. Inspect the DC voltmeter (40) and DC ammeter (41) for secure panel mounting and for chipped, cracked, or loose cover glass, and broken indicators. Inspect the equalizer timer (39) for secure panel mounting. Ensure that the timer knob rotates freely and remains positioned as set.

c. Inspect the output and input fuse (45 and 46) dips for signs of damage or deterioration, and check with an ohmmeter set to the RX1 scale. An ohmmeter connected across the ends of either the output or input fuse (15 or 16) should indicate continuity. A reading of infinity indicates a blown fuse. Replace the output and the input fuses (15 and 16) as necessary.

d. Inspect the insulation of transformer (24) and reactor assembly (29) for signs of deterioration or damage by using 500 V dc megohmmeter. If the insulation of transformer (24) or reactor assembly (29) is damaged or shows signs of deterioration, the unit must be replaced.

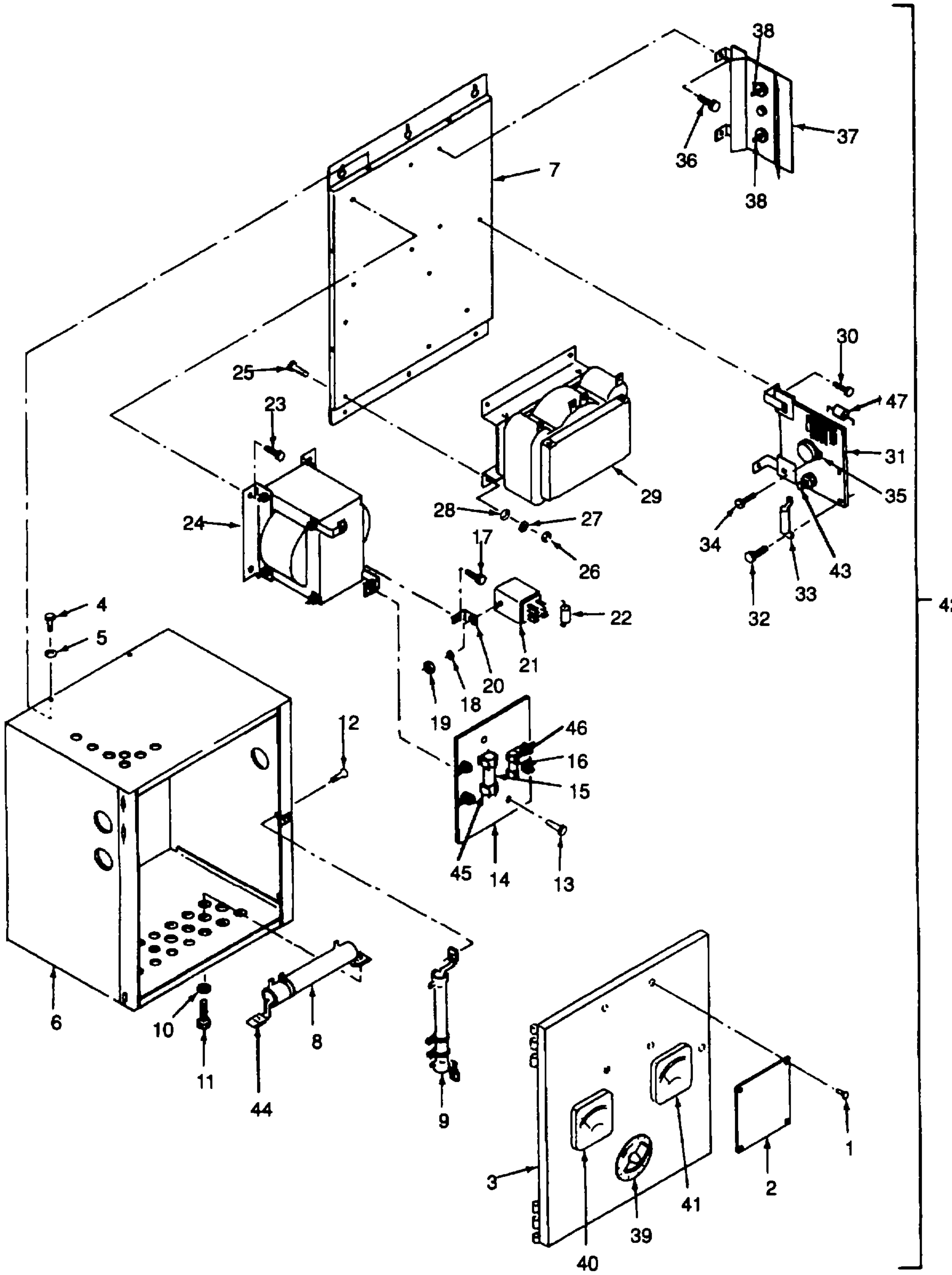


Figure 4-2. Battery Charger BC1, Exploded View (Sheet 1 of 2)

1. RIVET
2. NAMEPLATE
3. FRONT COVER
4. HEXAGON HEAD SCREW
5. LOCKWASHER
6. ENCLOSURE
7. ENCLOSURE REAR PANEL
8. RESISTOR
9. RESISTOR
10. FLAT WASHER
11. HEXAGON HEAD SCREW
12. HEXAGON HEAD SCREW
13. SCREW
14. FUSE BOARD
15. OUTPUT FUSE
16. INPUT FUSE
17. HEXAGON HEAD SCREW
18. LOCKWASHER
19. HEXAGONAL NUT
20. BRACKET
21. CUT OUT RELAY
22. FIXED CAPACITOR
23. HEXAGON HEAD SCREW
24. TRANSFORMER
25. HEXAGON HEAD SCREW
26. HEXAGONAL NUT
27. LOCKWASHER
28. FLAT WASHER
29. REACTOR ASSEMBLY
30. CAPSCREW
31. TERMINAL BOARD
32. SCREW AND CAPTIVE WASHER ASSEMBLY
33. ZENER RESISTOR
34. ROUND HEAD SCREW
35. TRANSISTOR
36. CAPSCREW
37. HEATSINK
38. SILICONE DIODE
39. EQUALIZER TIMER
40. DC VOLTMETER
41. DC AMMETER
42. BATTERY CHARGER BC1 ASSEMBLY
43. DIODE
44. RETAINING CLIP
45. FUSE HOLDER
46. FUSE HOLDER
47. ZENER DIODE

Figure 4-2. Battery Charger BC1, Exploded View (Sheet 2 of 2)

e. Inspect the diodes (38 and 43) for signs of damage or deterioration. Check the diodes (38) with an ohmmeter set to the RX1 scale as follows:

(1) Temporarily install the diode (38) on the heatsink (37). Do not reconnect any electrical wiring to the diode (38).

(2) Connect an ohmmeter across the nipple (or pig-tail) lead of the diode (38) and the heatsink (37) and note the reading.

(3) Reverse the ohmmeter leads from their positions in step (2), above, and note the reading.

(4) Compare the two readings obtained in steps (2) and (3), above. One of the two readings should indicate a high resistance and the other should indicate a low resistance. If the readings do not indicate both a high and low resistance value, or if either a zero resistance or an infinity reading was obtained, the diodes (38) are faulty and must be replaced.

CAUTION

Do not change the position of the red slider band or the green slider band on the resistor (9) If It Is to be reused, otherwise the float voltage and equalizer voltage values will be changed and will need to be readjusted before the battery charger BC1 can be returned to service.

f. Inspect the resistors (8 and 9) for signs of damage or deterioration.

g. Inspect the transistor (35) for signs of damage or deterioration. Replace the transistor (35) as necessary.

4-7. BATTERY CHARGER BC1 ASSEMBLY. Components that were removed by unsoldering may be replaced by soldering.

a. Install the silicone diodes (38, Figure 4-2) on the heatsink (37), and install the heatsink on the enclosure rear panel (7) with the capscrews (36).

b. Install the transistor (35) on the terminal board (31) with the round head screw (34). Install the zener resistor (33) on the terminal board (31) with the screw and captive washer assemblies (32). Install the diode (43) and the zener diode (47) on the terminal board. Install the terminal board (31) on the enclosure rear panel (7) with the capscrews (30).

c. Install the bracket (20) on the enclosure rear panel (7) with the hexagon head screw (17).

d. Install the fixed capacitor (22). Install the cut out relay (21) on the bracket (20) with the hexagonal nut (19) and lockwasher (1 8).

e. Install the reactor assembly (29) on the enclosure rear panel (7) with the hexagon head screws (25), hexagonal nuts (26), lockwashers (27), and flat washers (28).

f. Install the transformer (24) on the enclosure rear panel (7) with the hexagon head screws (23).

g. Install the fuse holders (45 and 46). Install the input and output fuses (16 and 15) on the fuse board (14). Install the fuse board on transformer (24) with the screw (13).

h. Install the resistor (9) on the enclosure (6) with the hexagon head screws (12). A new resistor (9) must be adjusted as follows:

(1) Adjust the float voltage to 5 V dc with the red slider band on the resistor (9). Move the red slider band toward the green slider band to raise the taper and shutdown point, and move the red slider band away from the green slider band to lower the taper and shutdown point. Taper and shutdown point should be 23 V dc.

(2) Adjust the equalizer voltage with the green slider band on the resistor (9). The equalizer voltage may be adjusted in the same manner as the float voltage.

i. Install the retaining clip (44). Install the resistor (8) on the enclosure (6) with the hexagon head screws (11) and flat washers (10).

j. Install the enclosure (6) on the enclosure rear panel (7) with the hexagon head screws (4) and lockwashers (5).

k. Install the nameplate (2) with rivets (1), and install the front cover (3) on the enclosure (6), if removed.

l. Install wiring as tagged. Discard tags.

4-8. INSTALLATION OF BATTERY CHARGER BC1. Install the battery charger BC 1 in accordance with paragraph 4-20 of the Operator and Organizational Maintenance Manual.

4-9. TESTING OF BATTERY CHARGER BC1. Test battery charger BC 1 in accordance with paragraph 4-20 of the Operator and Organizational Maintenance Manual.

SECTION III. STARTER MOTOR B1 AND B2 REPAIR

4-10. GENERAL. Both starter motors B1 and B2 used on the engine are identical 24 V dc units, and have positive-engagement drive pinions. Current, supplied to the S terminal on the solenoid switch activates a plunger. The plunger performs two functions: it moves the shift lever to engage the pinion with the flywheel ring gear teeth, and closes a switch to supply current to the field coils after the pinion and ring gear teeth have meshed. (The switch will not close on butt contact of the pinion and ring gear teeth; the teeth must be meshed.) After the engine is started, an overrunning clutch in the pinion protects the starter motors B1 and B2 from overspeed, and allows the return spring to disengage the pinion when the starting current is cut off.

4-11. STARTER MOTORS B1 AND B2 REPAIR

a. Remove. Remove the starter motors B1 and B2 in accordance with the Operator and Organizational Maintenance Manual.

b. Disassemble.

(1) Match-mark the starter housing (43, Figure 4-3) and lever housing (28) to the field frame (64) and the stator housing (2) to the lever housing (28). Disassemble the starter motor as follows: (2) Tag and remove the terminal lead (4).

(3) Remove the brush inspection plugs (1) and gasket (2) from field frame (64). Discard the gaskets.

(4) Remove the field coil screws (59) and the field leads from the brush holders. See Figure 44.

(5) Remove the plain hexagon nut (37, Figure 43) and terminal lead (4). Remove ground wire (67). Remove four machine bolts (3), and slide the electrical solenoids B1 L3 or B2L4 (13) off of the plunger (12) and free of protector bellows (10).

(6) Remove the lever housing inspection plug (65) and gasket (66) from the lever housing (28). Discard the gasket.

(7) Remove the plunger rod nut (5), and remove the plunger (12) with attached parts (7 through 11).

(8) Compress the plunger spring (8), remove the snap ring (6), and remove the recessed washer (7), plunger spring (8), recessed washer (9), protector bellows (10), and spring retainer washer (11) from the plunger (12). Discard snap ring (6).

(9) Remove the snap ring (6) and push out the shift lever shaft (17). Remove and discard the preformed packings (14 and 16).

(10) Remove the drive housing screw (19) and internal housing bolts (20) and separate the stator housing (21) from lever housing (28). Remove the protective dust cap (22), and remove and discard the oil wick (23) and gasket (26).

(11) Slide the armature (63) half way out of the field frame (64). Tilt the shaft lever (15) and remove the shaft lever and drive assembly (25) from the lever housing (28). Remove the brake washer (33).

(12) Remove machine bolts (27), and separate the lever housing (28) from the field frame (64). Remove the protective dust cap (29) and remove and discard the oil wick (30), preformed packing (35), and oil seal (34).

(13) Remove the machine bolts (27) and starter housing (43). Remove protective dust cap (44) from starter housing (43).

(14) Withdraw the armature (63) from the field frame (64) completely. Remove and discard the spacer washer (36) and flat washer (52).

c. Cleaning, Inspection, Testing, and Repair.

WARNING

Dry cleaning solvent, PD-680, Type III, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

WARNING

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

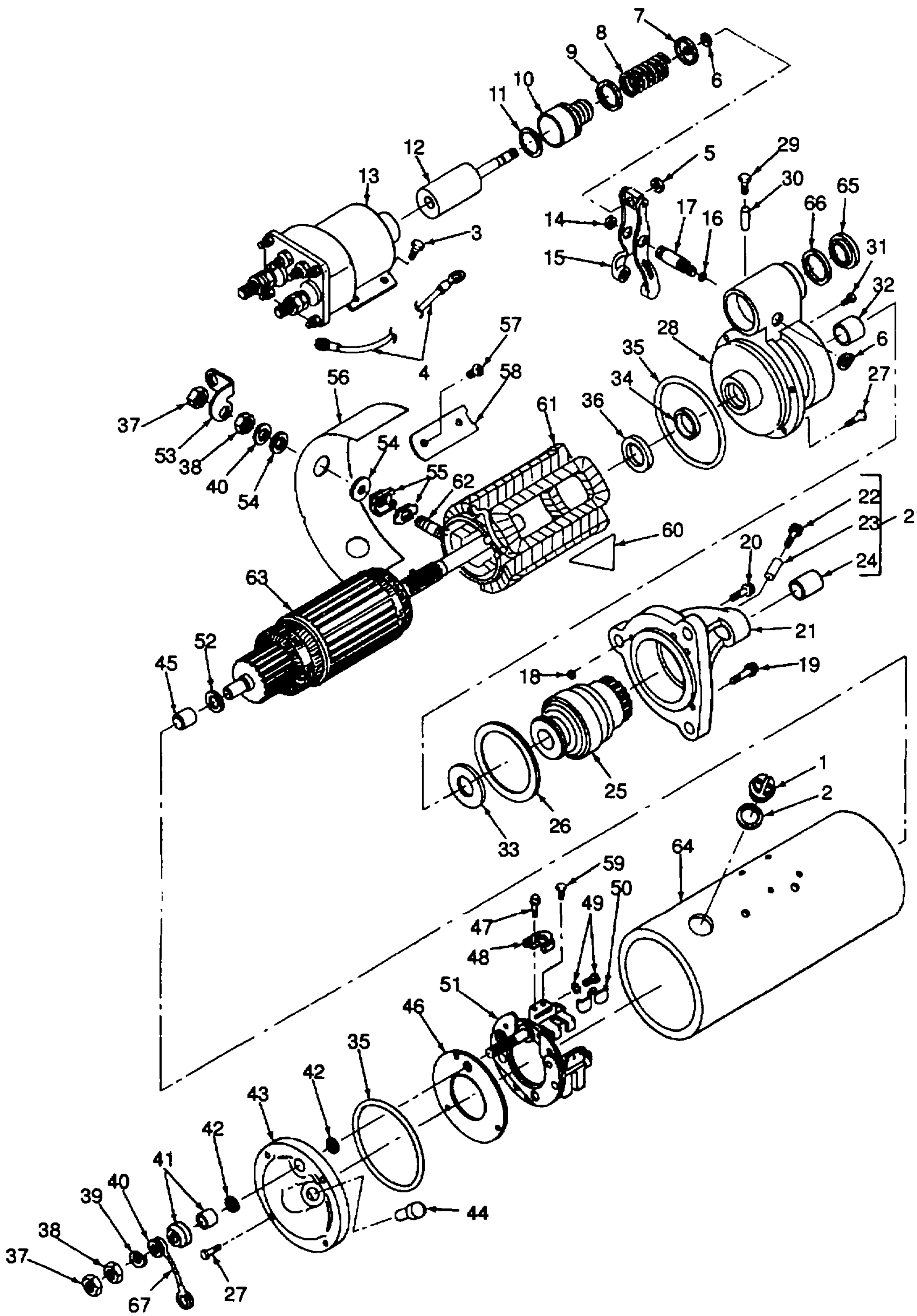


Figure 43. Starter Motors B1 and B2 and Related Parts (Sheet 1 of 2)

1. BRUSH INSPECTION PLUG
2. GASKET
3. MACHINE BOLT
4. TERMINAL LEAD
5. PLUNGER ROD NUT
6. SNAP RING
7. RECESSED WASHER
8. PLUNGER SPRING
9. RECESSED WASHER
10. PROTECTOR BELLOWS
11. ELECTRICAL SOLENOID SPRING RETAINER WASHER
12. PLUNGER
13. ELECTRICAL SOLENOID B1 L3, B2L4 P
15. SHAFT LEVER
16. PREFORMED PACKING
17. SHIFT LEVER SHAFT
18. RUBBER BALL
19. DRIVE HOUSING SCREW (SOCKET HEAD)
20. INTERNAL HOUSING BOLT
21. STATOR HOUSING
22. PROTECTIVE DUST CAP
23. OIL WICK
24. DRIVE HOUSING BUSHING
25. DRIVE ASSEMBLY
26. LEVER TO DRIVE GASKET
27. MACHINE BOLT
28. LEVER HOUSING
29. PROTECTIVE DUST CAP
30. OIL WICK
31. LEVER HOUSING PLUG
32. HOUSING LEVER BUSHING
33. BRAKE WASHER
34. OIL SEAL
35. PREFORMED PACKING
36. SPACER WASHER
37. PLAIN HEXAGONAL NUT
38. PLAIN HEXAGONAL NUT
39. LOCKWASHER
40. FLAT WASHER
41. TERMINAL STUD BUSHING
42. INSULATOR WASHER
43. STARTER HOUSING
44. PROTECTIVE DUST CAP
45. SLEEVE BEARING
46. BRUSH PLATE INSULATOR
47. MACHINE SCREW
48. ELECTRICAL BRUSH
49. BRUSH PLATE SCREW
50. HELICAL SPRING
51. ELECTRICAL HOLDER ASSEMBLY
52. FLAT WASHER
53. TERMINAL LUG
54. FIELD TERMINAL WASHER
55. TERMINAL BUSHING
56. FIELD COIL INSULATOR
57. POLE SHOE SCREW
58. POLE ROTOR SHOE
59. FIELD COIL SCREW
60. INSULATOR PLATE
61. FIELD COILS
62. TERMINAL STUD
63. ARMATURE
64. FIELD FRAME
65. LEVER HOUSING INSPECTION PLUG
66. INSPECTION PLUG GASKET
67. GROUND WIRE

Figure 4-3. Starter Motor and Related Parts (Sheet 2 of 2)

(1) Clean all parts except the armature (63, Figure 4-3), field coils (61), electrical solenoids B1 L3 or B2L4 (13), and drive assembly (25) in cleaning solvent PD680, Type 11, or equivalent, and blow dry with compressed air.

CAUTION

Do not Immerse the drive assembly (25) In solvent. This would wash the lubricant from the overrunning clutch, and result In premature wear and failure of the drive assembly.

(2) Clean the drive assembly (25) with solvent dampened cloth.

(3) Clean the windings and insulated parts with a dry brush and dry compressed air to remove loose dust and dirt. Remove oily, caked deposits from the windings and insulated parts with a brush and solvent and blow dry. Do not immerse or soak insulation. Dry the solvent cleaned armature or field coils in an oven at 175 to 200OF (790to 930C) for 2 hours.

(4) Wipe serviceable brushes with a dean, dry cloth to remove dirt or oil. Do not use solvent. Replace oil-soaked brushes.

CAUTION

Do not use emery cloth or paper for the following operation. Emery dust could cause electrical shorts In the starter motor.

(5) If the commutator is in good condition, polish it with O0 grade sand paper P-P-105, to obtain a bright surface. Blow off with compressed air after sanding. Do not use emery cloth or emery paper. If the commutator slots are filled with dirt, dean with a toothpick or narrow piece of wood soaked in solvent, and blow dry.

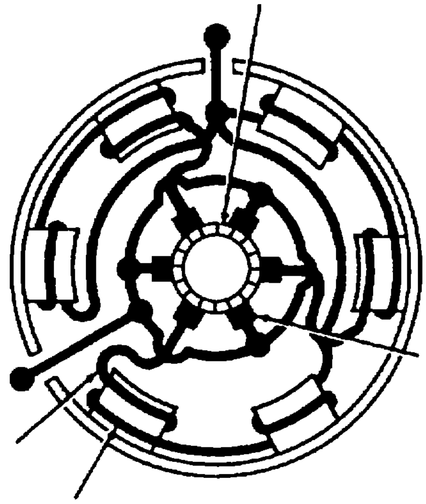


Figure 4-4. Starter Motors B1 and B2, Location of Field Loads

(6) Visually inspect the frame and housing for cracks or other damage that would impair proper operation.

(7) Check the threaded parts for crossed, deformed, or stripped threads.

(8) The drive housing and housing lever bushings (24 and 32) and the sleeve bearing (45) are a press fit in their respective bores, with clearance of -0.0005 to -0.0020 inch (-0.013 to -0.051 mm). Check that they are a tight fit, and show no signs of rotation in the bores.

(9) Check the drive housing and housing lever bushings (24 and 32) and sleeve bearing (45) for scoring and proper fit on armature (63). Clearance shall not exceed 0.006 inch (0.15 mm).

(10) Visually inspect the armature (63) for the following defects: scored or grooved bushing surfaces, damaged laminations due to rubbing on the pole rotor shoes (58), burned or scored commutator bars, high insulation between commutator bars, loose commutator bars, damaged splines, and damaged or loose windings due to thrown solder.

(11) Check the armature (63) for shorted or open windings using an armature growler. Refer to Figure 45.

WARNING

Failure to exercise caution when using energized test equipment may result In Injury to personnel.

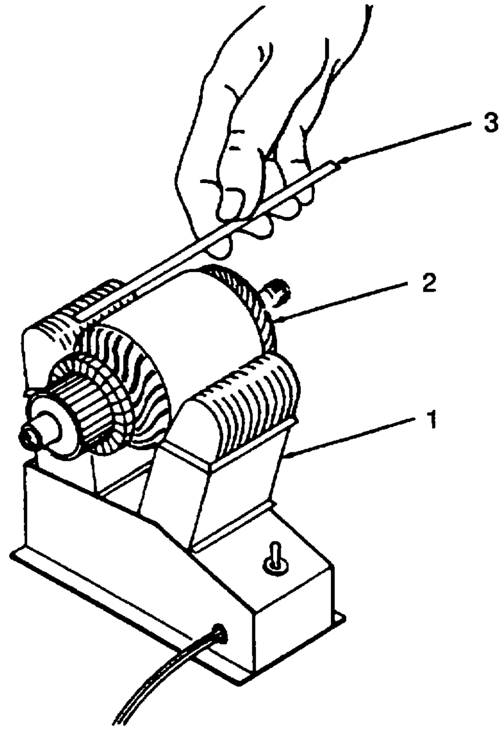
(12) Using a 110V ac test lamp or multimeter set to RX1 scale, check each commutator bar for grounds and continuity. Refer to Figure 4-6.

(13) Using V-blocks and a dial indicator, check the total indicated runout (TIR) of the armature (63, Figure 4-3) at the laminations, and at the commutator. TIR shall not exceed 0.005 inch (0.13 mm).

(14) Visually check the field coils (61, Figure 43) and leads for damaged insulation or oil soaking.

WARNING

Failure to exercise caution when using energized test equipment may result In Injury to personnel.



1. ARMATURE
2. GROWLER
3. HACKSAW BLADE

Figure 4-5.

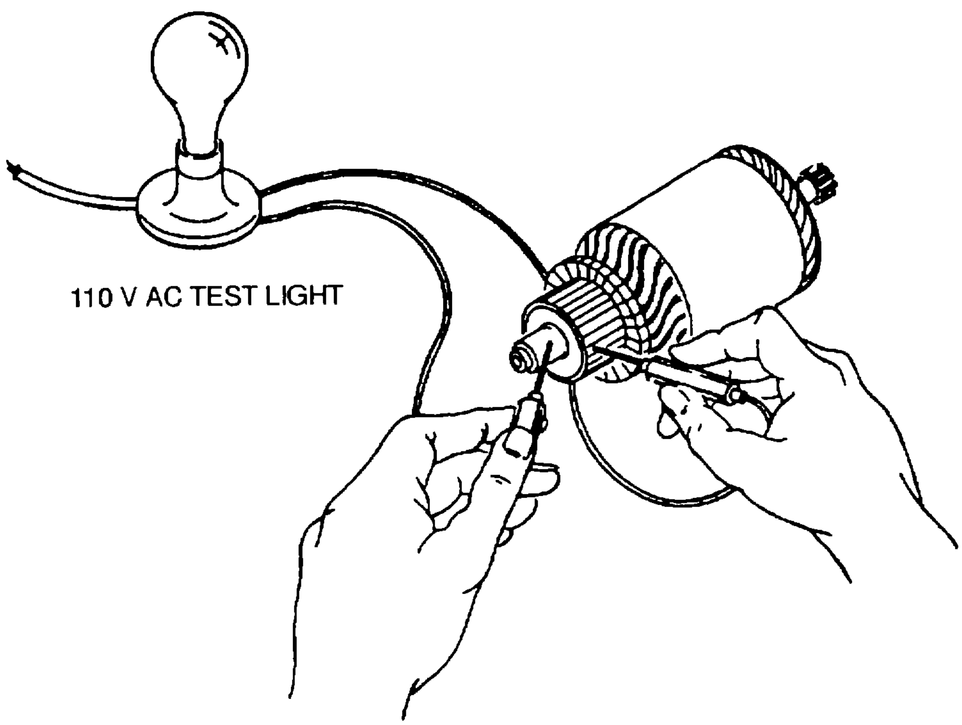


Figure 4-6. Testing Starter Armature for Grounds and Opens

(15) Using a 110 V ac test lamp or multimeter set to RX1 scale, test for field coil ground. Touch one probe to the field coil terminal and the other probe to the field frame (64). If lamp lights, the coil or terminal is grounded. Remove attaching parts (37 through 54) and position the terminal and insulators (56) so that they are not in contact with the field frame (64). Repeat the test. I the lamp lights, the coil(s) are grounded. If the lamp does not light, the terminal was grounded. Replace the field terminal washers (54) and terminal bushing (55) and field coil insulator (56) to correct the defect.

(16) Test the field coils for continuity by connecting the 110 V ac test lamp, or multimeter set to RX1 scale, between the two field coil leads. If the lamp does not light, the field coils are open and must be replaced.

(17) Visually check the brush holders, electrical holder assembly (51) and flat washer (52) for physical damage.

(18) Using a 110 V ac test lamp, or multimeter set to RX1 scale, test the insulated brush holders for grounding to the electrical holder assembly (51). N the test lamp lights, replace the electrical holder assembly.

(19) Test the electrical holder assembly (51) for isolation from the starter housing (43) by placing one probe of the 110 V ac test lamp, or multimeter set to RX1 scale, to the terminal on the electrical holder assembly, and the other probe to the starter housing. If the test lamp lights, replace the insulators (41, 42, and 46) as necessary.

(20) Temporarily install the electrical holder assembly (51) and electrical brushes (48) over the commutator. Inspect the helical springs (50) for heat discoloration and check the spring tension using a spring scale and suitable bent rod. The tension required to lift a brush just dear of the commutator shall not be less than 2 pounds (0.9 kg).

(21) Test the electrical solenoids B1 L3 or 82L4 (13) in accordance with the Operator and Organizational Maintenance Manual.

(22) Check the fit of the plunger (1 2) in the bore of the electrical solenoids B1L3 or B2L4 (13), the plunger must move freely in the bore.

(23) Check the free length of the plunger spring (8). The minimum free length shall be 2.296 inches (58.32 mm).

(24) Check the shift lever shaft (17) for wear.

(25) Check the shaft lever (15) for wear or elongation of the shaft holes, and excessive wear at the drive contact pads.

(26) Check the pinion teeth of the drive assembly (25) for burrs, nicks, cracks, and uneven wear. Replace a defective drive assembly.

(27) Check the overrunning clutch in the drive assembly (25) for proper action. The pinion should turn freely in a clockwise direction, and lock when turned counterclockwise. No detectable backlash should be felt when going from the overrunning to the locked position.

CAUTION

To avoid damage to the armature In the following test, do not damp the commutator or the bushing surfaces of the armature In the vise. Pad the vise laws with thick leather, wood, or several layers of shop cloths.

(28) Temporarily install the drive assembly (25) on the armature (63) and clamp the armature in a padded vise. Using a 12-point deep socket and torque wrench, apply 50 pound-feet (68 newton-meters) of torque in a counterclockwise direction of the pinion. Replace the drive assembly if slippage occurs.

(29) Check the prevailing torque of the plunger rod nut (5) in accordance with Table 1-3. Replace the plunger rod nut if it does not meet the minimum requirements of Table 1-3.

(30) Replace the starter housing (43, Figure 4-3) and stator and lever housings (21 and 28) if cracks or other damage are found that would impair proper functioning.

(31) Repair threaded holes in accordance with paragraph 2-12.

(32) The drive housing and housing lever bushings (24 and 32) and sleeve bearing (45) are bronze and must be lubricated and installed properly to achieve long service life. Replace worn bushings and bearings as follows: (a) Remove drive housing and housing lever bushings (24 and 32) using bushing drivers. Remove sleeve bearing (45) using a blind-hole bushing puller, or a bushing cutter, being careful not to cut into the starter housing (43).

(b) Be sure both hands are dean, place a new bushing on the palm of the hand, and fill it with SAE 20 lubricating oil. Place the thumb of the free hand over the open end of the bushing, and push hard to pressurize the oil in the bushing. The bushing is properly lubricated when the oil seeps through the entire outside diameter of the bushing.

CAUTION

Do not drill, ream, or machine bronze bushings. Machining will seal or plug the bushing pores, and prevent proper lubrication.

NOTE

If the new lubricated bushing is not going to be installed immediately, store it in a dean plastic bag.

(c) Install the new, lubricated drive housing and housing lever bushings (24 and 32) or sleeve bearing (45) using the correct size bushing driver. Be sure the bushing is started square and driven straight into the housings (21, 28, or 43) until level with, or slightly below the thrust surface. The bushings are sized to be a correct fit on the armature shaft when installed. Do not ream, drill, or otherwise machine the bushing.

(d) Check the fit of the bushings or bearing on the armature (63). The correct clearance should be 0.0015 to 0.003 inch (0.038 to 0.08 mm). If the bushing fits too tightly, it was incorrectly installed; remove the damaged bushing and install a new one. If the fit is too loose, check the armature shaft for wear.

(33) Replace the armature (63) for the following defects: thrown solder (from overheating), loose windings, loose commutator bars, bushing surface worn or scored over 0.003 inch (0.08 mm) deep, damaged or uneven wear of the splines, or shaft runout over 0.005 inch (0.13 mm) TIR.

(34) Replace the armature (63) if electrical opens, shorts, or grounds are found.

WARNING

Lathe or milling operations create metal particles which may enter the eyes. Wearing of **goggles Is required to avoid Injury to personnel.**

(35) If the commutator runout is over 0.005 inch (0.13 mm), or if it is scored, uneven, or burned, resurface the commutator using armature and undercutting lathe MIL-L-14576.

(36) After machining, undercut the insulation between the 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.

(37) After machining and undercutting, remove any burrs from the commutator using sand paper P-P-105; do not use emery cloth. After deburring, remove any sanding or copper dust from the slots between the commutator bars.

WARNING

Avoid breathing fumes generated by soldering. Remove rings and watches. Eye protection Is required to avoid Injury to personnel.

WARNING

Varnish Is flammable and moderately toxic to the sin, eyes, and respiratory tract Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

(38) Make simple electrical repairs to the field coils, such as resoldering leads, wrapping frayed windings with insulating s tape, and painting with insulating varnish MS355632. Solder in accordance with MIL-S6872, using solder QQ-S571, Type SN 60, and rosin flux.

(39) Replace the field coils for electrical shorts, opens, or grounds, and for oil soaking, or insulation obviously damaged beyond repair. Replace the field coils as follows:

(a) Place a pole shoe spreader between opposite pole rotor shoes (58) and tighten it in place.
(b) Using a pole shoe screwdriver and an arbor press, remove the pole shoe screws (57), then remove the pole shoe spreader and the pole shoes.
(c) Repeat steps (a) and (b), above, for the other two pole shoes.
(d) Remove the plain hexagonal nut (37), terminal lug (53), hexagonal nut (38), flat washer (40), and field terminal washer (54).
(e) Push in the field coil terminal stud, and slip the field coils (61) out of the field frame (64).
(f) Remove the field cod insulators (56), insulator plate (60), field terminal washer (54), and terminal bushings (55). Discard the insulators, bushings, or washers if defective.
(g) Insert the new field coil (61) into the field frame (64) using new field coil insulators (56), insulator plates (60), terminal bushings (55), and field terminal washer (54).

NOTE
If the pole rotor shoes (58) have a long lip on one side, the lip must face in the direction of armature rotation when viewed from the drive end). This locates the lip as the trailing edge of the pole rotor shoe.

(h) Insert the pole rotor shoes (58) into position in the field coils, and retain with the pole shoe screws (57). Do not tighten the screws at this time.
(i) Check to be sure that the insulators (56 and 60) are properly placed, and the pole rotor shoes are not pinching the field coils (61). Tighten the pole shoe screws (57) using an ordinary screwdriver.
(j) Place a pole shoe spreader between opposite pole rotor shoes (58), and tighten it in place.
(k) Using a pole shoe screwdriver and an arbor press, tighten the pole shoe screws (57) in accordance with Table 1-2, and remove the pole shoe spreader.
(I) Repeat steps 0) and (10, above, for the other two pole shoes.
(m) Be sure the terminal bushings (55) and field terminal washer (54) are property positioned on the stud, and install another field terminal washer (54), flat washer (40), and hexagonal nut (38) on the terminal stud.
(n) To make sure that the field coils (61) have been installed properly and were not damaged during installation, check for grounds and opens in accordance with steps (15) and (16), above.
(o) Install the terminal lug (53) and hexagonal nut (37) on the terminal stud. Do not tighten the nut at this time.

(40) Replace a defective electrical holder assembly (51) and insulators as follows:

(a) Remove the hexagonal nut (38), lockwasher (39), flat washer (40), terminal stud bushing (41), and insulator washer (42).
(b) Remove the bush plate screws (49), and remove the electrical holder assembly (51), brush plate insulator (46), and insulator washer (42). Discard the insulators if defective.
(c) Install the brush plate insulator (46) and insulator washer (42) on the electrical holder assembly (51), and insert the stud through the hole in the starter housing (43).
(d) Install the insulator washer (42), terminal stud bushing (41), flat washer (40), lockwasher (39), and hexagonal nut (38). Do not fully tighten the nut at this time.
(e) Install the brush plates screws (49), and tighten them in accordance with Table 1-2.
(f) Tighten the hexagonal nut (38, Figure 4-3) to 20 to 25 pound-feet (27 to 34 newton-meters).

(41) Replace oil soaked or cracked electrical brushes (48), or if they are less than 0.656 inch (16.66 mm) in length.

(42) Replace the helical springs (50) i the tension is under 2 pounds (0.9 kg) (see step (20), above).

(43) Remove nicks or accumulated dirt from the plunger (12) or bore to the electrical solenoids B1L3 or B2L4 (13) that would interfere with free movement of the plunger.

(44) Replace the electrical solenoids B L3or B2L4(13) if tests (see Operator and Organizational Maintenance Manual) show it to be defective.

(45) Replace the plunger spring (8) if it is warped or if the free length is less than 2.296 inches (58.32 mm).

(46) Replace the shift lever shaft (17) if it is visibly worn or grooved.

(47) Replace shaft lever (15) if the pin holes are worn or elongated or if the pads are visibly worn or deformed.

(48) Remove slight burrs or nicks from the pinion teeth of the drive assembly (25). Replace the drive assembly if the teeth are cracked or excessively worm, or the overrunning clutch is defective.

d. Assemble. During reassembly, keep all parts dean, and align all match-marks made during disassembly. Unless otherwise instructed, torque all screws and bolts in accordance with Table 1-2. Reassemble the starter motor as follows:

(1) Lubricate the spacer washer (36, Figure 4-3), and flat washer (52) with a thin film of petrolatum V-V-P236, and install them on the armature (63).

(2) Soak new oil wicks (23 and 30) in SAE 20 motor oil, and install them in the lever housing (28) and stator housing (21). Secure the wicks with the protective dust caps (22 and 29).

NOTE

To aid in installation of starter housing (43) and electrical holder assembly (51) on the armature (63), do not attempt to install the starter housing and electrical holder assembly with electrical brushes loaded by the helical springs (50). Instead, position the electrical brushes (48) in the electrical holder assembly (51) so that the tangs of the helical springs (50) rest against the sides of the electrical brushes and hold the electrical brushes in retracted position. Once the starter housing (43) and electrical brush holder assembly (51) has been installed on the armature (63), the tangs of the helical springs (50) may be placed in their normal positions on the electrical brushes (48), tensioning the electrical brushes against the commutator.

(3) Install the protective dust cap (44) and a new preformed packing (35) on the starter housing (43), and install the assembled housing and electrical holder assembly (51) over the commutator of armature (63).

(4) See Figure 4-4. Thread the field coil (61, Figure 4-3) brush leads through the inspection holes in the field frame (64) and install the armature (63) in the field frame. Secure the starter housing (43) to the field frame (64) using the machine bolts (27).

(5) Attach the brush leads to the brush holders using the field coil screws (59).

(6) With the lip facing the housing lever bushing (32), install a new oil seal (34) in the lever housing (28).

(7) Install a new preformed packing (35) on the lever housing (28), and install the lever housing on the field frame (64) and secure with machine bolts (27).

(8) Install a brake washer (33) over the shaft of armature (63), insert the shaft lever (15) into lever housing (28), bit the shaft lever, and install the lever housing (28), taking care that the shaft lever is properly positioned in the collar of the drive assembly.

(9) Install preformed packings (14 and 16), install the shift lever shaft (17), and secure it with a new snap ring (6).

(10) Using a gasket (26), install the stator housing (21), drive housing screw (19) and internal housing bolts (20). Cross-tighten the screws to 13 to 17 pound-feet (18 to 23 newton-meters).

(11) Install the spring retainer washer (11), protector bellows (10), recessed washer (9), plunger spring (8), and o recessed washer (7) over plunger (12), and secure with snap ring (6).

(12) Install the plunger (12) through the shaft lever (15), and install the plunger rod nut (5) on the shaft until several threads are engaged.

(13) Install the electrical solenoids B1 L3 or B2L4 (13) over plunger (12), and into the protector bellows (10). Secure the electrical solenoids B1 L3 or B2L4 to the field frame (64) with the machine bolts (3).

(14) Position terminal lug (53) over the field terminal on electrical solenoids B1L3 or B2L4 (13), install hexagonal nut (37), and tighten it, and the other hexagonal nut (37) (installed in step c(39), above), to 20 to 25 pound-feet (27 to 34 newton-meters).

(15) Check and adjust the pinion end clearance as follows:

CAUTION

To prevent overheating damage to the windings, do not energize the hold-in windings longer than 30 seconds. If the adjustment cannot be made In this time, disconnect the battery and allow the windings to cool.

(a) Energize the hold-in windings in the electrical solenoids by connecting a 24 V dc battery to the G and S terminals, and momentarily energize the pull-in windings by flashing a jumper lead from the G to the MTR terminal (A, Figure 4-7). Do not leave the jumper lead connected. The hold-in windings will keep the solenoid plunger in the operating position as long as the battery is connected between the G and S terminals.

(b) Push the drive assembly towards the commutator end of the starter to remove slack and measure the pinion clearance (B, Figure 47).

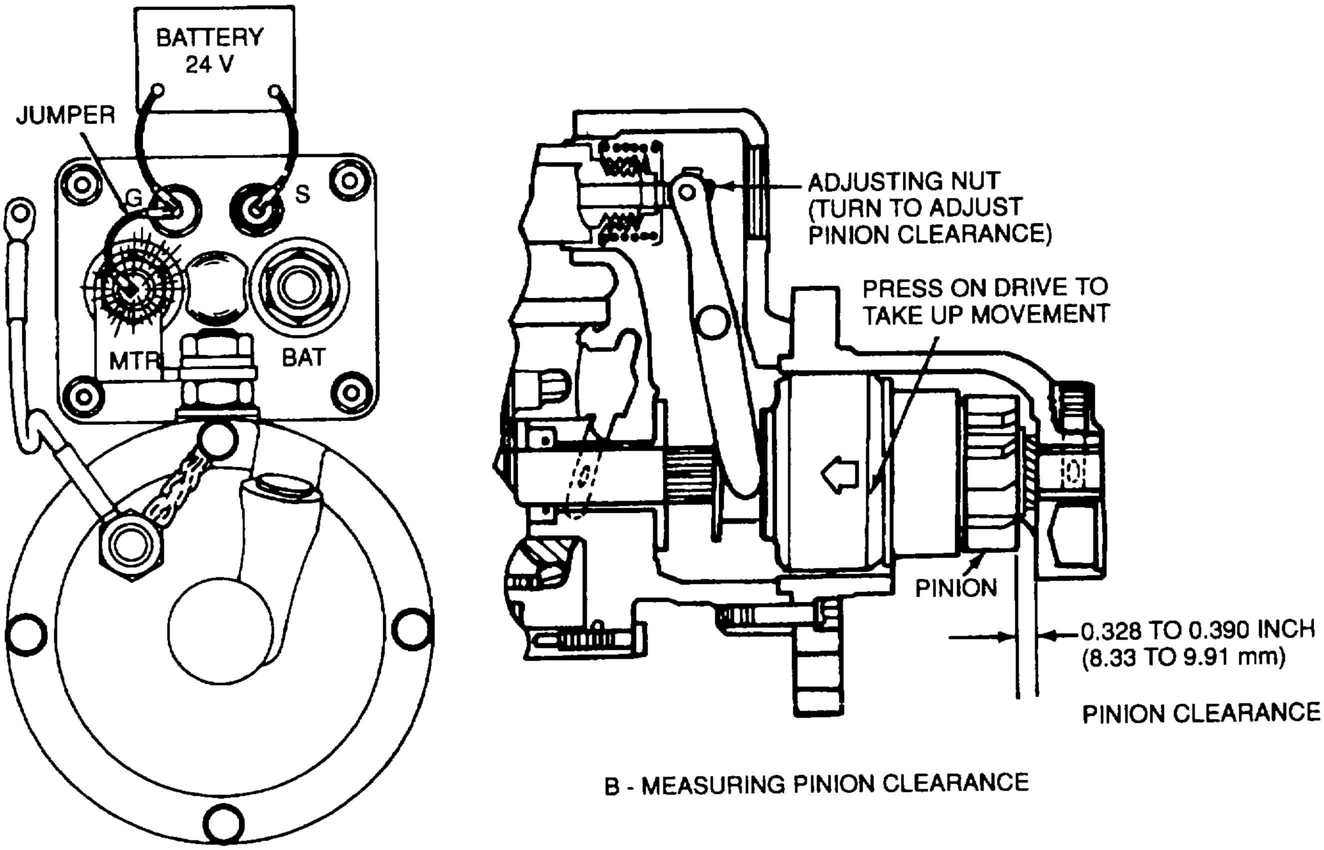
(c) Turn the plunger rod nut (5, Figure 4-3) as necessary to achieve a pinion clearance of 0.328 to 0.390 inch (8.33 to 9.91 mm).

(d) When the adjustment has been completed, disconnect the battery from the G and S terminals.

(16) Install the terminal lead (4, Figure 43).

(17) Using a new inspection plug gasket (2) install brush inspection plug (1).

(18) Install the starter motors B1 and B2 in accordance with the Operator and Organizational Maintenance Manual.



A - ENGERGIZING SOLENOID WINDINGS

NOTE:
DO NOT LEAVE JUMPER CONNECTED
AFTER WINDINGS HAVE BEEN ENERGIZED.

Figure 4-7. Adjusting Starter Pinion Clearance

CHAPTER 5

MAINTENANCE OF AC ELECTRICAL POWER GENERATION AND CONTROL SYSTEM

SECTION I. WIRING HARNESS OVERHAUL

5-1. 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.

5-2. WIRING HARNESS OVERHAUL. If 30 percent of the wires in a harness are defective, it must be overhauled. FO-15 through FO-32 are wiring harness fabrication drawings. These drawings specify the length and gage of every wire used in each harness, as well as the termination points, lugs or connectors, and wire marking data. The harness drawings also provide routing information for each harness.

SECTION II. MAINTENANCE OF GENERATOR G1

5-3. GENERAL. In the following discussion, "rear" of the generator is toward the engine.
A solid rolled steel frame provides support for the stator core and end bracket. Bar steel core supports, welded to the core and frame, anchor the stator core.

The end bracket is made of cast iron and supports the stationary exciter field structure. The frame is fitted with a cast iron machining adapter which aligns with the engine. An iron hub is keyed and heat shrunk to the shaft. This hub carries ten flexible steel drive discs which have holes for fastening to the flywheel. Two spacers are used between the hub and discs to maintain the proper distance between the discs and machining adapter face. This affords flexibility in the axial direction, while in the radial direction it acts as rigid coupling, providing a uniform air gap.

The stator laminations are composed of thin, low-loss steel. The cores are reinforced by steel stack rings and supporting bars which are welded around the core. When the insulated coils have been inserted in the stator core, the entire core is given multiple dips and bakes in thermosetting varnish. This insulation system utilizes all synthetic and non-hygroscopic materials making the windings fungus resistant and suitable for operation in high humidity and abrasive environments. Subsequently, the wound core is placed into and welded to the frame.

The rotor pole assembly is heat shrunk and keyed to the shaft. A thermo-setting bond epoxy is applied between layers of the field winding and is applied to the finished rotor. The completed rotor is baked under a controlled cycle. Rotors are dynamically balanced and then tested at 125 percent of operating speed.

The ac exciter armature and the heat sink which carries the diodes are mounted on an assembly which is placed on the generator shaft on the outboard side of the front generator bearing.

The generator employs a flow-through ventilation system. The cast aluminum alloy ventilating fan draws air through louvers in the conduit box, over the main stator and exciter windings and exhausts it through ventilation screens on the machining adapter.

Two strip heaters provide heating for the generator when it is not in service to prevent moisture buildup. These are powered by 240 V ac from an external source.

5-4. GENERATOR OR GENERATOR COMPONENTS DRYING PROCEDURES. Machines that have been idle for some time in unheated and damp locations, may have "sweated" as a result of sudden changes in temperature or may have become wet by accident. These should be dried out thoroughly before being put into service. The following are recommended drying methods.

a. Space Heaters. Enclose the generator with a covering and insert heating units (space heaters, lamps, or coils of steam pipe) to raise the temperature. Leave a hole at the top of the enclosure to permit the escape of moisture.

b. Forced Air. A portable forced air heater can be used by directing heat to the end of the generator opposite the coupling and running the generator with no load and without excitation (this can be accomplished by removing the regulator fuses). Heat at point of entry should not exceed 150OF (660C) at the bearing hub.

c. Insulation Testing. If It is necessary to dry out the generator, it is recommended that the unit be thoroughly tested using the procedures specified in paragraph 5-6.

5-5. GENERATOR G1 CLEANING AND INSPECTION.

a. Whenever the generator is disassembled, the windings should be given a thorough inspection and the insulation cleaned, if necessary. The inspection should cover the condition of the windings and insulation, and the effectiveness of the supporting ties as evidenced by rigidity of the coil end turns.

WARNING

Adequate ventilation must be available to avoid fire, explosion, and health hazards where solvents are used Avoid breathing solvent vapors Rubber gloves or other suitable protection for the hands should be used.

WARNING

Dry cleaning solvent, PD-680, type 11, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation.

CAUTION

Care must be taken not to get solvent on insulating varnishes or deterioration of varnish will occur.

b. Safety type solvent, such as PD-680, Type 11, or equivalent, should be used. The flash point of any solvent used should be greater than 1 000F (38"C).

c. Solvent is usually required to remove accumulated soil containing oil or grease. A wet rag with solvent is suitable for wiping. Dry components thoroughly with moisture-free, low-pressure compressed air.

WARNING

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.

d. Cleaning with a dry cloth may be satisfactory when components are small, and the surfaces are accessible. Blowing dirt out with compressed air is usually effective particularly when the dirt has collected in places which cannot be reached with a cloth. Use dean dry air at 30 psi (207 kPa).

e. Dust and dirt may be removed by brushing with bristle brushes followed by vacuum deaning. Do not use wire brushes. Vacuum deaning is an effective and desirable method of removing dust and dirt.

f. Electrical components, after deaning, storing, or shipping must be dried before placing in operation if tests indicate that the insulation resistance is below a safe value. See approved drying procedures in paragraph 5-4.

5-6. TESTING GENERATOR G1. The following tests are used to check minimum insulation resistance while the generator is installed on the generator set. This group of tests is performed using 5 k V dc and 500 V dc megohmmeters. Additional testing of the generator is accomplished by performing tests on the individual components.

a. Main Stator.

(1) Shut down the generator set completely in accordance with paragraph 2-5 of the Operator and Organizational Maintenance Manual.

(2) Open main disconnect switch S120 in accordance with the Operator and Organizational Maintenance Manual.

WARNING

Place load cables In the park position prior to grounding generator leads. Failure to do so may result In Injury to personnel.

(3) Remove rear cabinet B access panel. Use grounding stick to discharge generator leadsT1, T2, and T3 where they connect to bad circuit breaker CB1 01.

(4) Tag and disconnect leads, T4, T5, and T6 from terminal block TB202 at the lower left side of rear cabinet B. Tag and disconnect lines Ti, T2, and T3 from the rear of load circuit breaker CB1 01.

(5) Tie the terminal lug ends of lines Ti to T6 together as follows for proper phase isolation and tag according to phase.

(a) Tie lines T4 and Ti together for phase A.
(b) Tie lines T2 and T5 together for phase B.
(c) Tie lines T3 and T6 together for phase C.

(6) Obtain a5 kV dc megohmmeter. Connect megohmmeter leads as shown below, observing proper megohmmeter lead connections as noted in parentheses (black or red) for each phase set tested. Operate megohmmeter for 60 seconds for each set under test and monitor resistance reading. After each test, always short the black megohmmeter lead to ground (where needed) with the cable still connected. Connect megohmmeter leads as follows:

(a) Phase A (red) to phase B (black)
(b) Phase B (red) to Phase C (black)
(c) Phase C (red) to Phase A (black)
(d) Phase A (red) to ground (black)
(e) Phase B (red) to ground (black)
(f) Phase C (red) to ground (black)

Megohmmeter reading for each set tested should be no less than 5.16 megohms. Any reading lower than 5.16 megohms is unacceptable. Clean, dry, repair, or replace stator as necessary.

(7) After testing, restore stator leads as follows:

(a) Remove and discard phase tags.
(b) Untie cable terminal lugs.
(c) Restore lines T4, T5, and T6 on terminal block TB202. Remove and discard lead tags.
(d) Restore lines Ti, T2, and T3 on rear of load circuit breaker CB1 01. Remove and discard lead tags.
(e) Reinstall cabinet B rear access panel.

b. Main Rotor (Main Field).

(1) Perform steps (1) through (3), above.

(2) See Figure 5-1. Remove conduit box cover assembly (6) by removing hexagon head screws (5).

(3) Tag and disconnect the two generator field leads coming out of keyway in the rotor shaft. These leads connect to each of the two rectifier angles on the rotating rectifier assembly. See detail A, Figure 5-1.

(4) Obtain a 500 V dc megohmmeter. Make sure neither of the two field leads disconnected in step (3), above, touch any other part. Connect one megohmmeter lead to one field lead and the other megohmmeter black lead to the aluminum standoff casting (behind insulation plate on exciter rotor) or to any suitable chassis ground. Operate the megohmmeter for 60 seconds and monitor the resistance reading. Discharge the main rotor field with grounding stick after performing test.

(5) Resistance reading should be no less than 2 megohms. Clean, dry, repair, or replace the main rotor assembly as required if reading is lower than 2 megohms.

(6) Reconnect rotor field leads to the rotating rectifier assembly as tagged. Remove and discard tags.

(7) Reinstall the conduit box cover assembly (6, Figure 5-1) using hexagon head screws (5).

c. Exciter Rotor Assembly (Armature).

(1) Perform steps a(1) through (3), above.

(2) Remove generator conduit box cover assembly (6, Figure 5-1) by removing hexagon head screws (5).

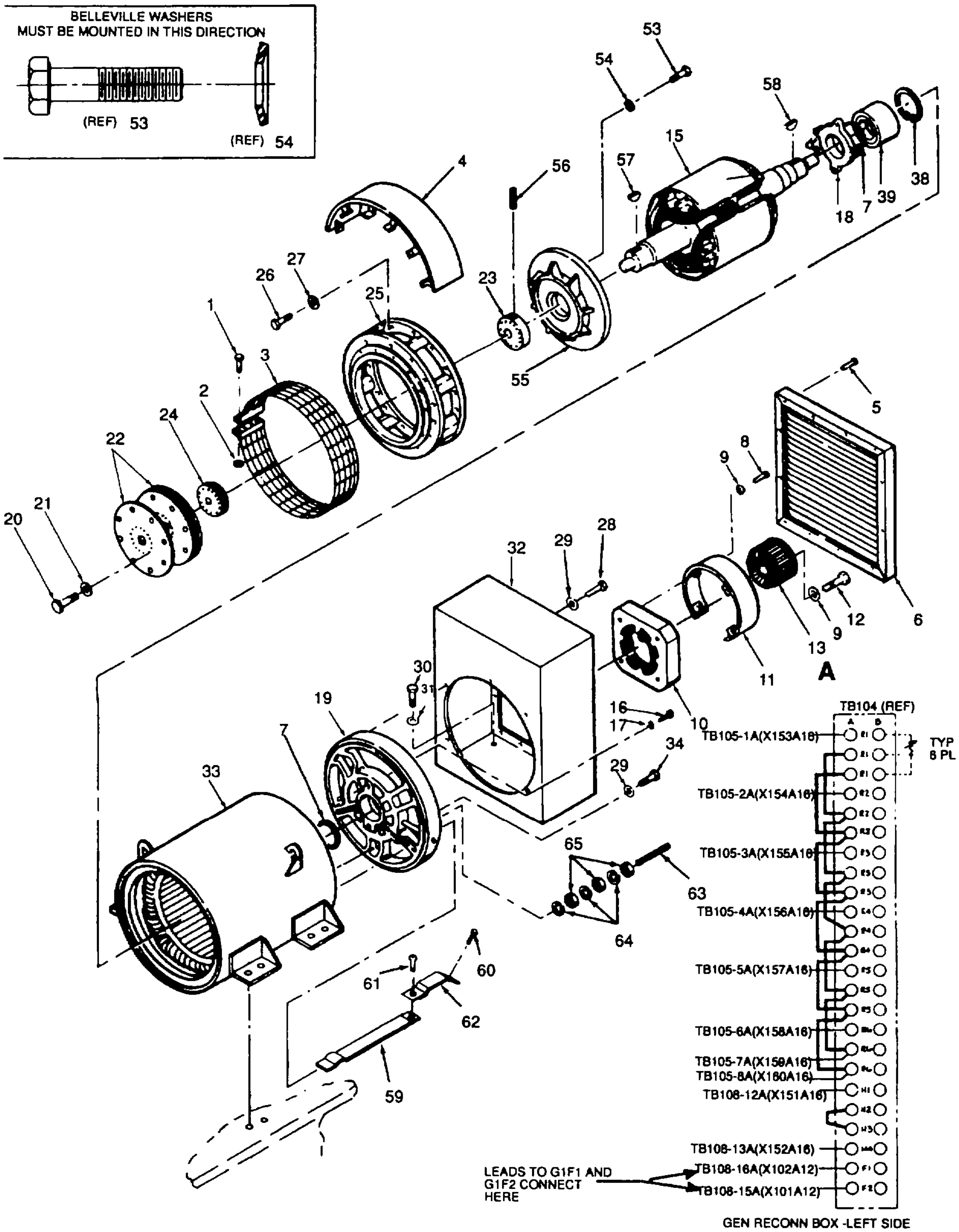


Figure 5-1. Generator G1 and Related Parts (Sheet 1 of 3)

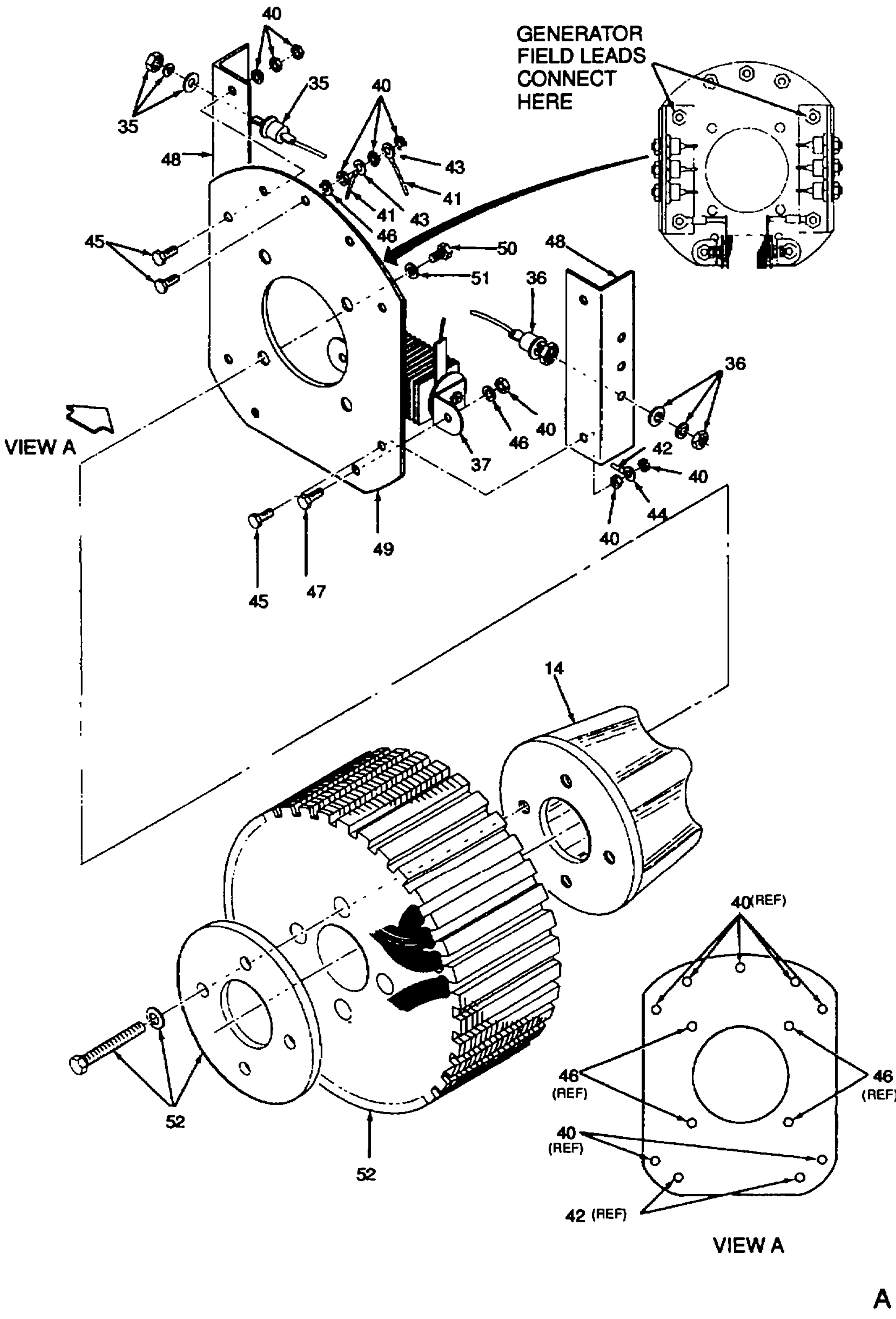


Figure 5-1. Generator G1 and Related Parts (Sheet 2 of 3)

1. HEXAGON HEAD SCREW
2. HEXAGONAL NUT
3. SCREEN ASSEMBLY
4. DRIP COVER ASSEMBLY
5. HEXAGON HEAD SCREW
6. CONDUIT BOX COVER ASSEMBLY
7. SEAL
8. HEXAGON HEAD SCREW
9. BELLEVILLE WASHER
10. EXCITER STATOR ASSEMBLY
11. LEAD SHIELD
12. HEXAGON HEAD SCREW
13. EXCITER ROTOR ASSEMBLY
14. STANDOFF
15. ROTOR ASSEMBLY
16. HEXAGON HEAD SCREW
17. LOCKWASHER
18. BEARING CAP
19. BRACKET
20. HEXAGON HEAD SCREW
21. PLAIN WASHER
22. COUPLING DRIVE DISC
23. HUB
24. SPACER PLATE
25. MACHINING ADAPTER
26. HEXAGON HEAD SCREW
27. LOCKWASHER
28. HEXAGON HEAD SCREW
29. MOUNTING WASHER
30. GROUNDING BOLT
31. GROUNDING WASHER
32. CONDUIT BOX ASSEMBLY
33. COIL ASSEMBLY
34. HEXAGON HEAD SCREW
35. REVERSE POLARITY RECTIFIER AND ATTACHING HARDWARE
36. STANDARD POLARITY RECTIFIER AND ATTACHING HARDWARE
37. SURGE PROTECTOR
38. RETAINER RING
39. BALL BEARING
40. NUTS
41. LEAD
42. LEAD
43. TERMINAL
44. TERMINAL
45. HEXAGON HEAD SCREW
46. LOCKWASHER
47. SCREW
48. RECTIFIER ANGLE
49. INSULATOR PLATE
50. HEXAGON HEAD SCREW
51. LOCKWASHER
52. WOUND ARMATURE ASSEMBLY
53. HEXAGON HEAD SCREW
54. BELLEVILLE WASHER
55. FAN
56. SETSCREW
57. HUB KEY
58. MOUNTING KEY
59. STRIP HEATER
60. MOUNTING SCREW
61. MOUNTING SCREW
62. MOUNTING BRACKET
63. STUD
64. LOCKWASHER
65. HEXAGONAL NUT

Figure 5-1. Generator GI and Related Parts (Sheet 3 of 3)

(3) Tag and disconnect rectifier leads on the rotating rectifier assembly (detail A, Figure 5-1).

(4) Disconnect the three exciter armature leads from the rotating rectifier assembly and tag according to phase (phase A, B, and C).

(5) Obtain a 500 V dc megohmmeter. Connect leads as shown below and operate megohmmeter 60 seconds for each set. Monitor resistance reading for each set tested. Short black megohmmeter lead to ground after each test with exciter armature leads still connected.

(a) Phase A to phase B
(b) Phase B to phase C
(c) Phase C to phase A
(d) Phase A to ground
(e) Phase B to ground
(f) Phase C to ground

(6) Megohmmeter reading for each phase-to-phase test (A to B, B to C, and C to A) should indicate greater than 1 megohm. Clean, dry, or repair exciter rotor assembly if megohmmeter indicates greater than 1 ohm, and retest. Repair or replace exciter rotor assembly if any phase to phase test indicates less than 1 megohm.

(7) Megohmmeter reading for each phase to ground test (phase A to ground, phase B to ground, or phase C to ground) should be no less than 1 megohm. Clean, dry, or repair exciter rotor assembly if megohmmeter reading any phase to ground indicates less than 1 megohm. Replace if necessary.
(8) If all tests are satisfactory, reconnect exciter armature lead wires as tagged to the rotating rectifier assembly. Remove and discard tags. Reconnect rectifier leads as tagged. Remove and discard tags. Reinstall generator conduit box cover assembly (6) using hexagon screws (5).

d. Current Transformers CT2 CT3.

(1) Perform step a(l) through (3), above.
(2) Remove generator conduit box cover assembly (6, Figure 5-1) by removing hexagon head screws (5).
(3) See Figure 5-2. Tag and disconnect wiring from current transformers CT2 and CT3 (5) located on either interior side of the conduit box assembly (1 1).
(4) With multimeter set for resistive reading, check winding of each current transformer for continuity. Resistance reading should be less than 1 ohm (typical).
(5) Connect a 500 V dc megohmmeter across either transformer lead and to ground. Operate megohmmeter for 60 seconds and monitor resistance reading. Perform this procedure on both transformers.
(6) Megohmmeter resistance reading for each transformer should be no less than 100 megohms. Replace current transformer that fails to pass this test.
(7) If readings are satisfactory, connect wiring to current transformers CT2 and CT3 as tagged. Remove and discard tags. Replace conduit box cover assembly (6, Figure 5-1) with hexagon head screws (5).

e. Exciter Stator (Field).

(1) Perform step a(1) through (3), above.
(2) Remove conduit box cover assembly (6, Figure 5-1) by removing hexagon head screws (5).
(3) Tag and disconnect exciter field leads Fl and F2 from terminal strip TB104 (12, Figure 5-2) on left side of conduit box assembly (11).
(4) Obtain a 500 V dc megohmmeter. Connect red megohmmeter lead to one exciter field lead and the black megohmmeter lead to the exciter stator frame or ground. Operate megohmmeter for 60 seconds and monitor resistance reading.
(5) Resistance reading should be no less than 1 megohm. If reading is less, dean, dry and/or repair the exciter stator. Replace, if necessary.
(6) If reading is satisfactory reinstall exciter field leads Fl and F2 on terminal strip TB104 (12) as tagged. Remove and discard tags. Replace conduit-box cover assembly (6, Figure 5-1) using hexagon head screws (5).

5-7. GENERATOR GI DISASSEMBLY. Repair of the generator Gi consists of disassembly to the extent required for repair or replacement of a damaged component. Overhaul is accomplished by rewinding of generator coils by the manufacturer. Remove generator Gi from the generator set in accordance with paragraph 2-16 and disassemble as follows:

WARNING

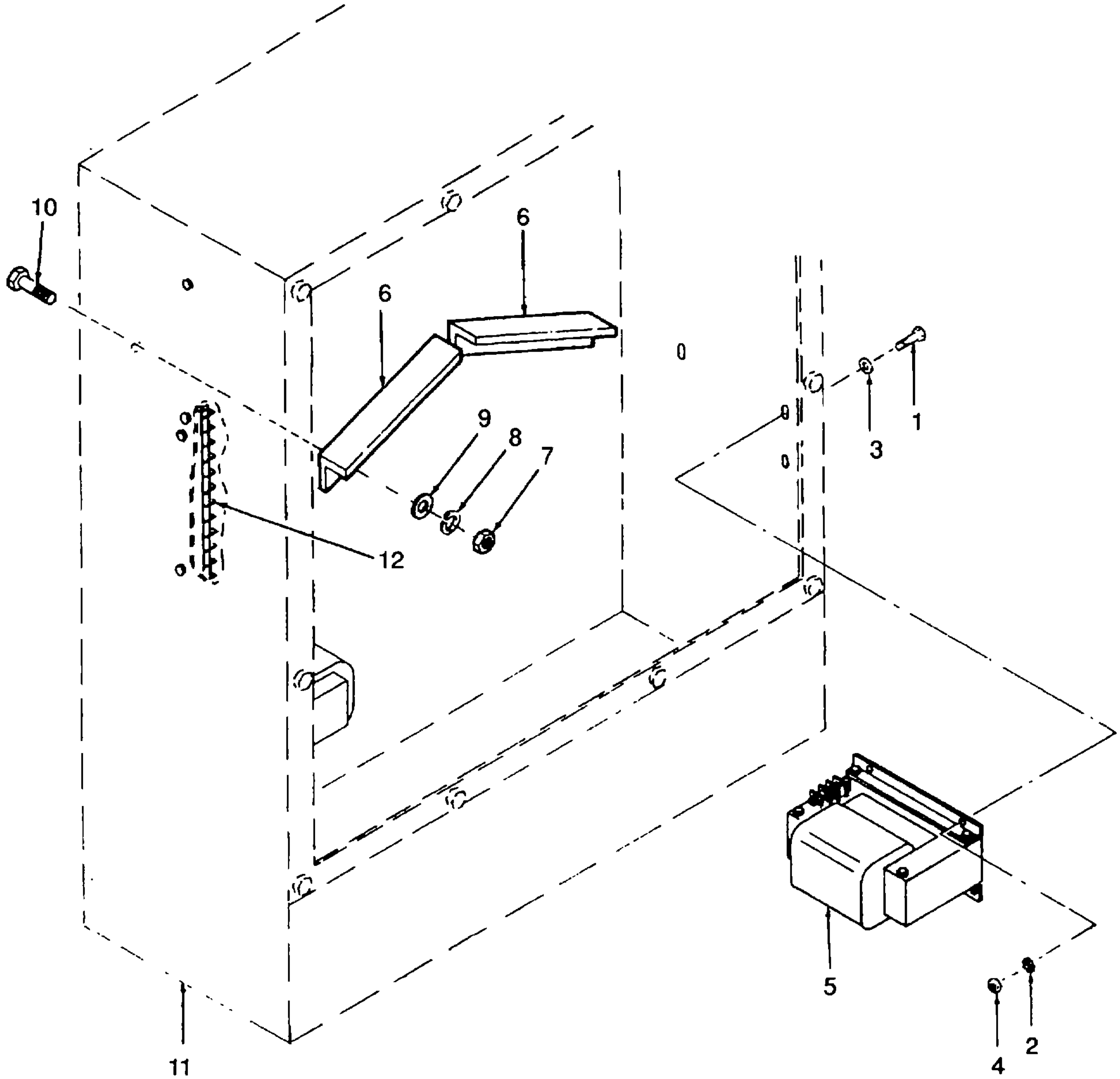
Disconnect all power before servicing. Failure to follow all safety Instruction may result In death or serious Injury.

a. Strip Heaters Assemblies.

(1) Remove.

(a) Remove hexagon head screws (5, Figure 5-1) to remove conduit box cover assembly (6).

(b) Tag and disconnect wires HI, H2, H3, and H4 from terminal strip TB1 04 (12, Figure 5-2) at left interior of conduit box (11). Remove four wire damps, two on each wire harness and separate exciter field wires Fl and F2 from heater wires Hi to H4. Remove wire damp holding heater wires to bracket (19, Figure 5-1). Remove mounting screws (60 and 61) and mounting bracket (62) holding strip heater (59) to the generator bracket (19).



1. HEXAGON HEAD CAPSCREW
2. LOCKWASHER
3. FLAT WASHER
4. HEXAGONAL NUT
5. CURRENT BOOST TRANSFORMER CT2 or CT3
6. WIRE SUPPORT ANGLE
7. HEXAGONAL NUT
8. LOCKWASHER
9. FLAT WASHER
10. CAPSCREW
11. CONDUIT BOX ASSEMBLY
12. TERMINAL STRIP TB104

Figure 5-2. Current Boost Transformers CT2 and CT3

(c) Remove strip heaters (59) with a pair of pliers by pulling towards rear of the generator.

WARNING

Compressed air used for deaning 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.

(2) Inspect.

(a) Clean strip heater assemblies (59) of dust and dirt with a dean cloth, brush, or low pressure, moisture-free air.

(b) Inspect heater assemblies for cracks, signs of scorching, and other damage. Check heater wires for secure mounting and burned or damaged insulation. Check spring dips for damage and secure mounting.

(3) Test.

WARNING

Failure to exercise caution when working on energized components may result in Injury to personnel.

(a) Connect each strip heater to 120 V ac, or connect them both. In series to 240 V ac. Wait 2 minutes. Without touching the strip heaters check for heat emanating along the length of each.

NOTE

Current draw of each space heater is 2.6 to 4.0 amperes.

(b) Disconnect power from the strip heater assemblies (59). Before they cool, measure the resistance of each individual strip heater with a multimeter. A measurement other than 30 to 46 ohms indicates a defective strip heater. Replace defective strip heater.

(4) Repair. Replace strip heater (59) If damaged.

b. Rotating Rectifier Assembly.

(1) Remove.

(a) Perform paragraph 5-6, step a(l) through (3).

(b) Remove conduit box cover assembly (6) by removing hexagon head screws (5).

(c) See detail A, Figure 5-1. Tag and disconnect generator rotor field leads and exciter rotor leads from rotating rectifier assembly by removing nuts (40).

(d) Remove four hexagon head screws (50) and lockwashers (51) to detach rotating rectifier assembly from the aluminum standoff (14).

(2) Inspect and Clean.

(a) Check the rotating rectifier assembly for loose, frayed, or burnt wiring, loose mounting of components, and other damage. Repair or replace as necessary.

WARNING

Dry cleaning solvent, PD-680 Type III, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

(b) Clean all metal parts with deaning solvent PD-680, Type 11, or equivalent

(c) Clean dust and dirt from the rotating rectifier assembly with a soft cloth or brush.

(3) Test.

(a) See detail A, Figure 5-1. Check the polarity of the rectifiers on the rotating rectifier assembly. There are three standard polarity rectifiers (36) on one rectifier angle and three reverse polarity rectifiers (35) on the other rectifier angle.

(b) Test each rectifier for proper operation using a multimeter set for resistive reading. Remove the bolted leadwires from all rectifiers at the terminal studs. Test the resistance between the disconnected leadwire and base of each rectifier. Ensure that all rectifier lead wires are disconnected and separated. Note the reading and reverse the multimeter probes. One reading should be high and the other low if the rectifier is good. If this is the case, proceed to the next rectifier, repeating the procedure until all six rectifiers have been checked. If the high and low reading is not achieved, the rectifier tested is defective and should be replaced. Torque the new rectifier to 20 to 30 pound-inches (2.3 to 3.4 newton-meters).

(c) Locate the surge protector (37) and disconnect one of the two bolted surge protector leads. With multimeter set for resistive reading, measure the resistance of the surge protector. Reverse the multimeter probes and repeat the test. I resistance is low in one or both directions, replace the surge protector.

(d) If all readings are satisfactory, reinstall the rotating rectifier assembly in accordance with paragraph 5-9, step g

(4) Repair. Repair the rotating rectifier assembly by replacement of damaged or defective components.

(a) Disassembly. See Figure 5-1, Detail A.

1 Tag and disconnect rectifier leads (41 and 42) with terminal lugs (43 and 44) by removing hexagon head screws (45), nuts (40), and lockwashers (46).

2 Remove rectifiers (35 and 36) from angles (48) by removing attaching nuts, washers, and lockwashers.

3 Tag and disconnect surge protector (37) wiring by removing nuts (40). Remove surge protector (37) by removing screws (47), lockwashers (46), and nuts (40) at both ends.

4 Remove rectifier angles (48) by removing nuts (40) and screws (45) at both ends of each angle.

(b) Assemble. See Figure 5-1, Detail A.

1 Install three standard polarity rectifiers (36) on one rectifier angle (48), if removed, and secure with rectifier mounting hardware (36). Install three reverse polarity rectifiers (35) on the other rectifier angle (48) and secure with rectifier mounting hardware (35). Torque to 20 to 30 pound-inches (2.2 to 3.3 newton-meters).

2 Install rectifier angles (48) with mounted rectifiers on the insulator plate (49) using one hexagon head screw (45) and nut (40) at the end of each angle (48).

3 Install surge protector (37) on insulation plate (49) and secure at both ends with screws (47), lockwashers (46), and nuts (40). Connect surge protector wiring to the lower screw on each adjacent angle (48) with a nut (40).

4 Connect rectifier leads as previously tagged to the wire hexagon head capscrews (45) at the top end of the insulator plate and secure with lockwashers (46) and nuts (40). Remove and discard tags.

c. Exciter Rotor Assembly.

(1) Remove.
(a) Perform paragraph 5-6, step a(l) through (3).
(b) Remove rotating rectifier assembly (detail A, Figure 5-1) in accordance with paragraph 5-7, step b.
(c) Remove hexagon head capscrews (12) and belleville washer (9) holding exciter rotor assembly (13) to the main rotor assembly (15) shaft.
(d) Thread an 8 inch (195 mm), 314-16NF capscrew into the aluminum standoff (14) inside exciter rotor to push against the end of the main rotor assembly shaft (15). Carefully feed the generator rotor field leads through the lead hole in the standoff (14) to protect the leads from damage during removing of the exciter rotor assembly. Tape the generator field leads onto the main rotor assembly (15) keyway shaft to protect against damage of main rotor is to be removed.
(e) Remove 8 inch (195 mm) 314-16NF capscrew from aluminum standoff (14) when exciter rotor assembly comes off the main rotor (15) shaft.

(2) Inspect and Clean.

(a) Clean dust and dirt from the exciter rotor assembly with a soft doth or brush.
(b) Check the exciter rotor assembly (13, Figure 5-1) for loose, frayed or burnt windings and other damage. Check the aluminum standoff (14) inside for possible damage.

(3) Repair. Repair of the exciter rotor assembly is limited to replacement of the aluminum standoff (14), if damaged. Rewinding of the coil is done by the depot or the manufacturer.

(a) Disassemble. See detail A, Figure 5-1. Remove aluminum standoff (14) from wound armature assembly (52) by removing hexagon head screws (50) and lockwashers (51).
(b) Assemble. See Figure 5-1. Install aluminum standoff (14) on wound armature assembly (52) and secure with hexagon head screws (50) and lockwashers (51). Tighten hexagon head screws (50) to 25 pound-feet (34 newton-meters).

d. Exciter Stator Assembly.

(1) Remove

(a) Remove rotating rectifier assembly in accordance with paragraph 5-7, step b.
(b) Remove exciter rotor assembly in accordance with paragraph 5-7, step c.
(c) Tag and disconnect exciter stator field wires Fl and F2 from terminal strip TBl 04 (12, Figure 5-2) on left side of conduit box assembly.
(d) Remove nylon tiewraps holding exciter stator field wires to the bracket (19, Figure 5-1).
(e) Remove hexagon head capscrews (8) and belleville washers (9) to remove lead shield (11) and exciter stator assembly (10). Mark the exciter stator 'top front for future reference during installation.

NOTE

Ensure that adequate support is provided when removing or installing exciter stator assembly, both for ease in removing mounting screws and to prevent the exciter stator assembly (10) and lead shield (11) from falling when mounting hardware is removed.

(2) Inspect.

(a) Visually check the exciter stator winding for loose, frayed. or burnt winding.
(b) Look for score marks in the bore of the exciter core caused by rubbing. If evidence of rubbing is found, perform megohmmeter test and determine cause of rubbing. Replace a damaged exciter stator.

(3) Clean. Clean dust and dirt from the exciter stator winding with a soft cloth or brush.

(4) Repair. Repair of the exciter stator is limited to replacement of the item. Winding repair may be performed by depot or the manufacturer.

e. Current Transformers CT2 and CT3.

(1) Remove.

(a) Perform paragraph 5-6, step a(l) through (3), above.

(b) Tag and disconnect leads Ti, T2, and T3 from load circuit breaker CB10 at the lower rear section of cabinet B.

(c) Cut and remove tiewraps, as necessary, to free up generator Gl leads, then pull all three leads Ti, T2, and T2 into the conduit box assembly (32, Figure 5-1).

(d) Cut and remove tiewraps, as necessary, and unwind leads from Ti and T2 from current boost transformer CT2 or CT3 to be removed.

(e) Refer to Figure 5-2. Remove hexagon head capscrews (1), lockwashers (2), flat washers (3), and hexagonal nuts (4) to remove boost transformer CT2 or CT3 (5).

(2) Inspect. Check current boost transformers CT2 and CT3 for secure mounting and electrical connections. Check for signs of overheating.
(3) Test. Test current transformer CT2 or CT3 by replacement if it fails to pass testing.
(4) Repair. Repair current transformer CT2 or CT3 by replacement if it fails to pass testing.

f. Conduit Box Assembly.

(1) Remove.

(a) Remove current boost transformers CT2 and CT3 in accordance with step e, above.

(b) Remove main generator leads Ti through T6 from the two wire support angles (6, Figure 5-2) mounted inside the conduit box assembly (11). Tag and remove leads T1, T4, and T6 from the left wire support angle by loosening the mounting rings and removing the heat shrinkable fittings holding generator leads to the angles. Pull generator lead Ti, T4, and T6 downwards through the left wire support angle to remove. Repeat this procedure to remove leads T2, T3, and T5 mounted on the right wire support angle.

(c) Tag and disconnect all wiring from terminal strip TB 04 (12) at the left interior of the conduit box assembly (11). See TB1 04 detail inset in Figure 5-1. Tag leads from right (B) side TBi 04 in functional sets using letter suffixes to denote position on the terminal strip. Example: R1 A, R1 B, and R1 C; R2A, R2B, R2C, and so on.

(d) Remove hexagon head screws (28, Figure 5-1) and mounting washers (29) holding the conduit box assembly (32) and bracket (19) to the main stator coil assembly (33). Lift off the conduit box assembly (32). Generator bracket (19) will be held in place by weight of the main rotor assembly and a recessed mounting screw at its base.

g. Bracket.

(1) Remove.

(a) Remove conduit box assembly in accordance with step f, above.

(b) Remove rotor assembly in accordance with paragraph 5-8.

WARNING

Do not use a lifting device with a capacity of less than 2,000 pounds (900 kg) when lifting bracket (19). Failure to observe this warning may result In serious Injury to personnel.

(c) Attach a lifting device with a minimum of 2,000 pounds (900 kg) capacity to the bracket (19).

(d) Remove hexagon head screw (34) and mounting washer (29) at the bottom of the bracket (19).

(e) Lift the bracket (19) from the stator coil assembly (33).

(2) Inspect and Clean.

WARNING

Dry deaning solvent, PD680, Type III, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

WARNING

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) Clean the bracket (19), grease pipes (1 and 2, Figure 5-3), and hexagonal screws (28, Figure 5-1) in solvent PD-680, Type III, or equivalent, to remove all dust, dirt, and grease. Dry the parts thoroughly with compressed air.

(b) Inspect the bracket (19) and hexagon head screws (28) for stripped threads and replace if defective.

(c) Inspect the bracket (19) for cracks and burred or rough mating surfaces. Inspect the bearing bore for buns or wear. R the bracket shows excessive bearing bore wear, it should be replaced.

h. Stator Coil Assembly.

(1) Test. Test stator coil winding in accordance with paragraph 5-6, step a.
(2) Remove. See Figure 5-1.

(a) Remove conduit box assembly (32) in accordance with step f, above.

(b) Remove main rotor assembly (15) in accordance with paragraph 5-8.

(c) Remove bracket (19) in accordance with step g, above.

(3) Inspect.

(a) Visually inspect the coil assembly for loose, frayed, or burnt winding.

(b) Inspect the frame for cracks, burred mating surfaces, or other damage.

WARNING

Compressed air used for deaning 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.

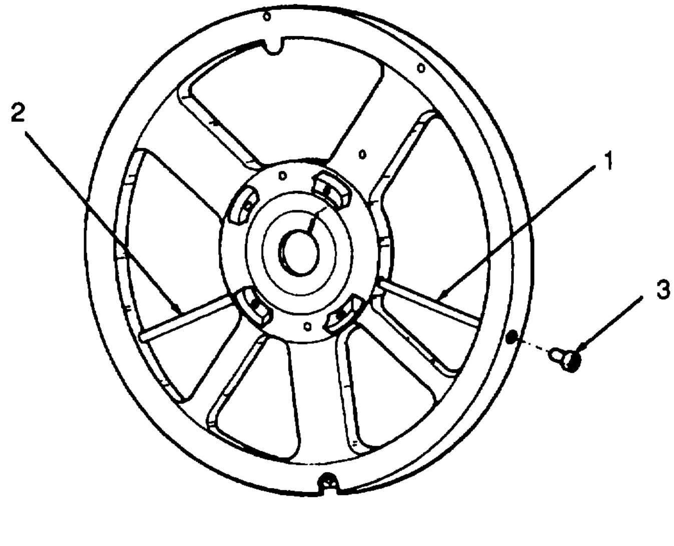
(4) Clean. Clean dust and dirt from the coils with 2 soft, cloth, brush or low-pressure, moisture-free air.
(5) Repair. Repair of the stator coil assembly is limited to minor repairs to the frame and mounting flanges. Rewinding is done by depot or the manufacturer.

5-8. GENERATOR G1 MAIN ROTOR ASSEMBLY MAINTENANCE.

a. Remove. See Figure 5-1.

(1) Remove four hexagon head screws (16) and lockwashers (17) holding bearing cup (18) to bracket (19).

(2) Remove hexagon head screws (20) and plain washers (21) holding coupling drive discs (22) to hub (23). Start at the bottom and remove the screws in alternating fashion up to the top of the generator. Remove all drive discs (22) and spacer plates (24).
(3) Remove screen assembly (3) and drip cover assembly (4) by removing hexagon head screws (1) and hexagonal nuts (2).



1. FILLER GREASE PIPE
2. DRAIN GREASE PIPE
3. GREASE PLUG

Figure 5-3. Bracket, Grease Pipes and Plugs

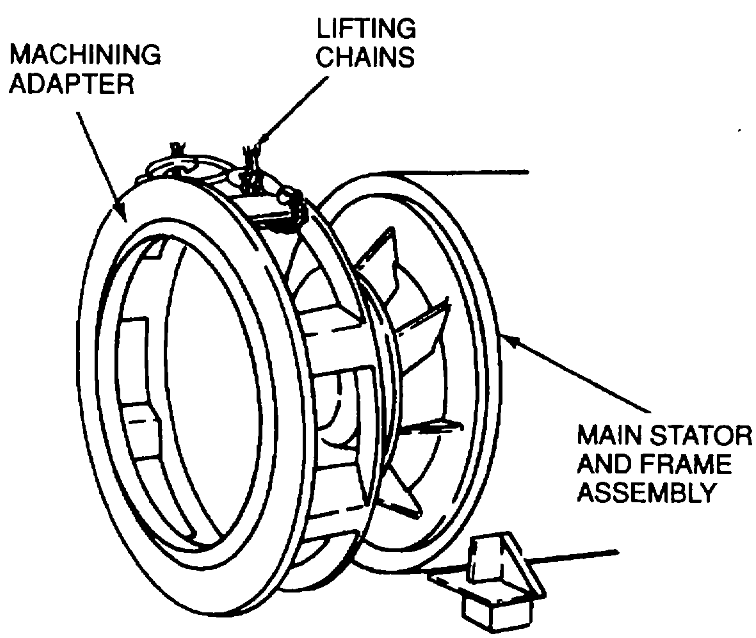


Figure 5-4. Removal of Machining Adapter

WARNING

Do not use a lifting device with a capacity of less than 215 pounds (98 kg) when lifting adapter. Failure to observe this warning may result In serious Injury or death to personnel.

(4) Attach a suitable lifting device with a 215 pound (98 kg) capacity to machining adapter (25) (see Figure 5-4). Then remove hexagonal head screws (26, Figure 5-1) and lockwashers (27) to remove the adapter (25).

WARNING

Do not apply any force to the generator fan for lifting or rotating the generator rotor. Disregarding these Instructions may cause Injury to personnel or equipment damage.

WARNING

To avoid personnel Injury or equipment damage when lifting the generator rotor, use a lifting device rated for a minimum 4,000 pounds (1800 kg).

CAUTION

Special care should be used In rotor assembly removal, or winding damage could occur.

(5) Using D-511856 rotor lifting fixture and a suitable hoist, carefully remove the rotor assembly (15, Figure 5-1) as follows:

(a) Refer to Figure 5-5. Install flange assembly (1) on rotor assembly (15, Figure 5-1). Secure with six or more hexagon head screws (20), torqued to 150 pound-feet (230 newton-meters).

(b) Slide lift assembly (2, Figure 5-5) onto flange assembly (1).

(c) Attach pin (3) to flange assembly (1).

(d) Select lifting plug location closest to center of gravity of rotor assembly.

(e) Carefully remove rotor assembly and rest it on a suitable working surface.

(f) Disassemble.

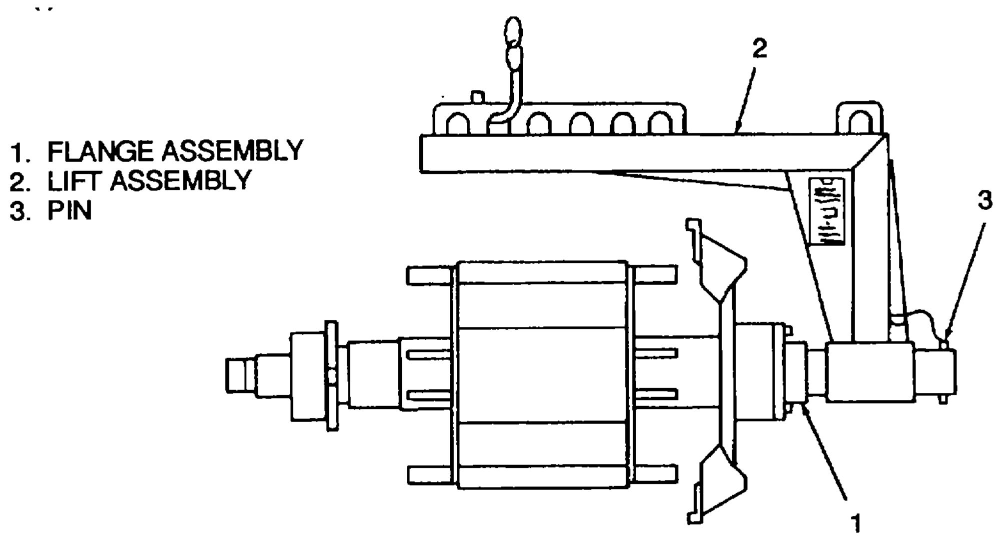


Figure 5-5. Rotor Assembly, Removal and Installation

b. Disassemble and Service. Unless a complete overhaul is required, disassemble main rotor assembly only to the extent required to dean, repair, or replace a dirty, damaged or defective component. Do not disassemble rotor if coil rewinding is required. Rewinding is performed by depot or the manufacturer. Remove, inspect and dean; or repair main rotor assembly components and auxiliaries in accordance with the procedures below. Install components in accordance with step c, below. Disassemble main rotor assembly as follows:

WARNING

Dry deaning solvent. PD-680, Type III, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid injury to personnel.

WARNING

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.

(1) Coupling drive discs and spacer (22 and 24, Figure 5-1).

(a) Remove. Remove coupling drive discs (22) and spacer (24) in accordance with step a, above.
(b) Inspect and dean.

1 Inspect coupling drive discs (22) and spacers (24) for distorted or bent edges and other damage. Check for worn mounting holes. Inspect drive disc hexagonal head screws (20) for damaged threads.

2 Clean coupling drive discs (22) and spacers (24) with solvent PD-680, Type 111, or equivalent. Dry thoroughly with compressed air.

(c) Repair. Repair by replacement of damaged components. Replace all defective discs as necessary. Replace spacers, if damaged. Replace screws if damaged.
(d) Install. Install drive discs in accordance with paragraph 5-9.

(2) Machining Adapter.

(a) Remove. Remove the machining adapter (25, Figure 5-1) in accordance with step a, above.
(b) Inspect and Clean.

1 Inspect the machining adapter for cracks, burred or rough mating and other damaged surfaces. Inspect the hexagon head screws (26) for stripped threads. Replace if defective.

2 Clean the machining adapter (25), hexagon head screws (26), and screen assembly (3) in solvent PD-680, Type III, or equivalent, to remove all dust, dirt, and grease. Dry the parts thoroughly with compressed air.

(c) Repair. Repair by replacement. Replace the machining adapter (25) if damaged. Replace the hexagon head screws (26) as needed.
(d) Install. Install machining adapter (25) in accordance with paragraph 5-9, step b.

(3) Ball Bearing and Bearing Cap (39 and 18, Figure 5-1).
(a) Inspect and Clean. inspect the ball bearing (39) for damage or wear while bearing (39) is installed on the rotor assembly (15, Figure 5-1). Inspect bearing cap for worn threads in the screw mounting holes.
(b) Repair. Repair by replacement. Replace bearing cap if threads are wom.
(c) Remove.

NOTE

If the ball bearing is removed for any reason, always install a new ball bearing.

1 Remove retainer ring (38), then remove the ball bearing (39) with a general purpose puller with 20 ton (9072 kg) capacity.

2 Slide off bearing cap (18) from the main rotor shaft. Remove and discard oil seal (7) if bearing cap is to be removed.

(d) Clean. Clean the old grease from the bearing cap (18) and fill the bearing cap grease cavity 113 to 1/2 full of new multi-purpose lithium grease, MILT-18709. Install new oil seal (7).

(e) Install. Install new bearing cap (18) and ball bearing (39) in accordance with step c. below.

(4) Hub (23, Figure 5-1).

(a) Inspect and dean. Inspect the drive hub (23) while mounted on the main rotor assembly. Check the hub for cracks or stripped drive disc screw mounting holes.

(b) Repair. Repair damaged or defective hub by replacement. Install replacement hub in accordance with step c, below.

(c) Remove.

1 Match-mark the fan (55) and hub (23) for alignment to ensure proper balance after reassembly. Mark the replacement hub (23) in the same place as the old hub relative to the keyway.

2 Remove the fan mounting hardware, hexagon head screws (53), and belleville washers (54) and move the fan (55) back away from hub (23).

3 Install a suitable puller on the hub (23).

4 Remove the setscrew (56) in the hub (23) over the hub key (57).

WARNING

Failure to exercise caution when heating components using a torch may result In Injury to personnel.

5 Using a torch, rapidly heat the hub at the outer diameter while tightening the puller. This must be done rapidly before the heat can expand the shaft. Remove the hub (23) using heat resistant gloves.

(5) Fan (55, Figure 5-1).

(a) Inspect.

WARNING

Dry deaning solvent, PD680, Type 1II, or equivalent Is flammable and moderately toxic to the sin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

WARNING

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.

1 Check fan (55) for cracks or blades while installed on the rotor.

2 Clean the fan, using solvent PD-680, Type III, or equivalent Dry with compressed air.

(b) Repair. Replace damaged or defective fan (55). Install in accordance with step c, below.

(c) Remove.

1 Remove the hub (23) in accordance with step (4)(c), above.

2 Slide the fan (55) off the shaft.

(6) Main Rotor Core and Winding.

(a) Test. Test the main rotor winding in accordance with paragraph 5-6, step b.

(b) Remove. Remove main rotor assembly in accordance with step a, above.

(c) Inspect and clean.

1 Check rotor winding for signs of overheating. Check for loose, frayed, or burnt winding.

2 Clean all metal parts of rotor core with solvent PD8, Type li1, or equivalent. Remove dust and dirt from rotor windings with a soft cloth or brush.

CAUTION
If a piece of wire Is used to clean the air channels, take care not to scratch the winding or Insulation failure could occur.

3 Remove any accumulated dust or dirt in the winding air channels with a piece of wire or with low pressure, moisture-free air.

(d) Repair. A damaged or defective rotor winding must be returned to the manufacturer for rewinding.

c. Assemble. See Figure 5-1. Assemble main rotor assembly (15) as follows: (1) Install Bearing Cap and Bearing.

(a) Fill bearing cap (18) grease cavity 1/3 to 112 full of new multi purpose lithium based grease, MILT-18709.

(1) Install new oil seal (7). Slide bearing cap onto bearing end of main rotor assembly (15).

NOTE
Never install an old bearing. Always use a new bearing.

(b) Heat new bail bearing (39) in an oven to approximately 212OF (100,C).

(c) Apply a thin coat of dean lubricating oil MILT-1 8709, to the press fit area of the main rotor shaft.

CAUTION
Under no circumstances should pressure be applied to the outer race of the bearing, as permanent bearing damage could result. If the ball bearing binds on the shaft before being fully seated, then a piece of tubing, slightly larger than the press fit area, can be used to drive the ball bearing Into place. Using light taps with a soft mallet, apply pressure to the Inner race only.

(d) Using heat resistant gloves, install ball bearing (39), with the seal side facing the bearing cap(18), over the end of the shaft until it seats against the shaft shoulder. The ball bearing (39) should slide onto the shaft and be seated without excessive force.

(e) Allow ball bearing (39) to cool for 1 hour before attempting to assemble the generator.

(2) Install fan (55, Figure 5-1).

NOTE
The rotor assembly must be rebalanced if a new fan is installed.

(a) Slide the fan (55, Figure 5-1) over the drive end of the main rotor shaft making sure the fan mounting surface is toward the hub (23).

NOTE

Install belleville washers (54) with indented sides facing away from the hexagon screw. (53) heads. See detail inset, Figure 5-1.

(b) Mount the hub (23) in accordance with step (3), below. Mount the fan (55) to the hub with hexagon head screws (53) and belleville washers (54). Torque hexagon head screws (53) to 60 pound-feet (81 newton- meters).

(3) Install hub (23, Figure 5-1).

(a) Mark the new hub (23) in the same place as the old hub relative to the keyway. Install key (57) on key slot on shaft shoulder.

(b) Heat the new hub (23) in an oven to 500 to 600*F (260 to 3600C).

(c) Be sure the fan (55) is installed on the shaft. Using heat resistant gloves, slide the hub (23) over the key in the shaft until it seats against the shaft shoulder.

(d) Allow the hub (23) to cool for 1 hour.

(e) Tighten the setscrew (56) in the hub to 50 pound-feet (68 newton-meters).

NOTE

Install belleville washers (54) with indented side facing away from the capscrew head. See detail inset, Figure 5-1.

(f) Match the alignment marks on the fan (55) and hub (23) and mount the fan to the hub with hexagon head screws (53) and belleville washers (54). Tighten the screws (53) to 60 pound-feet (81 newton-meters).

5-9. GENERATOR G1 ASSEMBLY. Assemble generator Gi as follows:

a. Bracket. See Figure 5-1 and proceed as follows:

(1) Fill the grease cavity of the bracket (19) with new multipurpose lithium grease MILT-18709, and install a new oil seal (7). Assemble all grease pipes (1 and 2, Figure 5-3) and plugs (3) on the bracket.
(2) Install two guide pins in the main stator coil assembly (33, Figure 5-1).

WARNING

Use a lifting device with a minimum capacity of 2000 pounds (907 kg). Do not allow generator to swing while It Is suspended Failure to observe this warning may result In serious injury or death to personnel.

(3) See Figure 5-6 and attach a hoist with a minimum capacity of 2,000 pounds (907 kg) to the bracket (19, Figure 5-1).
(4) Align the bracket mounting holes to the guide pins on the main stator coil assembly (33) and slide the bracket over the pins.
(5) Install the hexagon head screw (34) and mounting washer (29). Remove the lifting gear from the bracket (19).

b. Rotor Assembly. See Figure 5-1 and proceed as follows:

WARNING

Do not apply any force to the generator fan for lifting or rotating the generator rotor. Disregarding these Instructions may cause Injury to personnel or equipment damage.

CAUTION

Special care should be used In the rotor assembly Installation, or winding damage could result.

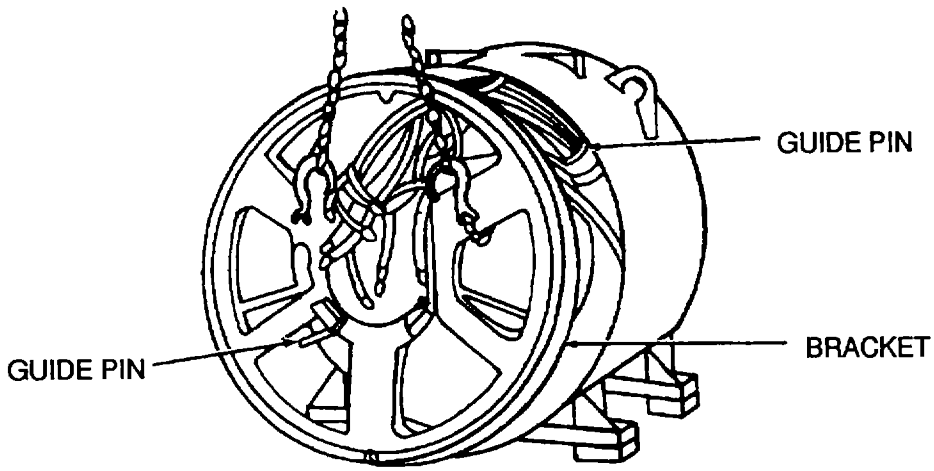


Figure 5-6. Bracket Installation

(1) Install bracket (19) on stator coil assembly (33) in accordance with step a, above.

WARNING

Do not use a lifting device with a capacity of less than 4,000 pounds (1 600kg) when lifting rotor assembly (15). Failure to observe this warning may result In serious Injury or death to personnel.

(2) Using a rotor lifting fixture and a suitable hoist (see Figure 5-5), carefully install the rotor assembly (15, Figure 5-1) into the stator coil assembly (33) through the drive end. Carefully feed the taped rotor leads through the bracket shaft hole as the rotor is installed (see Figure 5-7).

WARNING

Do not use a lifting device with capacity of less than 215 pounds (98 kg) when lifting machining adapter (25). Failure to observe this warning may result in serious injury or death to personnel.

(3) Attach a suitable hoist with a capacity of 215 pounds (98 kg) to the machining adapter (25). See Figure 5-4.
(4) Pilot the machining adapter (25, Figure 5-1) to the fan (55) and secure to the coil assembly (33) with hexagon head screws (26) and lockwashers (27). Torque hexagon head screw (26) to 60 pound-feet (68 newton-meters). It may be necessary to raise the rotor assembly (15) slightly to allow the mounting of the machining adapter (25).
(5) Insert a guide stud into the hub (23).
(6) Install two spacers (24) and ten coupling drive discs (22), one at a time. Make sure all coupling drive disc mounting holes at the inner and outer diameter are properly aligned.
(7) Remove the guide stud and secure the coupling drive discs (22) with hexagon head screws (20) and plain washers (21). Torque in accordance with to 216 pound-feet (293 newton-meters).
(8) Check the torque of each bolt in a clockwise direction around the bolt circle to ensure that all bolts are properly torqued.
(9) Mount the screen assembly (3) and drip cover assembly (4) to the machining adapter (25) and secure with hexagon head screws (1) and hexagonal nuts (2).
(10) Insert two sets of hexagon head screws (16) and lockwashers (17) into the bracket (19) and secure the bearing cap (1 8).

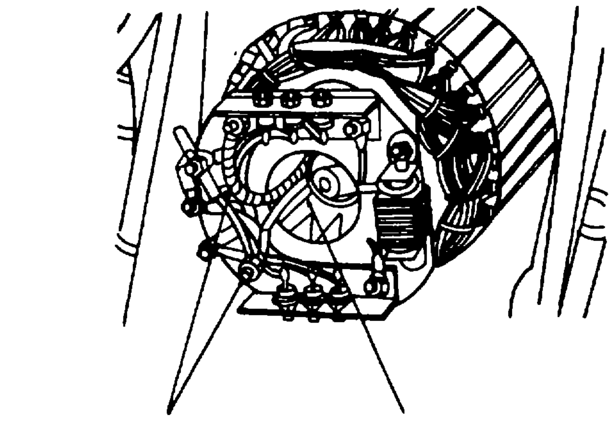


Figure 5-7. Rotor Installation

c. Conduit Box Assembly.

(1) Install bracket (19), if removed, in accordance with paragraph 5-7g.
(2) Mount the conduit box assembly (32) using two guide pins used in paragraph 5-9, step (2), above, and secure to the bracket (19) and coil assembly (33) with hexagon head screws (28) and mounting washers (29). Remove the guide pins and install hexagon head screws (28) and mounting washers (29) in place of the guide pins.
(3) Install the main generator leads Ti through T6 on the wire support angles (6, Figure 5-2) as follows:

(a) Slide new heat shrinkable fittings on generator leads Ti through T6 before feeding the leads through the wire support angles (6). Install the fittings such that the shrink sleeves are facing toward the generator coil assembly (33, Figure 5-1). Do not heat shrink the fittings at this point.

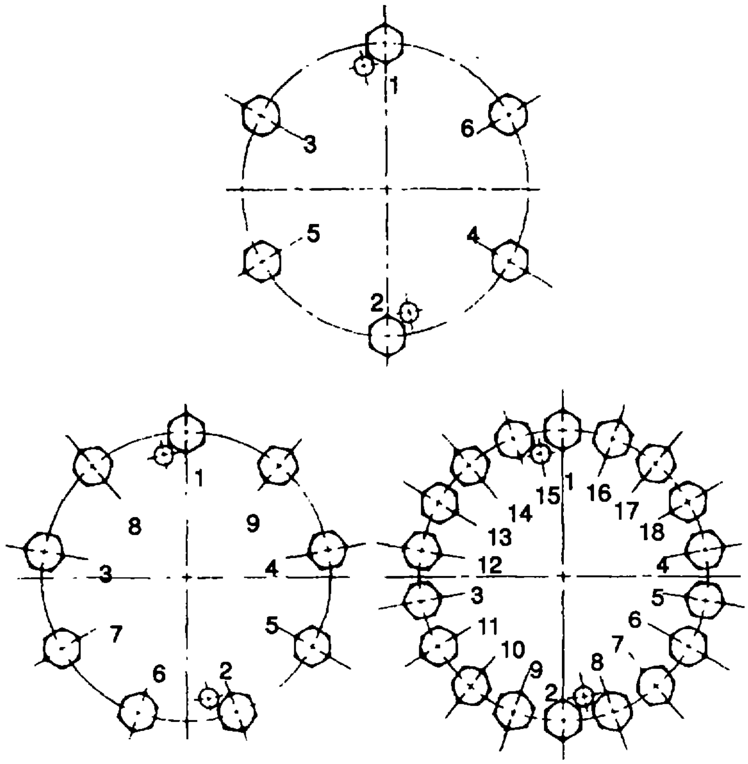
(b) With shrink fittings installed, thread generator leads Ti, T4, and T6, left to right in that order, upward through the mounting holes on the left wire support angle (6, Figure 5-2). Thread generator leads T2, T5, and T3, left to right in that order, upward through the right wire support angle (6). Secure the heat shrinkable fittings on the wire support angles with the mounting rings at the top.

(c) Individually adjust each generator lead by pulling upwards or downwards as necessary through the wire support angles and fittings to assure that the generator lead insulation material does not chafe against metal surfaces on the conduit box assembly (11) or the generator bracket (19, Figure 5-1), nor interfere with armature rotation. Using a heat shrink device, heat each fitting as soon as this adjustment is made on the corresponding generator lead. Tighten mounting rings on top of the angles until they are flush tight against the wire support angle surface.

(4) Install current boost transformers CT2 and CT3 in accordance with step d, below.

d. Current Boost Transformers CT2 and CT3.

(1) Refer to Figure 5-2. Install current boost transformer CT2 or CT3 (5) and secure with hexagon head capscrews (1), lockwashers (2), flat washers (3), and hexagonal nuts (4).
(2) Reconnect wiring to transformers as tagged. Remove and discard tags.
(3) Wrap generator lead Ti, three turns through current transformer CT3. Wrap generator lead T2 three turns through current transformer CT2. Secure generator leads Ti, T4, and T6 together with tiewraps. Secure generator leads T2, T5, and T3 with tiewraps. Connect terminal lugs of leads Ti, T2, and T3 to terminals of load circuit breaker CB1 01 as shown in Figure 10-3. Generator lead Ti connects through load circuit breaker CB1 01 to output line L1; lead T2 connects to output line L2; and generator T3 connects to line L3 via the circuit breaker.
(4) Install tiewraps, as necessary, to secure leads in place along their length and to relieve stress at their lugs.
(5) Reinstall rear cabinet B access panel.



Torque the bolts in the above sequence according to the correct bolt pattern.

Then check the torque in each bolt in a clockwise direction around the bolt circle to insure that all the bolts are properly torqued.

Figure 5-8. Torque Sequence, Drive Discs

e. Exciter Rotor Assembly.

(1) Using a safety wire of adequate length, feed through the lead hole in the aluminum standoff (14, Figure 5-1 inside the exciter rotor assembly (13). Remove tape from main rotor field wires (if field wires were taped to the shaft).
(2) Install the mounting key (58) in the main rotor assembly (15) shaft keyway.
(3) Position exciter rotor assembly (13) for installation. Attach one end of the safety wire coming through the lead hole in the aluminum standoff (14) to the two main rotor field wires coming out of the main rotor assembly (15) shaft.
(4) Align keyway at rear of aluminum standoff (14) with the key (58) installed on main rotor assembly (15) shaft. Slide the exciter rotor assembly (13) on the main rotor shaft while carefully pulling the main rotor field leads through the lead hole in the aluminum standoff (14) with the safety wire.
(5) Position the belleville washer (9) on the hexagon head screw (12) with its indented side facing away from the screw head. (See detail inset, Figure 5-1. Belleville washers should always be positioned as shown.) Insert the hexagon head screw (12) and belleville washer (9) through the mounting hole in the aluminum standoff (14) and secure to the main rotor shaft. Tighten until the exciter rotor assembly (13) seats fully on the shaft. Torque hexagon head screw (12) to 95 pound-feet (129 newton-meters).

f. Exciter Stator Assembly.

(1) Align the lead shield (11, Figure 5-1) with the exciter stator assembly (10), noting sop front position on the latter previously marked for reference.
(2) Mount the lead shield (1i1) and exciter stator assembly (10) to the generator bracket (19) with hexagon head screws (8) and belleville washers (9). Position belleville washers (9) such that the indented washer sides are facing away from the screw (8) heads (see detail inset Figure 5-1). Torque screws (8) to 60 pound-feet (81 newton-meters).
(3) Tie together the two exciter field wires Fl and F2 with clamps and secure to the bracket (19) and conduit box assembly (32).
(4) Reconnect exciter stator field wires Fl and F2 to the terminal strip TB1 04 (12, Figure 5-2) as tagged. Remove and discard tags.
(5) Install exciter rotor assembly in accordance with paragraph 5-7.

g. Rotating Rectifier Assembly.

(1) See detail A, Figure 5-1. Position the rotating rectifier assembly on the aluminum standoff (14) such that the top hexagon head screws (45) are within reach of the exciter rotor leads.
(2) Secure rotating rectifier assembly to the aluminum standoff (14) using four hexagon head screws (50) and lockwashers (51).
(3) Reconnect generator field leads and exciter rotor leads as tagged on hexagon head screws (45) and secure with nuts (40). Remove and discard tags.
(4) Reinstall conduit box cover assembly (6) using hexagon head screws (5).

h. Strip Heaters.

(1) Slide the strip heater (59, Figure 5-1) and mounting bracket (62) assemblies along the bottom of the main stator coil assembly (33) (one strip heater on each side of the bottom stator bar) with the spring clip end in first and facing upwards.
(2) Continue sliding the heater assemblies in until spring clip snaps in place and heater mounting bracket holes are aligned with the predrilled heater mounting holes on the generator bracket (19). Secure strip heaters in place with mounting screws (60).
(3) With wire clamp, tie together heater lead wires Hi, H2, H3, and H4 and secure to the clamp mounting hole near the bottom of the conduit box assembly (32).
(4) Tie together heater wires Hi, H2, and exciter field wire Fl with wire clamps and secure clamps to the left side of the conduit box assembly (32). Tie together heater wires H3, H4, and exciter field wire F2 with wire clamps, and secure on the left side of conduit box assembly (32).
(5) Reinstall conduit box cover assembly (6) using hexagon head screws (5).

5-10. GENERATOR GI INSTALLATION. Install generator Gi on generator set in accordance with Chapter 2.

SECTION III. VOLTAGE REGULATOR VR101

5-11. GENERAL. See Figure 5-9 and Figure 5-10. Voltage regulator VR1 01 monitors and regulates the output voltage at generator G1.

a. Isolation transformer T102 senses generator Gi voltage from lines T2 and LO. The transformer steps down the voltage from 2400 V ac to 240 V ac which is applied to VRi01 terminals 3 and 4.
b. Inside voltage regulator VR101, the 240 V ac is converted to DC and compared to a reference voltage. Based on this comparison, VR1 01 supplies DC current, via output terminals F+ and F-, to the exciter field of generator GI.

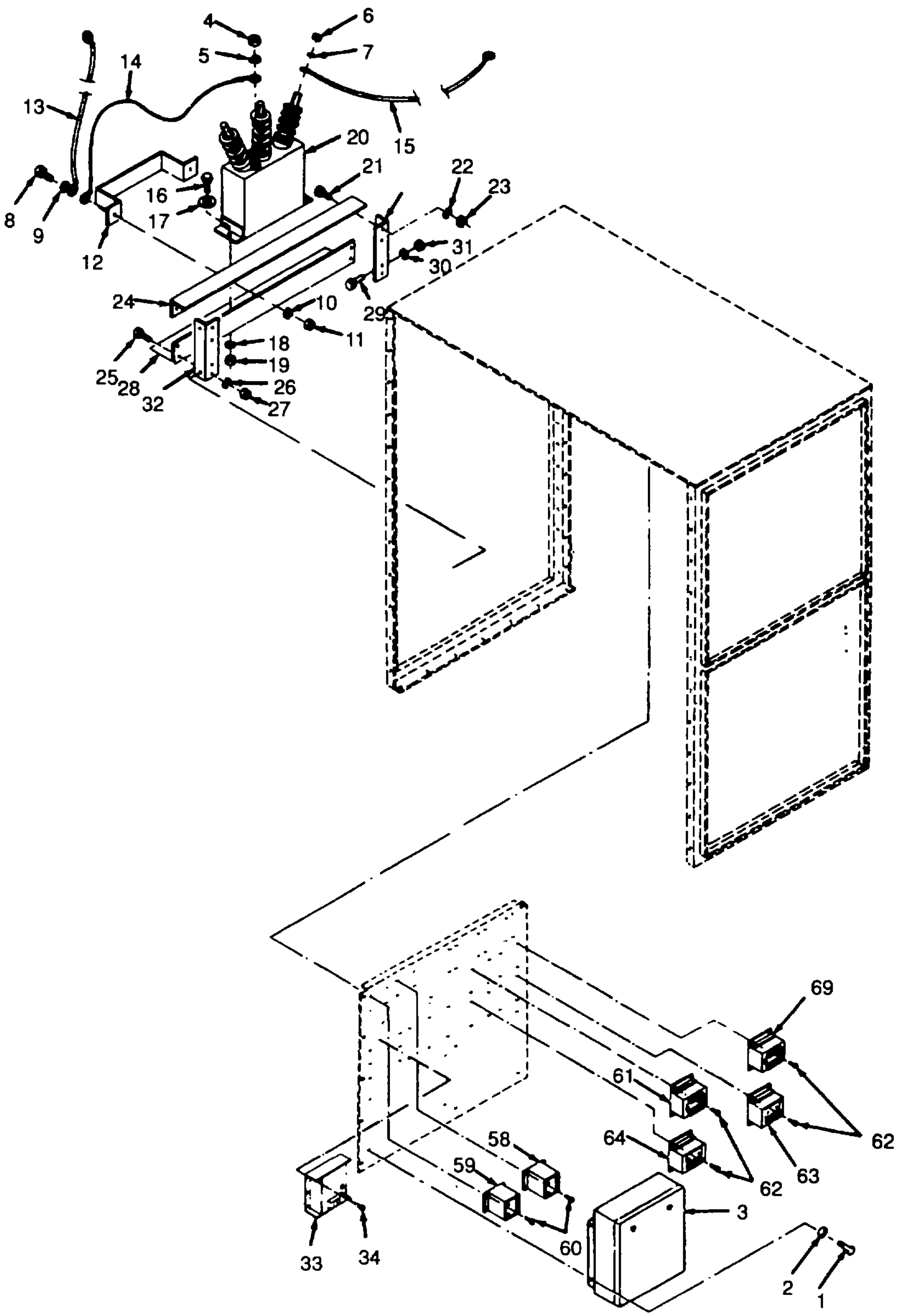


Figure 5-9. AC Electrical Components and Related Parts (Sheet 1 of 5)

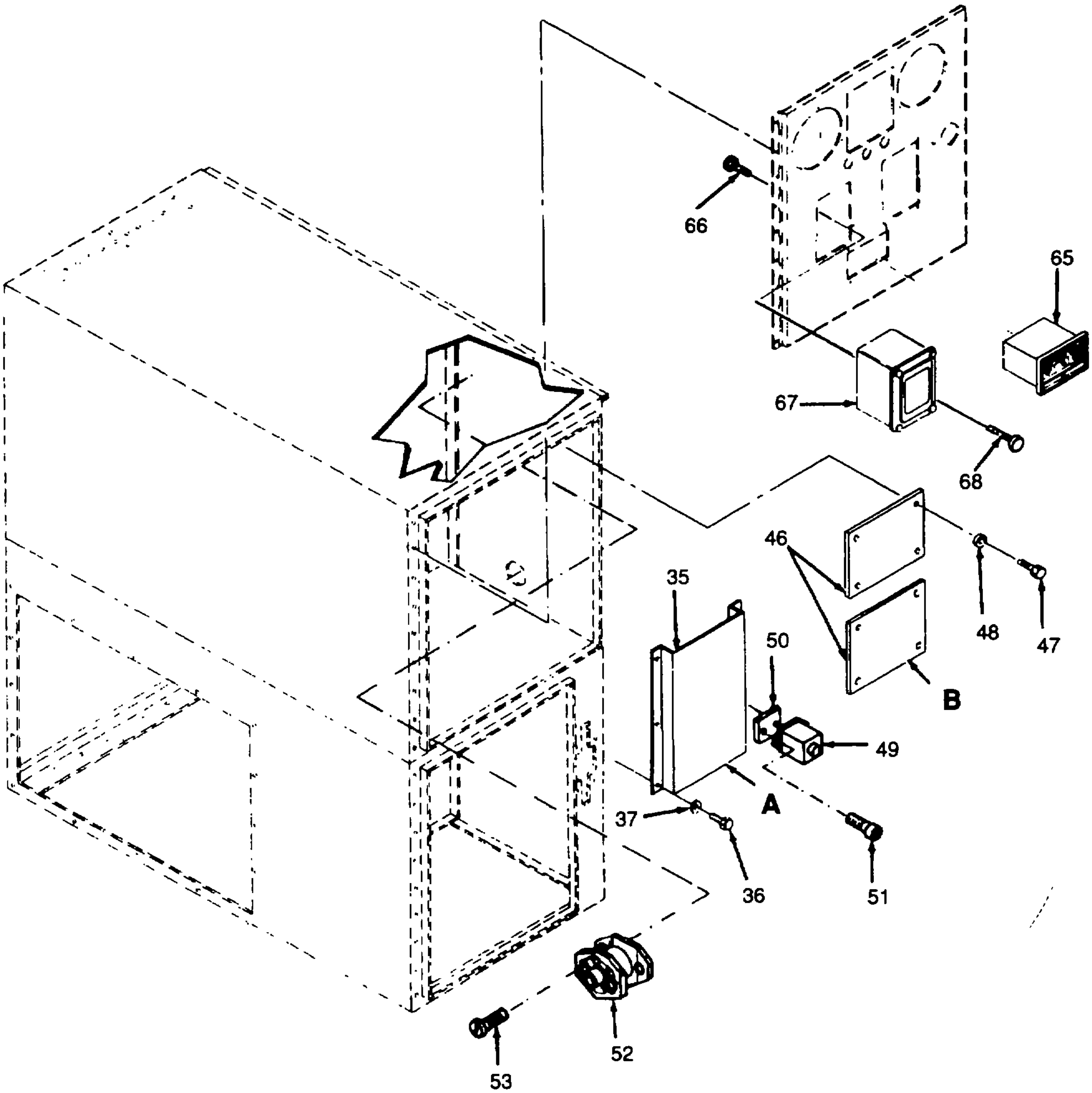
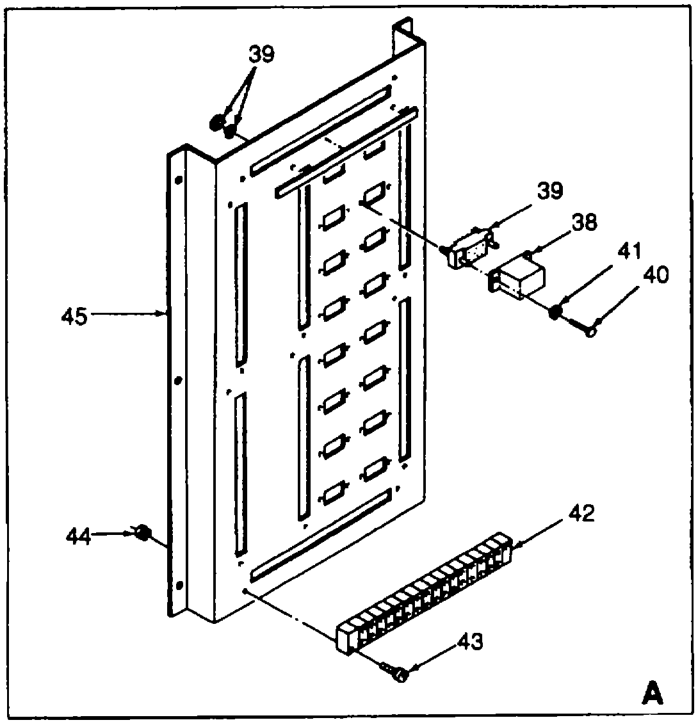


Figure 5-9. AC Electrical Components and Related Parts (Sheet 2 of 5)



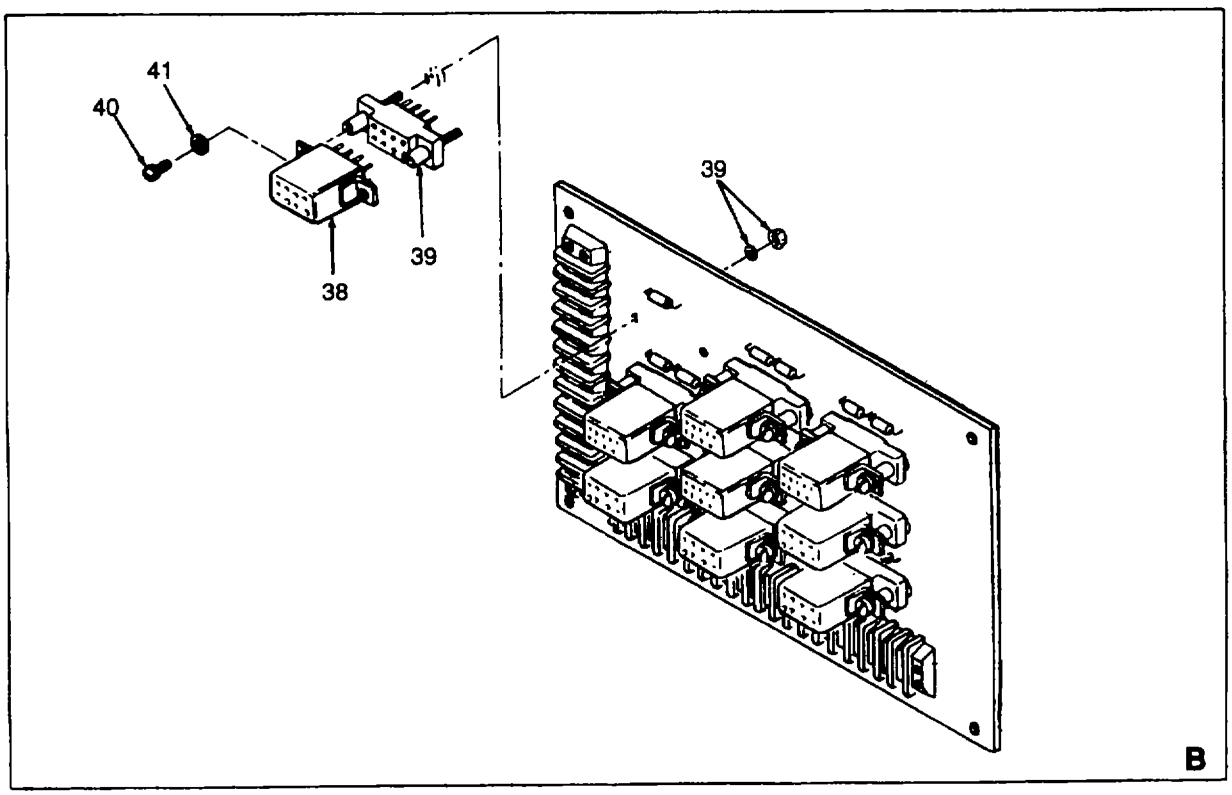


Figure 5-9. AC Electrical Components and Related Parts (Sheet 3 of 5)

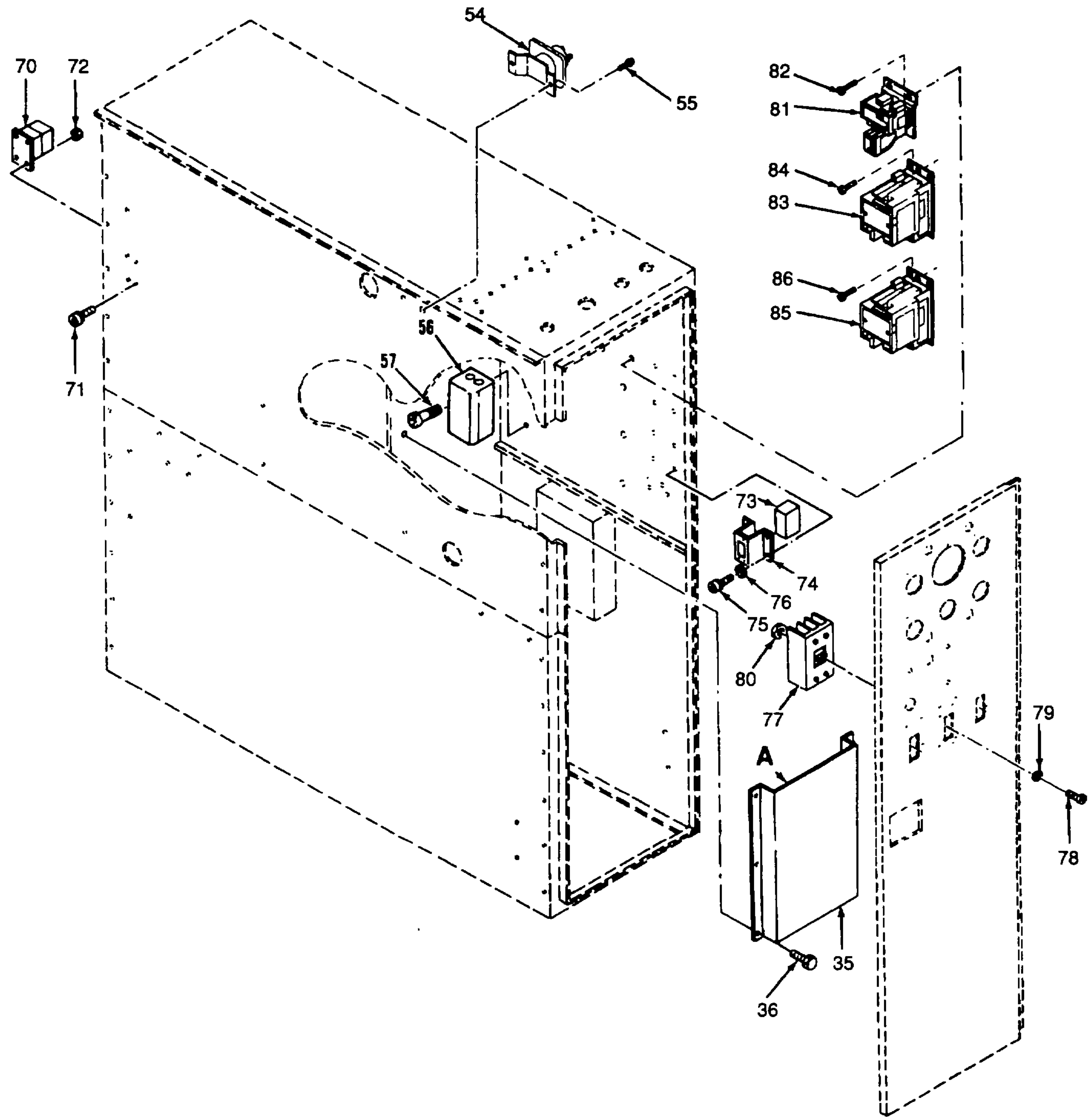
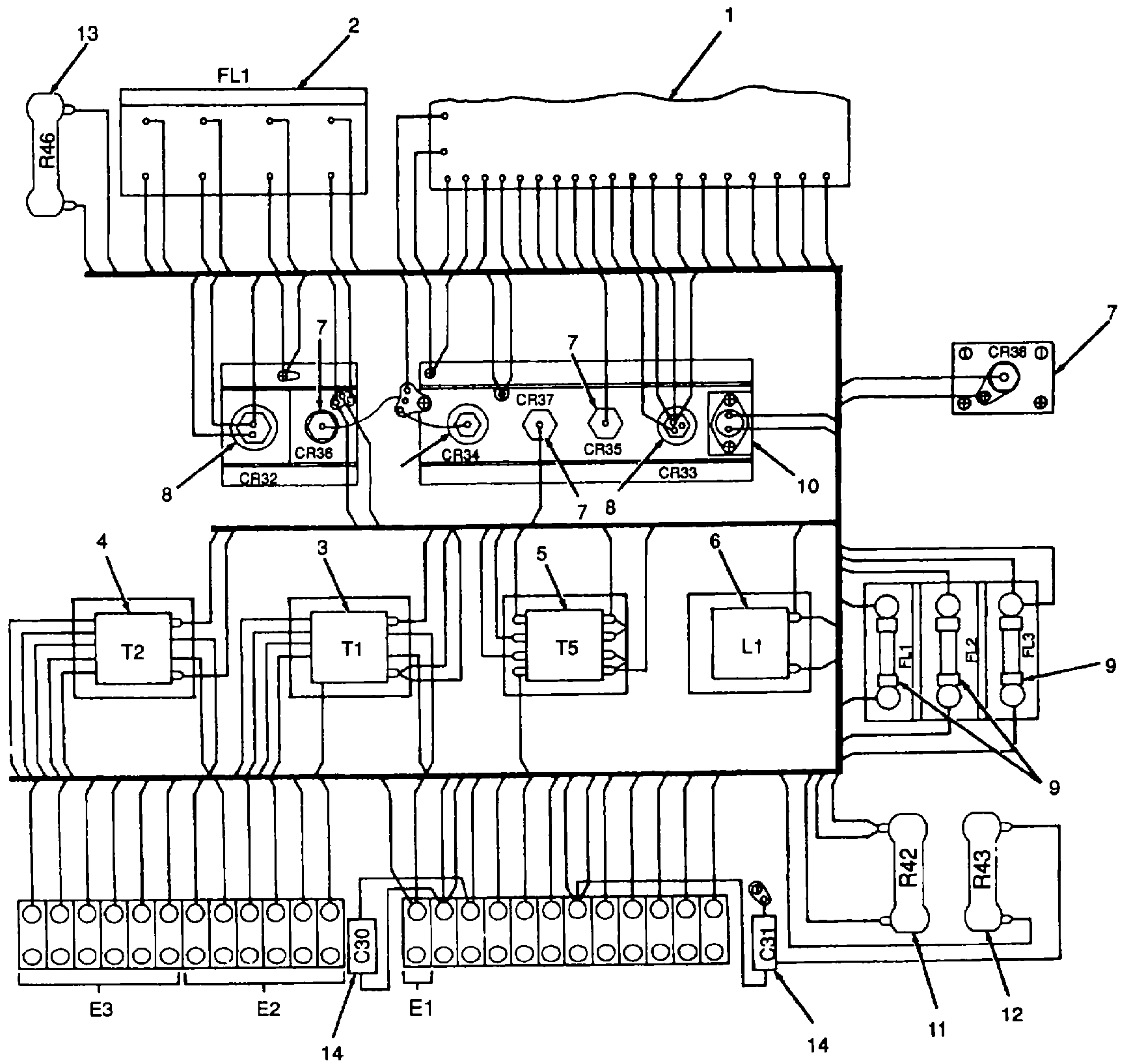


Figure 5-9. AC Electrical Components and Related Parts (Sheet 4 of 5)

1. HEXAGON HEAD SCREW
2. LOCKWASHER
3. VOLTAGE REGULATOR VR101
4. HEXAGONAL NUT
5. LOCKWASHER
6. HEXAGONAL NUT
7. LOCKWASHER
8. HEXAGON HEAD CAPSCREW
9. FLAT WASHER
10. LOCKWASHER
11. HEXAGONAL NUT
12. SURGE MOUNTING STRAP
13. CABLE
14. CABLE
15. CABLE
16. HEXAGON HEAD CAPSCREW
17. FLAT WASHER
18. LOCKWASHER
19. HEXAGONALNUT
20. SURGE CAPACITOR C101
21. HEXAGON HEAD CAPSCREW
22. LOCKWASHER
23. HEXAGONAL NUT
24. SURGE CAPACITOR BRACE
25. HEXAGON HEAD CAPSCREW
26. LOCKWASHER
27. HEXAGONAL NUT
28. SURGE CAPACITOR SUPPORT
29. HEXAGON HEAD CAPSCREW
30. LOCKWASHER
31. HEXAGONAL NUT
32. SURGE CAPACITOR SUPPORT BRACKETS
33. CURRENT BOOST MODULE Al 01
34. SCREW AND CAPTIVE WASHER ASSEMBLY
35. RELAY PANEL ASSEMBLY
36. HEXAGON HEAD SCREW
37. LOCKWASHER
38. RELAY, K3, K4A/4B/4C, K5, K6A/6B, K7A/7B, K9, K10, Kll, K12, K13, K14, K1 5A/1 5B/1 5C, K16, K17, K18, K19A/i19B, K20A/20B, K21, K22, K24, K25, K26, K27, K28
39. RELAY SOCKET
40. SCREW ASSEMBLY
41. LOCKWASHER
42. TERMINAL BOARD TB5 THROUGH TB20
43. SCREW AND CAPTIVE WASHER ASSEMBLY
44. NUT AND CAPTIVE WASHER ASSEMBLY
45. RELAY PANEL CHASSIS
46. COMPONENT BOARD ASSEMBLY Al0, All
47. SCREW AND CAPTIVE WASHER ASSEMBLY
48. SPACER
49. TIME DELAY (LOW FUEL SHUTDOWN) RELAY K23
50. RELAY SOCKET
51. SCREW AND CAPTIVE WASHER ASSEMBLY
52. CIRCUIT BREAKER TIP RELAY K30
53. SCREW AND CAPTIVE WASHER ASSEMBLY
54. RELAY, K15D
55. SCREW AND CAPTIVE WASHER ASSEMBLY
56. EMERGENCY LIGHT RELAY K100
57. SCREW AND CAPTIVE WASHER ASSEMBLY
58. 50 HERTZ FREQUENCY RELAY K108
59. 60 HERTZ FREQUENCY RELAY K107
60. SCREW AND CAPTIVE WASHER ASSEMBLY
61. REVERSE POWER RELAY K109
62. SCREW AND CAPTIVE WASHER ASSEMBLY
63. OVERVOLTAGE RELAY K110
64. UNDERVOLTAGE RELAY Kll
65. OVERCURRENT RELAY K114
66. SCREW
67. GROUND FAULT RELAY K115
68. SCREW AND CAPTIVE WASHER ASSEMBLY
69. SYNCHRO CHECK RELAY K116
70. SWITCHGEAR HEATER CONTACTOR K117
71. SCREW AND CAPTIVE WASHER ASSEMBLY
72. NUT AND CAPTIVE WASHER ASSEMBLY
73. SWITCHGEAR CIRCUIT BREAKER CB123
74. CIRCUIT BREAKER BRACKET
75. HEXAGONAL HEAD SCREW
76. LOCKWASHER
77. MAINTENANCE LOCKOUT CIRCUIT BREAKER S100
78. SCREW
79. FLAT WASHER
80. NUT AND CAPTIVE WASHER ASSEMBLY
81. FUEL TRANSFER PUMP CONTACTOR K106
82. SCREW AND CAPTIVE WASHER ASSEMBLY
83. COOLANT HEATER CONTACTOR K104A
84. SCREW AND CAPTIVE WASHER ASSEMBLY
85. COOLANT HEATER CONTACTOR K104B
86. SCREW AND CAPTIVE WASHER ASSEMBLY

Figure 5-9. AC Electrical Components and Related Parts (Sheet 5 of 5)



1. ETCHED CIRCUIT BOARD
2. EMI FILTER ASSEMBLY, VR101FL1
3. SINGLE PHASE SENSING TRANSFORMER, VR101T1
4. THREE PHASE SENSING TRANSFORMER, VR101T2
5. TRANSFORMER, VR101T5
6. FILTER CHOKE, VR101L1
7. DIODE, VR101CR34 THROUGH VR101CR38
8. SILICON CONTROLLED RECTIFIER, VR101CR32, VR101CR33
9. FUSE, VR101F11 THROUGH VR101F13
10. THERMAL SWITCH, VR101S3
11. RESISTOR, VR101R42
12. RESISTOR, VR101R43
13. RESISTOR, VR101R46
14. CAPACITOR, VR101C30, VR101C31

Figure 5-10. Voltage Regulator VR101, Diagram

c. Voltage regulator terminals 6 and 7 allow manual adjustment of generator Gi voltage output by VOLT ADJUST rheostat RI 01 on cabinet B door, or by reactive load voltage adjust rheostat Ri 06 inside cabinet A. Ri01 is used when OPERATION SELECTOR SWITCH S3 is set to MANUAL. R106 is used when the switch is set to AUTO.

d. Voltage regulator terminals 1 and 2 are used when the generator set is in parallel operation. Paralleling current transformer CT114 senses the reactive current of generator Gi, line T2, in each set being paralleled. When an unbalance occurs in field excitation between paralleled set, circulating currents begin to flow between the generators. This current will appear as a LAG on the POWER FACTOR meter of the highly excited generator, and as a LEAD on the meter of the generator with the lower field current. This is known as the reactive circulating current; it is controlled by reactive droop compensation when sets are in FREQUENCY DROOP or ISOCHRONOUS mode in parallel operation.

512. VOLTAGE REGULATOR VR101 INSPECTION (3, Figure 5-9).

a. Inspect unit for cleanliness and apparent damage to exterior. Loosen two hexagon head screws and swing open cover.

b. Inspect interior for burned and scorched components. Check security of all wiring connections. Check for burned insulation.

c. Inspect three fuses VRl1 O Fll, VRl01 F12, and VR101 F13, located inside voltage regulator VR101, and spare fuses located on the inside of voltage regulator VR1 01 front cover, for signs of damage or deterioration. Remove and test each fuse using a multimeter set to the RX1 scale. Multimeter should indicate zero resistance. Replace a fuse which does not pass this test

5-13. VOLTAGE REGULATOR VR101 TEST (3, Figure 5-9).

a. On-Equipment Test.

(1) Operate the generator set in accordance with the Operator/Crew and Organizational Maintenance Manual (single unit operation) with a 750 kW load bank connected to the generator set output.

NOTE

Voltage values may be measured across terminals F+ and F- of voltage regulator VR1 01. Current (amperes) values may be measured by disconnecting terminal F+ of voltage regulator VR1 01 and installing a multimeter in series between the F+ terminal and lead.

NOTE

The values obtained in the following tests may vary due to environmental conditions such as temperature, humidity, etc.

(2) Using two multimeters, check for the following outputs at VR101 F+ and VR101 F- terminals at the loads and frequencies specified below.

(a) No load (60 Hz) - 25.1 V dc at 0.73 amperes.

(b) 1/4 load (60 Hz) - 27.3 V dc at 0.89 amperes.

(c) 1/2 load (60 Hz) - 36.5 V dc at 1.16 amperes.

(d) 314 load (60 Hz) - 44.2 V dc at 1.4 amperes.

(e) Full load (60 Hz) - 56.7 V dc at 1.79 amperes.

(f) No load (50 Hz) - 35 V dc at 1.08 amperes.

(g) 1/4 load (50 Hz) - 37 V dc at 1.2 amperes.

(h) 112 load (50 Hz) - 50 V dc at 1.55 amperes.

(i) 3/4 load (50 Hz) - 56 V dc at 1.84 amperes.

(j) Full load (50 Hz) - 70 V dc at 2.3 amperes.

b. Operational Test. This test is performed with voltage regulator VR1 01 removed from the generator set.

(1) Remove voltage regulator VR101(3, Figure 5-9) in accordance with paragraph 5-15.

(2) Connect the voltage regulator VRI01 as shown in Figure 5-11.

(3) Mark position of rheostat VR1OI R11 on etched circuit board (1, Figure 5-10).

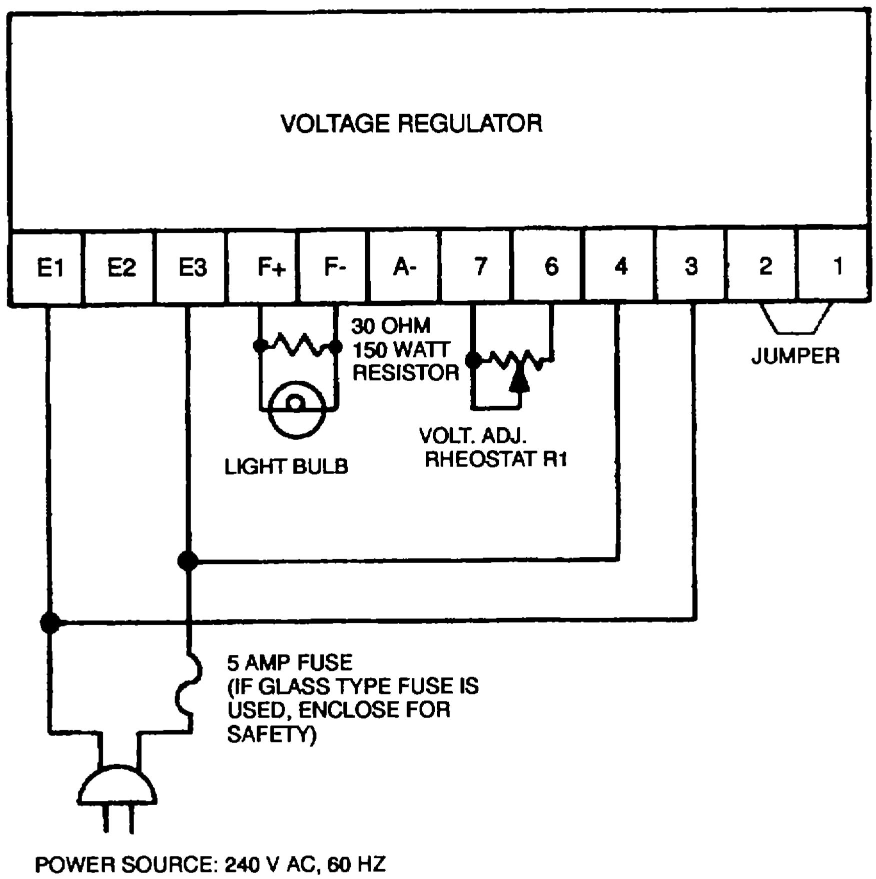


Figure 5-11. Voltage Regulator VR101, Test Setup

NOTE

R1 rheostat in test setup simulates VOLTS ADJUST rheostat R1 01 on cabinet B control panel. In the fully counter clockwise position, generator output voltage is at minimum. When R1 is clockwise (minimum resistance), generator is at maximum voltage.

(4) et rheostat VR1 01 R1 1, on etched circuit board (1, Figure 5-10) fully counter clockwise.

(5) Adjust R1 test rheostat for maximum resistance (fully counter clockwise).

(6) lowly rotate R1 clockwise. Before reaching minimum resistance, light should come on to near full brilliance. If light does not go on, adjust external voltage range rheostat VR101 R14.

NOTE

Normally, VR101 R14 is preset to provide RI with an adjustment span of il0 percent of rated range.

(7) When VR101 R14 and R1 are both correctly adjusted, a small change in R1 will turn the light bulb on and off. If slight remains "full on", or does not come on at all, the voltage regulator is defective.

NOTE

R11 stability adjustment affects speed at which light goes on and off. Normal setting, which assures good stability, is in the almost fully clockwise position. This setting tends to slow up generator response time, hence, rotating counterclockwise speeds up system response time. However, when set too far counterclockwise, the generator voltage tends to oscillate (hunt). Final setting of VR1O1 R1 should be well above the point where oscillation occurs in that system voltage stability is most critical in no load condition.

(8) Reset VRiO1 rc to its original position, as marked.
(9) Disconnect from test setup.
(10) Install voltage regulator VR101 in accordance with paragraph 5-15.

5-14. VOLTAGE REGULATOR VR101 ADJUSTMENT (3, Figure 5-9).

a. Voltage RANGE ADJUST rheostat VR101 R14. VR101 Ri4 is located on the etched circuit board (1, Figure 5-10) inside voltage regulator VR1 01. It provides a means of varying the limits of the VOLTS ADJUST rheostat R1 01 on Cabinet B door which optimally is set at midrange and VR101 R14 adjustment used for obtaining rated generator voltage. This gives VOLTS ADJUST rheostat Ri01 a balanced external voltage adjustment range of ±500 V.

b. Stability Adjustment Rheostat VRl01 R11.

(1) Start the generator set and operate at 60 Hz and no load.
(2) Set VOLTS ADJUST rheostat RI 01 on cabinet B control panel to the midrange of its adjustment.
(3) Adjust voltage RANGE ADJUST rheostat VR1 01 RI 4, located on the etched circuit board of the voltage regulator VR101, to obtain a reading of 4160 V on the AC KILOVOLTS meter Mil01.
(4) Rotate rheostat VR101 Rh1, located on the etched circuit board of the voltage regulator VR1I01 clockwise while monitoring AC KILOVOLTS meter Ml 01.
(5) When AC KILOVOLTS meter Ml01 indicator begins to oscillate, rotate rheostat VR1 01 R1 1 counter-clockwise until the oscillation ceases.
(6) Vary the position of VOLTS ADJUST rheostat R1 01 from fully clockwise to fully counter-clockwise and monitor AC KILOVOLTS meter M101. Clockwise rotation should increase voltage and counterclockwise rotation should decrease voltage. Variation in voltage through the full range of VOLTS ADJUST rheostat Ri01 should be ±l0 percent of voltage obtained in step (3), above.
(7) Operate the generator set at full load and monitor AC KILOVOLTS meter Ml 01.
(8) Voltage readings noted in steps (3) and (7), above, during no load and full load operation respectively should not vary by more than ±i percent.

NOTE

Voltage stability is most critical at no load condition. Ensure that final adjustment satisfies this condition.

5-15. VOLTAGE REGULATOR VR101 REPLACEMENT. Voltage regulator VR101 (3, Figure 5-9) is located inside the top section of Cabinet B.

a. Remove. See Figure 5-9.
   (1) Loosen two hexagon head screws and swing open cover.
   (2) Tag and disconnect all electrical wiring.
   (3) Remove hexagon head screws (1) and lockwashers (2) and lift out voltage regulator VR101 (3).

b. Install. See Figure 5-9.
   (1) Position voltage regulator VR101 (3) in the top section of cabinet B and secure with hexagon head screws (1) and lockwashers (2).
   (2) Make all wiring connections as tagged. Ensure ground strap is securely fastened.
   (3) Close cover and secure with two hexagon head screws.

5-16. VOLTAGE REGULATOR VR101 REPAIR. Repair of voltage regulator VR101 is limited to replacement of those components identified in Figure 5-10. The unit must be returned to the manufacturer for additional repair or overhaul.

a. Remove.
   (1) Tag leads prior to disconnecting them. Note polarity and orientation of components when tagging.
   (2) Exercise care not to apply excessive heat when unsoldering components. Use heat sinks whenever unsoldering solid-state components.

b. Install.
   (1) Position replacement components in accordance with tags and Figure 5-10.
   (2) Solder components into place. Check solder joints after they have cooled to ensure proper connection.
   (3) Double-check wire tags and then discard them.

SECTION IV. LOAD CIRCUIT BREAKER CB101

5-17. GENERAL. Interruption in the load circuit breaker CB1 01 is performed by the vacuum interrupter module assemblies (Figure 5-13) which are mounted vertically within the breaker frame. The vacuum interrupter module assemblies consist of a pair of butt contacts, one moveable and one fixed, which are hermetically sealed in a high vacuum. The vacuum interrupter module assemblies require only a short contact gap for circuit interruption. The resulting high operating speed allows the entire operating sequence, from fault to clear, to be consistently performed in three cycles or less. The possibility of restriking is minimized because the dielectric strength of the vacuum gap recovers more rapidly than the rate of rise of the applied voltage. The primary connections to the switchgear are made through six primary disconnects (Figure 5-13) mounted horizontally at the rear of the breaker. The operating mechanism contains all necessary controls and interlocks. It is mounted at the front of the breaker so that it can be easily accessed for inspection and servicing. Opening and closing can be performed electrically or manually. A schematic diagram of the control circuitry is presented in Figure 5-14.
The following subparagraphs describe the operation of the various components of the control circuitry.

a. Auxiliary Switch. The auxiliary switch (Figure 5-15) is a multi-stage switch used to operate those circuits which are dependent upon either the position of the breaker contacts or the position of the drive springs. The schematic diagram (Figure 5-14) indicates how each of the auxiliary switch stages are interconnected with breaker circuitry.
The function of each stage is discussed below:
   (1) The a-type auxiliary contacts are connected in series with trip solenoid TC (Figure 5-16). Since these stages are open when the breaker is in the open position, the auxiliary contacts prevent the trip solenoid from being energized when the breaker is in the open position.
   (2) The b-contact, connected in series with the closing solenoid (Figure 5-16), disables the closing solenoid when the breaker contacts are in the closed position.

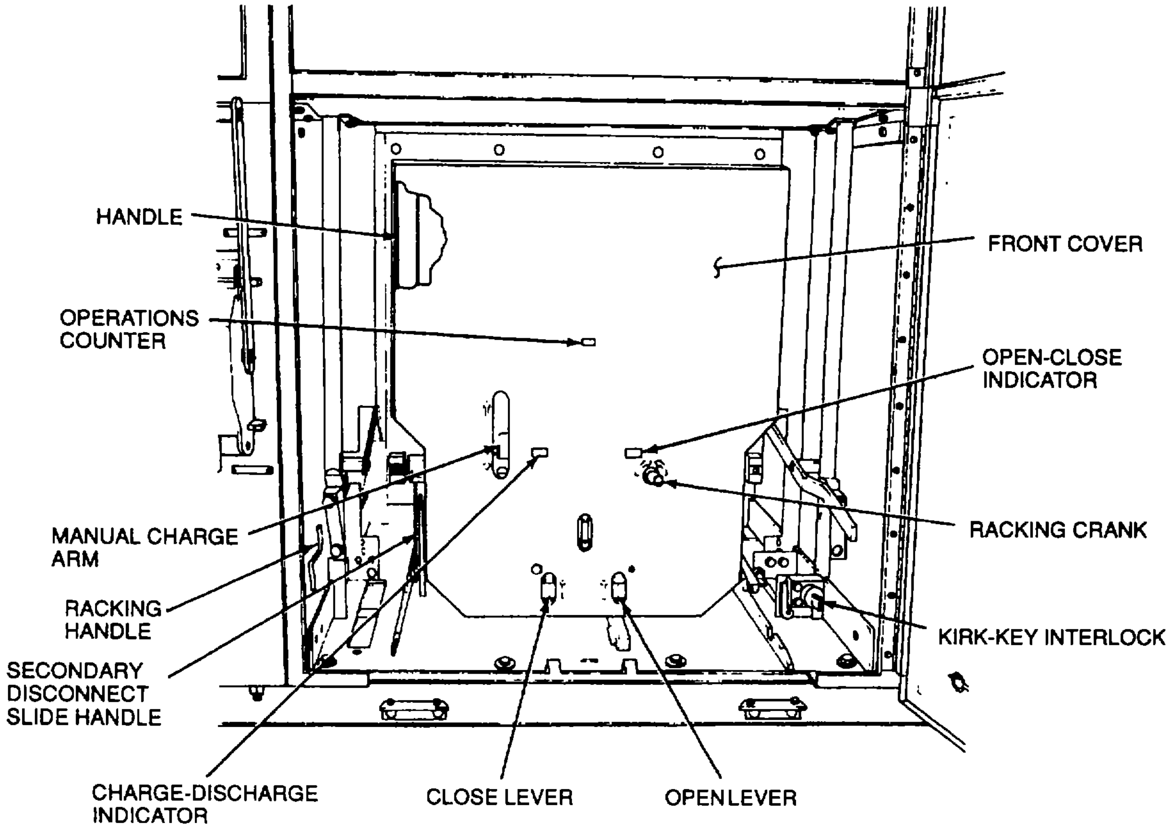


Figure 5-12. Load Circuit Breaker CB101, Front View, Installed

b. Charging Motor Limit Switch. Charging motor limit switch LS (Figure 5-16) energizes the motor relay MR (Figure 5-15) when a drive spring charging operation is required and deenergizes the motor relay when the drive springs (Figure 5-15) reach the fully charged position. As shown in the schematic diagram (Figure 5-14), charging motor limit switch LS is connected in the normally open position. Whenever the drive springs are not in the fully charged position, the charging motor limit switch cam (Figure 5-16) actuates the charging motor limit switch. The cam allows the switch to assume its normally open position once the drive springs are fully charged.

c. Motor Relay. When energized by the closing of motor limit switch LS (Figure 5-14), motor relay MR energizes the spring charging operation limit motor M through a pair of normally open contacts and disables the closing solenoid X through a pair of normally closed contacts.

d. Anti-Pump Relay. Anti-pump relay Y (Figure 5-14) ensures that, should the control switch CS (which energizes the closing solenoid) be continuously maintained in the closed position, the springs will not be continuously charged and discharged. Anti-pump relay Y performs this function by allowing the closing solenoid to be energized only if the control switch CS (Figure 5-14) is closed after the drive springs have reached the fully charged position, and motor relay MR has been deenergized. The anti-pump relay Y will be energized if control switch CS is closed and motor relay MR is energized. If the control switch is held continuously, the anti-pump relay will be latched in the energized position after the motor relay is deenergized by a pair of its own normally open contacts. When the anti-pump relay Y is energized, a pair of its normally closed contacts, in series with the closing solenoid, ensures that the closing solenoid cannot be energized by the control switch. The closing solenoid cannot be energized unless the control switch is first opened (deenergizing the anti-pump relay), then closed again.

e. Indicators. Two indicators are provided on the operating mechanism. The OPEN-CLOSE indicator (Figure 5-12) designates the position of the vacuum interrupter contacts. The CHARGE-DISCHARGE indicator displays the state (charged or discharged) of the drive springs.

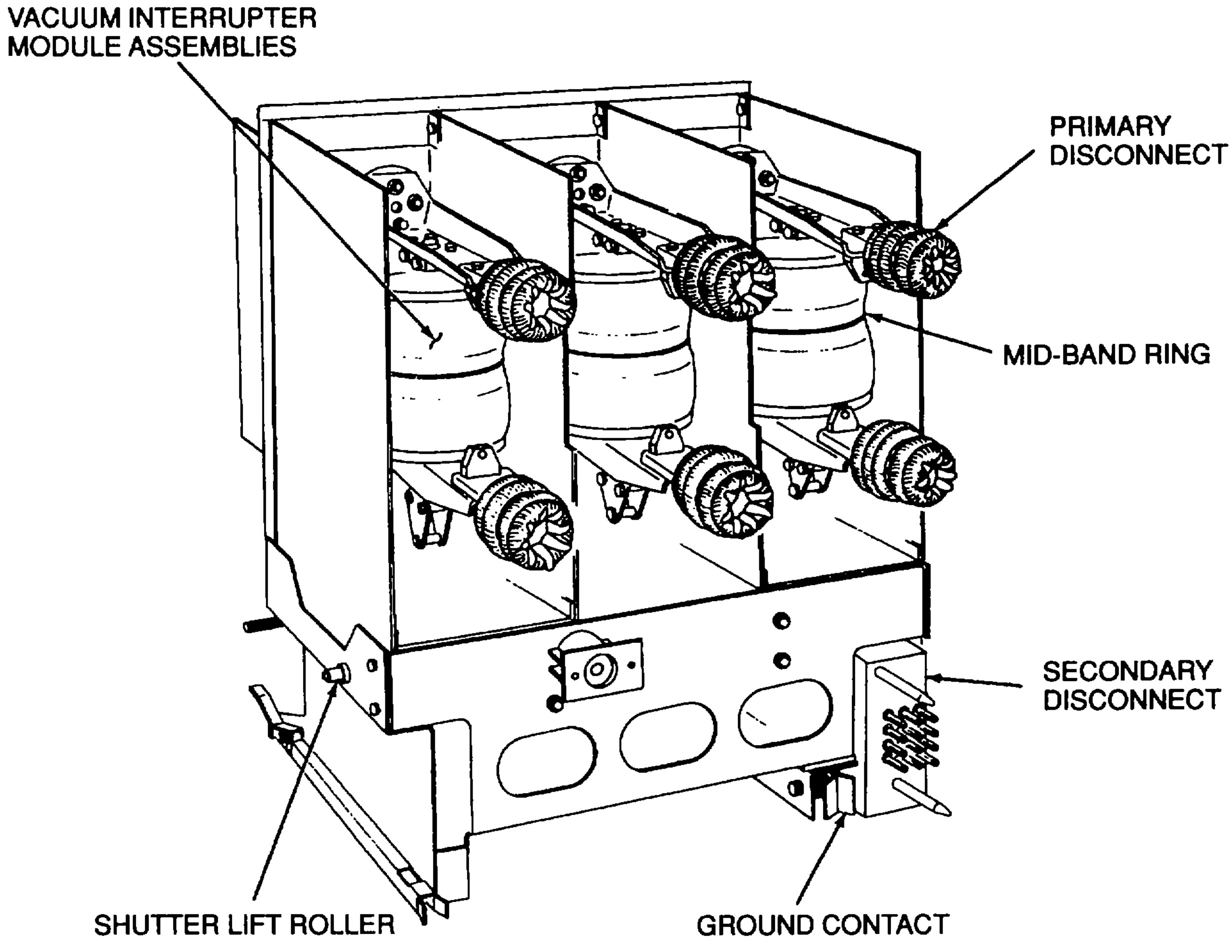
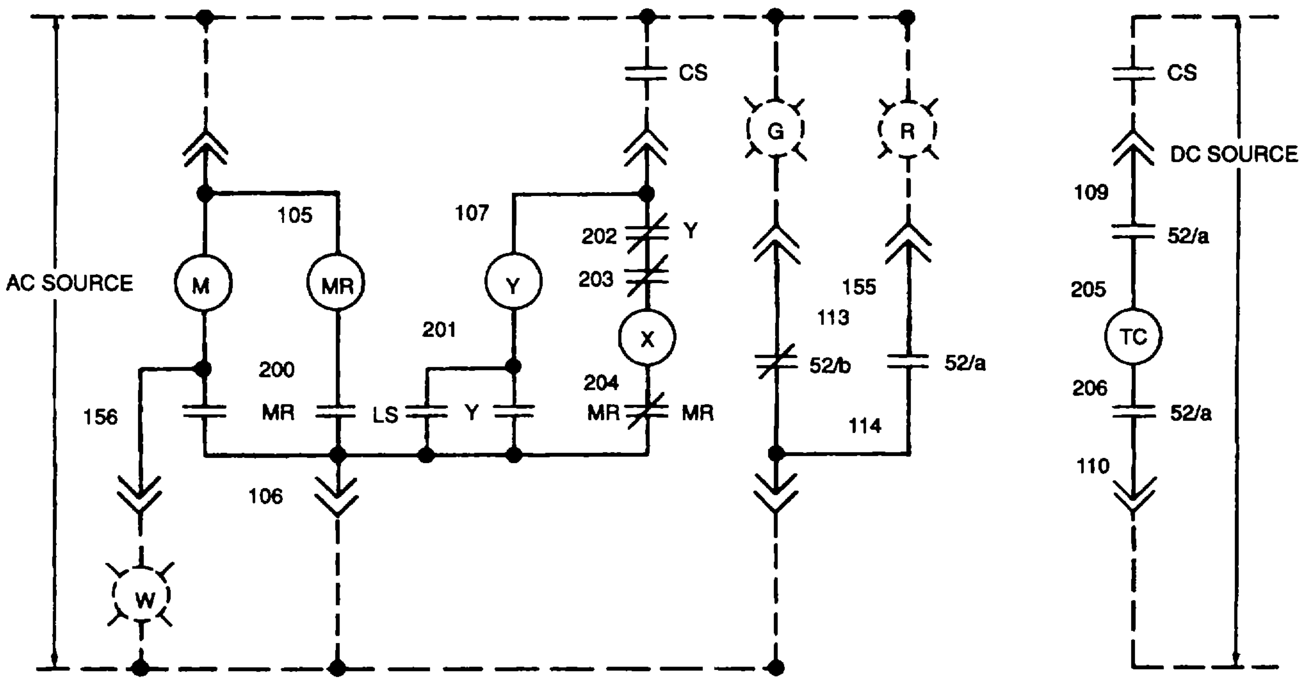


Figure 5-13. Load Circuit Breaker CB101, Rear View

f. Manual Charge Arm Assembly. The drive springs (Figure 5-15) can be manually charged by using the handle end of the racking crank (located on the lower inside door of Cabinet B) to move the manual charge arm (Figure 5-12) up and down until the drive springs are fully charged. The drive springs are fully charged when the CHARGE-DISCHARGE indicator reads charged and the manual charge arm can no longer be raised.

g. Secondary Disconnect Slide Handle. The secondary disconnect slide handle (Figure 5-12) Is used to engage and disengage the secondary disconnect slide (193, Figure 5-19) when performing secondary control power testing of load circuit breaker CBI 01. This is accomplished only after load circuit breaker CB1 01 has been partially withdrawn from its cubicle in lower cabinet B, the primary disconnects are disengaged, and the circuit breaker is In a safe condition with no high voltage current present. To operate the secondary disconnect slide handle, lift the handle to a horizontal position. Continue lifting the handle until it clears the catch and then push the handle into the circuit breaker just until the roll pin in the catch engages and locks the handle in position.

h. Operating Mechanism. The following is a description of the operation of the operating mechanism. This manual will refer to the operating mechanism as the front of the breaker. The terms left and right will be used as if facing the operating mechanism. The terms clockwise and counterclockwise will be used as if facing the left side of the breaker.

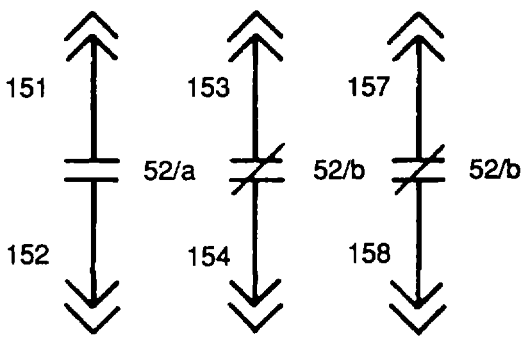


NOTES

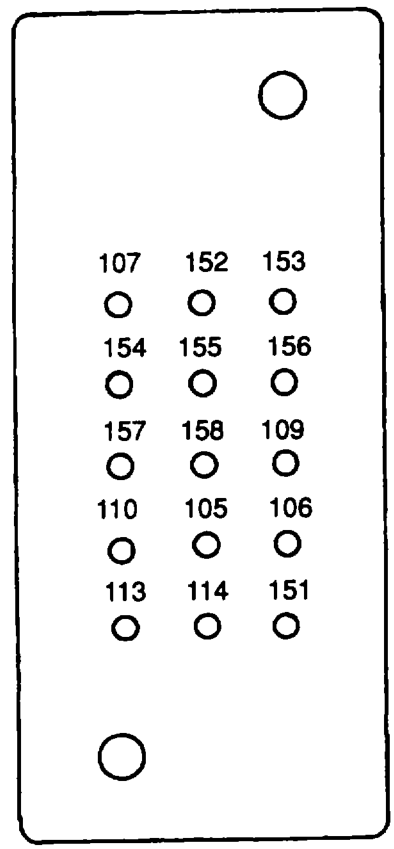
1. 52/b OPEN WHEN BREAKER IS CLOSED
2. 52/a OPEN WHEN BREAKER IS OPEN

Figure 5-14. Load Circuit Breaker CB101, Rear View (Sheet 1 of 2)

(1) Drive Spring Charging. Assume that the interrupter contacts are in the open position and that the drive springs (Figure 5-15) and the return springs (Figure 5-16) are discharged. When power is supplied to the breaker control circuitry, the spring charging motor (Figure 5-15) is energized. The motor eccentric (Figure 5-17), mounted on the charging motor shaft, drives the ratchet arm assembly backward and forward. With each forward stroke of the ratchet arm, the spring loaded drive on the gear advances the gear a few degrees counterclockwise. The holding pawl holds the gear in position while the drive pawl makes its reverse stroke to engage another tooth. The gear is free to rotate on the gear shaft. As the gear is advanced, the drive block, mounted on the outside face of the gear, engages the gear on the drive hub and rotates the drive hub. A roll pin connects the drive hub to the gear shaft and drive lever (Figure 5-15). The gear shaft and drive lever thus rotate with the drive hub. As the drive lever rotates, the lifting roller on the drive roller contacts the lift arm on the drive shaft (Figure 5-17) and pushes the lift arm up, rotating the drive shaft counterclockwise. The counterclockwise drive shaft rotation compresses the drive springs until the spring load against the drive lever passes top dead center and attempts to discharge. At this point, the drive lever rotates a few degrees until the trip closing roller (Figure 5-15) on the drive lever can rotate no farther and the drive springs are held on this charged position until a closing operation is initiated. When the drive springs reach the fully charged position, the charging motor limit switch cam (Figure 5-16) allows the charging motor limit switch to open, deenergizing the charging motor. Simultaneously, the pawl lift slide (Figure 5-17) is pushed forward by the cam lobe on the drive hub so that the drive pawl rides on the pawl lift slide and does not engage the gear. This arrangement allows the charging motor and ratchet assembly to coast smoothly to a stop.



AUXILIARY CONTACTS



SECONDARY DISCONNECT WIRING

CIRCUIT BREAKER SIDE
(CONNECTION VIEW)

SCHEMATIC DIAGRAM

CONTROL SCHEMATIC
CIRCUIT BREAKER, AC CLOSE, DC TRIP

LEGEND

SM	SPRING CHARGING MOTOR
52	VACUUM CIRCUIT BREAKER
LS	SPRING CHARGING MOTOR LIMIT SWITCH
TC	TRIP COIL (OPENING COIL)
X	SPRING RELEASE COIL (CLOSING COIL)
Y	ANTI-PUMP RELAY
MR	MOTOR RELAY
G	GREEN INDICATING LIGHT
R	RED INDICATING LIGHT
CS	CONTROL SWITCH
—≪	INDICATES SECONDARY DISCONNECT POINT
W	WHITE INDICATING LIGHT

Figure 5-14. Load Circuit Breaker CB101, Schematic (Sheet 2 of 2)

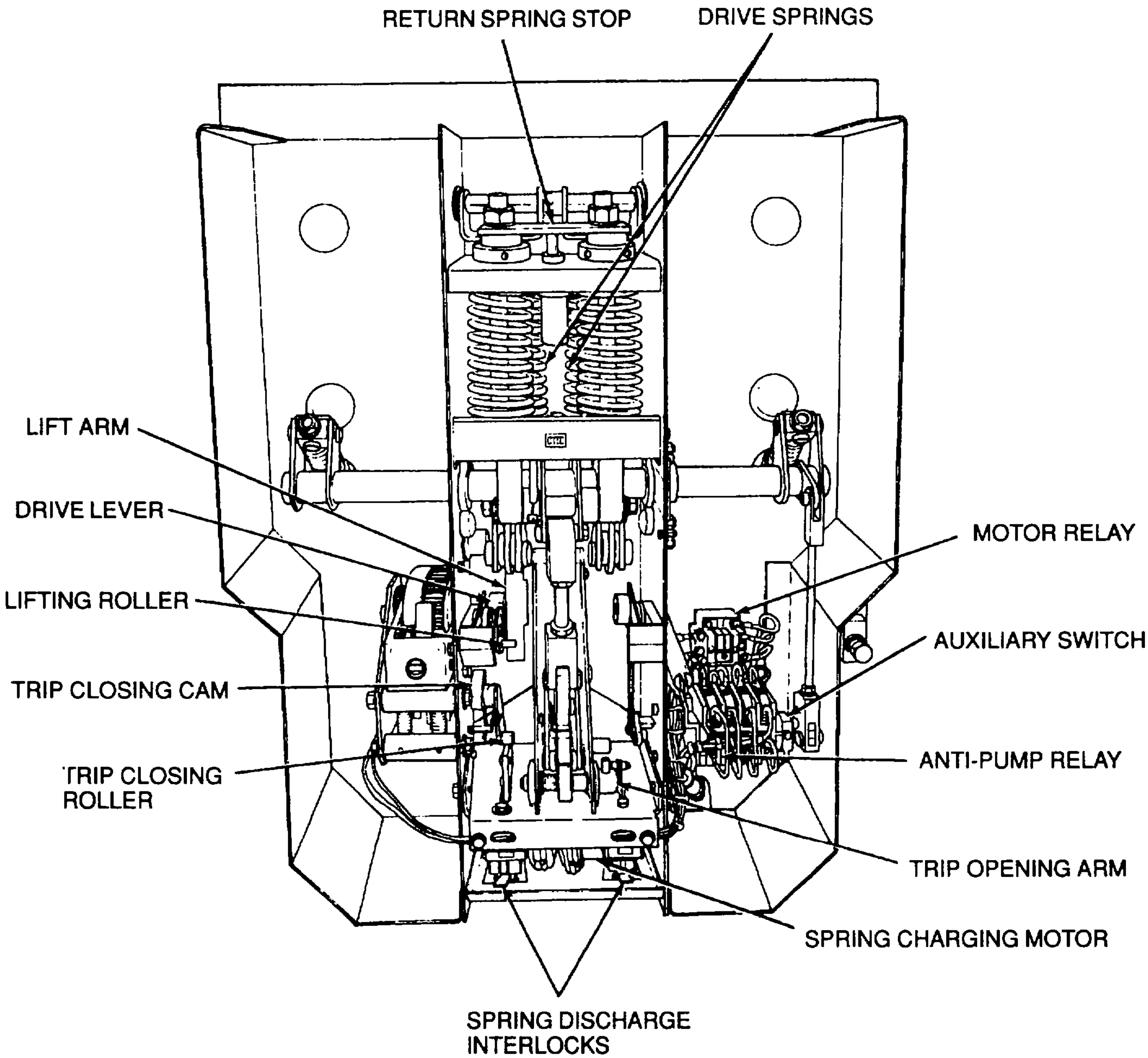


Figure 5-15. Load Circuit Breaker CB101, Front Right Side Interior View

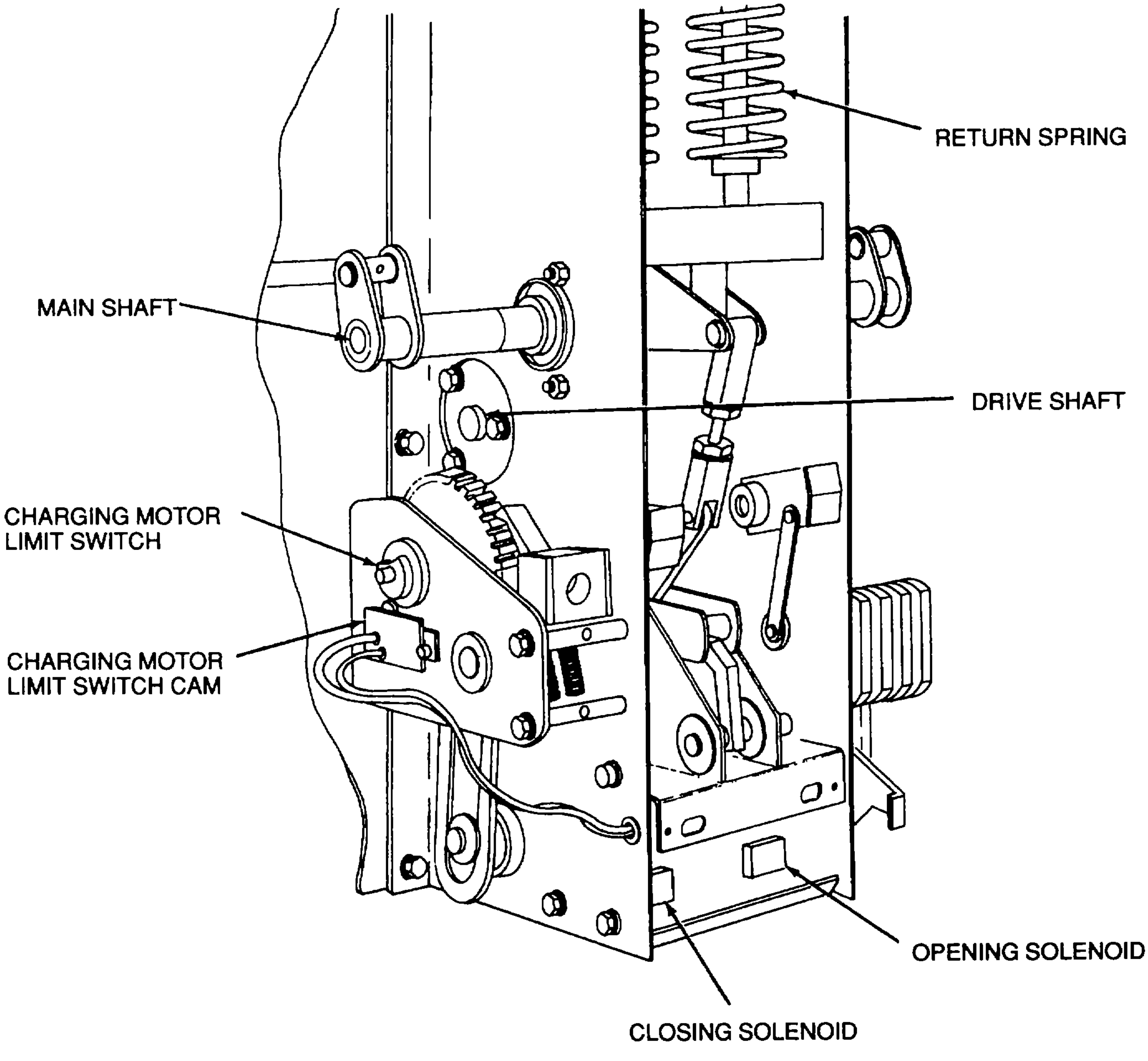


Figure 5-16. Load Circuit Breaker CB101, Front Left Side Interior View

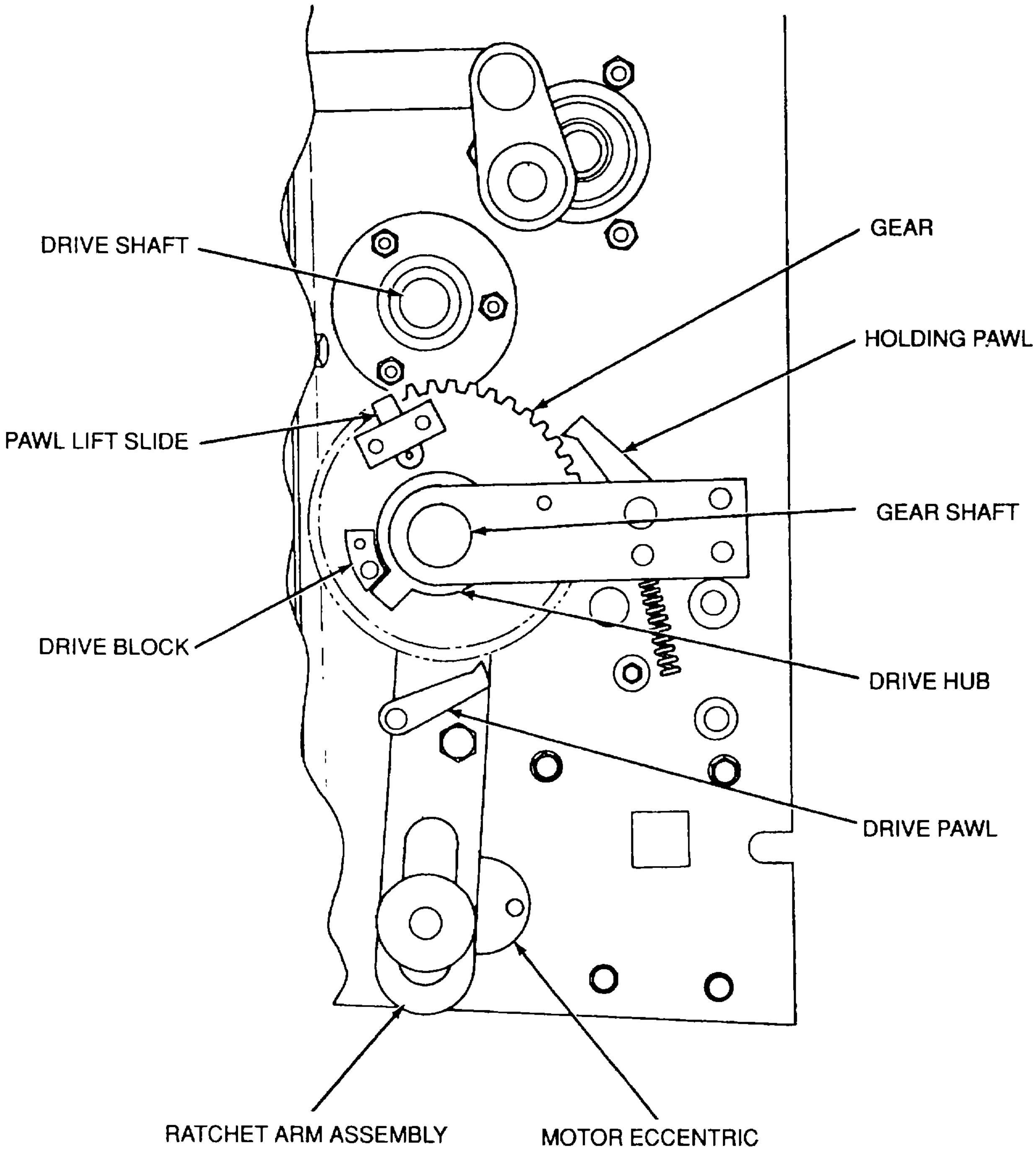


Figure 5-17. Load Circuit Breaker CB101, Detail of Drive Spring Charging Mechanism

(2) Closing Operation. Once the drive springs (Figure 5-15) have been charged, the breaker can be dosed by lifting the dose lever (Figure 5-12) or by energizing the dosing solenoid (Figure 5-16). Either method disengages the trip dosing roller and allows the drive springs to discharge. The discharging drive springs rotate the drive shaft (Figure 5-17) clockwise. The clockwise rotation of the drive shaft gives the drive spring bearing (Figure 5-18) a downward motion. The drive spring bearing engages the toggle cam, thus rotating the front of the toggle cam up and the rear of the toggle cam down the catch. The front of the toggle cam is connected to the main shaft (Figure 5-16) by the drive linkage (Figure 5-18). The upward motion of the front of the toggle cam thus rotates the main shaft counterclockwise and compresses the return springs (Figure 5-16). The drive connecting links (Figure 5-15) transform the rotary motion of the main shaft into a linear motion which doses the vacuum interrupter contacts. The trip opening cam (Figure 5-18) forces the entire toggle assembly to remain latched in this position. When the drive springs discharge, rotating the drive shaft in a counter-clockwise direction, the descending lift arm rotates the drive lever such that the drive lever completes the remaining 360 degrees of rotation to its initial position where it can once again perform a drive spring charging operation. The gear shaft and drive hub rotate with the drive lever. The drive hub rotates out of contact with the drive block since the gear (Figure 5-17) rotates freely on the gear shaft, the gear remains stationary. The rotation of the drive hub is such that the pawl lift slide follows the cammed surface of the drive hub until the pawl lift slide moves back below the gear teeth, permitting the drive pawi to engage the gear. The charging motor limit switch cam (Figure 5-16) rotates with the gear shaft and doses the charging motor limit switch, energizing the charging motor which once again charges the drive springs.

(3) Opening Operation. With the return springs (Figure 5-16) charged, the operating mechanism is now ready to perform an opening operation. If the open lever (Figure 5-12) is lifted or if the opening solenoid (Figure 5-16) is energized, the trip opening cam (Figure 5-18) will be rotated clockwise out from under the toggle bearing. The force of the charged return springs pushing down on the front of the toggle cam will cause the rear of the toggle subassembly to rotate clockwise. When the rear of the toggle cam dears the catch, the return springs will completely discharge, rotating the main shaft (Figure 5-16) and the toggle cam clockwise. The clockwise rotation of the main shaft is transformed to a linear motion by the drive connecting links (Figure 5-15). The drive connecting links are connected to the vacuum interrupters (Figure 5-13), and their motion opens the vacuum interrupter contacts.

(4) Spring Discharge Interlocks. The spring discharge interlocks (Figure 5-15) are located directly below the opening and dosing solenoids (Figure 5-16). Three cams, located on the floor of the skeleton cell, engage the spring discharge interlocks in such a manner that the primary disconnects (Figure 5-13) cannot be engaged or disengaged with the interrupter contacts in the closed position and all springs are automatcally discharged whenever the load circuit breaker is inserted into or removed from its cell.

WARNING

Discharge to ground the primary disconnects and vacuum Interrupter mid-band rings before handling to prevent Injury to personnel as a result of electrocution.

WARNING

To avoid Injury to personnel, always remove the load circuit breaker CB101 from Its cubide and discharge or block the return drive springs.

WARNING

To avoid Injury to personnel, no electrical component will be worked on while energized. Ensure equipment Is "tagged out" In accordance with Chapter 1, Section III, of the Operator and Organizational Maintenance Manual and equipment Is NOT energized. Residual voltage Is present at the generator leads with the regulator turned off, reaching SEVERAL HUNDRED VOLTS on the generator set. Proper Insulation and Isolation of metering equipment must be observed when testing this generator. USE PROPER TEST EQUIPMENT TO CHECK FOR VOLTAGE before proceeding with work.

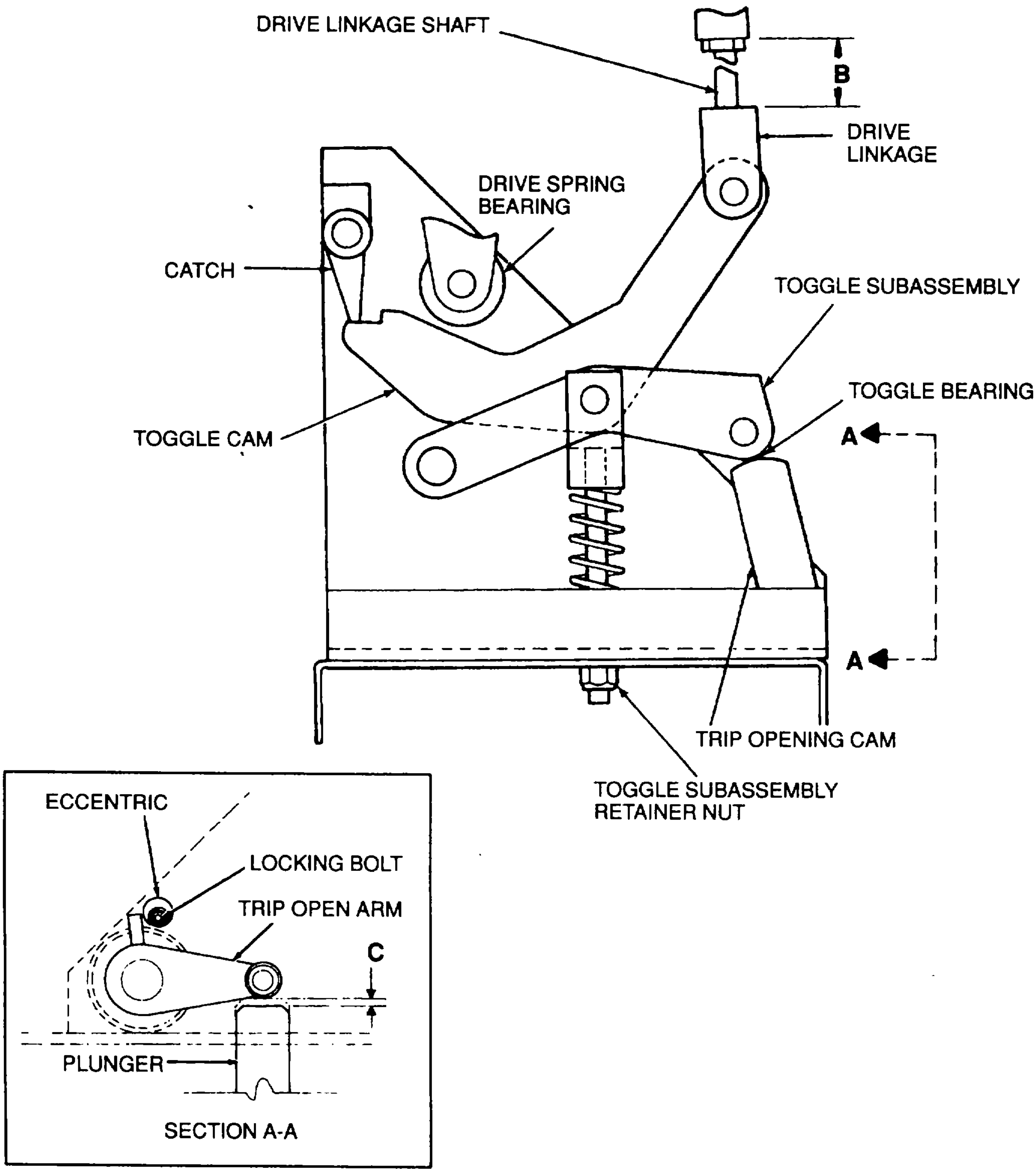


Figure 5-18. Load Circuit Breaker CB101, Adjustment

5-18. LOAD CIRCUIT BREAKER CB101 INSPECTION. Ensure that the generator set is shut down and fully deenergized, load cables are in the park position and surge protectors are grounded. Remove load circuit breaker CB101 in accordance with paragraph 2-17. Inspect entire load circuit breaker and operating mechanism for loose hardware and worn or broken parts. All wiring should be checked for loose connections and damaged insulation. Inspect all bearings and contact surfaces for damage or excessive wear. Check the adjustments in accordance with paragraph 5-21.

NOTE

It is important to measure and record the spring overtravel of a vacuum interrupter when it is first put into service to ensure reliable service.

To ensure reliable interruption, perform a contact erosion inspection. Any contact erosion will result in a reduction in spring overtravel. Contact erosion can be determined by dosing the breaker and measuring the spring overtravel. The difference between this measurement and the original spring overtravel measurement at the time the vacuum interrupter was put into service represents contact erosion. When the spring overtravel has been reduced to 0.30 inch (7.62 mm), the primary contacts have eroded 1/8 inch (3.2 mm) and the vacuum interrupter must be replaced. Refer to paragraph 5-22, step b, for the procedure to determine spring overtravel.

WARNING

All personnel must stay at least 6 feet (18 mm) away from vacuum Interrupters under test to avoid Injury In case of explosion.

WARNING

Discharge to ground the primary disconnects and vacuum Interrupter mid-band rings before handling to prevent Injury to personnel as a result of electrocution.

WARNING

I To avoid injury to personnel, always remove the load circuit breaker CB1O1 from Its cubide and discharge or block the return and drive springs.

5-19. LOAD CIRCUIT BREAKER CB1O1 TEST. Remove load circuit breaker CB101 in accordance with paragraph 2-17. Perform a hipot test on each vacuum interrupter while the breaker is in the OPEN position. Gradually raise the voltage to 19 kV. The contact gap of the vacuum interrupter should sustain this potential for 1 minute. If any vacuum interrupter fails, it must be replaced. Observe the following instructions when performing the hipot test

a. Do not exceed the voltage specified above.

b. Do not test vacuum interrupters with open gaps less than 112 inch (1.3 mm).

c. Discharge to ground the primary disconnects (Figure 5-13) and vacuum interrupter mid-band ring (Figure 5-13) before handling. These areas can retain a static charge after a hipot test.

WARNING

To avoid Injury to personnel, always remove the load circuit breaker from Its cubide and discharge or block the return and drive springs.

WARNING

Discharge to ground the primary disconnects and vacuum Interrupter mid-band rings before handling to prevent Injury to personnel as a result of electrocution.

5-20. LOAD CIRCUIT BREAKER CB1D1 SERVICE. Ensure that the generator set is shutdown and the unit fully deenergized, load cables are in the park position and surge protectors are grounded. Remove load circuit breaker CB101 in accordance with paragraph 2-17. Use a dean dry both to remove dirt and moisture that may have collected on the vacuum interrupters and all insulating parts. Ensure that all electrical connections are tight and dean. Lubricate the load circuit breaker in accordance with Table 5-1. It should be noted that all bearings used in load circuit breaker are sealed and do not require lubrication. Table 5-1 provides the location of all lubrication points, the type of lubrication required, and the two methods of lubrication. Method I is the periodic lubrication required after 2000 operations (Figure 5-12) or 1 year. Method 11 is the lubrication procedure to be used whenever the load circuit breaker is disassembled for repair. Severe operating conditions, such as use in extremely hot, cold, or dusty environments, may warrant more frequent lubrication intervals. Load circuit breaker CB101 must be manually operated several times after lubrication and observed for proper operation. Manually operate the load circuit breaker as follows: a. Move the manual charge arm assembly (Figure 5-12) up and down using the handle end of the racking crank until the drive springs are fully charged.

b. The drive springs are fully charged when the CHARGE-DISCHARGE indicator reads CHARGED, and the manual charge arm assembly can no longer be raised.

WARNING

To avoid Injury to personnel, always remove the load circuit breaker from Its cubide and discharge or block the return and drive springs.

WARNING

Discharge to ground the primary disconnects and vacuum Interrupter mid-band rings before handing to prevent Injury to personnel as a result of electrocution.

5-21. LOAD CIRCUIT BREAKER CB101 ADJUSTMENT. During periodic inspections and when the load circuit breaker is replaced or repaired, the following adjustments must be checked. To perform these adjustments, first remove the breaker from its cubide in accordance with paragraph 2-17, then remove the front cover (1, Figure 5-19) by removing bolts (2), and lockwashers (3) and washers (4).

WARNING

Whenever an adjustment is to be checked or performed with the drive springs In the charged position, It Is mandatory to block the drive springs by placing the blocking pins In the holes at the upper end of the drive spring center shafts (the blocking pins are located In the tool box).

a. Trip Open Eccentric Adjustment. With the breaker in the OPEN position and the drive springs charged, the vertical free movement in the opening solenoid plunger (C, Figure 5-18) should be 1/8 ±1/16 inch (3.2 ±1.6 mm). Loosen the locking bolt and rotate the eccentric to move the trip open arm until the correct distance is obtained.

b. Toggle Bearing Clearance Adjustment With the breaker in the OPEN position and the drive springs charged, the clearance between the toggle bearing (Figure 5-18) and the trip opening cam should be 1/32 +1/32-0 inch (0.8 +0.8/-0 mm). If adjustment is necessary, the toggle subassembly retainer nut should be adjusted clockwise to increase clearance; counter-clockwise to decrease clearance.

c. Charging Motor Limit Switch Adjustment. The charging motor limit switch is actuated by the charging motor limit switch cam (Figure 5-16). The charging motor limit switch serves to energize the charging motor (Figure 5-15) during a drive spring charging operation and deenergize the charging motor when the drive springs reach the fully charged position. The charging motor limit switch is properly adjusted it its contacts are open when the drive springs are in the fully charged position and closed when the drive springs are discharged. The position of the charging motor limit switch contacts can be determined by using an ohmmeter to test for continuity. If adjustment is necessary, loosen the two screws (136, Figure 5-19) which hold the charging motor limit switch in place and move the switch up or down as required. Tighten the two screws (136) after completing the adjustment.

Table 5-1. Load Circuit Breaker CB101 Lubrication Chart

LUBRICATION POINT	METHOD I	METHOD 11
Ground surfaces, such as gear teeth, rollers, and pawls	Wipe dean and apply lubricant MILG18709	Disassemble, wipe dean, and apply lubricant MILG18709
Contact surfaces on lift arm (Figure 515), toggle cam (Figure 518), re turn spring connecting block (Figure 522), and catch (Figure 518)	Wipe dean and apply lubricant MILG18709	Disassemble, wipe dean, and apply lubricant MILG18709
Gear shaft and drive shaft (Figure 517)	No lubrication required lubricant MILG1 8709	Disassemble, wipe dean, and apply
Ratchet arm (Figure 517)	No lubrication required	Disassemble, wipe dean, and apply lubricant MILG1 8709 to all bronze bushings and all contact surfaces
Contact and pivot points of all linkages	Wipe dean and apply lubricant MIL18709	Disassemble, wipe dean, and apply lubricant MILG18709
Drive spring assembly lubricant MILG1 8709 to center shaft	No lubrication required	Disassemble, wipe dean, and apply
Motor eccentric (Figure 517) and eccentric roller	Wipe dean and apply lubricant MILG18709 to slot in ratchet arm	Disassemble, wipe dean, and apply lubricant MILG18709
All shafts, sleeves, and bushings	No lubrication required	Disassemble, wipe dean, and apply lubricant MILG18709
Silver plated primary disconnect (Fig ure 513) contacts and grounding contact	Wipe dean and apply conduc tive contact lubricant	Wipe dean and apply a conductive contact lubricant
Jacking screw MILG1 8709	Wipe dean and apply lubricant lubricant MILG1 8709	Disassemble, wipe dean, and apply

d. Return Spring Assembly. The return spring assembly (67, Figure 5-19) is equipped with a hydraulic shock absorber to dampen the action of the return springs. The shock absorber must be adjusted if the return spring assembly has been disassembled for any reason. To adjust the shock absorber, loosen the setscrews located in the knurled adjustment knob and rotate the knob so that the indicator arrow on the knob points to the number 3 printed on the cylinder surrounding the shock absorber shaft. Lock the knurled adjusting knob in place after adjusting by tightening the setscrews in the knob.

WARNING

To avoid Injury to personnel, no electrical component will be worked on while energized. Ensure equipment Is 'tlgged out" In accordance with Chapter 1, Section 1II, of the Operator and Organizational Maintenance Manual and equipment Is NOT energized. Residual voltage Is present at the generator leads with the regulator turned off, reaching SEVERAL HUNDRED VOLTS on the generator set. Proper Insulation and Isolation of metering equipment must be observed when testing this generator. USE PROPER TEST EQUIPMENT TO CHECK FOR VOLTAGE before proceeding with work,

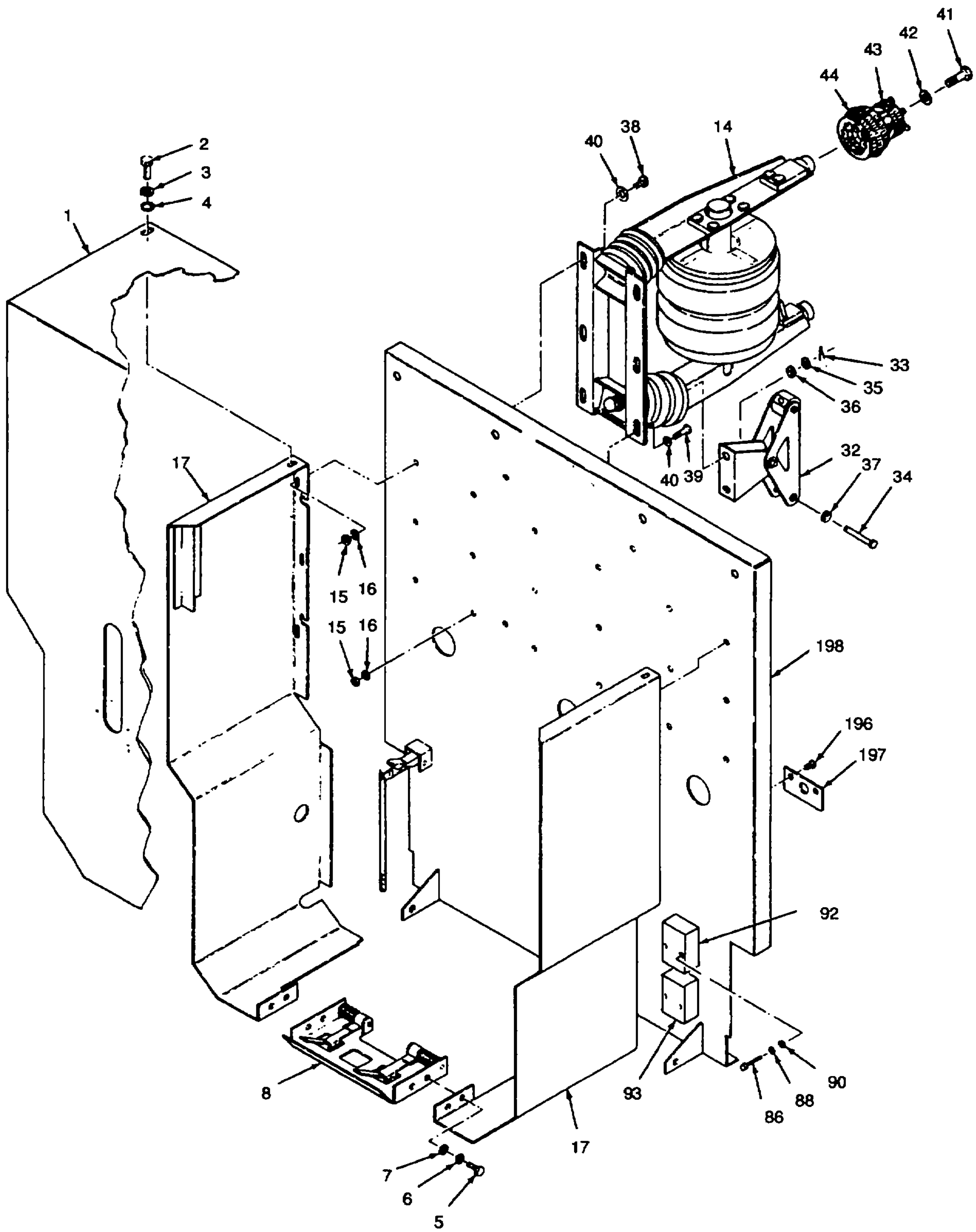


Figure i19. Load Circuit Breaker CB101, Exploded View (Sheet 1 of 6)

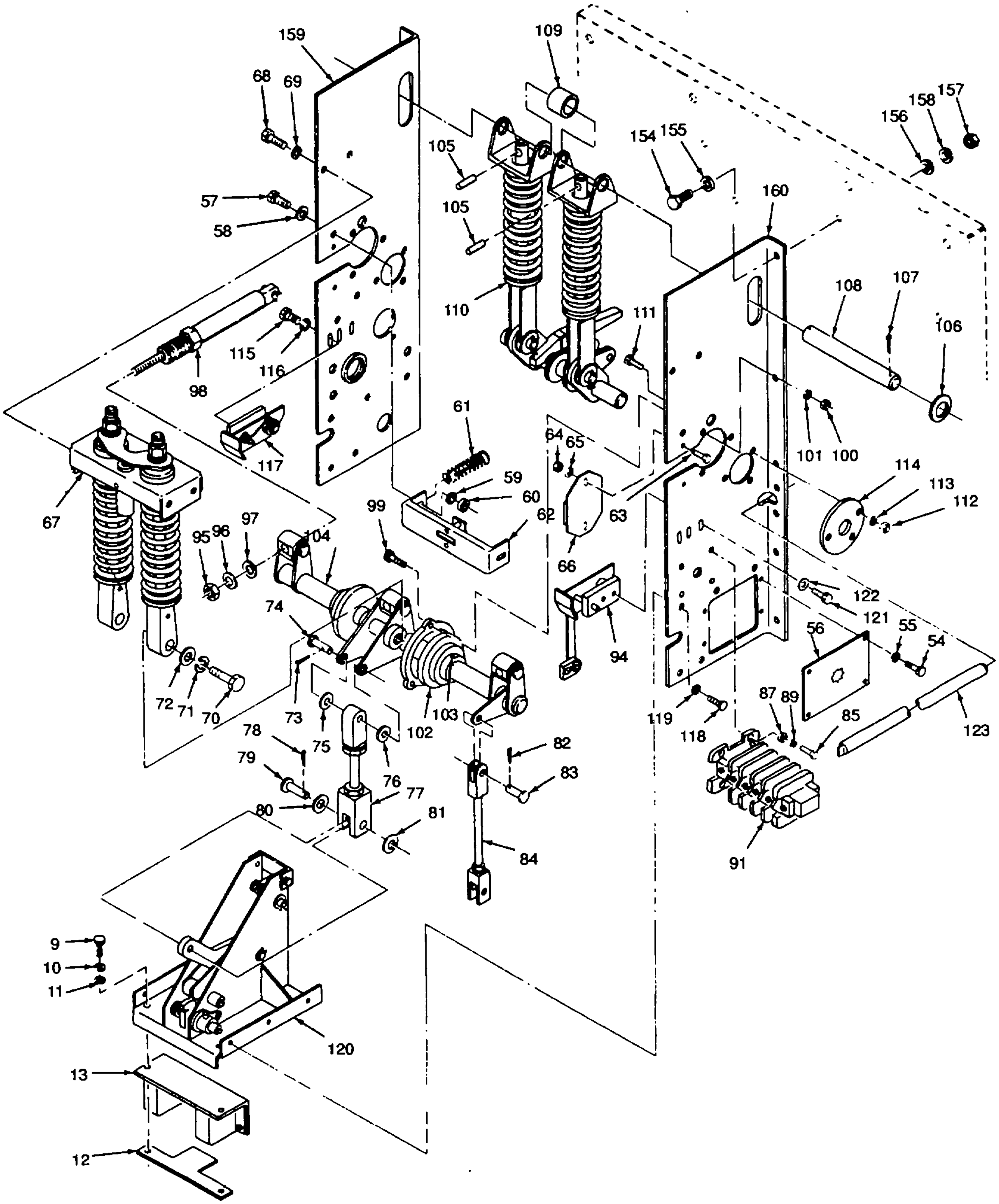


Figure 5-19. Load Circuit Breaker CB101, Exploded View (Sheet 2 of 6)

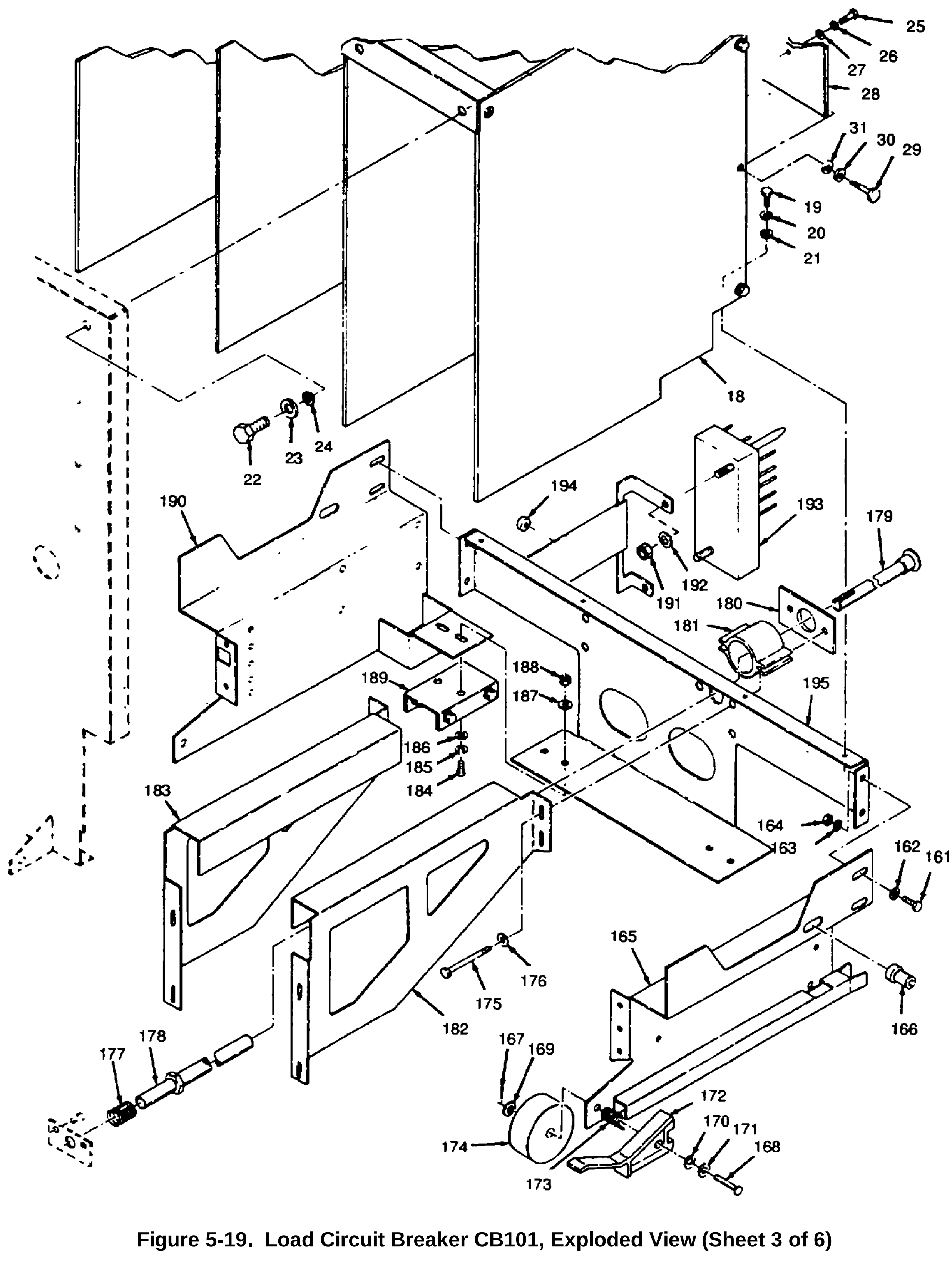


Figure 5-19. Load Circuit Breaker CB101, Exploded View (Sheet 3 of 6)

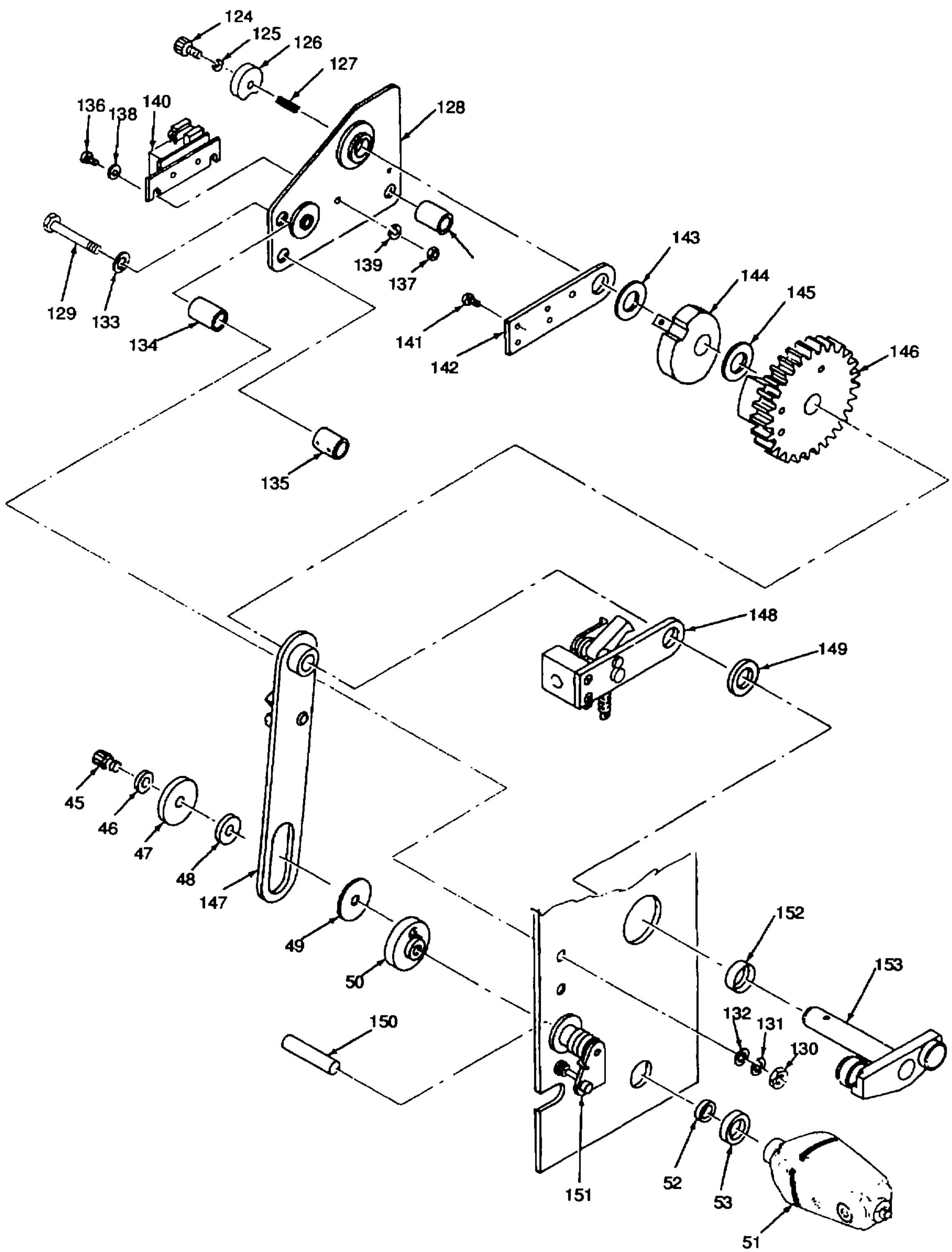


Figure 5-19. Load Circuit Breaker CB101, Exploded View (Sheet 4 of 6)

1. FRONT COVER
2. BOLT
3. LOCKWASHER
4. WASHER
5. BOLT
6. LOCKWASHER
7. WASHER
8. FLOOR TRIP PAN ASSEMBLY
9. BOLT
10. LOCKWASHER
11. WASHER
12. BRACKET
13. SOLENOID ASSEMBLY
14. INTERRUPTER MODULE ASSEMBLY
15. NUT
16. WASHER
17. MECHANISM LEFT AND RIGHT HAND SHIELD ASSEMBLIES
18. PHASE INSULATOR ASSEMBLY
19. BOLT
20. LOCKWASHER
22. BOLT
22. BLTCWSE
23. LOCKWASHER
24. SHER
25. BOLT WASHER
26. LOCKWASHER
27. WASHER
28. REAR BRACE
29. BOLT
30. LOCKWASHER
31. WASHER
32. PIVOT WING ASSEMBLY
33. COTTER PIN
34. CONNECTING PIN
35. WASHER
36. WASHER
37. WASHER
38. BOLT
39. BOLT
40. LOCKWASHER
41. CAPSCREW
42. FLAT WASHER
43. PRIMARY DISCONNECT FINGER
44. PRIMARY DISCONNECT SPRING
45. BOLT
46. FLAT WASHER
47. BRASS BUSHINGWASHER
48. ECCENTRIC ROLLER
49. BRASS BUSHING WASHER
50. MOTOR ECCENTRIC
51. MOTOR
52. BUSHING
53. DRIVE LEVER BUSHING HOUSING
54. BOLT
55. LOCKWASHER
56. MOTOR ACCESS PLATE
57. BOLT
58. WASHER
59. WASHER
60. NUT
61. SPRING
62. COUNTER ASSEMBLY
63. BOLT
64. NUT
65. WASHER
66. MAIN SHAFT REMOVAL INSERT
67. RETURN SPRING ASSEMBLY
68. BOLT
69. LOCKWASHER
70. BOLT
71. LOCKWASHER
72. FLAT WASHER
73. COTTER PIN
74. UPPER PIN
75. WASHER
76. WASHER
77. DRIVE LINKAGE ASSEMBLY
78. COTTER PIN
79. LOWER PIN
80. WASHER
81. WASHER
82. CN
83 COTTER PIN
83. CONNECTING PIN
84. PUSH ROD ASSEMBLY AUXILIARY SWITCH ACTIVATOR
85. BOLT
86. BOLT
87. LOCKWASHER
88. LOCKWASHER
89. WASHER
90. WASHER
91. SWITCH
92. RELAY
93. RELAY
94. OPEN-CLOSED INDICATOR ASSEMBLY
95. NUT
96. CONNECTING RODSPACER
97. CONNECTING ROD SPACER
98. DRIVE CONNECTING LINK ASSEMBLY
99. BOLT

Figure 5-19. Load Circuit Breaker CB101, Exploded View (Sheet 5 of 6)

100. NUT
101. LOCKWASHER
102. DRIVE SHAFT BEARING HOUSING
103. SETSCREW
104. MAIN SHAFT AND PIVOT ASSEMBLY
105. BLOCKING PINS
106. WASHER
107. COTTER PIN
108. TOP DRIVE SPRING SHAFT
109. SPACER
110. DRIVE SPRING AND SHAFT ASSEMBLY
111. BOLT
112. NUT 161.
113. LOCKWASHER
114. SHAFT MOUNTING PLATE
115. BOLT
116. LOCKWASHER
117. CHARGE-DISCHARGE INDICATOR ASSEMBLY
118. BOLT
119. LOCKWASHER
120. TOGGLE BOX ASSEMBLY
121. BOLT
122. LOCKWASHER
123. RACKING SHAFT ASSEMBLY
124. BOLT
125. LOCKWASHER
126. CHARGING MOTOR LIMIT SWITCH CAM
127. PIN
128. GEAR MOUNTING PLATE
129. BOLT
130. NUT
131. LOCKWASHER
132. WASHER
133. WASHER
134. BEARING
135. BEARING
136. SCREW
137. NUT 187.
138. FLAT WASHER
139. LOCKWASHER
140. CHARGING MOTOR LIMIT SWITCH ASSEMBLY
141. BOLT
142. ARM 193.
143. GEAR PLATE FRONT SPACER
144. DRIVE HUB
145. GEAR PLATE REAR SPACER
146. GEAR ASSEMBLY
147. RATCHET ARM ASSEMBLY
148. MANUAL CHARGE ARM ASSEMBLY
149. RATCHET ARM SPACER
150. TRIP CLOSING SPACER
151. TRIP CLOSING ASSEMBLY
152. DRIVE LEVER SPACER
153. DRIVE LEVER
154. BOLT
155. FLAT WASHER
156. FLAT WASHER
157. NUT
158. LOCKWASHER
159. RIGHT SIDE PLATE
160. LEFTSIDE PLATE
BOLT
162. FLAT WASHER
163. WASHER
164. NUT
165. RIGHT HOUSING ASSEMBLY
166. SHUTTER LIFT EAR ASSEMBLY
167. COTTER PIN
168. BOLT
169. WASHER
170. WASHER
171. WASHER
172. TEST POSITION INTERLOCK LATCH
173. SPRING
174. CASTER
175. BOLT
176. WASHER
177. RACKING SPRING COLLAR
178. RACKING NUT SLEEVE
179. RACKING NUT SLEEVE ASSEMBLY
180. PLATE
181. COLLAR
182. RIGHT HOUSING BRACE
183. LEFT HOUSING BRACE
184. BOLT
185. LOCKWASHER
186. FLAT WASHER
WASHER
188. NUT
189. GROUND CONTACT ASSEMBLY
190. LEFT HOUSING ASSEMBLY
191. HEXAGONAL NUT
192. FLAT WASHER
SECONDARY DISCONNECT SLIDE
194. SLIDE ROLLER
195. HOUSING BACK PLATE
196. BOLT
197. SPRING SHAFT KEEPER
198. 5KV FRONT HOUSING

Figure 5-19. Load Circuit Breaker CB101, Exploded View (Sheet 6 of 6)

5-22. LOAD CIRCUIT BREAKER CB1O1AULGNMENT. The following alignments must be made when a vacuum interrupter assembly is replaced. The primary contact gap must also be set when a return spring is replaced. These alignments are listed in the order in which they must be performed. Refer to paragraph 5-24 and remove cover (1, Figure 5-19) and phase insulator assembly (18) to perform these adjustments.

a. Drive Linkage. Distance B(Figure 5-18) for the drive linkage shall be23/16±1/16inch (55.56i1.59 mm). Adjustment is performed by loosening the jam nuts on the drive linkage shaft. Be certain to tighten the jam nuts after obtaining the correct dimension.

WARNING

Whenever a procedure Is to be performed with the drive springs In the charged position, It Is mandatory to block the drive springs by placing the blocking pins (105, Figure 5-19) In the holes at the upper end of the drive spring center shafts. (The blocking pins are located In the tool box). See Figure 4-1 of the Operator and Organizational Maintenance Manual for the location of the tool box.

b. Spring Overtravel. When the breaker is in the CLOSED position, the spring overtravel (distance E, Figure 5-20) must be 0.188 +.06/-0 inch (4.78 +1.5/-0 mm). The following procedure applies to new vacuum interrupters and is not to be performed on existing vacuum interrupters, as this gap provides contact erosion information (see paragraph 518, above). For new vacuum interrupters, proceed as follows: (1) With the load circuit breaker in the fully CLOSED position and the drive springs charged, check the spring overtravel (distance E).

(2) If adjustment is necessary, either of the two methods described below may be used to adjust the two outer drive connecting links (Figure 5-1 5); only the first method may be used on the center drive connecting link (a) Remove the nut, lockwasher, and washer (Figure 5-20) at the top of the drive connecting link insert spring overtravel adjusting tool (05464) T-1 into slots in the end of the erosion indicator. Turn tool T-1 clockwise to shorten or counter-clockwise to lengthen the overtravel. Remove tool T-1. Install the washer, lockwasher, and nut on the drive connecting link Recheck and readjust until proper dimensions are achieved.

NOTE

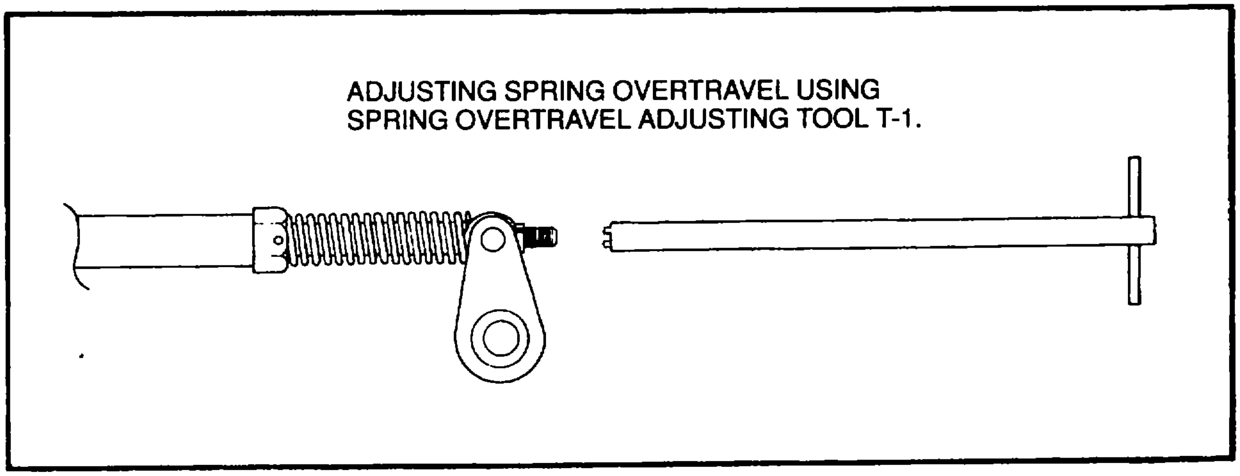
This method of adjustment may only be used on the two outer drive connecting links.

(b) Loosen the nut, lockwasher, and washer at the top of the drive connecting link Grasp the bottom spring retainer (Figure 5-20) with a wrench and turn the erosion indicator clockwise to shorten or counter-clockwise to lengthen the overtravel. Retighten nut, lockwasher, and washer at the top of the drive connecting link Recheck and readjust until proper dimensions are achieved.

c. Primary Contact Gap. With the load circuit breaker CB101 in the OPEN position, the primary contact gap shall be 0.625 to 0.800 inch (15.88 to 20.32 mm). To determine the primary contact gap, use a telescoping gauge and micrometer (0-1 inch) to measure distance D (Figure 5-21) with the breaker in the OPEN position, then with the breaker in the CLOSED position, remeasure distance D. The difference between these two measurements is the primary contact gap. To adjust the primary contact gap, proceed as follows: CAUTION This procedure Is performed with the return springs In the charged position.

NOTE

This procedure must be performed if a vacuum interrupter or return spring has been replaced. To facilitate this adjustment after a return spring has been replaced, the initial setting (distance C, Figure 5-21) should be approximately 9 5/8 inches (244 mm) when the breaker is in the open position.



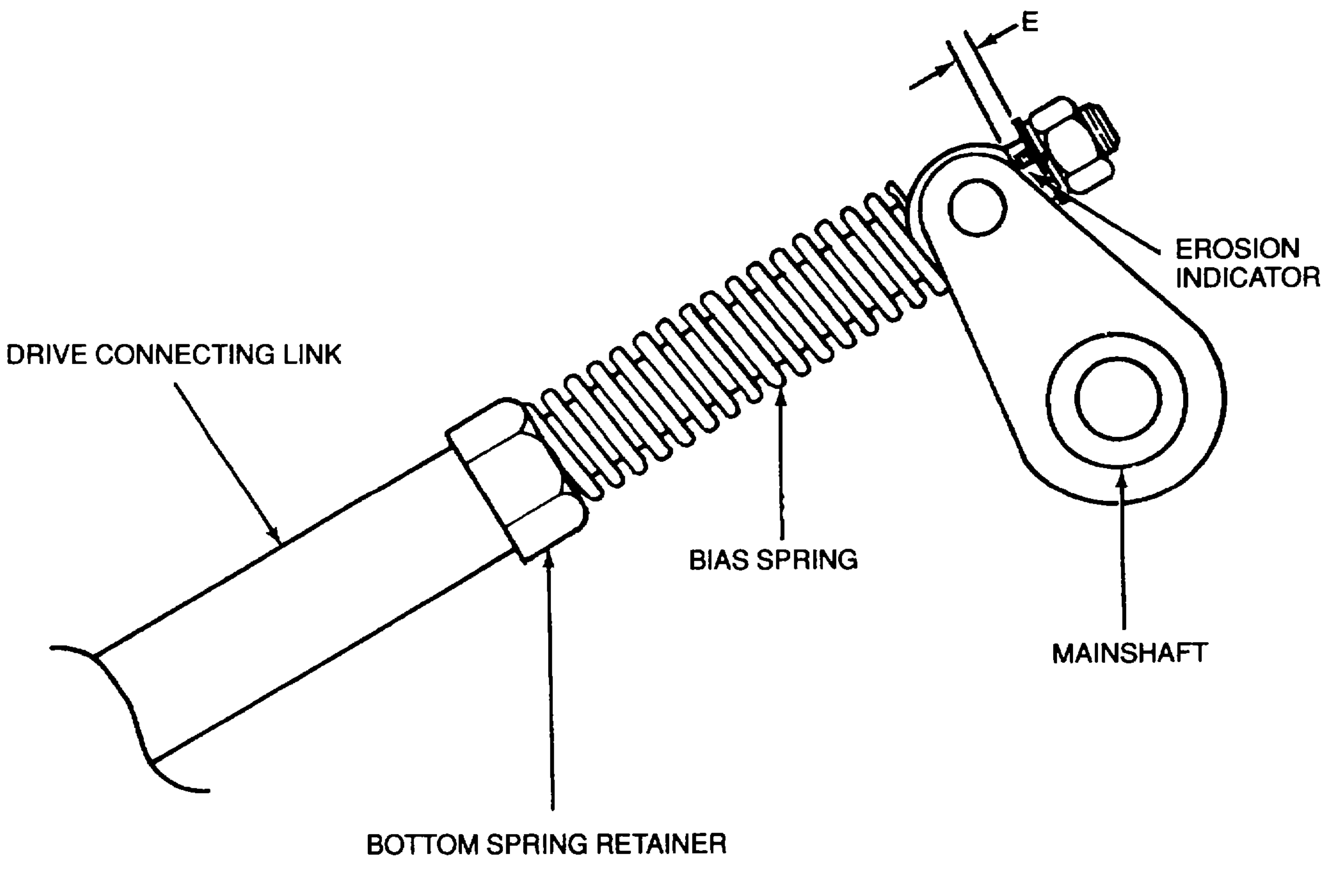


Figure 5-20. Load Circuit Breaker CB101, Spring Overtravel Setting

(1) Evenly turn the stops (Figure 5-21) clockwise (viewed from above) to decrease the primary contact gap and counterclockwise to increase the primary contact gap. Both stops must be turned the same amount to prevent uneven wear and/or damage. It should be noted that both stops can be turned easily if the locking nuts are loosened and the breaker is in the CLOSED position. Use caution since the return springs (Figure 5-16) are in the charged position.

(2) After performing the adjustment, tighten the locking nuts against the stops.

(3) Open and close the breaker, then remeasure the primary contact gap.

(4) Repeat steps (1) through (3), above, until the correct primary contact gap is obtained.

d. Return Spring Preloading Setting. The return spring preloading setting is determined by measuring distance B as shown in Figure 5-22. With the load circuit breaker in the OPEN position, distance B shall be 5.75 O.13 inches (146 i3.2 mm). To adjust distance B, turn the adjustable retainer clockwise (viewed from above) to increase distance B and counterclockwise to decrease distance B.

e. Contact Compression. Once the above settings and alignments have been performed, cycle load circuit breaker CB1 01 OPEN and CLOSED 25 times to compress the contacts of the new vacuum interrupter(s) which has been installed. After cycling load circuit breaker CB1 01, remeasure the distances specified in steps b, c, and d, above.

Repeat this procedure as necessary until the correct dimensions are obtained. Install phase insulator assembly (18, Figure 5-19) and front cover (1) in accordance with paragraph 5-24, step d (36) and (38).

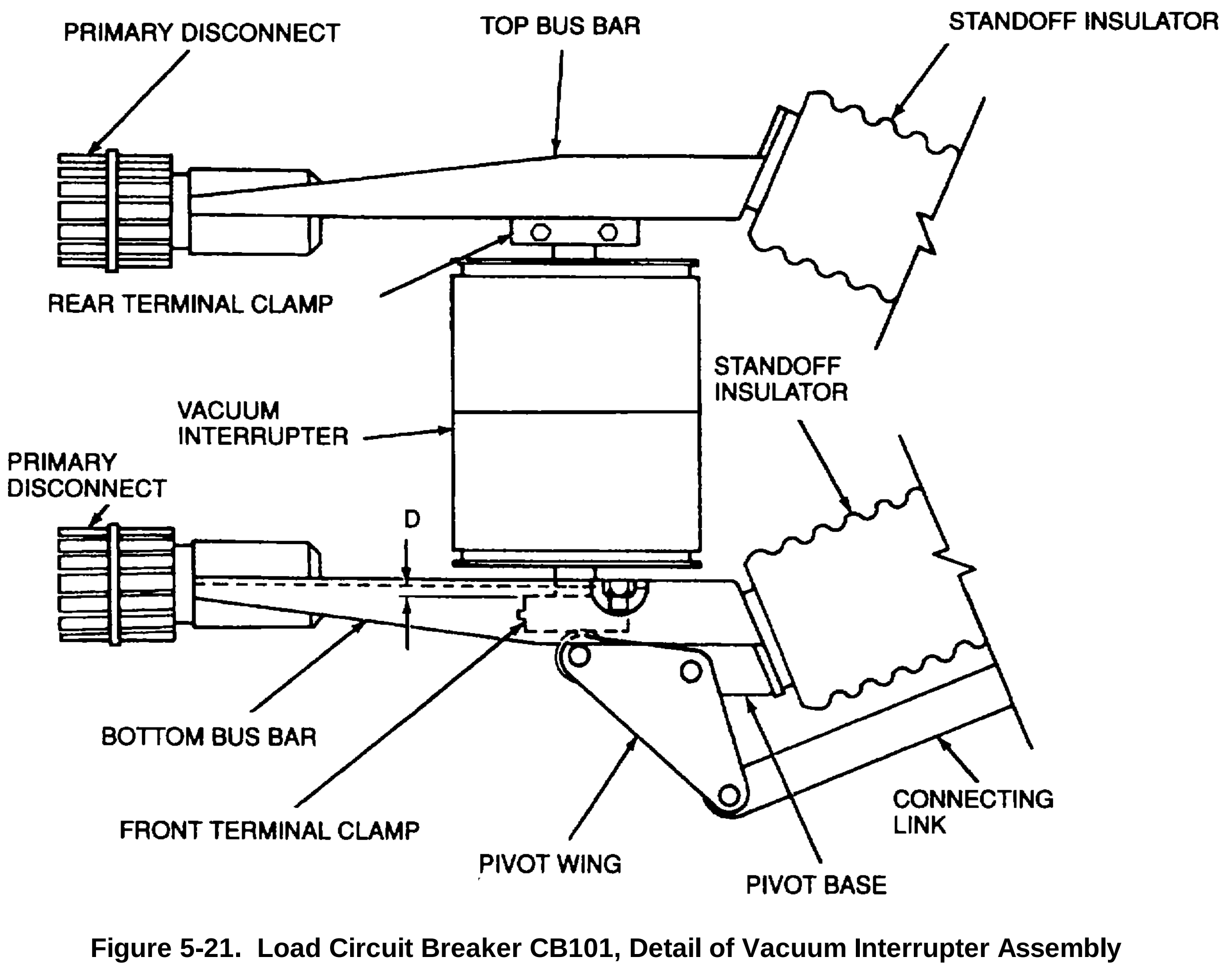


Figure 5-21. Load Circuit Breaker CB101, Detail of Vacuum Interrupter Assembly

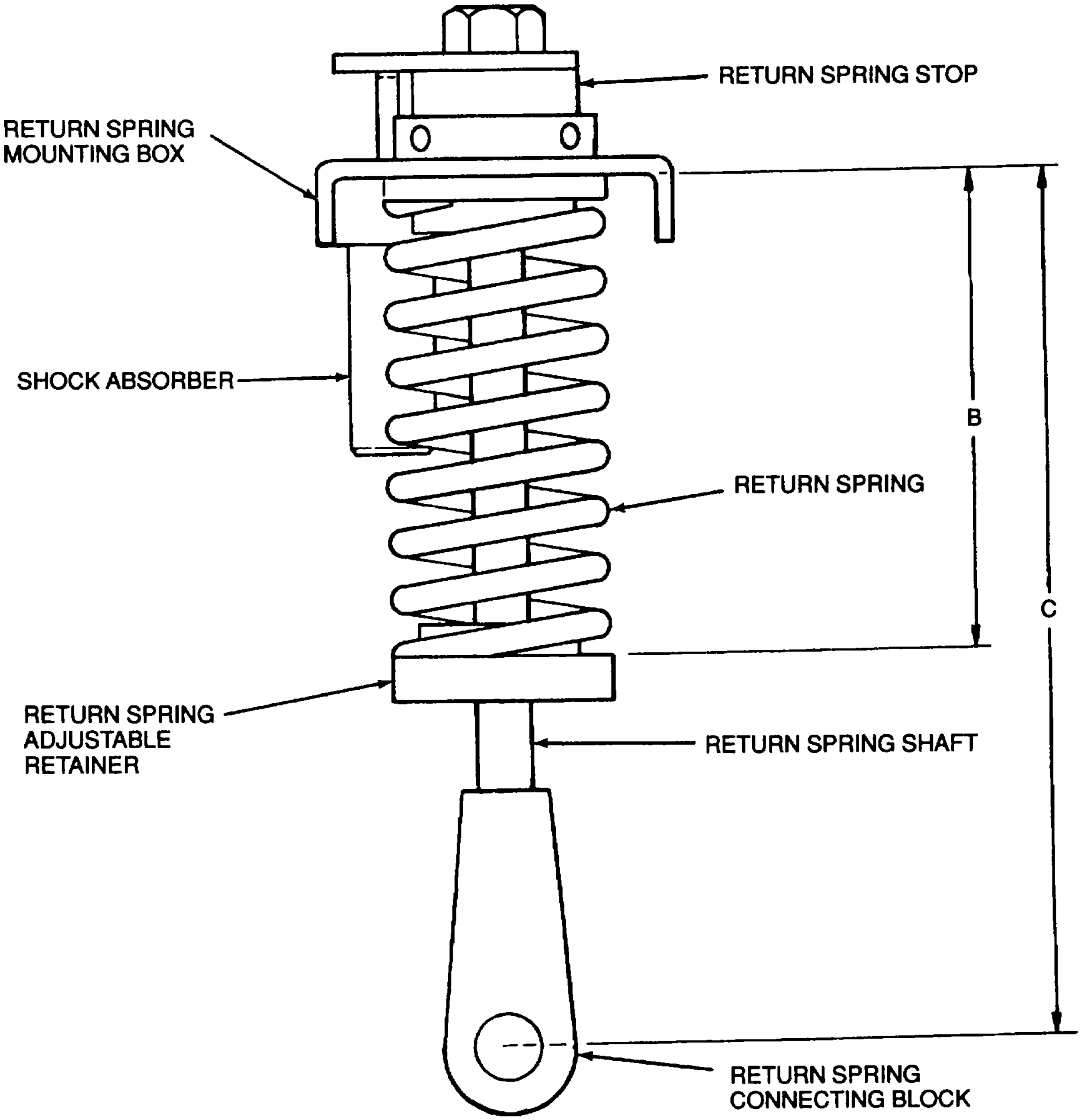


Figure 5-22. Load Circuit Breaker CB101, Return Spring Preload Setting

5-23. LOAD CIRCUIT BREAKER CBIOI REPLACEMENT. Refer to paragraph 2-17.

5-24. LOADCIRCUIT BREAKERCBIOI REPAIR. Repair of load circuit breakerCB101 is accomplished by disassembling the breaker to the extent necessary to remove and replace defective parts. If a vacuum interrupter is being replaced, the alignment procedures of paragraph 5-22 must be performed. The return spring assembly (67, Figure 5-19) and two drive springs and shaft assemblies (110) are to be repaired by replacement of the entire assembly if damage to individual components is detected. If the return spring assembly is replaced, the primary contact gap must be set as specified in paragraph 5-22, step c. All of the adjustment procedures of paragraph 5-21, above, must be performed after any disassembly and reassembly. Additionally, load circuit breaker CB1 01 must be lubricated in accordance with Table 5-1 during and or after reassembly.

WARNING

Dry cleaning solvent PD-680, Type III, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory tract protection Is required to avoid Injury to personnel.

a. Clean. Clean all parts in solvent PD-680, Type III, or equivalent, as necessary.

b. Inspect As parts are removed during disassembly, inspect them for cracks, breaks, or damage. Replace any parts which are damaged or visibly worm.

c. Disassemble. See Figure 5-1 9.

(1) Remove front cover (1) by removing four bolts (2), and lockwashers (3), and washers (4).

(2) Remove four bolts (5), lockwashers (6), and washers (7) to remove floor trip pan assembly (8). Tag and disconnect wires, then remove bolts (9), lockwashers (10), and washers (11) to remove bracket (12) and solenoid assembly (13).

(3) While supporting interrupter module assembly (14), remove nuts (15), and washers (16) to remove mechanism left and right shield assemblies (1 7). Reinstall nuts (15), and washers (16).

(4) To remove phase insulator assembly (18), remove four bolts (19), lockwashers (20), and washers (21) at bottom rear; four bolts (22), lockwashers (23), and washers (24) from front; and six bolts (25), lockwashers (26), and washers (27) through rear brace (28). Remove four bolts (29), lockwashers (30), and washers (31) securing ends of rear brace (28). Remove rear brace (28) and remove phase insulator (18).

NOTE

Phase A and Phase C interrupter module assemblies are retained by slightly longer bolts (38). These bolts are also used to secure the shield assemblies.

(5) In order to free pivot wing assembly (32), remove cotter pin (33), connecting pin (34), and washers (35, 36, and 37). Remove six bolts (38 and 39), lockwashers (40), washers (16), and nuts (15)) to remove each interrupter module assembly (14).

(6) Remove capscrews (41) and flat washers (42) to remove primary disconnect finger (43) and primary disconnect spring (44) assemblies.

(7) Remove bolt (45), flat washer (46), brass bushing washer (47), eccentric roller (48), and brass bushing washer (49). Insert bolt (45) into motor eccentric (50), tap lightly and turn motor eccentric (50) clockwise to remove motor eccentric (50) from motor (51). Remove bushing (52) and drive lever bushing housing (53).

(8) Remove bolts (54) and lockwashers (55) to remove motor access plate (56). Tag and disconnect wires and remove spring charge motor assembly (51).

(9) Remove bolts (57), washers (58 and 59), nuts (60), and unhook spring (61) to remove counter assembly (62).

(10) Remove bolts (63), nuts (64), and washers (65) to remove main shaft removal inserts (66).

(11) While supporting the return spring assembly (67), remove bolts (68), lockwashers (69), bolts (70), lockwashers (71), and flat washers (72) to remove return spring assembly (67).

(12) Remove cotter pin (73) and discard. Remove upper pin (74), and washers (75 and 76) from drive linkage assembly (77). Remove cotter pin (78) and discard. Remove lower pin (79), and washers (80 and 81) to remove drive linkage assembly (77).

(13) Remove cotter pins (82) and discard. Remove connecting pin (83) to remove push rod assembly auxiliary switch activator (84).

(14) Tag and disconnect wires, and remove bolts (85 and 86), lockwashers (87 and 88), and washers (89 and 90) to remove switch (91) and two relays (92 and 93). Separate switch from OPEN-CLOSE indicator assembly (94).

NOTE

The brass springs in each drive connecting link (98) are under tension. Use care when removing nut (95).

(15) Remove nut (95) and connecting rod spacers (96 and 97) from drive connecting link assembly (98). Remove drive connecting link assembly (98) with its attaching hardware (removed in step (5), above).

(16) Remove bolts (99), nuts (100), lockwashers (101), and dismount drive shaft bearing housing (102). Loosen setscrews (103) in drive shaft bearing housing (102) and remove mainshaft and pivot assembly (104) with bearing housing (102) on shaft WARNING Failure to exercise caution In the following procedure may result In damage to components or Injury to personnel as a result of charged condition of the springs.

WARNING

Failure to exercise caution in the following procedure may result in damage to components or injury to personnel as a result of charged condition of the springs.

NOTE

Insert spring blocking pins (105) through hole in spring and shaft assemblies (110) to prevent springs from releasing. Lockwire the blocking pins (105) into place to prevent accidental removal of the pins.

(17) Remove cotter pins (107) and discard. Remove washers (106) to remove top drive spring shaft (108) and spacer (109). A rubber mallet may be used to aid in removing the shaft (108). Do not use a hammer as this will distort the shaft In order to remove spring and shaft assemblies (110), remove bolts (111), nuts (112), lockwashers (113), and shaft mounting plate (114).

(18) Remove bolt (115) and lockwasher (116) to remove charge discharge indicator assembly (117).

(19) Remove bolts (118) and lockwashers (119) to remove toggle box assembly (120).

(20) Remove bolts (121) and lockwashers (122) to remove OPEN-CLOSED indicator assembly (94).

(21) Remove racking shaft assembly (123).

(22) Remove bolt (124), lockwasher (125), charging motor limit switch cam (126), and pin (127) from inner side of gear mounting plate (128).

(23) Remove bolts (129), nut (130), lockwashers (131), washers (132 and 133), and bearings (134 and 135).

(24) Remove screws (136), nuts (137), flat washers (138), and lock-washers (139) to remove charging motor limit switch assembly (140). Remove gear mounting plate (128).

(25) Remove bolts (141), arm (142), gear plate front spacer (143), drive hub (144), gear plate rear spacer (145), gear assembly (146), ratchet arm assembly (147), manual charge arm assembly (148), and ratchet arm spacer (149).

(26) Remove trip dosing spacer (150) and trip closing assembly (151).

(27) Remove drive lever spacer (152) and drive lever (153).

(28) Remove bolts (154), flat washers (155 and 156), nuts (157), and lockwashers (158), to remove right and left side plates (159 and 160).

(29) Remove bolts (161), flat washers (162), washers (163), and nuts (164) to remove right housing assembly (165), Remove shutter lift ear assembly (166).

(30) Remove cotter pin (1 67), pin (1 68), and washers (1 69,170, and 171) to remove test position interlock latch (172), spring (173), and caster (174).

(31) Remove bolts (175) and washers (176). Remove racking spring collar (177), racking nut sleeve (178), racking nut sleeve assembly (179), plate (180), and collar (181). Remove right housing brace (182).

(32) Remove boots (175) and washers (176) and remove left housing brace (183).

(33) Remove boots (184), lockwashers (185), flat washers (186), washers (187), and nuts (188) to remove ground contact assembly (189). Remove left housing assembly (190).

(34) Remove hexagonal nuts (191) and flat washers (192). Remove secondary disconnect slide (193) and slide roller (194) from housing back plate (195).

(35) Remove bolts (196) to remove spring shaft keeper (197) from 5 kV front housing (198).

NOTE

Do not reuse cotter pins. Discard used pins and replace with new cotter pins at assembly.

d. Assemble. See Figure 5-19.

(1) Install spring shaft keeper (197) to 5 Kv front housing (198) and secure with bolts (196).

(2) Install slide roller (194) and secondary disconnect slide (193) to housing back plate (195) with hexagonal nuts (191) and flat washers (192).

(3) Install ground contact assembly (189) and secure with boots (184), lockwashers (185), flat washers (186), washers (187), and nuts (188). Install left housing assembly (190) and secure with bolts (184) and washers (185).

(4) Install left housing brace (183) and secure with boots (175) and washers (176).

(5) Install collar (181), plate (180), racking nut sleeve assembly (179), racking nut sleeve (178), and racking spring collar (177). Install right housing brace (182) and secure with bolts (175) and washers (176).

(6) Install caster (174), spring (173), and test position interlock latch (172) and secure with washers (171, 170, and 169), pin (168), and cotter pin (167).

(7) Install shutter lift ear assembly (166) to right housing assembly (165). Install right housing assembly (1 65) and secure with bolts (161), flat washers (162), washers (163), and nuts (164).

(8) Install right and left-side plates (159 and 160) and secure with bolts (154), flat washers (155 and 156), nuts (157), and lockwashers (158).

(9) Install drive lever (153) and drive lever spacer (152).

(10) Install trip closing spacer (150) and trip dosing assembly (151).

(11) Install manual charge arm assembly (148), ratchet arm spacer(149), and ratchet arm assembly (147).

(12) Install gear assembly (146), gear plate rear spacer (145), drive hub (144), gear plate front spacer (143), arm (142), and bolts (141).

(13) Install charging motor limit switch assembly (140) and secure to gear mounting plate (128) with screws (136), nuts (137), flat washers (138), and lockwashers (139).

(14) Install gear mounting plate (128) and secure with bearings (134 and 135), washers (132 and 133), lockwashers (131), bolts (129) and nuts (130).

(15) Install pin (127), charging motor limit switch cam (126) and secure with washer (125) and bolt (124).

(16) Install racking shaft assembly (123).

(17) Install OPEN-CLOSED indicator assembly (94) and secure with bolts (121) and lockwashers (122).

(18) Install toggle box assembly (120) and secure with bolts (118) and lockwashers (119).

(19) Install charge-discharge indicator assembly (117) and secure with bolts (115) and lockwashers (116).

(20) Install spring and shaft assemblies (110) and secure with bolts (111), nuts (112), lockwashers (113), and shaft mounting plate (114). Install spacer (109) and top drive spring shaft (108) and secure with washers (106) and cotter pins (107). A rubber mallet may be used to aid in installing the shaft (108). Do not use a hammer as this will distort the shaft.

(21) Install mainshaft and pivot assembly (104) and drive shaft bearing housing (102) and secure with lockwashers (101), nuts (100), and bolts (99). Install mainshaft removal insert (66), washers (65), nuts (64) and bolts (63).

(22) Install return spring assembly (67) and secure with flat washers (72), lockwashers (71), bolts (70), lockwashers (69), and bolts (68).

(23) Install counter assembly (62) and secure with bolts (57), washers (58 and 59), and nuts (60). Attach spring (61).

NOTE

Phase A and phase B interrupter module assemblies are retained by slightly longer bolts(38)which must be used to remount those same interrupter module assemblies. These bolts are also used to secure the shield assemblies.

(24) Install primary disconnect finger (43) and spring (44) assemblies with capscrews (41) and flat washers (42).

(25) Install interrupter module assembly (14), and secure with six bolts (38), lockwashers (40), washers (16), and nuts (15). Attach drive connecting link assemblies (98) to pivot wing assemblies (32) with washers (35, 36, and 37), connecting pin (34), and cotter pin (33).

(26) Secure drive connecting link assembly (98) with spacers (96 and 97) and nut (95).

(27) Install push rod assembly auxiliary switch activator (84) and secure with connecting pin (83) and cotter pins (82).

(28) Install drive linkage assembly (77) and secure with washers (80 and 81), lower pin (79), and cotter pin (78). Install washers (76 and 75), upper pin (74), and cotter pin (73).

(29) Mount relays (93 and 92) with bolts (86), lockwashers (88), and washers (87). Mount switch (91) with bolts (85), lockwashers (87), and washers (89). Attach switch to OPEN-CLOSE indicator (94). Attach wires and remove wire tags.

(30) Position spring charge motor assembly (51) and install motor access plate (56) with lockwashers (55) and bolts (54).

(31) Install drive lever bushing housing (53) and bushing (52).

(32) Install motor eccentric (50), brass bushing washer (49), eccentric roller (48), brass bushing washer (49), flat washer (46),bolt (45). Ensure that eccentric roller (48) is seated within slot of rachet arm assembly (147). Attach wires to motor and remove tags.

(33) Install solenoid assembly (13) and bracket (12) with bolts (9), lockwashers (10), and washers (11). Attach wires and remove tags.

(34) Mount floor trip pan assembly (8) with four bolts (5), lockwashers (6), and washers (7).

(35) Install mechanism left and right shield assemblies (17) and secure to interrupter module assembly (14) with washers (16), nuts (15), lockwashers (40), and bolts (38).

(36) Install phase insulator assembly (18) using four bolts (19), lockwashers (20), and washers (21) at bottom rear; and four bolts (22), lockwashers (23), and washers (24) from the front. Mount the rear brace (28) with four bolts (29), lockwashers (30), and washers (31) at the ends. Attach the rear brace (28) and phase insulator assembly (18) with six bolts (25), lockwashers (26), and washers (27).

(37) Remove lockwire and spring blocking pins.

(38) Install front cover (1) and secure with four bolts (2), lockwashers (3), and washers (4).

SECTION V. SURGE CAPACITOR C101

5-25. GENERAL. The surge capacitor is a radio frequency interference (RFI) component designed to filter RFI emissions from generator G1 output to ground.

5-26. MAINTENANCE OF SURGE SUPPRESSOR CAPACITOR C101.

a. Remove. See Figure 5-9.

WARNING

Allow 5 minutes after deenergizing or disconnecting system to permit the capacitor to drain through the Internal discharge resistor. Then for safety, short circuit the terminals again using a shorting bar with Insulated handles, before handling.

(1) Tag cables (13, 14, and 15).

(2) Remove hexagonal nuts (6) and lockwashers (7). and remove cable (15) from surge capacitor C101 (20).

(3) Remove hexagonal nuts (4) and lockwashers (5), and remove cable (14) from surge capacitor C101 (20).

(4) Remove hexagonal head capscrews (8), flat washers (9), lockwashers (10), and hexagonal nuts (11), and remove surge capacitor mounting strap (12) and cables (13 and 14).

(5) Remove hexagon head capscrews (16), flat washers (17), lockwashers (18), and hexagonal nuts (19), and remove surge capacitor C1 01 (20).

(6) Remove hexagon head capscrews (21), lockwashers (22), and hexagonal nuts (23), and remove surge capacitor x, brace (24).

(7) Remove hexagon head capscrews (25), lockwashers (26), and hexagonal nuts (27), and remove surge capacitor brace (28).

(8) Remove hexagon head capscrews (29), lockwashers (30), and hexagonal nuts (31), and remove surge capacitor support bracket (32).

b. Inspect.

(1) Inspect for chips, cracks or looseness in ceramic standoffs.

(2) Inspect for fluid leaks from main case.

(3) Inspect cable ends for frayed or broken wires, cracked insulation or loose connectors. Replace or repair damaged cables.

c. Test

(1) Using a 5 KV megohmmeter, check continuity between each terminal and the ground stud. Meter should indicate 15.3 to 18.7 megohms. This is the resistance of the internal discharge resistor.

WARNING

Allow 5 minutes after testing to permit the capacitor to drain through the Internal discharge resistor. Then for safety, short circuit the terminals again using a grounding stick with Insulated handles before handling.

(2) Replace surge capacitor C101 if resistance is not within tolerance.

d. Install. Refer to Figure 5-9.

(1) Install surge capacitor support brackets (32) with hexagon head capscrews (29), lockwashers (30), and hexagonal nuts (19).

(2) Install surge capacitor support (28) with hexagon head capscrews (25), lockwashers (26), and hexagonal nuts (27).

(3) Install surge capacitor brace (24) with hexagon head capscrews (21), lockwashers (22), and hexagonal nuts (23).

(4) Install surge capacitor Cl01 (20) with hexagon head capscrews (16), flat washers (17), lockwashers (18), and hexagonal nuts (19).

(5) Install surge capacitor mounting strap (12) and cables (13 and 14), as tagged, with hexagon head capscrews (8), flat washers (9), lockwashers (10), and hexagonal nuts (11).

(6) Install cable (14) to surge capacitor C101 (20) with hexagonal nuts (4) and lockwashers (5).

(7) Install cables (15), as tagged, to surge capacitor Cl01 (20) with hexagonal nuts (6) and lockwashers (7).

(8) Remove and discard tags.

SECTION VI. RELAYS

5-27. GENERAL. Control and protective relays are used in the generator set. Control relays actuate or deactuate as a result of operator actions or interaction with protective relays. Protective relays actuate or deactuate as a result of fault conditions detected by sensors.

5-28. RELAYS K3 THROUGH K7, K9 THROUGH K22, K24 THROUGH K28, A10K1 THROUGH A10K9, AND A11 K1 THROUGH A11 K9. These are socket-mounted, sealed, nonadjustable relays. Relays K3 through K7, K9 through K22, and K24 through K28 are mounted on two relay panel assemblies (35, Figure 5-9) located in cabinets A and C. Relays A10K1 through A10K9 and A11K1 through A11K9 are mounted on component board assemblies A10 and A11 (46, Figure 5-9). See Figure 5-23, Figure 5-24, and Figure 5-25 for relay locations and applications.

a. Remove. Remove relay (38, Figure 5-9) by removing screw assembly (40) and lockwasher (41) and unplugging relay from relay socket (39).
b. Inspect. Check relays (38) and relay sockets (39) for broken or bent pins, shorts from pin to case, and signs of obvious damage.
c. Clean. Clean relays with a dean lint-free cloth.
d. Test. See Figure 5-26.

NOTE

Contacts 3 and 1 and contacts 6 and 8 work opposite to contacts 3 and 5 and contacts 6 and 4.

(1) Connect a multimeter set to RX1 scale across relay pins 3 and 5.

(2) Connect a 24 V dc power supply across relay pins 2 and 7.

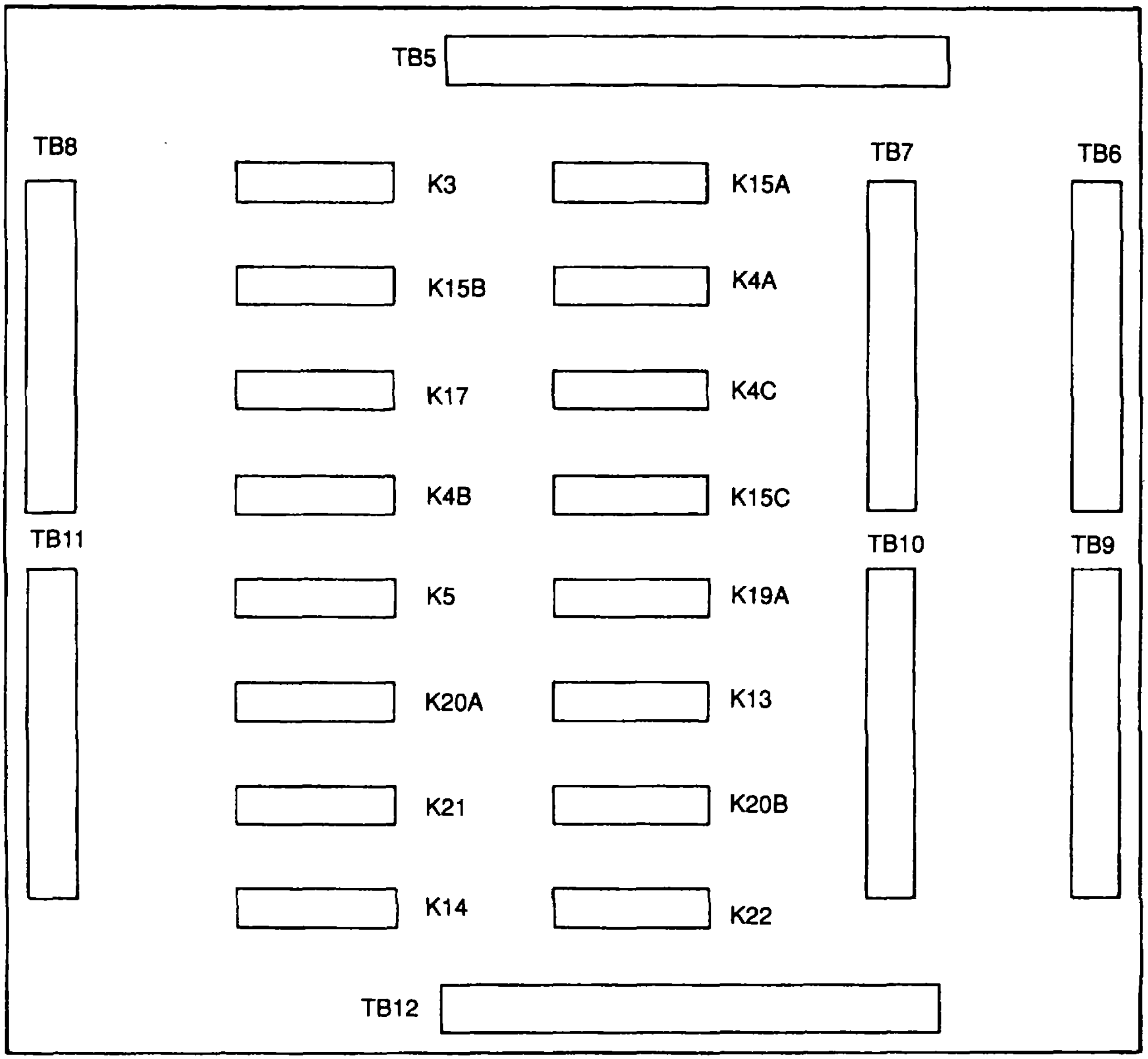
(3) Observe that multimeter reads less than 1 ohm.

(4) Disconnect 24 V dc power supply.

(5) Observe that multimeter reads infinite ohms.

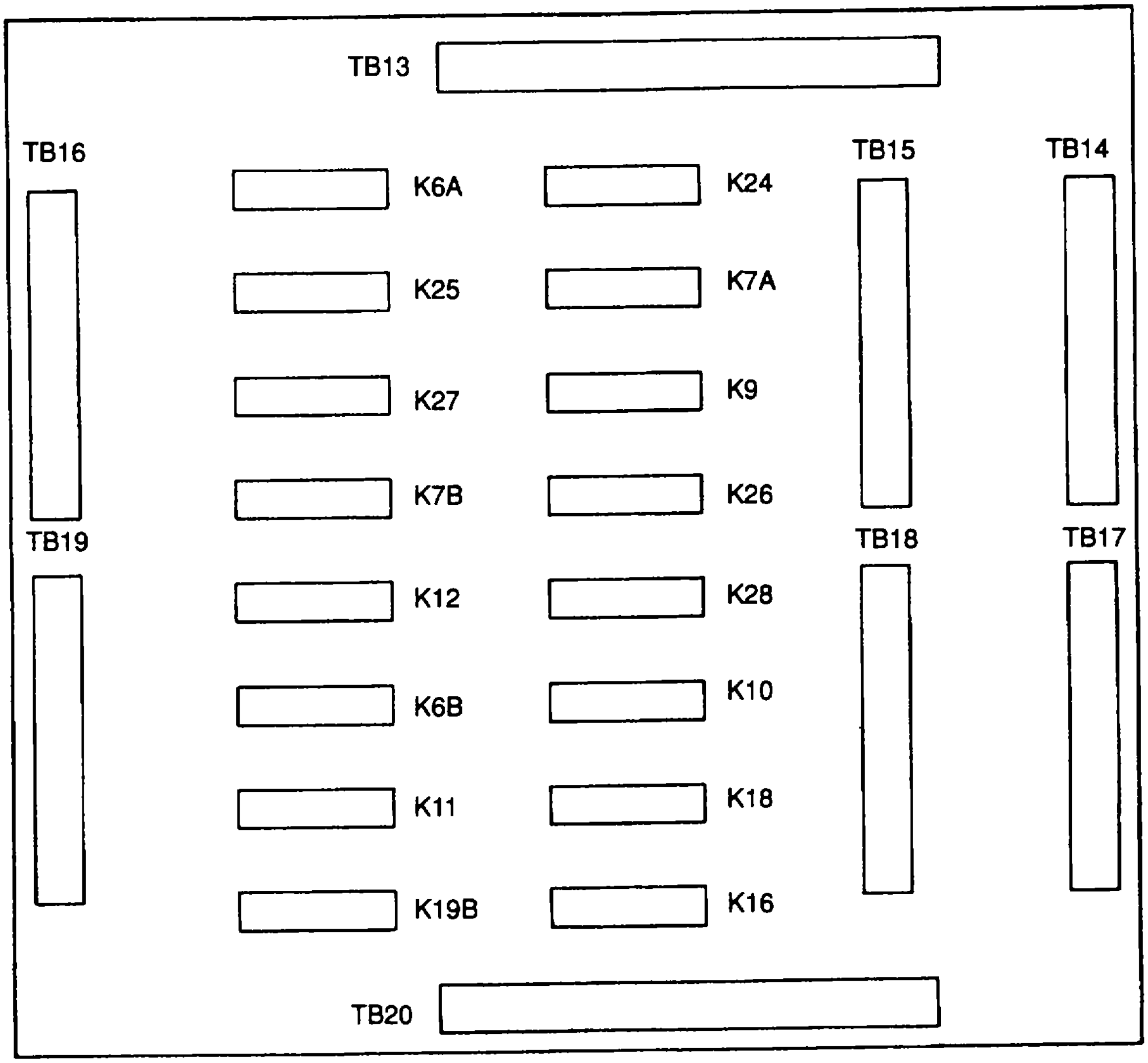
(6) Connect multimeter across pins 4 and 6.

(7) Reconnect 24 V dc power supply to pins 2 and 7.



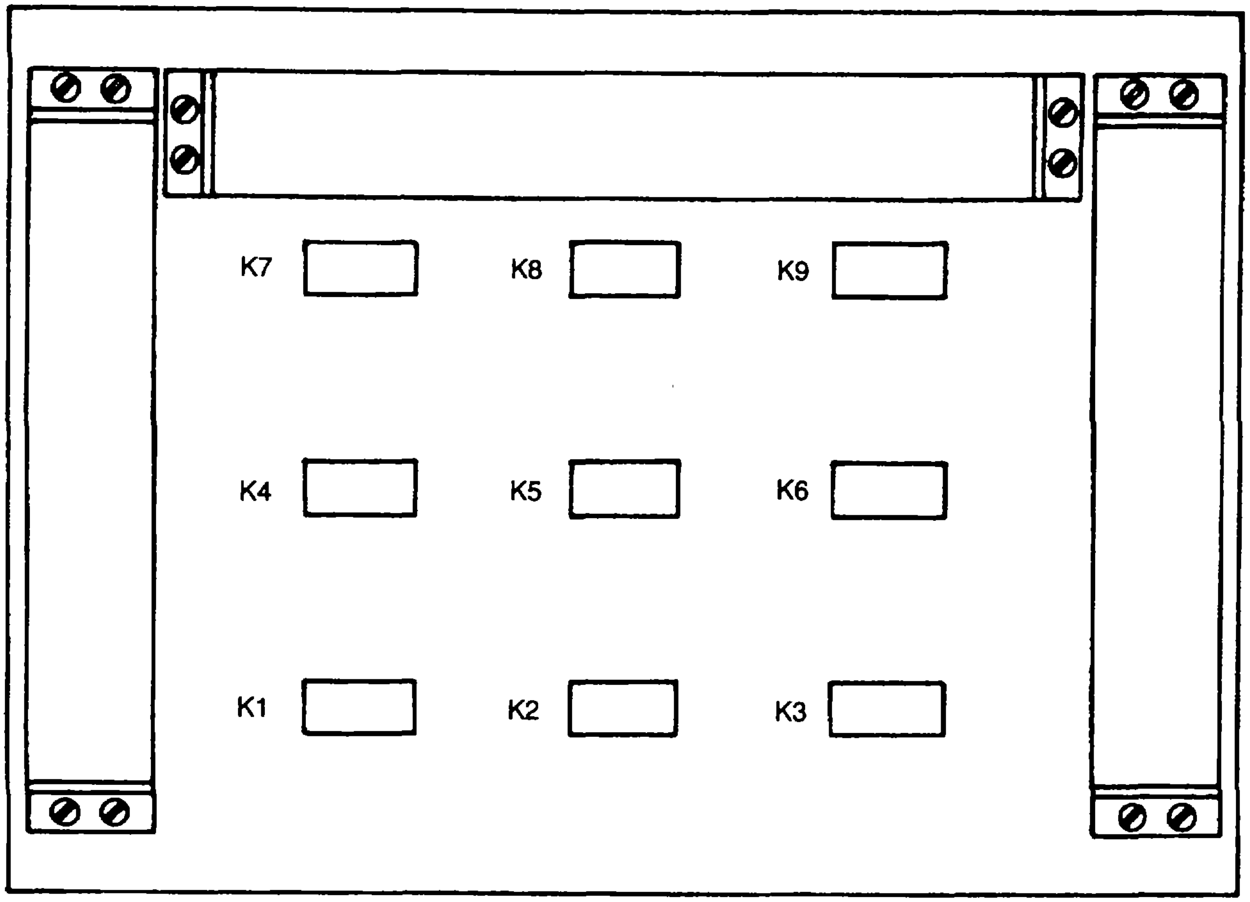
K3	CRANK RELAY
K4A/4B/4C	PARALLEL RELAY
K5	HIGH FUEL LEVEL FAULT SLAVE RELAY
K13	FUEL PUMP CONTACTOR
K14	SHUTDOWN RELAY
5A/15B/15C	ENGINE RUN RELAY
K17	FAULT BY-PASS RELAY
K19A	OVERSPEED SHUTDOWN RELAY
K20A/20B	FAULT SHUTDOWN RELAY
K21	LOW COOLANT LEVEL SHUTDOWN RELAY
K22	COOLANT LEVEL ALARM SLAVE RELAY

Figure 5-23. Cabinet C Relay Panel Assembly



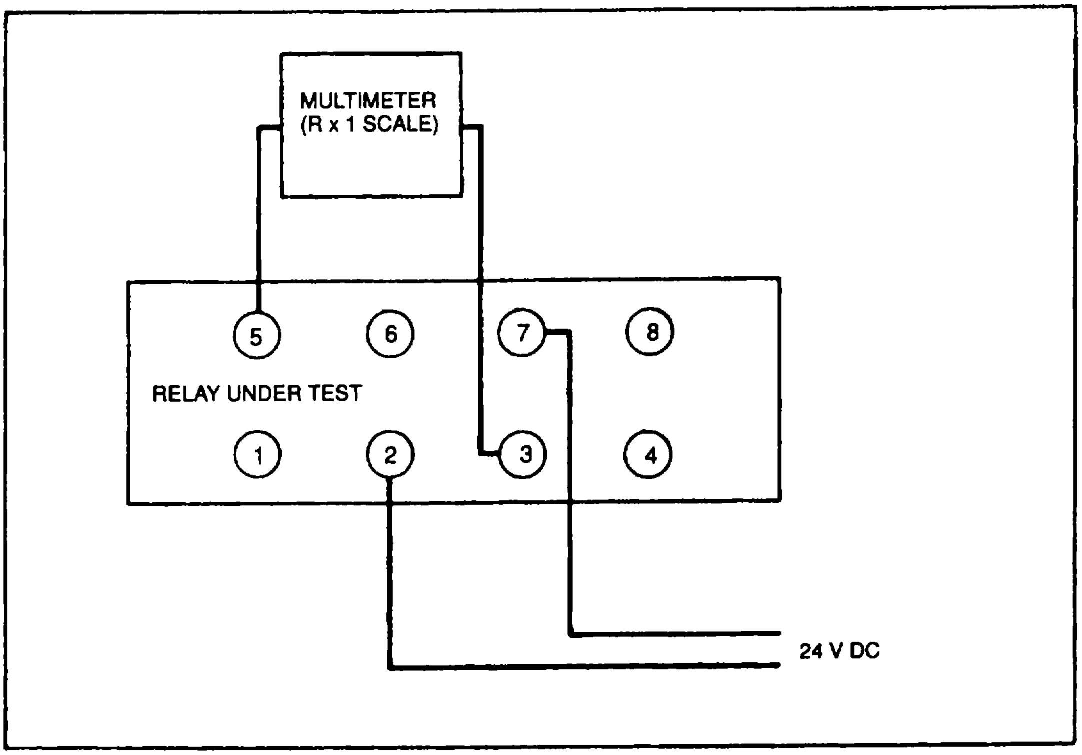
K6A/6B	CIRCUIT BREAKER CLOSED RELAY
K7A/7B	PARALLEL SLAVE RELAY
K9	OVERVOLTAGE FAULT SLAVE RELAY
K10	OVERCURRENT FAULT SLAVE RELAY
K11	GROUND FAULT SLAVE RELAY
K12	FUEL PUMP SLAVE RELAY
K16	OVERCRANK SLAVE RELAY
K18	OIL PRESSURE SHUTDOWN RELAY
K19B	OVERSPEED SHUTDOWN RELAY
K24	FLASHER RELAY
K25	ALARM SILENCE RELAY
K26	ALARM RELAY
K27	ALARM RELAY
K28	ALARM RELAY

Figure 5-24. Cabinet A Relay Panel Assembly



A10K1 OVERSPEED FAULT RELAY
A10K2 OIL PRESSURE ALARM RELAY
A10K3 COOLANT TEMPERATURE ALARM RELAY
A10K4 OIL TEMPERATURE ALARM RELAY
A10K5 LOW FUEL LEVEL ALARM RELAY
A10K6 HIGH FUEL LEVEL ALARM RELAY
A10K7 OVERVOLTAGE FAULT RELAY
A10K8 UNDERVOLTAGE FAULT RELAY
A10K9 OVERCURRENT FAULT RELAY
A11K1 REVERSE POWER FAULT RELAY
A11K2 GROUND FAULT RELAY
A11K3 SPARE
A11K4 OVERCRANK FAULT RELAY
A11K5 UNDERFREQUENCY FAULT RELAY
A11K6 COOLANT LEVEL FAULT RELAY
A11K7 SPARE
A11KB SPARE
A11K9 SPARE

Figure 5-25. Component Board Assembly A10 and A11



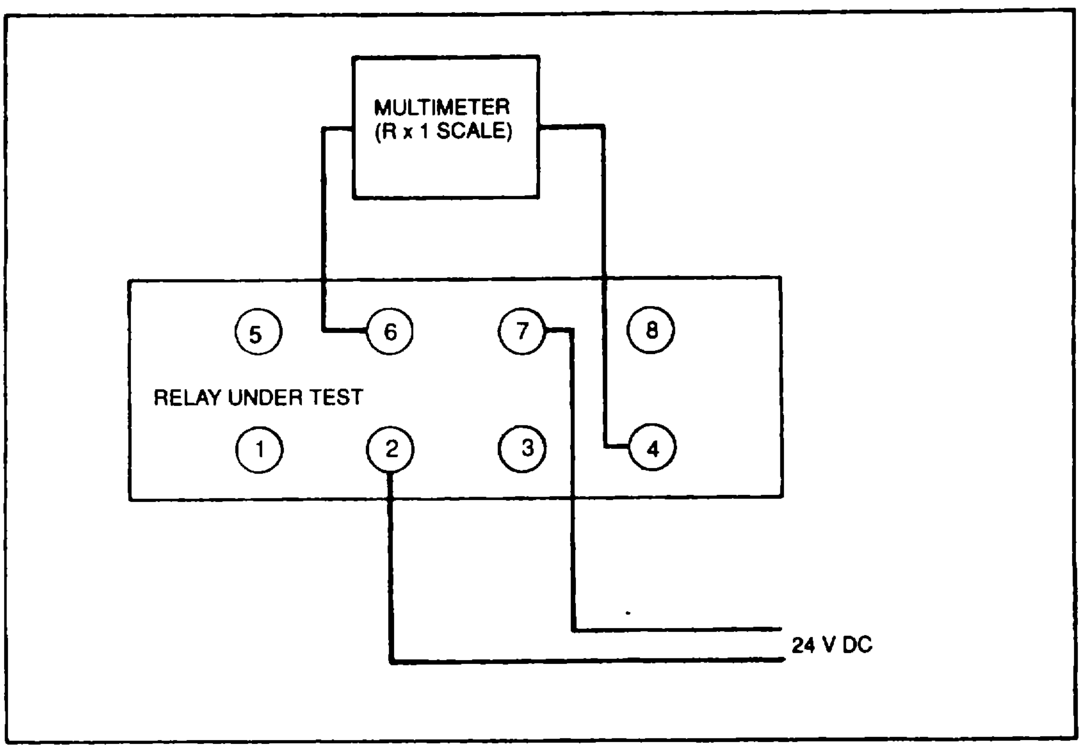


Figure 5-26. Test Setup, Relays K3 through K7, K9 through K22, K24 through K28, A10K1 through A10K10, and A11K1 through A11K9

(8) Observe that multimeter reads less than 1 ohm.

(9) Disconnect 24 V dc power supply.

(10) Observe that multimeter reads infinite ohms.

(11) Repeat steps (1) through (10), above, several times to ensure that relay works consistently.

(12) If multimeter does not produce required reading, relay is defective and must be replaced.

e. Install. Install relay (38) by plugging into relay socket (39) and securing with screw assembly (40) and lockwasher (41).

5-29. TIME DELAY (LOW FUEL LEVEL SHUTDOWN) RELAY K23 (49, Figure 5-9). This socket mounted relay is located in the upper cabinet A panel and is energized by high/low alarm float switch FL3 and low fuel level alarm relay A10K5. If K23 remains energized for 35 minutes, it will energize the fault shutdown relays K20A and K20B and the generator set will shut down.

a. Remove. Remove relay K23 (49, Figure 5-9) by removing screw and captive washer assemblies (51) and unplugging it from its socket (50).

b. Inspect.

(1) Inspect adjustment knob and nylon case for damage.

(2) Verify adjustment knob is set to mid-range (35 minute) setting.

(3) Remove in accordance with step a, above. Inspect for bent or broken pins. Check for cracks in phenolic base.

c. Off Equipment Test (see Figure 5-27).

(1) Connect a multimeter (RX1 scale) across relay pins 1 and 3.

(2) Observe that multimeter reads infinity.

(3) Connect a 24 V dc power supply across relay pins 2 (positive) and 7 (negative).

(4) Set adjust knob to desired trip time.

(5) Observe that multimeter first reads infinite ohms, then less than 1 ohm after the preset time has elapsed.

(6) Disconnect 24 V dc power supply.

(7) Observe that multimeter reads infinite ohms.

(8) If multimeter reading is not as specified for any step, replace the relay.

(9) Relay K23 should always be adjusted to the mid-range setting. This will produce a delay of 33 to 37 minutes between energizing and contact closure. In step (5), above, elapsed time should be 33 to 37 minutes.

d. Adjust. Adjust relay K23 by setting the adjust knob to the midrange (35 minute) setting.

e. Install. Install relay K23 (49, Figure 5-9) by plugging it into its socket (50) and secure with mounting screws (51).

5-30. CIRCUIT BREAKER TRIP RELAY K30 (52, Figure 5-9). This relay is energized whenever the operator sets BREAKER CONTROL switch S4 to TRIP (and LOCAL REMOTE SWS2 is set to LOCAL) and whenever a fault condition occurs. If LOCAL REMOTE SW S2 is set to REMOTE, BREAKER CONTROL switch S4R will energize relay K30. When energized. K30 energizes the trip coil of load circuit breaker CB101, and the circuit breaker trips (opens).

a. Remove.

(1) Tag and disconnect wires to relay K30 (52, Figure 5-9).

(2) Remove screw and captive washer assembly (53) to remove relay K30 (52).

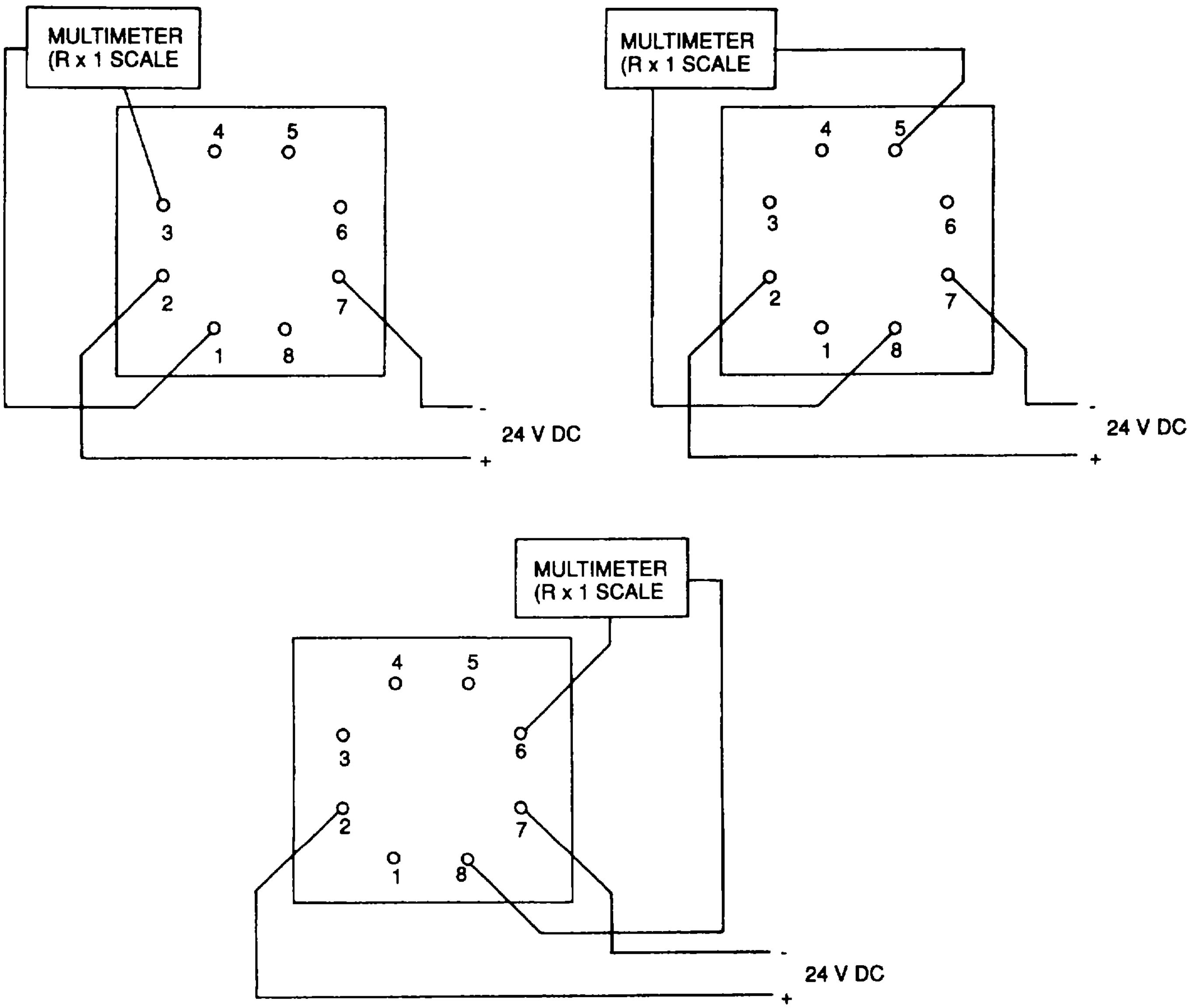


Figure 5-27. Test Setup, Time Delay (Low Fuel Shutdown) Relay K23

b. Inspect.

(1) Inspect for evidence of burning or insulation breakdown.

(2) Examine contacts for evidence of arcing, pitting, or burning.

c. Test.

(1) Connect a multimeter across relay terminals A3 and A4.

(2) Observe that multimeter reads less than 1 ohm.

(3) Connect a 24 V dc power supply across relay terminals X1 (positive) and X2 (negative).

(4) Observe that multimeter reads infinite ohms.

(5) Connect multimeter across relay terminals Al and A2.

(6) Observe that multimeter reads less than 1 ohm.

(7) Disconnect 24 V dc power supply.

(8) Observe that multimeter reads infinite ohms.

(9) Repeat steps (1) through (8), above, several times to ensure that relay works consistently.

(10) If multimeter does not indicate required readings, relay is defective and should be replaced.

d. Install.

(1) Install relay K30 (52, Figure 5-9) and secure with screw and captive washer assemblies (53).

(2) Make required wire connections to relay terminals and remove tags.

5-31. EMERGENCY LIGHT RELAY K100 (56, Figure 5-9). This relay will deactuate to apply battery voltage to the emergency lights upon failure of station power.

a. Inspect.

(1) Remove screws to remove cover.

(2) Inspect mounting hardware and electrical connections for security.

(3) Inspect for evidence of burning or insulation breakdown.

(4) Examine contacts for evidence of arcing, pitting, or burning.

b. Remove.

(1) Tag and disconnect wires from all four terminals.

(2) Remove relay cover by removing screws.

(3) Remove emergency light relay K1OO (56) by removing three screw and captive washer assemblies (57).

c. Test.

(1) Connect a multimeter across the normally closed contact terminals. These are located at each side of emergency light relay K100.

(2) Multimeter should read less than 1 ohm.

WARNING

Failure to exercise caution when using energized test equipment may result in Injury to personnel.

(3) Connect a 120 V ac power supply to the coil terminals. These are located at the comers of emergency light relay K100.

(4) Multimeter should read infinite ohms.

(5) Repeat steps (1) through (4), above, several times to ensure that power relay K100 works consistently.

(6) Disconnect 120 V ac power supply.

(7) Check resistance of coil. Resistance should be 246 to 334 ohms.

(8) Replace emergency light relay K100 if readings are incorrect or out of tolerance as indicated in steps (2), (4), and (7), above.

d. Install.

(1) Install emergency light relay K100 (56, Figure 5-9) and secure with screw and captive washer assemblies (57).

(2) Make wiring connections as necessary and discard wire tags.

(3) Install relay cover and secure with screws.

5-32. 50 HERTZ AND 60 HERTZ FREQUENCY RELAYS K108 AND K107 (58 and 59, Figure 5-9). The 50 hertz and 60 hertz frequency relays are boated inside cabinet B. The units are identical. Either relay may be set to trip anywhere over a frequency range of 45 to 66 hertz. Unless otherwise specified, the following procedures apply to both K108 and K107.

a. Inspect.

(1) Inspect screw and captive washer assemblies (60, Figure 5-9) and electrical connections for security.

(2) Examine wires connected to 50 hertz and 60 hertz frequency relays for evidence of burning or insulation breakdown.

b. Remove. See Figure 5-9.

(1) Tag and disconnect wires to relay terminals.

(2) Remove 50 hertz and 60 hertz frequency relays K108 and K107(58 and 59) by removing screw and captive washer assemblies (60).

c. Test and Adjust.

(1) Connect a variable frequency 120 V ac power supply across relay terminals 1 and 2. Apply 120 V ac, 50 Hz to the K108 relay. Apply 120 V ac, 60 Hz to the K107 relay.

(2) Connect a multimeter set to RX1 across the NC terminals. Multimeter should read infinite ohms. If reading is not infinite ohms, consider relay to have tripped above maximum and adjust in accordance with step (4), below.

(3) Gradually decrease the frequency of the applied voltage until multimeter indication goes to zero ohms, 50 hertz relay K108 trips at between 45.5 and 47.5 Hz; 60 hertz relay K107 trips at 55.5 to 57.5 Hz.

(a) If multimeter reads zero ohms at an applied frequency between 45.5 and 47.5 hertz (for K108) or between 55.5 and 57.5 hertz (for K107), go to step (5), below.

(b) If multimeter does not read zero ohms as specified, adjust 50 hertz and 60 hertz frequency relays in accordance with step (4), below.

(4) Adjust K108 or K107 as follows:

(a) Apply 120 V ac, 60 Hz across K107 terminals 1 and 2. Apply 120 V ac, 50 Hz across K108 terminals 1 and 2.

(b) The frequency trip range of each relay is adjustable. I the relay tripped above maximum specified in step (3)(a), above, turn PICK-UP ADJUST slightly counterclockwise and repeat step (3), above.

(c) If relay tripped below minimum specified in step (3)(a), above, turn PICK-UP ADJUST slightly clockwise and repeat step (3), above.

(d) Repeat steps (3) and (4), above, until relay satisfies requirements of step (3)(a), above.

(5) Apply 120 V ac, 60 Hz across K107 terminals 1 and 2. Apply 120 V ac, 50 Hz across K108 terminals 1 and 2.

(6) Connect a multimeter set to RX1 across the NO terminals. Multimeter should read zero ohms.

(7) Gradually decrease the frequency of the applied voltage until multimeter reads infinite ohm. Note frequency at which relay trips.

(a) If 60 hertz (50 hertz) frequency relay trips as specified in step (3)(a), above, the 60 hertz (50 hertz) frequency relay is good. Disconnect test equipment and install 60 hertz (50 hertz) frequency relay back in generator set.

(b) If 60 hertz (50 hertz) frequency relay does not trip as specified in step (3)(a), above, the 60 hertz (50 hertz) frequency relay is defective and should be replaced. Install an adjusted replacement 60 hertz (50 hertz) frequency relay in the generator set.

d. Install. See Figure 5-9.

CAUTION

Relays K107 and K108 are identical items, but are adjusted to different trip points. Do not get them reversed. Each relay must be adjusted for proper trip point prior to installation. K107 must be adjusted as the 60 Hz frequency relay; K108 as the 50 Hz frequency relay. Accidental reversal of the relays may result in equipment damage.

(1) Verify relay K107 (Kl08) has been properly adjusted for 60 Hz (50 Hz) operation.

(2) Install relay K107 (59) or K108 (58) and secure it with screw and captive washer assembly (60).

(3) Make wiring connections as necessary and discard wire tags.

5-33. REVERSE POWER RELAY K109 (61, Figure 5-9).

a. Inspect.

(1) Inspect screw and captive washer assemblies (62) and electrical connectors for security.

(2) Inspect wires connected to reverse power relay K109 for evidence of burning or insulation breakdown.

b. Remove. See Figure 5-9.

(1) Tag and disconnect wires from relay terminals.

(2) Remove reverse power relay K109 by removing screw and captive washer assemblies (62).

c. Test.

(1) Preparation for bench test.

(a) Remove reverse power relay K109 in accordance with step b, above.

(b) Obtain single phase 120 V ac power source, 0-1 ampere AC ammeter, variable 0-10 V ac power source, and a multimeter set to RX1 scale.

(c) See Figure 5-28. Connect 120 V ac, single phase power source at terminals 3 and 4 of K109. Connect the 0-1 ampere AC ammeter in series with a 0-10 V ac power source installed across terminals 5 and 6 of K109. Connect multimeter set to RX1 scale across the terminals marked NC (normally closed) on the relay.

(2) Test

(a) Turn on 120 V ac, single phase power source and 0-10 V ac power source set to zero volts. Observe multimeter indication. Reading should be zero ohm.

(b) From zero setting, increase 0-10 V ac source input into terminals 5 and 6 of K109 while monitoring current reading on the ammeter.

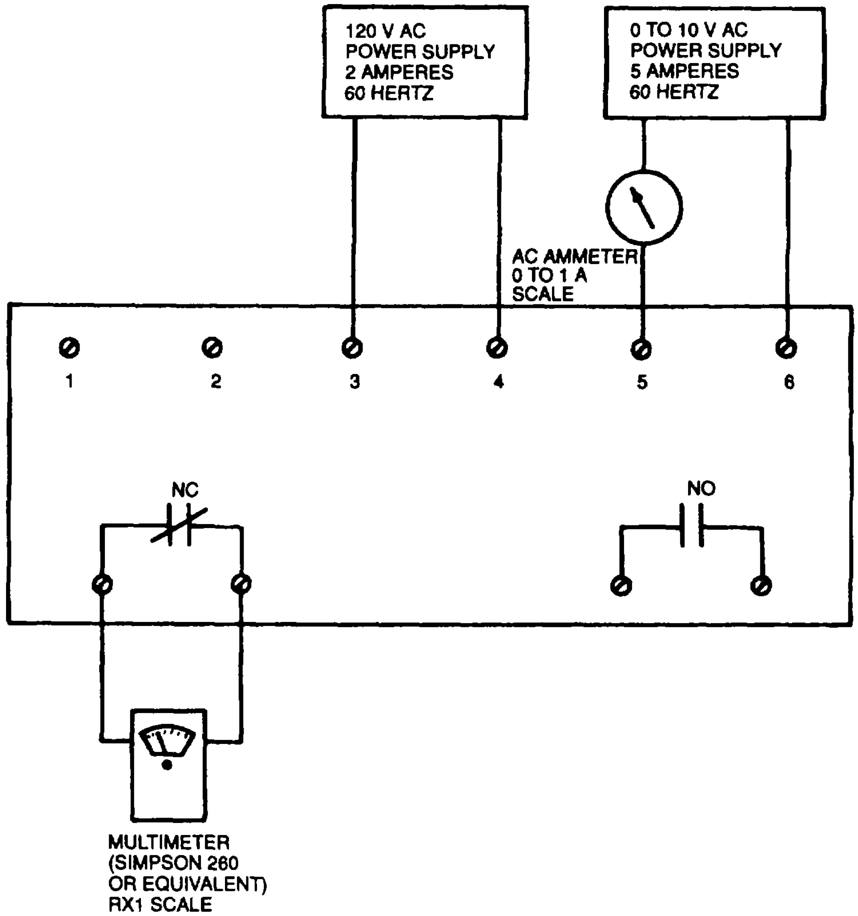


Figure 5-28. Test Setup, Reverse Power Relay K109

(c) Note multimeter and ammeter indications. Multimeter across the NC terminal should deflect to infinite ohms (contacts open) when ammeter reading reaches approximately 0.74 amperes. If not, establish proper polarity by reversing connections across terminals 5 and 6 of the relay. Multimeter should then read Infinite ohms (contacts open).

(d) If relay contacts change state as described in step (c), above, bring variable 0-10 V ac power source to zero. Multimeter will deflect to zero (contacts closed). Gradually increase input at relay terminals 5 and 6 while monitoring both the ammeter and multimeter readings. Multimeter should deflect to infinite ohms (contacts open) when ammeter reading reaches approximately 0.74 amperes.

(3) Adjust. If relay does not trip (open contacts) at 0.74 amperes, adjust the RAISE-LOWER pot on the relay to increase or decrease relay threshold level. Repeat test step (d), above, until the desired 0.74 amperes trip level is obtained.

(4) Replace. If 0.74 amperes trip level adjustment cannot be made, replace the relay.

d. Install. See Figure 5-9.

(1) Install reverse power relay K109 (61) and secure with screw and captive washer assemblies (62).

(2) Make wiring connections as tagged and discard wire tags.

5-34. OVER VOLTAGE RELAY KIIO (63, Figure 5-9).

a. Inspect.

(1) Inspect screw and captive washer assemblies (62) and electrical connections for security.

(2) Inspect wires connected to over voltage relay K110 for evidence of burning or insulation breakdown.

b. Remove. See Figure 5-9.

(1) Tag and disconnect wires from over voltage relay K110 terminals.

(2) Remove over voltage relay K110 (63) by removing screw and captive washer assemblies (62).

c. Bench-Test.

(1) Preparation for bench test.

(a) Remove over voltage relay Kl0 in accordance with step b, above.
(b) Obtain a 3 phase, O to 250 V ac variable power source with a built-in voltmeter, a multimeter (or a relay tester) and a stopwatch.

NOTE

If variable power source has no built in voltmeter, a separate 0-300 V ac voltmeter may be connected across any two output lines of the three phase power source.

(c) See Figure 5-29. Connect the 3 phase 250 V ac variable voltage source at terminals 1, 2, and 3 of K110. Set multimeter to RX1 scale and connect across terminals 4 and 6 of the relay.

(2) Test.

(a) Turn on variable voltage source with voltage output set at zero and observe multimeter reading. Multimeter at this point should read zero ohms.
(b) Increase voltage into relay K10 while monitoring power source voltmeter and multimeter connected at relay terminals 4 and 6. Relay contacts should trip at 239 ±5 V ac as indicated by multimeter deflecting to infinite ohms. Record voltage trip point as indicated on voltmeter.
(c) Turn off variable power source with voltage output level set at the trip point (239 ±5 V ac) recorded in step (b), above, After 10 seconds turn variable voltage source back on while timing relay trip time with a stopwatch. Relay should trip within 3 ±1 seconds as indicated by the multimeter needle deflecting to infinite ohms (contacts open).

(3) Adjust.

(a) If relay does not trip at the specified voltage (239 ±5 V ac), turn the trip voltage adjustment at the upper left of the relay clockwise or counter clockwise to accordingly increase or decrease the over voltage threshold level. Repeat step (2)(b), above, and continue adjusting until the desired 239 ±5 V ac trip point is attained.
(b) If relay does not trip within the specified 3 ±l second time, turn the TIME RELAY adjustment on the upper right of the relay clockwise or counterclockwise to increase or decrease the time delay. Repeat step (2)(c), above, and continue adjusting until the specified 3 ii second time delay is attained.

(4) If specified over voltage threshold and/or time delay period cannot be attained through the relay adjustment pots. Replace the over voltage relay Ki10.

d. Install. See Figure 5-9.

(1) Install over voltage relay K110 (63) and secure with screw and captive washer assemblies (62).

(2) Make wiring connections as tagged and discard tags.

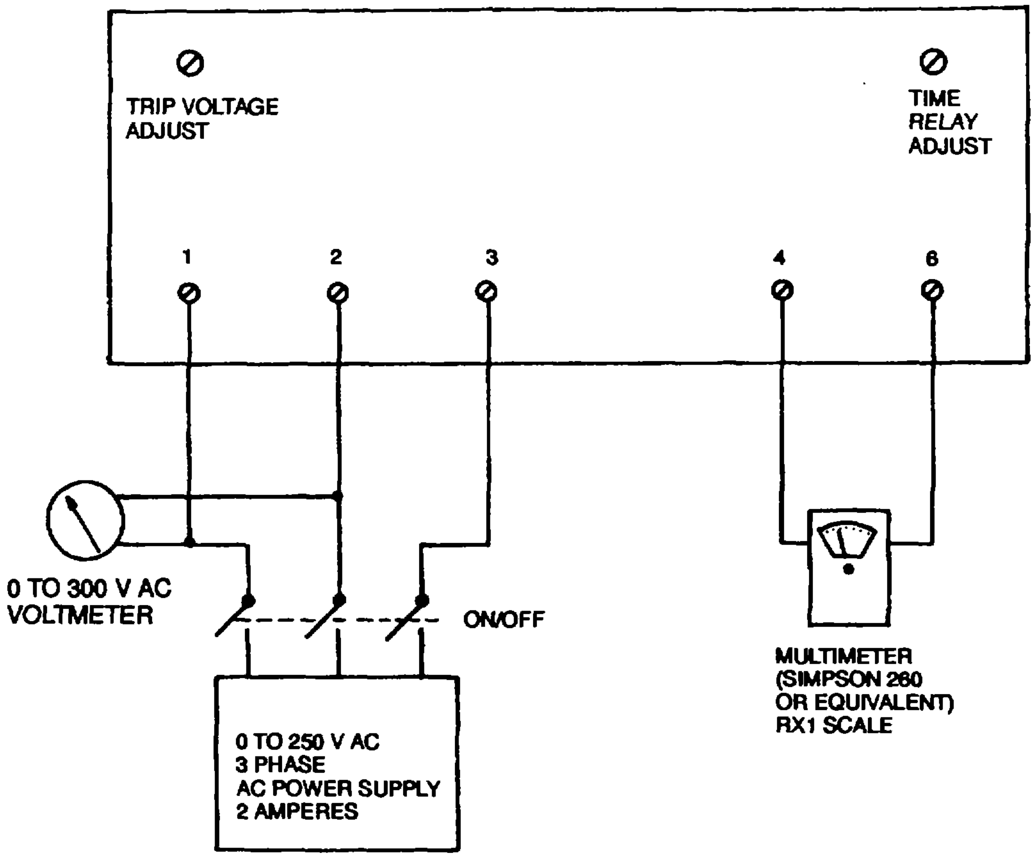


Figure 5-29. Test Setup, Over/Undervoltage Relay K110 and K111

5-35. UNDERVOLTAGE RELAY K111 (64, Figure 5-9).

a. Inspect. See Figure 5-9.

(1) Inspect screw and captive washer assemblies (62) and electrical connections for security.

(2) Inspect wires connected to undervoltage relay Kill (64) for evidence of burning or insulation breakdown.

b. Remove. See Figure 5-9.

(1) Tag and disconnect wires from overvoltage relay K111 terminals.

(2) Remove overvoltage relay K11 (64) by removing screw and captive washer assemblies (62).

c. Bench-Test

(1) Preparation for Bench Test.

(a) Remove overvoltage relay K111 in accordance with step b, above.

(b) Obtain a 3 phase, O to 250 V ac variable voltage source with a built-in voltmeter, a multimeter, (a relay tester) and a stopwatch.

NOTE

If variable voltage source has no built in voltmeter, a separate 0-300 V ac voltmeter may be connected across any two output lines of the three phase voltage source.

(c) See Figure 5-29. Connect the 3 phase 250 V ac variable voltage source at terminals 1,2, and 3 of relay K111. Set multimeter to RX1 scale and connect across terminals 4 and 6 of the relay.

(2) Test.

(a) Turn on variable voltage source connected at terminals 1, 2, and 3 of K111 and set for an output voltage of 240 V ac as reflected on the voltmeter. Monitor multimeter at terminals 4 and 6 of the relay. Multimeter should read zero ohms.

(b) Gradually decrease voltage input into the relay by turning down the variable voltage source. The relay should trip when voltage from the variable voltage source decreases to 166 ±5 V ac as indicated on the voltmeter. Multimeter should read infinite ohms at this point, showing that the relay contacts have changed state. Record voltmeter reading.

(c) Turn off the variable voltage source with its output level set at the trip voltage recorded in step (b) above. After 10 seconds, turn variable voltage source back on while timing relay trip time with a stopwatch. Multimeter at this point should deflect to zero ohms. Relay should trip within 1 1/2±1 seconds as indicated by the multimeter deflecting back to infinite ohms.

(3) Adjust

(a) If relay does not trip at specified voltage (166 i5 V ac), turn the trip voltage adjustment at upper left of the relay clockwise or counterclockwise to either increase or decrease the undervoltage threshold level. Repeat step (2)(b), above, and continue adjusting until the desired 166 ±5 V ac trip point is obtained.

(b) If relay does not trip within the specified 1 1/2±1 seconds time delay, turn the time delay adjustment pot at upper right of relay clockwise or counterclockwise to either increase or decrease the relay's time delay setting. Repeat step (2)(c), above, and continue adjusting until the specified 1 1/2±1 seconds time delay is attained.

(4) Replace. If the specified undervoltage threshold and/or time delay period cannot be attained through the relay adjustment pots, replace the undervoltage relay.

d. Install. See Figure 5-9.

(1) Install undervoltage relay K1 (64) and secure with screw and captive washer assemblies (62).

(2) Make wiring connections as tagged and discard tags.

5-36. OVERCURRENT RELAY K114 (65, Figure 5-9).

a. Inspect.

(1) Inspect for overall cleanliness and damage.

(2) Ensure that plexiglass faceplate is clean, intact, and securely fastened by the three captive screws.

(3) Ensure that all electrical wiring and mounting connections are secure.

b. Remove. See Figure 5-9.

(1) Tag and disconnect wiring from overcurrent relay K114 (65).

(2) Remove four screws (66) from rear of panel and carefully slide overcurrent relay K114 (65) free from front of panel.

c. Test. See Figure 5-30.

(1) Preparation for bench test.

(a) Remove overcurrent relay in accordance with step b, above.

(b) Obtain a 24 V dc power source, a 24 V, 0-15 ampere ac power source, a dc voltmeter, and an ac ammeter.

(c) Connect the positive lead of the 24 V dc power source to terminal 7 of relay K114 and the negative lead to terminal 8 of relay K114. Install the dc voltmeter across terminal 12 of relay K114 and the negative lead of the 24 V dc power source. Connect the 24 V, 0-15 ampere ac power source across terminals 5 and 6 of relay K114. Install the ac ammeter in series between the 24 V, 0-15 ampere ac power source and terminal 6 of relay K114.

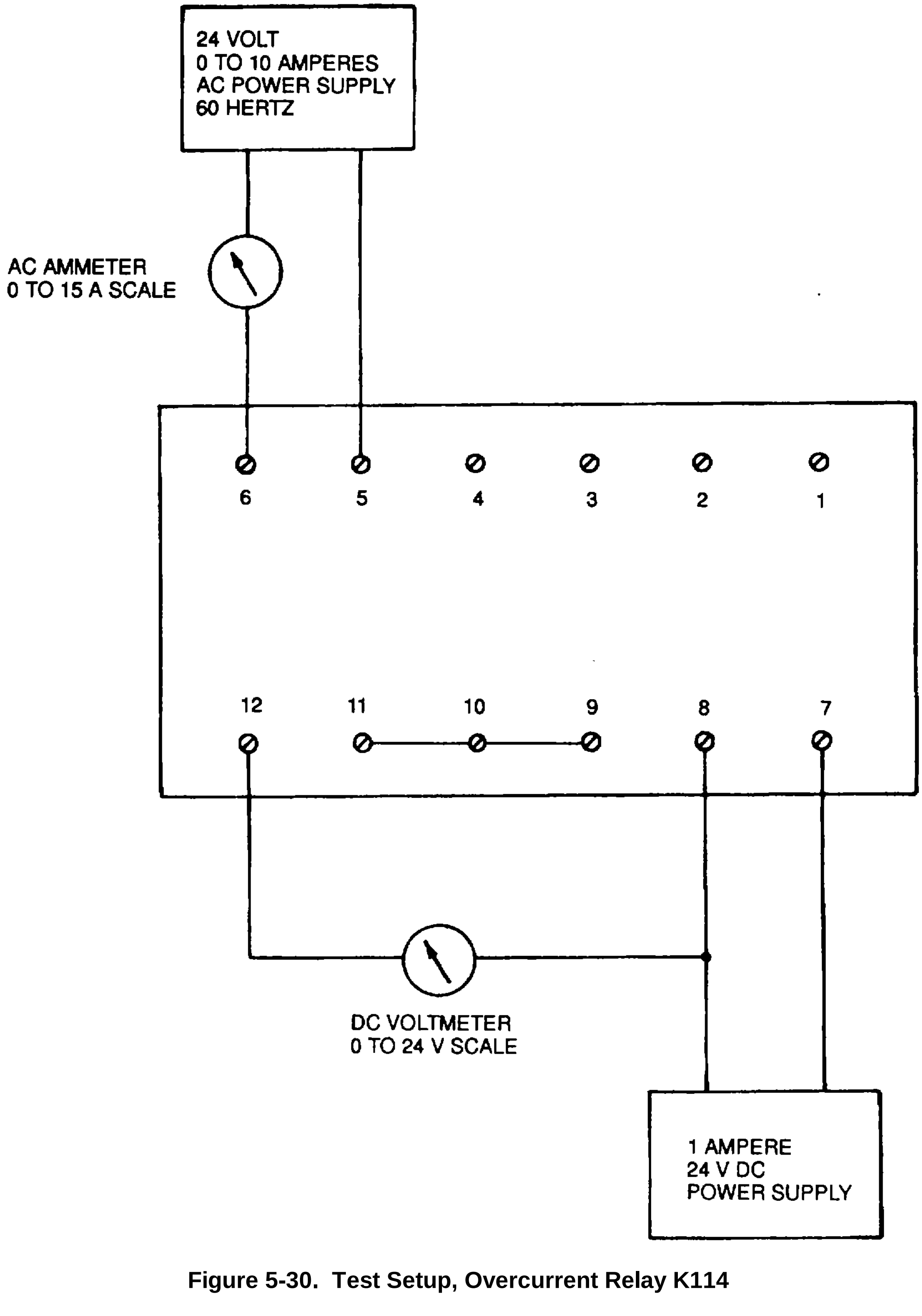


Figure 5-30. Test Setup, Overcurrent Relay K114

(2) Test.

(a) Turn on both power sources and increase output of the ac power source to 5.4 amperes. The dc voltmeter should read 24 V dc. Relay K114 should trip in 20 i5 seconds as measured by a stopwatch. This will be indicated by the dc voltmeter reading zero volts.

(b) Turn off both power sources and reset relay K114. Connect the ac power source across terminals 3 and 4 of relay K114 and repeat step (a), above.

(c) Turn off both power sources and reset relay K114. Connect the ac power source across terminals 1 and 2 of relay K114, and repeat step (a), above.

(d) Ensure power sources are turned off and reposition tap on relay K114 to 1 X position. Turn on both power sources and set ac power source output to 4.5 amperes. Relay K114 should trip immediately.

(e) Turn off both power sources and reset relay K114. Connect ac power source across terminals 3 and 4 of relay K114. Turn on both power sources and set ac power source output to 4.5 amperes. Relay K114 should trip immediately.

(f) Turn off both power sources and reset relay K114. Connect ac power source across terminals 5 and 6 of relay K114, Turn on both power sources and set ac power output to 4.5 amperes. Relay K114 should trip immediately.

(g) Ensure power sources are turned off and reposition tap on relay K114 to 3 X 4 position. Turn on both power sources and set ac power output to 13 amperes. Relay K114 should trip immediately.

(h) Turn off both power sources and reset relay K114. Connect ac power source to terminals 3 and 4 of relay K114. Turn on both power sources and set ac power source output to 13 amperes. Relay K114 should trip immediately.

(i) Turn off both power sources and reset relay K114. Connect ac power source to terminals 1 and 2 of relay K114. Turn on both power sources and set ac power source output to 13 amperes. Relay K114 should trip immediately.

(j) Ensure both power sources are turned off. Reset relay K114 and return tap to its original position. Disconnect all test equipment.

(3) Replace. Replace overcurrent relay K114 if it fails any portion of this test.

d. Install. See Figure 5-9.

(1) Slide overcurrent relay K114 (65) through cutout in front of panel and secure with four screws (66) at the rear of panel.

(2) Securely reconnect wiring as tagged and discard tags. Ensure that jumper link is restored across terminals 9, 10, and 11 if removed.

5-37. GROUND FAULT RELAY K115 (67, Figure 59). The ground fault relay K115 is an overvoltage relay that has been installed for ground fault detection. It operates by comparing generator set ground with phase neutral of the output of generator G1. Any voltage difference sensed by ground fault relay K115 indicates that current is flowing in the neutral phase. Ground fault relay K115 then trips to open the load circuit breaker CB101. Ground fault relay K115 is mounted on Cabinet A door. Figure 5-31 is a graph of the time voltage curve of ground fault relay K115.

a. Inspect. See Figure 5-32.

(1) Check that there are no broken or cracked molded parts or other signs of physical damage to ground fault relay K115 (67).

(2) Open ground fault relay K115 cover. Endplay of disc should not be so great as to allow the disc to strike the drag magnet. Check that top and bottom pivot screws are tight. There should be no noticeable friction in the rotating structure.

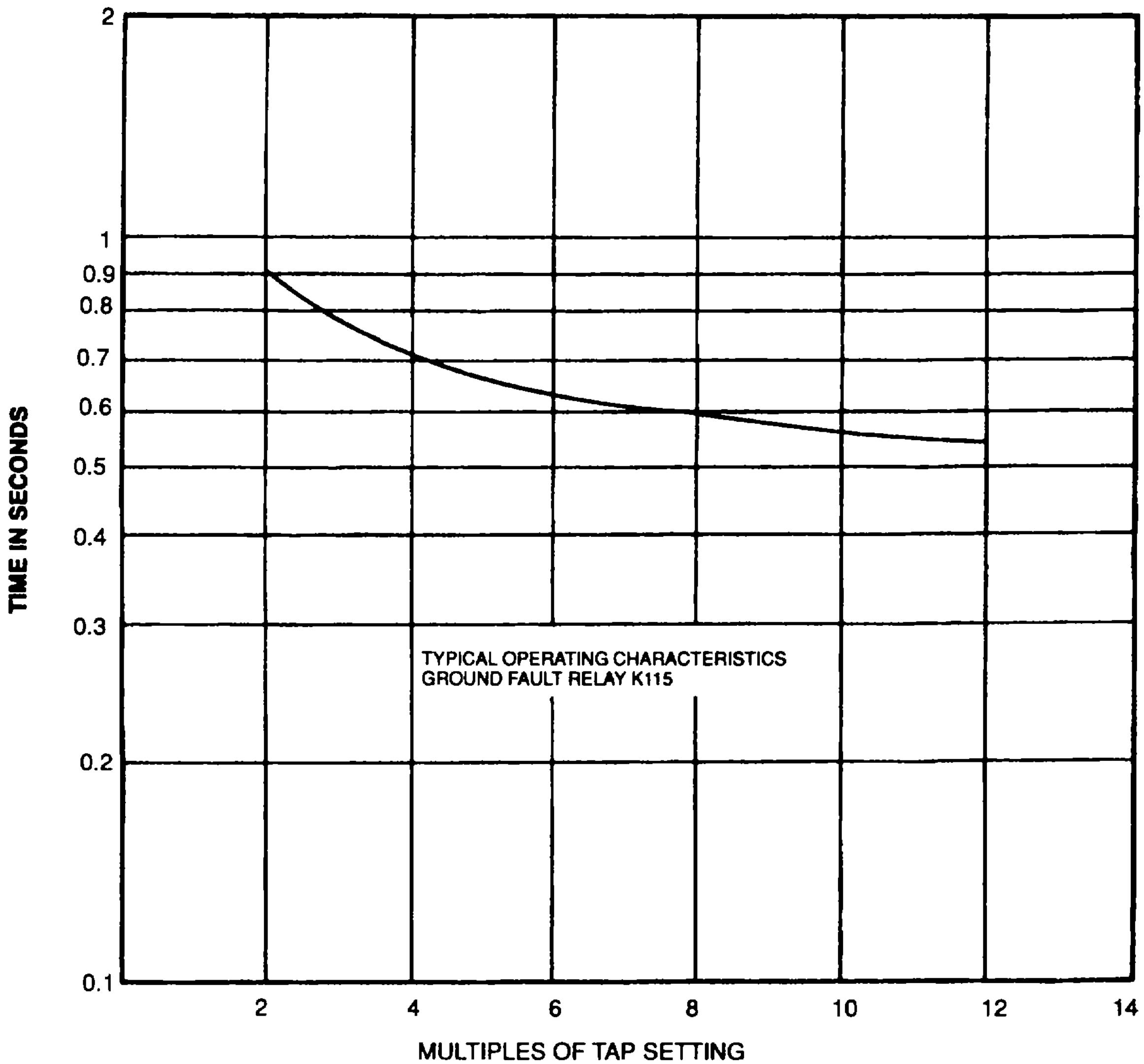


Figure 5-31. Ground Fault Relay K115, Time Voltage Curve

(3) See Figure 5-32. Check tap for proper setting. Tap should be in the 2 ampere tap. If not, proceed as follows:

(a) The tap plug is the screw holding the right-hand stationary contact of the sealed-in element.
(b) Take a screw from the left-hand stationary contact and place it in the 2 ampere tap.
(c) Remove the screw from the other tap and place it in the left-hand contact.

(4) See Figure 5-32. Verify that the time dial is set at the number 1 time dial position. If not, turn the time dial until the number lines up with the notch in the adjacent frame.

(5) See Figure 5-32. Verify that the tap plug is set at the number 16 position on the tap block. If not, remove the tap plug and install it in this location.

b. Remove. See Figure 5-9.

(1) Tag and disconnect wires from ground fault relay K111 (67).

(2) Remove ground fault relay K115 (67) cover by loosening captive screw and washer assemblies (68).

(3) Remove ground fault relay K111 (67) by removing screws (66).

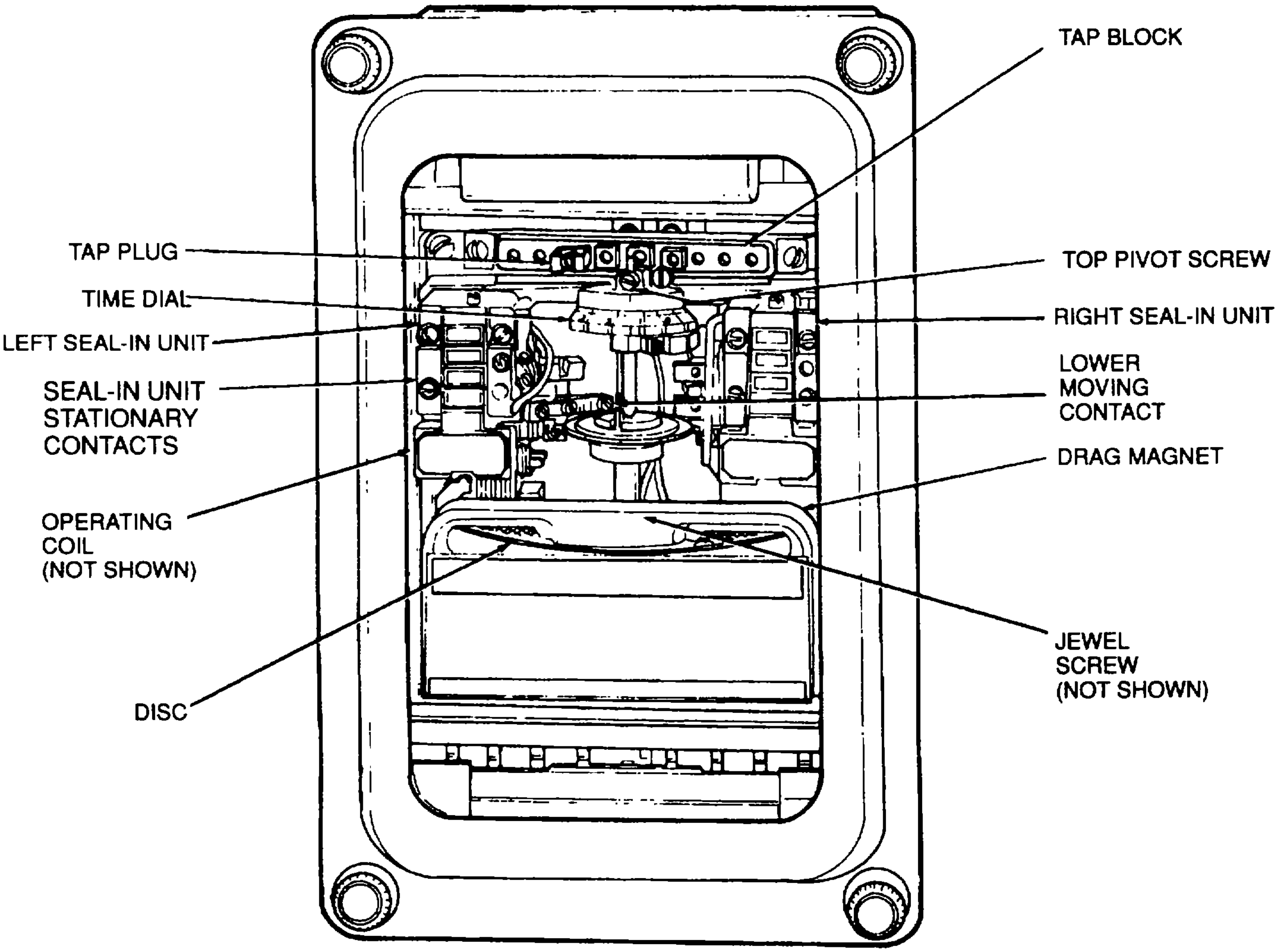


Figure 5.32. Ground Fault Relay K115 (Sheet 1 of 3)

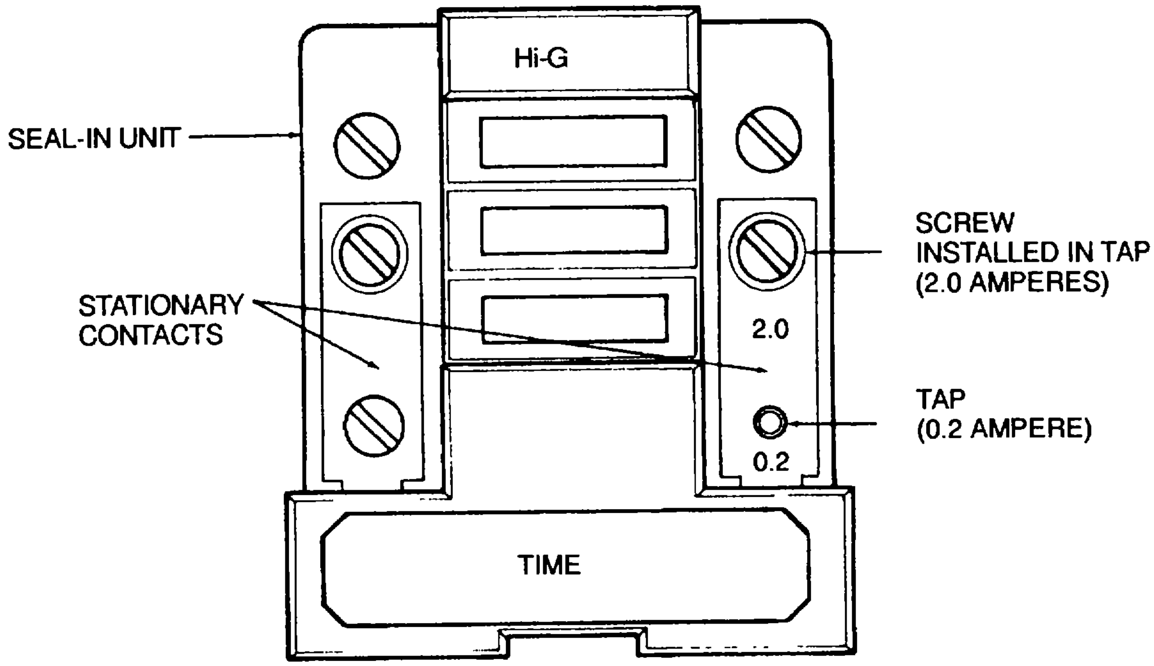
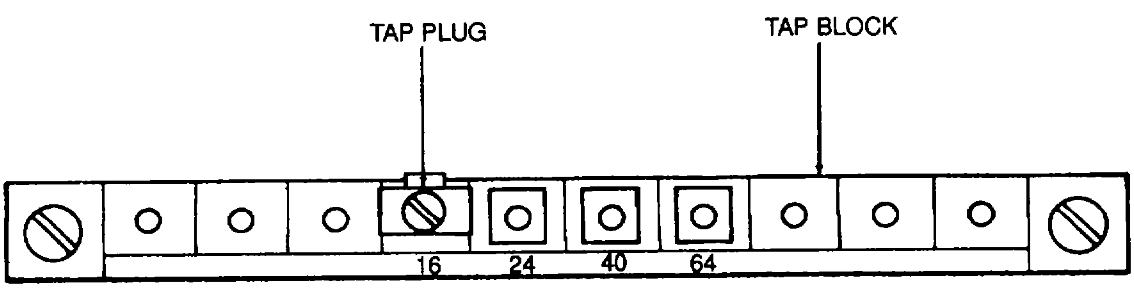


Figure 5-32. Ground Fault Relay K115 (Sheet 2 of 3)



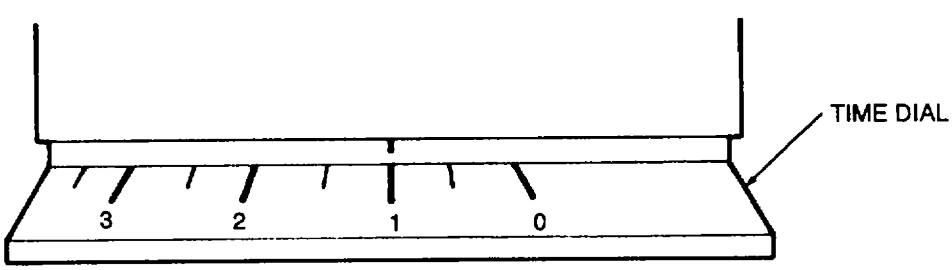


Figure 5-32. Ground Fault Relay K115 (Sheet 3 of 3)

c. Test. See Figure 5-33.

(1) Pick up voltage test.

(a) With switch open, apply 120 V ac power to terminals 5 and 6 at rear of K115.

(b) Adjust potentiometer for voltmeter indication of zero V ac.

(c) Close switch.

(d) While observing voltmeter, adjust potentiometer to increase voltage until relay trips.

(e) Verify relay trips at 20 i4 V ac.

(2) Time voltage test.

(a) With switch open, apply 120 V ac power as in step (1), above.

(b) Adjust potentiometer for voltmeter indication of 24 V ac.

(c) Set time totalizing timer to zero seconds.

(d) Close switch S2.

(e) Verify relay trips at 1 ±0.5 seconds by referring to timer.

d. Repair. See Figure 5-32. Repair ground fault relay K115 by replacement of defective components.

e. Install. See Figure 5-9.

(1) Remove cover from ground fault relay K111 (67). If installed, by removing screw and captive washer assemblies (68).

(2) Install ground fault relay K115 (67) in cabinet A door and secure with screws (66).

(3) Install cover on ground fault relay Kl15 (67) by installing screw and captive washer assemblies (68).

(4) Connect wiring as tagged and discard tags.

5-38. SYNCHRO CHECK RELAY K116 (69, Figure 59).

a. Inspect. See Figure 5-9.

(1) Inspect synchro check relay K116 (69) for damage.

(2) Check wire connections for security.

b. Remove. See Figure 5-9.

(1) Tag and disconnect wires from synchro check relay KI16 (69).

(2) Remove synchro check relay Kl16 (69) by removing screw and captive washer assemblies (62).

c. Test.

(1) Connect synchro check relay K116 to 120 V ac, 50/60 Hz power source and multimeter set to RX1 scale as shown in Figure 5-34. Apply 120 V ac, 50 Hz, A phase, to terminals 1 and 2 of relay K 116.

(2) Apply 120 V ac, B phase, to terminals 3 and 4.

(3) The multimeter should indicate infinite ohms (contacts open). Voltages are not synchronized.

(4) Repeat steps (1) and (2), above, with 120 V ac. 60 Hz, C phase, applied to terminals 3 and 4.

(5) The multimeter should indicate infinite ohms (contacts open). Voltages are not synchronized.

(6) Connect synchro check relay K116 to 120 V ac 50/60 Hz power source and multimeter set to RX1 scale as shown in Figure 5-34.

(7) Apply parallel 120 V ac, A phase, to terminals 1 and 2, and terminals 3 and 4 of relay K 116.

(8) The multimeter should indicate zero ohms (contact closure).

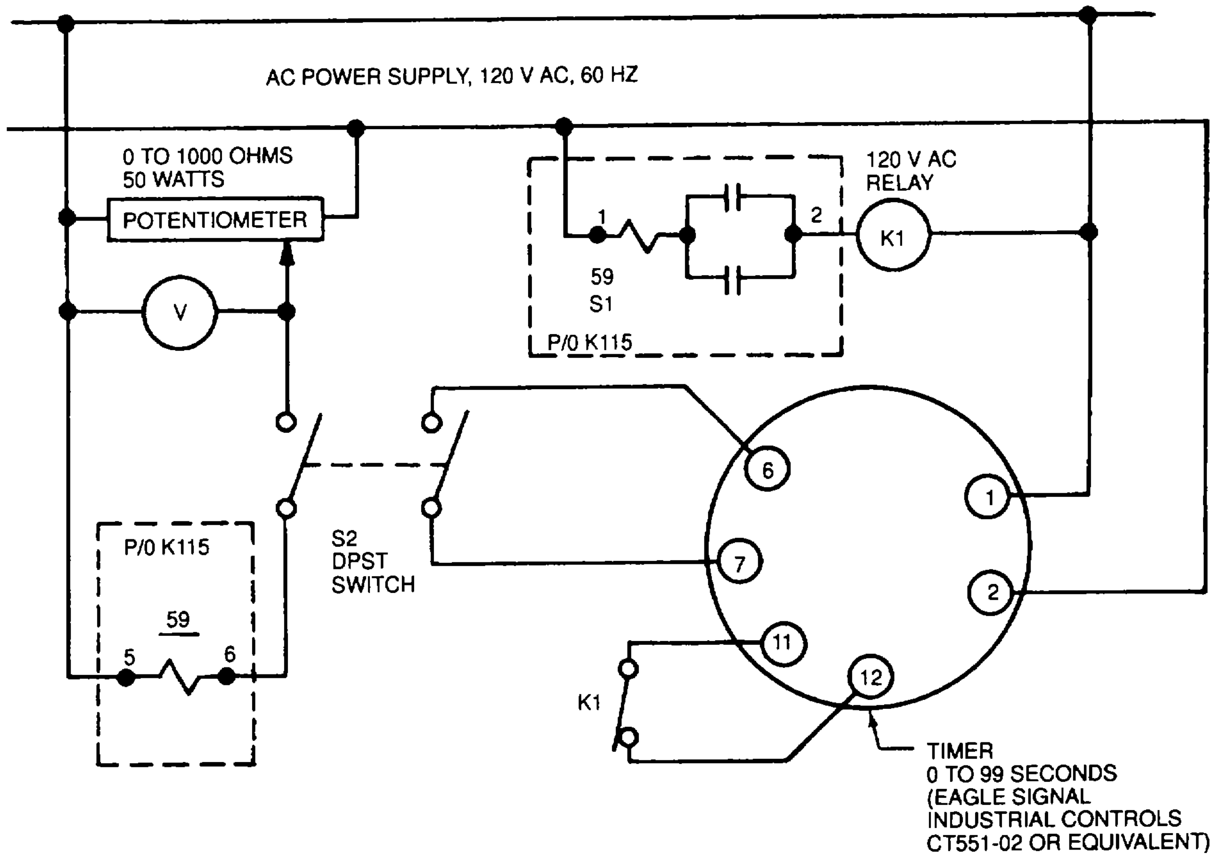


Figure 5-33. Test Setup, Ground Fault Relay K115

d. Adjust. The relay phase angle is adjustable between 6 and 18 degrees via the adjustment tap on the relay. Adjust as necessary and repeat test.

e. Replace. Replace the synchro check relay K116 if it fails any portion of this test.

f. Install.

(1) Install synchro check relay K116 (69) and secure with screw and captive washer assemblies (62).

(2) Make wiring connections as tagged and discard tags.

5-39. SWITCHGEAR HEATER CONTACTOR K117 (70, Figure 5-9).

a. Inspect.

(1) Inspect screw and captive washer assemblies (71) nut and captive washer assemblies (72) and electrical connections for security.

(2) Inspect switch gear heater contactor K117 (70) for evidence of damage.

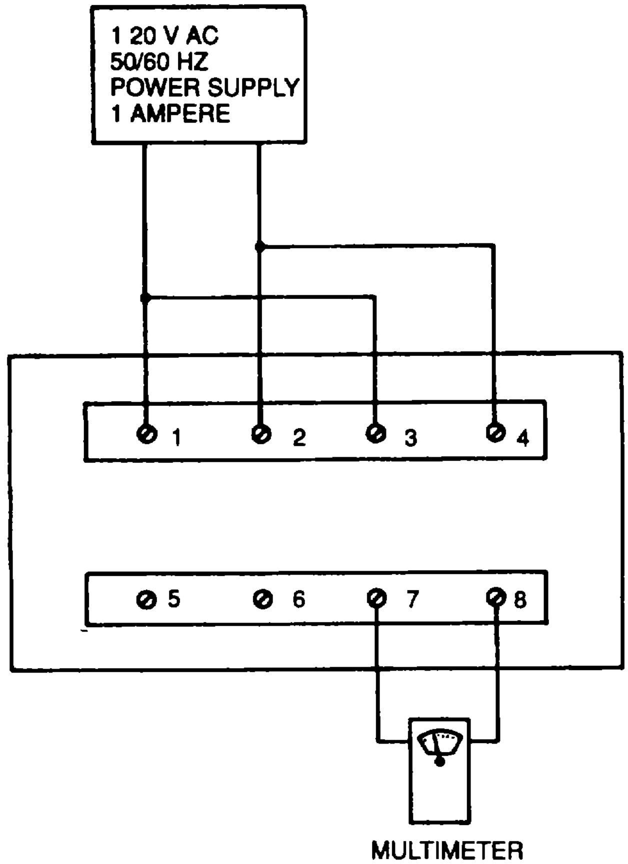


Figure 5-34. Test Setup, Synchro Check Relay K116

b. Remove.

(1) Tag and disconnect wires from K117 (70).

(2) Remove relay Kl17 (70) by removing screw and captive washer assemblies (71) and nut and captive washer assemblies (72).

c. Test.

(1) Connect multimeter set to RX1 scale across one set of normally closed contacts. Observe reading of less than 1 ohm.

(2) Repeat step (1), above, for the other set of contacts.

(3) Connect multimeter across one set of normally open contacts. Observe reading of infinite ohms.

(4) While continuing to observe multimeter, apply 120 V ac power source to coil. Observe reading drop from infinite ohms to less than 1 ohm.

(5) Disconnect 120 V ac power source to coil.

(6) Repeat steps (3) through (5), above, for the other set of normally open contacts.

(7) Replace K117 (70) if any readings are not as specified.

d. Install.

(1) Install switch gear heater contactor Ki17 (70) and secure with screw and captive washer assemblies (71) and nut and captive washer assemblies (72).

(2) Make wiring connections as tagged and discard tags.

5-40. COOLANT HEATER CONTACTORS K104A AND K104B.

a. Inspect. See Figure 5-9.

(1) Inspect screw and captive washer assemblies (84 and 86) and electrical connections for security.

(2) Inspect coolant heater contactors K1O4A and K1O4B (83 and 85) for evidence of damage.

b. Remove. See Figure 5-9.

(1) Tag and disconnect wires from coolant heater contactors K104A and K104B (83 and 85).

(2) Remove coolant heater contactors K104A and K104B (83 and 85) by removing screw and captive washer assemblies (84 and 86).

c. Test.

(1) Connect multimeter set to RX1 scale across one set of normally closed contacts. Observe reading of less than 1 ohm.

(2) Repeat step (1), above, for the other set of contacts.

(3) Connect multimeter across one set of normally open contacts. Observe reading of infinite ohms.

(4) While continuing to observe multimeter, apply 120 V ac power source to coil. Observe reading drop from infinite ohms to less than 1 ohm.

(5) Disconnect 120 V ac power source from coil.

(6) Repeat steps (3) through (5), above, for the other set of normally open contacts.

(7) Replace coolant heater contactor K104A or K104B if any readings are not as specified.

d. Install. See Figure 5-9.

(1) Install coolant heater contactor K104A or K104B (83 and 85) with screw and captive washer assemblies (84 and 86).

(2) Make wiring connections as tagged and discard tags.

5-41. FUEL TRANSFER PUMP CONTACTOR K106.

a. Inspect. See Figure 5-9.

(1) Inspect screw and captive washer assemblies (82) and electrical connections for security.

(2) Inspect fuel transfer pump contactor K106 (81) for evidence of damage.

b. Remove. See Figure 5-9.

(1) Tag and disconnect wires from fuel transfer pump contactor K106 (81).

(2) Remove fuel transfer pump contactor K106 (81) by removing screw and captive washer assemblies (82).

c. Test.

(1) Connect multimeter set to RX1 scale across one set of normally closed contacts. Observe reading of less than 1 ohm.

(2) Repeat step (1), above, for the other set of contacts.

(3) Connect multimeter across one set of normally open contacts. Observe reading of infinite ohms.

(4) While continuing to observe multimeter, apply 120 V ac power source to coil. Observe reading from infinite ohms to less than 1 ohm.

(5) Disconnect 120 V ac power source from coil.

(6) Repeat steps (3) through (5), above, for the other set of normally open contacts.

(7) Replace fuel transfer pump contactor K1 06 if any readings are not as specified.

d. Install. See Figure 5-9.

(1) Install fuel transfer pump contactor K106 (81) with screw and captive washer assemblies (82).

(2) Make wiring connections as tagged and discard tagged.

SECTION VII. AC CIRCUIT BREAKERS

5-42. GENERAL. Switchgear circuit breaker CB123 (73, Figure 5-9) connects and disconnects station power to load circuit breaker CB101. MAINTENANCE LOCKOUT circuit breaker S100 connects and disconnects station power to the array of circuit breakers on distribution panel DP2.

5-43. SWITCHGEAR CIRCUIT BREAKER CB123 MAINTENANCE (73, Figure 5-9).

a. Inspection. Check switchgear circuit breaker CB123 (73, Figure 5-9) for security of mounting, signs of burning or scoring, and security of electrical connections.

b. Remove.

(1) Tag and disconnect wires to switchgear circuit breaker CB1 23 (73, Figure 5-9).

(2) Remove hexagonal head screws (75) and lockwashers (76) to remove circuit breaker bracket (74) and switchgear circuit breaker (73).

c. Test.

(1) With circuit breaker set to OFF position, use a multimeter set to RX1 scale to check continuity across the breaker. Meter should indicate infinite ohms (contacts open).

(2) Set circuit breaker to ON position. Use multimeter to check continuity across breaker. Meter should indicate zero ohms (contacts closed).

(3) If circuit breaker fails this test, it must be replaced.

d. Installation.

(1) Position switchgear circuit breaker CB123 (73, Figure 5-9) and secure with circuit breaker bracket (74), hexagonal head screws (75), and lockwashers (76).

(2) Connect wires as tagged and discard tags.

5-44. MAINTENANCE OF MAINTENANCE LOCKOUT CIRCUIT BREAKER S100 (77, Figure 5-9).

a. Inspect. Check MAINTENANCE LOCKOUT circuit breaker S100 (77, Figure 5-9) for security of mounting, signs of burning or scorching, and security of electrical connections.

b. Remove.

(1) Tag and disconnect wires to MAINTENANCE LOCKOUT circuit breaker S100 (77, Figure 5-9).

(2) Remove screws (78), flatwashers (79), and nut and captive washer assemblies (80) to remove MAINTENANCE LOCKOUT circuit breaker S100.

c. Test.

(1) With circuit breaker set to OFF position, use a multimeter set to RX1 scale to check for continuity across the breaker. Meter should indicate infinite ohms (contacts open).

(2) Set circuit breaker to ON position. Use multimeter to check for continuity across breaker. Meter should indicate zero ohms (contacts closed).

(3) If circuit breaker fails to meet this test, it must be replaced.

d. Install.

(1) Install MAINTENANCE LOCKOUT circuit breaker S100 (77, Figure 5-9) with screws (78), flat washers (79), and nut and captive washer assemblies (80).

(2) Connect wires to MAINTENANCE LOCKOUT circuit breaker S100 as tagged and discard tags.

SECTION VIII. MAIN DISCONNECT SWITCH S120

5-45. GENERAL. Main disconnect switch S120 is a mechanical assembly used to buss the output of the generator set to the output load terminals and to isolate the set from any external bus voltage source during maintenance. The switch is opened or closed using the switch handle on the right exterior side of lower cabinet A. Repair of the disconnect switch consists of disassembly to the extent required for replacement of a worn or damaged component.

5-46. MAIN DISCONNECT SWITCH S120 DISASSEMBLY.

a. Remove the main disconnect switch S120 assembly and switch handle assembly in accordance with the Operator and Organizational Maintenance Manual.

b. Detach the operating mechanism assembly (1, Figure 5-35) from the disconnect switch frame (2) by removing two hexagonal nuts (3) from the frame assembly. Do not remove hexagonal bolts (3, Figure 5-36) from the mechanism assembly (1, Figure 5-35) at this time. Detach operating mechanism assembly (1) from the shaft assembly (4) and remove shaft sleeve (5) if needed.

c. Disassemble operating mechanism assembly as follows: (1) See Figure 5-36. Remove sprocket assembly (14) from the operating mechanism assembly by removing retaining ring (15) and sprocket washer (16). Using a gear puller, remove sprocket (17) from drive lever assembly (11). Remove coupling key (18). Check sprocket (17) for chipped worn, or broken teeth.

   (2) Remove two hexagonal nuts (1) from exterior sides of the housing plates (12 and 13) and remove housing spacer studs (2) to separate outer housing plate (13) from inner housing plate (12). Remove right hand latch (7) and left hand latch (6). Remove drive lever spacers (8 and 9). Remove drive spring assembly (10) and drive lever assembly (11).

   (3) Remove hexagonal bolts (3) from outer housing plate (13) to remove housing spacer bushings (4) and latch springs (5).

d. Disassemble disconnect switch assembly as follows:

   (1) Remove retaining rings (6, Figure 5-35) and pins (7) to detach connecting links (8) from the shaft assembly (4). Discard retaining rings (6). Remove bearing plate (9) from frame (2), it needed, by removing hexagon head bolt (10), lockwashers (11), and hexagonal nuts (12).

   (2) Remove three switch blade assemblies (13) from frame (2) by removing hexagon head bolts (14) and flat washers (15) from top and bottom of the switch bases (18) and removing lockwashers (16) and hexagonal nuts (17) from behind the frames.

   (3) Detach blades (19) from hinges (20) by removing elastic stop nut (21), pivot spring washers (22) and hexagon head bolts (23).

   (4) Separate the two blades (19) and the connecting links (8) by removing hexagonal nuts (24), hexagonal head bolts (25), and spacers (26). Remove cotter pin (27) from rivet (28) and remove flat washers (29) and spring (30).

   (5) Detach jaw (31), arc chute support (32), and hinge (20) from base (18) by removing hexagon head bolts (33).

e. Disassemble switch handle assembly as follows:

   (1) Remove chain (30, Figure 5-36) from housing. Remove cotter pin (19) from spacer (22) inside the housing (32). Pull handle (20) away from housing (32) and remove two interlock discs (27), sprocket (24), and spacers (22 and 23) from interior of housing (32). Remove two bearings (21) from bearing mounting holes at side of housing.

   (2) Remove OPEN and CLOSED indicator plates (28 and 29) from housing (32).

f. Separate chain (30, Figure 5-36) halves, if needed, by loosening or removing turnbuckles (31).

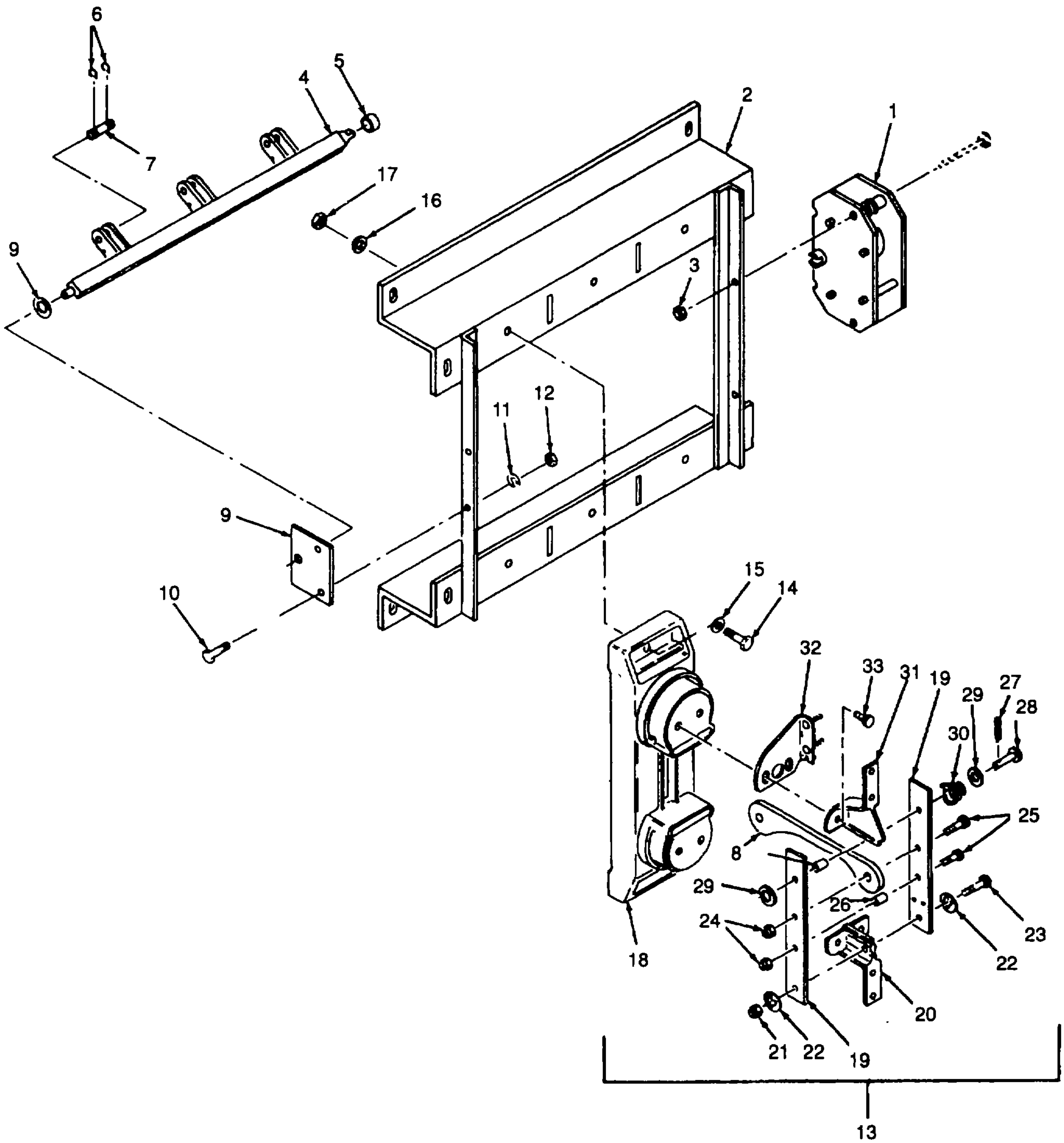


Figure 5-35. Main Disconnect Switch S120, Exploded View (Sheet 1 of 2)

1. OPERATING MECHANISM ASSEMBLY
2. FRAME
3. HEXAGONAL NUT
4. SHAFT ASSEMBLY
5. SHAFT SLEEVE
6. RETAINING RING
7. PIN
8. CONNECTING LINK
9. BEARING PLATE
10. HEXAGON HEAD BOLT
11. LOCKWASHER
12. HEXAGONAL NUT
13. BLADE ASSEMBLY
14. HEXAGON HEAD BOLT
15. FLAT WASHER
16. LOCKWASHER
17. HEXAGONAL NUT
18. BASE
19. BLADE
20. HINGE
21. ELASTIC STOP NUT
22. PIVOT SPRING WASHER
23. HEXAGON HEAD BOLT
24. HEXAGONAL NUT
25. HEXAGON HEAD BOLT
26. SPACER
27. COTTER PIN
28. RIVET
29. FLAT WASHER
30. SPRING
31. JAW
32. ARC CHUTE SUPPORT
33. HEXAGON HEAD BOLT

Figure 5-35. Main Disconnect Switch S120, Exploded View (Sheet 2 of 2)

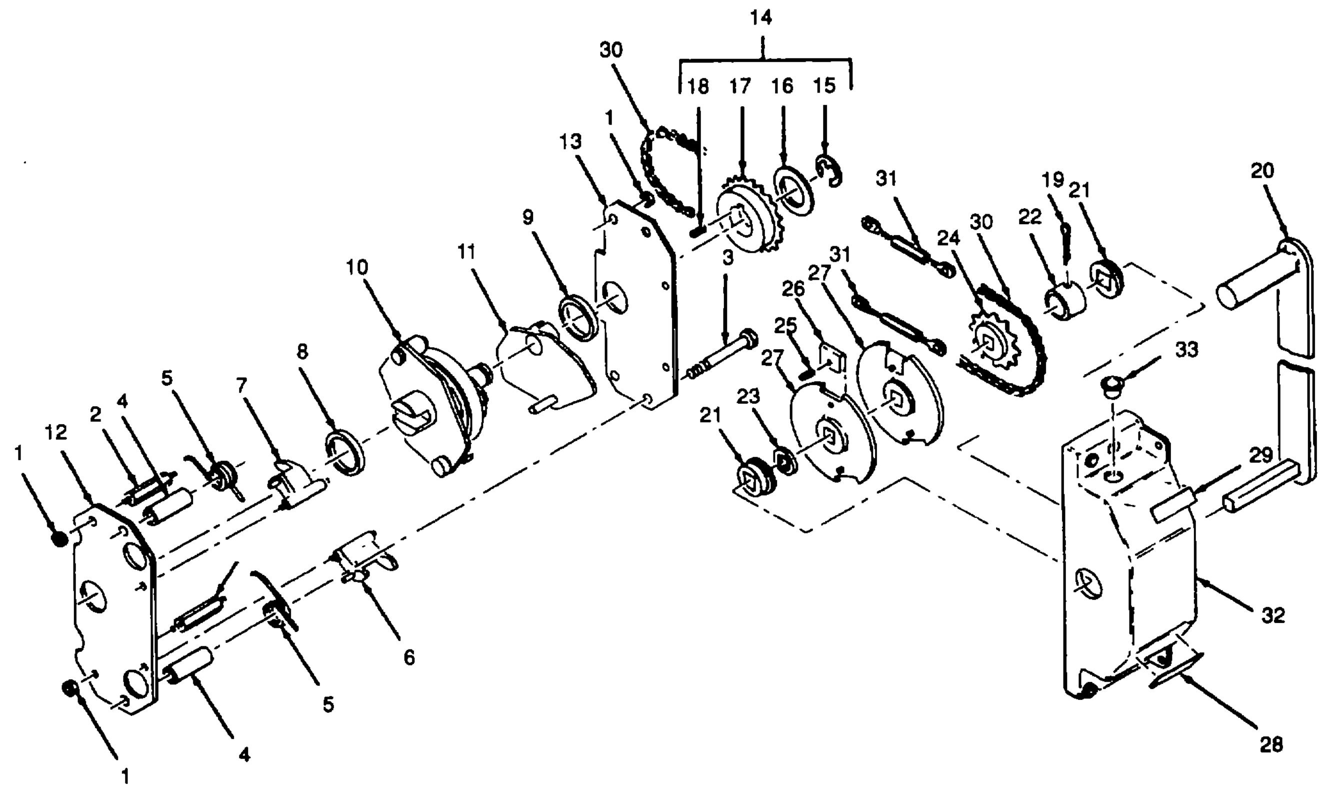


Figure 5-36. Main Disconnect Switch S120, Operating Mechanism, Exploded View (Sheet 1 of 2)

1. HEXAGONAL NUT
2. SPACER STUD
3. HEXAGONAL BOLT
4. SPACER BUSHING
5. LATCH SPRING
6. LEFT HAND LATCH
7. RIGHT HAND LATCH
8. DRIVE LEVER SPACER
9. DRIVE LEVER SPACER
10. DRIVE SPRING ASSEMBLY
12. INNER HOUSING PLATE
13. OUTER HOUSING PLATE
14. SPROCKET ASSEMBLY
15. RETAINING RING
16. SPROCKET WASHER
17. SPROCKET
18. COUPLING KEY
19. COTTER PIN
20. HANDLE
21. BEARING
22. SPACER
23. SPACER
24. SPROCKET
25. ROLLPIN
26. INTERLO CK STOP
27. INTERLOCK DISC
28. OPEN INDICATOR PLATE
29. CLOSED INDICATOR PLATE
30. CHAIN
31. TURNBUCKLE
32. HOUSING
33. PLASTIC PLUG

Figure 5-36. Main Disconnect Switch S120, Operating Mechanism, Exploded View (Sheet 2 of 2)

5-47. ASSEMBLY OF MAIN DISCONNECT SWITCH S120.

a. Assemble switch assembly as follows:

(1) If housing (32, Figure 5-36) is to be replaced, remove bottom plastic plug (33) from replacement housing (32) to accommodate kirk-key interlock system.

(2) Install two bearings (21) on bearing mounting holes at sides of the housing (32).

(3) Turn housing (32) face down and install internal components one by one by threading through with the handle (20) shaft. Install the handle (20) in the CLOSED (up) position through the bearing (21) mounted on the housing (32) side equipped with lock flanges.

(4) Install spacer (22), sprocket (24), two interlock discs (27) and spacer (23). If interlock discs are to be replaced, remove interlock stops (26) from replacement discs by removing roll pins (25). Position left interlock disc (27) in relation to the handle shaft as shown in Figure 5-36. The interlock disc (27) furthest from the handle (20) must be installed so that the beveled side of the interlock stop slots face the handle and are positioned at the top and bottom of the interlock discs when the handle is in the fully CLOSED (up) position. Thread through all components with handle (20) shaft, as described in step (3) above until shaft tip goes through bearing (21) mounted on the other side of the housing.

(5) Secure all components in place by installing cotter pin (19) through spacer (22) and handle (20) shaft. Align spacer (22) holes with handle shaft hole as necessary to install the cotter pin (19). When installed, bend cotter pin ends outwards in opposite directions.

b. Assemble disconnect switch assembly as follows (perform identical procedures for the three blade assemblies):

(1) Attach arc chute support (32), jaw (31, Figure 5-35), and hinge (20) to the base (18) and secure with hexagon head bolts (33). Align hinge (20) and jaw (31) before finally tightening the hexagon head bolts (33).

(2) Install spacer (26) between second holes from bottom of each blade (19) and secure with hexagon head bolt (25) and hexagonal nut (24). Position end of connecting link (arc side down) between second holes from top of blades and secure with similar mounting hardware (24 and 25).

(3) Position spacer (26) between top holes of blades. Position spring (30) and flat washer (29) against outer side of right hand blade (19) and through to the left blade with rivet (28). Install flat washer (29) at rivet (28) end and secure with cotter pin (27).

(4) Install completed blade assembly on hinges (20) mounted on base (18) with hinge (20) between the bottom holes of the blade assembly. Position pivot spring washers (22) at outer side of blades (concave side inwards) and secure in place using hexagon head bolt (23) and plastic stop nut (21). Thread the connecting links (8) through slot at middle of the base (18).

NOTE

Coat hinge and jaw contact between blades with number OX-1 P, Grade E, before installing switch blades.

(5) Attach completed base (18) and blade (19) assembly to the switch frame (2) using hexagon head bolts (14) and flat washers (15) through the base (18) mounting holes. Secure at rear of frame (2) with lockwashers (16) and hexagonal nuts (17). Open each mounted blade assembly and adjust the elastic stop nuts (21) at the blade pivot points until blades cease to drop due to their own weight.

(6) Attach free ends of connecting links (8) to the shaft assembly (4) using pins (7) and secure with retaining rings (6). Ensure that grooved shaft end is positioned to the right to accommodate coupling with the operating mechanism assembly (1). Install flat washer (9) at other end of shaft assembly and thread through pivot hole on the bearing plate. Mount bearing plate (9) on frame using hexagon head bolts (10), lockwashers (11), and hexagonal bolts (12). If bearing plate was not removed, install flat washer (9) at pivot end of shaft assembly (4), and position through bearing plate (9) before attaching connecting links (8) from blades.

c. Assemble operating mechanism assembly as follows:

(1) Install two housing spacer studs (2, Figure 5-36) on the interior side of outer housing plate (13) and secure with hexagonal nuts (1) on plate exterior side.

(2) Install two spacers (8) on drive spring subassembly (10) shaft and one spacer (9) on drive lever subassembly (11) shaft. Install drive spring and lever assembly through the outer housing plate (13) with the drive lever subassembly (11) flush against the plate.

(3) Install upper and lower latches (5) in latch pivot holes on outer housing plate (13). Position latches so that the spring catch dowel on both latches (6 and 7) is confined within the circular ports on the outer housing plate (13).

(4) Align corresponding mounting holes on inner housing plate (12) over housing spacer studs (2), spring drive subassembly (10) shaft, and latch (6 and 7) pivot points. Mount inner housing plate (12) using hexagonal nuts (1) on threaded ends of the housing spacer studs (2) going through the plate (12). Tighten the hexagonal nuts (1) only to the extent required to hold the plate in place.

(5) Install one latch spring (5) each over upper and lower housing spacer bushings (4). Position upper spacer bushing (4) so that when fully installed inside the housing, the attached latch springs (5) straight end will be flush against the spring catch dowel on the upper latch; and its curved end will be both flush against the housing plate interior and pressing against the upper housing spacer stud (2).

(6) Position upper housing spacer bushing (4), with spring (5) attached, in its place between the two housing plates (12 and 13). Apply sufficient pressure when aligning spacer bushing with the bolt mounting holes to overcome spring tension once the spring ends are positioned as described step (5), above. With the spacer bushing (4) bore and bolt mounting holes aligned, push hexagon head bolt (3) through exterior side of the outer housing plate (13), until it goes through the inner housing plate (12). Hold temporarily in place with hexagonal nut (1) on plate exterior.

(7) Repeat installation procedure for lower housing spacer bushing, ensuring that the lower latch spring's straight end is pressing against the spring catch dowel on the lower latch (6) and flush against the lower housing spacer stud (2).

(8) Install coupling key (18) on drive lever assembly (11) shaft Align sprocket (17) with shaft and install. Secure sprocket (17) in place with flat washer (16) and new retaining ring (15).

d. Install operating mechanism assembly (1, Figure 5-35) on switch frame (2) as follows:

(1) Open or dose switch blades as required to couple operating mechanism (1) with shaft assembly (4). Slip shaft coupling sleeve (5) over free end of shaft assembly. Align hexagonal bolts (3), Figure 5-36) on operating mechanism assembly with mounting holes on switch frame (2, Figure 5-35) while at the same time coupling the shaft assembly with drive shaft on the operating mechanism assembly (1). Mount the operating mechanism assembly by tightening hexagonal nuts (3).

e. Install main disconnect switch S120 and handle assembly in accordance with the Operator and Organizational Maintenance Manual.

SECTION IX. PARALLEL CABLE ASSEMBLIES

5-48. GENERAL. The reactive circuit and governor circuit cable assemblies are used to interconnect the sensing circuits of two or more generator sets working in parallel. During parallel operation, the phase sequence, frequency, and voltage of each generator set output must be made to coincide with the others. The reactive circuit and governor circuit cable assemblies provide a means of connecting the governor and voltage regulator circuits.

5-49. REPAIR OF PARALLEL CABLE ASSEMBLIES. See Figure 5-37.

a. Remove screws to remove clamps (2 or 8).
b. Unsolder and remove plug connector (3 or 9) from shielded cable (6 or 12).
c. Remove bushings (4 or 10) and band markers (5 or 11) from shielded cable (6 or 12).
d. Replace damaged or defective components.
e. Position band markers (5 or 11) on shielded cable (6 or 12).
f. Slide bushings (4 or 10) onto shielded cable (6 or 12) and solder plug connectors (3 or 9) onto cable (6 or 12).
g. Position bushings (4 or 10) over sleeve of plug connectors (3 or 9) and secure with clamps (2 or 8).

SECTION X. CURRENT BOOST MODULE A101

5-50. GENERAL. See Figure 5-38 and Figure 5-39. The purpose of the current boost module Al 01 (CBM) is to assist the voltage regulator VR1 01 during generator overload conditions such as engine starting, and to independently supply the generator exciter field current during generator short circuit faults. Operating power for the CBM is provided by two associated current transformers located in the conduit box assembly attached to the rear of the generator. The CBM consists of five functional circuits.

a. DC Output Circuit. The DC output circuit contains a power bridge rectifier and two silicon controlled rectifiers (SCR's) in series with the AC input. When the SCR's are turned off, the power bridge rectifier supplies boost current to the exciter field. If the SCR's are turned on continuously, the AC input will be shorted, thus removing the DC output voltage. The DC output circuit is controlled by two associated circuits, the firing circuit and the voltage limiting circuit.
b. Firing Circuit. During normal generator operation the firing circuit will ensure continuous conduction of the DC output circuit SCR's (the continuous conduction of the SCR's removes the DC output). If the generator output voltage decreases below the comparator circuit's preset limit, the firing circuit will turn off. This causes the DC output circuit to turn on and supply boost current.
c. Voltage Sensing Circuit. The AC generator voltage is stepped down to the required level and rectified, and the resultant DC signal is applied to the comparator circuit.
d. Comparator Circuit. This circuit compares the sensing voltage with a preset reference voltage established by the operation point adjustment control R13. If the generator voltage decreases below the value set by R13, the comparator circuit enables the firing circuit. When the generator voltage increases above the value set by R13, the comparator circuit disables the firing circuit to remove the boost current.
e. Voltage Limiting Circuit. The voltage limiting circuit monitors the DC output voltage and adjusts the firing angle of the DC output circuit SCR's to limit the DC output to 180 V dc.

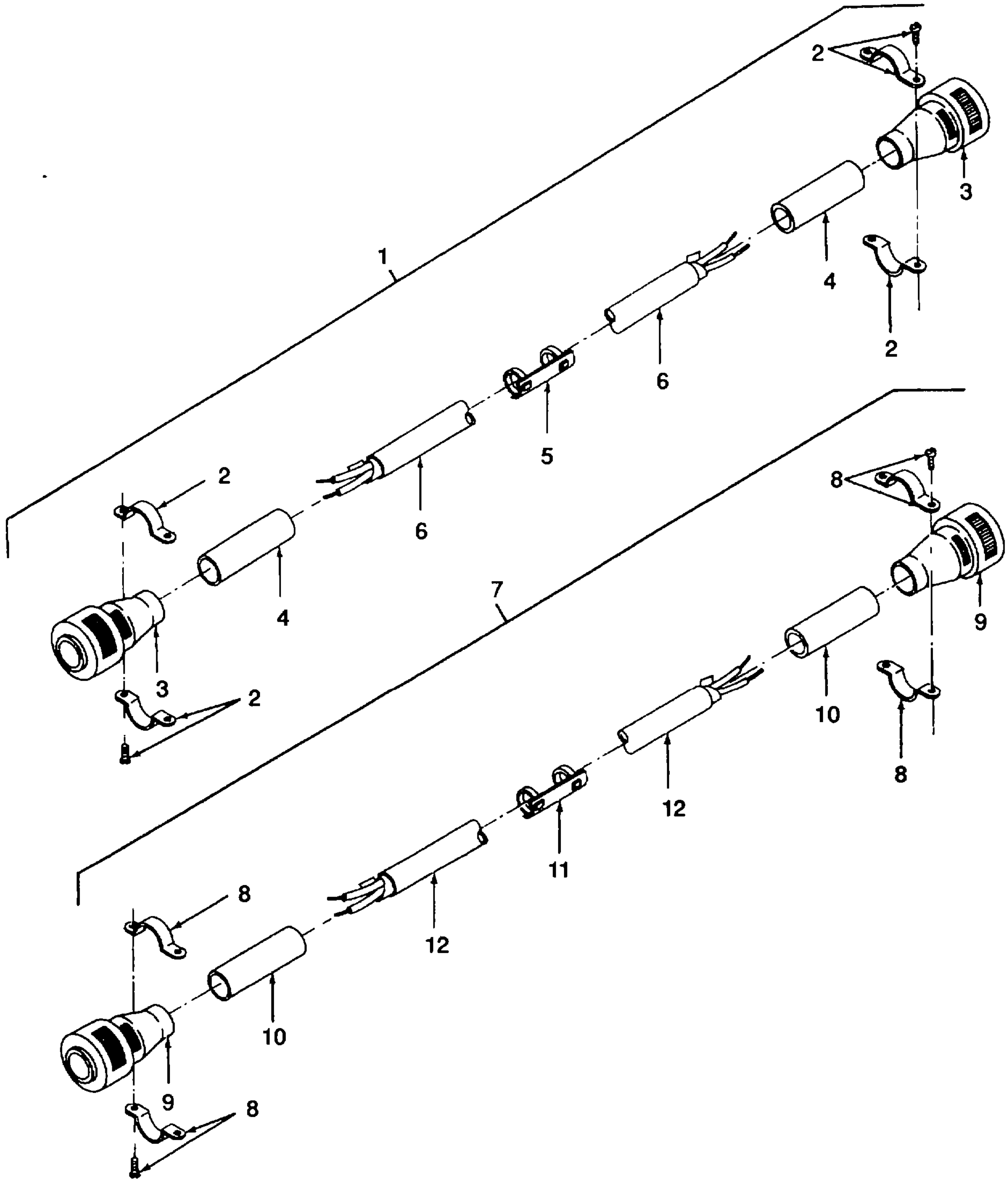


Figure 5-37. Parallel Cable Assemblies (Sheet 1 of 2)

1. REACTIVE CIRCUIT CABLE ASSEMBLY
2. CLAMP
3. PLUG CONNECTOR
4. BUSHING
5. RLC MARKER BAND
6. SHIELDED CABLE
7. GOVERNOR CIRCUIT CABLE ASSEMBLY
8. CLAMP
9. PLUG CONNECTOR
10. BUSHING
11. GPC MARKER BAND
12. SHIELDED CABLE

Figure 5-37. Parallel Cable Assemblies (Sheet 2 of 2)

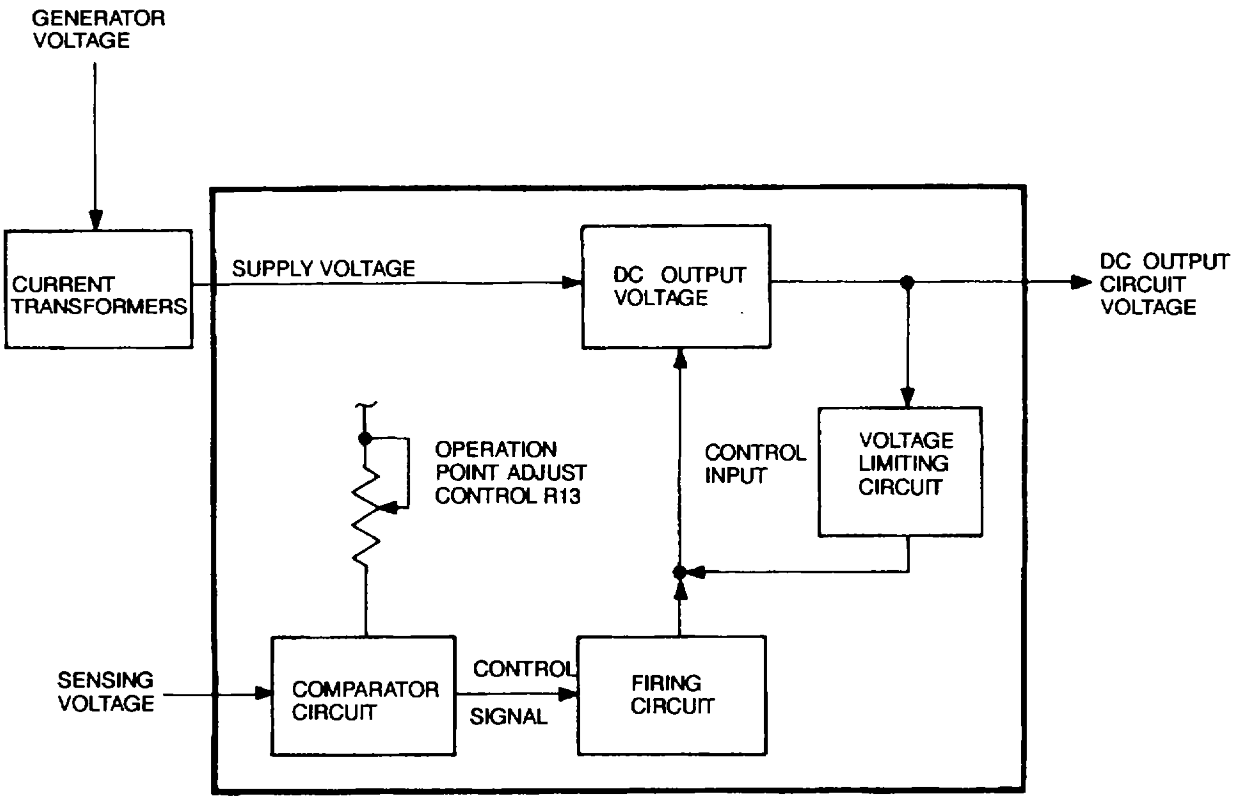


Figure 5-38. Current Boost Module A101, Functional Diagram

5-51. MAINTENANCE OF CURRENT BOOST MODULE A101 (33, Figure 5-9).

a. Inspect. See Figure 5-9. Check current boost module A101 for security of mounting, signs of burning and security of electrical connections.

b. Service. See Figure 5-9. Tighten any loose electrical connections and dean any dust or dirt that has accumulated on the terminal block.

c. Adjust. See Figure 5-39.

(1) With the generator running at no-load, rotate the operation point adjustment control R13 fully counterclockwise.

(2) Reduce generator voltage to 240 volts.

(3) Rotate the operation point adjustment control clockwise until the operation indicator (LED) turns off.

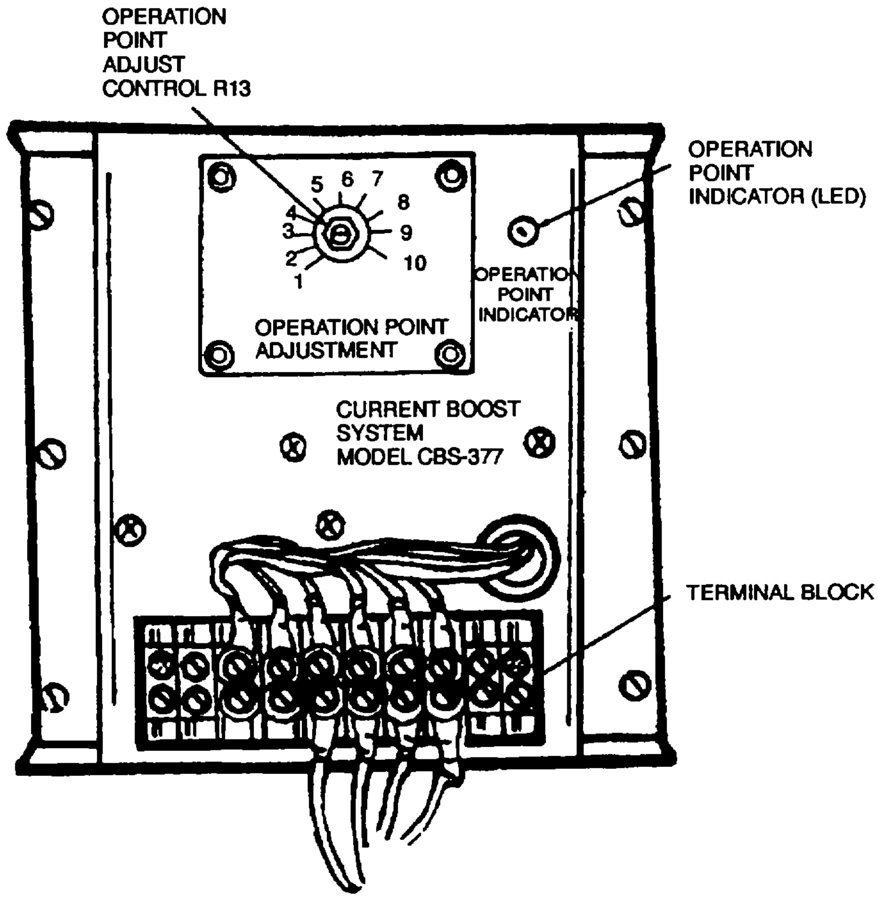


Figure 5-39. Current Boost Module A101, Adjusting

d. Remove.

(1) Set MAINTENANCE LOCKOUT switch S100 to MAINTENANCE.

(2) Open door to upper cabinet B.

(3) Tag and disconnect wires from current boost module A101 (33, Figure 5-9).

(4) Remove six screws and captive washer assemblies (34) and remove current boost module A101 (33).

e. Test. See Figure 5-39 and Figure 5-40.

CAUTION

High potential test equipment must not be used. Use of such equipment may destroy the semiconductors In current boost module A 101.

(1) Connect a 0 to 300 volt AC variable power supply with voltmeter, and ampermeter that has a five amp capacity across terminals 1 and 2, and a load resistor in series such as 500 watt 240 volt light bulb. Also connect another like power supply to terminals 3 and 4 of current boost module A101.

(2) Connect a DC voltmeter and load (such as a 240 volt 500 watt light bulb) to terminals N and P of current boost module A101.

(3) Turn on power supply to terminals 3 and 4 then adjust voltage to 240 VAC. Rotate operation point adjust control R13 to just turn out operation point indicator (LED). Lower power supply voltage to 200 VAC operation point indicator should light.

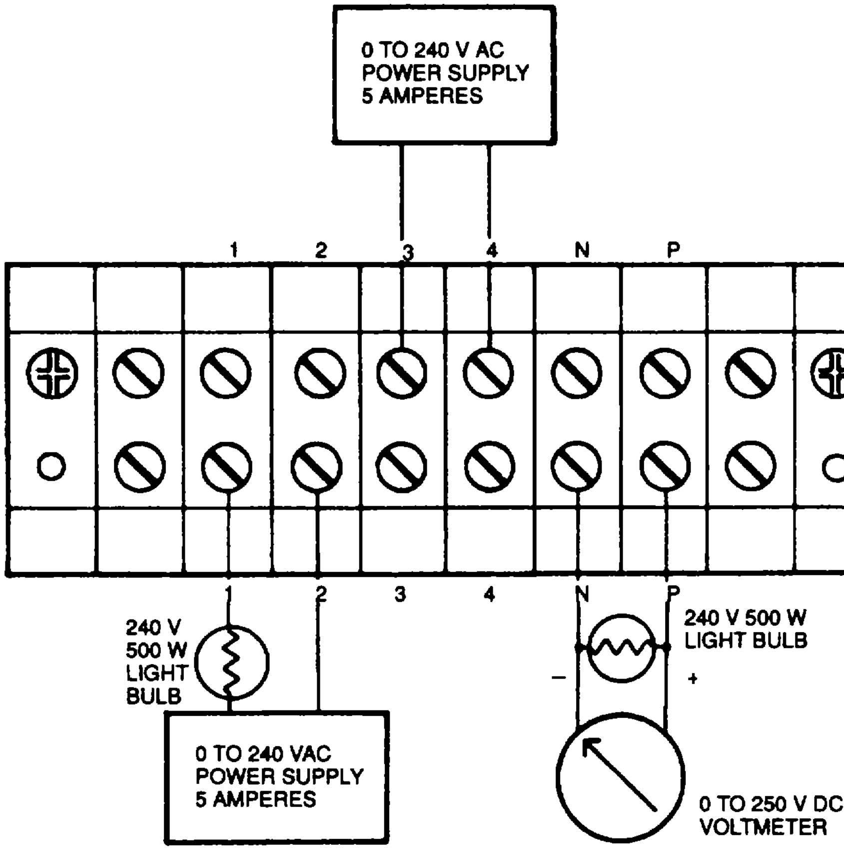


Figure 5-40. Test Setup, Current Boost Module A101

(4) Turn on power supply to terminals 1 and 2 and adjust voltage up and down observing the DC voltage on terminals N and P increases and decreases but does not go above 180 volts. Now adjust power supply 60 the DC voltmeter reads 100 volts.

(5) Now adjust power supply to terminals 3 and 4 above 240 VAC and the DC voltmeter should read about zero. The power supply on terminals 1 and 2 should indicate some amperage which is dependent on its load resistor. Now adjust this power supply voltage below 240 VAC the DC voltmeter should read 100 volts as set in above step. Replace current boost module if it fails the above test.

(6) Turn off both power supplies and disconnect all wiring used in the above steps.

(7) Reconnect wiring to the current boost module A101 and discard tags.

(8) Shut upper cabinet B door and set MAINTENANCE LOCKOUT switch S100 to OPERATE.

SECTION XI. LOAD TERMINALS

5-52. GENERAL The load terminals act as receptacles for the external load cables. The load terminals provide a physical connection between Main Disconnect Switch S120 and the external load cables.

5-53. LOAD TERMINAL DISASSEMBLY. See Figure 5-41.

NOTE

Before proceeding, ensure that the generator set is shut down and the external load cables are disconnected.

a. Set the MAINTENANCE LOCKOUT switch S100 to MAINTENANCE and place a danger tag on the switch.

b. Remove nut (1) and washer (2) which secure the load cable (3) to the rear of the load terminal (4).

c. Remove the nut (5), washer (6). and screw (7) which secure the ground wire (8) to the load terminal insert (9) and remove the ground wire.

d. Remove the load terminal insert (9) by pulling it out of the load terminal.

e. Remove the two nuts (10) and screw (11) which secure the ground wire (8) to the load terminal (4) and remove the ground wire.

f. Remove the four capscrews (12) and washers (13) that secure the load terminal (4) to the outgoing power enclosure and remove the load terminal.

5-54. TEST OF LOAD TERMINAL See Figure 5-41.

WARNING

Be sure that the test equipment is turned off before connecting the tester to the load terminal. Death by electrocution may result N test equipment Is turned on when connecting It to the load terminal.

a. Connect the positive lead of a 30 kV dc hi-pot tester to the center conductor of the load terminal.

b. Connect the negative lead of the tester to the outer shield of the load terminal.

WARNING

Be sure that personnel do not come In contact with load terminal during test. Death by electrocution may result.

c. Set all controls on the tester to zero and turn on the tester.

d. Increase output voltage of the tester to 5 kV and maintain for 1 minute. Record reading on current meter.

e. Increase tester output to 10 kV for 1 minute and record reading on current meter.

f. Increase tester output to 15 kV for 1 minute and record reading on current meter.

g. Increase tester output to 20 kV for 1 minute and record reading on current meter.

h. Increase tester output to 25 kV and maintain for 15 minutes. Record readings on current meter at 1 minute intervals.

i. After 15 minutes, decrease tester output to zero volts and turn off tester.

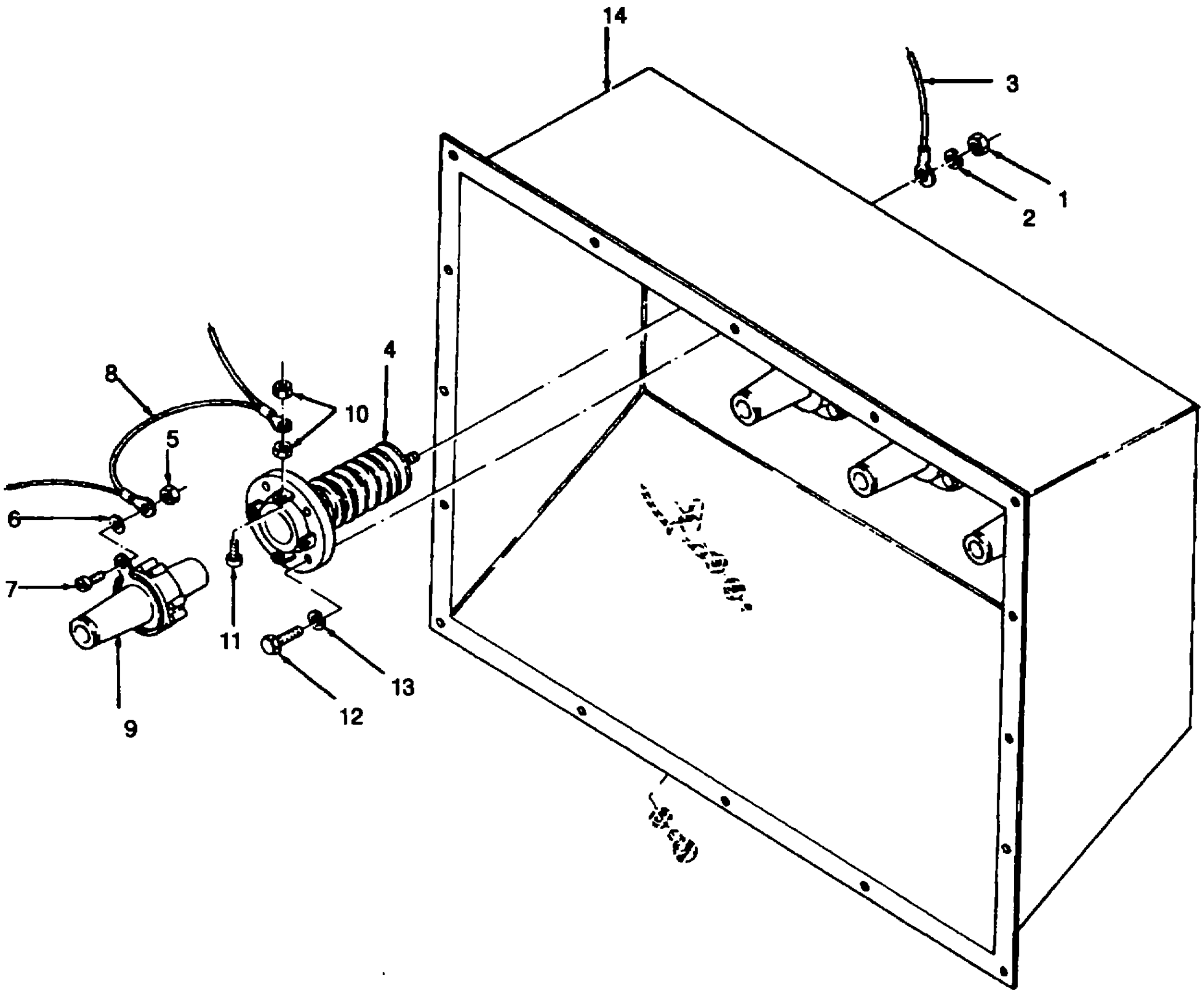
WARNING

Be sure tester Is turned off before disconnecting leads Death by electrocution may result.

NOTE

Leakage current is dependent on insulation condition as well as atmosphere conditions (humidity). Leakage current normally should not exceed 50 microamperes.

j. Disconnect leads from load terminal. Compare all meter readings taken during the test. Any sharp increase in readings during waiting periods indicates insulation breakdown of the load terminal and terminal should be replaced.



1. NUT
2. WASHER
3. LOAD CABLE
4. LOAD TERMINAL
5. NUT
6. WASHER
7. SCREW
8. GROUND WIRE
9. LOAD TERMINAL INSERT
10. NUT
11. SCREW
12. CAPSCREW
13. WASHER
14. OUTGOING POWER ENCLOSURE

Figure 5-41. Load Terminals, Exploded View

5-55. LOAD TERMINAL ASSEMBLY. See Figure 5-41.

a. Place load terminal (4) in position in the outgoing power enclosure (14) and secure with four capscrews (12) and washers (13).

b. Reconnect the ground wire (8) on the load terminal (4) and secure with screw (11) and two nuts (10).

c. Reinstall the load terminal insert (9).

d. Reconnect the ground wire (8) to the load terminal insert (9) and secure with screw (7), washer (6), and nut (5).

e. Reconnect the load cable (3) to the rear of the load terminal (4) and secure with nut (1) and washer (2).

f. Remove danger tag from MAINTENANCE LOCKOUT switch S100 and set switch to OPERATE.

CHAPTER 6

FUEL SYSTEM

SECTION I. FUEL TRANSFER PUMP

6-1. GENERAL. The purpose of the fuel transfer pump is to fill the generator set fuel tank from an outside fuel reservoir. The fuel transfer pump is a gear pump and is driven by an ac electric motor.

6-2. FUEL TRANSFER PUMP REPAIR. Repair of the fuel transfer pump is accomplished by replacement of worn or damaged components.

a. Remove. Remove the fuel transfer pump in accordance with paragraph 4-47 of the Operator and Organizational Maintenance Manual.

b. Disassemble.

(1) Remove cap (1, Figure 6-1) and gasket (2) from pump.

NOTE

When removing pressure relief valve adjusting screw, be sure to note the number of turns it takes to remove it. This screw must be reinstalled the same number of turns.

(2) Remove pressure relief valve adjusting screw (3), valve spring (4), and valve stem (5).

(3) Remove drain screw (6) and gasket (7).

(4) Remove the six screws (8) that retain pump end cap (9) and remove pump end cap, bushings (10), and housing (11) from stand (12).

(5) Remove screws (13) and remove gland (14).

(6) Remove carbon seal (15), performed packing (16), retainer (17), tapered spring (18), and split ring (19) from stand (12). Discard seal and preformed packing.

(7) Remove drive and driven gears (20) and bushings (10) from stand.

c. Assemble.

(1) Lubricate drive and driven gear shafts (20) with dean lubricating oil, such as MIL-L-9000. Install drive and driven gears (20) and bushings (10) in stand (12).

(2) Install split ring (19), tapered spring (18), retainer (17), preformed packing (16), and carbon seal (15) in stand (12).

(3) Install gland (14) and secure it with screws (13).

(4) Position bushings (10) in pump end cap (9), slide pump end cap and housing (11) over gears and secure with six screws (8).

(5) Install drain screw (6) and gasket (7).

(6) Install valve stem (5), valve spring (4), and adjusting screw (3). Be sure adjusting screw is turned the same number of turns as before it was removed.

(7) Install cap (1) and gasket (2).

d. Test. After repair, test fuel transfer pump in accordance with the Operator and Organizational Maintenance Manual.

e. Install. Install the fuel transfer pump in accordance with paragraph 447 of the Operator and Organizational Maintenance Manual.

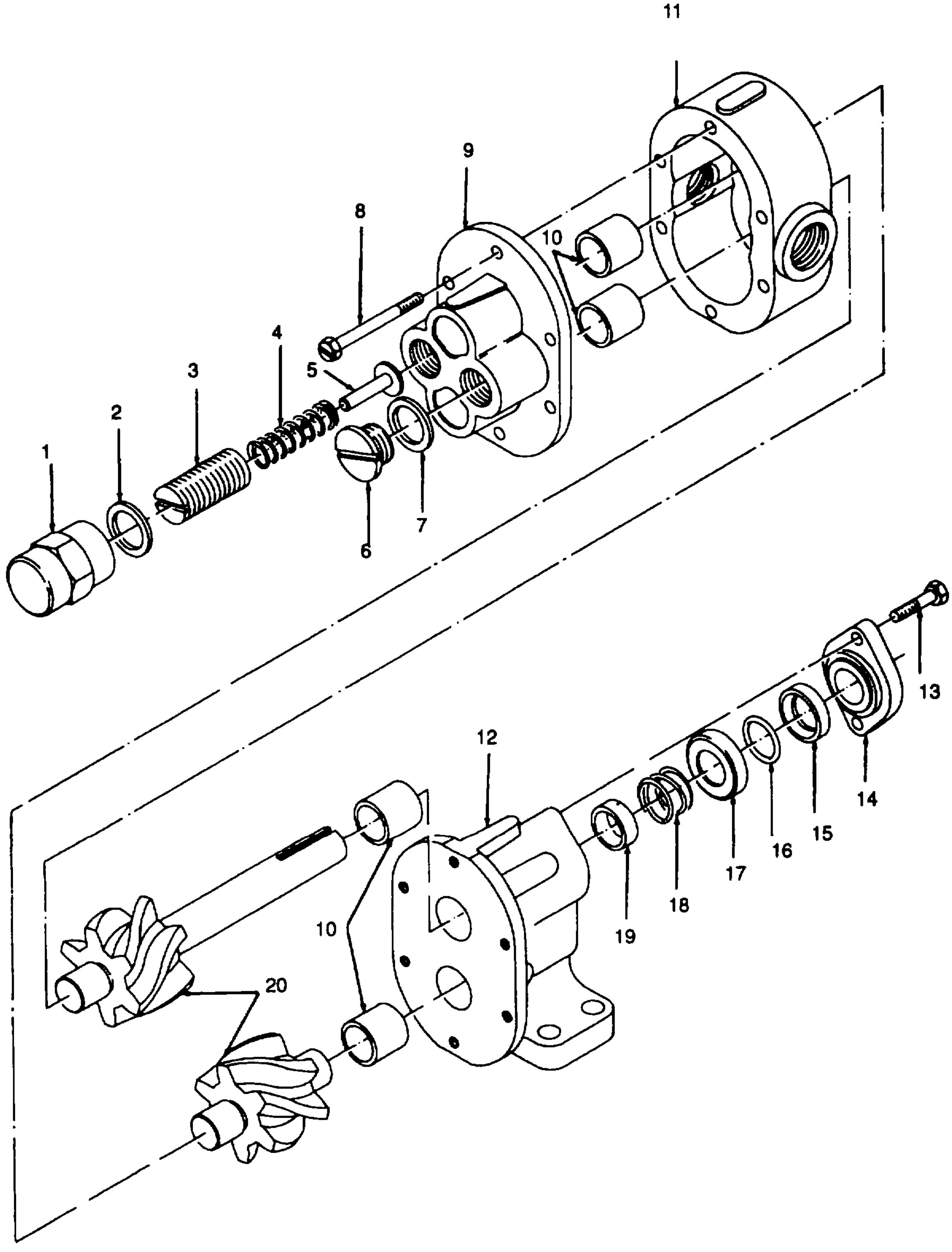


Figure 6-1. Fuel Transfer Pump, Exploded View (Sheet 1 of 2)

1. CAP
2. GASKET
3. ADJUSTING SCREW
4. VALVE SPRING
5. VALVE STEM
6. DRAIN SCREW
7. GASKET
8. SCREW
9. PUMP END CAP
10. BUSHING
11. HOUSING
12. STAND
13. SCREW
14. GLAND
15. CARBON SEAL
16. PREFORMED PACKING
17. RETAINER
18. TAPERED SPRING
19. SPLIT RING
20. DRIVE AND DRIVEN GEARS

Figure 6-1. Fuel Transfer Pump, Exploded View (Sheet 2 of 2)

SECTION II. SOLENOID VALVE L102

6-3. GENERAL. Fuel transfer solenoid valve L102 is connected in series in the fuel line between the auxiliary fuel inlet port and the fuel strainers. Solenoid valve L102 actuates to pass fuel whenever fuel transfer pump contactor K106 is actuated. Fuel may enter the generator set only when the fuel transfer pump is operating. The valve is closed at all other times to prevent fuel from siphoning into or out of the generator set.

6-4. SOLENOID VALVE L102 DISASSEMBLY. See Figure 6-2.

a. Tag and disconnect wiring from solenoid valve L102.

b. Remove retaining cap and clip (2) to separate nameplate (3), housing subassembly (4), coil (6), base plate (7), and solenoid base subassembly (8).

c. Unthread to remove bonnet (9) and bonnet gasket (10) from solenoid base subassembly (8).

d. Remove screws (1) to separate body (14), body gasket (13), diaphragm-core assembly (12), and core spring (11) from bonnet (10).

6-5. SOLENOID VALVE L102 REPAIR. See Figure 6-2. Repair of the valve is accomplished by replacement of worn or damaged parts. A repair kit (FV-158-929, FSCM 04845) consisting of a bonnet gasket (9), core spring (11), diaphragm core assembly (12), and body gasket (13) is available.

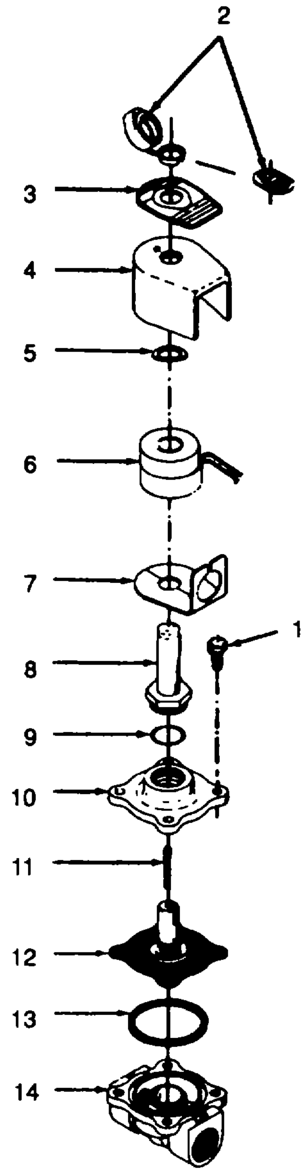
6-6. SOLENOID VALVE L102 ASSEMBLY. See Figure 6-2.

a. Install core spring (11) in diaphragm-core assembly (12). Install body gasket (13) in body (14). Then install diaphragm-core (12) and body (14) on bonnet (10) and secure with screws (1).

b. Install bonnet gasket (10) in bonnet (9) and thread onto solenoid base subassembly (8).

c. On solenoid base subassembly (8), install base plate (7), coil (6), spring wave washer (5), housing subassembly (4), and nameplate (3), and secure with retaining cap and clip (2).

d. Reconnect wiring to solenoid valve L102 as tagged and discard tags.



1. SCREW
2. RETAINING CAP AND CLIP
3. NAMEPLATE
4. HOUSING SUBASSEMBLY
5. SPRING WAVE WASHER
6. COIL
7. BASE PLATE
8. SOLENOID BASE SUBASSEMBLY
9. BONNET GASKET
10. BONNET
11. CORE SPRING
12. DIAPHRAGM-CORE ASSEMBLY
13. BODY GASKET
14. BODY

Figure 6-2. Solenoid Valve L102, Exploded View

SECTION III. MAINTENANCE OF THE FUEL INJECTION PUMP

6-7. GENERAL. See Figure 6-3, Figure 6-4, and Figure 6-5. The engine fuel system consists of a fuel pump, fuel filter set, manual fuel shutoff valve, fuel lines and manifolds, and fuel injectors. The fuel system operates according to the principle that the volume of fluid flow is proportionate to the fluid pressure, the flow time, and the size of the fluid passages. The fuel pump is driven from the engine front gear train via an accessory drive unit which couples to the fuel pump main shaft. The fuel pump main shaft operates an integral gear pump, upper and lower governor assemblies, and tachometer shaft. Fuel enters the fuel pump through a fitting at the rear of the gear pump and is pumped to a filter in the lower portion of the fuel pump housing. A pulsation damper attached to the gear pump contains a steel diaphragm which reduces pressure pulses in the fuel system and a pressure valve, located in the gear pump, restricts the return flow of fuel from the lower governor. Fuel then flows through the lower governor to the throttle shaft. The throttle provides a means of manually controlling the engine at speeds above idle when maintenance or repairs require this type of operation. During normal operation the throttle is locked in the fully open position and fuel passes to the electronic fuel control actuator. The electronic fuel control actuator is an electromagnetic rotary solenoid valve, operated by a remote electronic governor control. The actuator regulates fuel pressure and thereby regulates engine speed and horsepower. Fuel leaving the electronic fuel control actuator flows through the upper governor to the shutoff valve located on top of the fuel pump. The shutoff valve is electronically operated, and blocks the supply of fuel leaving the fuel pump; it is actuated by an operator in the control room of the generator set selecting the STOP position of MASTER SWITCH S9. The shutoff valve is also operated automatically by any one of the automatic shutdown systems in the generator set. During normal operation, with the shutoff valve open, fuel leaves the fuel pump through a fitting on the shutoff valve.

6-8. FUEL PUMP INSPECTION. See Figure 6-4 and Figure 6-5. Inspect the fuel pump as follows:

a. Inspect the fuel supply and fuel discharge hoses (1 and 2, Figure 6-4) and fittings for damage and leakage. Repair or replace damaged or leaking hoses and fittings.

b. Inspect for leakage at the joints between the pulsation damper assembly (10, Figure 6-5), gear pump assembly (14), fuel pump housing (29), main shaft, cover, and governor assembly (31), and shutoff valve assembly (18). Repair leaks by replacing gaskets or seals in accordance with paragraph 6-9.

c. Inspect the pump components for physical damage. Replace damaged components in accordance with paragraph 6-9.

6-9. FUEL PUMP REPAIR. Repairs consist of replacing defective subassemblies, and on-engine adjustments. Test and calibration procedures are contained in paragraph 6-11. Refer to troubleshooting, Chapter 2, Section 11 , to isolate the problem, and replace the defective subassemblies as follows:

a. Remove.

(1) Disconnect the fuel supply and discharge hoses (1 and 2, Figure 6-4) from the gear pump assembly (14, NO TAG) and shutoff valve assembly (18), respectively.

(2) Remove the two electrical wires from the shutoff valve assembly (18).

(3) Remove the two electrical wires from the actuator (4).

(4) Remove electrical connector J1 (3, Figure 6-4) from the speed switch SS1/SS21SS3 (4), and remove the speed switch SS1/SS2/SS3 from the main shaft, cover, and governor assembly (31, Figure 6-5).

(5) Remove the capscrews (33), lockwashers (34), and washers (35), and remove the fuel pump (7, Figure 6-4) from the accessory drive (6).

(6) Remove the spider (19, Figure 6-12) and retain with the fuel pump (7, Figure 6-4). Discard the gasket (32, Figure 6-5).

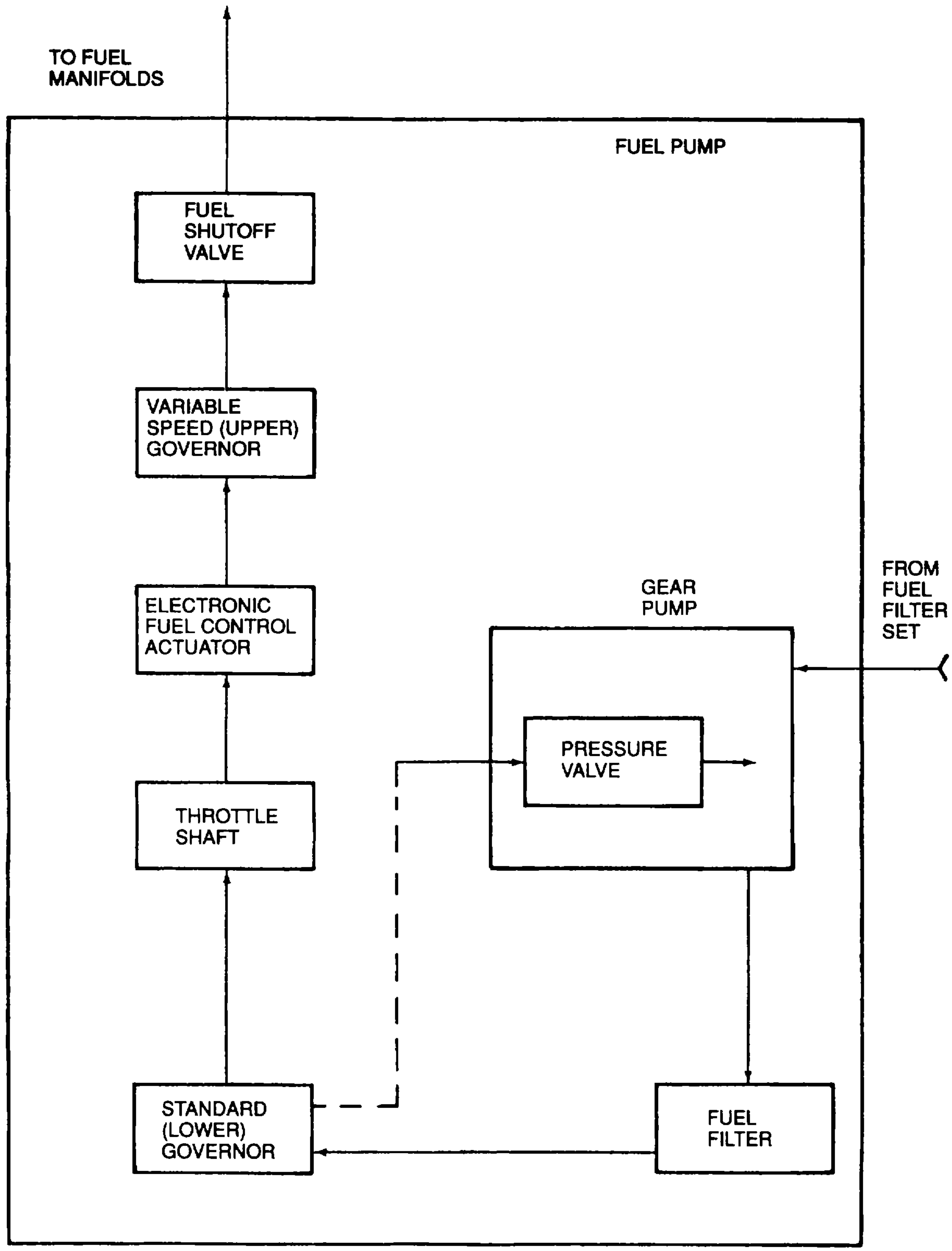
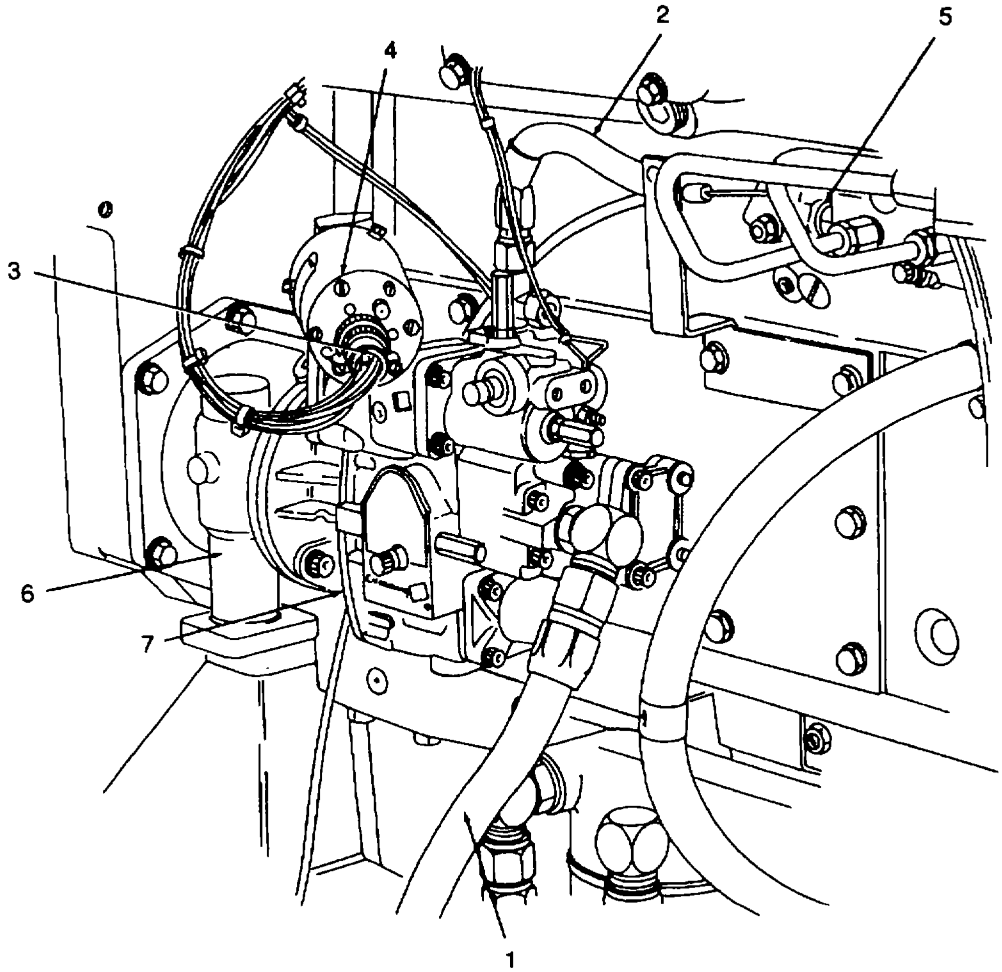


Figure 6-3. Fuel Injection Pump, Fuel Flow Schematic



1. FUEL SUPPLY HOSE
2. FUEL DISCHARGE HOSE
3. ELECTRICAL CONNECTOR
4. SPEED SWITCH SS1/SS2/SS3
5. MANUAL SHUTDOWN VALVE
6. ACCESSORY DRIVE
7. FUEL PUMP

Figure 6-4. Fuel Injection Pump, Left Side View

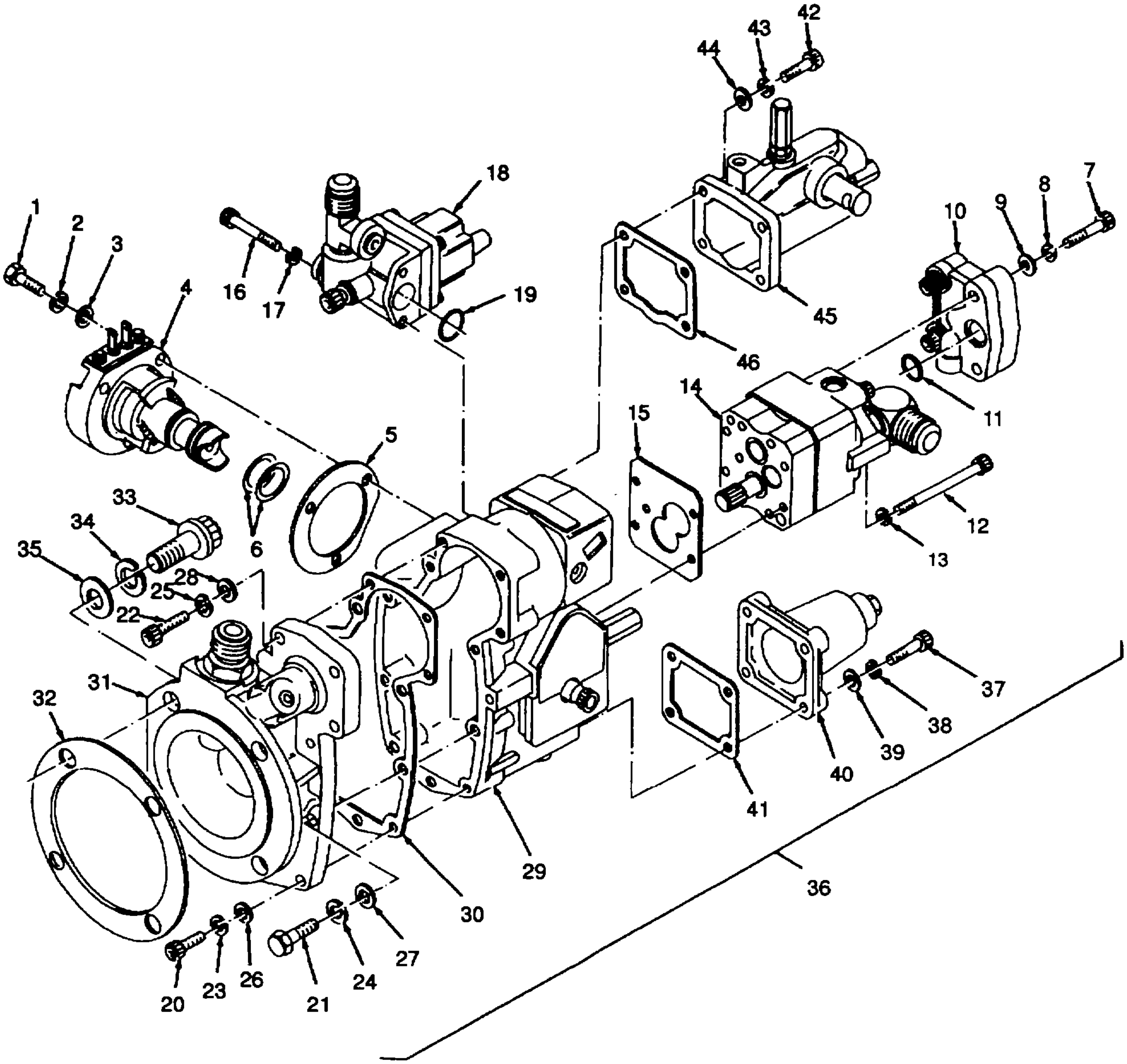


Figure 6-5. Fuel Injection Pump Subassemblies, Exploded View (Sheet 1 of 2)

1. CAPSCREW
2. LOCKWASHER
3. WASHER
4. ACTUATOR
5. GASKET
6. PREFORMED PACKING
7. CAPSCREW
8. LOCKWASHER
9. WASHER
10. DAMPER ASSEMBLY
11. PREFORMED PACKING
12. CAPSCREW
13. LOCKWASHER
14. GEAR PUMP ASSEMBLY
15. GASKET
16. CAPSCREW
17. LOCKWASHER
18. SHUTOFF VALVE ASSEMBLY
19. PREFORMED PACKING
20. CAPSCREW
21. CAPSCREW
22. CAPSCREW
23. LOCKWASHER
24. LOCKWASHER
25. LOCKWASHER
26. WASHER
27. WASHER
28. WASHER
29. FUEL PUMP HOUSING
30. GASKET
31. MAINSHAFT, COVER, AND GOVERNOR ASSEMBLY
32. GASKET
33. CAPSCREW
34. LOCKWASHER
35. WASHER
36. FUEL PUMP ASSEMBLY
37. CAPSCREW
38. LOCKWASHER
39. WASHER
40. SPRING PACK COVER
41. GASKET
42. CAPSCREW
43. LOCKWASHER
44. WASHER
45. COVER
46. GASKET

Figure 6-5. Fuel Injection Pump Subassemblies, Exploded View (Sheet 2 of 2)

b. Disassemble. In some cases it will be possible to replace a subassembly without complete disassembly. In these instances, replace a subassembly by selecting the appropriate steps. Mount the fuel pump to the fuel pump mounting plate 3375133, install it in ball joint vise ST-302, and disassemble as follows:

(1) Remove all tamper proof seals and wires, and remove the capscrews (7, Figure 6-5), lockwashers (8), washers (9), and remove the damper assembly (10) and packing (11). Discard the packing.

(2) Remove the capscrews (12) and lockwashers (13) and remove the gear pump assembly (14), and gasket (15). Discard the gasket.

(3) Remove the capscrews (1, Figure 6-5), lockwashers (2), and washers (3) securing the actuator (4) to the fuel pump housing (29).

(4) Pull the actuator (4) from the fuel pump housing (29). It may be necessary to rotate the actuator slightly from side to side to aid in removal. Discard the preformed packings (6).

(5) Remove the capscrews (16) and lockwashers (17) and remove the shutoff valve assembly (18). Remove and discard the preformed packing (19).

(6) Remove the capscrews (20, 21, and 22), lockwashers (23, 24, and 25), and washers (26, 27, and 28) and separate the fuel pump housing (29) from the mainshaft, cover, and governor assembly (31). Remove and discard the gasket (30).

c. Inspect. See Figure 6-5.

CAUTION

To avoid contamination of the subassemblies, do not perform any operations Involving drilling, filing, or machining. Do not Immerse subassemblies in solvent for cleaning. If extensive cleaning Is necessary, replace or rebuild the sub assembly in accordance with paragraph 6-10.

(1) Inspect gasket surfaces for damage that would prevent proper sealing. Repair damaged gasket surfaces in accordance with rebuilding procedures only, paragraph 6-10. or replace the subassembly.

(2) Inspect all threaded holes for damage. Repair damaged threads in accordance with rebuilding procedures only, paragraph 6-10, or replace the subassembly.

(3) Inspect all capscrews for thread damage. Repairs lightly damaged threads by chasing. Replace severely damaged or stripped capscrews.

d. Repair. Replace any subassemblies found to be defective in accordance with step c, above, or Troubleshooting, Chapter 2, Section 11.

e. Reassemble.

CAUTION

To avoid damage to the speed switch SS1/SS2/SS3 or governor components, be sure the speed switch SS1/SS2/SS3 gears are engaged, and the drive tangs on the governor plunger and weight carrier are aligned horizontally before the gasket surfaces are brought together.

Turn drive shaft while tightening the capscrews to be sure binding does not o: cur. If binding occurs, disassemble and determine the cause before proceeding with assembly.

(1) Using a new gasket (30, Figure 6-5), install the fuel pump housing (29) on the mainshaft, cover, and governor assembly (31), and secure with capscrews (20, 21, and 22), lockwashers (23, 24, and 25), and washers (26, 27, and 28). Cross tighten the capscrews to 9 to 11 pound-feet (12 to 15 newton-meters).

(2) Install shutoff valve assembly (18) with a new preformed packing (19) using the capscrews (16) and lockwashers (17). Tighten the capscrews to 9 to 11 pound-feet (12 to 15 newton-meters).

CAUTION

To avoid damage to the gear pump assembly, turn the drive shaft while tightening the capscrews to be sure binding does not occur. If binding occurs, disassemble and determine the cause before proceeding with assembly.

(3) Using a new gasket (15), install the gear pump assembly (14) on the fuel pump housing (29), and secure with capscrews (12) and lockwashers (13). Cross-tighten the capscrews to 11 to 13 pound-feet (15 to 18 newton-meters).

(4) Using a new preformed packing (11), install the damper assembly (10) with capscrews (7), lockwashers (8), and washers (9). Cross-tighten the capscrews to 11 to 13 pound-feet (15 to 18 newton-meters).

(5) Install the actuator (4) as follows:

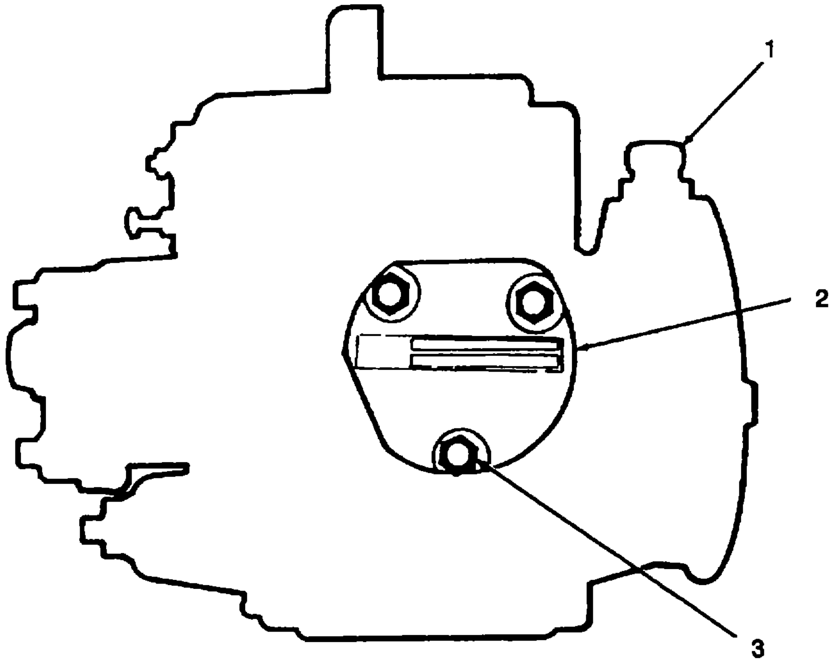
(a) Ensure that the plug (85, Figure 6-11) and preformed packing (86) are securely seated in the fuel pump housing (6) cavity. Refer to paragraph 6-10, step e.

(b) Test the actuator (4, Figure 6-5) by using a jumper wire to connect one terminal of the actuator to a source of 24 V dc current, such as the generator set batteries. Connect the other terminal to ground. A distinct click should be heard when current is supplied to and removed from the actuator terminals.

(c) Lubricate the preformed packings (6) with clean engine lubricating oil, such as MIL-L-9000 or equivalent, and install the gasket (5) on the actuator (4).

(d) Insert the actuator (4) and gasket (5) into the cavity in the fuel pump housing (29) until the actuator flange is approximately 3/8 inch (9.53 mm) from the fuel pump housing.

(e) Using the palm of the hand, firmly push the actuator (4) into the cavity in the fuel pump housing (29). Simultaneously rotate the actuator approximately 30 degrees in a clockwise direction until the flange of the actuator contacts the fuel pump housing.



1. FUEL PUMP (RIGHT SIDE VIEW)
2. ACTUATOR
3. CAPSCREW

Figure 6-6. Actuator Capscrew, Torque Sequence

(f) Rotate the actuator (4) in a counterclockwise direction to align the mounting holes, and install the capscrews (1), lockwashers (2), and washers (3) as follows:

1 See Figure 6-6 and tighten the capscrews (3) 1/8 turn in the sequence shown.

2 Tighten the capscrews (3) in the sequence shown, in three steps, to 25 pound-inches (2.8 newton-meters), to 50 pound-inches (5.6 newton-meters), and to a final torque of 75 pound-inches (8.5 newton-meters).

3 Loosen all three capscrews (3) completely, and retighten as in steps 1 and 2. above.

(g) Recheck the operation of the actuator (4) as in step (b), above. Loosen all three capscrews (1) and retighten as in step (f), above, if the same distinct click is not heard during this test.

f. Install.

(1) Place the spider (19, Figure 6-12) on the fuel pump drive coupling (23) and secure for assembly with masking tape, such as A-A-883A.

(2) Install the fuel pump assembly (36, Figure 6-5) with a new gasket (32) onto the accessory drive (6, Figure 6-4) with capscrews (33, Figure 6-5), lockwashers (34), and washers (35). Cross-tighten the capscrews to 40 to 45 pound-feet (54 to 61 newton-meters).

(3) Install the speed switch SS1/SS2/SS3 (4, Figure 6-4) into the mainshaft, cover, governor assembly (31, Figure 6-5).

(4) Install electrical connector J1 (3, Figure 6-4) to the speed switch SS1/SS2/SS3.

(5) Install the two electrical wires from the actuator (4, Figure 6-5).

(6) Install the two electrical wires to the shutoff valve assembly (18).

(7) Pour a small amount of clean lubricating oil MIL-L-9000 in the fuel pump supply fitting on the gear pump assembly (14) to provide initial lubrication and to prime the gear pump.

(8) Install the fuel supply and discharge hoses (1 and 2, Figure 6-4) to the gear pump assembly (14, Figure 6-5) and shutoff valve assembly (18), respectively.

6-10. FUEL PUMP REBUILD.

a. General.

(1) This paragraph contains disassembly, cleaning, inspection, repair, replacement, and reassembly instructions. Test and calibration instructions for the fuel pump assembly are contained in paragraph 6-11.

(2) Because of the precision fit and finish of the related components of the fuel pump assembly, it is essential to avoid contamination by airborne dust or other contaminants.

(3) The work area should be located as far as possible from grinding, painting, or other activities that could be a source of airborne contaminants.

(4) The workbench, tools, and equipment must be kept dean and free of oil or grease.

(5) To ensure thorough cleaning, the fuel pump assembly must be completely disassembled during overhaul.

(6) Place small parts together in trays to prevent loss.

(7) Remove all traces of corrosion-preventive compound from new parts before installation in the assembly.

(8) Clean all parts thoroughly before inspection and assembly using dean diesel fuel, regular grade DF2 W-F-800.

WARNING

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.

(9) Whenever possible, blow-dry parts with filtered, dry, compressed air.

(10) Discard old gaskets and packings.

(11) Torque all screws, bolts, or nuts in accordance with Table 1-1 and Table 1-2.

(12) Inspect all parts for wear and correct clearances in accordance with Table 1-4.

(13) Lubricate preformed packings and seals with petrolatum VV-P236.

(14) Avoid excessive stretching of packings. Where a packing or seal must be installed over splined or threaded shafts, use the correct assembly tool if available, or wrap the splines or threads with paper to avoid cutting the packing or seal.

(15) The inspection area must be thoroughly dean. Use a bright light and magnification when possible. Visually inspect all parts for corrosion, pitting, nicks, cracks, deformation caused by excessive wear, or any other damage that may impair efficient operation of the unit. Inspect all splined and threaded parts for damage. Replace all parts that do not pass inspection or that cannot be repaired as specified.

(16) The instructions that follow cover the rebuilding of the fuel pump as subassemblies. Disassemble the fuel pump in accordance with paragraph 6-9, and rebuild the subassemblies in accordance with steps b through f, below. Test and calibrate there built fuel pump in accordance with paragraph 6-11.

b. Damper Assembly. The damper assembly attaches to the rear of the gear pump. A steel diaphragm in the assembly reduces pressure pulses in the fuel system to a minimum.

(1) Disassemble.

(a) Remove the capscrews (1, Figure 6-7), lockwashers (2). and washers (3), and separate the body (4) from the plate (9).

(b) Remove the preformed packings (7), diaphragm (6), preformed packing (5), and nylon washer (8). Discard the packings.

(2) Inspect. Refer to Figure 6-7.

WARNING

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) Clean all parts in dean diesel fuel, regular grade DF2 W-F-800, and blow dry it with compressed air.

(b) Inspect all threaded parts for damage and stripped threads. Repair minor thread damage by chasing. Repair stripped holes in accordance with paragraph 2-12. Replace stripped capscrews.

(c) Visually inspect the body (4) and plate (9) for cracks, and defects in the packing grooves that would prevent proper sealing. Replace a defective body or plate.

(d) Replace the nylon washer (8) if it is cracked or damaged.

(e) Replace the diaphragm (6) if it is visibly cracked or damaged.

(f) Check the diaphragm (6) for hidden cracks by dropping it on a flat, hard surface. The diaphragm shall have a dear, ringing sound when it strikes the hard surface. Replace the diaphragm if it has a dull or flat sound.

(3) Reassemble.

(a) Install the nylon washer (8, Figure 6-7) in the groove of the plate (9), followed by the preformed packing (7), and diaphragm (6).

(b) Install the preformed packing (5) in the groove in the body (4), position the body on the plate (9), and install the capscrews (1), lockwashers (2), and washers (3). Cross-tighten the capscrews in three steps to 9 to 11 pound-feet (12 to 15 newton-meters).

c. Gear Pump. The gear pump pulls fuel from the generator set fuel tank, and supplies it to the fuel pump.

(1) Disassemble.

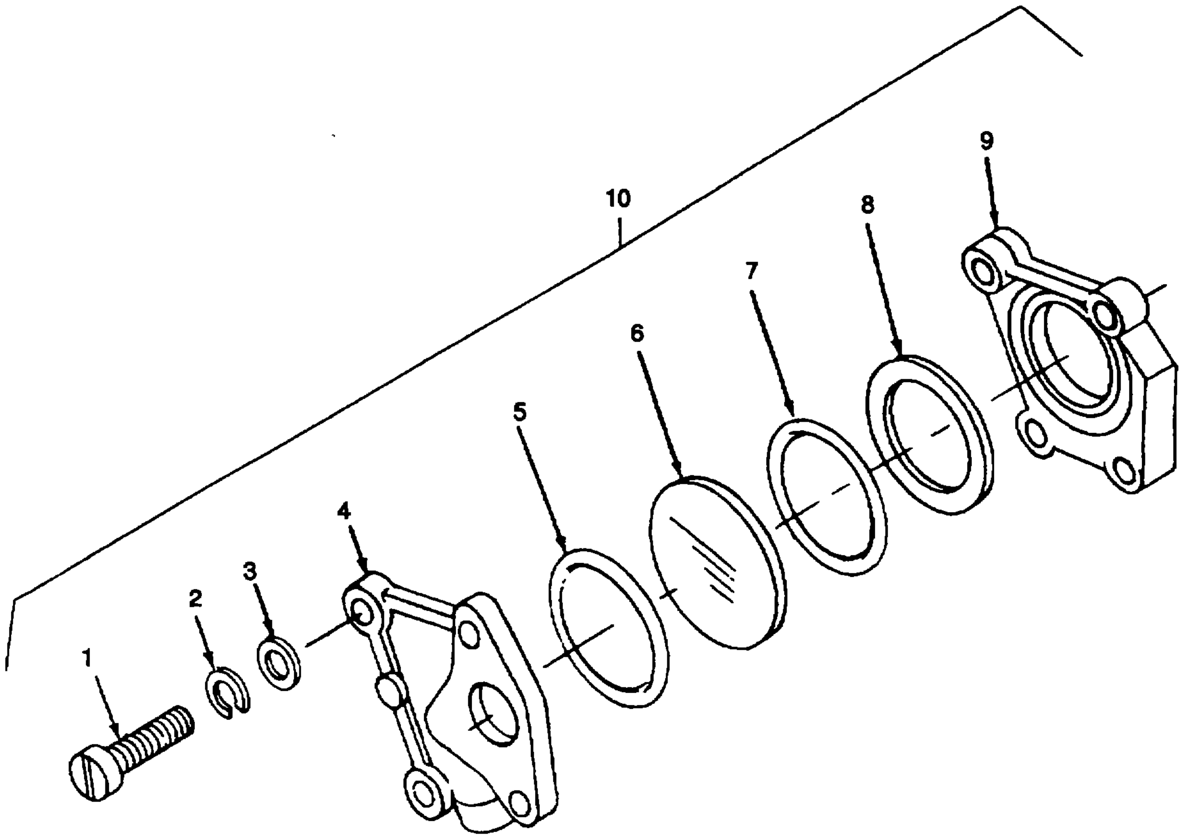
(a) Remove the capscrews (1, Figure 6-8), lockwashers (2), and washers (3).

CAUTION

To avoid damage to the mating surfaces of the housing and cover do not Insert a screwdriver or any other metal object between the mating surfaces to pry off the cover. The cover dowels are a press fit In the cover; remove the cover by pushing against the dowels from the housing end.

(b) Clamp the rectangular lug on the side of the housing (7) in the padded jaws of a vise, and remove the cover (15) by pushing, or lightly tapping against the cover dowels (16) from the housing end. Remove and discard the gasket (8).

(c) Using needle nose pliers, remove the pressure valve (14), and discard it. Remove the cover dowels (16) only if damaged.



1. CAPSCREW
2. LOCKWASHER
3. WASHER
4. BODY
5. PREFORMED PACKING
6. PLAIN SOLID DISK DIAPHRAGM
7. PREFORMED PACKING
8. NYLON WASHER
9. PLATE
10. FUEL PUMP DAMPER ASSEMBLY

Figure 6-7. Damper Assembly, Exploded View

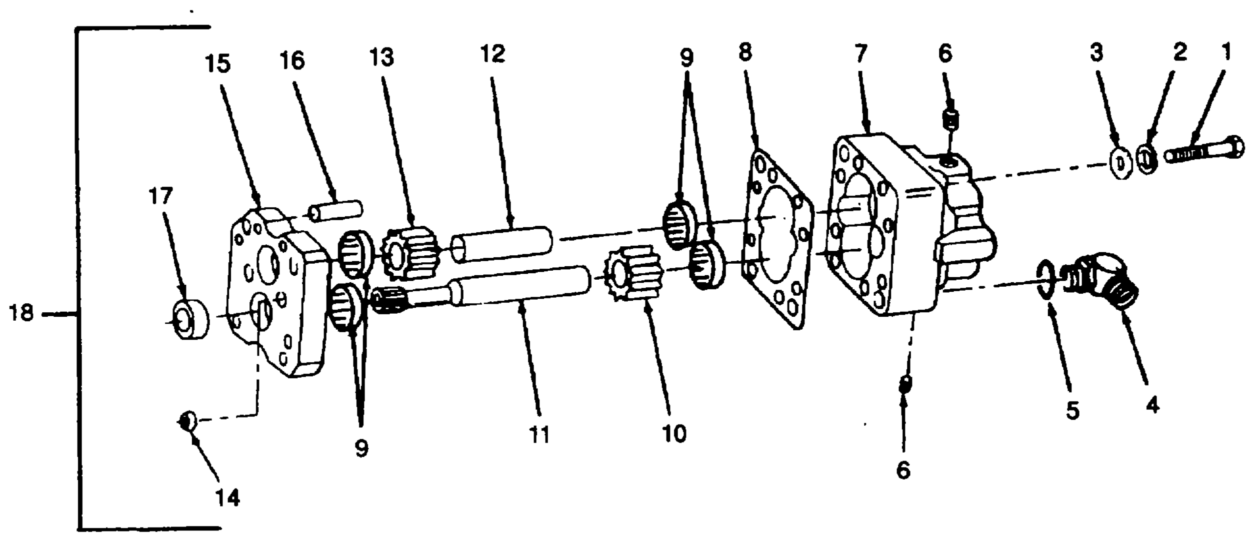
CAUTION

Do not separate gears (10 and 13) from drive shaft (11) and Idler shaft (12) at this time. Gears and shafts must not be Interchanged If they are to be reused. Refer to step (2)(o), below, for disassembly procedure.

(d) Remove the drive shaft (11), and idler shaft (12) with gears (10 and 13) from the housing (7). Remove the drive shaft dowel ring (17) only if damaged.

(e) Remove the pipe plugs (6) from the housing (7).

(f) Remove the fuel inlet connection (4) from the housing (7). Remove and discard the preformed packing (5).



1. CAPSCREW
2. LOCKWASHER
3. WASHER
4. FUEL INLET CONNECTION
5. PREFORMED PACKING
6. PIPE PLUG
7. HOUSING
8. GASKET
9. BUSHING
10. GEAR
11. DRIVE SHAFT
12. IDLER SHAFT
13. GEAR
14. PRESSURE VALVE
15. COVER
16. COVER DOWEL
17. DOWEL RING
18. GEAR PUMP ASSEMBLY

Figure 6-8. Gear Pump, Exploded View

(2) Inspect. See Figure 6-8.

WARNING

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) Clean all parts in dean diesel fuel, regular grade DF2 W-F-800, and blow dry with compressed air.

(b) Inspect all threaded parts for damaged and stripped threads. Repair minor thread damage by chasing. Repair stripped holes in accordance with paragraph 2-12. Replace stripped capscrews and fittings.

(c) Inspect the cover (15, Figure 6-8) for wear and scoring in gear rotation area. Replace the cover if scoring or a wear edge can be felt with the fingernail.

(d) Check the bushings (9) in the cover (15). Replace a bushing if the bushing maximum inside diameter is greater than 0.5016 inch (12.741 mm).

(e) Replace the cover dowels (16), or dowel ring (17), if necessary, using an arbor press. Install the dowel ring (17) so that it bottoms in the recess in the cover (15). Install the cover dowels (16) so that they will protrude slightly below the surface of the cover, and will extend through the gasket (8) into the housing (7).

(f) Check the housing (7) for wear and scoring in the gear rotation area. Replace the housing if scoring or a wear edge can be felt with the fingernail.

(g) Check the bushings (9) in the housing (7). Replace a bushing if the bushing maximum inside diameter is greater than 0.5016 inch (12.741 mm).

(h) Check the depth of the gear bore in the housing (7). Replace the housing if the gear bore depth exceeds 1.2485 inches (31.712 mm).

(i) Check the diameter of the drive and idler shafts (11 and 12) for wear. Minimum diameter shall be 0.4998 inch (12.695 mm).

(j) Check the gears (10 and 13) for worn, scored, cracked, or chipped teeth.

(k) Check the width of the gears (10 and 13). The minimum width shall be 1.2483 inches (31.707 mm).

(l) Temporarily install the gears (10 and 13) and drive and idler shafts (11 and 12) in the housing (7) and measure the gear protrusion with a straight edge and feeler gage. The gear protrusion shall be -0.0001 to +0.0005 inch (-0.003 to +0.013 mm). If the gear protrusion is unacceptable, it will be necessary to replace the housing, select fit new gears, or replace both housing and gears to achieve the correct protrusion.

(m) Using a narrow 0.25 inch (6.4 mm) bladed feeler gage, or a wire gage, check the flank clearance between the meshed gear (10 and 13) teeth. Replace gears if clearance is not 0.006 to 0.010 inch (0.15 to 0.25 mm).

(n) Check the protrusion of the drive shaft (11) from the housing (7). Drive shaft protrusion shall be 2.370 to 2.412 inches (60.2 to 61.3 mm).

(o) If the checks made in steps (i) through (n), above, indicate the replacement of either the gears (10 and 13) or drive and idler shafts (11 or 12), proceed as follows:

1 If the gears (10 and 13) are to be reused, match-mark them so that they will be reinstalled on the proper shaft, and in the same top-to-bottom position.

2 Remove the gears (10 and 13) using a 7/16 inch (11 mm) punch and an arbor press.

3 Press the drive and idler shafts (11 and 12) into the gears until the housing (7) end of each shaft protrudes a distance of 0.680 to 0.690 inch (17.27 to 17.53 mm) from the gear face.

(3) Reassemble. Lubricate all moving parts with lubricating oil MIL-L-9000, and reassemble the gear pump as follows:

(a) Apply a single wrap of Teflon tape MIL-T-27730, to the pipe plugs (6, Figure 6-8), and install them in the housing (7). Tighten the plugs to 5 to 8 pound-feet (7 to 11 newton-meters).

(b) Using driver 3375959, install a new pressure valve (14) in the cover (15) until it is even with the cover face, or to within to 0.015 inch (038 mm) below the cover face.

(c) Install the idler shaft and gear (2, Figure 6-9) in the housing cavity nearest the location notches (1) and install the drive shaft and gear (3) in the other cavity.

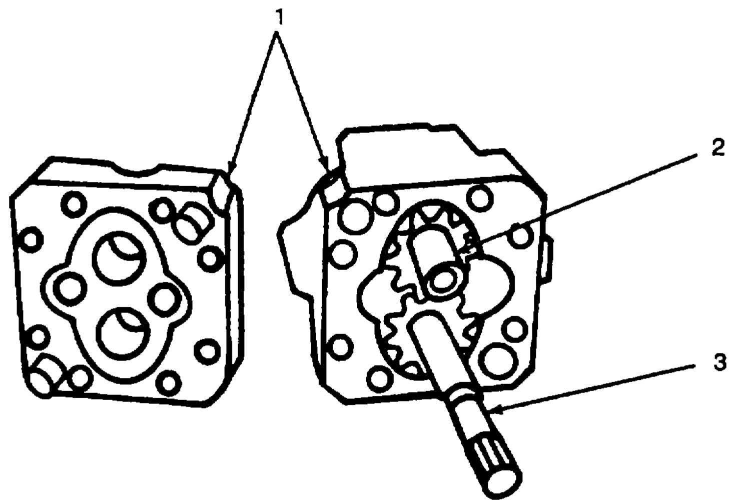
(d) Align the location notches (1), and install the cover (15, Figure 6-8) on the housing using a new gasket (8).

CAUTION

To avoid damage to the gear pump assembly (18), turn the drive shaft (11) while tightening the capscrews (1). If binding occurs, disassemble and determine the cause before final tightening.

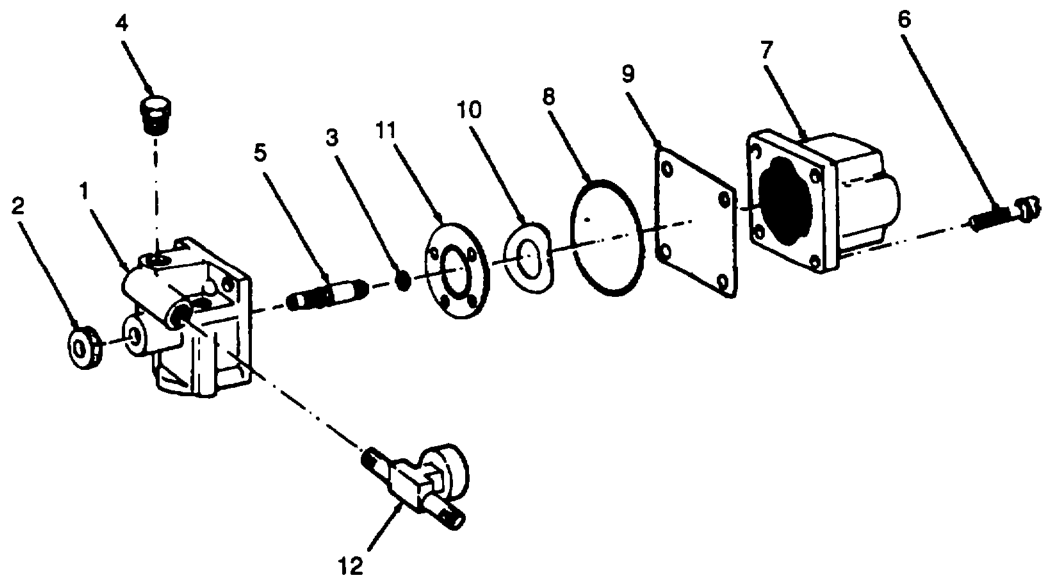
(e) Install the capscrews (1), lockwashers (2), washers (3), and cross-tighten the capscrews in three steps to 11 to 13 pound-feet (15 to 18 newton-meters).

(f) Install the fuel inlet connection (4) and preformed packing (5) in the housing (7).



1. LOCATION NOTCHES
2. IDLER SHAFT AND GEAR
3. DRIVE SHAFT AND GEAR

Figure 6-9. Assembly of Gear Pump



1. VALVE HOUSING
2. KNOB
3. PREFORMED PACKING
4. PIPE PLUG
5. SHAFT
6. CAPSCREW AND WASHER
7. COIL ASSEMBLY
8. PREFORMED PACKING
9. SHIELD
10. SPRING WASHER
11. PLATE VALVE
12. FUEL OUTLET CONNECTION

Figure 6-10. Fuel Shutoff Valve L1

d. Shutoff Valve. The shutoff valve is an electrically operated solenoid valve; when energized, it allows fuel flow into the engine. When deenergized, the shutoff valve cuts off the fuel flow from the fuel pump, causing the engine to shut down.

(1) Disassemble. See Figure 6-10.

(a) Remove the coil assembly (7) and shield (9) from valve housing (1) by removing capscrews and washers (6).

(b) Discard housing preformed packing (8). Remove spring washer (10) and plate valve (11).

(c) Remove knob (2) and remove shaft(5)from valve housing (1). Check the shaft for wear and discard preformed packing (3).

(2) Inspect See Figure 6-10.

WARNING

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) Clean all parts except coil assembly (7) in dean diesel fuel, regular grade DF2 W-F-800, and blow dry with compressed air. Wipe the coil assembly (7) with a dean dry both.

(b) Inspect the plate valve (11), spring washer (10), and valve seat inside valve housing (1) for dirt, wear, bonding separation, corrosion, and deterioration of rubber parts as applicable. Replace as necessary.

(c) Check width of the valve seat inside valve housing (1). Replace housing if width is less than 0.015 inch (0.38 mm).

(d) With multimeter set to RX100 scale, check the coil assembly (7). Resistance reading should be 30 ± 2 ohms. Replace the coil if it does not meet this specification.

(3) Assembly. See Figure 6-10.

(a) Install new preformed packing (3) on the shaft (5).

(b) Screw the shaft (5) into the valve housing (1) until it comes to a full stop. With depth micrometer set at 0.118 inch (2.997 mm) check distance from top of the shaft (5) to the plate valve (11) seat in the valve housing (1). If necessary turn the shaft (5) out to the required distance as set on the depth micrometer. Without moving the shaft (5) install the knob (2) on the other end of the shaft.

(c) Install the valve plate (11) inside the valve housing (1) with its rubber side against the seat in the valve housing.

(d) Install new housing preformed packing (8) inside the valve housing (1).

(e) Install spring washer (10) on the valve plate (11) with its cavity side up and around the valve locator.

(f) Install the shield (9) and coil assembly (7) on the valve housing (1). Tighten the coil screws and washers (6) to 25 to 30 inch-pounds (2.8 to 3.4 newton-meters).

e. Fuel Pump Assembly. See Figure 6-11.

(1) Disassemble.

(a) Note the method of seal wiring for-later reassembly, cut the seal wire, remove the fuel pump seal (1) and discard the seal wire and fuel pump seal.

(b) Remove the capscrews (2), washers (3), lockwashers (4), spring pack cover (5), gasket (6), and plug (7). Discard the gasket.

(c) Remove the snap ring (8), high speed spring retainer (9), governor spring shims (10), governor idle spring spacer (11), high speed governor spring (12), idle adjust screw (13), dip (14), idle and dip guide (15), adjusting screw washer (16), idling speed spring (17), and idle spring plunger (18). Discard the snap ring.

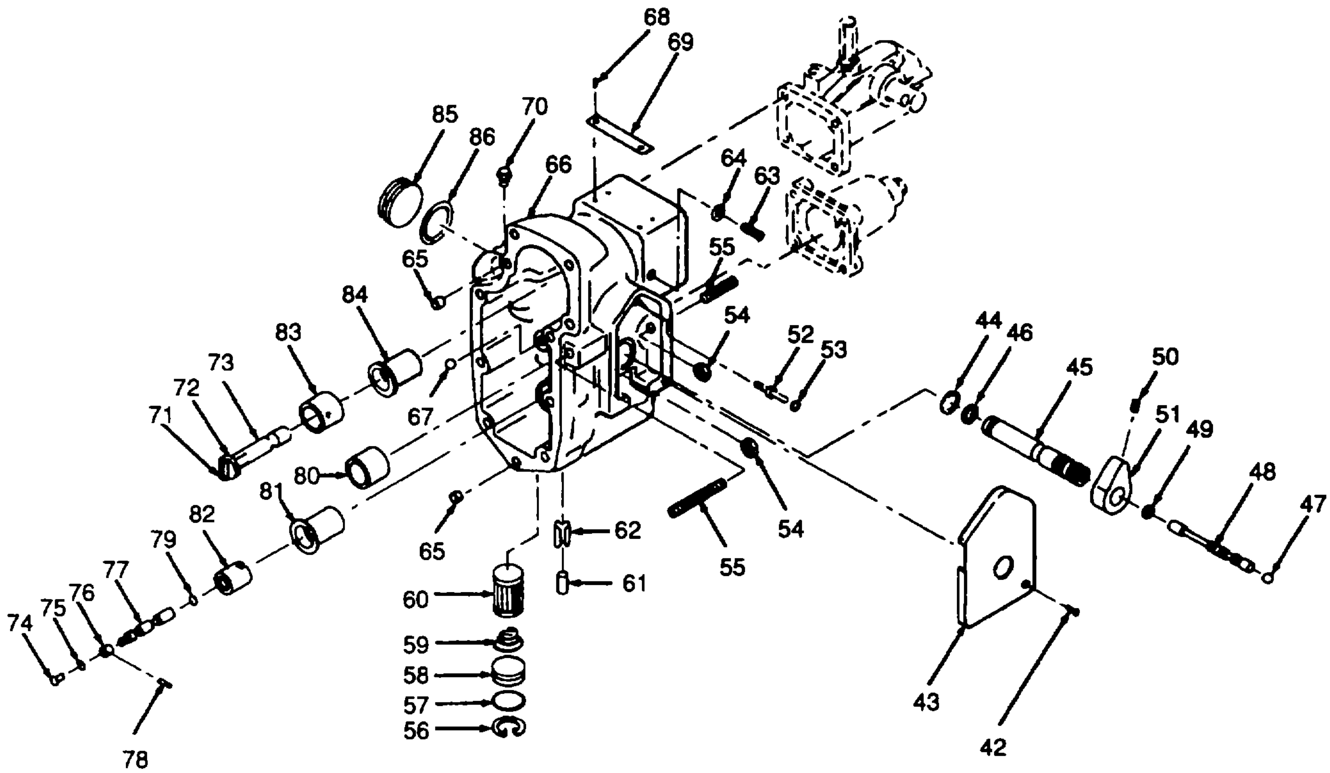


Figure 6-11. Fuel Injection Pump Housing and Related Parts, Exploded View (Sheet 1 of 3)

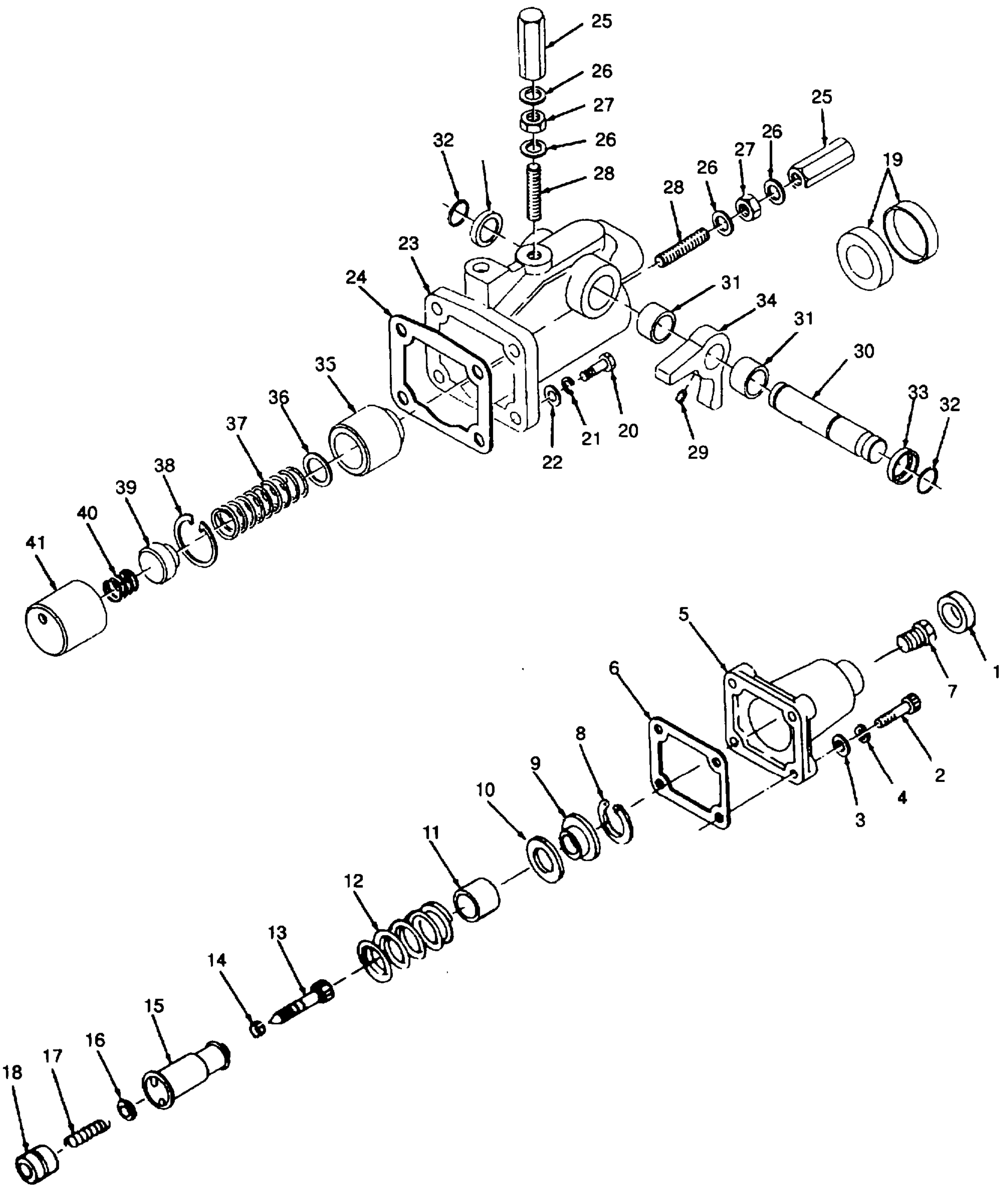


Figure 6-11. Fuel Injection Pump Housing and Related Parts, Exploded view (Sheet 2 of 3)

1. FUEL PUMP SEAL
2. CAPSCREW
3. WASHER
4. LOCKWASHER
5. SPRING PACK COVER
6. GASKET
7. PLUG
8. SNAP RING
9. HIGH SPEED SPRING RETAINER
10. GOVERNOR SPRING SHIM
11. GOVERNOR IDLE SPRING SPACER
12. HIGH SPEED GOVERNOR SPRING
13. IDLE ADJUST SCREW
14. CLIP
15. IDLE AND CLIP GUIDE
16. ADJUSTING SCREW WASHER
17. IDLING SPEED SPRING
18. IDLE SPRING PLUNGER
19. LOCK SEAL
20. CAPSCREW
21. LOCKWASHER
22. WASHER
23. COVER
24. GASKET
25. ADJUSTING SCREW NUT
26. COPPER WASHER
27. ADJUSTING SCREW NUT
28. SETSCREW
29. THROTTLE LEVER SETSCREW
30. THROTTLE SHAFT
31. BUSHING
32. PREFORMED PACKING
33. DUST SEAL
34. THROTTLE SHAFT STOP
35. THROTTLE PLUNGER
36. SHIM
37. GOVERNOR SPRING
38. SNAP RING
39. PLUNGER SEAT
40. IDLING SPRING
41. IDLE SPRING PLUNGER
42. RIVET
43. THROTTLE SHAFT COVER
44. RETAINING RING
45. THROTTLE SHAFT
46. PREFORMED PACKING
47. THROTTLE SHAFT BALL
48. FUEL ADJUSTING SCREW
49. PREFORMED PACKING
50. SETSCREW
51. CONTROLEND
52. SCREW
53. PREFORMED PACKING
54. HEXAGONAL NUT
55. ADJUSTING SCREW
56. SNAP RING
57. PREFORMED PACKING
58. FUEL FILTER COVER
59. FILTER SPRING
60. FILTER ELEMENT
61. PIPE PLUG
62. GOVERNOR BARREL CLIP
63. PAN HEAD SCREW
64. PACKING WITH RETAINER
65. HOLLOW PIN
66. HOUSING
67. PLUG BALL
68. RIVET
69. NAMEPLATE
70. FUEL OUTLET PLUG
71. PLUNGER DRIVER
72. THRUST WASHER
73. PLUNGER
74. PLUNGER DRIVER
75. WASHER
76. SPACER
77. PLUNGER
78. GOVERNOR PLUNGER PIN
79. SHIM
80. SLEEVE BEARING
81. LOWER SPRING PACK HOUSING
82. LOWER GOVERNOR BARREL
83. UPPER GOVERNOR BARREL
84. UPPER SPRING PACK HOUSING
85. PLUG
86. PREFORMED PACKING

Figure 6-11. Fuel Injection Pump Housing and Related Parts, Exploded View (Sheet 3 of 3)

(d) Remove the lock seal (19), capscrews (20), lockwashers (21), and washers (22), and remove the spring pack cover (23), and gasket (24). Discard the gasket (e). Remove the adjusting screw nuts (25), copper washers (26), adjusting screw nuts (27), and setscrews (28).

(f) Remove the throttle lover setscrew (29) from the throttle shaft (30), and pull the throttle shaft from the spring pack cover.

(g) Remove the bushings (31) only if worn. Check in accordance with step (2)(q), below.

(h) Remove the preformed packings (32) and dust seals (33) from the throttle shaft (30) and discard. Remove the throttle shaft stop (34).

(i) Pull the throttle plunger (35) and governor spring (37) from the spring pack cover (23). Remove the snap ring (38), idle spring plunger (41), idling spring (40), plunger seat (39), and shim (36).

(j) Remove the rivets (42) and throttle shaft cover (43).

(k) Remove the retaining ring (44), and withdraw the throttle shaft (45). Discard the retaining ring and remove and discard the preformed packing (46).

WARNING

Drilling operations create metal chips that may enter the eyes. Wearing of goggles Is required to avoid injury to personnel.

(I) Drill into the center of the throttle shaft ball (47) with a 17/64, drill bit. That portion of the throttle shaft ball (47) which remains in the throttle shaft (45) after the initial drilling operation can then be extracted on the end of the drill bit.

(m) Remove the fuel adjusting screw (48), and remove and discard the preformed packing (49).

NOTE

Two setscrews (50) are used to lock the control end (51) on the throttle shaft (45). Both screws are located in the same hole, the outer setscrew serving as a lockscrew for the inner setscrew.

(n) Remove the two setscrews (50), and remove the control end (51) from the throttle shaft (45).

(o) Remove the screw (52), and remove and discard the preformed packing (53).

(p) Remove the hexagonal nuts (54), and remove the adjusting screws (55).

(q) Remove the snap ring (56), fuel filter cover (58), filter spring (59), and filter element (60). Discard the snap ring and filter and remove and discard the preformed packing (57).

(r) Remove the pipe plug (61) and governor barrel dip (62).

(s) Remove the plunger driver (74), washer (75), spacer (76), governor plunger pin (78), plunger (77), and shim (79).

(t) Replace the lower governor barrel (82) and lower spring pack housing (81) in accordance with step (2)(x), below.

(u) Replace the sleeve bearing (80) in accordance with step (2)(v), below.

(v) Remove the fuel outlet plug (70).

(w) Remove the plunger driver (71), plunger (73), and thrust washer (72).

(x) Replace the upper governor barrel (83) and upper spring pack housing (84) in accordance with step (2)(x), below.

(y) Remove the pan head screw (63) and remove and discard the packing with retainer (64).

(z) Remove the hollow pins (65) and plug ball (67) only if defective. If necessary, remove the rivets (68) and nameplate (69).

(aa) Using governor plug tool 3376457, remove the plug (85) and preformed packing (86).

(2) Inspect and Repair. See Figure 6-11.

WARNING

Compressed air used for cleaning or drying can create air borne particles that may enter the eyes. Pressure shall not exceed 30 ps (207 kla). Wearing of goggles Is required to avoid Injury to personnel.

(a) Clean all parts in dean diesel fuel, regular grade DF2 W-F-800, and blow dry with compressed air.
(b) Inspect all threaded parts for damage and stripped threads. Repair minor thread damage by chasing. Repair stripped holes in accordance with paragraph 2-12. Replace stripped capscrews and fittings.
(c) Inspect the covers (5, 23, and 43, Figure 6-11) for warping, cracks, or damaged gasket surfaces. Remove slight nicks or burrs on the gasket surface using a flat mill file. Replace any cover that is cracked or warped.
(d) Inspect the fuel pump housing (66) for cracks, warping, or damaged gasket surfaces. Remove slight nicks or burrs on the gasket surfaces with a flat mill file. Replace the housing if it is cracked or warped.
(e) Check all retainers, shims, special washers, and spacers for cracks, warping, or other damage that would impair proper functioning.
(f) Check the high speed governor spring (12) for cracks and distortion, and measure the free length. Replace the high speed governor spring if it is distorted, or if the free length does not measure 1.227 to 1.247 inches (31.17 to 31.67 mm).
(g) Using a spring tester, check the load required to compress the high speed governor spring (12) to 1.00 inch (25.4 mm). The load required shall be 12.75 to 13.81 pounds (5.78 to 6.26 kg). Replace the high speed governor spring if the load requirements are incorrect.
(h) Check the idling speed spring (17) for distortion, and measure the free length. Replace the idling speed spring if it is distorted, or if the free length does not measure 1.015 to 1.035 inches (25.78 to 26.29 mm).
(i) Using a spring tester, check the load required to compress the idling speed spring (17) to 0.955 inch (24.26 mm). The load required shall be 0.69 to 0.85 pound (0.31 to 0.39 kg). Replace the idling speed spring if the load requirements are incorrect.
(0) Check the metering area of the idle adjust screw (13) and the idle and dip guide (15) for erosion and pitting. Replace a defective idle adjust screw or idle and dip guide.
(k) Replace the idle spring plunger (18) if it is scored or grooved.
(I) Check the governor spring (37) for cracks and distortion, and measure the free length. Replace the governor spring if It is distorted, or if the free length does not measure 1.308 to 1.328 inches (33.22 to 33.73 mm).
(m) Using a spring tester, check the load required to compress the governor spring (37) to 1.12 inches (28.45 mm). The load required shall be 6.47 to 8.03 pounds (2.98 to 3.64 kg). Replace the governor spring if the load requirements are incorrect.
(n) Check the idling spring (40) for distortion, and measure the free length. Replace the idling spring if it is distorted, or if the free length does not measure 0.335 inch (8.50 mm).
(o) Using a spring tester, check the load required to compress the idling spring (40) to 0.265 inches (6.70 mm). The load required shall be 0.28 to 0.36 pounds (0.13 to 0.16 kg). Replace the idling spring if the load requirements are incorrect.
(p) Replace the throttle plunger (35) and idle spring plunger (41) if they are scored or grooved.
(q) Check the bushings (31) in the cover (23). The bushing inside diameter must be 0.560 to 0.563 inch (14.22 to 14.30 mm). Press the bushings out of the cover, and press in new bushings if necessary.
(r) Check the throttle shaft (45) and its mating sleeve in the fuel pump housing (66) for scoring or grooving. If the sleeve in the housing is damaged or scored, replace the housing. If the throttle shaft is damaged or scored, replace it with a throttle shaft of the same color code and size class, Table 6-1.

(s) Replace the fuel adjusting screw (48) if it is scored or grooved.
(t) Replace the control end (51) if it is worn at the adjusting screw (55) contact points.
(u) Check the filter spring (59) for cracks, distortion, and mss of tension. Replace the filter spring if it is cracked or distorted. The tension is not critical, but replace the filter spring if it will not hold the filter element (60) against its seat, and the fuel filter cover (58) firmly against the snap ring (56) when installed. Replace the fuel filter cover (58) if the packing groove is damaged.
(v) Check the sleeve bearing (80) in the fuel pump housing (66) for wear. The maximum inside diameter shall be 0.7525 inch (19.114 mm). Replace a worn sleeve bearing as follows:

1 Thread the sleeve bearing using a 112 inch NPT pipe tap, and install a 1/2 inch pipe plug in the sleeve bearing.
2 Working from the opposite side of the housing, use a hammer and punch to remove the sleeve bearing by driving against the pipe plug.
3 Using an arbor press, install a new sleeve bearing flush with the face of the housing bore.
4 UsingST-490 reaming fixture and a 0.750 inch reamer, ream the sleeve bushing to 0.7495 to 0.7505 inch (19.037 to 19.063 mm).

Table 6-1. Fuel Pump Throttle Shaft Color Code and Class Size

COLOR	RED	BLUE	GREEN	YELLOW	ORANGE	BLACK	GRAY	PURPLE
CLASS	0	1	2	3	4	5	6	7
PART NO	3017140	3017141	3017142	3017143	3017144	3017145	3017146	3017147

(w) Check the plunger driver (74), spacer (76), and governor plunger (77) for scoring and grooving. Check the plunger driver (71) and plunger (73) for scoring and grooving. Replace all scored or grooved parts. If the plunger (77 or 73) is to be replaced, select fit a new one in accordance with step (y), below.

NOTE
The replacement procedure for the upper governor barrel is the same as for the lower governor barrel.

(x) Check the lower governor barrel (82) for scoring or grooving. Check the upper governor barrel (83) for scoring or grooving. If the lower or the upper governor barrel is scored or grooved, replace as follows:

1 Scribe a match mark across the face of the fuel pump housing (66) and lower and upper governor barrels (82 and 83) as an aid to correct alignment of the new governor barrel.
2 Heat the fuel pump housing (66) in a control led heat oven to 300°F (149°C).
3 Remove the fuel pump housing (66) from the oven, and remove the lower and upper governor barrels (82 and 83) and lower and upper spring pack housings (81 and 84) using an arbor press if necessary.

NOTE
Replacement governor barrels are available in standard 1.5020 to 1.5025 inch (38.15 to 38.16 mm) diameter, and 0.010 inch (0.25 mm) or 0.020 inch (0.51 mm) oversize.

4 Allow the fuel pump housing (66) to cool, and measure the inside diameter of the governor barrel bore in the fuel pump housing, and the outside diameter of the new governor barrels (82 and 83). To allow for a press fit, the governor barrel bore in the fuel pump housing must be at least 0.002 inch (0.05 mm) smaller than the outside diameter of the governor barrel. If the fuel pump housing bore is oversize, line bore it for a new oversize governor barrel.

5 Return the fuel pump housing (66) to the oven, and heat it to 300°F (149°C).

6 Orient the fuel passages of the new governor barrels (82 and 83) with those of the old governor barrels, an scribe a match-mark on the new governor barrel to align with the match-mark made in step 1, above. Put a light coat of anti-seize compound MIL-A-907 on the barrel.

7 Remove the fuel pump housing (66) from the oven, install the spring pack housings (81 and 84), align the match-marks, and install the governor barrels (82 and 83) in the fuel pump housing using an arbor press if necessary.

8 Check that the hole in the fuel pump housing (66) and lower governor barrel (82) for the governor barrel dip (62) are aligned. Using lock dip driver 3376136, install the governor barrel dip with the slot facing the governor end of the fuel pump housing.

9 Check that the hole in the fuel pump housing (66) and upper governor barrel (83) for the pan head screw (63) are aligned, and install the pan head screw. Let the fuel pump housing (66) cool, and remove and reinstall the pan head screw (63) with packing with retainer (64).

10 Let the fuel pump housing (66) cool, and install the pipe plug (61) using a single wrap of teflon tape MIL-T-27730 on the pipe plug threads. Tighten the pipe plug to 5 to 8 pound-feet (7 to 11 newton-meters).

11 Select fit new plungers (73 or 77) in accordance with step (y), below.

(y) Select fit a new plunger (73 or 77) as follows (see Table 6-2).

CAUTION

To avoid damage to the plunger (73 or 77) and governor barrel (82 or 83) follow the fitting Instructions carefully. The plunger should fit without forcing. The plungers are color coded and graded as to class of fit

1 Try a class 2 (green) plunger (73 or 77) for ft in the governor barrel (82 or 83). If the class 2 (green) plunger fits, try a class 3 (yellow).a

2 Continue trying larger class plungers (73 or 77) until one is found that will not enter the governor barrel (82 or 83).

3 Select a plunger (73 or 77) two classes smaller than the one that would not fit. For example: if a class 4 (orange) would not enter the bore, select a class 2 (green).

4 Check to be sure that both the plunger (73 or 77) and governor barrel (82 or 83) mating surfaces are dean. Dip the plunger in dean calibrating fluid 3375634, start the plunger in the bore, and release it. The plunger shall drop slowly into the bore of its own weight. If the plunger hangs up, or will not drop into the lower governor barrel of its own weight, check for the presence of dirt or foreign material, and recheck the class fit in accordance with steps 1 through 3, above.

Table 6-2. Fuel Pump Governor Plunger Color Code and Class Size

COLOR	RED	BLUE	GREEN	YELLOW	ORANGE	BLACK	GRAY	PURPLE
CLASS	0	1	2	3	4	5	6	7
UPPER PULUNGER PART NO.	3018640	3018641	3018642	3018643	3018644	3018645	3018646	3018647
LOWER PLUNGER PART NO.	3009380	3009381	3009382	3009383	3009384	3009385	3009386	3009387

(3) Reassemble. During reassembly, lubricate all valves and other moving parts with dean calibrating fluid 3375634. Lubricate packings with petrolatum VV-P-236.

(a) If removed, install the nameplate (69, Figure 6-11) and secure it with the rivets (68).
(b) If removed, install the hollow pins (65) and plug ball (67).
(c) If the pan head screw (63) and packing with retainer (64) were not previously installed, install them in accordance with step (2)(x), above.
(d) If the governor barrel dip (62) and pipe plug (61) were not previously installed, install them in accordance with step (2Xx), above.
(e) Install the shim (79), plunger (77), governor plunger pin (78), spacer (76), washer (75), and plunger driver (74).
(f) Install the filter element (60) and filter spring (59). Install new preformed packing (57) on the fuel filter cover (58), install the cover and secure with the snap ring (56).
(g) Install the adjusting screws (55) and hexagonal nuts (54). Tighten the hexagonal nuts to 70 to 80 pound-inches (8 to 9 newton-meters).
(h) Install the preformed packing (53) and screw (52).

NOTE

Two setscrews (50) are used to lock the control end (51) on the throttle shaft (45). Both setscrews are located in the same hole, the outer setscrew serving as a lockscrew for the inner setscrew. The throttle shaft (45) may have two locating holes. If so, the locating hole referred to in the following procedure is on the left side of the throttle shaft (45) when viewing the throttle shaft from the splined end.

(i) Align the locating hole on the throttle shaft (45) with the hole in the control end (51), install the control end on the throttle shaft, and secure it with two setscrews (50).
(j) Install anew preformed packing (49) on the fuel adjusting screw (48), and install it in the throttle shaft (45). Do not install the throttle shaft ball (47) until calibration has been completed.
(k) Install the assembled throttle shaft (45) and the retaining ring (44). Do not install the throttle shaft cover (43) until calibration has been completed.
(l) Install the snap ring (38), idle spring plunger (41), idling spring (40), plunger seat (39), and shim (36). Install the throttle plunger (35) and governor spring (37).
(m) Install the dust seals (33) in the cover (23).
(n) Install the preformed packings (32) on the throttle shaft (30), and install the throttle shaft in the cover (23) through the throttle plunger (35). Install the throttle lever setscrew (28) in the throttle plunger.
(o) Replace the adjusting screw nuts (25), copper washers (26), adjusting screw nuts (27), and setscrews (28).
(p) Using a new gasket (24), install the cover (23) with capscrews (20), lockwashers (21), and washers (22).
(q) Install the idle spring plunger (18), idling speed spring (17), adjusting screw washer (16), idle and dip guide (15), idle adjust screw (13), high speed governor spring (12), governor idle spring spacer (11), governor spring shim (10), high speed spring retainer (9), and snap ring (8).
(r) Using a new gasket (6), install the spring pack cover (5), with capscrews (2), lockwashers (4), and washers (3). Install the plug (7).

NOTE

Do not tighten governor plug tool 3376457 to the plug (85). Tightening governor plug tool 3376457 to the plug may make it impossible to remove the tool once the plug has been inserted into the cavity.

(s) Lubricate the preformed padding (86) with dean engine lubricating oil, such as MIL-L-9000 or equivalent, and install on the plug (85). Install the plug and preformed packing in the cavity in the fuel pump housing (66) using governor plug tool 3376457. Press the plug into the cavity until it is securely seated and withdraw governor plug tool 3376457.

f. Mainshaft, Cover, and Governor. The mainshaft, cover, and governor contains the tachometer drive, main drive shaft assembly, and governor weight carrier assemblies.

(1) Disassemble. See Figure 6-12.

(a) Make a preliminary check for wear of the bushing (10). I side play is evident, replace the bushing in accordance with step (2) (t), below.

NOTE

To avoid a false backlash reading in the following check, be sure the fuel pump end of the cover (11) faces up. Turn the drive shaft (31) gently to avoid angular movement of the unsupported shaft end.

(b) See Figure 6-13 and check the backlash between the gears (9 and 28, Figure 6-12). I the gear backlash is not within 0.005 to 0.009 inch (0.13 to 0.23 mm), replace the gears in accordance with step (2), below.
(c) Remove the lower weight and carrier assembly (4) using puller ST-709, and remove the shoulder pin (1), shims (2), and weight assist spring (3). Remove the bushing (10) from the cover (11) in accordance with step (2) (t), below.
(d) Remove the capscrew (20), lockwasher (21), and washer (22). Remove the fuel pump drive coupling (23) using puller ST-709, remove the tachometer drive gear (24), and remove the drive key (32).
(e) Remove the male connector (12). Using puller ST-1 326, remove the tachometer assembly (18). Discard the tachometer seal (14).
(f) Working from the gear end of the tachometer drive assembly (18), press out the tachometer drive shaft (13), and remove the tachometer driven gear (17) and sleeve bearing (16).
(g) Using needle nose pliers, remove the retaining ring (29) from the groove in the cover (11).
(h) Temporarily install the capscrew (20) in the drive shaft (31), and press out the drive shaft assembly (26). Remove and discard the retaining ring (29). Disassemble the drive shaft assembly in accordance with step (2), below.
(i) Remove and discard the of oil seals (25).
(j) Refer to step (b), above, and check the backlash of the idler gear (34) and governor gear (44). Replace the gears if backlash is not between 0.005 to 0.009 inches (0.13 to 0.23 mm).
(k) Heat the cover (11) in the vicinity of the bushing (35) with a propane torch. Thread a capscrew of the appropriate size into the recess. Place a washer behind the head of the capscrew large enough to hold the gear on the idler shaft. Remove the idler shaft assembly using puller ST-709.
(l) Remove the retaining ring (38), washer (37), and bushing (35), from the idler shaft (36).
(m) Remove the upper weight carrier assembly (39) and bushing (45) using puller ST-709, as in step (c), above.

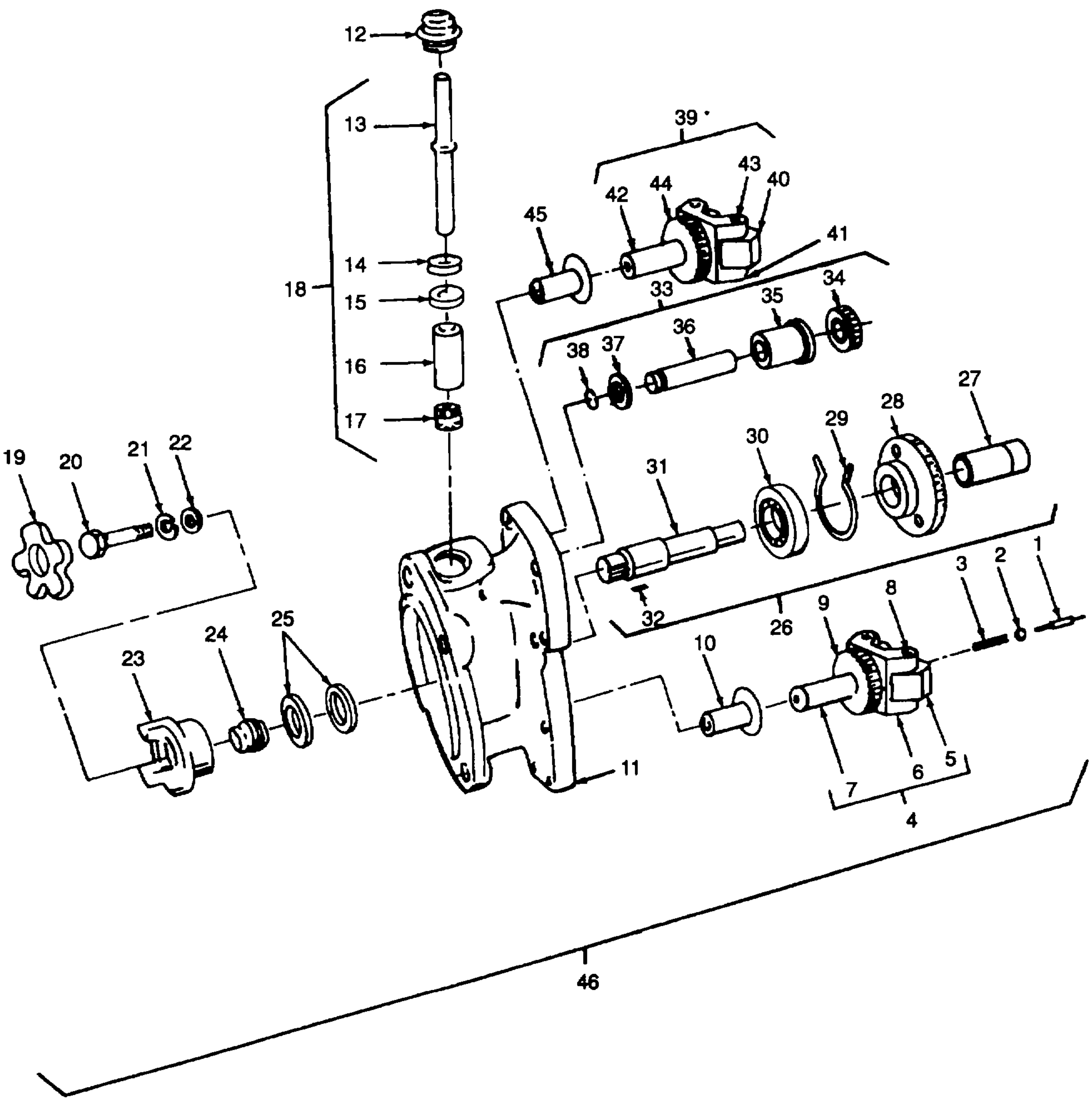


Figure 612. Mainshaft, Cover, and Governor, Exploded View (Shoot 1 of 2)

1. SHOULDER PIN
2. SHIMS
3. WEIGHT ASSIST SPRING
4. LOWER WEIGHT CARRIER ASSEMBLY
5. GOVERNOR WEIGHT
6. GOVERNOR CARRIER
7. CARRIER SHAFT
8. WEIGHT PINS
9. GOVERNOR GEAR
10. BUSHING
11. COVER
12. MALE CONNECTOR
13. TACHOMETER DRIVE SHAFT
14. TACHOMETER SEAL
15. TACHOMETER SEAL SPACER
16. SLEEVE BE ARING
17. TACHOMETER DRIVEN GEAR
18. TACHOMETER DRIVE ASSEMBLY
19. SPIDER
20. CAPSCREW
21. LOCKWASHER
22. WASHER
23. FUEL PUMP DRIVE COUPLING
24. TACHOMETER DRIVE GEAR
25. OIL SEAL
26. DRIVE SHAFT ASSEMBLY
27. FUEL PUMP DRIVE COUPLING
28. FUEL PUMP DRIVE GEAR
29. RETAINING RING
30. BALL BEARING
31. DRIVE SHAFT
32. DRIVE KEY
33. IDLER SHAFT ASSEMBLY
34. IDLER GEAR
35. BUSHING
36. IDLERNSHAF
37. WASHER
38. RETAINING RING
39. UPPER WEIGHT CARRIER ASSEMBLY
40. GOVERNOR WEIGHT
41. GOVERNOR CARRIER
42. CARRIER SHAFT
43. WEIGHT PINS
44. GOVERNOR GEAR
45. BUSHING
46. MAINSHAFT, COVER, AND GOVERNOR ASSEMBLY

Figure 6-12. Mainshaft, Cover, and Governor, Exploded View (Sheet 2 of 2)

(2) Inspect and Repair. See Figure 6-12.

WARNING

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) Clean all parts in dean diesel fuel, regular grade DF2 W-F-800, and blow dry with compressed air.
(b) Inspect all threaded parts for damaged and stripped threads. Repair minor thread damage by chasing. Repair stripped holes in accordance with paragraph 2-12. Replace stripped machine bolts and fittings.
(c) Place a 1/4 inch drill bit shank under the weight feet of the lower and upper weight carrier assemblies (4 and 39), and try to insert a 11 /64 inch drill bit shank between the weight feet (1, Figure 6-14). If the 11/64 inch drill bit will enter, replace the weight pins (8 and 43, Figure 6-12) or the governor weights (5 and 40), or both the governor weights and the governor pins in accordance with step (e), below.
(d) Check the weight carrier assemblies (4 and 39) for worm, cracked, or chipped governor gear (9 and 44) teeth; check the carrier shafts (7 and 42) for wear, scoring, and grooving, and check the governor carriers (6 and 41) for cracks and wear. If the governor gear teeth are defective, the governor carriers worn or cracked, or a wear edge on the carrier shafts can be felt with the fingernail, replace the defective parts in accordance with step (e), below.

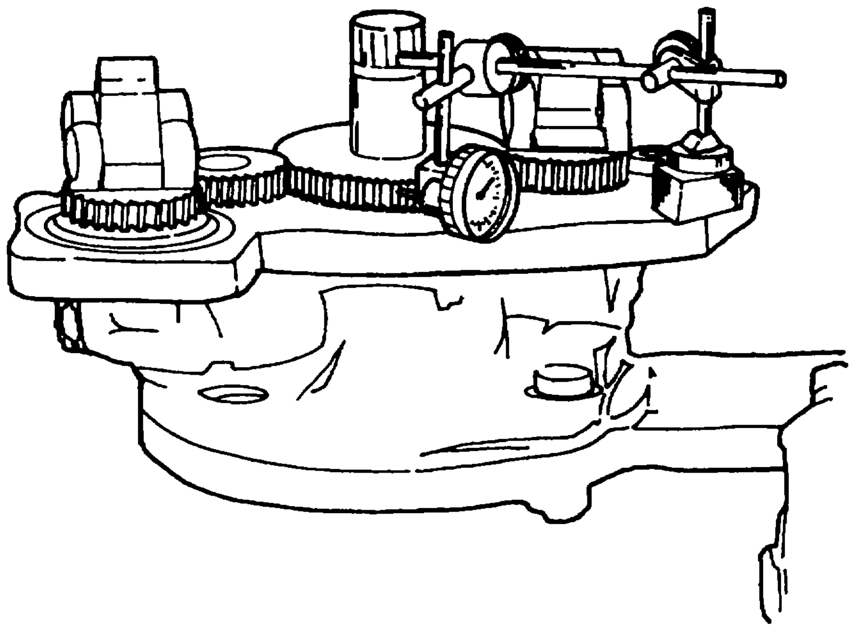
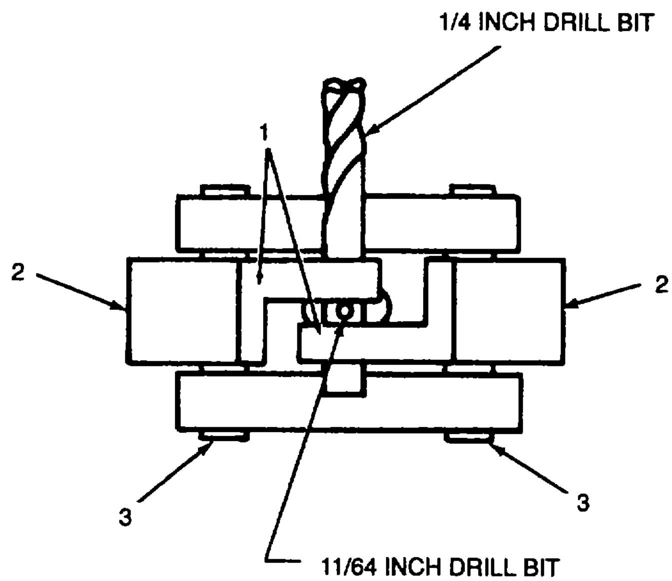


Figure 6-13. Measuring Gear Backlash



1. WEIGHT FEET
2. GOVERNOR WEIGHT
3. WEIGHT PIN

Figure 6-14. Wear Check of Governor Weight Carriers

(e) Replace worn weight pins (8 and 43), governor weights (5 and 40), governor gears (9 and 44), carrier shafts (7 and 42), or governor carriers (6 and 41) as follows:

1 Press out the weight pins (8 and 43) and remove the governor weights (5 and 40).
2 Remove the governor gears (9 and 44) using weight carrier block ST-1 231.
3 Press out the carrier shafts (7 and 42) working from the governor carriers (6 and 41) side.
4 Press in new carrier shafts (7 and 42) so that they are flush with, or not over 0.005 inch (0.13 mm) below the face on the weight side of the governor carriers (6 and 41).
5 Support the carrier shafts (7 and 42) on the governor carriers (6 and 41) side, install the replacement governor gears (9 and 44) on the shafts with the chamfered side of the governor gears facing the governor carriers, and press the gears onto the shafts until they bottom on the governor carriers.
6 Align the holes in the replacement governor weights (5 and 40) with the holes in the governor carriers (6 and 41) and press in new weight pins (8 and 43).

(f) Check the tachometer drive shaft (13) for wear. Replace the tachometer drive shaft if the minimum diameter is under 0.3950 inch (10.033 mm).
(g) Check the sleeve bearing (16) for wear. Replace the sleeve bearing if the inside diameter is over 0.3970 inch (10.084 mm).
(h) Check the gear teeth on the tachometer driven gear (17) for wear, chipping, or cracking. Check the inside diameter of the tachometer driven gear for wear. Replace the tachometer driven gear if the teeth are defective, or the inside diameter exceeds 0.3948 inch (10.028 mm).
(i) Replace the tachometer seal spacer (15) If it Is distorted or cracked.
(j) Replace the spider (19) if it is worn or cracked.
(k) Replace the fuel pump drive coupling (23) if it is cracked, if the keyway slot is worn, or if it is worn in the drive area.
(I) Replace the drive key (32) if it is worn, cracked, or distorted.
(m) Replace the tachometer drive gear 124) if the teeth or splines are worn, cracked, or chipped.
(n) Replace the drive shaft (31) if the splines are worn, cracked, or chipped, or the keyway is worn in accordance with step (r), below.
(o) Check the fuel pump drive coupling (27) for wear and scoring in the bearing area. Replace the fuel pump drive coupling if a wear edge can be felt with the fingernail in accordance with step (r), below.
(p) Replace the fuel pump drive gear (28) if the teeth are worn, cracked, or chipped in accordance with step (r), below.
(q) Replace the ball bearing (30) if any roughness can be felt when turning the outer race, or if the balls or races are visually scored, chipped, or flaked in accordance with step (r), below.
(r) Replace a defective drive shaft (31), fuel pump drive coupling (27), fuel pump drive gear (28), or ball bearing (30) as follows:

1 Support the fuel pump drive gear (28) on a bearing splitter, and press out the drive shaft (31) from the fuel pump drive coupling (27) end, and remove the fuel pump drive coupling and fuel pump drive gear from the drive shaft.
2 Support the inner race of the ball bearing (30) on a bearing splitter, press on the drive shaft at the fuel pump drive coupling (27) end, and remove the ball bearing from the drive shaft.
3 Lubricate the drive shaft (31) with a high pressure lubricant such as MIL-L-24478B and install the ball bearing (30) on the drive shaft using driver 3375172.
4 Using driver 3375172, press the fuel pump drive gear (28) on the drive shaft (31) with the hub end toward the ball bearing (30).

5 Press the fuel pump drive coupling (27) on the drive shaft (31) with the machined end for the sleeve bearing (80, Figure 6-11) away from the fuel pump drive gear (28, Figure 6-12) until the fuel pump drive coupling bottoms on the fuel pump drive gear.

(s) Check the cover (11, Figure 6-12) for cracks, and for warped or damaged gasket surfaces. Replace the cover if it is warped or cracked. Remove minor surface defects from the gasket surfaces with a flat mill file.

(t) Check the bushings (10 and 45) for wear. If the maximum inside diameter of either bushing exceeds 0.504 inch (12.80 mm), replace it as follows:

1 Remove the bushing (10 and 45) from the cover (11) using a blind hole bushing puller.
2 Place the new bushing (10 and 45) on the carrier shaft (7 and 42), and install the bushing by pressing on the governor carrier (6 and 41) until the shoulder of the bushing is seated against the cover (11).

(u) Check the weight assist spring (3) for free length and tension. Replace the weight assist spring if the free length is not 0.574 to 0.594 inch (14.58 to 15.09 mm), or if the tension is not within 3.30 to 3.70 pounds (1.50 to 1.68 kg) when the weight assist spring is compressed to 0.325 inch (8.26 mm).

(v) Check the bushing (35) for wear. If the maximum inside diameter of the bushing exceeds 0.507 inch (12.88 mm), replace the bushing.

(3) Reassemble. See Figure 6-12.

(a) Install the retaining ring (38) and washer (37) on the idler shaft (36). Slide the bushing (35) on the idler shaft and press the idler gear (34) onto the idler shaft with the smooth side of the idler gear against the bushing.

(b) Ensure that the idler gear (34) to bushing (35) end clearance is 0.002 to 0.007 inch (0.05 to 0.18 mm). If clearance is insufficient, remove the retaining ring (38) and bushing, and check for an irregular surface on the bushing.

(c) Heat the cover (11) in the vicinity of the bushing (35) bore with a propane torch.

(d) Press the idler shaft assembly (33) into the cover by applying pressure to the idler gear (34).

(e) Install the sleeve bearing (16) on the tachometer drive shaft (13), and press the tachometer driven gear (17) onto the tachometer drive shaft until the clearance between the sleeve bearing and the tachometer driven gear is 0.002 to 0.005 inch (0.05 to 0.13 mm).

(f) Align the oil hole in the sleeve bearing (16) on the tachometer drive assembly (18) with the oil hole in the cover (i11), and press in the sleeve bearing until the shoulder bottoms on the cover.

(g) Install the tachometer seal spacer (15) with the slotted end down, and install the tachometer seal (14).

(h) Draw the tachometer assembly (18) into the cover (11) by turning in the male connector (12). Tighten the male connector (12) to 35 to 45 pound-feet (47 to 61 newton-meters).

(i) Install the upper weight carrier assembly (39) in the cover (11), and check the backlash of the idler gear (34) and governor gear (44) as in step (1) (b), above. Backlash must be between 0.005 and 0.009 inches (0.13 to 0.23 mm).

(j) Install the pilot of seal driver 3375173 over the drive shaft (31), lubricate a new oil seal (25) with petrolatum VV-P-236, and, with the lip towards the cover (11), install the oil seal with seal driver 3375173.

(k) Position a new retaining ring (29) between the fuel pump drive gear (28) and ball bearing (30), and press the drive shaft assembly (26) into the cover (11) until the ball bearing bottoms in the bore.

(l) Using needle nose pliers, install the retaining ring (29) in the groove in the cover (11).

(m) Lubricate another new oil seal (25) with petrolatum VV-P-236, and, with the lip facing away from the cover, install the oil seal with seal driver 3375173.

(n) Install the tachometer drive gear (24), drive key (32), fuel pump drive coupling (23), and capscrew (20), lockwasher (21), and washer (22). Tighten the capscrew to 5 pound-feet (7 newton-meters).

NOTE

To avoid a false backdash reading in the following check, be sure the fuel pump end of the cover (11) faces up. Turn the drive shaft (31) gently to avoid angular movement of the unsupported drive shaft end.

(o) Install the lower weight carrier assembly (4) in the cover (11), and check the backlash of the fuel pump drive gear (28) and governor gear (9) as in step (1) (b), above. Back lash must be between 0.005 to 0.009 inch (0.13 to 0.23 mm).

(p) Using masking tape such as A-A-883A, secure the spider (19) to the fuel pump drive coupling (23) for use at installation on the engine.

NOTE

The following adjustment is only an approximation used as a starting point in the calibration procedure. The exact plunger protrusion will be set during the calibration procedures.

(q) Install the weight assist spring (3), shims (2), shoulder pin (1), and check the pin protrusion with gage ST-1241. Add or remove shims (2) to achieve a pin protrusion of 0.890 inch (22.61 mm).

(r) Reassemble the fuel pump in accordance with paragraph 6-9.

6-11. FUEL PUMP TEST AND CAUBRATION.

a. General. The test and calibration procedure sets the fuel pump to the correct delivery standards. Test specifications are summarized in 6-3. After calibration, it may be necessary to carry out minor adjustments on the engine in accordance with paragraph 6-9. Test stand 3375698 is used to perform testing and calibration procedures (figures Figure 6-15, Figure 6-16, and Figure 6-17). The test oil referred to in the following steps is 3375365.

b. Setup.

(1) Oil the tachometer gears (17 and 24, Figure 6-12)with clean lubricating oil MIL-L-9000to provide lubrication during the testing and calibration procedure.

(2) Position the fuel pump to the pump drive adapter (2, Figure 6-15) on the fuel pump test stand (5), and adjust the coupling (3) to give 0.062 inch (1.57 mm) clearance between the coupling and coupling spider (19, Figure 6-12).

(3) Attach the fuel pump to the pump drive adapter (2, Figure 6-15) using the capscrews (33, Figure 6-5), lockwashers (34), and washers (35). Cross-tighten the capscrews to 40 to 45 pound-feet (54 to 61 newton-meters).

(4) Open the shutoff valve (Figure 6-10) by turning the knob (2) clockwise as far as it will go. Do not force. This will lift plate valve (11) off its seat on valve housing (1) and allow for full fuel flow through the shutoff valve during the calibraton process.

(5) Prime the gear pump assembly (18, Figure 6-8) by squirting some dean test oil through the suction side of the fuel inlet fitting (4).

(6) Connect the fuel supply, outlet and return hoses (5, 1, and 3, Figure 6-16) in accordance with Figure 6-16.

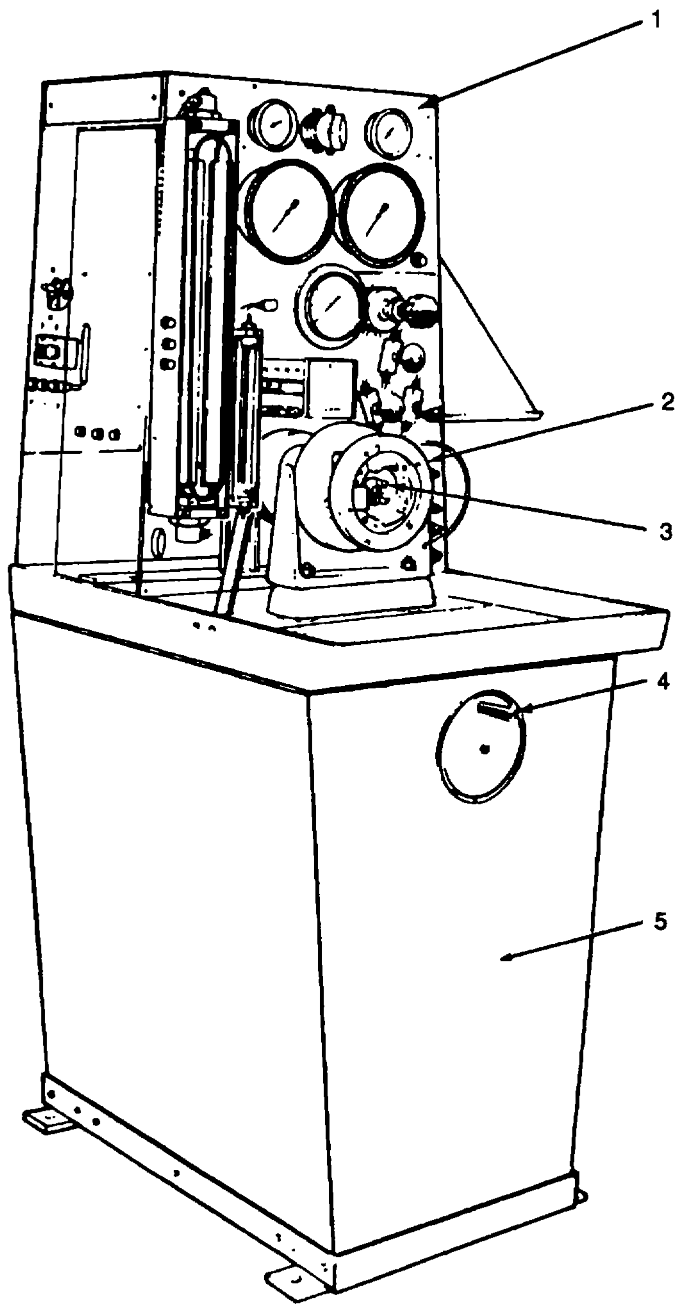
(7) Turn on the temperature control switch (17, Figure 6-17).

(8) Loosen the hexagonal nuts (54, Figure 6-11) and back out the adjusting screws (55) completely so that they do not interfere with the free movement of the control end (51) on the throttle shaft (45).

NOTE

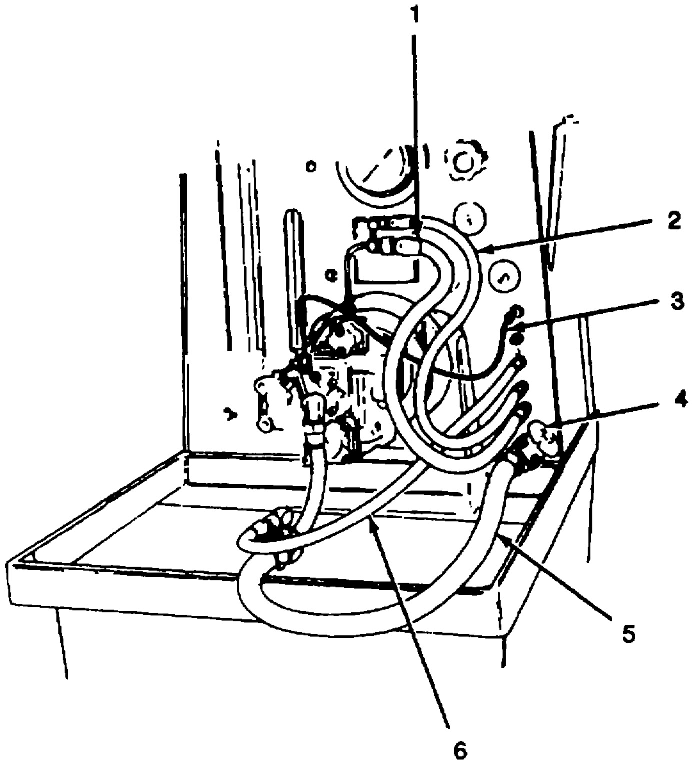
The throttle shaft (45, Figure 6-11) located in the fuel pump housing (66) turns counter clockwise to open. The throttle shaft (30) located in the cover (23) turns clockwise to open.

(9) Lightly damp a pair of locking pliers on the splined end of the throttle shaft (45) to be used as a lever. Hook one end of a universal spring to the handle of the locking pliers, and hook the other end of the spring to a point on the pump drive adapter (2, Figure 6-15). The handle of the locking pliers should be in a near vertical position over the throttle shaft (45), and the spring tension should be maintaining the throttle shaft (45) in the fully open position (rotated fully counter clockwise).



1. CONTROL PANEL
2. PUMP DRIVE ADAPTER
3. COUPLING
4. SPEED CONTROL HANDLE
5. FUEL PUMP TEST STAND

Figure 6-15. Fuel Pump Test Stand



1. OUTLET HOSE
2. HOSE TO PRESSURE GAGE
3. RETURN HOSE
4. SUCTION VALVE
5. SUPPLY HOSE
6. HOSE TO VACUUM GAGE

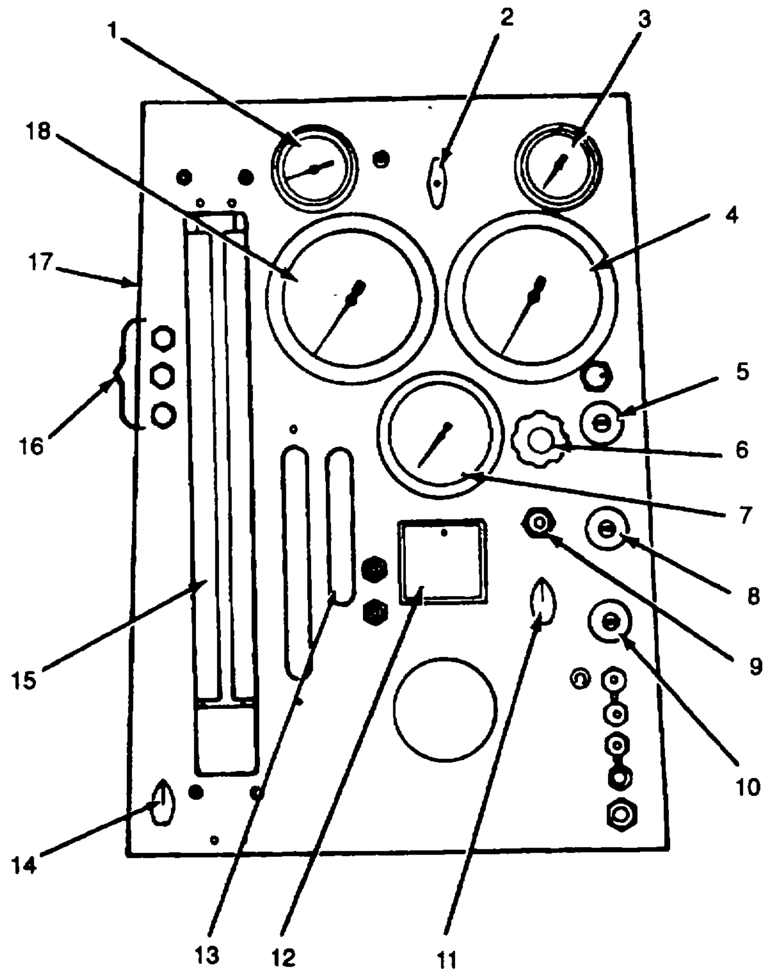
Figure 6-16. Test Stand Hose layout

(10) Loosen the adjusting screw nuts (25 and 27, Figure 6-11) and back out the setscrews (28) completely so that they do not interfere with the free movement of the throttle shaft stop (34) on the throttle shaft (30).
(11) Lightly damp a pair of locking pliers on the throttle shaft (30), and install a universal spring to hold the throttle shaft in the fully open position (rotated fully clockwise) as in step (9), above.
(12) Open the suction valve (4, Figure 6-16), set the rotation switch (2, Figure 6-17) for right hand rotation, and press the start/stop light button (16).
(13) Using speed control handle (4, Figure 6-15), adjust the pump speed to 500 rpm, and check the vacuum gage (7, Figure 6-17) to be sure the fuel pump has suction. If the vacuum gage (7) does not indicate suction, stop rotation and repeat step (5), above.
(14) Increase the pump speed to 1700 rpm, and adjust the suction valve to give vacuum gage (7) reading of 8 inches (200 mm) Hg.
(15) After 2 or 3 minutes of running time, check the main flowmeter (15) for the presence of air bubbles.

NOTE

It will take 2 to 3 minutes for the fuel pump to become completely primed and expel all air. During this time, the presence of air bubbles in the main flowmeter is normal.

(16) If the bubbles persist after 2 to 3 minutes of running time, a vacuum leak is indicated. Check and repair vacuum leaks in the suction hoses before continuing.
(17) Run the pump for 30 minutes and any additional time necessary to reach a test oil temperature of 90° to 1 000F (320 to 38"C) on fuel temperature gage (1).



1. FUEL TEMPERATURE GAGE
2. ROTATION SWITCH
3. GEAR PUMP PRESSURE GAGE
4. GAGE
5. FUEL FLOW CONTROL VALVE
6. PRESSURE CONTROL VALVE
7. VACUUM GAGE
8. THROTTLE LEAKAGE VALVE
9. TWO-WAY AIR SWITCH
10. IDLE ORIFICE VALVE
11. THREE-WAY VALVE
12. TACHOMETER
13. LEAKAGE FLOWMETER
14. THREE-WAY VALVE
15. MAIN FLOWMETER
16. START/STOP/LIGHT BUTTON
17. TEMPERATURE CONTROL SWITCH
18. FUEL PUMP PRESSURE GAGE

Figure 6-17. Test Stand Control Panel

c. Upper and Lower Governor Cut Off Speeds.

(1) Ensure that the fuel pump has been prepared for calibration in accordance with step b, above.
(2) Close the idle orifice valve (10, Figure 6-17), throttle leakage valve (8), and pressure control valve (6). Open the fuel flow control valve (5) completely.
(3) Adjust the fuel pump speed to 1800 rpm.
(4) Adjust the fuel flow control valve (5, Figure 6-17) until the main flowmeter (15) indicates 1275 lbs/hr (575 kg/hr). There must be no air in the main flowmeter (15).
(5) Adjust the suction valve (4, Figure 6-16) to get a reading of 7 inches (127 mm) Hg on vacuum gage (7, Figure 6-17). If you cannot get the vacuum gage to indicate 57 inches (127 mm) Hg, check for a restriction in the fuel pump test stand (5, Figure 6-15) filter or in the supply hose (5, Figure 6-16).
(6) Open the pressure control valve (6, Figure 6-17) and increase the fuel pump speed until the fuel pump pressure gage (18, Figure 6-17) indicates that fuel pump pressure is just beginning to decrease. This peak fuel pump pressure must be reached at a fuel pump speed of 2010 to 2040 rpm.
(7) If the fuel pump speed is less than 2010 to 2040 rpm, increase the speed by adding governor spring shims (10, Figure 6-11). If the fuel pump speed is greater than 2010 to 2040 rpm, decrease the speed by removing shims (10). Each 0.001 inch of shim (10) thickness will cause a change in fuel pump speed of approximately 2 rpm. Shims (10) are available in thick nesses of 0.005, 0.010, and 0.020 inch (0.13, 0.25, and 0.51 mm).
(8) After replacing the spring pack cover (5, Figure 6-1 1), and with the fuel pump running in the fuel pump test stand (5, Figure 6-15), open the fuel flow control valve (5, Figure 6-17) completely. Rotate the throttle shaft (45, Figure 6-11) fully clockwise and counter clockwise to help purge air from the fuel pump. When no air is present in the main flowmeter (1 5, Figure 6-17), adjust the main flowmeter as in step (4), above.
(9) Adjust the fuel pump speed to 1800 rpm. Turn in the setscrew (28, Figure 6-11), located on top of the cover (23), until the fuel pump pressure gage (18, Figure 6-17) indicates that fuel pump pressure is just beginning to decrease. This peak fuel pump pressure must be reached at a fuel pump speed of 1910 to 1940 rpm. If the fuel pump speed is more or less than 1910 to 1940 rpm, adjust the setscrew (28), located on top of the cover (23), until peak fuel pump pressure is reached at this speed.
(10) Lock the throttle shaft (30) into position by turning in the setscrew (28), located on the rear side of the cover (23), until it contacts the throttle shaft stop (34). Tighten the adjusting screw nuts (25 and 27) on the setscrews (28), located on the top and on the rear side of the cover (23), to lock the throttle shaft (30) in position.
(11) Remove the locking pliers and universal spring installed to the throttle shaft (30) in step b (11), above. No further adjustments are required to the upper governor.

d. Throttle Leakage.

(1) Remove the universal spring and locking pliers installed on the throttle shaft (45, Figure 6-11) in step b (9), above, and reinstall so that the throttle shaft is held in the fully dosed position (rotated fully dodkwise). Ensure that the adjusting screw (55), located towards the rear of the fuel housing (66), does not interfere with the movement of the control end (51).
(2) Open the throttle leakage valve (8, Figure 6-17) completely, and dose the fuel flow control valve (5) and idle orifice valve (10) completely. Adjust the fuel pump speed to 1800 rpm.

NOTE

The following adjustment must be made with the test oil temperature between 900 and 100 °F (32° and 38°C). The temperature of the test oil may be reduced if too hot by slowing the fuel pump speed of the fuel pump test stand. If the temperature of the test oil exceeds 135 °F (57°C), however, the test oil must be drained and replaced with new test oil.

(3) Using the adjusting screw (55, Figure 6-11), located towards the rear of the fuel pump housing (66), adjust the throttle leakage to 110 cc/min., as indicated by the leakage flowmeter (13, Figure 6-17).
(4) Lock the adjusting screw (55, Figure 6-11), located towards the rear of the fuel pump housing (66), by tightening the hexagonal nut (54). Recheck the throttle leakage.

(5) Close the throttle leakage valve (8. Figure 6-17).
(6) Leave the locking pliers and universal spring positioned as in step (1), above, for use in setting the idle speed in step e, below.

e. Idle Speed.

(1) Ensure that the locking pliers and universal spring are positioned as in step d (1), above, so that the throttle shaft (45, Figure 6-11) is held fully dosed (rotated fully clockwise).
(2) Close the fuel flow control valve (5, Figure 6-17), and open the idle orifice valve (10).
(3) Ensure that the control end (51) on the throttle shaft (45) is held against the adjusting screw (55), located towards the rear of the fuel pump housing (66), by the universal spring installed in step d (1), above.
(4) Adjust the fuel pump speed to 600 rpm.
(5) Remove the plug (7, Figure 6-11) at the rear of the lower spring pack cover (5). Using the idle speed adjusting tool 3375981, adjust the idle adjust screw (13) until the leakage flowmeter (13, Figure 6-17) indicates the flow of 310 i± 5 cc/min. at the established fuel pump speed of 600 rpm.

f. Throttle Travel and Calibration Pressure.

(1) Position the locking pliers and universal spring as in step b (9), above, so that the throttle shaft (45, Figure 6-11) is held fully open (rotated fully counter clockwise).

NOTE

During the following procedure, do not change the position of the adjusting screw (55, Figure 6-11), located towards the rear of the fuel pump housing (66), from its setting established in step d, above.

(2) Using a protractor, adjust the adjusting screw (55, Figure 6-11), located towards the front of the fuel pump housing (66), so that the throttle shaft (45) travel (rotation) between the adjusting screws (55) is 27 to 29 degrees. This will ensure full fuel flow through the throttle shaft (45) metering passage.
(3) Lock the adjusting screw (55), located towards the front of the fuel pump housing (66), by tightening the hexagonal nut (54).
(4) Ensure that the throttle shaft (45) is held in the fully open position (rotated fully counter clockwise). Close the idle orifice valve (10, Figure 6-17) and throttle leakage valve (8), and open the fuel flow control valve (5).
(5) Adjust the fuel pump speed to 1800 rpm.
(6) Check the torque required to turn the fuel adjusting screw (48, Figure 6-11) is at least 1.5 pound-inches (0.169 newton-meters). Replace the fuel adjusting screw (48) if torque required is less than this.
(7) Adjust the fuel flow control valve (5, Figure 6-17) until the main flowmeter (15) indicates 1275 lbs/hr (575 kg/hr), and adjust the suction valve (4, Figure 6-16) until the vacuum gage (7, Figure 6-17) indicates 7 inches (178 mm) Hg, or as close as possible.
(8) Using the fuel adjusting screw (48, Figure 6-11), adjust the fuel pressure as indicated by fuel pump pressure gage (18, Figure 6-1 7), to 185 psi (1276 kPa). Recheck in accordance with steps (4) through (7), above.
(9) Leave the locking pliers and universal spring positioned as in step (1), above, for use in checking the check point pressure in step g, below.

g. Check Point Pressure.

(1) Ensure that the locking pliers and universal spring remain positioned as in step f, above, so that the throttle shaft (45, Figure 6-11) is held fully open (rotated fully counter clockwise).
(2) Reduce the fuel pump speed to 1500 rpm.
(3) Adjust the fuel flow control valve (5, Figure 6-17) until the main flowmeter (15) indicates 1080 lbs/hr, (486 kg/hr), and check the fuel pressure as indicated by the fuel pump pressure gage (18). Fuel pressure must be 137 to 143 psi (945 to 986 kPa).

Table 6-3. Fuel Pump Calibration Specifications and Technical Data

ITEM	SPECIFICATION
Lower Throttle Shaft Rotation	Counterclockwise to open
Upper Throttle Shaft Rotation	Clockwise to open
Test Oil Temperature maximum	90 to 100°F (32 to 38°C) 135°F (57"C) allowable
Fuel Rate	426 to 444 lbs/hr (192 to 200 kg/hr)
Fuel Rail Pressure	176 to 194 psi (1214 to 1338 kPa) at 1800 rpm
Lower Governor Cut Off Speed	2010 to 2040
Upper Governor Cut Off Speed	1910 to 1940 rpm
Throttle Leakage	110 cc/min. at 1800 rpm
Idle Speed Flow	310 ±15 cc/min. at 600 rpm
Throttle Travel (Rotation)	27 to 29 degrees
Calibration Pressure	185 psi (1276 kPa)
Calibration Flow	1275 lbs/hr (575 kg/hr)
Check Point Pressure	137 to 143 psi (945 to 986 kPa)
Check Point Flow	1080 lbs/hr (486 kg/hr)

(4) If the fuel pressure is more or less than this proceed as follows:

(a) Check that the correct high speed governor spring (12, Figure 6-11) has been installed, and that the high speed governor spring is seated properly. Governor spring shims (10) may be added or removed in accordance with step c(7), above. If the high speed governor spring (12) is replaced, or If governor spring shims (10) are added or removed, the fuel pump must be recalibrated commencing with step b, above.

(b) Check the protrusion of the shoulder pin (1, Figure 6-12) in accordance with paragraph 6-10, step f. Shims (2) may be added behind the shoulder pin (1) if the fuel pressure is less than 137 to 143 psi (945 to 986 kPa), or removed if the fuel pressure is more than this. Shims (2) are available in 0.007 and 0.015 inch (0.18 and 0.38 mm) thicknesses.

(5) Once fuel pump testing and calibration is completed, reset the shutoff valve (Figure 6-10), (set open in step b (4), above) to is original closed position by turning the knob (2) counterclockwise as far as it will go. Do not force.

(6) The throttle shaft (45, Figure 6-11) may now be locked in the fully open position (rotated fully counterclockwise). During engine operation engine speed will be automatically controlled by the electric governor control (Figure 6-30) and the actuator (4, Figure 6-5). Loosen the hexagonal nut (54, Figure 6-11), located towards the rear of the fuel pump housing (66), and turn in the corresponding adjusting screw (55) until it contacts the control end (51). The control end (51, Figure 6-11) should now be fixed between the adjusting screw (55), located towards the rear of the fuel pump housing (66), and the adjusting screw (55), located towards the front of the fuel pump housing. Lock the adjusting screw (55), by tightening the hexagonal nut (54).

(7) Remove the locking pliers and universal spring from the throttle shaft (45, Figure 6-11), and from the throttle shaft (30, Figure 6-11), if not ready removed in step c (11), above.

(8) Replace the throttle shaft cover (43) on the fuel pump housing (66) with the rivets (42).

(9) Disconnect the fuel supply, outlet, and return hoses (5, 1, and 3, Figure 6-16) from the fuel pump, and remove the fuel pump from the pump drive adapter (2, Figure 6-15).

SECTION IV. MAINTENANCE OF FUEL INJECTORS

6-12. GENERAL

a. This section contains disassembly, cleaning, inspection, repair, replacement, reassembly, test, and adjustment instructions for the fuel injectors.
b. Because of the precision fit and finish of the related components, it is essential to avoid contamination by airborne dust or other contaminants.
c. The work area should be located as far as possible from grinding, painting, or other activities that could be a source of airborne contaminants. An enclosed, fuel systems service room is preferred.
d. The workbench, tools, and equipment must be kept dean and free of oil, grease, or other contaminants.
e. To ensure thorough cleaning, the fuel injectors must be completely disassembled during overhaul.
f. Place small parts together in trays to prevent loss.
g. Remove all traces of corrosion-preventive compound from new parts before installation in the assembly.
h. Ultrasonically dean all parts thoroughly before inspection and assembly.
i. This section is arranged on the assumption that a known defective injector is to be repaired, tested, and adjusted in that order. The paragraphs may be performed in any other order, but, any injector disassembled must be bench tested and adjusted after reassembly. Also, any injector received as a service replacement must be adjusted before installation in the cylinder head. An injector leakage tester 3375375 (Figure 6-18), injector cup spray tester 3376350 (Figure 6-19), and injector test stand 3375410 (Figure 6-20) are required to perform injector maintenance.

6-13. FUEL INJECTOR REMOVAL

NOTE

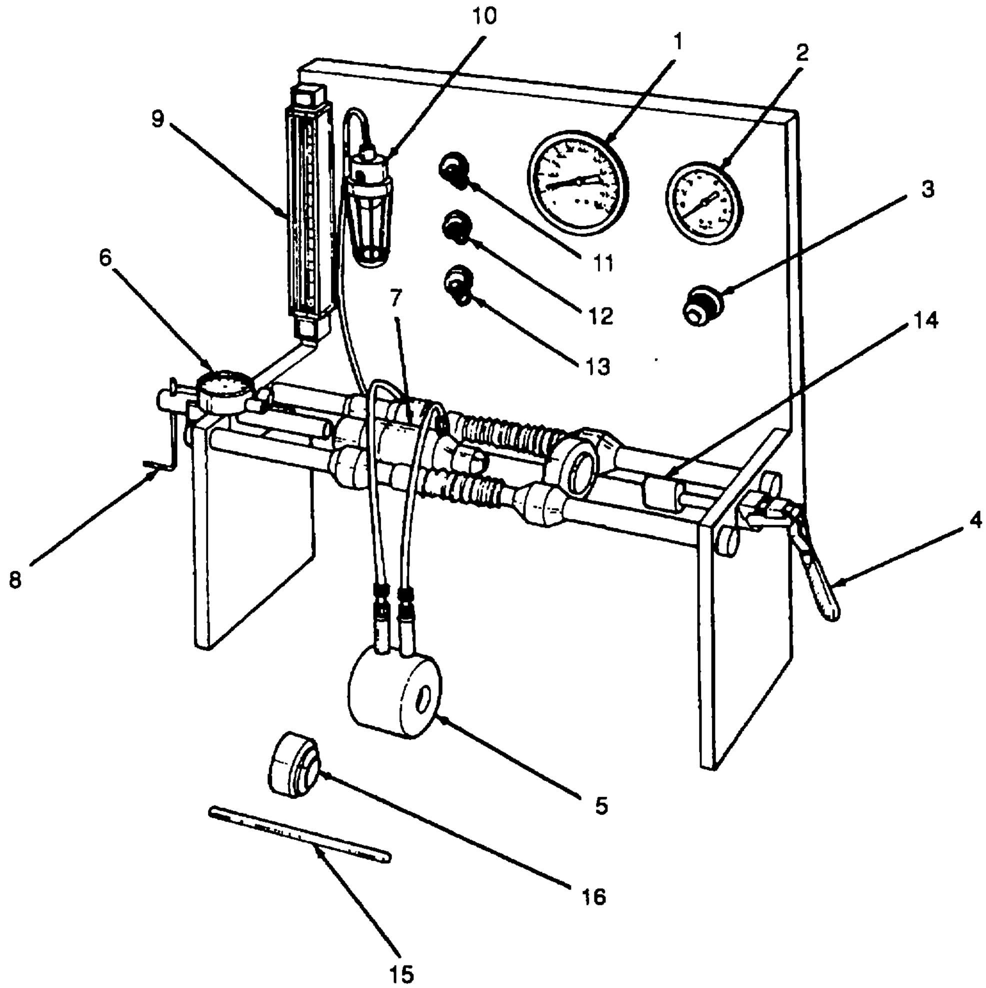
It is not necessary to remove push rods (1 and 2, Figure 9-13) from the cylinder head in order to remove the fuel injectors. I the push rods are removed at this time, it will be necessary to matchmark them in accordance with paragraph 9-6 in order to ensure that they will be correctly installed during reassembly.

a. Remove the rocker arm cover (6, Figure 9-2), rocker arms (12, 13, and 14), and shaft (11) assembly, and the valve crossheads (8, Figure 9-1) from the cylinder head in accordance with paragraph 9-5.

NOTE

Do not remove the plunger (3, Figure 6-21) and spring (4) from the fuel injector at this time. Removing the plunger (3) and spring (4) may result in dirt entering the barrel (15) and cup (16).

b. Match-mark the injector plunger link (2, Figure 6-21) and fuel injector. Remove the injector plunger link.
c. Remove the capscrews (19) and remove the damp (18) from the cylinder head.
d. Using injector puller 3376000, pull the fuel injector from the cylinder head.



1.	LOAD CELL GAGE	9.	FLOWMETER
2.	AIR PRESSURE GAGE	10.	BUBBLE CHECKER
3.	REGULATOR KNOB	11.	AIR SUPPLY VALVE
4.	CLAMP	12.	TIP SEAT PLUNGER LEAKAGE VALVE
5.	ADAPTER POT	13.	CHECK BALL LEAKAGE VALVE
6.	INDICATOR	14.	NOSE PIECE
7.	LOAD CELL ASSEMBLY	15.	INJECTOR LINK
8.	HAND CRANK	16.	ADAPTER POT LOCATOR

Figure 6-18. Injector Leakage Tester

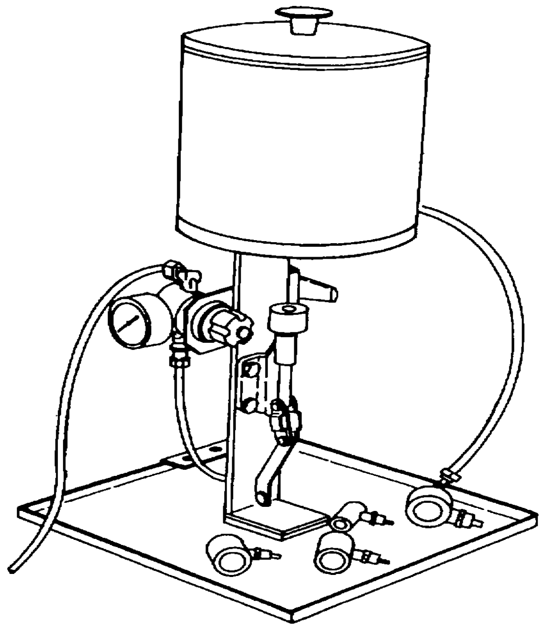


Figure 6-19. Injector Cup Spray Tester

6-14. FUEL INJECTOR DISASSEMBLY.

CAUTION

Injectors are selective, class fit with the barrels. Match-mark or otherwise Identify each plunger so that It will be kept with Its mating barrel. To avoid warping or scratching the plungers, do not lay them on their sides; stand them upright on the spring seat end.

a. Remove the sealing ring (1, Figure 6-21), injector plunger link (2), plunger (3), and spring (4). Store the plunger by standing it upright on the spring seat end. Discard the sealing ring (1).
b. Remove and discard the preformed packing (5, 6, and 7).
c. Remove filter screen dip (8) and strainer element (9). Discard the strainer element and dip.

NOTE

Do not remove the orifice (10) at this time unless it is visibly damaged.

d. Position the groove in the adapter (17) of the fuel injector in the body wrench portion of the injector assembly stand ST-1 298 with the injector retainer (12) facing upward. Position injector cup wrench ST-995 on the injector retainer (12) and loosen the retainer using a 1-1/4 inch box or open end wrench on ST-995.

CAUTION

To prevent loss of the check ball when removing the retainer, hold the Injector upright with the retainer facing down.

e. Hold the injector upright with the retainer (12) facing down. and remove the retainer, check ball (13), barrel (15), and cup (16). Remove the spiral pins (14) only if damaged. Discard the spiral pins.

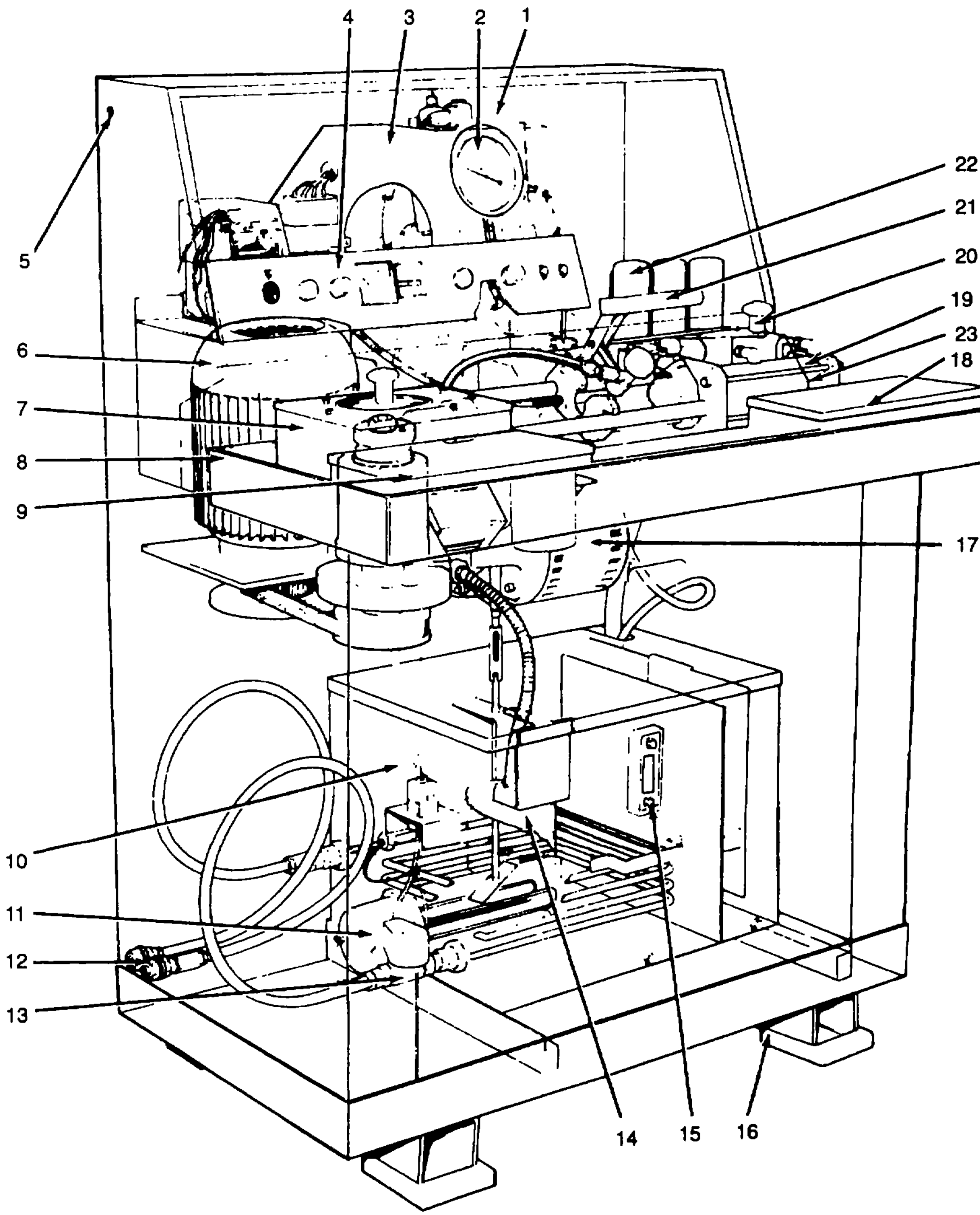


Figure 6-20. Injector Test Stand (Sheet 1 of 2)

1. FRONT PANEL
2. DIAL INDICATOR
3. ELECTRICAL CHASSIS
4. CONTROL PANEL
5. MAIN ELECTRICAL SUPPLY
6. CAMSHAFT DRIVE MOTOR
7. CAM BOX
8. TOP TRAY
9. STORAGE BOX
10. FUEL TANK
11. FUEL TANK HEATER
12. COOLER CONNECTIONS
13. COOLER SOLENOID
14. MAIN FUEL FILTER
15. FUEL SIGHT GAGE
16. ANTI-VIBRATION RUBBER PADS
17. FUEL PUMP MOTOR
18. STORAGE BOX (ADAPTERS AND LINKS)
19. INJECTOR CLAMPING CYLINDER
20. CLAMPING CONTROL HANDLE
21. FUELARM
22. DEADWEIGHT VALVES
23. GUARD

Figure 6-20. Injector Test Stand (Sheet 2 of 2)

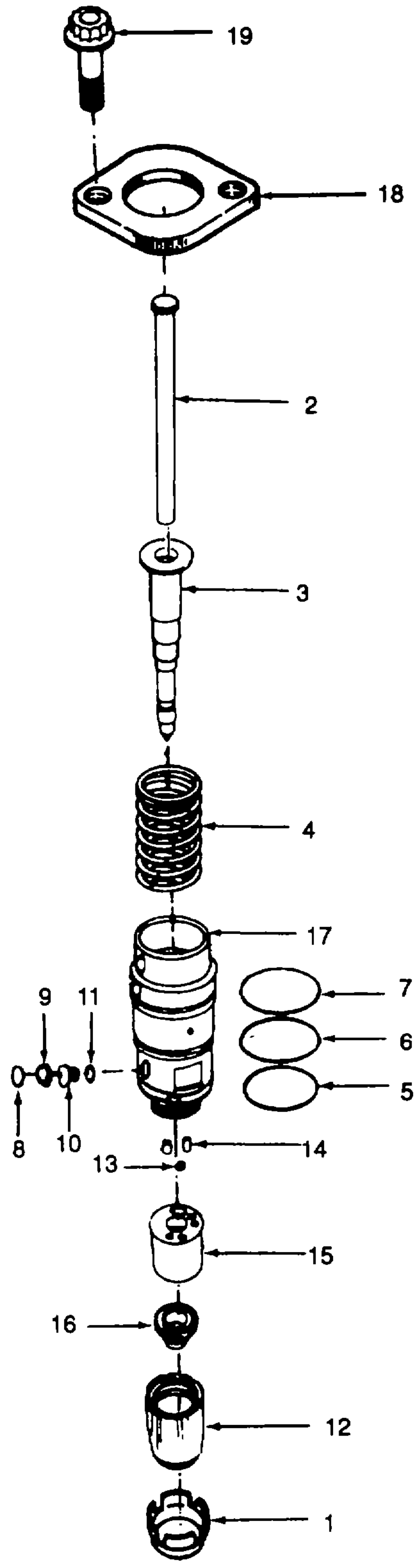
6-15. FUEL INJECTOR CLEANING, INSPECTION, AND REPAIR.

a. Clean all parts ultrasonically to remove all traces of gum, varnish, and carbon.
b. Check the ball ends of the injector plunger links (2, Figure 6-21) for wear in accordance with Figure 6-22. Replace the plunger links that show any signs of wear.
c. Injector Plunger and barrel Inspection.

    (1) General. Usually, seizure will be the only true indication of scuffing or scoring. As a result of rocker lever thrust, bright spots or streaks may appear at the top of the plunger (3, Figure 6-21), and on the opposite side at the bottom of the plunger. Provided seizure or scoring is not evident, these spots are normal and the plunger should be reused. Narrow streaks running from the top to the bottom of the plunger are usually caused by thickness variations in the penetrant treatment used to prevent corrosion. Again, unless seizure or scoring is evident, reuse the plunger.
    (2) Check the plunger (3) surface for signs of seizure, scoring, and wear ridges. The surface should show no signs of wear or scoring.
    (3) Check the plunger (3) spring seat for wear or cracks. The spring seat should show no cracks or signs of wear.
    (4) Inspect the bore of the barrel (15) using a four power magnifying glass. The bore should show no signs of wear or scoring.
    (5) Using a four power magnifying glass, inspect the check ball seat in the barrel (15) for burrs and wear. The seat should show no signs of burrs or wear.
    (6) See Figure 6-23. Install a check ball (1) in the barrel (2), and check the depth of the check ball seat by measuring A. Measurement of A must be 0.030 to 0.055 inch (0.76 to 1.40 mm). Replace the check ball (1) or the barrel (2), or both, as necessary to achieve the required depth.
    (7) Replace both the plunger (3, Figure 6-21) and barrel (15) as a matched set for any defects found in steps (2) through (5), above.

d. Cup inspection.
    (1) Inspect the cup (16, Figure 6-21) tip and spray holes with a four power magnifying glass. There should be no signs of abrasive wear, corrosion, or enlarged or elongated spray holes.Replace the cup if it is defective.
    (2) Check the cup (16) spray pattern using injector cup spray tester 3376350 (Figure 6-19). Replace cups that have irregular spray patterns.

e. Using spring tester MIL-T-43560, check the load required to compress the spring (4, Figure 6-21) to a length of 2.40 inches (61.0 mm). Replace the spring if the required load is less than 129.00 pounds (58.51 kg), or more than 149.75 pounds (67.93 kg).
f. Inspect the injector retainer (12) for nicks or burrs which could prevent proper seating with the sealing ring (1).



1. SEALING RING
2. INJECTOR PLUNGER LINK
3. PLUNGER
4. SPRING
5. PREFORMED PACKING
6. PREFORMED PACKING
7. PREFORMED PACKING
8. FILTER SCREEN CLIP
9. STRAINER ELEMENT,
10. ORIFICE
11. ORIFICE PLUG GASKET
12. INJECTOR RETAINER
13. CHECK BALL
14. SPIRAL PIN
15. BARREL
16. CUP
17. ADAPTER
18. CLAMP
19. CAPSCREW

Figure 6-21. Fuel Injector and Related Parts

Figure 6-22. Plunger Link Wear

g. Replace the check ball (13) if it shows any signs of wear or deformation when examined under four power magnification.
h. Inspect the packing ring grooves in the adapter (17) for defects which would prevent proper sealing. Replace defective adapters.
i. Use a four power magnifying glass to check the orifice (10) for burrs or an elongated hole. If the orifice shows signs of damage, replace it with a new one of the same size.

NOTE
Orifices are available in 0.029, 0.030, 0.031, and 0.032 inch (0.74, 0.76, 0.79, and 0.81 mm).

6-16. FUEL INJECTOR ASSEMBLY.

a. Install the check ball (13, Figure 6-21) and, if removed, new spiral pins (14) into the barrel (15).
b. Holding the barrel (15) upright to prevent loss of the check ball (13), install the adapter (17) on the barrel.
c. Turn the assembled barrel (15) and adapter (17) upside down, and place the cup (16) on the barrel.
d. Lubricate the threads of the injector retainer (12) with 20 or 30 weight motor oil MIL-L-9000, and install it on the assembled cup (16), barrel (15), and adapter (17). Tighten the retainer finger tight e. Dip the plunger (3) in clean injector test oil, and install it in the assembled injector. Do not install the spring (4) at this time.
f. Install injector cup wrench ST-995 on the retainer (12), and install the injector and wrench in assembly stand ST-1 298.
g. Activate the air cylinder on ST-1 298, and adjust the pressure to 70 psi (483 kPa), to align the cup (16) and plunger (3).
h. Using a torque wrench in conjunction with 1-1/4 inch crow-foot wrench, tighten the retainer to 50 pound-feet (68 newton-meters).

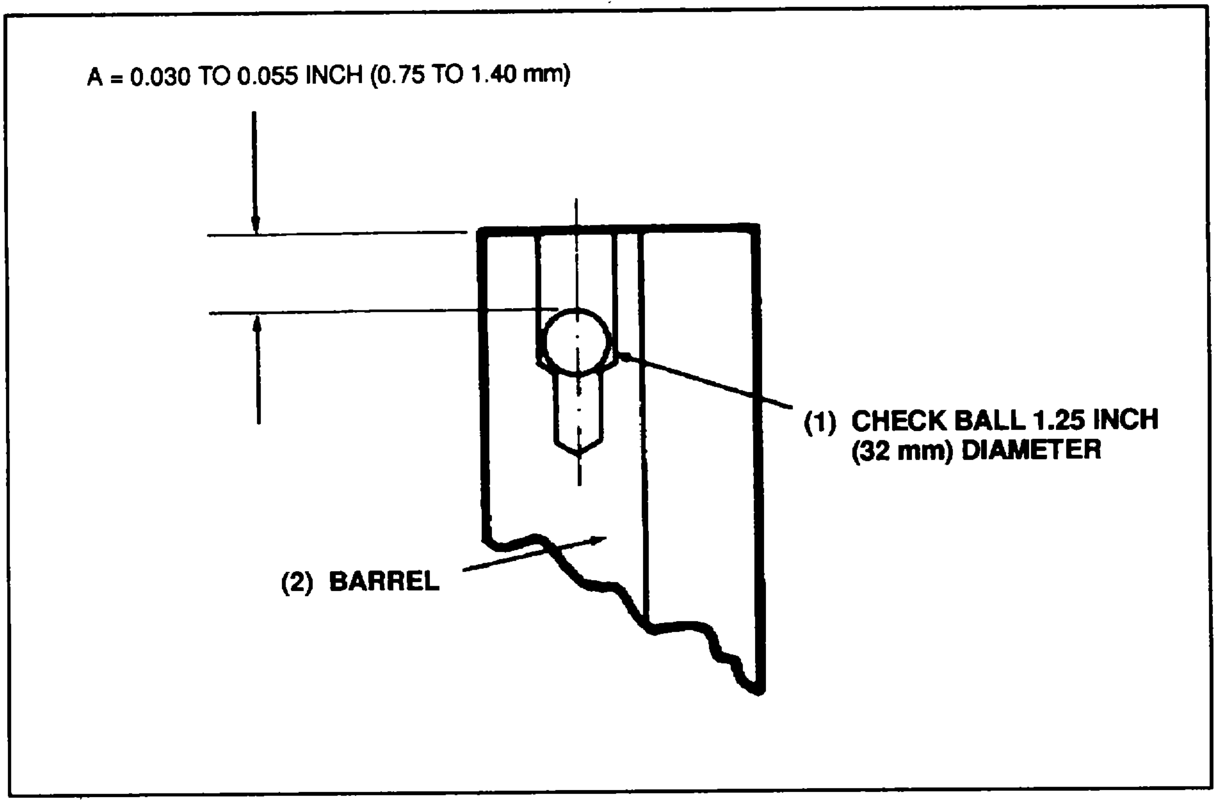


Figure 6-23. Checking Check Ball Seat Depth

i. Remove the injector from the assembly stand, withdraw the plunger (3), and dip it in dean test oil.
j. Hold the injector in a vertical position with the cup down, and allow the plunger (3) to drip a few drops of test oil into the cup (16).
k. Insert the plunger (3) about 0.5 inch (13 mm) into barrel (15) to be certain the plunger is started straight.
l. Rap the plunger with the palm of the hand, hold it firmly against the seat, and rotate it 90 degrees.
m. Hold the injector with the cup (16) up. The plunger (3) should slide out when the injector is lifted quickly.
n. If the plunger (3) does not slide out, remove it, coat the tip with test oil, and repeat steps h and m, above.
o. If the plunger (3) sticks because of misalignment, loosen injector retainer (12), rotate the cup (16) 1/4 turn, and retorque it in accordance with steps f, g, and h, above. Repeat as necessary.
p. Test all injectors in accordance with paragraph 6-17.

NOTE

Do not install the strainer element (9), filter screen clip (8), or spring (4) at this time.

q. Lubricate and install the preformed packings (5, 6, and 7).

6-17. FUEL INJECTOR TEST.

a. Leakage Test. Leakage tests are performed using leakage tester 3375375 (Figure 6-18). The leakage tester should be set up in a dean, well lighted, tightly enclosed area. When a tightly enclosed room is used, float on the tester may fluctuate if the test room door is opened and dosed. To avoid inaccuracies, readings must be taken with the door dosed. To avoid inaccurate readings due to vibration, the tester must be mounted on a heavy workbench. The air supply must be capable of supplying a constant pressure of 80 psi (552 kPa) minimum. The panel must be mounted in a level position to avoid flowmeter inaccuracy.

(1) Prepare the tester for use as follows:

(a) Fin the bawd on the bubble checker (10, Figure 6-18) one-half full with injector test of oil.
(b) Adjust the screws on the load cell assembly (7) lock to a load of 50 pounds (22.7 kg).
(c) Install the dial indicator (5) and extension in the damp.
(d) Install the injector to be tested in the test fixture as follows:

1 Lubricate the packings, and install the injector in adapter pot 3375440 (5).
2 Install he 3375398 injector link (15) in the injector plunger.
3 Place the adapter pot locator (16) over the injector with the largest diameter toward the injector flange.
4 Install the assembly in the tester with the injector link in the load cell assembly (7), and the cup in the nose piece (14), and secure it in place with the damp (4).
5 Install the supply and drain hoses on the adapter pot (5).

(2) Cup-to-plunger test.

(a) Adjust the air pressure to 60 psi (414 kPa) using the regulator knob (3).
(b) Adjust the hand crank (8) to show 200 pounds (90.7 kg) on the load cell gage (1).

NOTE

To avoid blowing oil from the bubble checker, the air supply valve (11) must be off when turning the other valves (12 or 13) either on or off.

(c) Turn the tip seat plunger leakage valve (12) to ON.
(d) Turn the air supply valve (11) to ON, and check for bubbles in the bubble checker (10).
(e) If no bubbles appear within 10 seconds, or if the time between bubbles is more than 5 seconds, the cup-to-plunger seating is acceptable.
(f) If the cup-to-plunger seating is unacceptable, replace the cup.
(g) Before proceeding to the next test or removing the injector, turn the tip seat plunger leakage valve (12) to OFF, then turn the air supply valve (11) to OFF.

(3) Barrel-to-plunger test.

(a) If removed, install the injector in the leakage tester in accordance with step (1), above.
(b) Check that the air pressure is still set to 60 psi (414 kPa). Adjust as necessary using the regulator knob (3).
(c) Adjust the hand crank (8) to show 200 pounds (90.7 kg) on the load cell gage (1).
(d) Zero the dial indicator(6), and back out the hand crank(8) 0.047 inch (1.19 mm) as shown on the dial indicator.
(e) Turn the tip seat plunger leakage valve (12) to ON, then turn the air supply valve (11) to ON.

NOTE

The flowmeter (9) is calibrated to an altitude of 600 feet (183 m) above sea level; flowmeter readings must be corrected to the ambient altitude as follows: at sea level, add 0.012 units to the flowmeter reading; for every 500 feet (152 m) of altitude rise above 600 feet (183 m), subtract 0.1 unit. If the testing is being conducted at 2100 feet (640 m), for example, find the number of flowmeter units to subtract as follows:

$$\frac{2100\text{-}600}{500} \times 0.1 = 0.3 \text{ units}$$

where,

0.3 = corrected flowmeter reading

(f) Rotate the injector plunger in small increments until the highest reading is obtained on the flowmeter. (A zero reading on the flowmeter indicates no leakage.)

(g) The corrected flowmeter reading shall not exceed 4.5for injectors. If the flow rate exceeds these limits, replace the plunger (3, Figure 6-21) and barrel (15) as a matched set.
(h) Before proceeding to the next test, or removing the injector, turn the tip seat plunger leakage valve (12, Figure 6-18) to OFF, then turn the air supply valve (11) to OFF.

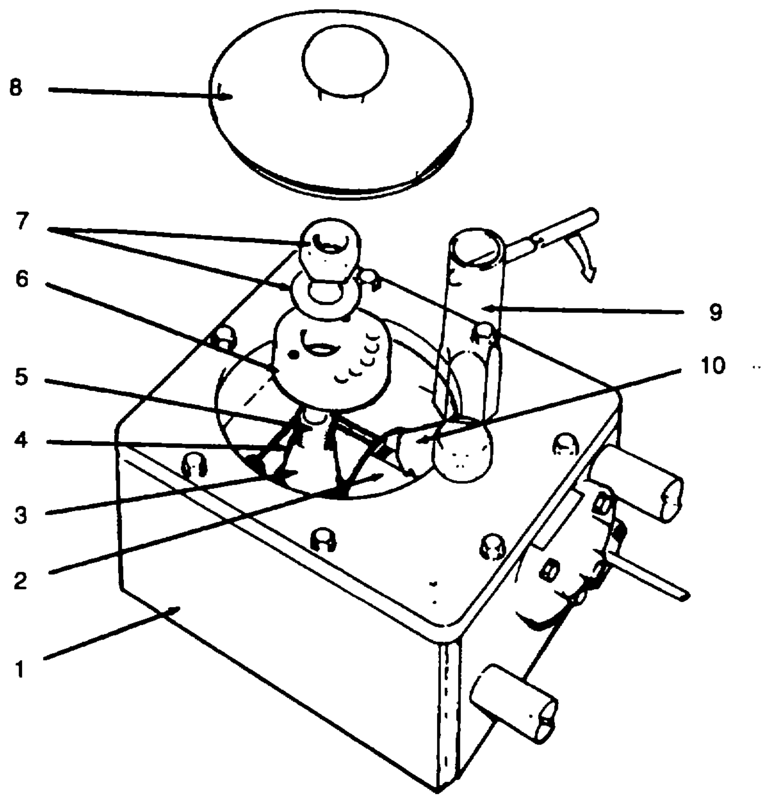
(4) Check ball leakage test.

(a) If removed, install the injector in the test stand in accordance with step (1), above.
(b) Adjust the hand crank (8) in accordance with step (3) (c) and (d), above.
(c) Turn the check ball leakage valve (13) to ON, then turn the air supply valve (11) to ON.
(d) Adjust the air supply regulator knob (3) to obtain 80 psi (552 kPa).
(e) Observe and correct the flowmeter reading in accordance with step (3), above.
(f) If the corrected flowmeter reading exceeds 10.0 units, replace the check ball (13, Figure 6-21), the plunger and barrel set (3 and 15), or both the check ball and plunger and barrel set as necessary.

(5) When all leakage tests have been passed, remove the injector from the test stand, and proceed to the flow test.

b. Flow Test Flow testing is conducted using injector test stand and calibration kit 3375410. All necessary tools and equipment used in the following steps are included in the kit; this includes the test stand 3375317 (Figure 6-20). The general test room requirements should be in accordance with step a, above. In addition, the ambient room temperature should be maintained between 60 to 90DF (15 to 320C), and the cooling water must be supplied at a pressure above 40 psi (276 kPa), and a temperature below 800F (270C), Check the fuel tank (10, Figure 6-20) level daily at the sight gage (15). I necessary, add calibration fluid 3375365 to bring the level to approximately 0.5 inch (13 mm) below the top of the sight gage. To ensure accuracy, the test stand must be maintained and calibrated periodically in accordance with the applicable service directive. Flow test the injectors as follows:

(1) Turn the main switch on the tester control panel (4) to ON.
(2) Press the fuel system ON button on the control panel (4) to activate the fuel tank heater (11).
(3) Check the cam box (7) to be sure the proper cam is installed; a chart on the underside of the cam storage box (9) lists the proper cam to be used for the injector being tested. N necessary, change the cam as follows:
   (a) Remove the cam box lid (8, Figure 6-24), and rotate the tappet (2) away from the camshaft (5) using the box wrench (9) provided.
   (b) Remove the cam nut and washer (7), and cam (6) using the box wrench (9).
   (c) Install the correct cam (6), and the cam nut and washer (7). Tighten the nut only until the camshaft (5) begins to turn.
   (d) Rotate the tappet (2) against the cam, and replace the lid (8).



1. CAMBOX
2. TAPPET
3. TAPER
4. KEY
5. CAMSHAFT
6. CAM
7. CAM NUT AND WASHER
8. LID
9. BOX WRENCH
10. TAPPET LIFTER

Figure 6-24. Injector Cam Installation

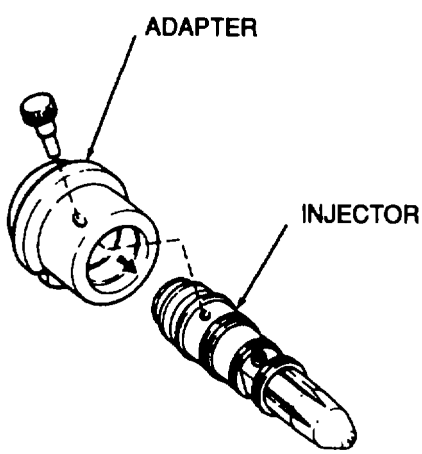


Figure 6-25. Adapter Installation

(4) Select the correct injector link and adapter from the storage box (18, Figure 6-20) using the chart on the storage box lid.
(5) Install the adapter on the injector (Figure 6-25) and install the link in the injector plunger.

NOTE
The damping control handle (20, Figure 6-20) must be in the released position in order to raise the guard (23).

(6) Raise the guard (23) and place the injector, adapter, and link into position (Figure 6-26). The two milled cut-outs in the adapter must fit over the parallel bars..
(7) Check the temperature indicator on the control panel (4, Figure 6-20). The temperature must register between 103 and 1 05OF (39.5 and 40.50C). If not, allow more time for the temperature to stabilize before continuing.
(8) Close the guard and turn the damping control handle (20, Figure 6-20) against its stop. This automatically provides the correct damping and sealing force on the injector.
(9) Check that the scribe mark on the cylinder flange aligns with the notch steel strip (Figure 6-27). If the scribe mark and notch do not line up, the injector has been incorrectly installed, or the wrong cam or adapters have been used. Make corrections as necessary in accordance with steps (3) through (8), above.
(10) Check that the packing is in place in the self-dosing valve in the fuel arm (Figure 6-28), and open the fuel line valve.
(11) Lower the fuel arm until the self-dosing valve is positioned over the injector orifice, and lock it in place by pulling the fuel arm to its over-center stop.

NOTE
The dial indicator (2, Figure 6-20) will stop registering at the completion of 1000 strokes. Raising the fuel arm (21) will stop the main drive motor to allow resetting the dial indicator.

(12) Press the main drive start button on the control panel (4, Figure 6-20), then press and release the metering button. Injected fuel flow will now register on the dial indicator (2) as cubic centimeters per 1000 strokes (ccl1000 strokes).

CAUTION
To avoid damage to the test stand, do not leave the Injector damped more than 1 minute after stopping the main drive. Do not, however, unclamp the Injector until the main drive motor has stopped.

(13) Allow the indicator readings to stop, raise the fuel arm (21), and allow the motor to stop.
(14) Press the metering button, then return the dial indicator (2) to zero using the ZERO SET screw within one minute.
(15) Lower the fuel arm (21) to restart the drive, press the metering button, and watch the small hand on the dial indicator (2) to see if it makes more than one revolution.
(16) Repeat steps (13), (14), and (15), above, until at least two identical indicator readings are obtained.
(17) Interpret the dial indicator (2) readings as follows (see Figure 6-29).

NOTE
Each revolution of the small hand equals 250 cc/l 000 strokes. Each revolution of the large hand equals 10 cCl/000 strokes.

(a) If the small hand has made less than one revolution, (A, Figure 6-29), use the figures on the inner dial (2 to 24).
(b) If the small hand has made more than one revolution (B, Figure 6-29), use the figures on the center dial (26 to 48).
(c) Multiply the reading of the small hand by 10, and add the reading of the large hand (outer dial) as shown in Figure 6-29. This figure is the injector flow in cc/1 000 strokes.

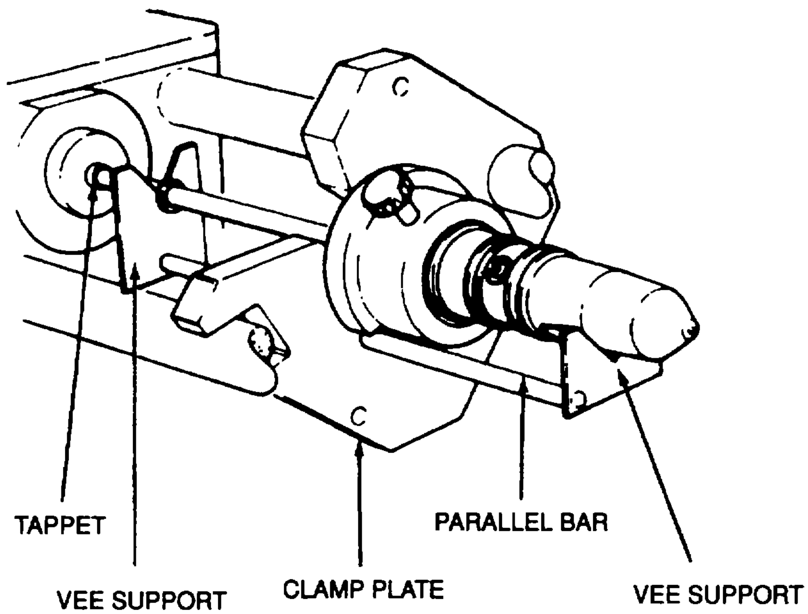


Figure 6-26. Loading Injector Into Test Stand

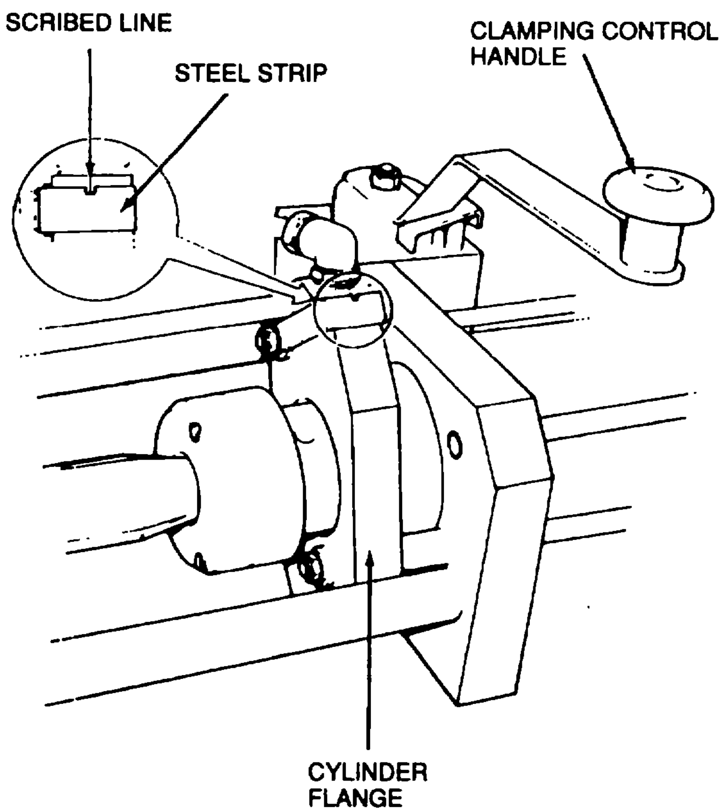


Figure 6-27. Checking Alignment In Test Stand

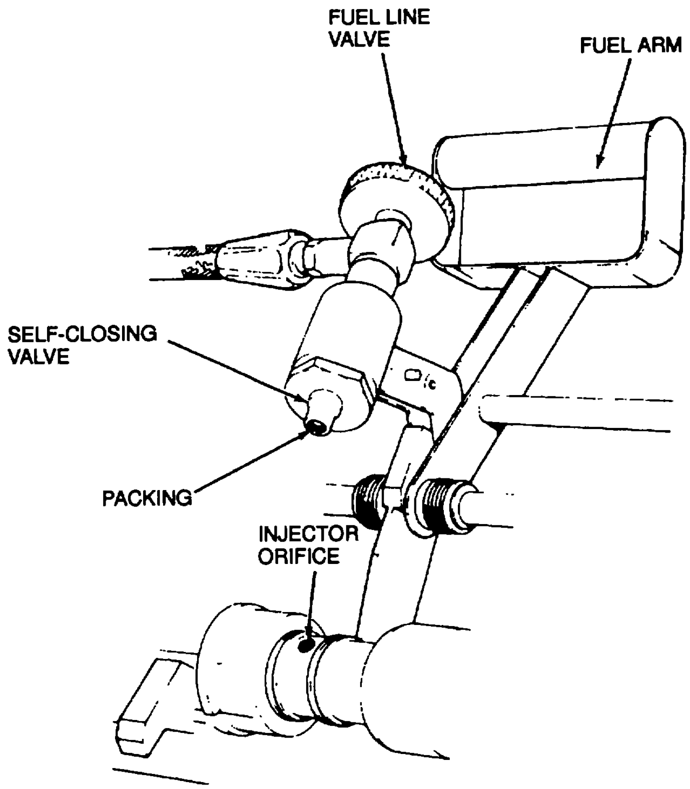


Figure 6-28. Fuel Arm and Supply Valve

(18) The injector flow per 1000 strokes should be 284.5 to 286.5 cc.

(19) It the injector over 286.5 cc, install a metering orifice as follows:

CAUTION

To avoid damage to the test stand, do not leave the injector clamped more than 1 minute after stopping the main drive. Do not, however, unclamp the injector until the main drive motor has stopped.

(a) Raise the fuel arm (21, Figure 6-20), wait until the main drive motor stops, then release the damping control the guard (20) and raise the guard (23).

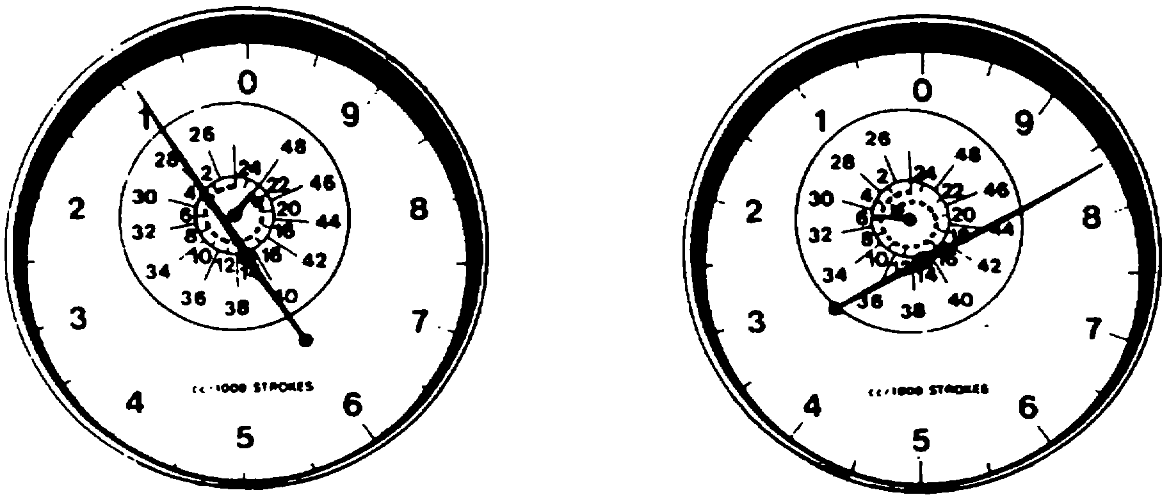
(b) Remove the orifice (10, Figure 6-21) from the adapter (17) using a 5/64 inch hex head driver. Remove and discard the orifice plug gasket (11).

NOTE

Orifices are available in sizes 0.029, 0.030, 0.031, and 0.032.

(c) Select a smaller orifice (10), and install a new orifice gasket (11) and the smaller orifice in the adapter (17). Tighten the orifice to 8 to 10 pound-inches (0.90 to 1.13 newton-meters).

(d) Recheck the injector flow in accordance with steps (14) through (17), above.



	A			B	
SMALL DIAL	23 + 23 X 10 = 230		SMALL DIAL	30 + 30 X 10 = 300	
LARGE DIAL	.9	+.9	LARGE DIAL	8.3	+ 8.3
TOTAL FLOW		230.9 cc	TOTAL FLOW		308.3

Figure 6-29. Calculating Dial Indicator Reading

(20) If the injector flow is under 284.5 cc, burnish the orifice as follow:

CAUTION

To avoid damage to the test stand, do not leave the injector clamped more than 1 minute after stopping the main drive. Do not, however, unclamp the injector until the main drive motor has stopped.

(a) Raise the fuel arm (21, Figure 6-20), wait until the main drive motor stops, then release the damping control handle (20) and raise the guard (23).

NOTE

Burnishing tool 3376135 uses adjustable spring tension to force the burnishing needle into the orifice. Increasing the spring tension will increase the orifice size and fuel flow.

(b) Using a light spring tension on burnishing tool 3376135, insert the tool into the orifice (10, Figure 6-21) and push in on the tool until it dicks.
(c) Recheck the injector fuel flow in accordance with steps (14) through (17), above.
(d) If the injector flow is still under 284.5 cc, increase the spring tension on the burnishing tool and repeat the burnishing operation.

(21) When the injector flow is satisfactory, raise the fuel arm (21, Figure 6-20), wait until the main drive motor stops, then release the damping control handle (20) and raise the guard (23).
(22) Remove the injector, adapter, and link from the test stand, and turn the fuel switch on the injector control panel (4) to OFF.
(23) Remove the adapter and link from the injector.
(24) Install a new strainer element (9, Figure 6-21) and filter screen dip (8), and install the injector plunger link (2).
(25) Store the assembled injector in a dean plastic bag until ready for installation.

6-18. FUEL INJECTOR INSTALLATION.

a. Ensure that the fuel injector bore in the cylinder head is dean. If necessary, dean carbon soot from the bore using a dean rag placed on the end of a wooden dowel.
b. Lubricate the fuel injector bore in the cylinder head with dean lubricating oil, such as MIL-L-9000, or equivalent.
c. Lubricate the preformed packings (5, 6, and 7, Figure 6-21) with dean lubricating oil, such as MIL-L-9000, or equivalent, and install them into the grooves on the adapter (17). Ensure that the preformed padrings (5, 6, and 7) are not twisted in the grooves after installation.

NOTE

If the fuel injector will not seat properly in the bore in the cylinder head, remove the fuel injector and inspect the preformed packings (5, 6, and 7) and the sealing ring (1) for signs of twisting or damage. Straighten or replace as necessary.

d. Install the sealing ring (1) on the cup (16), and place the fuel injector into the bore in the cylinder head. Seat the fuel injector in the bore in the cylinder head with a quick, hard push.
e. Place the damp (18) over the fuel injector and finger-tighten the capscrews (19).
f. Install the injector plunger link (2) in the plunger (3).
g. Torque the capscrews (19) alternately and evenly to 120 to 165 pound-inches (15 to 18 newton-meters).
h. Install the push rods (1 and 2, Figure 9-13), if removed, and install the valve crossheads (8, Figure 9-1), rock arms (12, 13, and 14, Figure 9-2) and shaft (11) assembly, and the rocker arm cover (6, Figure 9-2) on the cylinder head in accordance with paragraph 9-10.

SECTION V. FUEL TANK

6-19. GENERAL The fuel tank is of welded construction, and has a capacity of 130 gallons (492 liters). Three internal baffles are welded in place to prevent fuel sloshing. Welded flanges are provided for the vent hose fittings, drain valve nipple, fuel suction tube, fuel return hose elbow, liquid quantity transmitter, fuel level switch, and fuel level alarm switch.

6-20. FUEL TANK REPLACEMENT. Replace the fuel tank in accordance with paragraph 2-18.

6-21. FUEL TANK REPAIR.

a. Remove. Remove the fuel tank in accordance with paragraph 2-18.

WARNING

Although not as flammable as gasoline, diesel fuel is volatile and the vapor will bum or explode. To avoid injury to personnel, do not weld the fuel tank, or perform other operations that may produce sparks, until the tank is rendered safe.

b. Cleaning. Before performing repair operations, the fuel tank should be cleaned and rendered safe as follows: (1) Before starting the cleaning procedure, inspect for possible leak areas as indicated by fuel seepage, or wet spots. Mark these areas for further inspection and testing.

WARNING

Steam or vapor pressure cleaning creates hazardous noise levels, and may cause severe bums. Eye, skin, and ear protection is required.

(2) Steam dean the tank for at least 4 hours. During this time, high pressure steam should be introduced into all openings to vaporize and flush away all residual fuel.

(3) At the end of the steaming period, check for residual fuel vapors using an explosive vapor detector MIL-D-16191. If explosive vapors are detected, repeat the steam cleaning operation, and recheck for explosive vapors.
(4) During repair operations, check the fuel tank every 30 minutes for explosive vapors. If explosive vapors are detected during a check suspend work immediately, and repeat the cleaning and checking procedures.

c. Inspection. See Figure 2-16.

(1) Check all threaded holes for damaged or stripped threads, and mark them for repair.
(2) Mark obvious cracks and punctures in the tank (43) or filler pipe assembly (15), for repair. If damage to the tank is such that a patch would be required, replace the fuel tank
(3) Check for rust and corrosion on the tank or filler pipe assembly (15) that could become a source of future leaks. Test these areas by tapping them with a sharp punch. If they are easily penetrated, replace the fuel tank or the filler pipe assembly (15).
(4) Temporarily install the filler pipe assembly (15), plug all openings, then apply and maintain an air pressure of 3 psi (21 kPa) to the tank. Apply soap solution to the welds and suspected leak areas. Mark all leaks for repair, blood off the air pressure, and remove the filler pipe.

d. Repair. All welding shall be performed by qualified technicians in accordance with MIL-STD-1261, following the safety practices set forth by the American Welding Society publication Z49.1-67.

(1) Repair minor thread damage to fittings by chasing. Repair stripped or severely damaged threads in accordance with paragraph 2-12.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal sing, and airborne particles. Welding goggles, the proper tinted lenses, apron or jacket and welders boots are required to avoid injury to personnel.

(2) Repair leaks or cracks in the filler pipe assembly (15, Figure 2-16) by welding. Replace the filler pipe assembly if the flange is badly warped, or the tube is badly dented or out of round.

WARNING

To avoid explosions and injury to personnel during future repairs, do not weld patches on damaged areas of the fuel tank. Such patches will form fuel pockets. Fuel will gather in these pockets and be difficult or Impossible to remove or detect. The heat from welding operations will vaporize this fuel and form explosive gases.

(3) Weld cracks shorter than 2 inches (51 mm) in one pass. To prevent warping on longer cracks, tack weld the crack every 4 inches (102 mm), and use the back stop method of welding. Do not patch any crack or rusted through area; if a patch would be required, replace the fuel tank.

WARNING

Grinding operations create airborne, abrasive dust and particles. Respiratory and eye protection is required to prevent injury to personnel.

(4) Repair cracked or porous welds by grinding out the defect and rewelding.
(5) Check all new welds in accordance with step c (4), above.

e. Install. Install the fuel tank in accordance with paragraph 2-18.

SECTION VI. ELECTRIC GOVERNOR SYSTEM

6-22. GENERAL. The electric governor system is an electrical sensing system that maintains precise control of engine speed at any selected point, and provides rapid transient response to load changes. It is all electric and requires no engine drive or hydraulic system. It is ruggedly built to resist vibration and physical damage. The governor system is designed to provide steady state speed stability of less than plus or minus 0.25 percent, generally referred to as isochronous regulation. Droop can be obtained with a simple jumper connection at the control panel terminal block. The electric governor system consists of a magnetic pickup PUl (mounted in the engine flywheel housing), an actuator L101 (mounted on the fuel pump and electrically linked to the electric governor control unit), and a load sharing panel A104 (mounted inside cabinet B). The load sharing panel A104 is comprised of the electric governor control, a 50/60 Hz module, and a precise load sharing module.

a. Actuator.

(1) The actuator Li 01 is an electromagnetic rotary solenoid valve mounted in the PT (Type G) VS-EFC fuel pump. By regulating fuel pressure and hence fuel flow into the injectors, the actuator Li 01 determines engine speed and horsepower.
(2) The actuator Li 01 is controlled by the electric governor control unit which senses electrical signals proportional to actual engine speed from a magnetic pickup PUl, mounted on the engine flywheel housing.
(3) The electric governor control unit compares this feed back signal (engine speed and any speed variations brought about by load changes) against predetermined speed control reference set points and provides compensating current signals which turn the actuator shaft to either increase or decrease fuel pressure in order to maintain the preselected engine speed regardless of load changes.
(4) Anytime the load is increased, the engine slows down causing a decrease in frequency signal from the magnetic pickup PUl. This signal change is picked up by the electric governor control unit which then drives the actuator shaft to increase fuel pressure until the engine is brought back to the preselected speed.
(5) Refer to paragraph 6-9 for testing, removal, or replacement of the actuator.

b. Magnetic Pickup PUl.

(1) The magnetic pickup PUl is a magnetic device that is mounted in the flywheel housing. As the flywheel gear teeth pass the pickup, an ac voltage is induced, one cycle for each tooth. The frequency input signal from the magnetic pickup PUl may be as low as 0.5 volt rms or as high as 30 volts rms. A value of 1 volt rms at cranking speed is adequate.
(2) The magnetic pickup PUI is mounted through a threaded hole in the gear case of the flywheel bell housing. The magnetic pickup PU 1 can be screwed in (with engine stopped) until the tip strikes the top of the gear tooth, then backed out three-quarters of a turn and secured by the locknut.

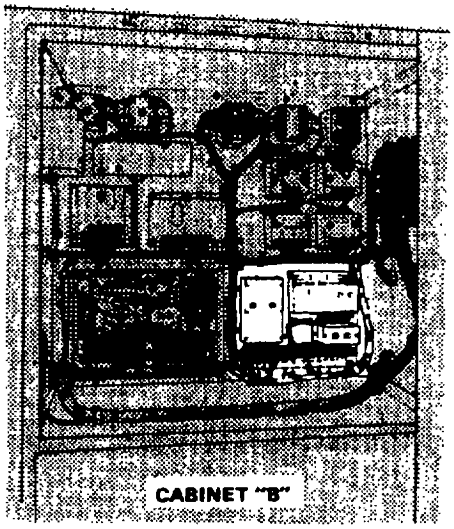
c. Battery Voltage Input. The input battery voltage is 24 V dc (do not connect to a battery charger). All circuits are isolated from the case; therefore, no ground is required. The maximum input current for 24 volts is approximately 3 amperes.

d. Load Sharing Panel A104 (see Figure 6-30).

(1) The load sharing panel A104 consists of three components:

(a) An electric governor control unit for engine speed control.
(b) A precise load-sharing module for load sharing of two or more engines.
(c) A 50/60 Hz module which permits the engine to operate generator G1 at 50 or 60 cycle operating output. This module contains two frequency trim adjustments.

(2) The load sharing panel A104 will provide accurate control at temperatures from -65 to 175°F (-54 to 79°C). The power resistors on the load sharing module will develop some heat which must be dissipated.
(3) The three load sharing panel A104 components are prewired into the top row of the 30-position terminal strip.



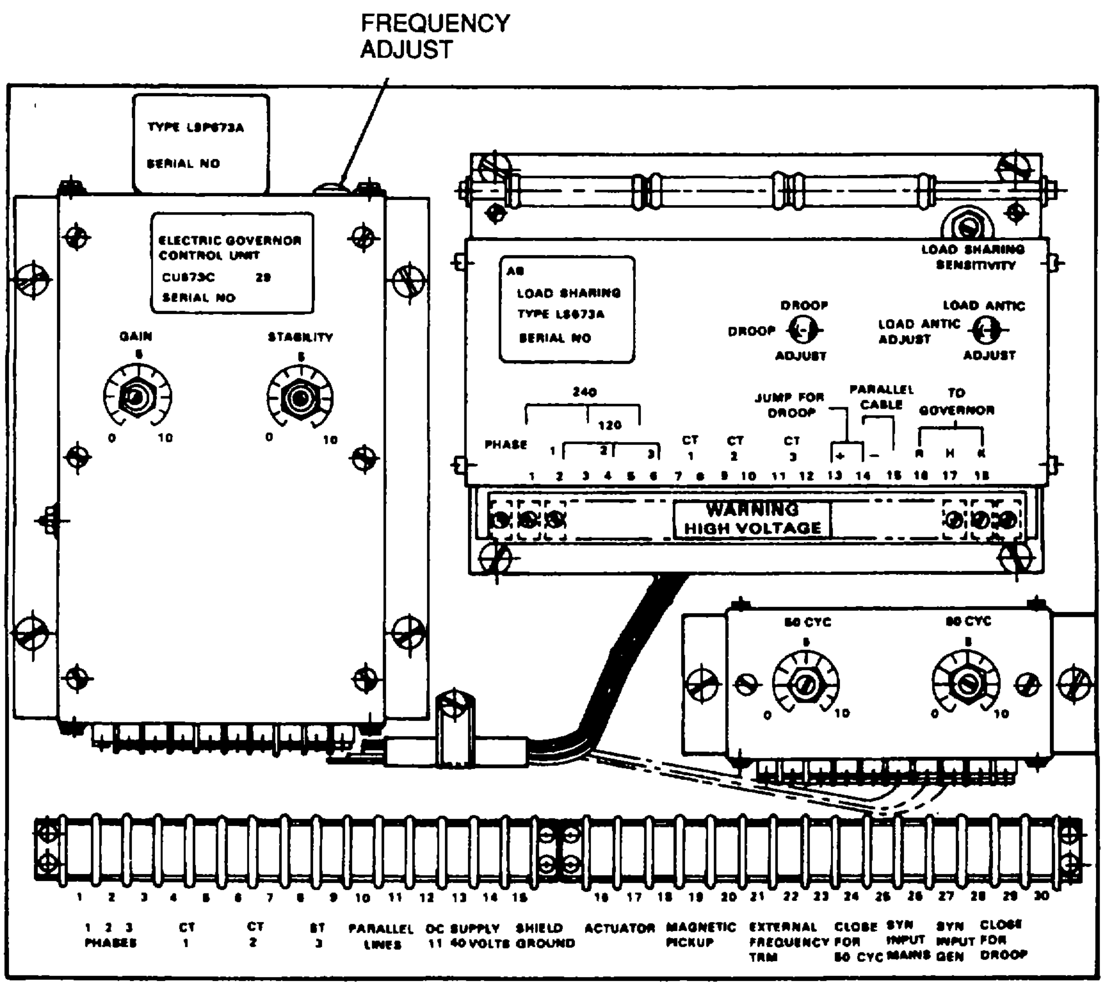


Figure 6-30. Load Sharing Panel A104 Controls

e. Electric Governor Control Unit.

(1) The electric governor control unit is an all electric, solid state unit with a circuit board coated on both sides with a compound to protect against vibration and humidity. The unit senses frequency signals from magnetic pickup PUl on the flywheel housing that are proportional to engine speed and compares them against a preselected speed reference. The unit accordingly adjusts current through the actuator L101 based on any difference between the two compared signals thus metering the fuel flow through the actuator L101 to maintain the engine at the predetermined speed regardless of any changes in load.

(2) The electric governor control unit is reverse acting in respect to loss of magnetic pickup PUI signal. If the signal is lost, the control unit will position the actuator metering valve to the no fuel position.

NOTE

The speed control adjustment procedures are contained in the Operator and Organizational Maintenance Manual.

(3) The electric governor control unit has three adjustments (see Figure 6-30): (a) The FREQUENCY ADJUST is a continuously variable 22-tum control for adjusting the speed setting. The control frequency range is from 300 to 10,000 Hz. Typical magnetic pickup PUl frequency at 1800 rpm is 4260 Hz. Clockwise adjustment increases the speed setting.

(b) The GAIN control is a single-turn control to adjust the sensitivity of the governor. Clockwise adjustment increases the gain. Instability will result with full clockwise adjustment while full counterclockwise adjustment will result in sluggish control. A small frequency change may be noted when the gain control is adjusted. If so, reset the frequency with the frequency trim potentiometer, which is located on the panel mounted 50/60 Hz module.

(c) The STABILITY control is a single-turn control to adjust the time constant of the electric governor control. The time constant is the length of time required for the engine to return to set speed after a load change. Clockwise adjustment shortens the time constant and counterclockwise rotation increases the time constant. The STABILITY control is adjusted for the shortest time constant while maintaining stability.

f. Load Sharing Module A104 (see Figure 6-30). The precise loadsharing module measures the true power output of an ac alternator and converts this output to a proportional dc voltage. By proper connection of the outputs, a multiple arrangement of generator sets can be connected in parallel to share the load equally. The inputs to the load-sharing unit are: line-to-line voltage, line currents, and battery supply. This module also includes load anticipation and adjustable droop control circuitry.

g. Instability. Instability may occasionally result when units are paralleled. Instability can be caused by the LOAD SHARING SENSITIVITY control (Figure 6-30) being set too high. Turn the sensitivity control counterclockwise until stability is restored. The system should stabilize with the control no more than 75 percent counterclockwise. This must be done the same on all units. If instability is still present, the GAIN adjustment on the speed control unit may have to be reduced slightly.

h. Load Anticipation Adjustment. The load sharing module has a load anticipation circuit to improve transient response. The load anticipation adjustment is factory set at zero sensitivity (full counterclockwise). The load anticipation should be adjusted while the engines are in parallel. Carefully advance the LOAD ANTIC ADJUST while occasionally varying the throttle position or changing the load. Instability or overshoot may result if the control is advanced too far.

i. Droop Adjustment. Five percent adjustable droop with load is obtainable after disconnecting the parallel cable, and adding a shorting plug to J21, J22, or J23. The shorting plug applies a direct short circuit to the parallel cable connection. Adjust the DROOP ADJUST control to the desired droop level. It is linear and may be set at any load.

6-23. ELECTRIC GOVERNOR SYSTEM TEST AND ADJUSTMENT.

NOTE

All tests referred to in this paragraph require that OPERATION SELECTOR SWITCH S3, located on cabinet B door, be set to MANUAL, and that FREQUENCY SEL. SW. S118, located inside cabinet A, be set to 60 HZ. Except where indicated, all tests are to be performed with components to be tested installed and wired as during normal use.

WARNING

Hazardous voltages appear at terminals inside cabinet B during generator set operation. Observe safety precautions applicable to maintenance on high voltage equipment. Failure to do so may result in injury or death.

WARNING

High voltages and currents appear at load sharing panel A104 terminals 1 through 9. Observe safety precautions applicable to maintenance of high voltage equipment Failure to do so may result in injury or death.

a. Electric Governor Control Unit See Figure 6-31.

(1) Set 24 V dc CONTROL POWER CIRCUIT BREAKER CB1 to ON.
(2) Using a multimeter set to 0 to 50 V dc scale, measure voltage from either of the two terminals identified as F G H to terminal K.
(3) Multimeter should indicate 10.1 V dc.
(4) Using a multimeter set to 0 to 10 V dc scale, measure voltage from either of the two terminals identified as F G H to terminal B.
(5) Multimeter should indicate a maximum of 2.5 V dc.
(6) Disconnect and tag wiring to fuel shutoff valve LI, located on the fuel injection pump.
(7) While cranking the engine, the multimeter should indicate battery voltage.
(8) Using a multimeter set to 0 to 10 V dc scale, measure voltage from either of the two terminals identified as F G H to terminal N while cranking the engine.
(9) Multimeter should indicate 8.5 to 9.5 V dc.
(10) Using a multimeter set to 0 to 10 V dc scale, measure voltage from either of the two terminals identified as F G H to terminal L while cranking the engine.
(11) Multimeter should indicate more than 5.1 V dc.
(12) Reconnect wiring as tagged to fuel shutoff solenoid L1, start the engine and operate at 1800 rpm and no load.
(13) Multimeter should indicate 5.1 V dc.
(14) Disconnect and tag wiring to fuel shutoff valve L1.
(15) Using a multimeter set to 0 to 10 V ac, measure voltage from either of the two terminals identified as F G H to terminal S while cranking the engine.
(16) Multimeter should indicate at least 1.0 V ac rms.
(17) Replace an electric governor control unit which fails any of the tests described in steps (1) through (16), above.

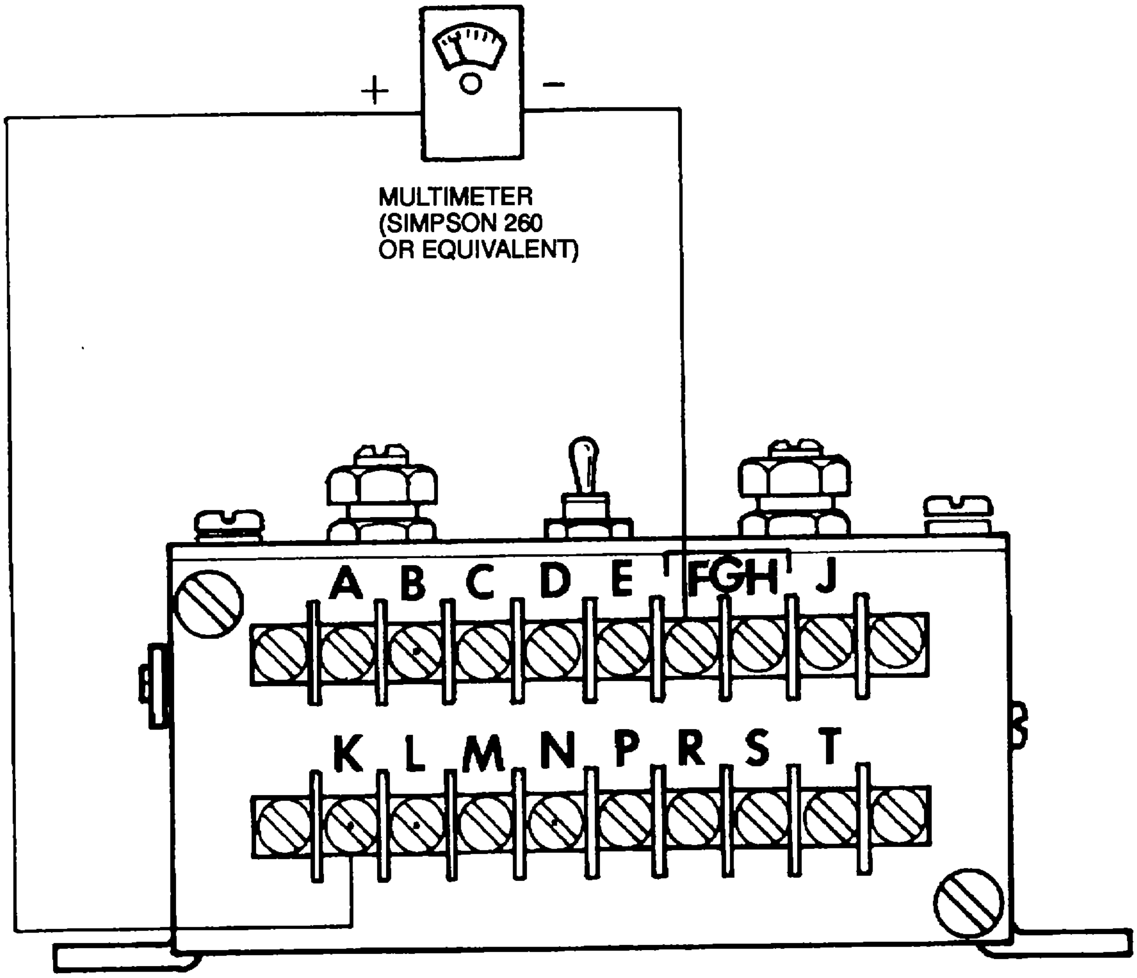


Figure 6-31. Test Setup (Typical), Electric Governor Control Unit

b. 50/60 Hz Module. See Figure 6-32.
   (1) Start the engine and operate at 1800 rpm and no load.
   (2) Using a multimeter set to 0 to 2.5 V dc scale, measure voltage from terminal J to terminal 3.
   (3) Multimeter should indicate a slight positive (+) voltage from terminal J to terminal 3.
   (4) Set FREQUENCY SEL. SW. S118 to 50 Hz.
   (5) Multimeter should indicate zero volts.
   (6) Replace a 50/60 Hz module which fails this test.

WARNING

High voltages and currents appear at load sharing panel A104 terminals 1 through 9. Observe safety precautions applicable to maintenance on high voltage equipment Failure to do so may result in injury or death.

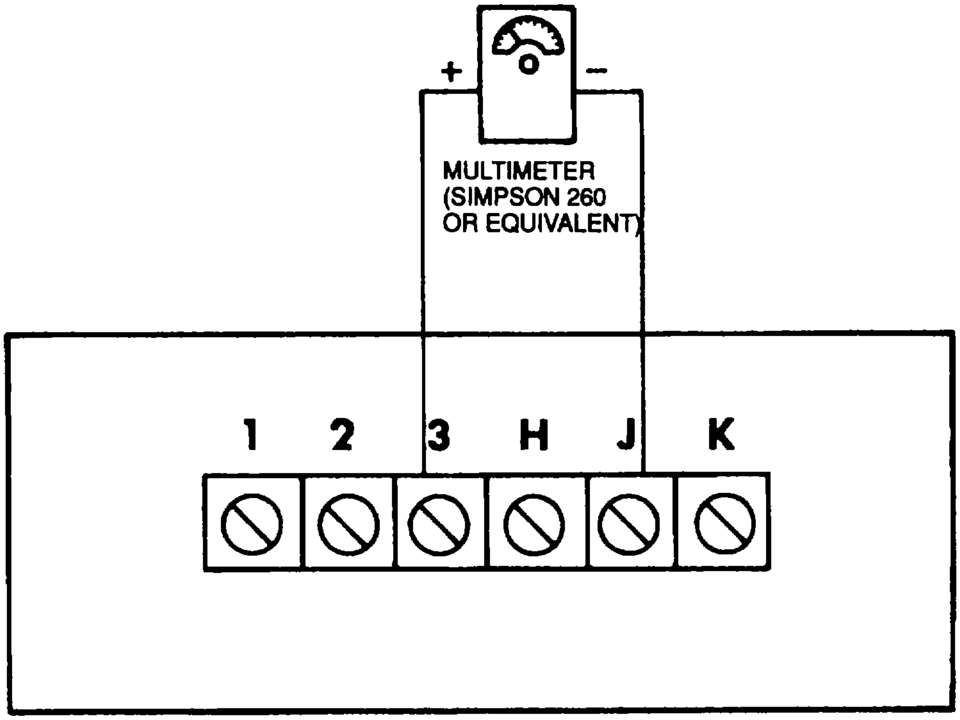


Figure 6-32. Test Setup, 50/60 Hz Module

c. Precise Load Sharing Module. See Figure 6-33.

(1) Start the engine and operate at 1 800 rpm and no load (2) Using a multimeter set to 0 to 250 V ac scale, measure voltage across terminals 1 and 3, 1 and 5, and 3 and 5.
(3) Multimeter should indicate nominal 208 V ac rms.
(4) Using multimeter set to 0 to 50 V dc scale, measure voltage from terminal 17 to terminal 18.
(5) Multimeter should indicate 10.2 ± 0.6 V dc.
(6) Using multimeter set to 0 to 10 V dc scale, measure voltage from terminals 14 to 17, 15 to 17, and 16 to 17.
(7) Multimeter should indicate 5.1 ± 0.3 V dc.
(8) Replace a precise load sharing module which fails any of the tests described in steps (1) through (7), above.

d. Synchronizer A105. See Figure 6-34.

(1) Disconnect terminal 14 lead from terminal board and insulate in order to prevent load circuit breaker CB1 01 from closing once voltage has been synchronized.
(2) Connect the generator set to a five bus such as utility power.
(3) Using a multimeter set to the appropriate scale, measure voltage and compare values obtained in accordance with Figure 6-34.
(4) Using a multimeter set to RX1 scale, measure resistance across terminals 13 and 14.
(5) Multimeter should indicate greater than zero ohms.
(6) Replace a synchronizer which fails any of the tests described in steps (3) through (5), above.

e. Adjust Load Sharing Panel A104. To adjust load sharing panel A104, perform an operational checkout of the generator set in accordance with the Operator and Organizational Maintenance Manual.

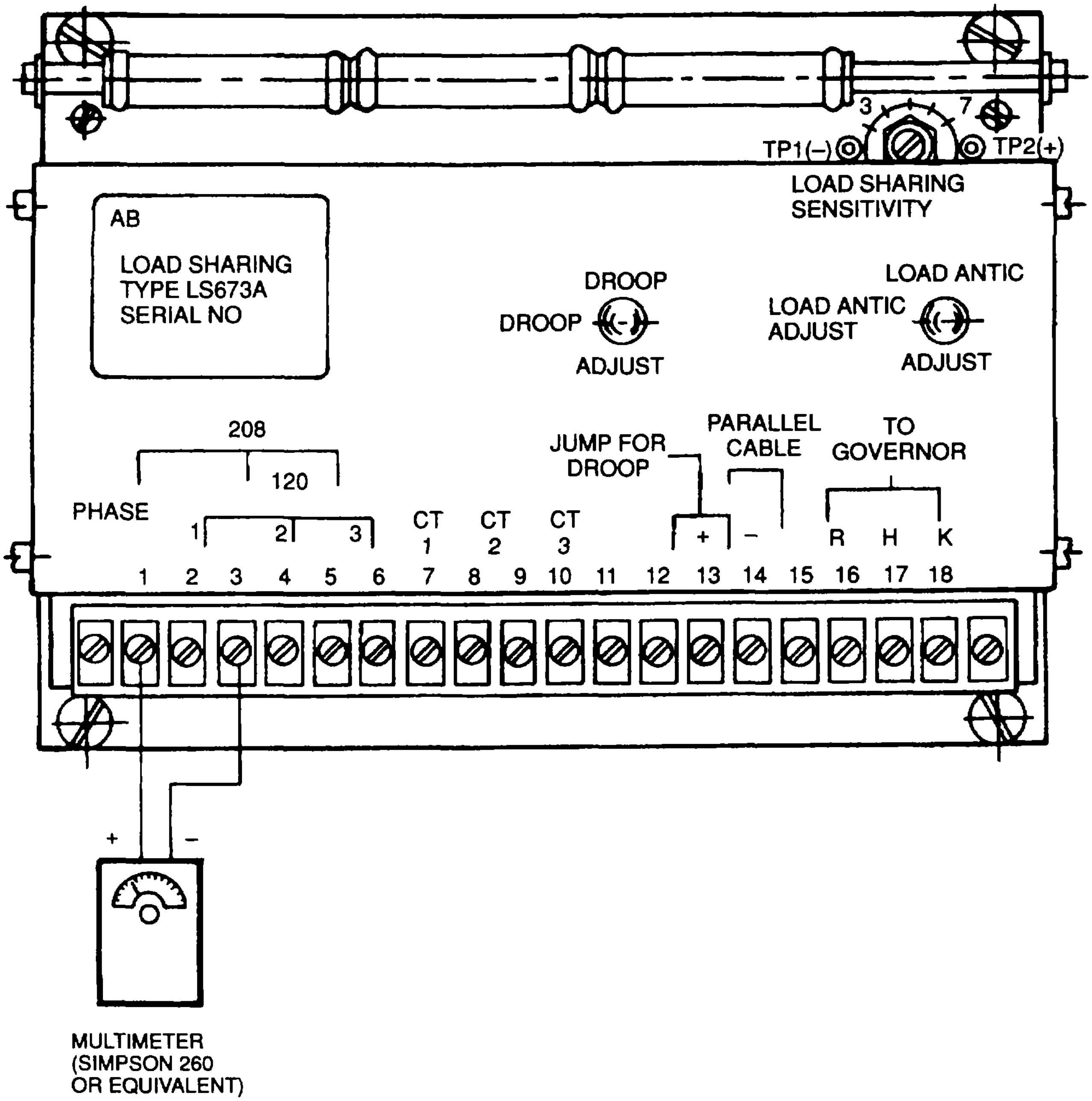
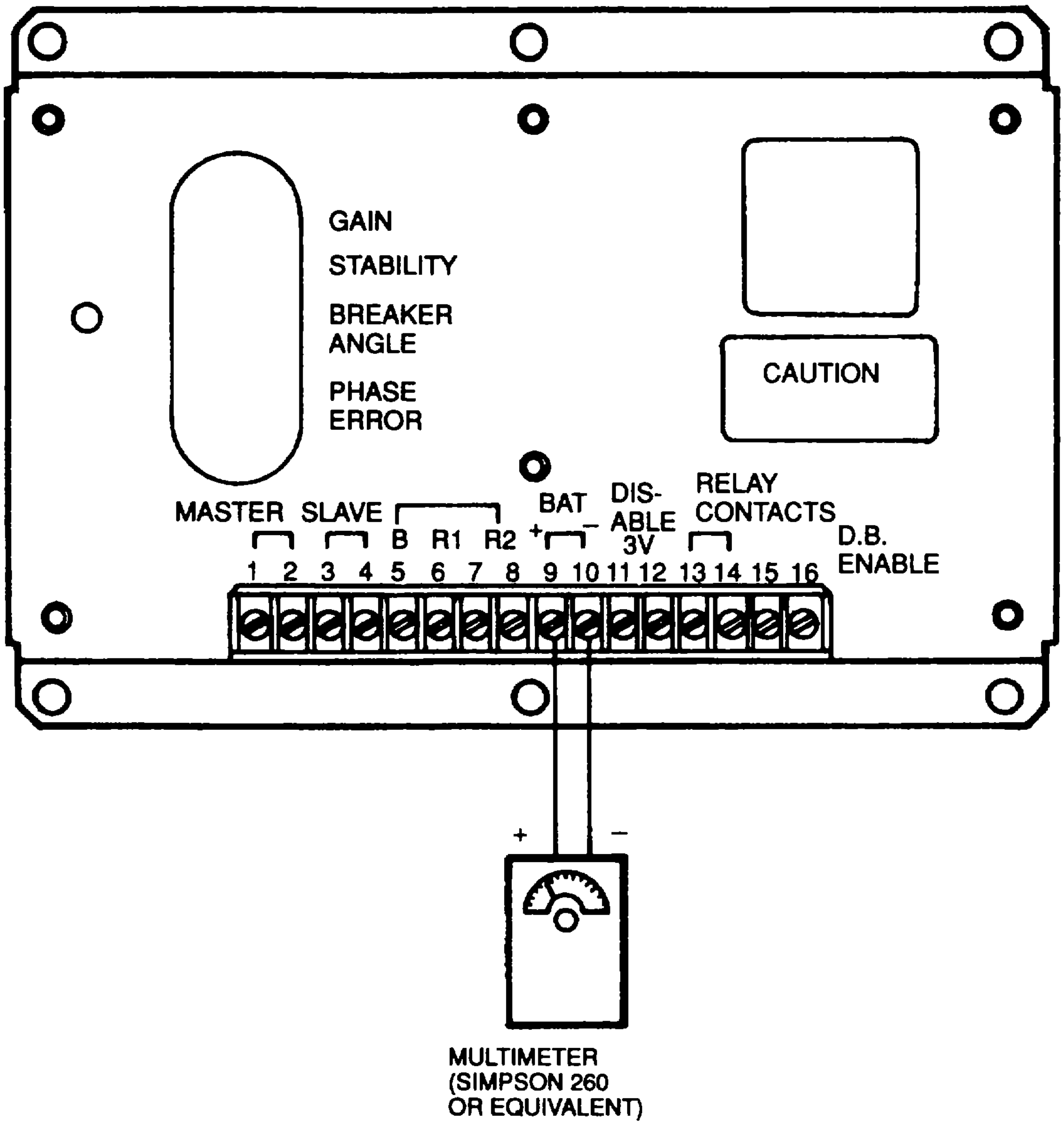


Figure 6-33. Test Set (Typical), Precise Load Sharing Module



GENERATOR SET CONNECTED TO LIVE BUS TERMINAL 14 LEAD DISCONNECTED FROM TERMINAL BOARD AND INSULATED.

Figure 6-34. Test Set (Typical), Synchronizer A105 (Sheet 1 of 2)

TERMINALS		NORMAL VOLTAGE
FROM	TO	
9(+)	10(-)	24 V DC
1	2	NOMINAL 208 V RMS
3	4	NOMINAL 208 V RMS
5	10(-)	5 TO 20VDC
8	10(-)	5.0(±) 0.3VDC
11	10(-)	ZERO VDC
15	16	1 VDC (MAX)
7	10	3.5 TO 3.6 6.5 VDC
6	10(-)	3.5 TO 3.6 6.5 VDC

Figure 6-34. Test Setup (Typical), Synchronizer A105 (Sheet 2 of 2)

SECTION VII. FUEL MANIFOLDS

6-24. GENERAL. Fuel manifolds are used to distribute the fuel from the fuel pump to the injector passages in the cylinder heads. Procedures for replacement of the manifolds and related parts are contained in this section.

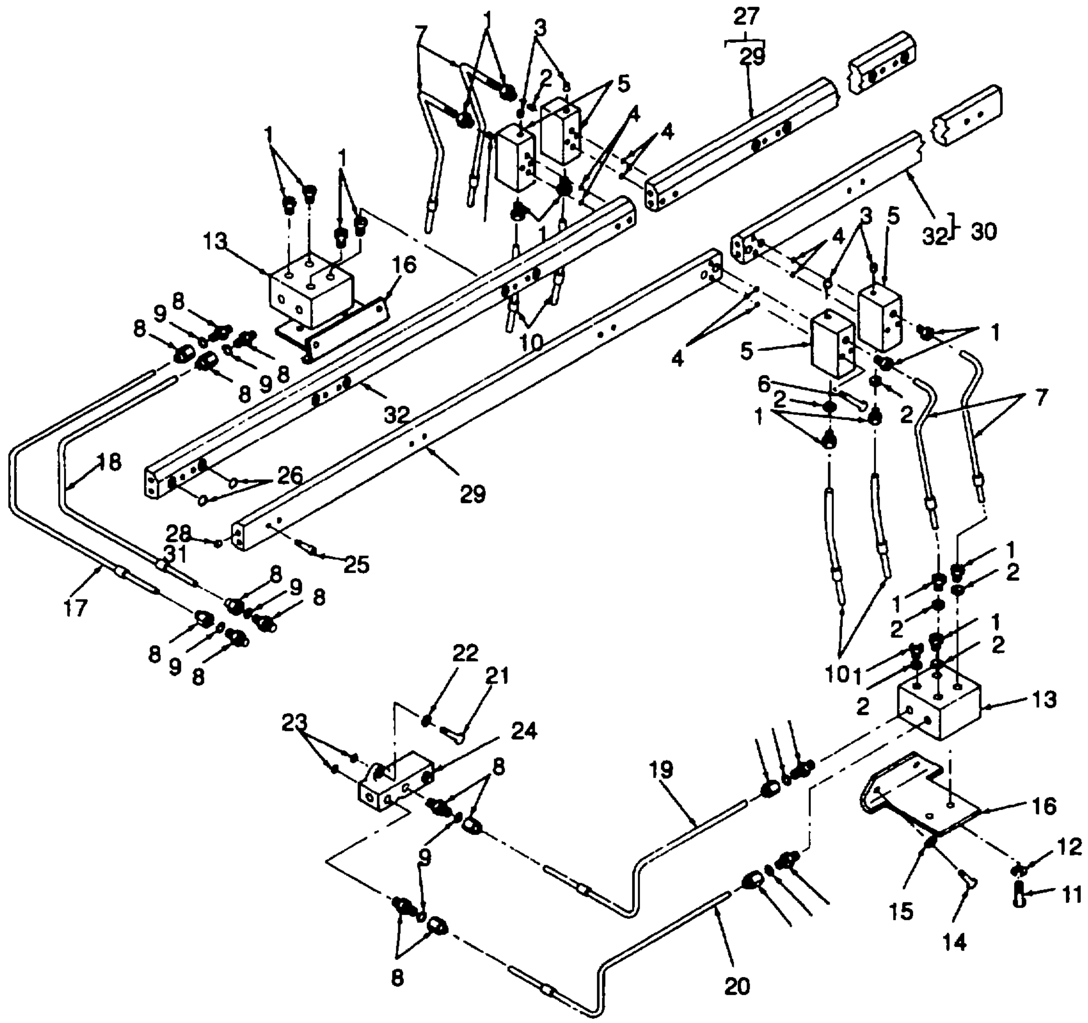
6-25. FUEL MANIFOLD REMOVAL. Procedures in this paragraph may on only be performed with the intake manifolds removed. Refer to paragraph 9-43 for both removal and installation of the intake manifolds.

a. Right Bank Manifold. See Figure 6-35.

(1) Disconnect fuel supply and fuel drain tubes (7 and 10) at the fuel block connection (13). Remove the fitting and ferrule assemblies (1).
(2) Disconnect fuel supply and fuel drain tubes (7 and 10) at the fuel block connection (5). Remove the fitting and ferrule assemblies (1).
(3) Remove socket head capscrews (6) to remove fuel block connection (5). Remove and discard preformed packings (4).
(4) Remove fuel manifold assemblies (27) by removing socket head capscrew (25). Remove and discard preformed packings (26).

b. Left Bank Manifold. See Figure 6-35.

(1) Remove left bank fuel supply tubes (7 and 10) and fuel block connection (5) in accordance with step a(1), (2), and (3), above.
(2) Remove fuel manifold assemblies (30) by removing socket head capscrews (25). Remove and discard preformed packings (26).



1. FITTING AND FERRULE ASSEMBLY
2. RUBBER FERRULE
3. PIPE PLUG
4. PREFORMED PACKING
5. FUEL BLOCK CONNECTION
6. SOCKET HEAD CAPSCREW
7. FUEL SUPPLY TUBE
8. CONNECTOR ASSEMBLY
9. RUBBER FERRULE
10. FUEL DRAIN TUBE
11. HEXAGON HEAD CAPSCREW
12. LOCKWASHER
13. FUEL BLOCK CONNECTION
14. HEXAGON HEAD CAPSCREW
15. WASHER
16. FUEL BLOCK BRACKET
17. RIGHT BANK FUEL SUPPLY TUBE
18. RIGHT BANK FUEL DRAIN TUBE
19. LEFT BANK FUEL DRAIN TUBE
20. LEFT BANK FUEL SUPPLY TUBE
21. CAPSCREW
22. LOCKWASHER
23. PREFORMED PACKING
24. FUEL BLOCK
25. SOCKET HEAD CAPSCREW
26. PREFORMED PACKING
27. FUEL MANIFOLD ASSEMBLY
28. MACHINE THREAD PIPE
29. FUEL MANIFOLD
30. FUEL MANIFOLD ASSEMBLY
31. MACHINE THREAD PIPE
32. FUEL MANIFOLD

Figure 6-35. Fuel Manifolds and Related Parts, Exploded View

6-26. FUEL MANIFOLD INSTALLATION.

a. Fuel Manifolds. See Figure 6-35.

(1) Coat the preformed packings (26) with lubricant and position them into the center bores on the block sides of the fuel manifold assemblies (27 and 30).

NOTE

The preformed packings (26) must stay in position in the fuel manifold assemblies (27 and 30) center bores during installation.

(2) Carefully position the fuel manifold assemblies (27 and 30) on the cylinder heads, aligning the preformed packings (26) with the cylinder head fuel drillings. Secure the manifold assemblies (27 and 30) with socket head capscrews (25).

NOTE

Coat the mating head surface of the screw heads with an anti-seize compound to aid in removal.

(3) Using a 1/4 inch socket and an inch-pound torque wrench, start in the center of each manifold assembly (27 and 30) and tighten the socket had capscrews (25) to 40 to 45 pound-inches (4.5 to 5.1 newton-meters) torque.

b. Fuel Tubing (Left Bank and Right Bank). See Figure 6-35.

(1) Lubricate the preformed packings (4) with petrolatum VV-P-236. Position the packings in the counterbores of the fuel block connections (5).
(2) Position the fuel block connections (5) to the fuel manifold assemblies (27 and 30). Install the socket head capscrews (6) and finger tighten.
(3) Position and finger tighten the fuel supply tubes (7) and fitting and ferrule assemblies (1) to the fuel block connections (5 and 13).
(4) Tighten socket head capscrews (6) to 40 to 45 pound-inches (4.5 to 5.1 newton-meters). Secure all fitting and ferrule assemblies (1).

NOTE

See paragraph 9-43 for intake manifold installation procedures.

SECTION VIII. ACCESSORY DRIVE

6-27. ACCESSORY DRIVE. The accessory drive is used to transmit power from the engine crankshaft to drive the fuel pump.

a. Remove.

(1) Refer to paragraph 6-9 and remove fuel pump (7, Figure 6-4) from accessory drive (6).
(2) Refer to paragraph 9-33 and remove the accessory drive pulley (7, Figure 9-59) from the shaft (9, Figure 6-36).
(3) Remove capscrews (13, 14, and 15) and lockwashers (16) to remove accessory drive from engine front gear housing. Remove gasket (17) and discard.

b. Disassemble. See Figure 6-36.

(1) Remove capscrew (1), plain washer (2), and pull half coupling (3) and coupling washer (4) from the accessory drive shaft (9).

(2) Remove shaft (9) and fuel pump gear (6) assembly from accessory drive housing (12). Remove hourmeter spacer (5).
(3) Press accessory drive shaft (9) from fuel pump gear (6). Remove key (8) and thrust washer (7) from accessory drive shaft (9).

c. Inspect. See Figure 6-36.

(1) Inspect the fuel pump gear (6) for worn or broken teeth. Replace as necessary.
(2) Inspect the shaft (9) forwear, chips, or burrs. Measure shaft outside diameter at gear end and at bearing contact areas. Shaft diameter at gear end should be 1.3765 to 1.377 inches (34.963 to 34.98 mm). Shaft diameter at bearing contact area should be 1.3115 to 1.312 inches (33.312 to 33.32 mm). The shaft wear limit at bearing contact area is 1.310 inches (33.27 mm). Replace the shaft if it does not meet these specifications.
(3) Inspect the bushing (10) inside the accessory drive housing (12) for looseness, scoring, and other damage. Measure the bushing inside diameter. The bushing (10) inside diameter should be 1.316 to 1.319 inches (33.43 to 33.50 mm). The bushing (10) inside diameter wear limit is 1.320 inches (33.53 mm). Replace the bushing (10) if it does not meet these specifications. If bushing (10) has turned in the retaining bore and ruined the housing (12), replace the housing and the bushing.

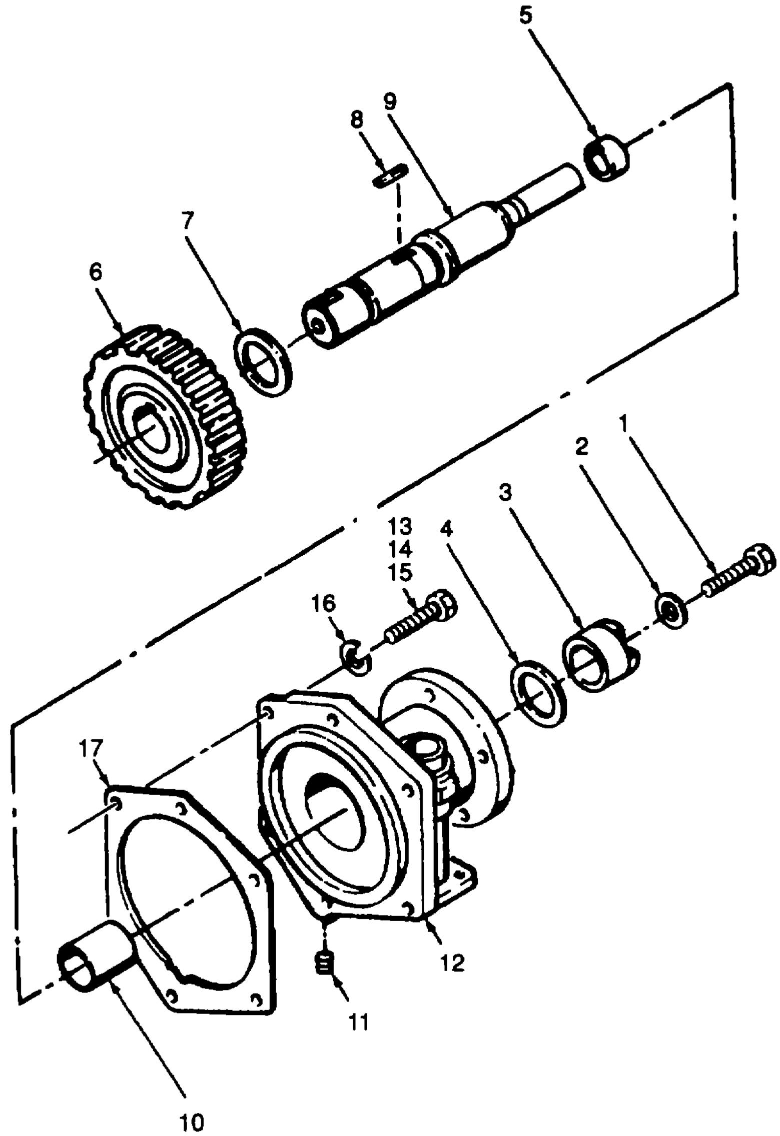
d. Repair. Repair of the accessory drive assembly consists of replacement of worn or damaged part as determined by inspection, step c, above.

e. Reassemble. See Figure 6-36.

(1) Install hourmeter spacer (5) over coupling end of shaft (9). Install the shaft (9) through the housing (12) and bushing (10). Slip on the thrust washer (7), face side up, over gear end of shaft (9).
(2) Install the key (8) on the shaft (9) and press on the fuel pump gear (6).
(3) Slip the coupling washer (4) over coupling end of shaft (9). Press on the half coupling (3), hub end down, on the shaft (9). Secure with plain washer (2) and capscrew (1).
(4) Rotate gear and shaft assembly inside the housing (12) to check freedom of movement.
(5) Check end clearance between housing (12) and drive gear (6). Clearance should be 0.002 to 0.012 inch (0.04 to 0.30 mm) with the unit assembled.

f. Install. See Figure 6-36.

(1) Install new gasket (17) over front mounting flange of housing (12) and install accessory drive on engine front gear housing using capscrews (13, 14, and 15) and lockwashers (16). Tighten capscrews (13, 14, and 15) to 45 to 55 pound-feet (60 to 75 newton-meters).
(2) Refer to paragraph 9-33 and install the accessory drive pulley (7, Figure 9-59) on the shaft (9, Figure 6-36).
(3) Refer to paragraph 6-9, and install the fuel pump (7, Figure 6-4) on the accessory drive (6).



1. CAPSCREW
2. PLAIN WASHER
3. HALF COUPLING
4. COUPLING WASHER
5. SPACER
6. FUEL PUMP GEAR
7. THRUSTWASHER
8. KEY
9. ACCESSORY DRIVE SHAFT
10. BUSHING
11. PIPE PLUG
12. ACCESSORY DRIVE HOUSING
13. CAPSCREW
14. CAPSCREW
15. CAPSCREW
16. LOCKWASHER
17. GASKET

Figure 6-36. Accessory Drive, Exploded View

CHAPTER 7
MAINTENANCE OF COOLING SYSTEM

SECTION I. WATER PUMP AND WATER PUMP DRIVE

7-1. GENERAL.

a. Water is circulated by a centrifugal water pump mounted on the right bank side of the block. The pump is driven by an idler gear from the crankshaft.

b. Coolant flows from the water pump volute into the center of the “V” cylinder block, then around lubricating oil cooler elements. The center of the "V" serves as a water distribution manifold to supply a flow of coolant through the aftercooler elements and around cylinder liners.

c. From the liner area, the coolant flows into individual cylinder heads through passages between valves and around injector "wells". From the cylinder heads coolant flows to the rocker housing (water outlet manifold) then to the thermostat housings. At the thermostat housings, coolant is returned to the water pump via a bypass tube until engine coolant temperature activates the thermostats. Coolant flow is then directed through the radiator. Coolant circulated through the aftercooler is also returned into the thermostat housings.

7-2. WATER PUMP DISASSEMBLY. See Figure 7-1.

a. Remove water pump in accordance with paragraph 4-54 of the Operator and Organizational Maintenance Manual.

b. Remove the capscrew (1) holding the impeller on the shaft. Use the 3375265 puller and remove the water pump impeller (3) and pump drive key (2) from the water pump shaft (12).

c. Remove the large retaining ring (4).

d. Support the drive end of the water pump body (13) and press the bearings (9 and 10) and shaft (12) assembly from the water pump body (13) by applying pressure to the impeller end of the shaft.

e. Before disassembling the bearing and shaft assembly, measure the installed diameter of the retaining ring (8) at 90 degrees to the retaining ring gap. The diameter must be 1.351 inches (34.32 mm) or less. If the diameter is greater than 1.351 inches (34.32 mm), the retaining ring engagement is inadequate and shaft machining is required to bring the installed retaining ring outside diameter to this measurement.

f. Remove the water pump seal and seat (5). Drive the water pump seal (6) and oil seal (7) from the body. Discard the seat and seals.

g. Use the 3375326 bearing separator to support the outer ball bearing (9) and press the water pump shaft (12) from the bearing.

h. Support the inner ball bearing (10) on the 3375326 bearing separator, remove the retaining ring (8), and press the shaft from the bearing. Remove the bearing spacer (11).

7-3. WATER PUMP PARTS INSPECTION. See Figure 7-1.

a. Inspect the ball bearings (9 and 10). Rough or worn races indicate possible damage to the shaft diameter and the pump body bore. Discard the bearings if damaged.

b. Visually inspect the water pump body (13) for cracks, corrosion, and excessive wear. Measure the body bore. If it is larger than the maximum specifications replace the body. Maximum bore specifications are as follows:

(1) Body bore (outer bearing): 2.8431 inches (72.215 mm) maximum.
(2) Body bore (inner bearing): 2.4493 inches (62.212 mm).
(3) Body bore (oil seal): 1.500 inches (38.10 mm).

c. Inspect the water pump impeller (3) for cracks or erosion to the extent that it will retard the coolant circulation. Replace if damaged.

d. Measure the water pump impeller (3) bore and shaft diameters. There should be a minimum of 0.001 inch (0.03 mm) press-fit between the shaft and bore mating surfaces. Replace if damaged.

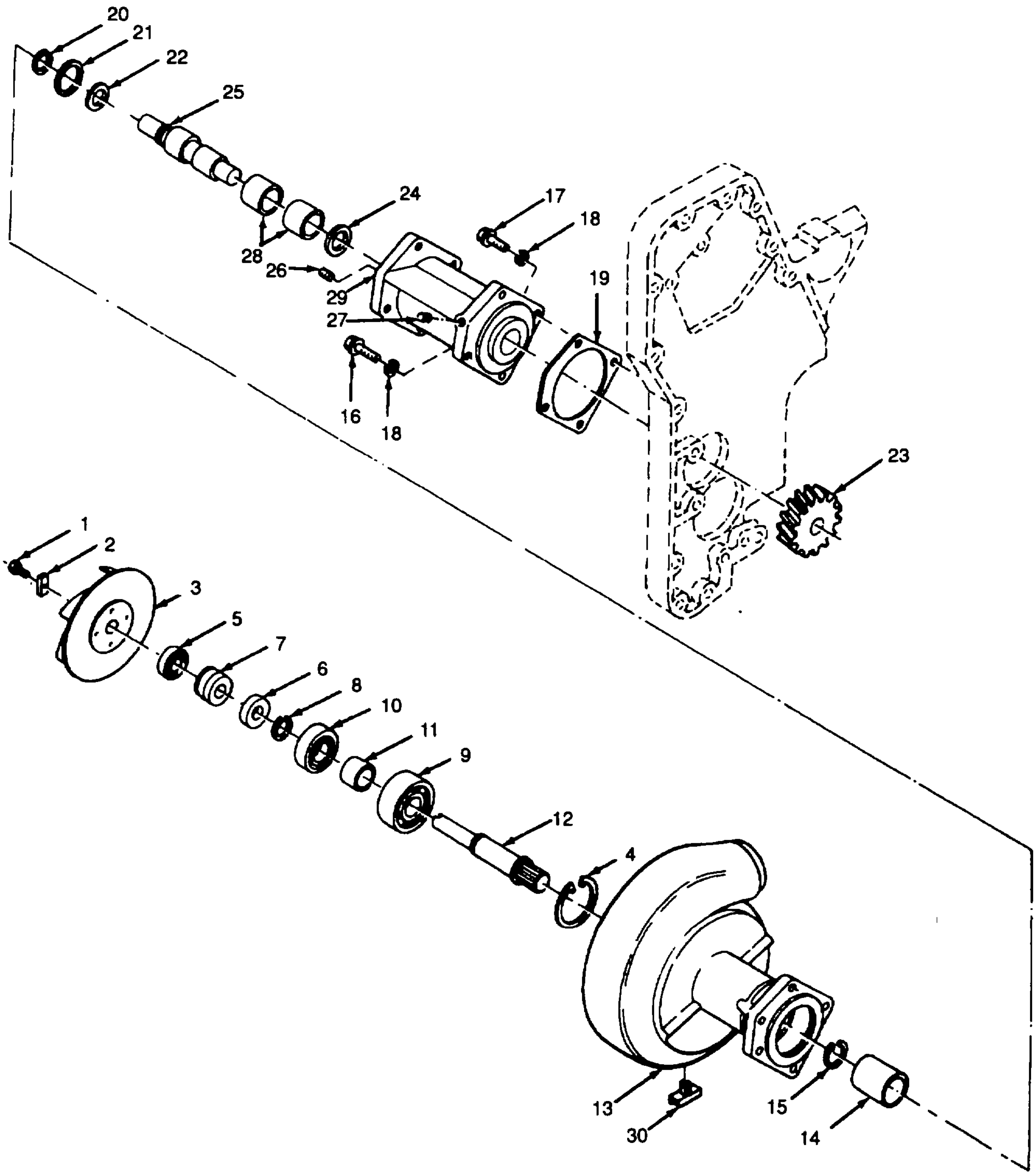


Figure 7-1. Water Pump and Water Pump Drive, Exploded View (Sheet 1 of 2)

1. CAPSCREW	16. CAPSCREW
2. PUMP DRIVE KEY	17. CAPSCREW
3. WATER PUMP IMPELLER	18. LOCKWASHER
4. RETAINING RING	19. GASKET
5. WATER PUMP SEAL AND SEAT	20. RETAINING RING
6. WATER PUMP SEAL	21. CLAMPING WASHER
7. OIL SEAL	22. THRUST BEARING
8. RETAINING RING	23. GEAR
9. BALL BEARING	24. THRUST BEARING
10. BALL BEARING	25. SHAFT
11. BEARING SPACER	26. EXPANSION PLUG
12. WATER PUMP SHAFT	27. PIPE PLUG
13. WATER PUMP BODY	28. BUSHING
14. COUPLING	29. SUPPORT
15. SNAP WIRE	30. DRAIN COCK

Figure 7-1. Water Pump and Water Pump Drive, Exploded View (Sheet 2 of 2)

e. Inspect the water pump shaft (12) for straightness and galling on the press-fit diameter surfaces. Replace if damaged.
f. Inspect the bearing spacer (11) for cracks.

WARNING
Dry cleaning solvent PD-680, Type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid injury to personnel.

WARNING
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.

g. Clean all parts in cleaning solvent PD-680, Type III, or equivalent, and dry with moisture-free compressed air. Discard all parts that do not meet the inspection criteria.

7-4. WATER PUMP ASSEMBLY. See Figure 7-1.

a. Lubricate the water pump shaft (12) bearing surfaces with a thin coat of dean lubricating oil MIL-L-9000 and install the bearing spacer (11). Use a ST658 mandrel to support the inner ball bearing (10); press the impeller end of the shaft through the bearing until the shaft shoulder seats on the bearing inner race. Install the retaining ring (8) on the water pump shaft (12).
b. Support the outer ball bearing (9) on special mandrel 3375318 and press the drive end of the shaft through the bearing until the shaft shoulder seats on the bearing inner race.

CAUTION
Care must be taken not to damage the oil seal.

c. Support the water pump body (13) on the inlet end. Use the 3375319 seal driver with lip of the seat toward the driver face and press the oil seal (7) into the body until it is flush to 0.030 inch (0.76 mm) below the seal bore.

d. Apply a thin coat of bearing retaining compound such as MIL-R46082. Type 1, to the ball bearings (9 and 10) outer race only. Lubricate the shaft seal mating surface, option the bearing and shaft assembly into the water pump bore and press into the body until the outer ball bearing (9) seats. Use special mandrel 3375318 to support the bearing outer race.

e. Install the large retaining ring (4) with the chamfered side facing away from the ball bearing (9).
f. Apply a thin coat of pipe joint sealing compound such as TT-S-1 732 in the brass case on the water pump seal (6). Support the water pump on the drive end of the water pump body (13), not on the shaft, and press the water pump seal (6) into the body until it seats by using special mandrel 3375256.

g. Use special mandrel 3375256 and press a new water pump seal and seat (5) into place on the shaft The mandrel 3375256 is designed to position the seal and seat to an exact location against the water pump seal (6).

CAUTION
Excessive quantities of sealant will run off and enter the seal face, resulting in seal failure.

h. Following the installation of the water pump seal and seat (5), a small quantity (1 drop) of adhesive sealant MIL-S-46163, Type 3, Grade R, (wicking type) must be applied to the joint between the seat and shaft. The sealant must be allowed to cure for at least 30 minutes before the pump is placed in operation.
i. Apply a thin coat of bearing retaining compound such as MIL-R46082, Type 1, to the water pump impeller (3) bore. Supporting the drive end of the shaft (12), align the slot in the impeller to the slot in the shaft and press the impeller on flush with end of the shaft.
j. Install the pump drive key (2), into the machined slot on the water pump shaft (12). Install the capscrew (1) and tighten to 12 to 15 pound-feet (16 to 20 newton-meters).

7-5. WATER PUMP DRIVE REPAIR.

a. Remove.

(1) Remove the water pump in accordance with the Operator and Organizational Maintenance Manual.
(2) Remove the splined coupling (14, Figure 7-1) from the shaft (25). Remove the snap wire (15) from the splined coupling only if it is damaged.
(3) Remove the capscrews (16 and 17), lockwashers (18), and remove the drive unit items 20 through 29). Remove and discard the gasket (19).

b. Disassemble.

(1) Remove the retaining ring (20, Figure 7-1), damping washer (21) and thrust bearing (22) from the shaft (25). Discard the retaining ring.
(2) Remove the gear (23) and shaft (25) from the support (29) as a unit, and remove the thrust washer (24). Do not remove the gear from the shaft at this time.
(3) Remove the expansion plug (26) and pipe plug (27) from the support (29). Do not remove the bushings (28) from the support at this time.

WARNING
Dry cleaning solvent PD-680, Type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid injury to personnel.

WARNING
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.

c. Clean. Clean all parts in cleaning solvent PD-680, Type ll, or equivalent, and blow dry with compressed air.

d. Inspect.
  (1) Inspect the gear (23, Figure 7-1) for cracked, chipped, or scored teeth. Replace the gear in accordance with step e, below, if the teeth are cracked or chipped, or scored.
  (2) Inspect the shaft (25) as follows:
    (a) Inspect the splines for cracking, chipping, or distortion.
    (b) Check the bushing journals for scoring, and check the outside diameter of the bushing journals.
    (c) Replace the shaft in accordance with step e, below, if the splines are cracked, chipped, or distorted, if the journals are scored deeper than 0.003 inch (0.08 mm), or if the journal diameter is less than 1.748 inch (44.40 mm).

  (3) Inspect the support (29) for cracks, loose bushings (28) or evidence that the bushings have turned in their bores. If the support is damaged, replace both the support and bushings.

  (4) Inspect the bushings (28) for scoring, and measure the inside diameter. Replace the bushings in accordance with step e, below, if the bushings are scored deeper than 0.003 inch (0.08 mm), or worn larger than 1.755 inch (44.58 mm).
  (5) Replace the thrust bearings (22 and 24) and the clamping washer (21) if they are visibly worn, or scored deeper than 0.003 inch (0.08 mm).
  (6) Inspect the splines in the coupling (14) for damage. If defective, replace both the coupling and the snap wire (15).

e. Repair.

  (1) Replace worn bushings (28, Figure 7-1) using an arbor press and bushing drivers. Line bore the new bushings to an inside diameter of 1.751 to 1.754 inch (44.48 to 44.55 mm).
  (2) Replace the gear (23) on the shaft (25) using an arbor press. Press the replacement gear on the shaft until it bottoms against the shaft shoulder.

f. Assemble. During assembly, lubricate all parts with lubricating oil MIL-L-9000.

  (1) Coat the expansion plug (26, Figure 7-1) and pipe plug (27) with a light coating of sealant MIL-S-45180, or equivalent, and install them in the support (29).
  (2) Place the thrust bearing (24), steel side towards support (29), over the shaft (25), and position it against the gear (23). Install the shaft and gear assembly into the support (29).
  (3) Install the thrust bearing (22), steel side towards support (29), over the shaft (25). Install the clamping washer (21), chamfered side towards support (29), and secure with the retaining ring (20).
  (4) Check the shaft end clearance using a feeler gage between the gear (23) and thrust boss on the support (29). If the clearance is not between 0.002 and 0.012 inch (0.05 and 0.30 mm), replace the thrust bearings (22 and 24).

g. Install.

  (1) Using a new gasket (19, Figure 7-1), install the drive unit on the timing gear housing using the lockwashers (18), and capscrews (16 and 17). Tighten the capscrews to 30 to 35 pound-feet (41 to 47 newton meters).
  (2) Install the coupling (14) on the shaft (25).
  (3) Install the water pump in accordance with the Operator and Organizational Maintenance Manual.

SECTION II. RADIATOR

7-6. GENERAL. Coolant leaves the engine thermostat housings and enters the upper inlet tank of the radiator. Engine driven, fan-forced air cools the coolant as it travels down through the radiator cores to the outlet tank at the bottom of the radiator. Coolant is drawn out of the radiator by the engine water pump. A sight glass on the upper radiator tank allows visual inspection of coolant level while the engine is running.

7-7. RADIATOR REMOVAL. Remove the radiator in accordance with the Operator and Organizational Maintenance Manual.

7-8. RADIATOR CLEANING INSPECTION, AND i t I ING.

a. Core Assemblies (24, Figure 7-2).

(1) Check for bent fins and bent or damaged gasket surfaces.
(2) Check soldered joints for corrosion.
(3) Check the core tubes for soundness and evidence of internal corrosion. Press lightly against the tube wall; tubes that dent or penetrate easily have been eaten away by internal corrosion.
(4) Plug or block off either the inlet or outlet tube, and attach a regulated air supply to the other tube.

CAUTION

To avoid damaging or permanently distorting the core, do not exceed an air pressure of 15 psi (103 kPa).

(5) Immerse the radiator in a water tank, and pressurize the core assemblies (24) to 10 psi (69 kPa). Escaping air bubbles will show the location of any leak points.
(6) Repair leaks in soldered points or core tubes by soldering in accordance with MIL-S-6872. After soldering, test for leaks.
(7) Straighten bent fins of the core assemblies (24).
(8) Reverse flush the core assemblies (24) thoroughly using a flushing gun MIL-G-14562. Attach the flushing gun to the core outlet tube, allow the core assembly to fill with water, and flush, using short bursts of air pressure. Apply the air pressure gradually, and allow the core assemblies to fill with water between each burst. Continue the flushing procedure until all traces of rust and scale have been removed. This will be evident by dear water flowing from the inlet tube.

b. Gaskets (see Figure 7-2). Inspect gaskets for evidence of leakage and for signs of damage. Repair damaged radiator gaskets by disassembling radiator to replace the gaskets.
c. Structural Members (see Figure 7-2). Inspect structural members for cracks, tears, and signs of damage. Repair damaged structural members by welding cracks and tears in accordance with paragraph 2-9.
d. Top and Bottom Tank Assemblies (15 and 16, Figure 7-2). Inspect the top and bottom tank assemblies (15 and 16) for signs of damage. Using a suitable straight edge, check the top and bottom tank assemblies (15 and 16) for warping or distortion. Replace components which are damaged, warped, or distorted.

7-9. RADIATOR DISASSEMBLY. See Figure 7-2.

a. Remove hexagon head capscrews (1), hexagonal nuts (2), flat washers (3), and lockwashers (4), and remove shroud assembly (5).
b. Remove hexagon head capscrews (6 and 7), flat washers (8), and lockwashers (9) to remove left side assembly (10) and right side assembly (11).
c. Remove hexagon head capscrews (1 2), hexagonal nuts (13), and lockwashers (14) to remove top tank assembly (15), bottom tank assembly (16), header bars (17) and front/rear header bars (18), and header gaskets (19).
d. Remove hexagon head capscrews (20), flat washers (21), lockwashers (22), and hexagonal nuts (23) to separate core assemblies (24), center ring assembly (25), header bars (26), front/rear header bars (27), and header gaskets (28).

WARNING

Dry cleaning solvent PD680, Type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid injury to personnel.

e. Clean all parts, except the core assemblies (24), in cleaning solvent PD-68M, Type III, or equivalent.

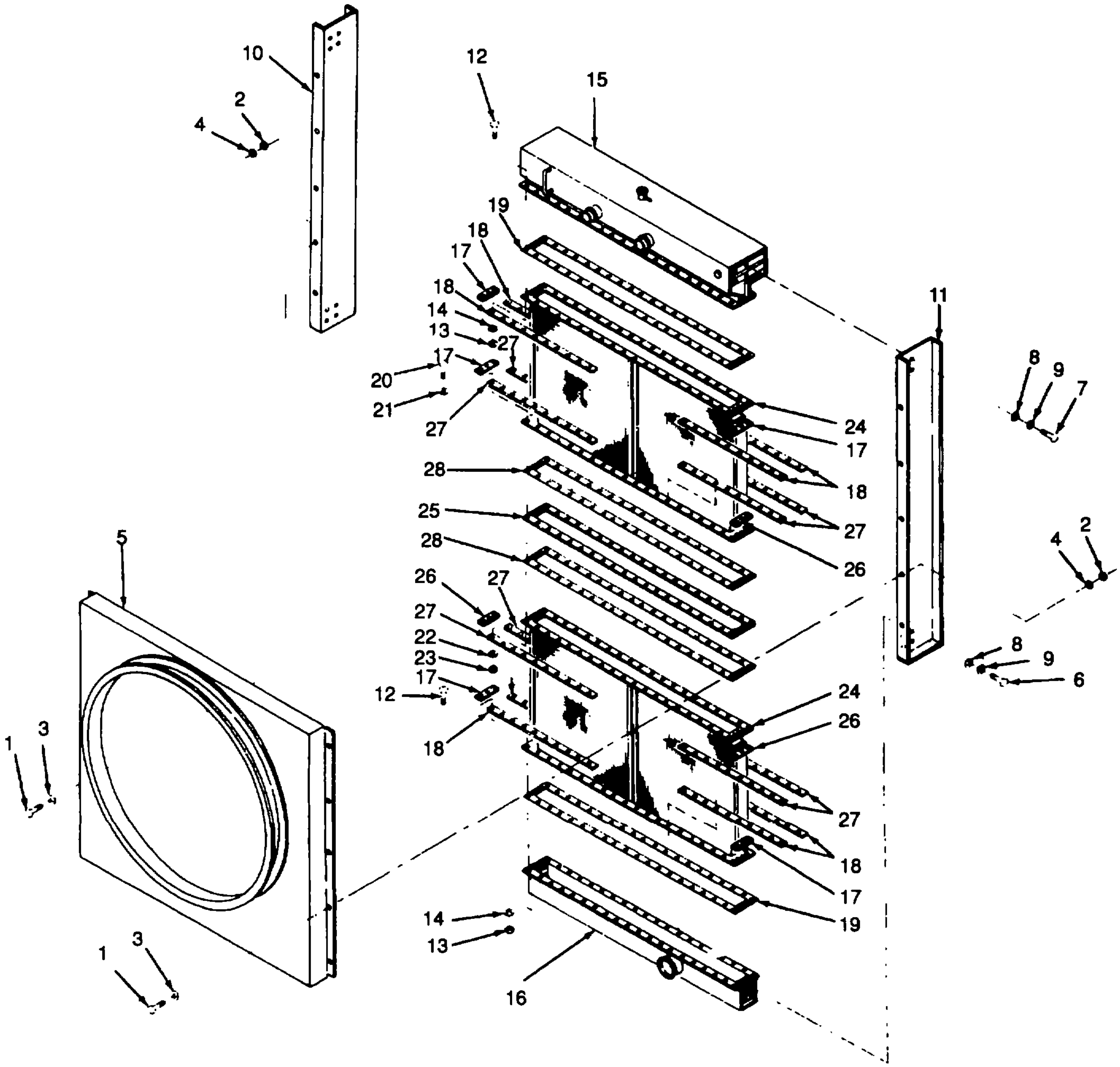


Figure 7-2. Radiator, Exploded View (Sheet 1 of 2)

1. HEXAGON HEAD CAPSCREW
2. HEXAGONAL NUT
3. FLAT WASHER
4. LOCKWASHER
5. SHROUD ASSEMBLY
6. HEXAGON HEAD CAPSCREW
7. HEXAGON HEAD CAPSCREW
8. FLAT WASHER
9. LOCKWASHER
10. LEFT SIDE ASSEMBLY
11. RIGHT SIDE ASSEMBLY
12. HEXAGON HEAD CAPSCREW
13. HEXAGONAL NUT
14. LOCKWASHER
15. TOP TANK ASSEMBLY
16. BOTTOM TANK ASSEMBLY
17. HEADER BAR
18. FRONT/REAR HEADER BAR
19. HEADER GASKET
20. HEXAGON HEAD CAPSCREW
21. FLAT WASHER
22. LOCKWASHER
23. HEXAGONAL NUT
24. CORE ASSEMBLY
25. CENTER RING ASSEMBLY
26. HEADER BAR
27. FRONT/REAR HEADER BAR
28. HEADER GASKET

Figure 7-2. Radiator, Exploded View (Sheet 2 of 2)

7-10. RADIATOR REPAIR. Repair the radiator by repair or replacement of components in accordance with paragraphs 7-8 and 7-9.

7-11. RADIATOR ASSEMBLY. See Figure 7-2.

a. Assemble core assemblies (24), center ring assembly (25), header bars (26), front/rear header bars (27), and header gaskets (28) and secure with hexagon head capscrews (20), lockwashers (22), flat washers (21), and hexagonal nuts (23).
b. Assemble top and bottom tank assemblies (15 and 16), header bars (17), front/rear header bars (1 8), and header gaskets (19) and secure with hexagon head capscrews (12), hexagonal nuts (13), and lockwashers (14).
c. Install left and right side assemblies (10 and 11) and secure with hexagon head capscrews (6 and 7), flat washers (8), and lockwashers (9).
d. Install shroud assembly (5) and secure with hexagon head capscrews (1), hexagonal nuts (2), flat washers (3), and lockwashers (4).

7-12. RADIATOR INSPECTION AND TESTING. After assembly, inspect, and test the radiator in accordance with paragraph 7-8.

7-13. RADIATOR INSTALLATION. Install the radiator in accordance with the Operator and Organizational Maintenance Manual.

SECTION III. THERMOSTAT HOUSING SUPPORT

7-14. GENERAL. The thermostat housing support is bolted to the front of the engine cylinder block. The thermostat housings, fan hub and pulley assembly, water pump by-pass tube, and water transfer tubes from the rocker lever housings and aftercooler attach to the housing support.

7-15. THERMOSTAT HOUSING SUPPORT REPAIR.

a. Remove.

(1) Remove the thermostat housings and the fan hub and pulley assembly in accordance with the Operator and Organizational Maintenance Manual.
(2) Remove the coolant temperature switch WT2, coolant temperature sender MT3, and the ether lockout temperature switch S17 in accordance with the Operator and Organizational Maintenance Manual.
(3) Remove the water transfer tubes from the aftercooler in accordance with paragraph 9-42.
(4) Remove the capscrews (1, Figure 7-3) and lockwashers (2), and remove the hose clamp securing the upper by-pass tube assembly (3) to the hose on the lower by-pass tube assembly. Remove the by-pass tube assembly (3) and gasket (4) from the thermostat housing support (16). Discard the gasket (4).

(5) Remove the capscrews (19) and lockwashers (2), and remove the water transfer tubes (17) from the thermostat housing support. Discard the preformed packings (18).

NOTE

Two persons may be required to perform the following procedure.

(6) Remove the support capscrews (5) and lockwashers (6), and remove the thermostat housing support (16) from the cylinder block.
(7) Remove the water transfer tubes (7 and 12) from the coolant passage openings in the rocker lever housings and remove the preformed packings (8 and 11) from the water transfer tubes.

b. Install.

(1) Lubricate the preformed packings (8and 11) with dean engine lubricating oil, such as MIL-L-9000 or equivalent, and install on the water transfer tubes (7 and 12).
(2) Position the water transfer tubes (7 and 12) in the coolant passage openings in the rocker lever housings.
(3) See Table 2-2. Fabricate two guide studs to aid in installing the thermostat housing support (16) to the cylinder block

NOTE

Two persons may be required to perform the following procedure.

(4) Position the two guide studs fabricated in step (3), above, in the cylinder block, and install the thermostat housing support (16) over the guide studs.
(5) Install the support capscrews (5, Figure 7-3) and lockwashers (6), and Tighten the support capscrews alternately and evenly to 250 to 270 pound-feet (339 to 366 newton-meters).

NOTE

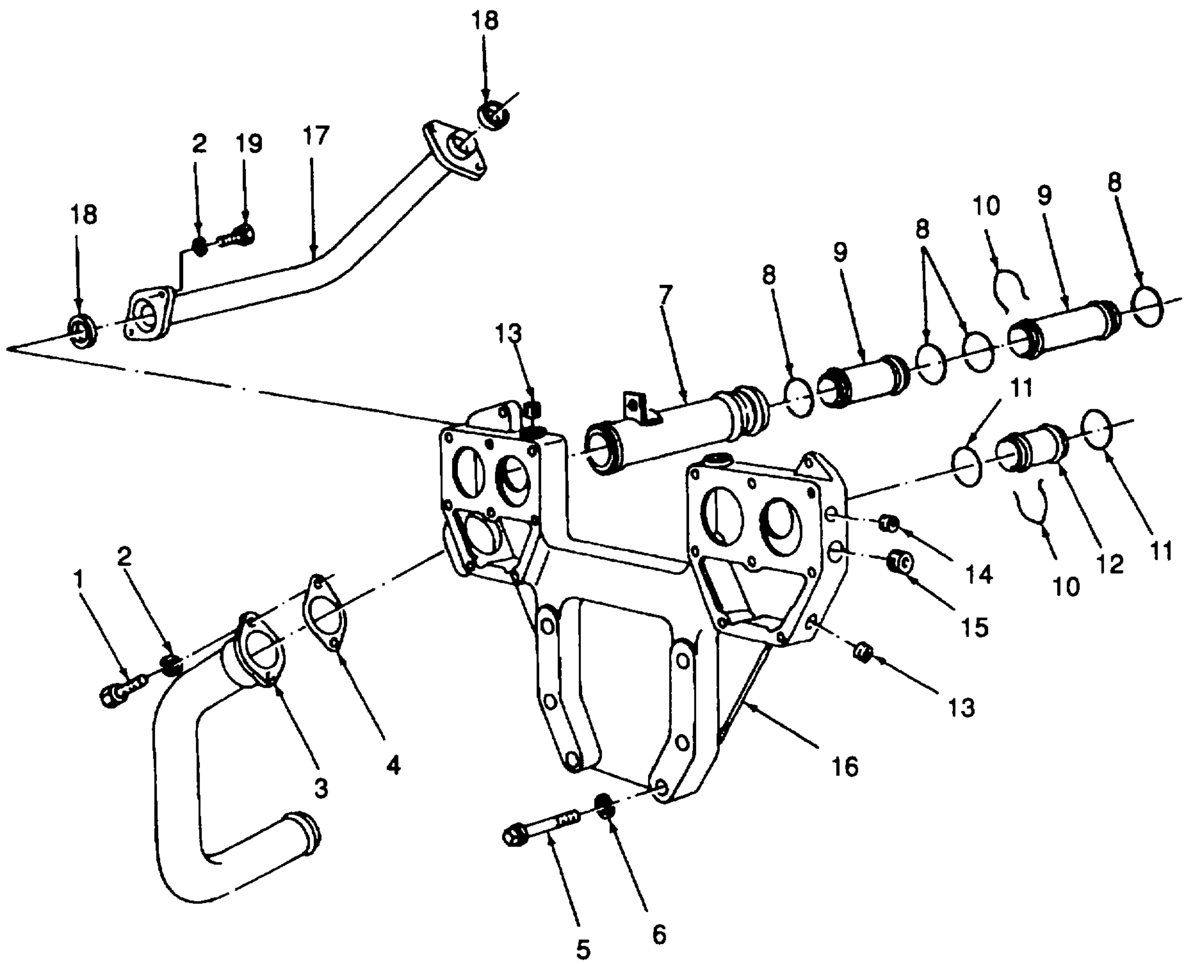
Tighten the capscrews (1) to 30 to 35 pound-feet (41 to 47 newton-meters).

(6) Install the water transfer tubes (17) in the thermostat housing support (16) with the preformed packings (18) using the capscrews (19) and lockwashers (2).

NOTE

Tighten the capscrews (1) to 30 to 35 pound-feet (41 to 47 newton-meters).

(7) Install the by-pass tube assembly (3) with the gasket (4) in the thermostat housing support (16), using the capscrews (1) and lockwashers (2). Install the hose damp to secure the upper by-pass tube assembly (3) to the hose on the lower by-pass tube assembly.
(8) Install the water transfer tubes (17) to the aftercooler in accordance with paragraph 9-42.
(9) Install the coolant temperature switch WT2, coolant temperature sender MT3, and the ether lockout temperature switch S17 in accordance with the Operator and Organizational Maintenance Manual.
(10) Install the thermostat housings and the fan hub and pulley assembly in accordance with the Operator and Organizational Maintenance Manual.



1. CAPSCREW
2. LOCKWASHER
3. BY-PASS TUBE ASSEMBLY
4. GASKET
5. SUPPORT CAPSCREW
6. LOCKWASHER
7. WATER TRANSFER TUBE
8. PREFORMED PACKING
9. WATER TRANSFER TUBE
10. RETAINER RING
11. PREFORMED PACKING
12. WATERTRANSFERTUBE
13. PIPE PLUG
14. PIPE PLUG
15. PIPE PLUG
16. THERMOSTAT HOUSING SUPPORT
17. WATER TRANSFER TUBE
18. PREFORMED PACKING
19. CAPSCREW

Figure 7-3. Thermostat Housing Support and Related Parts, Exploded View

CHAPTER 8
MAINTENANCE OF LUBRICATION SYSTEM

SECTION I. FILTER AND OIL BY-PASS ASSEMBLY

8-1. GENERAL Oil enters the filter and oil by-pass assembly under pressure. A pressure regulator valve dumps excess oil back into the oil pan. Oil enters the filter head from the oil cooler, then passes through the filter elements. A by-pass valve is provided in the filter head oil inlet cavity to ensure against interruption of oil flow if filter elements become dogged. Oil leaving the filter elements flows to the main oil passage in the block

8-2. REGULATOR VALVE DISASSEMBLY. See Figure 8-1.

a. Remove oil temperature sender MT2, oil pressure alarm and shutdown switch OP1/OP2, and air control box disconnect switch OP3 from the lube oil filter head (24) in accordance with the Operator and Organizational Maintenance Manual.
b. Remove capscrews (1 and 2) and lockwashers (3) to remove valve housing cover (4) and cover gasket (5). Discard the gasket
c. Remove the regulator valve (items 7 through 10) as an assembly.

CAUTION

Spring load will be released when roll pins are removed. Guard against loss of parts.

d. Hold the valve plunger guide (7) and regulator valve plunger (9) against the spring force, and remove roll pins (6).
e. Remove valve plunger guide (7), regulator valve spring (8), and regulator valve plunger (9) from regulator valve housing (10).

WARNING

Observe caution when removing by-pass valve cover (13). By-pass valve spring (15) may cause personal injury if spring tension is released suddenly.

f. Remove capscrews (11) and lockwashers (12) to remove by-pass valve cover (13) and valve cover gasket (14). Discard the gasket.
g. Remove relief plunger (16), by-pass valve spring (15), and valve housing (17).

NOTE

To aid in extracting piston cooling valve assembly (18), thread a 1/4 inch, 20 thread bolt, approximately 1 1/2 inch long, into the threaded recess in the pressure regulator stop (20). The pressure regulating valve assembly (18) may then be pulled from the lube oil filter head (24).

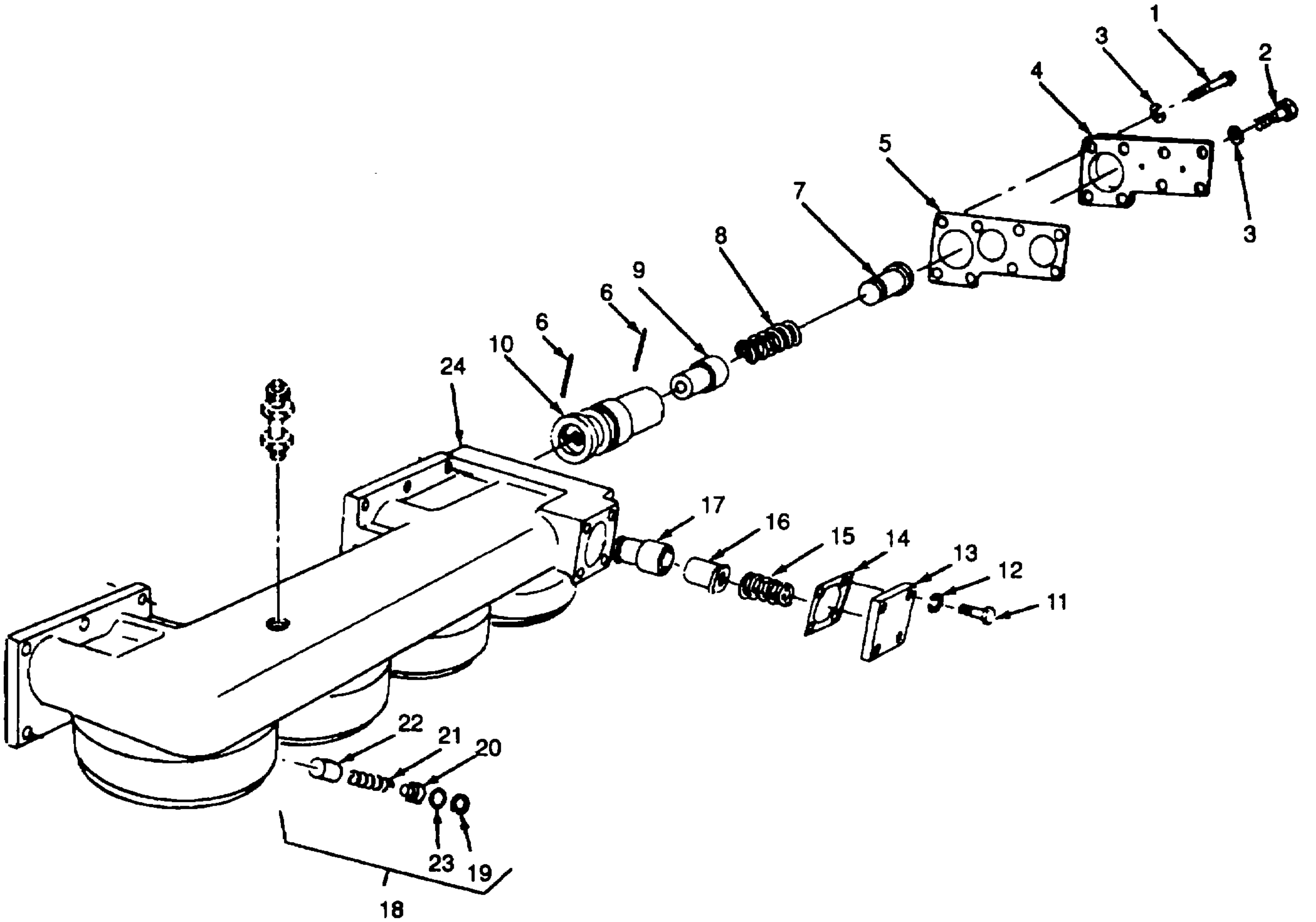
h. Remove internal retaining ring (19), pressure regulator stop (20), piston cooling spring (21), and piston cooling plunger (22). Remove and discard preformed packing (23).

WARNING

Dry cleaning solvent, PD0680, Type Ill, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid injury to personnel.

WARNING

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.



1. CAPSCREW
2. CAPSCREW
3. LOCKWASHER
4. VALVE HOUSING COVER
5. COVER GASKET
6. ROLL PIN
7. VALVE PLUNGER GUIDE
8. REGULATOR VALVE SPRING
9. REGULATOR VALVE PLUNGER
10. REGULATOR VALVE HOUSING
11. CAPSCREW
12. LOCKWASHER
13. BY-PASS VALVE COVER
14. VALVE COVER GASKET
15. BY-PASS VALVE SPRING
16. RELIEF PLUNGER
17. VALVE HOUSING
18. PISTON COOLING VALVE ASSEMBLY
19. INTERNAL RETAINING RING
20. PRESSURE REGULATOR STOP
21. PISTON COOLING SPRING
22. PISTON COOLING PLUNGER
23. PREFORMED PACKING
24. LUBE OIL FILTER HEAD

Figure 8-1. Regulator Valve Assembly, Exploded View

i. Clean all parts with PD-680, Type Ill, or equivalent, and dry with compressed air.
j. Check the plungers, stops, springs, and housing bores for evidence of wear, scoring, or distortion; replace all parts that show visual evidence of wear, scoring, or distortion.

8-3. REGULATOR VALVE ASSEMBLY. See Figure 8-1.

a. Install regulator valve plunger (9), regulator valve spring (8), and valve plunger guide (7) into regulator valve housing (1 0). Secure with roll pins (6).
b. Install the pressure regulator (items 7 through 10) in the lube oil filter head (24) as an assembly. Using a new cover gasket (5), install valve housing cover (4) and secure with lockwashers (3) and capscrews (1 and 2). Cross-tighten the capscrews in accordance with Table 1-2.
c. Install valve housing (17), by-pass valve spring (15), and relief plunger (16) into bore of lube oil filter head (24). Secure by installing a new valve cover gasket (14), by-pass valve cover (13), capscrews (11), and lockwashers (12). Cross-tighten the capscrews in accordance with Table 1-2.
d. Lubricate preformed packing (23) with dean engine lubricating oil and position it on pressure regulator stop (20).
e. Install piston cooling plunger (22), piston cooling spring (21), and pressure regulator stop (20) into bore of the lube oil filter head (24). Secure with internal retaining ring (19).

SECTION II. LUBE OIL COOLER

8-4. GENERAL. The lube oil cooler is located between the left and right cylinder head banks. Oil from the lube oil pump is routed through the finned elements of the lube oil cooler. The elements are immersed in coolant which absorbs the heat conducted through the element.

8-5. LUBE OIL COOLER REMOVAL. Drain engine coolant and oil in accordance with the Operator and Organizational Maintenance Manual. Remove the after-coolers in accordance with paragraph 9-42. Then see Figure 8-2 and proceed as follows:

a. Remove the self-locking nuts (1) that secure the lubricating oil elements (10) in the rear header covers (7).
b. Remove front and rear cover capscrews (2 and 3) and lockwashers (4 and 5). Insert capscrews (2 and 3) into the jacking screw holes provided in the rear of each cover (6 and 7). Remove front water cover (6) and rear header cover (7). Remove and discard gaskets (8 and 9).
c. Replace the self-locking nuts (1) and remove the lubricating oil cooler elements (1 0). Remove and discard the gaskets (11) and preformed packings (12).

8-6. LUBE OIL COOLER ELEMENT CLEANING AND INSPECTION.

WARNING

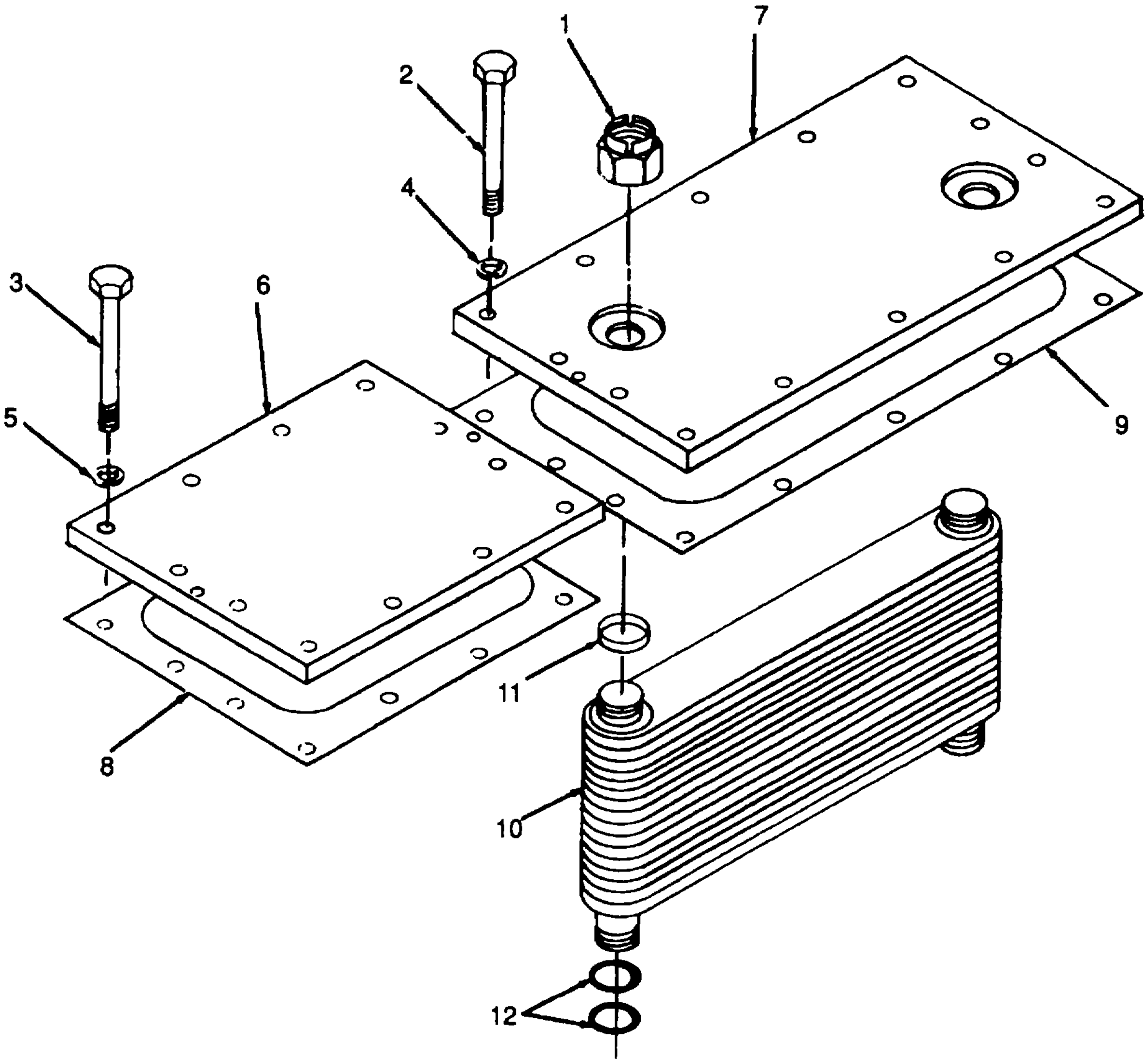
Cleaning compound M1S36426 is flammable and toxic to the side, eyes, and respiratory tract. Skin, eye, and respiratory protection is required to avoid injury to personnel. Use only with a dosed circuit, reverse flushing machine.

CAUTION

If any type of engine failure has occurred that might leave metal particles In the oil cooler elements, the elements will be difficult or impossible to clean successfully and must be replaced. Engine failure will result from reusing contaminated oil cooler elements.

a. Cleaning. To prevent the hardening and drying of foreign substances, clean the elements (10, Figure 8-2) immediately after removal as follows:

(1) Reverse flush the elements using cleaning compound MS36426.



1. SELF LOCKING NUT
2. REAR COVER CAPSCREW
3. FRONT COVER CAPSCREW
4. LOCKWASHER
5. LOCKWASHER
6. FRONT WATER COVER
7. REAR HEADER COVER
8. FRONT COVER GASKET
9. REAR HEADER COVER GASKET
10. LUBRICATING OIL'ELEMENT
11. OIL COOLER GASKET
12. PREFORMED PACKING

Figure 8-2. Lube Oil Cooler and Related Parts, Exploded View

WARNING

Dry cleaning solvent, PD-680, Type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid injury to personnel.

WARNING

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.

(2) After flushing, remove the residual cleaning compound by rinsing the cooler elements with solvent PD-680, Type III, or equivalent, and blow dry with compressed air.

b. Testing. Use suitable adapters to plug the openings in the elements and place the elements in a water tank; apply 60 psi (414 kPa) of air pressure to the element Inspect for air leaks. Replace defective cooler elements.

8-7. LUBE OIL COOLER INSTALLATION.

a. Lubricate the new preformed packings (12, Figure 8-2) and position them in the grooves on the lubricating oil element (10) transfer tubes.
b. Position the lubricating oil elements (10) in the block, seating the transfer tubes and preformed packings (12) in the holes provided. Install new oil cooler gaskets (11) on the cooler element stud shoulders.
c. Install the front water and rear header covers (6 and 7) on the block with new front cover gaskets (8 and 9) and secure with screws (2 and 3) and lockwashers (4 and 5). Cross-tighten the capscrews (2 and 3) to 25 to 30 pound-feet (34 to 41 newton-meters) torque.
d. Install the self-lockng nuts (1) on the element studs; tighten the nuts to 40 to 45 pound-feet (54 to 61 newton-meters) torque.
e. Install the aftercoolers in accordance with paragraph 9-42.

SECTION III. OIL PUMP ASSEMBLY

8-8. GENERAL. The engine is pressure lubricated by a gear-type lubricating oil pump boated inside of the oil pan at the rear of the engine. The pump is mounted to the block directly below the crankshaft and is driven by the rear crankshaft gear.

a. The oil pump draws lubricating oil from the oil pan via a suction tube. The pump gears transfer the oil from the suction cavity of the pump to the pressure cavity. A pressure regulator valve dumps excess oil back into the oil pan.
b. From the lubricating oil pump, oil flows through block drillings to the lubricating oil cooler located in the block "V, through the cooler, then to the filters. A by-pass valve is provided in the lube oil filter head inlet cavity to ensure against oil flow interruption if the filter elements become clogged.
c. From the filter head, oil enters and passes through filter elements, and flows to the piston cooling passages, and the main oil passage located in the block. Pressure control valves limit the flow of lubricating oil to piston cooling nozzles, depending on lubricating oil pump pressure.
d. The main bearings and camshafts are lubricated through intersecting drillings, directly from the main oil passage. Oil flows from the cam passages to the camshaft bushings, cam follower shafts, and through passages to the cylinder heads. The cam followers are individually drilled to supply lubricating oil to the rollers and push tube seats. Rocker lever bushings are shaft lubricated, and the adjusting screws and valve guides are lubricated through drillings in rocker levers and bushings.
e. The connecting rod bearings are lubricated from cross drillings in the crankshaft, and oil flows through drillings in connecting rods to lubricate the piston pins and bushings. Lubricating oil is routed from the main oil passage through passages in the gear housing and cover to lubricate front gear train gears, bushings, and idler shafts.
f. Lubricating oil is routed from the camshaft passages to each turbocharger through external lines from drillings in cylinder block Turbocharger drain oil is dumped back into oil pan through drillings in the cylinder block

8-9. OIL PUMP REMOVAL. See Figure 8-3 and Figure 8-4.

NOTE

If engine has been pulled from generator set for shop maintenance, start at step c, below.

a. Drain engine oil and remove lube oil hoses and fittings associated with the prelube pump B3, oil sight gage, lubricant temperature thermostat S101, lube oil heater H113, and lubricant temperature switch OT2, from the oil pan, and remove the on engine duplex fuel filter set and by-pass oil filter set in accordance with the Operator and Organizational Maintenance Manual.

b. See Figure 8-3 and proceed as follows to remove oil pan access plate and increase clearance beneath engine oil pan.

NOTE

Avoid dropping oil pan access plate (3) into skid base.

(1) Remove hexagon head capscrews (1) and lockwashers (2).

(2) Lift edge of oil panel access plate (3), grip firmly, and remove.

c. Remove oil pan assembly in accordance with paragraph 9-38.

d. Remove capscrews (1, Figure 8-4) and locknuts (2) to remove bracket damp (3).

e. Remove capscrews (4) and lockplates (5) to disconnect support brackets (6 and 13) from engine.

f. Remove capscrews (7), lockplates (8), oil suction tube (9), and remove and discard flange gasket (10).

g. Remove capscrews (11), locknuts (12), and bracket damp (3) from support bracket (13).

h. Remove capscrews (14 and 16), lockplates (15 and 17), oil connection (18), and remove and discard the gasket (19) and seals (20).

i. Remove the capscrews (21), lockplates (22), transfer tube (23), pressure relief housing (30), and remove and discard the seal (20) and relief gasket (31).

NOTE

Two persons may be required to perform the following procedure.

j. Remove hexagon head capscrews (24), lockplates (25), and oil pump assembly and shims (26), if used.

8-10. OIL PUMP DISASSEMBLY. See Figure 8-4.

a. Remove capscrews (27), lockplates (28), and lubricating pump cover (29).

CAUTION

Spring tension is released when retaining pin (33) is removed. Hold tension on washer (34) and spring (35) to prevent loss of parts.

b. Remove roll pin dowel (32), retaining pin (33), plain washer (34), relief spring (35), and relief plunger (36).

c. Remove hexagon head capscrews (37), and lockplates (38). Install two 5/16 inch, 18 thread, 1 1/4 inch long capscrews in the threaded recesses of the lubrication pump cover (39) over the dowel pins in the lubricating pump body (47). Turn in the capscrews against the dowel pins in the lubricating pump body (47) to remove the lubricating pump cover (39). Remove and discard the lubricating pump gasket (40).

NOTE

Do not remove the bushings (46), or the gears (41 and 44) from the shafts (42 and 45) unless inspection shows them to be defective.

d. Remove lubricating pump gear (41) and lubricating pump shaft (42) as an assembly.

e. Using a suitable press, press lubricating pump shaft (42) out of lubricating pump drive gear (41).

f. Remove lubricating pump gear (44) and lubricating pump shaft (45) as an assembly.

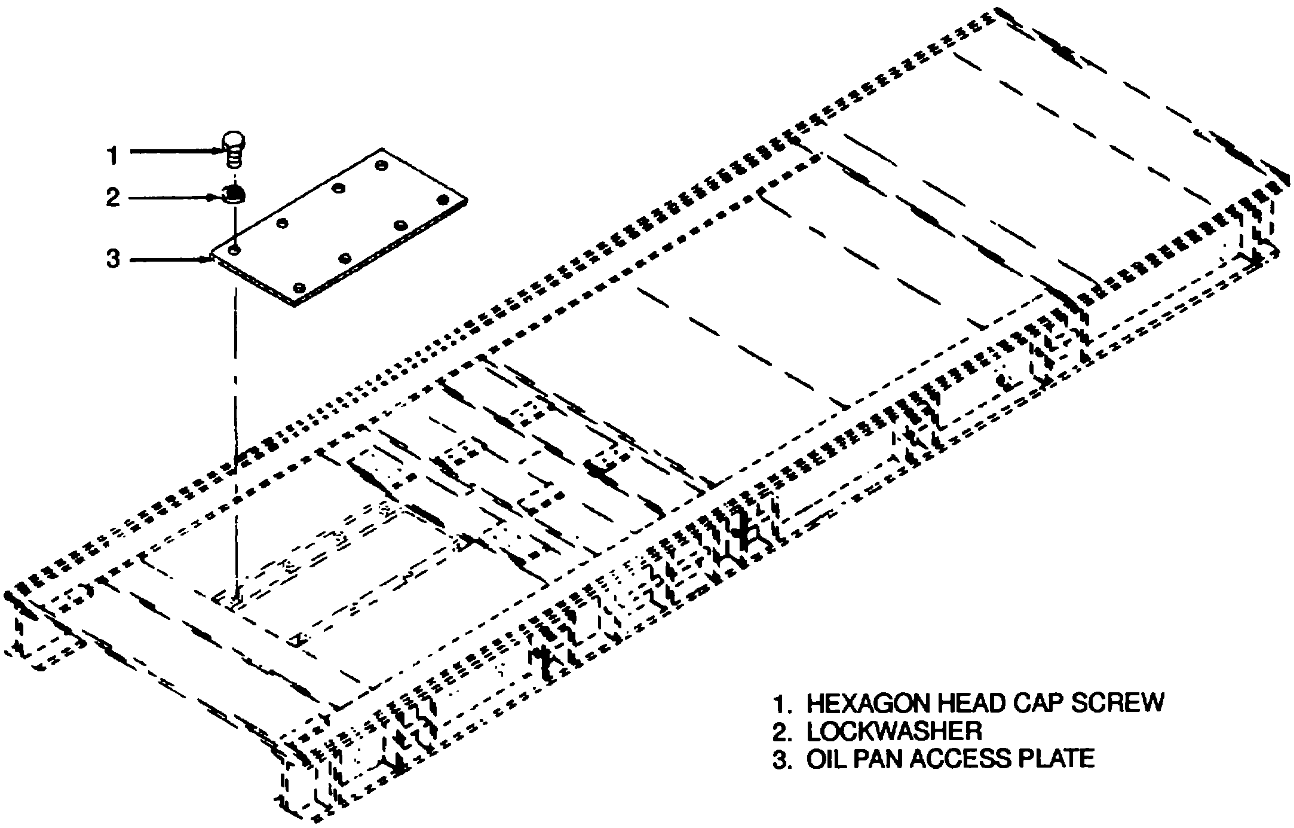


Figure 8-3. Removal and Installation of Oil Pan Access Plate

8-11. OIL PUMP CLEANING AND INSPECTION. See Figure 8-4.

WARNING

Dry cleaning solvent, PD-680, Type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid Injury to personnel.

WARNING

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. Clean all parts using cleaning solvent PD-680, Type III, or equivalent, and dry with compressed air.
b. Inspect the pump gears (41, 43, and 44), and replace them if the teeth are chipped or cracked, or if the thrust surfaces are scored deeper than 0.003 inch (0.08 mm).
c. Inspect the lubricating pump shafts (42 and 45) and replace them if they are scored deeper than 0.003 inch (0.08 mm), or worn smaller than 1.4993 inches (38.082 mm) in the bushing wear area.
d. Measure lubricating pump bushings (46) in the cover (39) and body (47). Replace them if they are worn larger than 1.505 inches (38.22 mm).
e. Check the gear pockets in the lubricating pump body (47). If the finished surfaces are scored deeper than 0.003 inch (0.08 mm), replace the body.

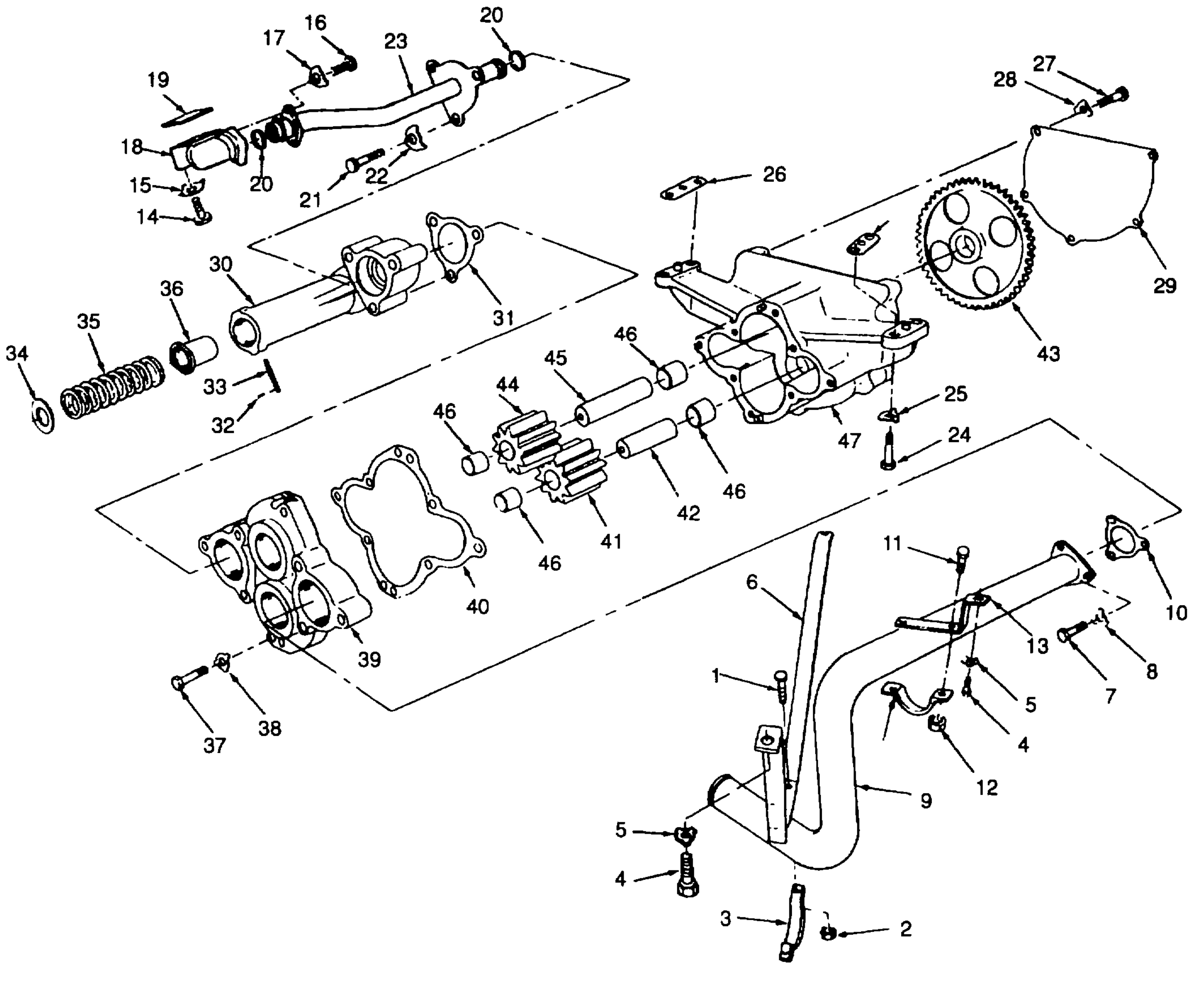


Figure 8-4. Lubricating Oil Pump, Exploded View (Sheet 1 of 2)

1. CAPSCREW
2. LOCKNUT
3. BRACKET CLAMP
4. CAPSCREW
5. LOCKPLATE
6. SUPPORT BRACKET
7. CAPSCREW
8. LOCKPLATE
9. OIL SUCTION TUBE
10. FLANGE GASKET
11. CAPSCREW
12. LOCKNUT
13. SUPPORT BRACKET
14. HEXAGON HEAD CAPSCREW
15. LOCKPLATE
16. HEXAGON HEAD CAPSCREW
17. LOCKPLATE
18. OIL CONNECTION
19. GASKET
20. SEAL
21. HEXAGON HEAD CAPSCREW
22. LOCKPLATE
23. TRANSFER TUBE
24. HEXAGON HEAD CAPSCREW
25. LOCKPLATE
26. SHIM
27. CAPSCREW
28. LOCKPLATE
29. LUBRICATING PUMP COVER
30. PRESSURE RELIEF HOUSING
31. RELIEF GASKET
32. ROLL PIN DOWEL
33. RETAINING PIN
34. PLAIN WASHER
35. RELIEF SPRING
36. RELIEF PLUNGER
37. HEXAGON HEAD CAPSCREW
38. LOCKPLATE
39. LUBRICATING PUMP COVER
40. LUBRICATING PUMP GASKET
41. LUBRICATING PUMP GEAR
42. LUBRICATING PUMP SHAFT
43. LUBRICATING PUMP DRIVE GEAR
44. LUBRICATING PUMP GEAR
45. LUBRICATING PUMP SHAFT
46. LUBRICATING PUMP BUSHING
47. LUBRICATING PUMP BODY

Figure 8-4. Lubricating Oil Pump, Exploded View (Sheet 2 of 2)

NOTE

The step at the gear thrust face and body surface controls gear end clearance.

f. Temporarily install the assembled gears and shafts (41, 42, 44, and 45) in the body (47) and measure the step at the gear thrust face and body surface with a feeler gage or depth micrometer. If the step is greater than 0.007 inch (0.18 mm), replace the gears or body, or both the gears and body so that the assembled end clearance will be 0.004 to 0.007 inch (0.01 to 0.18 mm).

g. Check the gear thrust surface on the cover (39). Replace the cover if the surface is worn or scored deeper than 0.003 inch (0.08 mm).

h. Check the pressure relief plunger (36), and pressure relief housing (30) for scoring, and check the plunger for binding in the housing. Replace the parts if they are visibly scored, or if binding exists.

i. Using a straight-edge, check the spring (35) for warping. Replace the spring if it is warped or out-of-square.

8-12. OIL PUMP REPAIR.

a. If the bushings in the body or cover are worm, replace them as follows:

(1) Using bushing drivers and an arbor press, remove the worn bushings and press new bushings to depth shown in Figure 8-5 and Figure 8-6.

(2) Using boring tool 3375206 bore the inside diameter of the new bushings in the body and/or cover to 1.5025 to 1.5040 inches (38.164 to 38.202 mm). The bored bushings must be within the dimensions shown in Figure 8-5 and Figure 8-6.

b. If either the lubricating pump shafts (42 and 45, Figure 8-4) or lubricating pump gears (41 and 44) are worn, replace them as follows:

(1) Using an arbor press, press the shafts (42 or 45) out of the gears (41 or 44).

(2) Assemble the drive shaft (45) to the gear (44) using an arbor press. Press the shaft into the gear to dimension 4, Figure 8-7.

(3) Assemble the idler shaft (42) to the gear (41) using an arbor press. Press the shaft into the gear to dimension 5, Figure 8-7.

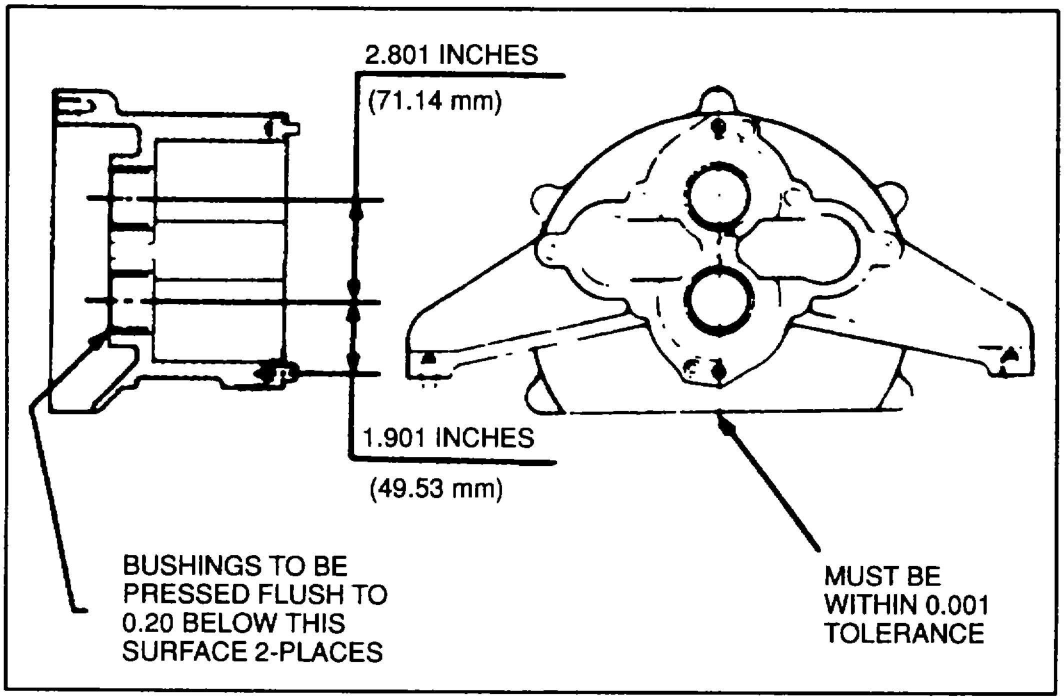


Figure 8-5. Dimensions of the Bushings In the Lubricating Oil Pump Body

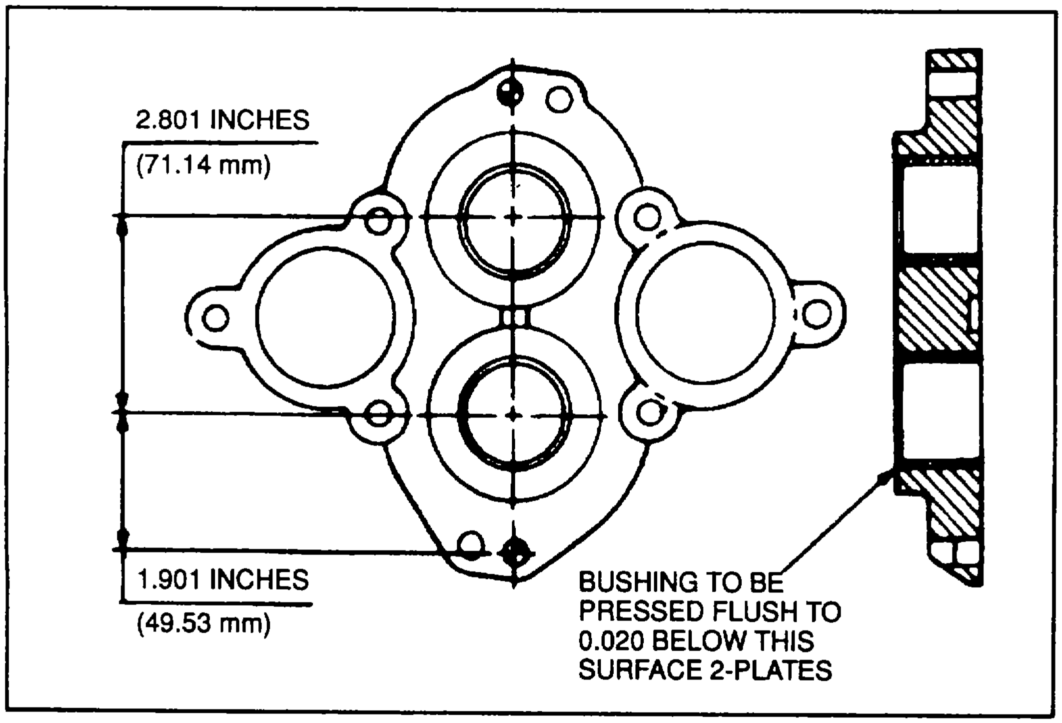


Figure 8-6. Dimensions of the Bushings In the Lubricating Oil Pump Cover

REF. NUMBER	MEASUREMENT	NEW MINIMUM	NEW MAXIMUM	WEAR LIMIT
1	BUSHING INSIDE DIAMETER	1.5025 (38.164)	1.5040 (38.202)	1.505 (38.23)
2	IDLER AND DRIVE SHAFT OUTSIDE DIAMETER	1.4995 (38.087)	1.5000 (38.100)	1.4993 (38.082)
3	DRIVE SHAFT END CLEARANCE	0.004 (0.10)	0.007 (0.18)	
4	PROTRUSION FROM GEAR	2.460 (62.48)	2.480 (62.99)	
5	IDLER SHAFT PROTRUSION FROM GEAR	1.280 (32.51)	1.300 (33.02)	

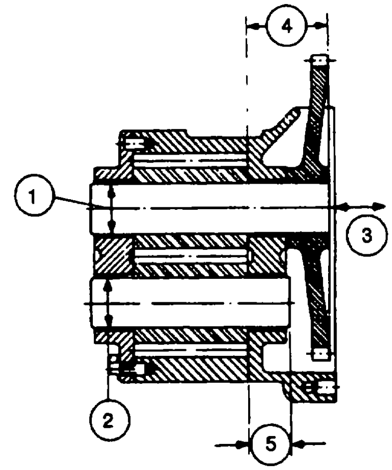


Figure 8-7. Lubricating Oil Pump Fits and Clearances

8-13. OIL PUMP ASSEMBLY. See Figure 8-4.

a. Install the lubricating pump shaft and gear (45 and 44) into the lubricating pump body (47).

b. Support the lubricating pump shaft (45) and press the lubricating pump drive gear (43) on the shaft until it is flush with the end of the shaft.

c. Install the lubricating pump shaft and gear (42 and 41) into the lubricating pump body (47).

d. Position a new lubricating pump gasket (40) on the pump body, and install the cover (39), hexagon head capscrews (37), and lockplates (38) and tighten to 30 to 35 pound-feet (41 to 47 newton-meters) torque. Bend the tabs on the lockplates to secure the capscrews.

e. Check the shaft end clearance (3, Figure 8-7). The end clearance shall be 0. 004 to 0. 007 inch (0. 10 to 0. 18 mm). If the end clearance is incorrect, replace the cover (39, Figure 8-4).

f. Position the relief plunger (36), relief spring (35), and plain washer (34) into the pressure relief housing (30). Secure with the retaining pin (33) and roll pin dowel (32).

CAUTION

It is possible to install the of oil transfer tube (23) in a reverse position (wrong end to the lubricating pump). Whenever this happens, the support bracket (6) for the oil suction tube (9) will not fit. Install the long end of the transfer tube to the pressure relief housing (30) connection on the lubricating oil pump.

g. Lubricate the supply tube seal (20) with clean engine lubricating of MIL-L-2104, or equivalent, and position it on the long-bend end of the transfer tube (23). Use a new relief gasket (31) and install the pressure relief housing assembly (30) and transfer tube (23) with supply tube seal (20) to the lubricating pump cover (39) with capscrews (21) and lockplates (22). Finger-tighten the capscrews (21) only.

h. Install lubricating pump cover (29) and secure with capscrews (1 7) and lockplates (18).

8-14. OIL PUMP INSTALLATION. See Figure 8-4.

NOTE

The shims (26) between the lubricating pump body (47) mounting pads and the cylinder block are used to obtain the specified gear backlash.

NOTE

Two persons may be required to perform the following procedure.

a. Position the lubricating oil pump by engaging the headless straight pins into the recesses in the cylinder block Engage the lubricating pump drive gear (43) with the rear crankshaft gear. Make sure the pump drive gear is fully engaged with the crankshaft gear.

NOTE

The exact end play is not important at this time.

b. Install the lockplates (25) and capscrews (24). Tighten the capscrews finger tight, and check for gear end play. If necessary, add shims (26) until gear backlash can just be felt.
c. Tighten the capscrews (24) to 70 to 75 pound-feet (95 to 102 newton-meters).
d. Use a dial indicator to check the lubricating pump drive gear (43) to crankshaft gear backlash. Add or subtract shims (26) as necessary to achieve a backlash of 0.003 to 0.012 inch (0.08 to 0.30 mm).
e. When the correct backlash is achieved, bend the tabs on the lockplates (25) to secure the capscrews (24).
f. Lubricate the transfer tube seal (20) with dean engine lubricating oil, MIL-L-2104, or equivalent, and position it on short-bend end of the transfer tube (23).

CAUTION

It is possible to install the oil transfer tube (23) in a reverse position (wrong end to the lubricating pump). Whenever this happens, the support bracket (6) for the oil suction tube (9) will not fit. Install the long end of the transfer tube to the pressure relief housing (30) connection on the lubricating oil pump.

g. Place the oil connection (18) over the short-bend end of the transfer tube (23) and install the oil connection with the gasket (19), lockplates (15), and capscrews (14). Tighten the capscrews finger tight.
h. Tighten the capscrews (14 and 21) to 30 to 35 pound-feet (41 to 47 newton-meters), and bend the lockplate tabs to secure the capscrews.
i. Install the bracket damp (3), support bracket (13), and install the capscrews (11) and locknuts (12) finger-fight.
j. Install the flange gasket (10), oil suction tube (9), and secure with capscrews (7) and lockplates (8). Finger tighten capscrews.
k. Install the support bracket (6), bracket damp (3), and secure with capscrews (1), locknuts (2), capscrews (4), and lockplates (5). Tighten the capscrews finger tight.
l. Torque all capscrews (1,4,7, and 11) to 30 to 35 pound-feet (41 to 47 newton-meters). Bend all lockplate tabs to secure the capscrews.
m. Install the oil pan in accordance with paragraph 9-38.

NOTE

If the engine has been pulled from the generator set for shop maintenance, the following steps in this sequence are not required.

NOTE

Avoid dropping of oil pan access plate (3, Figure 8-3) into skid base.

n. Install oil pan access plate (3, Figure 8-3) into skid base. Secure with hexagonal head capscrews (1) and lockwashers (2).

SECTION IV. PRELUBE PUMP ASSEMBLY

8-15. GENERAL. The prelube pump B3 is a gear-type fluid pump and is operated by a 24V dc electric motor coupled directly to the pump. The prelube pump B3 is equipped with a by-pass valve which provides pressure relief from excessive discharge pressures which overheat the pump. Rotation of the motor and drive shaft is counter clockwise when viewed from the pump side of the motor. Lubricating of oil enters the pump through the port adjacent the by-pass valve, and is discharged through the port on the opposite side of the pump body. The prelube pump B3 provides initial lubrication to the engine prior to engine start, and is manually operated by PRELUBE SYS switch S5 on panel C in the generator set control room. The prelube pump B3 is bolted to the skid base by the right rear engine mount; when operated, it draws of oil from the engine of oil sump and delivers R under pressure to the engine oil passages.

8-16. PRELUBE PUMP B3 DISASSEMBLY.

a. Remove the prelube pump B3 from the generator set skid base in accordance with the Operator and Organizational Maintenance Manual.
b. Remove the machine screws (1, Figure 8-8) and lockwashers (2), and remove the motor (5) with the pump assembly (8) from the motor base (4), if necessary.
c. Remove the grommets (3) from the motor base (4), if required.
d. Loosen the hexagon head capscrew (11) in the cover (12), and remove pump assembly (8) from the adapter (6). Remove the machine screws (7) and remove the adapter (6) from the motor (5).
e. Remove the coupling (9) from the drive shaft (26).
f. Remove the plug nut (14) and fiber washer (13) from the cover (12).

NOTE

The by-pass valve assembly (15) is factory set to 70 psi (483 kPa). Disassemble the by-pass valve only if necessary. If disassembly is required, count the number of turns required to turn out the adjusting screw (19). During assembly, return the adjusting screw (19) to this position, so that the approximate factory pressure setting will be retained.

g. Remove the by-pass valve assembly (15) from the cover (12) by removing the valve nut (16), fiber washers (1 7), locknut (18), adjusting screw (19), spring (20), and ball (21).

CAUTION

Do not pry the body (29) from the cover (12) using a sharp, a sharp instrument such as a screwdriver or chisel as this may damage the mating surfaces of the body and cover. If difficulty is experienced in separating the body (29) from the cover (12), tap on the body with a plastic or lead faced hammer.

h. Remove the machine screws (30), and remove the body (29) from the cover (12). Remove and discard the gasket (28).
i. Remove the idle shaft (24) and gear (23), and the drive shaft (26) and gear (25), from the cover (12).
j. Press the gear (23) from the idle shaft (24).
k. Press the pin (27) from the gear (25), and press the gear from the drive shaft (26).
l. Remove the carbon bearings (22) from the cover (12) and the body (29) only if worn. Check in accordance with paragraph 8-18, step c, below.
m. Remove the lip seal (10) from the cover (12).

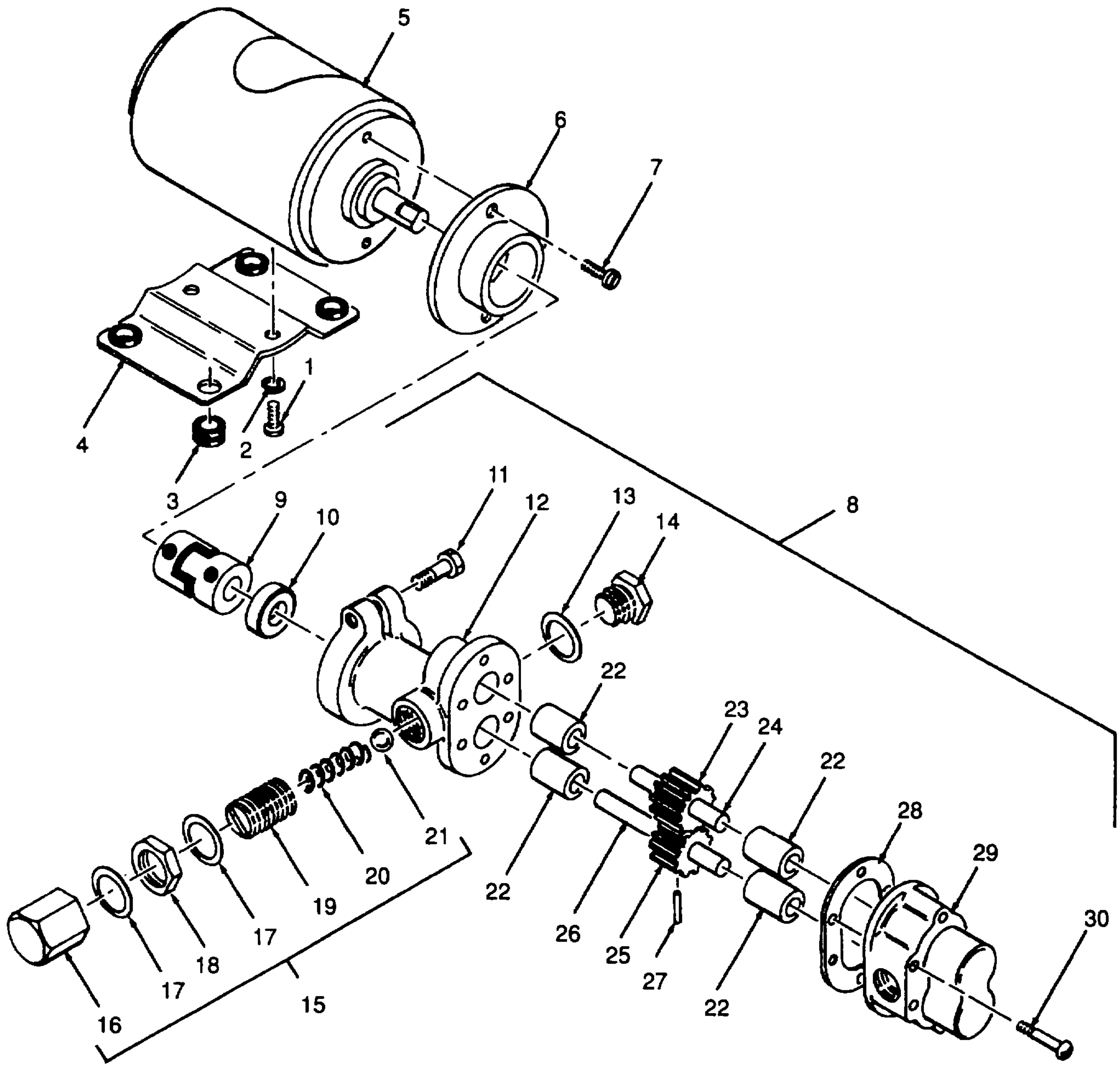


Figure 8-8. Prelube Pump Assembly, Exploded View (Sheet 1 of 2)

1. MACHINE SCREW
2. LOCKWASHER
3. GROMMET
4. MOTOR BASE
5. MOTOR
6. ADAPTER
7. MACHINE SCREW
8. PUMP ASSEMBLY
9. COUPLING
10. LIP SEAL
11. HEXAGON HEAD CAPSCREW
12. COVER
13. FIBER WASHER
14. PLUG NUT
15. BY-PASS VALVE ASSEMBLY
16. VALVE NUT
17. FIBER WASHER
18. LOCKNUT
19. ADJUSTING SCREW
20. SPRING
21. BALL
22. CARBON BEARING
23. GEAR
24. IDLE SHAFT
25. GEAR
26. GEAR
26. DRIVE SHAFT
27. PIN
28. GASKET
29. BODY
30. MACHINE SCREW

Figure 8-8. Prelube Pump Assembly, Exploded View (Sheet 2 of 2)

8-17. PRELUBE PUMP B3 CLEANING AND INSPECTION. See Figure 8-8.

WARNING

Dry cleaning solvent, PD-680, Type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid injury to personnel.

WARNING

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. Clean all parts using cleaning solvent PD-680, Type III, or equivalent, and dry with compressed air.
b. Inspect all threaded parts for stripped or damaged threads. Replace as necessary.
c. Inspect the carbon bearings (22), idle shaft (24), and drive shaft (26) for scoring of the friction surfaces. Replace as necessary.
d. Inspect the cover (12) and body (29) for damage, and ensure that the mating surfaces are not scored or grooved. Replace as necessary.
e. Check the spring (20) for signs of breakage or distortion. Replace as necessary.
f. Check the grommets (3) for signs of damage or deterioration. Replace as necessary.

8-18. PRELUBE PUMP B3 ASSEMBLY.

a. Install the lip seal (10, Figure 8-8) in the cover (12).
b. Press the carbon bearings (22) into the cover (12) and the body (29), if removed.
c. Press the gear (25) on the drive shaft (26), and press the pin (27) in the gear.
d. Press the gear (23) on the file shaft (24).
e. Lubricate the idle shaft (24) and gear (23), and the drive shaft (26) and gear (25), with dean lubricating oil, such as MIL-L-2104, and install in the cover (12). Ensure that the idle shaft (24) and gear (23), and the drive shaft (26) and gear (25), rotate freely in the carbon bearings (22).

f. Install the body (29) on the cover (11) with the gasket (28) and machine screws (30).

NOTE

Turn the end of the drive shaft (26) from inside the cover (12) to ensure that the drive shaft (26) and gear (25), and the idle shaft (24) and gear (23), rotate freely inside the pump assembly (8) after the machine screws (30) have been tightened.

g. Install the by-pass valve assembly (15) in the cover (12), if removed, by installing the ball (21), spring (20), adjusting screw (19), locknut (18), fiber washers (17), and the valve nut (16).
h. Install the plug nut (14) and fiber washer (13) in the cover (12).
i. Install the coupling (9) on the drive shaft (26).
j. Install the adapter (6) on the motor (5) with the machine screws (7). Install the pump assembly (8) on the adapter (6), taking care to ensure that the machined surfaces of the coupling (9) and the motor (5) drive shaft mate properly. Secure the cover (9) by tightening the hexagon head capscrew (11).
k. Install the pump assembly (8) with motor (5) to the motor base (4) with machine screws (1) and lockwashers (2).
l. Install the grommets (3) in the motor base (4), if removed.
m. The vertical position of the pump assembly (8) may be adjusted, if desired by loosening the hexagon head capscrew (11), and rotating the pump assembly (8) on the adapter (6).
n. Install the prelube pump B3 on the generator set skid base in accordance with the Operator and Organizational Maintenance Manual.

CHAPTER 9
MAINTENANCE OF ENGINE

SECTION I. MAINTENANCE OF ENGINE ASSEMBLY

9-1. GENERAL. This chapter details the procedures necessary to replace, repair, overhaul, or rebuild the engine assembly and related components as necessary.

a. Engine Assembly. The engine is a 12-cylinder diesel of V configuration having a displacement of 2300 cubic inches (37. 7 liters). The engine operates on the four stroke cycle principle and has two exhaust and two intake valves per cylinder. A turbocharger is used to increase power output by improving air induction. The turbochargers are after-cooled to provide denser air for combustion, and to reduce exhaust temperatures. Replaceable cartridge-type filters are provided for the fuel, lubricating, and cooling system.

b. Repair, Overhaul, Rebuild. These procedures employ the methods and specifications recommended by the manufacturer for the successful overhaul of the engine components. The information is given as an addition to the skills required by experienced service personnel. Due to the precision fit of components, all tolerance specifications and torque values should be strictly followed. Long engine life and efficient operation depend on the care and precision with which inspections, repairs, and adjustments are made. When performing maintenance procedures, note the following:

(1) The inspection area must be thoroughly dean.
(2) The area must be well lighted.
(3) Cover inspection tables with clean, dry paper; keep special gages and indicators in cabinet lockers when not in use.
(4) Close all openings that are uncovered during inspection and repair with covers, plugs, or caps.
(5) Inspection limits set forth in this manual are manufacturing and normal wear limits. Before condemning a part, check the specifications for operating limits with the mating part. The wear limits, given in the Table 1-4 are satisfactory for most repair procedures. The overhaul and rebuild of components, however, shall be carried out to new minimum or maximum tolerances where indicated. Stationary parts with cracks, stripped bolt or stud holes, and eroded, or otherwise damaged surfaces, may be repaired by sleeving, installing threaded inserts, or by welding or brazing. All welding or brazing shall be performed by certified operators.
(6) During both removal and disassembly operations, check parts and components for wear and damage before cleaning. Fine metallic particles present in a lubricant, for example, are evidence of wear that would be lost during cleaning operation.
(7) Parts must be inspected in accordance with good shop practice by experienced personnel. A careful visual inspection should precede any detailed check to eliminate unnecessary inspection procedures and to determine the extent of further checking. Inspection requirements in this section are provided as the basis for setting up inspection procedures.
(8) Check all micrometers, gages, indicators, and other measuring instruments periodically. Calibrate in accordance with MIL-STD-120 or with the applicable manufacturer's recommendations.
(9) Good shop practice includes complete and accurate inspection records. Records not only simplify reworking of the equipment, but also ensure a complete and thorough overhaul. Inspection records should be based upon the requirements outlined in this section. Parts needing rework or replacement should be so tagged, and a notation of the disposition of these parts should be entered on the inspection records. The same method should be followed for parts needing special treatment, such as magnetic or fluorescent inspections, painting, and similar treatments.
(10) Descriptive terms used in this section to describe the condition of parts are defined in General Defect Definitions, Table 9-1. Whenever these conditions exist, the inspector should refer to the dimensional data per Table 1-4 related to the damaged part and decide if rework is feasible. The part should be tagged accordingly and repaired or disposed of in accordance with current regulations. The disposition of the part should then be noted on the inspection record.
(11) Parts which are normally replaced at each overhaul should be given a brief, visual inspection. Damage of these parts may reflect malfunction of other components in the engine. Consider this possibility when any part has been damaged.

(12) Use corrosion-preventive procedures, in accordance with MIL-HDBK-721 on all steel parts after inspection unless the part is to be reworked or used immediately.
(13) Repair or replace AN standard parts (except those contained in repair kits) according to existing directives.
(14) Manufacturers tolerances and wear limits are given in Table 1-4 and in applicable maintenance procedures, and should be referred to before accepting or rejecting any component for reuse.
(15) General screw and bolt torques not specifically referred to in the text are listed in Table 1-2.
(16) Special screw and bolt torques referred to in the text are listed in Table 1-1 and should be strictly followed.

9-2. ENGINE ASSEMBLY REPAIR. Repair of the engine assembly is accomplished by repairing or replacing the subassemblies in accordance with the applicable paragraphs in this chapter.

Table 9-1. General Defect Definitions

TERM	DEFINITION	PROBABLE CAUSE
Break	Complete separation into two or more pieces.	Fatigue, shock, or overload.
Abrasion	A roughened area. Can be defined as light to heavy, dependent upon amount of rework necessary to restore surface.	Foreign particles between moving parts.
Broidering	Indentations sometimes found on surfaces of ball or roller bearing part and shaft surfaces. **NOTE** **Bearings which do not have full constant rotation, and are subjected to shock, loading, have brinelling tendencies.**	Improper assembly or disassembly technique, such as removing or installing a roller or ball bearing by hammering on free race. Repeated impact loads on bearings.
Burning	Injury to surfaces by excessive heat. Evidenced by discoloration; or sometimes by flow or loss of metal.	Improper clearance or lack of lubrication due to plugged oil passages or other lubrication malfunction.
Burr	A sharp projection or rough edge.	Excessive wear, careless handling, or improper machining.
Chafing	A rubbing action between two parts having a limited relative motion.	Improper assembly techniques, improper fits. Lack of lubrication.
Chipping	Breaking out of small particles of metal.	Careless handling or parts. concentration or stresses due to shock, nicks, scratches, etc.
Corrosion	Breakdown or pitting or surfaces by chemical action.	Use of improper lubricants, coolant, or fuel.
Crack	A partial failure.	Excessive stress due to shock, overloading, or faulty processing; extension of a nick or scratch; defective material, overheating.
Dent	Small, smoothly rounded hollow in surface.	Careless handling of parts.
Erosion	Carrying away of material by the flow of hot gases, grit, or chemicals.	Blow-by; flow of corroding liquids, hot gases, or grit-laden oil.
Fatigue Crack	Progressive damage as the stress on a piece is repeatedly applied and removed.	Originating at a surface defect or scratch.
Flaking	Breaking away of pieces of a plated, case hardened, or painted surface.	Incomplete bond, excessive load, or blistering. Excessive bearing preload.

Table 9-1. General Defect Definitions (Continued)

TERM	DEFINITION	PROBABLE CAUSE
Galling	A transfer of metal from one surface to another.	Severe chafing action; metal particles from relative parts are embedded in opposite surfaces. Lack of lubrication, improper - clearances.
Grooving	Smooth, rounded furrow, such as score marks whose sharp edges have been pol-ished off.	Concentrated wear, parts out of alignment, lack of lubrication.
Nick	A sharp indention.	Careless handling, or break-up of compo-nents during operation
Peening	Deformation of the surface.	Repeated impact of foreign objects; failure of components during operation.
Pitting	Small cavities on a surface.	Improper clearance or: (Mechanical) Pressure of foreign material. (Corrosive) Breakdown of surface by chemical action
Scoring	Deep scratches.	Presence of foreign particles between loaded surfaces having relative motion. Improper lubrication.
Scratches	Narrow, shallow marks on surfaces.	Careless handling, foreign particles in engine during operation. Improper lubrication.

SECTION II. MAINTENANCE OF CYLINDER HEAD ASSEMBLIES

9-3. GENERAL. The engine intake and exhaust is controlled by four valves for each cylinder, contained in 12 individual cylinder heads. Two camshafts, one located in each cylinder bank control the opening and dosing of the valves. Roller-type cam followers transmit the motion caused by the camshaft lobes to three push rods. Each push rod activates an intake, exhaust, and injector rocker lever located in the rocker lever housing bolted to the top of each cylinder head. The intake and exhaust valve crossheads, located in the cylinder heads, are moved by the rocker levers and each crosshead opens two intake or two exhaust valves. During the dosing cycle, the valves are dosed by springs keyed to the valve stems. Since 12 individual cylinder heads are used on the KTA 2300 engine, one cylinder head, or all cylinder heads may be replaced or repaired at one time, depending on the job to be accomplished. The removal and installation instructions cover the replacement of all cylinder heads. If it is desirable to replace one particular cylinder head. It may be possible to omit some of the steps. The technician will make this decision based on the job to be accomplished, and the individual cylinder head or heads to be replaced.

9-4. INSPECTION OF CYLINDER HEAD ASSEMBLIES. (See F igure 9-1 and Figure 9-2.)

a. Visually examine the area around the cylinder head capscrews (11, Figure 9-1), and pipe plugs (19 and 20) for evidence of coolant leakage.
b. Check all expansion plugs (21 and 22) for evidence of coolant leakage. Check expansion plugs for soundness by tapping lightly with a punch. Expansion plugs which penetrate easily shall be replaced in accordance with paragraph 2-10.
c. Inspect the head gasket area for signs of coolant leakage.
d. Remove the valve covers in accordance with paragraph 9-5, step h.
e. Inspect the rocker arms (12, 13, and 14, Figure 9-2) and crossheads (8, Figure 9-1) for breakage or outward signs of cracking.
f. Inspect the valve springs (3) for breakage.
g. Inspect the valve guides (25) for breakage or outward signs of cracking.

h. Make necessary repairs in accordance with paragraphs 9-5 through 9-11.
i. Install the valve covers in accordance with paragraph 9-11.

9-5. REMOVAL OF CYUNDER HEAD ASSEMBUES, (S ee Figure 9-1 and Figure 9-2).

a. Drain engine coolant in accordance with the Operator and Organizational Maintenance Manual.
b. Remove the water filter mounting heads in accordance with the Operator and Organizational Maintenance Manual.
c. Remove the thermostat housing assembly in accordance with the Operator and Organizational Maintenance Manual.
d. Remove the aftercooler in accordance with paragraph 9-42.
e. Remove the exhaust manifolds in accordance with paragraph 9-44.
f. Remove the intake manifolds in accordance with paragraph 9-43.
g. Remove the fuel manifolds in accordance with paragraph 6-25.
h. Remove the rocker arms and crossheads as follows:
   (1) Remove the capscrew and lockwasher (1, Figure 9-2), washer (2), two hexagon head capscrews (3), lockwashers (4), and washers (5) from the rocker arm cover (6).
   (2) Remove the rocker arm cover (6) and discard the gasket (7).
   (3) Relieve the spring pressure on the rocker arm assembly by loosening the locknuts (15), and backing out adjusting screws (16) one or two turns.
   (4) Match-mark the rocker arm shaft (11) to the rocker arm housing (20), and remove the capscrews (8 and 9), and washers (10).
   (5) Using both hands, lift straight up on the rocker arm shaft (11) to dear the ring dowel (24), and remove the rocker shaft and arm assembly from the rocker arm housing (20).
   (6) Match-mark the exhaust rocker arm (12), injector rocker arm (13), and intake rocker arm (14) to their respective positions on the rocker arm shaft (11), and remove rocker arms from shaft. Remove the locknuts (15) and adjusting screws (16) from the rocker arms.
   (7) Match-mark the valve crossheads (8, Figure 9-1) as to cylinder head and crosshead guide position, and remove the crossheads by pulling them straight up off of the crosshead guide (24). Remove the nuts (10) and adjusting screws (9) from the crossheads.
   (8) Remove the retainers (17, Figure 9-2) and tap the water transfer tubes (22) into the rocker arm housing (20) using ST-1319 driver.
   (9) Remove five capscrews (18), washers (19), capscrew (29), and washer (10), and remove the rocker arm housing (20) and gasket (21). Discard the gasket.
   (10) Remove the water transfer tubes (22), and remove and discard the packings (23).

i. Remove the engine poppet and injector push rods and place them in a numbered holder so that they will be installed in the same follower holes as removed.

CAUTION

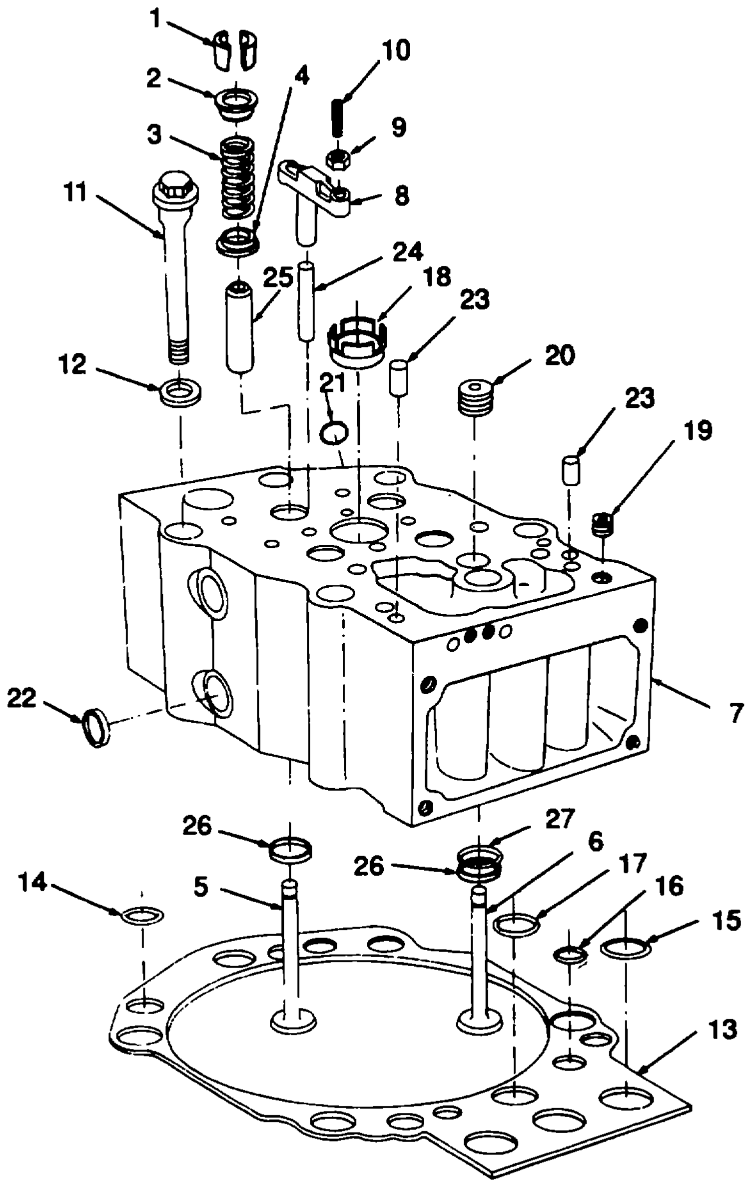
DO NOT remove the cylinder heads without removing the injectors. Injector tip damage could occur during cylinder head removal or subsequent handling.

j. Remove the fuel injectors and with seal seats in accordance paragraph 6-13.
k. Remove the fuel manifold accordance with paragraph 6-25.
l. Remove six capscrews (11, Figure 9-1), and washers (12) holding the cylinder head (7) to cylinder block

NOTE

Cylinder head weight is approximately 63 pounds (28 kg). Two persons may be required to lift the cylinder head.

m. Lift the cylinder head (7) to dear the dowel pins, and remove the cylinder head. Remove and discard the gasket (13), and grommets (14,15,16, and 17).
n. Remove the other cylinder heads following the above steps as necessary.



1. LOCK	15. GROMMET
2. SEAT	16. GROMMET
3. SPRING	17. GROMMET
4. GUIDE	18. SEAL SEAT
5. EXHAUST VALVE	19. PIPE PLUG
6. INTAKE VALVE	20. PIPE PLUG
7. CYLINDER HEAD	21. EXPANSION PLUG
8. CROSSHEAD	22. EXPANSION PLUG
9. NUJT	23. DOWEL
10. ADJUSTING SCREW	24. CROSSHEAD GUIDE
11. CAPSCREW	25. VALVE GUIDE
12. WASHER	26. VALVE SEAT
13. GASKET	27. AIR DEFLECTOR
14.GROMMET	

Figure 9-1. Exploded View of Cylinder Head

9-6. CYLINDER HEADS DISASSEMBLY. (See Figure 9-1.)

NOTE

It is desirable that each valve and port be identified so that valves can be reinstalled in the ports from which they were removed. Because valves, seats, and guides tend to mate during operation, returning each valve to its corresponding port will ensure a good fit. Furthermore, it will be easier to detect the source of unusual valve wear caused by defective seats or valve guides.

a. Using valve spring compressor ST448-6, compress the valve spring (3), and remove and discard the locks (1).
b. Release the tension on the valve spring, and remove the valve spring seat (2), valve spring (3), valve spring guide (4), and exhaust or intake valve (5 or 6) from the cylinder head (7).
c. Place the valve in a numbered valve board for later inspection and reconditioning.
d. Repeat steps a through e, above, for each valve. Be sure each valve is placed in a numbered valve board.
e. After cleaning and inspecting the cylinder heads, carry out further disassembly as necessary in accordance with paragraphs 9-9 and 9-10.

9-7. DISASSEMBLED CYLINDER HEAD CLEANING.

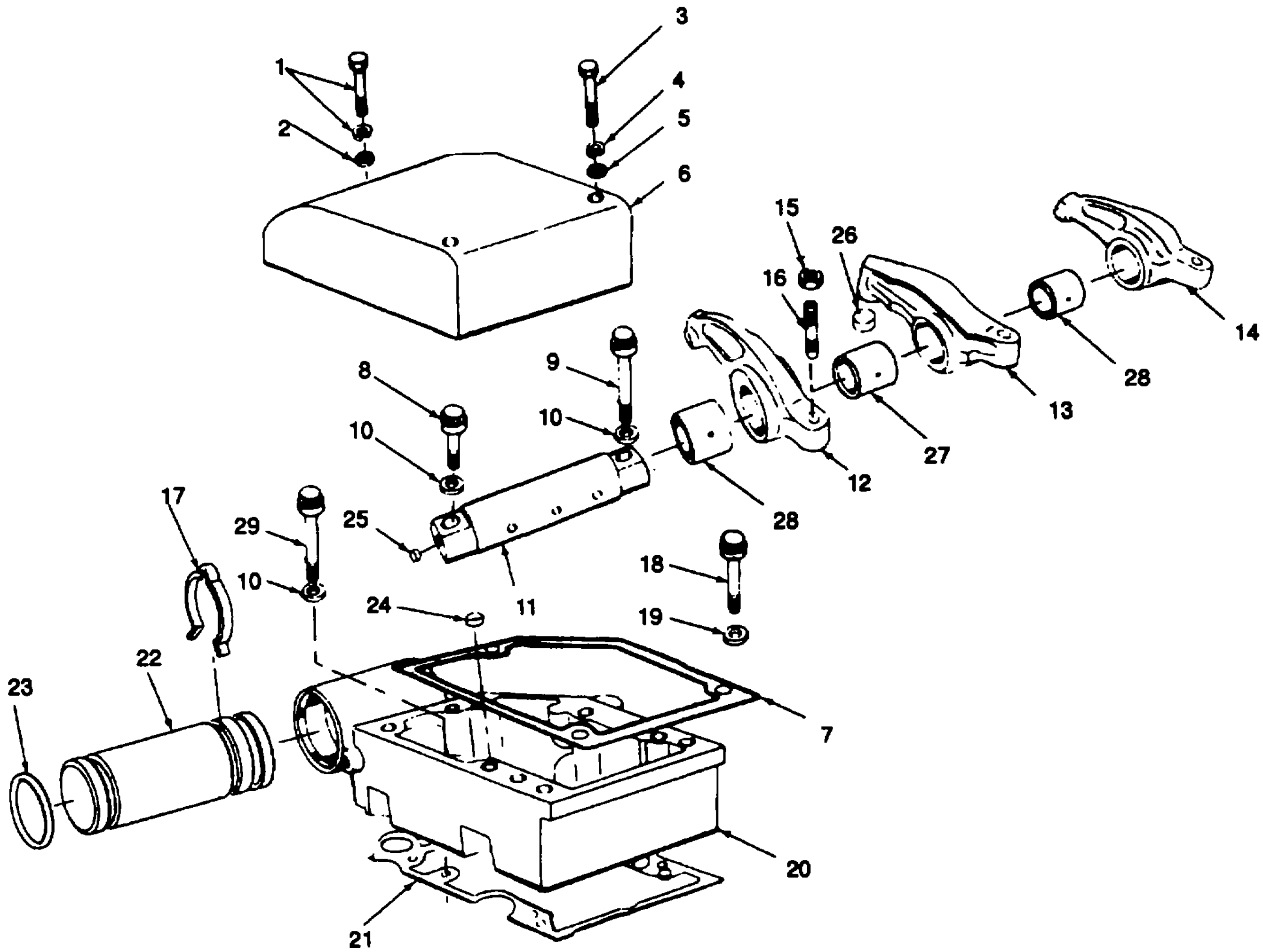
WARNING

Dry cleaning solvent PD-680, Type III, or equivalent, is flammable, and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid injury to personnel.

WARNING

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. Clean all disassembled parts in dry cleaning solvent P-D-680, Type III, or equivalent, and dry with compressed air or dean shop towels as necessary.
b. Clean the valves as follows:
   (1) Clean all traces of carbon or varnish from the valves using glass bead method MIL-STD-852, and glass beads MIL-G-9954 sieve 60, or finer.
   (2) Polish the valves with a buffer or crocus cloth P-C-458.
c. Clean the cylinder heads as follows:
   (1) Clean the fuel passages using brush ST-876, and solvent P-D-680, Type III, or equivalent. Flush passages with solvent and blow dry with compressed air.
   (2) Thoroughly dean the head of all carbon deposits, varnish, and accumulated dirt. Use extreme care when wire brushing around injector seat and valve seat areas to avoid damaging the seats.
   (3) If excessive deposits of rust or scale in the water jacket is apparent, or overheating has been a problem, dean the water jacket in accordance with paragraph 9-11.



1. CAPSCREW AND LOCKWASHER	16. ADJUSTING SCREW
2. WASHER	17. RETAINER
3. HEXAGONAL HEAD SCREW	18. CAPSCREW
4. LOCKWASHER	19. WASHER
5. WASHER	20. HOUSING (ROCKER ARM)
6. COVER (ROCKER ARM)	21. GASKET
7. GASKET	22. TUBE (WATER TRANSFER)
9. CAPSCREW	23. PACKING
10. WASHER	24. DOWEL
11. SHAFT	25. CUP PLUG
12. ROCKER ARM (EXHAUST)	26. BALL SOCKET SEAT
13. ROCKER ARM (INJECTOR)	27. BUSHING
14. ROCKER ARM (INTAKE)	28. BUSHING
15. LOCKNUT	29. CAPSCREW

Figure 9-2. Disassembly and Assembly of Rocker Arms

9-8. DISASSEMBLED CYLINDER HEAD INSPECTION.

a. Valves. Inspect both the intake and exhaust valves as follows (see Figure 9-3 and Figure 9-4):

(1) Discard any valve if the head is cupped, cracked, or burned. Do not mistake the small, circular depression in the center of the valve head for cupping.

(2) Discard any valve if the face is pitted or worn to the extent that regrinding would leave rim thickness (A, Figure 9-3) under 0.105 inch (2.67 mm).

(3) Discard any valve if the stem diameter (B) is under 0.4935 inch (12.535 mm), or rim thickness (A) is under 0.105 inch (2.67 mm).

(4) Discard any valve if the lock recess is worn to the extent that new locks will not fit securely.

(5) Inspect the valves using fluorescent magnetic particle inspection as follows (see Figure 9-4):

CAUTION

Some valves are of welded construction and have two types of metal. These valves may be inspected using the fluorescent magnetic particle method. Due to the change in metal at the weld area, however, a broad fuzzy leakage pattern will show. To avoid discarding a serviceable valve, magnetize this type of valve In a coil at 100 to 200 amperes, remove It from the coil, and apply fluorescent magnetic particles in suspension. A crack in the weld area will be indicated by a sharp, bright fluorescent line.

(a) Inspect the valves using fluorescent magnetic particle inspection in accordance with MIL-I-6868. Magnetize and inspect in two directions using coil shots of 100 to 300 amperes for transverse defects, and head shots of 500 to 700 amperes for radial defects.

(b) Using a 3-power magnifying glass, inspect each valve in accordance with Figure 9-4.

(c) Discard any valve if magnetic indications in area A are over 0.500 inch (12.70 mm) in length, or if more than 5 indications spaced closer than 0.125 inch (3.18 mm) are found in area A.

(d) Discard any valve if magnetic indications are found in areas B, C, D, or E.

(6) Repair acceptable valves in accordance with paragraph 9-9.

b. Valve Springs. Inspect and test the valve springs as follows (see Figure 9-1):

(1) Place the valve spring (3) on a surface plate and check the free length. The valve spring should be square, and have a free length of approximately 3.349 inches (85.06 mm). Discard valve springs that are obviously warped or collapsed.

(2) Using valve spring tester 3375182, compress the valve spring to a length of 2.470 inches (62.74 mm), and note the load needed to compress the spring. Discard springs that are outside the limits of Table 1-4.

(3) Inspect the valve spring seats (2) for cracks and worn or elongated lock holes. Discard the retainers if cracked, or if holes are worn or elongated.

(4) Inspect the valve spring guides (4) for cracks. Discard if cracked.

c. Cylinder Heads. Inspect the cylinder heads as follows (see Figure 9-1, Figure 9-5, Figure 9-6, and Figure 9-7):

NOTE

Depending on the equipment available, either an air pressure test, a water pressure test, or both air and water pressure tests will be used.

(1) Assemble the head in test fixture ST-1012 using adapter plates 3375070 (3 and 5, Figure 9-5), and perform an air pressure test as follows:

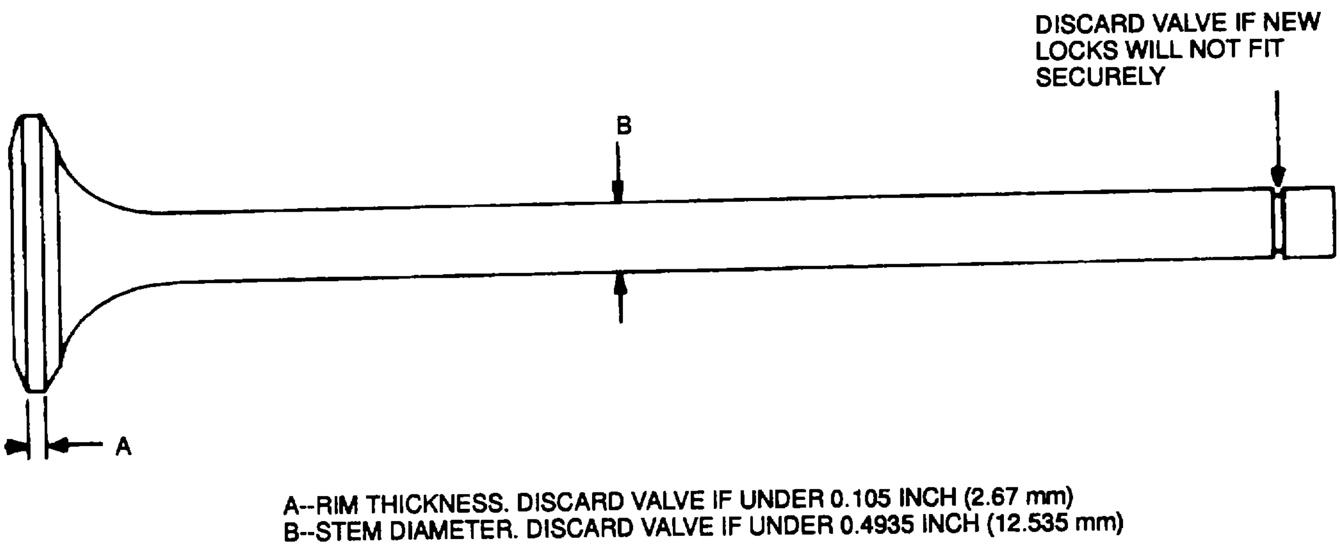
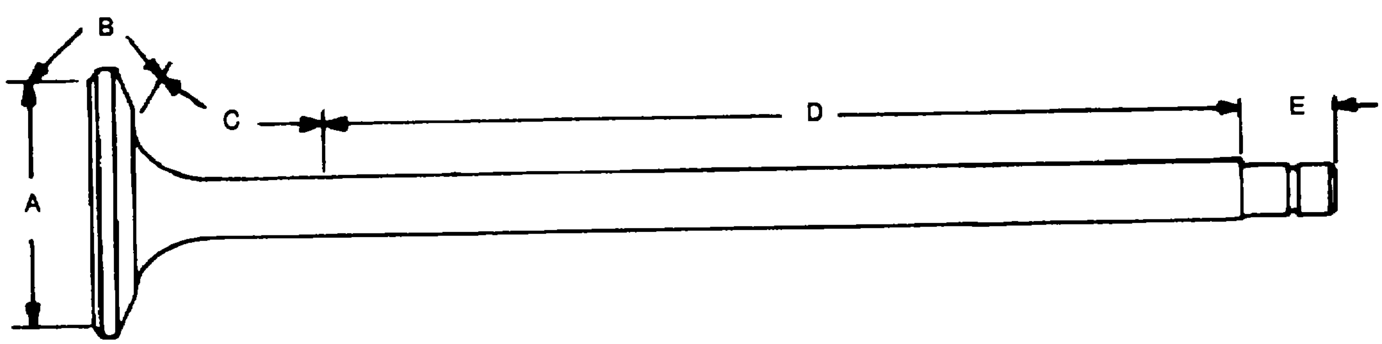


Figure 9-3. Inspection of Valves



NOTE: EXAMINATION OF AREAS A, B, C, D, AND E SHALL BE CARRIED OUT UNDER 3-POWER MAGNIFICATION.	
AREA	**STANDARDS**
A	NO MAGNETIC INDICATION OVER 0.500 INCH (12.70 mm) IN LENGTH, OR MORE THAN 5 INDICATIONS SPACED CLOSER THAN 0.125 INCH (3.18 mm).
B	NO VISIBLE MAGNETIC INDICATION.
C	NO VISIBLE MAGNETIC INDICATION.
D	NO VISIBLE MAGNETIC INDICATION.
E	NO VISIBLE MAGNETIC INDICATION.
SEE PARAGRAPH 9-8.	

Figure 9-4. Fluorescent Magnetic Particle Inspection of Valves

NOTE

Cylinder head weight is approximately 63 pounds (28 kg). Two persons may be required to lift cylinder heads.

(a) Position the head and test fixture ST-1012 over a water tank of sufficient capacity to completely submerge the head.
(b) Connect an air supply of 30 to 40 psi (207 to 276 kPa) to test fixture ST-1012 and submerge the head in water.
(c) Leaks are indicated by the presence of air bubbles. Check carefully around the area of the expansion plugs, pipe plugs, valve seats, and injector seal seat for leaks or cracks.

(2) Assemble the head in test fixture ST-1012, as in step (1), above, (Figure 9-5), and perform a water pressure test as follows:
(a) Position the head over a drain area and connect a water supply at 35 to 85 psi (241 to 586 kPa), and a temperature of 180° to 200°F (82° to 93° C). Close the water outlet, and inspect the same areas as in step (1) (c), above, for water leaks.
(b) Open the water outlet of the test fixture, and check for free water circulation through the coolant passages. If the water flow is restricted, the pipe plugs and expansion plugs must be removed and the water jacket cleaned in accordance with paragraph 9-11.
(c) Replace leaking expansion plugs in accordance with paragraph 2-10.
(d) Remove damaged or leaking pipe plugs, install new plugs using sealant MIL-S-45180, Type III, and re-test for leaks.

(3) Using magnetic crack detector ST-1166 or equivalent, check for cracks in the area of the valve ports and injector port. Discard the head if cracked.

(4) Visually inspect the head for damaged gasket surfaces and eroded water holes that would interfere with proper gasket sealing. Refinish damaged gasket surfaces and repair eroded water holes in accordance with paragraph 9-11.

(5) Inspect dowel pins for damage and tightness of fit, and check threaded holes for damage or stripping. Repair stripped holes in accordance with paragraph 2-12.

(6) Check the soundness of the expansion plugs by tapping them with a sharp punch. Replace expansion plugs that dent easily, or are penetrated easily, in accordance with paragraph 2-10.

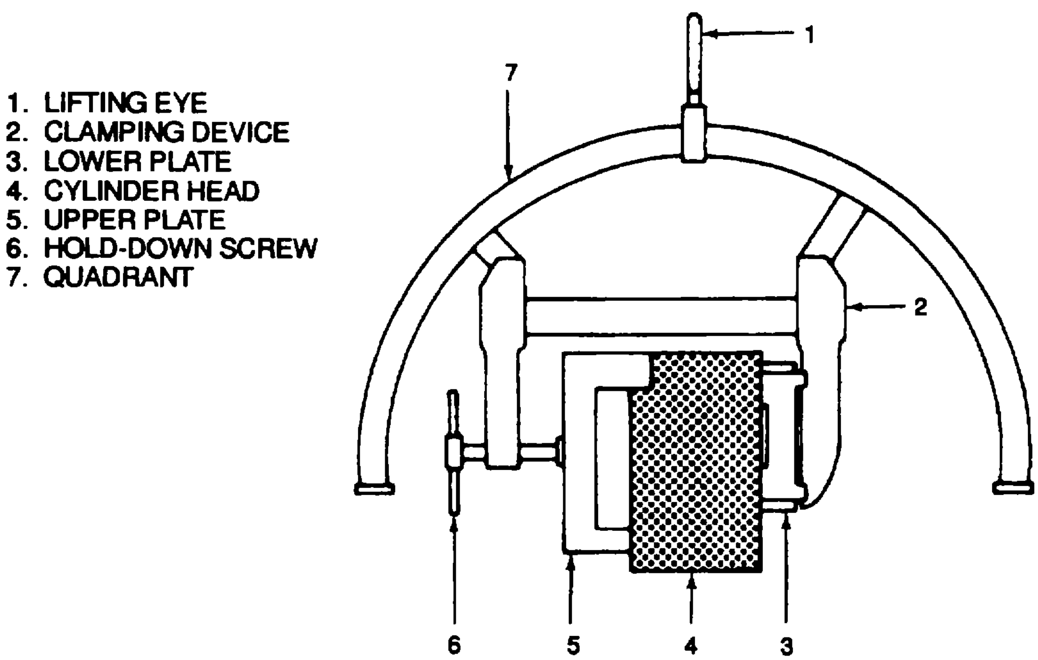


Figure 9-5. Cylinder Head Installed In ST-1012

CAUTION

To avoid damaging the gasket surface when checking the valve seat Inserts for looseness, do not hammer on the gasket surface.

(7) Using a light, brass hammer, check for loose valve seat inserts by tapping on the head adjacent to the valve seat. A loose valve seat insert will tend to move and bounce in the counterbore. Tighten or replace loose valve seat inserts in accordance with paragraph 9-11.

(8) Check the valve seat inserts for erosion, burning, pitting, and wear. Sufficient metal must remain so that regrinding is confined to the seat insert only. Regrind the valve seats in accordance with paragraph 9-9. Replace valve seat inserts in accordance with paragraph 9-11.

(9) Check injector tip protrusion and seal seat pattern as follows (see Figure 9-1, Figure 9-6, and Figure 9-7):

NOTE

Do not install packings on injectors when performing protrusion and seal seat checks.

(a) Lightly coat the injector seal seat (18, Figure 9-1) with Prussian blue compound. Install the injector and seal seat assembly in the well, and tighten the retaining screws to 11 to 13 pound-feet (15 to 18 newton-meters).

(b) Zero the indicator button of dial indicator of gage block 3376220 on the head surface, then index the indicator button on the injector tip to measure the protrusion (Figure 9-6). Injector tip protrusion shall be 0.090 to 0.110 inch (2.29 to 2.79 mm).

(c) Remove the injector and injector seal seat, and check the blueing pattern. The pattern shall show a blue band that is a minimum of 0.060 inch (1.5 mm) in width, and located approximately 0.469 inch (11.91 mm) from the head surface (Figure 9-7).

(d) Correct the injector tip protrusion by replacing the injector seal seat or injector, or by replacing both the injector seal seat and injector as required.

(e) Correct the injector seal seat pattern by replacing the injector seal seat or injector, or by replacing both the injector seal seat and injector as required.

(10) Inspect the valve crosshead guides as follows (see Figure 9-8).

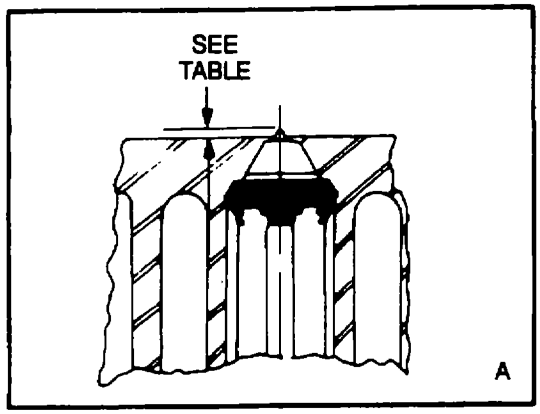
(a) Inspect the crosshead guides for straightness. Guides should be straight and at right angles to the milled surface of the head.

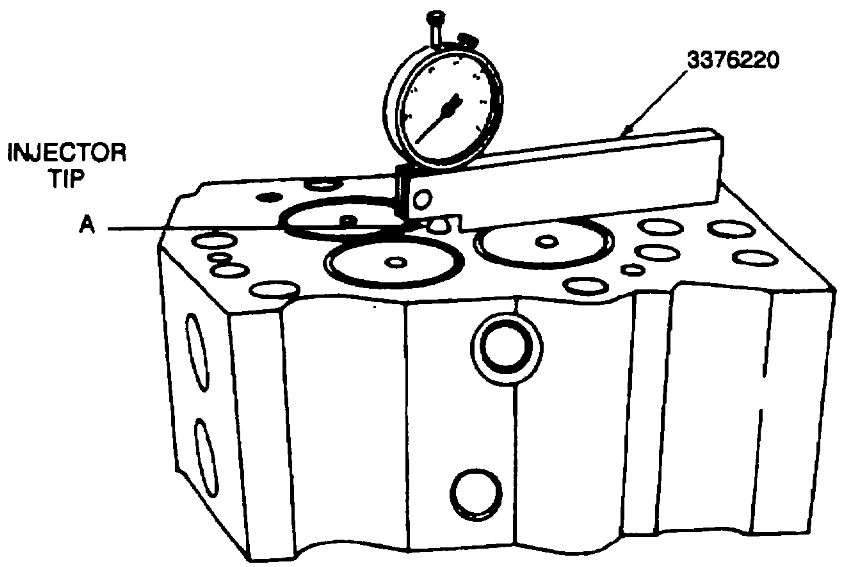
(b) Using a micrometer, check the crosshead guides for wear (dimension B, Figure 9-8). At the point of greatest wear, the guide shall be a minimum diameter of 0.432 inch (10.97 mm). Replace worn or bent crosshead guides in accordance with paragraph 9-10.

(11) Inspect the valve guides as follows (see Figure 9-8):

(a) Visually inspect the valve guides for chips, cracks, burrs, and galling.

(b) Using a small hole gage, check the valve guide inside diameter for wear and out-of-round (dimension C, Figure 9-8). Maximum inside diameter shall be 0.4996 inch (12.690 mm). Replace worn or damaged valve guides in accordance with paragraph 9-11.





DIMENSION
INJECTOR TIP PROTRUSION

MINIMUM	MAXIMUM
INCH (mm)	**INCH (mm)**
0.090 (2.29)	**0.110 (2.79)**

Figure 9-6. Measuring Injector Tip Protrusion

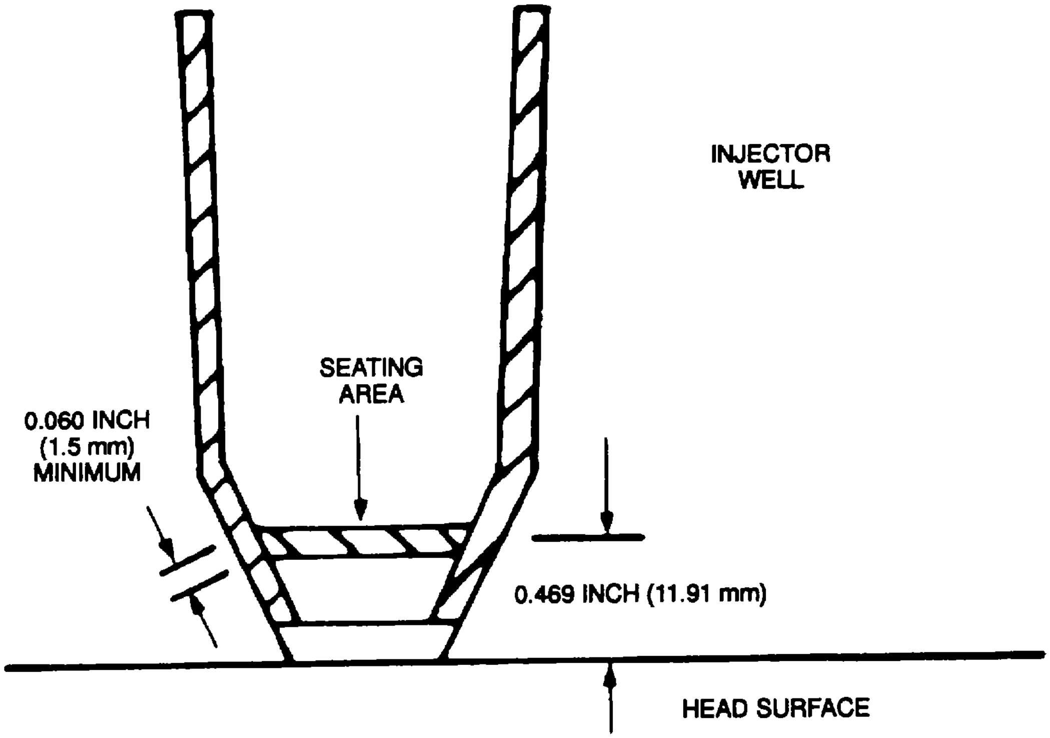


Figure 9-7. Injector Seat Pattern

NEW			
REF	MIN INCH (mm)	MAX INCH (mm)	WEAR LIMIT
A	2.350 (59.69)	2.370 (60.20)	
B	0.433 (11.00)	0.4335 (11.011)	0.432 (10.97)
C	0.4972 (12.629)	0.4980 (12.649)	0.4996 (12.690)
D	13.75 (34.93)	13.90 (35.31)	

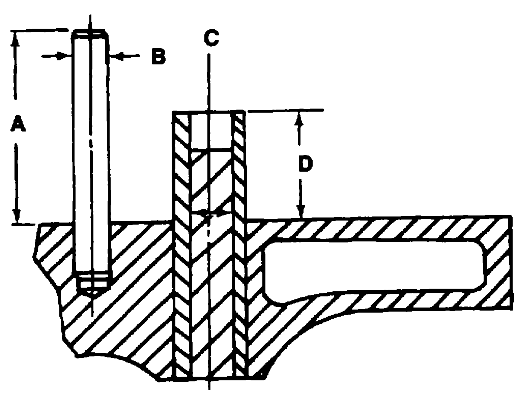


Figure 9-8. Inspection of Valve Crosshead Guides and Valve Guides

(12) Check all threaded holes for stripped threads. Repair stripped threads by installing helical inserts in accordance with paragraph 2-11.
(13) Check all capscrews for damaged or stripped threads. Repair minor thread damage by chasing; replace stripped capscrews.

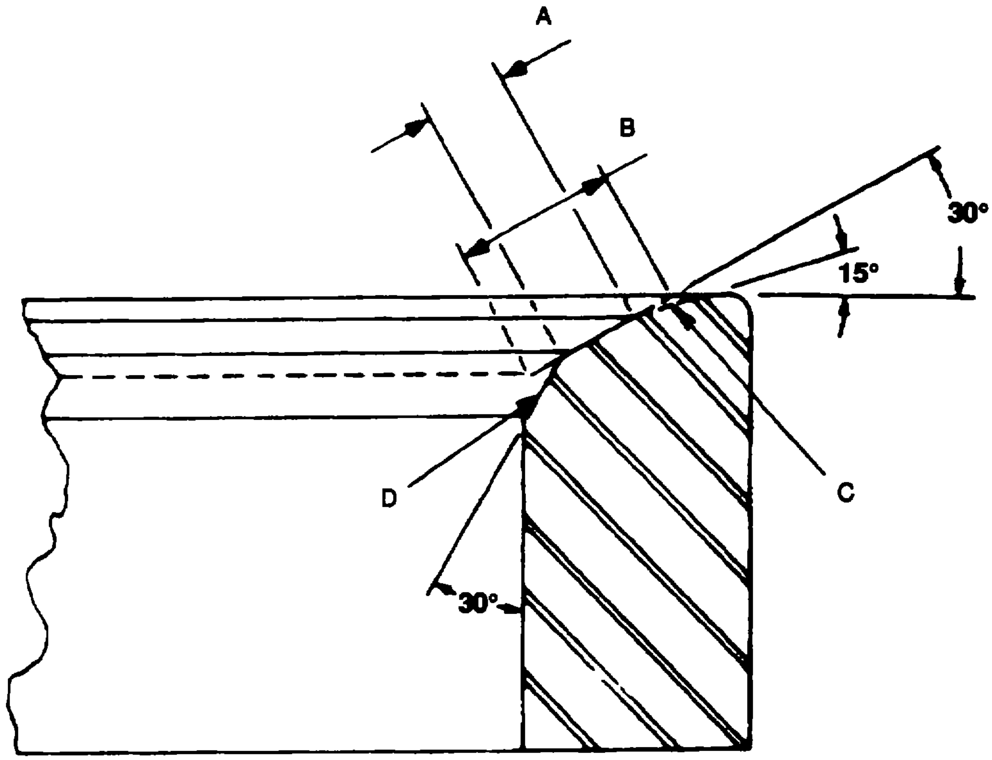
d. Rocker Arms, Crossheads, Push Rods, and Followers:
(1) Inspect, and replace or repair the rocker arms, crossheads, housings, covers, and water transfer tubes in accordance with paragraph 9-13.
(2) Inspect, and replace or repair the push rods in accordance with paragraph 9-14.

9-9. CYLINDER HEAD ASSEMBLIES REPAIR.

a. General. Good valve service life depends upon the careful use of precision equipment during refinishing operations. Keep all stones properly dressed, and dean the chuck of the valve refacer before each valve is refinished. Before using the valve refacer for refinishing, test the chuck for accuracy as follows:
(1) Chuck a new valve in valve refacing machine ST-684, or equivalent, and mount a dial indicator so that valve face run out can be checked.
(2) Indicate the around face of the valve and mark the high spot.
(3) Turn the valve 180 degrees in the chuck, and re-indicate the valve.
(4) If the high spot is at the same place as marked in step (2), above, and the run out exceeds 0.001 inch (0.03 mm), the valve is warped. (Through improper handling, it is possible for a new valve to be warped.) Select another valve and repeat steps (1) through (3), above.
(5) If the high spot is at a different place than that in step (2), above, and the run out exceeds 0.001 inch (0.03 mm), the chuck is out of alignment or the valve is improperly installed in the chuck. Correct the misalignment, or consult the equipment manual for proper operation of the equipment.

b. Valves. Reface the intake and exhaust valves as follows:
(1) Adjust the valve refacer chuck head to an exact 30 degree angle for both intake and exhaust valves.
(2) Install the valve in the chuck, start the coolant flow, and wet grind the valve until all face imperfections have been removed.
(3) Check the rim thickness (A, Figure 9-3) of each reground valve. Discard all valves found to have a rim thickness under 0.105 inch (2.67 mm).
(4) Using the V block on the grinding machine, resurface the stem end of the valve.

c. Valve Seats. Refinish the valve seats as follows (see Figure 9-9):
(1) Using grinding kit, ST-685 and 3375946 arbor, refinish the valve seats to an exact 30 degree angle. If necessary, use a coarse stone for rapid metal removal. Final finishing, however, should be done with a fine stone to leave a bright, dean seat.
(2) Using eccentric meter ST-685-4, check the valve seat run out. The valve seats shall be finished to a maximum run out of 0.002 inch (0.05 mm) TIR.
(3) Check the valve seat width (A and B, Figure 9-9). If the valve seat width is over 0.100 inch (2.54 mm), narrow the valve seats in accordance with step d, below.



CROSS-SECTION OF THE VALVE SEAT INSERT

A - MINIMUM VALVE SEAT WIDTH	0.060 INCH (1.52 mm)	
B - MAXIMUM VALVE SEAT WIDTH	0.100 INCH (2.54 mm)	
C - NARROWING AREA		
D - NARROWING AREA		
VALVE SEAT ANGLE		30 DEGREES FROM HORIZONTAL
TOP NARROWING ANGLE		15 DEGREES FROM HORIZONTAL
THROAT NARROWING ANGLE		30 DEGREES FROM VERTICAL
(60 DEGREES INCLUDED)		

Figure 9-9. Cross-Section of Valve Seat Insert

Figure 9-10. Testing of Valve Seating

d. Seating Check. Check each valve for proper seating as follows:
   (1) Using a common lead pencil, mark radial lines on the valve face (A, Figure 9-10).
   (2) Position the valve in the guide against the seat insert.
   (3) Using moderate hand pressure, hold the valve against the seat, rotate it 10 degrees, and remove the valve from the head.
   (4) Visually examine the pencilled lines; a good surface is indicated if all pencilled lines are broken at the approximate center of the valve face (B, Figure 9-10).
   (5) If all pencilled lines are not broken, check the valve grinding equipment for proper adjustment, operation, and stone dressing.
   (6) If the pencilled lines are broken at the inner diameter of the valve face, the seat must be narrowed at area D (Figure 9-9) using a stone dressed to an included angle of 60 degrees. f the pencilled lines are broken at the outer diameter of the face, narrow the seat at area C using a stone dressed to an angle of 15 degrees.
   (7) When properly narrowed, the seat width will be 0.060 to 0.100 inch (1.52 to 2.54 mm), and the pencilled lines will be broken at the approximate center of the valve face.
   (8) Narrowing may be done at both area C and D if necessary. When narrowing at area C, however, take care that grinding does not extend into the head metal and remove the seat insert staking. Removal of the staking metal will result in a loose valve seat insert.

NOTE

Valve sealing surfaces that are properly ground and narrowed on precision equipment should not need lapping to obtain a good seal. If necessary to pass the vacuum test, however, a small amount of lapping is permissible.

e. Valve Installation. Install the intake and exhaust valves as follows (see Figure 9-1).
   (1) Dip the valve stem in dean preservative of MIL-L-21260, and install the exhaust or intake valve (5 or 6) through the guide being careful to keep oil from the valve seat and face.
   (2) Install the valve spring guide (4), valve spring seat (2), and new locks (1). Do not install the spring (3) at this time.
   (3) Pull up on the spring seat (2) and, while pulling on the seat, measure the distance between the spring seat surface of the seat (2) and the valve spring guide (4). This is the valve spring assembled height and should not measure over 2.470 inches (62.74 mm) (see Table 1-4).

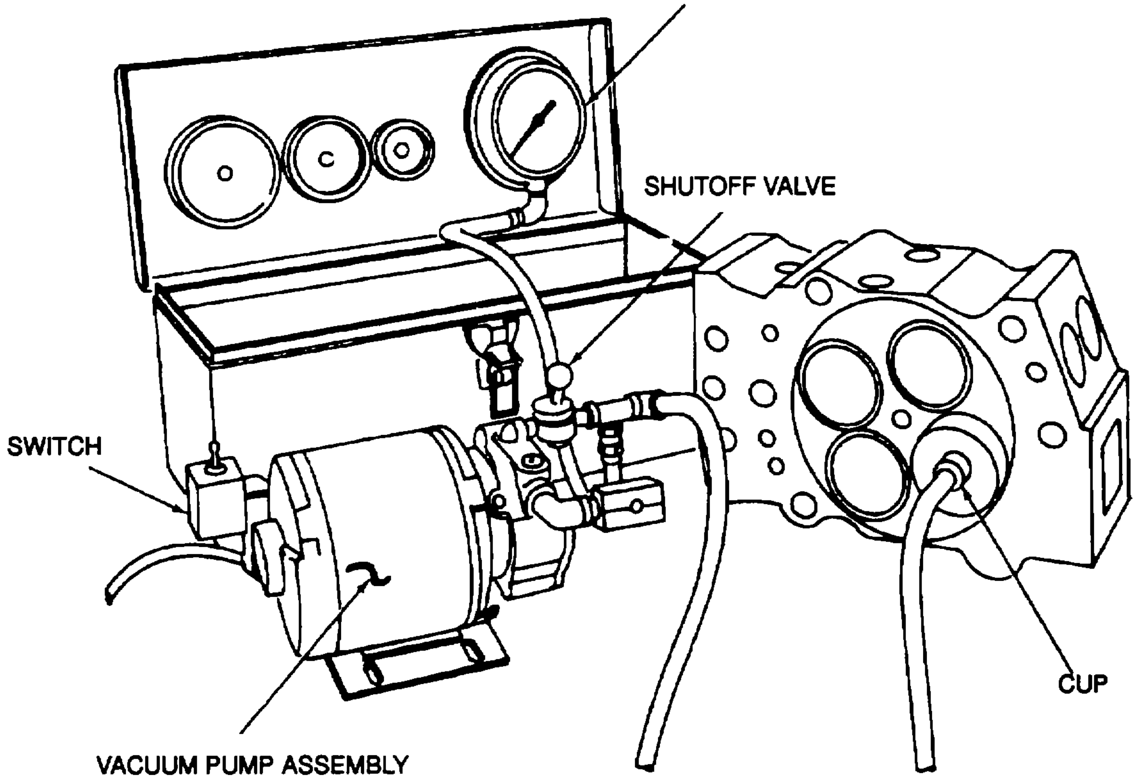


Figure 9-11. Vacuum Testing Valve Seats Using ST-1257

(4) If necessary, add a maximum of two valve spring shims under the valve spring guide (4), to adjust the assembled valve spring height to not over 2.470 inches (62.74 mm).

(5) If the correct valve spring assembled height cannot be obtained with two shims, the valve, the seat insert, or both the valve and the seat insert must be replaced. See paragraph 9-11 for valve seal insert replacement procedures.

(6) Remove locks (1), seats (2), spring (3), and guide (4). Install shims (if necessary), guide (4), spring (3), and seat (2) over valve (5 or 6).

(7) Using valve spring compressor ST-448-6, compress spring (3), and install new locks (1).

(8) Install the remaining valves using steps (1) through (6), above.

f. Vacuum Test. Check for satisfactory valve sealing using valve vacuum tester ST-1 257, as follows (see Figure 9-11):

CAUTION

Never vacuum test a cylinder head with the injectors installed The installation of injectors while the head is removed from the block could cause misalignment to the halves In the valve seat area resulting In leakage during testing. This leakage would not necessarily occur during actual engine operation.

(1) Before testing for valve leakage, check vacuum tester ST-1257, for leaks as follows:

NOTE

Cup number ST-1 257-38 is used for testing both intake and exhaust valves. Use seal ST-1 257-36 for testing exhaust valves, and seal ST-1 257-37 for testing intake valves.

(a) Install the cup on the vacuum hose, coat the seal with petrolatum, VV-P-236, and install it in the cup.
(b) Place the cup on a dean, flat piece of plate glass, turn on the pump, and open the shutoff valve.
(c) When the vacuum gage reaches 1 8 to 25 inches Hg (60.8 to 84.4 kPa), dose the shutoff valve to isolate the gage, hoses, and cup.
(d) If vacuum will not reach 18 to 25 inches Hg (60.8 to 84.4 kPa), or the gage drops after dosing the shutoff valve, leakage in the hoses or fittings is indicated. Repair leaks before combing the test procedure.

(2) Coat the seal with petrolatum VV-P-236, and place the cup over the valve so that the seal rests on the head surface (Figure 9-11).

(3) Operate the vacuum pump to pull a vacuum of 18 to 25 inches Hg (60.8 to 84.4 kPa) over the head of the valve.

(4) Close the shutoff valve, and time the vacuum drop from 18 to 8 inches Hg (60.8 kPa to 27.0 kPa).

(5) If the elapsed time is less than 10 seconds, leakage is indicated. To be sure the valve is seated, tap the stem and of the valve with a soft, light hammer and retest.

(6) If leakage is still indicated, remove the cup, and seal the outer edge of the valve seat insert and cylinder head joint with grease. Repeat the vacuum test (timing will not be necessary).

(7) Remove the cup and examine the grease seal. If breaks in the grease seal are found, leakage is indicated between the valve seat insert and the cylinder head counterbore. Re-stake or replace the valve seat insert in accordance with paragraph 9-11.

(8) If the grease seal is intact, leakage at the valve seat is indicated.

(9) Lap the valve and seat lightly using lapping compound SS-L-1 682, and repeat the timed vacuum test. If leak down still occurs in under 10 seconds, a complete check of reseating equipment and operating procedures should be made; a properly finished seat will hold vacuum for 10 seconds or more.

g. Preservation. If assembled head is to be stored, spray all surfaces with preservative oil MIL-L-21260. While spraying, lift each valve slightly to be sure preservative oil penetrates to the seat area

9-10. CYLINDER HEAD ASSEMBLES INSTALLATION. Install the cylinder heads as follows (see Figure 9-1, Figure 9-2, and Figure 9-12):

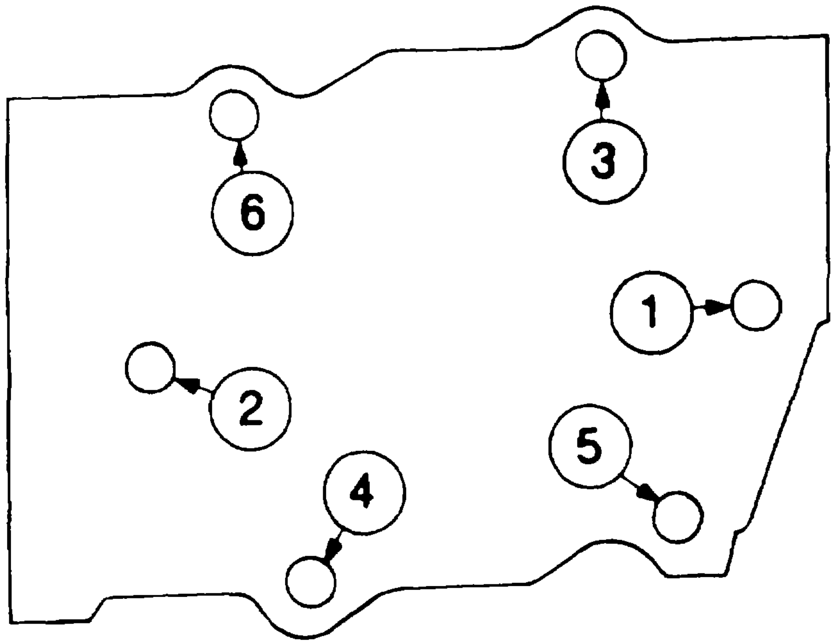
WARNING

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.

CAUTION

To avoid cylinder head leakage, clean all traces of old gaskets and carbon from the cylinder head and cylinder block gasket surfaces. During cleaning, plug all holes In the cylinder block to prevent entrance of dirt. Be especially careful that dirt does not block the orifice In the oil restrictor expansion plug. To avoid false torque readings, clean all capscrews and threaded holes using thread chasers, taps and dies, and compressed air as necessary.

a. Place a new cylinder head gasket (13, Figure 9-1) over the dowel pins in the cylinder block The word TOP must be visible when the gasket is in the installed position.
b. Install four new water seal grommets (14), three new push rod tube grommets (15), one new oil seal grommet (16), and one new cylinder head capscrew grommet (17) in the cylinder head gasket (13).



CYLINDER HEAD CAPSCREW TIGHTENING SEQUENCE

CYLINDER HEAD CAPSCREW TIGHTENING STAGES		
CAPSCREW TYPE	CADMIUM (SILVER OR GOLD)	LUBRICATED (BLACK)
STAGE	TORQUE	
	POUND-FEET (NEWTON METERS)	POUND-FEET (NEWTON METERS)
1. TIGHTEN IN SEQUENCE TO	40 TO 60 (54 TO 81)	40 TO 60 (54 TO 81)
2. TIGHTEN IN SEQUENCE TO	110 TO 130 (149 TO 176)	140 TO 160 (190 TO 217)
3. TIGHTEN IN SEQUENCE TO	180 TO 190 (244 TO 258)	140 TO 160 (325 TO 217)
4. TIGHTEN IN SEQUENCE TO FINAL TORQUE	250 TO 260 (339 TO 353)	350 TO 360 (475 TO 488)

Figure 9-12. Cylinder Head Tightening Procedure

CAUTION

Take care that grommets are not dislodged during cylinder head installation.

NOTE

Cylinder head weight is approximately 63 pounds (28 kg). Two persons may be required to lift cylinder heads.

c. Position the cylinder head over the cylinder, align the dowel pins, and lower the cylinder head into position.

d. Coat the washers (12) and threads of the cylinder head capscrews (11) with anti-seize compound MIL-A-907, and install through the cylinder head (7).

e. Using the sequence shown in Figure 9-12, run each capscrew down until the washer is in contact with the cylinder head and capscrew. Be sure each capscrew turns freely during run-down.

f. Tighten the cylinder head capscrews (11, Figure 9-1) in sequence and in four stages in accordance with Figure 9-12.

g. Coat new packings (23, Figure 9-2) with petrolatum W-P-236, install them in the water transfer tubes (22), and install the tubes in the rocker arm housings (20) so that the retaining ring groove will face toward the rear of the engine for the right bank and toward the front of the engine for the left bank Push the tubes far enough into the housing to allow room for the installation of the next housing (20) on the next cylinder head.

h. Using a new gasket (21), install the rocker arm housing (20), five washers (19), and capscrews (18), capscrew (29), and washer (10). Do not tighten the capscrews fully at this time.

i. Repeat steps a through h, above, for each cylinder head to be installed.

j. Using driver ST-1 319, drive the water transfer tubes (22) into the rocker arm housings (20), and install the retainers (17).

k. Starting at the center of the rocker arm housing (20) cross-tighten the capscrews (1 8) in three stages to a final torque of 60 to 70 pound-feet (81 to 95 newton-meters).

l. Install the push rods in the same holes from which they were removed.

m. Install the fuel injectors in accordance with paragraph 6-18.

n. Install the rocker arms and crossheads as follows: (1) Install adjusting screws (10, Figure 9-1) and locknuts (9) in the valve crossheads (8).

(2) Install the crossheads (8) on the same crosshead guides (24) from which they were removed, and adjust the valve crossheads in accordance with the Operator and Organizational Maintenance Manual.

(3) Install adjusting screws (16, Figure 9-2) in the exhaust rocker arms (12), injector rocker arm (13), and intake rocker arm (14). Install locknuts (15) on the adjusting screws. Do not tighten the locknuts at this time.

(4) Install the rocker arms (12, 13, and 14) on the rocker arm shaft (11), so that the counterbore in the shaft will fit over the ring dowel (24) in the rocker arm housing (20).

(5) Tilt the rocker arms so that the ball-ends of the adjusting screws (16) enter the push rod sockets, and install the assembly so that the counterbore in the shaft (11) fits over the ring dowel (24).

(6) Check to be certain that the ball-ends of the adjusting screws (16) remain in the push rod sockets; adjust the screws (1 6), if necessary, to keep the ball-ends in the sockets.

(7) Using washers (10), install capscrews (8 and 9) through the shaft (11) into the rocker arm housing (20).

(8) Cross-tighten capscrews (8 and 9) in three stages to a final torque of 60 to 70 pound-feet (81 to 95 newton-meters).

(9) Adjust the injector travel and rocker arm clearance in accordance with the Operator and Organizational Maintenance Manual.

(10) Using a new gasket (7), install the rocker arm cover (6) with plain washers (2), capscrew and lockwasher (1), two lockwashers (4), two plain washers (5), and hexagon head capscrews (3).

(11) Cross-tighten the capscrews and lockwashers (1) and hexagon head screws (3) in three stages to a final torque of 30 to 35 pound-feet (41 to 47 newton-meters).

o. Install the fuel manifolds in accordance with paragraph 6-26.

p. Install the intake manifolds in accordance with paragraph 943.

q. install the exhaust manifolds in accordance with paragraph 9-44.

r. Install the aftercooler in accordance with paragraph 9-42.

s. Install the turbochargers in accordance with the Operator and Organizational Maintenance Manual.

t. Install the thermostat housing assembly in accordance with the Operator and Organizational Maintenance Manual.

u. Install the water filter mounting heads in accordance with the Operator and Organizational Maintenance Manual.

v. Fill the cooling system in accordance with the Operator and Organizational Maintenance Manual.

9-11. CYLINDER HEAD ASSEMBLES OVERHAUL. Overhaul of the cylinder heads consists of the disassembly cleaning, inspection, and repair operations covered in paragraphs 96, 9-7, 9-8, and 9-9, and the following operations.

a. Remove the pipe plugs (19 and 20, Figure 9-1) from each cylinder head.

b. Remove the ten expansion plugs (21 and 22) from each cylinder head by driving a hole through each plug with a sharp punch, then pry out the plug using the punch.

c. If the dowels (22) are damaged, or if it is necessary to resurface the head, remove the dowels using puller ST-1134.

WARNING

Adds used for cleaning purposes are highly toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection Is required. Keep a base solution such as sodium bicarbonate at hand to neutralize acid spills.

d. Clean rust and scale from the water jacket passages using an acid bath and inhibited hydrochloric acid MIL-H-1 3528. After the rust and scale is removed, neutralize the acid using sodium bicarbonate solution, flush with water and spray with preservative oil MIL-L-21260 to prevent rusting.

e. If the valve crosshead guide dimension (B, Figure 9-8) is less than 0.433 inch (11.00 mm), remove the guides using puller ST-1134.

f. Loose valve seat inserts may be tightened in accordance with the instructions given below for valve seat insert installation.

g. If the valve stem guide dimension (C, Figure 9-8) is over 0.4980 inch (12.649 mm), drive out the guides from the valve seat side of the head using a valve guide punch having a pilot diameter of 0.495 inch (12.57 mm), and a driving diameter of 0.830 inch (21.08 mm).

h. If the valve seats (26, Figure 9-1) are to be replaced, or the cylinder heads are to be resurfaced, remove the valve seats and air deflector plates (27) using extractor ST-1 323.

i. Repair of Eroded Water Holes.

(1) Fabricate a sleeve from copper tubing that will restore the eroded hole to its original inside diameter. Cut the tubing for the sleeve approximately 0.5 inch (13 mm) long and measure the outside diameter with a micrometer caliper.

(2) Using ST-1010. bore and ream the eroded hole 0.002 to 0.005 inch (0.05 to 0.13 mm) smaller than the sleeve.

(3) Coat the sleeve with sealant MIL-S-45180, Type I1l, and install it in the hole using a bushing driver and hammer.

(4) Being careful not to damage the gasket surface, file the sleeve flush with the head surface using a flat mill file.

j. Resurfacing. To restore a damaged gasket surface, resurface the cylinder head. Up to 0.040 inch (1.02 mm) stock may be removed, provided a minimum head thickness of 4.715 inches (119.76 mm) is preserved. Resurface a cylinder head as follows: (1) Measure the cylinder head thickness using a micrometer caliper, or a surface plate and vemier depth gage. Record this measurement for future reference.

(2) Using a cylinder head grinder to specification MILL-4851, remove sufficient stock to restore the gasket surface.

The finished gasket surface shall have a finish of 125 micro inch (3.18 micrometer) RMS.

(3) Measure the head thickness as in step (1), above. If the minimum head thickness is less than 4.715 inches (119.76 mm), replace the head.

(4) Subtract the measurement obtained in step (3), above, from the measurement obtained in step (1), above. This amount of stock must be removed from the valve seat counterbore depth before installing new valve seat inserts. Also, 1 or 2 valve spring shims equaling the amount of stock removed should be used under the valve spring guide (4, Figure 9-1) at valve installation.

k. Valve Guides. If removed, install new valve guides as follows (see Figure 9-1 and Figure 9-8):

(1) Install new valve guides (25, Figure 9-1) from the rocker arm side of the head. I the new guides have tapered tops, use valve guide driver ST-1 265; if the new guides have flat tops, use valve guide driver ST1315. ST-1 265 and ST-1315 will install the guide to the correct depth. If these special tools are not available, use a standard valve guide driver having a pilot diameter of 0.495 inch (12.57 mm) and install the guide to dimension D, Figure 9-8.

(2) Check the valve fit in the new guide. If the valve will not enter the guide freely, use a floating head remaining fixture, i and ream the guide to a bore diameter of 0.4972 to 0.4980 inch (12.629 to 12.649 mm).

(3) If the valve seats have not been removed, refinish the valve seats in accordance with paragraph 9-9.

l. Valve Seats. H removed, install new valve seats as follows:

(1) Select new oversize valve seats (26, Figure 9-1) from Table 9-2 that will allow tight installation with a minimum of counterbore stock removal from the standard or resurfaced head.

(2) Using a micrometer caliper, measure and record the thickness and outside diameter of the new seats.

(3) Select the correct oversize cutter ST-1 310, for the oversize seats selected.

(4) Using cutter ST-1 310, arbor 3375946, and insert tool kit ST-257, cut the counterbore to the correct diameter.

(5) Cut the counterbore depth 0.006 to 0.010 inch (0.15 to 0.25 mm) deeper than the valve seat thickness for exhaust counterbore and the combined thickness of the valve seat and the air deflector plate (27) for intake counterbores.

(6) If the head surface was machined, deepen the counterbore an additional amount equal to the amount of metal that was removed from the head surface.

(7) Upon reaching the proper depth, allow the cutter to dwell for several revolutions. This will ensure a smooth. flat seating surface.

Table 9-2. Valve Seat Insert Selection

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

OVERSIZE VALVE SEAT INSERT PART NO.	OVERSIZE DIAMETER INCH (mm)	DEPTH INCH (mm)
205945	0.005 (0.13)	Std.
205981	0.010 (0.25)	Std.
205982	0.020 (0.50)	0.005 (0.13)
205983	0.030 (0.76)	0.010 (0.25)
205984	0.040 (1.02)	0.015 (0.38)

CAUTION

Do not over-stake the head metal when installing the valve seats (26). Stake only enough to seat and retain the valve seat. Over-staking will cause head cracking.

NOTE

In the following step, use air deflector plates (27) under the intake valve seats only. Deflector plates are not used under the exhaust valve seats.

(8) Install the air deflector plates (27) under the intake valve seats only. Install the valve seats (26) with the chamfered side up. Using driver ST-1122 and staking tool ST-1288, seat and stake the valve seats in place. If the staking tool is not available, a punch having a radius of 0.250 inch (6.35 mm) may be used to peen the head metal over the chamfer on the valve seat.

(9) Refinish the valve seats in accordance with paragraph 9-9.

m. Crosshead Guides. Using spacer ST-1264, press new crosshead guides (24, Figure 9-1) into the head. If spacer ST-1264 is not available, press new crosshead guides into the head to dimension A, Figure 9-8, being careful that crosshead guides are not bent during installation.

n. Install pipe plugs (19 and 20, Figure 9-1) using sealant MIL-S-45180, Type III. Install expansion plugs (21 and 22) in accordance with paragraph 2-10.

o. Recondition the valves in accordance with paragraph 9-9.

p. Inspect and test the valve springs in accordance with paragraph 9-9.

q. Check the seating, and install the valves and springs in accordance with paragraph 9-9.

r. Vacuum test the valve sealing in accordance with paragraph 9-9.

9-12. INTAKE AND EXHAUST VALVES MAINTENANCE.

a. Inspect.

(1) Remove the fuel injectors in accordance with paragraph 6-13.

(2) Insert a flexible borescope through the injector port and inspect the intake and exhaust valves for evidence of erosion and burning. Repair or replace defective valves as necessary.

(3) Install the fuel injectors in accordance with paragraph 6-18.

b. Remove.

(1) Remove the cylinder heads in accordance with paragraph 9-5.

(2) Remove the intake and exhaust valves in accordance with paragraph 9-6.

c. Repair. Repair the intake and exhaust valves in accordance with paragraph 9-9.

d. Install.

(1) Install the intake and exhaust valves in accordance with paragraph 9-9.

(2) Install the cylinder heads in accordance with paragraph 9-10.

9-13. ROCKER ARM AND CROSSHEAD MAINTENANCE.

a. Remove. Remove the valve covers, rocker arms, crossheads, and rocker arm housings in accordance with paragraph 9-5.

WARNING

Dry cleaning solvent PD680, Type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid injury to personnel.

WARNING

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.

b. Clean. Clean all parts in dry cleaning solvent PD-680, Type III, or equivalent, and blow dry with compressed air.

c. Inspect. (See Figure 9-1 and Figure 9-2.)

(1) Inspect all capscrews for damaged or stripped threads.

(2) Inspect the adjusting screws (16, Figure 9-2) and locknuts (15) for damaged or stripped threads.

(3) Inspect the ball-ends of the adjusting screws (16) using a 0.250 inch (6.35 mm) radius gage, or check the fit of the ball-end in a new push rod using Prussian blue compound. Ball-ends and socket seats shall show a seating area of at least 80 percent.

(4) Inspect the injector rocker arm ball socket seat (26) for a true fit on the injector link using Prussian blue compound and a new injector link Ball socket seat shall show a seating area of at least 80 percent.

(5) Inspect the intake and exhaust rocker arms (12 and 14) for wear, scoring, or galling at the crosshead contact surfaces.

(6) Using a small hole gage, or inside micrometer, check the rocker arm bushings (27 and 28) for wear. Maximum diameter shall be in accordance with Table 1-4.

(7) Inspect the rocker arm shaft (11) for scoring. Depth of scoring shall not exceed 0.003 inch (0.08 mm).

(8) Using a micrometer caliper, check the diameter of the rocker arm shaft (11). Minimum diameter shall be in accordance with Table 1 4.

(9) Inspect the rocker am is (12, 13, and 14) adjusting screw holes for worn or stripped threads.

(10) Inspect the valve crosshead adjusting screws (10, Figure 9-1) and nuts (9) for damaged or stripped threads, and for adjusting screw wear on the valve contact face.

(11) Inspect the valve crossheads (8) for thread damage, wear in the rocker arm contact area, and wear in the valve contact area.

(12) Using a small hole gage, check the crosshead guide hole for wear. Maximum diameter shall be in accordance with Table 1-4.

(13) Inspect the crossheads (8), rocker arm shaft (11, Figure 9-2), and rocker arms (12,13, and 14) using fluorescent magnetic particle inspection in accordance with MIL-1-6868. No defects are permitted.

(14) Inspect the rocker arm housing (20) and rocker arm cover (6) for stripped threads, cracks, and for nicks or dents in the gasket and packing sealing areas. Replace the ring dowel (24) if defective.

(15) Inspect the retainers (17) for distortion and cracks. Replace defective retainers.

(16) Inspect the water transfer tubes (22) for cracks, out-of-round, and corrosion. Pay particular attention to the packing grooves for corrosion that would interfere with proper sealing. Replace any defective tubes.

(17) Repair or replace the defective parts in accordance with step d, below.

d. Repair.

(1) Using a thin, sharp punch, remove the cup plug (25, Figure 9-2) from the rocker arm shaft (11).

WARNING

Dry cleaning solvent PD-680, Type III, or equivalent, is flammable, and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

WARNING

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.

(2) Flush the bore of the rocker arm shaft (11) thoroughly with dry cleaning solvent, PD-680, Type III, or equivalent, and blow dry with compressed air.

(3) Using a 0.156 inch (3.96 mm) diameter pin punch, install a new cup plug (25) in the rocker arm shaft (11).

(4) If worn beyond the limits given in Table 1-4, replace the bushings (27 and 28) in the rocker arms (12, 13, and 14) using mandrel ST-1 284 and an arbor press.

(5) Remove minor scoring or wear damage to the crosshead contact surface of the rocker arms (12 and 14) by grinding to the original contour using ST-684 or equivalent. After grinding, dean thoroughly and be sure the oil passage hole in the contact surface is not obstructed.

(6) Replace worn injector lever socket seats (26) as follows:

(a) Drill a 0.125 inch (3.2 mm) hole through the injector rocker arm (1 3) centered on and above the socket seats (26). Drive out the socket using a suitable pin punch.

(b) Remove all chips and burrs caused by drilling, and plug the hole drilled in the injector rocker arm (13) using a blind pull rivet MS20600-AD4W2.

(c) Install a new ball socket seat (26) in the injector rocker arm (13) using a soft drift and hammer. Be sure the socket seat is firmly seated.

(7) Replace all worn adjusting screws (16) and nuts (15).

(8) Remove minor defects in gasket surfaces of the rocker arm housing (20) using a flat mill file. Discard the housing for all other defects.

(9) Replace worn adjusting screws (10, Figure 9-1) and nuts (9) in the crossheads (8). Discard the crossheads for all other defects.

e. Replace. Replace the rocker arm housings, crossheads, rocker arms, and valve covers in accordance with paragraph 9-10.

9-14. PUSH RODS AND FOLLOWERS MAINTENANCE.

a. Inspect. (See Figure 9-13.)

(1) Remove the cam follower covers in accordance with step b, below.

(2) Rotate the engine to line up one set of valve set marks, and rotate push rods (1 and 2) by hand while feeling for roughness, and visually checking for push rod runout. Runout shall not exceed 0.025 inch (0.64 mm).

(3) Rock the cam followers (12 and 13) from side-to-side while feeling for excess play between the cam followers and shaft (14). Clearance shall not exceed 0.004 inch (0.10 mm).

(4) Rotate the cam follower rollers (18 and 20), and visually inspect for wear, scoring, galling, flaking, or chipping.

NOTE

If galling, flaking, or chipping of the rollers is noted, the mating camshaft lobe should be carefully inspected in accordance with paragraph 9-15.

(5) Rotate the cam follower rollers (18 and 20) and check for binding, excessive clearance between the rollers and pins (17 and 19), and excessive side clearance. The clearance between the rollers and pins shall not exceed 0.008 inch (0.20 mm), and side clearance shall not exceed 0.024 inch (0.61 mm).

(6) Visually inspect the followers (12 and 13) for cracks.

(7) Repeat steps (2) through (6), above, for each cylinder.

(8) Replace all defective parts in accordance with steps b through d, below.

b. Remove. (See Figure 9-13.)

(1) Separate fuel block connections (13, Figure 6-35) from brackets (16) by removing hexagon head capscrews (11) and lockwashers (12).

(2) Remove the rocker arms in accordance with paragraph 9-5. Match-mark and withdraw the push rods (1 and 2, Figure 9-13) from the cylinder head bores.

(3) Remove the capscrews (3 and 4), lockwashers (5), flat washer (6), and remove the cover (7) and gasket (8).Discard the gasket.

(4) Match-mark the shaft (14) to the cylinder number, remove the capscrews (9), flat washers (6), and the follower and shaft assembly.

(5) If damaged, remove the bushings (10) from the cylinder block (6) Match-mark the followers (12 and 13) to the cam follower shaft (14), remove the retaining rings (11), and remove the followers from the shaft. Discard the retaining rings.

(7) Remove the cup plugs (15) from the cam follower shaft (14), and discard the plugs.

(8) Remove the roll pins (1 6), press out the cam follower pin (17 or 1 9), and remove the cam follower rollers (18 or 20).

c. Inspect and Repair. (See Figure 9-13 and Figure 9-14).

WARNING

Dry cleaning solvent PD-0, Type Ill, or equivalent, Is flammable, and moderately toxic to the skin, eyes, and respiratory tract Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

WARNING

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.

(1) Clean all parts in dry cleaning solvent PD-480, Type II, or equivalent, and blow dry with compressed air.

(2) Check for bent push rods (1 and 2, Figure 9-13) using V blocks and a dial indicator. Replace push rods that exceed 0.063 inch (1.60 mm) TIR. Using an arbor press and V-block straighten acceptable push rods to within 0.025 inch (0.64 mm) TIR.

(3) Check the ball-ends of the push rods for wear using Prussian blue compound and a new socket (21). Replace the push rods if the blueing patten does not show in at least 80 percent of the socket area.

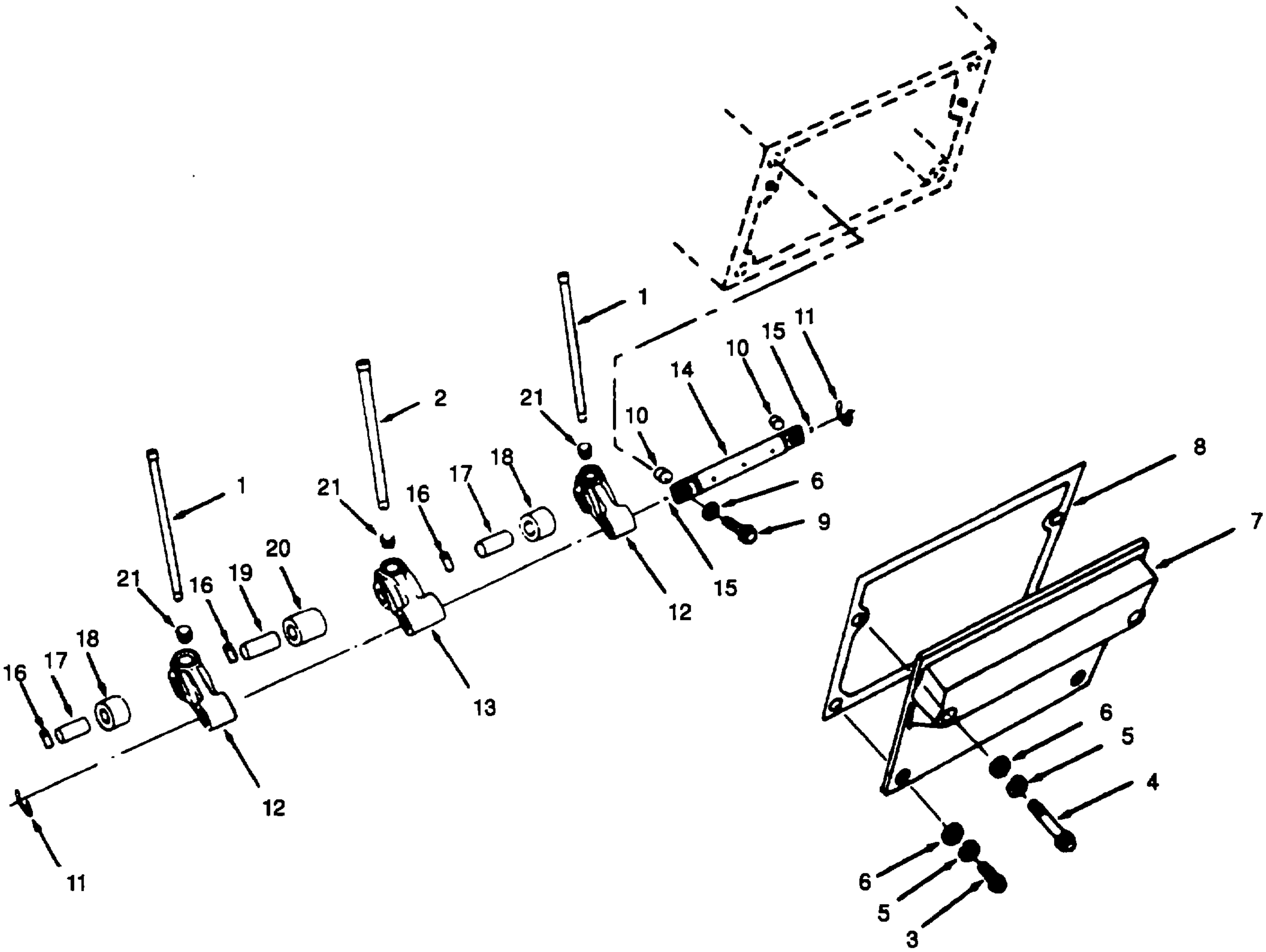
(4) Check the socket ends of the push rods for wear using Prussian blue compound and a new rocker arm adjusting screw (16, Figure 9-2). Replace the push rods if the blueing pattern does not show in at least 80 percent of the socket area.

(5) Check the cam follower shafts (1 4, Figure 9-13) for cracks and surface imperfections using fluorescent magnetic inspection in accordance with MIL-1-6868. Replace any follower shafts that are defective.

(6) Check the follower shafts (1 4) for coring and grooving. Replace any shaft scored or grooved over 0.002 inch (0.05 mm) in depth.

(7) Check the outside diameter of the cam follower shafts (1 4) for wear and out-of-round. Replace the shafts if the minimum diameter is not in accordance with Table 1 -4.

(8) Check the followers (12 and 13) for cracks in accordance with step (5), above. Replace any followers that are defective.



1. PUSH ROD (ENGINE POPPET)
2. PUSH ROD (INJECTOR)
3. CAPSCREW
4. CAPSCREW
5. LOCKWASHER
6. FLAT WASHER
7. COVER
8. GASKET
9. CAPSCREW
10. BUSHING
11. RETAINING RING
12. FOLLOWER (CAM VALVES)
13. FOLLOWER (INJECTOR CAM)
14. SHAFT
15. CUP PLUG
16. ROLL PIN
17. PIN
18. ROLLER
19. PIN
20. ROLLER
21. SOCKET

Figure 9-13. Removal and Replacement of Push Rods and Followers

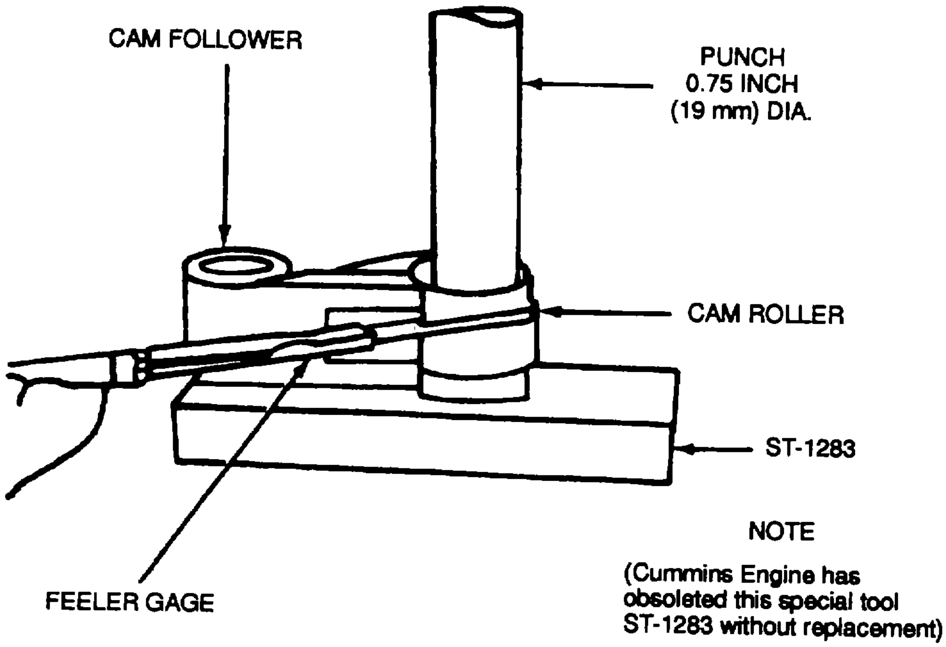


Figure 9-14. Removing and Installing Cam Rollers and Pins

(9) Check the shaft bore of the follower (12 or 13) for scoring and galling. Replace any follower scored over 0.002 inch (0.05 mm) in depth.

(10) Check the inside diameter of the shaft hole in the follower (12 or 13) for wear and out-of-round. Replace the follower if the maximum diameter of the shaft hole is not in accordance with Table 1-4.

(11) Check the rollers (18 or 20) for galling, flaking, or chipping at the outer edges of the rollers. Replace the rollers for any imperfections noted.

NOTE

If galling, flaking, or chipping of the rollers is noted, the mating camshaft lobe should be carefully inspected in accordance with paragraph 9-15.

(12) Check the outside diameter of the rollers (18 or 20) for wear and out-of-round. Replace the roller if the diameter is not in accordance with Table 1-4.

(13) Measure and record the diameter inside of the rollers (18 or 20). Maximum diameter shall be in accordance with Table 1-4. Out-of-round shall be within 0.002 inch (0.05 mm).

(14) Check the pins (17 and 19) for scoring. Replace the pins if scored deeper than 0.002 inch (0.05 mm).

(15) Measure and record the diameter of the pins (17 and 19). Minimum diameter shall be in accordance with Table 1-4. Out-of-round shall be within 0.003 inch (0.08 mm). Replace undersize and out-of-round pins.

(16) Subtract the measurement obtained in step (15), above, from that obtained in step (13), above; this is the roller-to-pin clearance.

(17) It the roller-to-pin clearance exceeds 0.0045 inch (0.114 mm), replace the pins (17 or 19), rollers (18 or 20), or replace both pins and rollers as necessary to obtain a clearance of 0.0030 to 0.0045 inch (0.076 to 0.114 mm).

(18) Check the roller-to-follower side clearance. Replace the roller or follower, or both roller and follower, if the side clearance exceeds 0.024 inch (0.61 mm).

(19) Check the cam follower sockets (21) for wear using a new push rod (1 or 2) and Prussian blue compound. The blueing pattern shall show in at least 80 percent of the socket area.

(20) Replace worn cam follower sockets (21) by pressing out the old socket. Press in a new socket being sure that the socket seats in the bore of the cam follower (12 or 13).

(21) Inspect the cover (7) for cracks, warping, or damaged gasket surface. Remove slight warping or imperfections using a flat mill file. Replace the cover if it is cracked.

NOTE

Cummins Engine has obsolete this special tool ST-1283 without replacement.

(22) Install the rollers (18 or 20) in the cam follower (12 or 13) using an arbor press and roller pin block ST-1283 as follows: (a) Position the cam follower (12 or 13), rollers (18 or 20), and pin (17 or 19) in ST-1 283 under the ram of the press.

(b) Carefully align the roll pin hole and lubrication hole of the pin (17 or 19) with the holes in the follower (12 or 13).

(c) Insert a 0.010 inch (0.26 mm) feeler gage between the follower (12 or 13) and roller (18 or 20) as shown in Figure 9-14. Do not allow the feeler gage to extend over the shaft hole in the follower.

(d) Being careful to align the roller (18 or 20) with the pin, press the pin (17 or 19, Figure 9-13) into the follower (12 or 13) until the roll pin hole is aligned with the hole in the follower.

(e) Remove the feeler gage and check the side clearance. The side clearance shall be 0.009 to 0.024 inch (0.23 to 0.61 mm).

(f) Install the roll pin (16) through the follower (12 or 13) and pin (17 or 19).

(23) Install new cup plugs (15) in the cam follower shafts (14) using a 0.125 inch (3.18 mm) pin punch and arbor press.

CAUTION

When assembling the followers (12 and 13) to the shaft (14), be sure that the elongated capscrew hole In the shaft will face the front of the engine when Installed. The elongated hole allows passage of lubricating oil. Severe damage will result from running the engine with an Improperly Installed shaft.

(24) Using new retaining rings (11), assemble the followers (12 and 13) to the shaft (1 4), observing the match-mark made before disassembly.

(25) Check the capscrews (3, 4, and 9) for stripped or damaged threads. Replace damaged or stripped capscrews.

(26) Inspect the slot in each capscrew (9) for distortion due to overtightening. Replace the capscrews if the slots are distorted.

d. Install.

(1) If removed, install bushings (10, Figure 9-13) in the cylinder block.

CAUTION

Be sure the elongated capscrew hole In the shaft (14) faces the front of engine when the shaft Is Installed. The elongated hole allows passage of lubricating oil. Severe damage will result from running the engine with an Improperly Installed shaft.

(2) Observing the match-marks made during removal (the elongated hole in the shaft (14) must face the front of the engine), position the follower assembly on the bushings (10).

(3) Using flat washers (6), install capscrews (9), and tighten to 29 to 31 pound-feet (39 to 42 newton-meters).

(4) Observing the match-marks, install the push rods (1 and 2) taking care that the ball-end of the push rods are properly seated in the sockets (21).

(5) Install the rocker arms in accordance with paragraph 9-10.

(6) Using a new gasket (8), position the follower cover (7) to the cylinder block, and install flat washers (6), lockwashers (5), and capscrews (3 and 4). Cross-tighten the capscrews to a final torque of 30 to 35 pound-feet (41 to 47 newton-meters).

SECTION III. MAINTENANCE OF CAMSHAFTS, BUSHINGS, AND COVER GEARS

9-15. CAMSHAFTS AND GEARS MAINTENANCE

a. Inspect. The camshaft lobes can be inspected without removing the camshaft from the engine. Inspect the camshaft lobes as follows:

(1) Remove the push rods and followers in accordance with paragraph 9-14.

(2) While slowly rotating the engine, visually inspect the camshaft lobes for scoring, flaking, chipping, and abnormal wear.

(3) If the camshaft lobes are scored over 0.0002 inch (0.005 mm) deep, or show flaking, chipping, or abnormal wear, replace the camshaft.

b. Remove. Remove the camshafts as follows (see Figure 9-15):

(1) Remove the radiator in accordance with the Operator and Organizational Maintenance Manual.

(2) Remove the front engine support in accordance with paragraph 9-36.

(3) Remove the timing gear cover in accordance with paragraph 9-18.

(4) Remove the rocker arms in accordance with paragraph 9-5.

(5) Remove the push rods and followers in accordance with paragraph 9-14.

(6) Check the timing gear backlash and end play in accordance with paragraph 9-18 to determine if further repair or replacement is necessary.

NOTE

If only one camshaft or camshaft gear is to be remove, match-mark the camshaft gear and cam idler gear prior to removal.

NOTE

If the camshaft and gears are to be reinstalled without replacement, omit the following step (7).

(7) Using puller kit 3376400, remove the camshaft gears (29 and 30, Figure 9-15) and keys (31), if damaged.

(8) If the gears have been removed in step NO TAG, above, straighten the tab on the lock-plates (24), remove the capscrews (25) and remove the thrust plates (32). Discard the lock-plates.

(9) Remove the capscrews (19), washers (20), lockwashers (21), and remove the rear camshaft covers (22). Remove and discard the gaskets (23).

(10) Install the camshaft pilot ST-1313 on the rear of the camshaft.

CAUTION

To avoid scoring the camshaft bushings during camshaft removal or installation, the services of two technicians are required.

(11) With a second technician to observe and support the rear of the camshafts (26 and 27), carefully rotate and withdraw the camshaft. During removal, do not allow the front of the camshaft to drop, and take care that the camshaft lobes do not score the bushings.

(12) Remove the camshaft pilot ST-1313 from the rear of the camshaft.

(13) Remove the other camshaft by repeating steps (9) through (12), above.

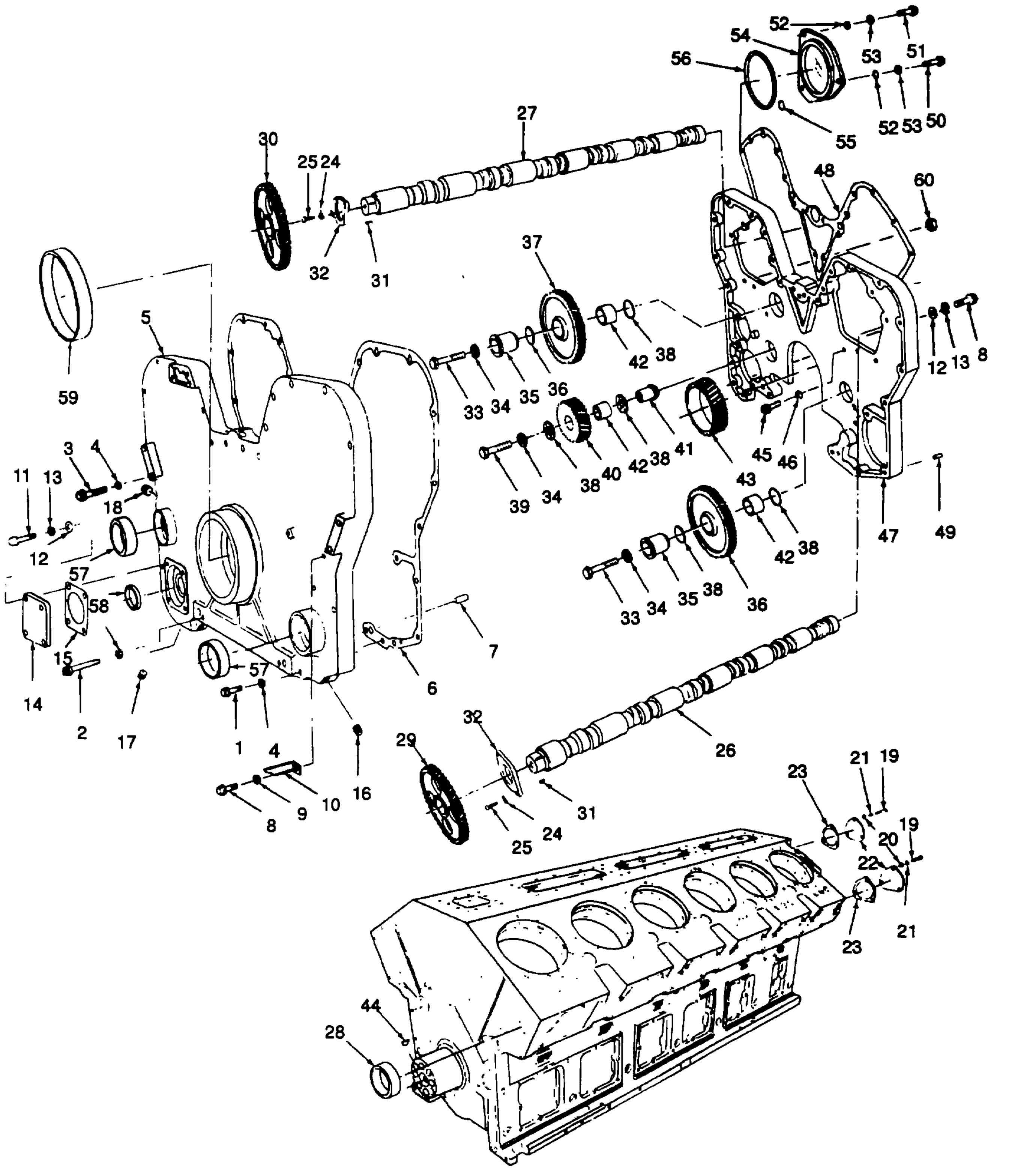


Figure 9-15. Removal and Installation of Camshafts, Bushings, and Timing Gears (Sheet 1 of 2)

1. HEXAGON HEAD SCREW
2. CAPSCREW
3. CAPSCREW
4. LOCKWASHER
5. COVER
6. GASKET
7. DOWEL
8. CAPSCREW
9. LOCKWASHER
10. TIMING POINTER
11. CAPSCREW
12. WASHER
13. LOCKWASHER
14. HOLE COVER
15. GASKET
16. PIPE PLUG
17. PIPE PLUG
18. PIPE PLUG
19. CAPSCREW
20. WASHER
21. LOCKWASHER
22. REAR CAMSHAFT COVER
23. GASKET
24. LOCK-PLATE
25. CAPSCREW
26. LEFT BANK CAMSHAFT
27. RIGHT BANK CAMSHAFT
28. CAMSHAFT BUSHING
29. LEFT BANK CAMSHAFT GEAR
30. RIGHT BANK CAMSHAFT GEAR
31. KEY
32. THRUST PLATE
33. BOLT
34. WASHER
35. SHAFT
36. IDLER GEAR
37. IDLER GEAR
38. THRUSTWASHER
39. CAPSCREW
40. WATER PUMP IDLER GEAR
41. SHAFT
42. BUSHING
43. CRANKSHAFT GEAR
44. KEY
45. CAPSCREW
46. LOCKWASHER
47. HOUSING
48. GASKET
49. DOWEL
50. CAPSCREW
51. CAPSCREW
52. WASHER
53. LOCKWASHER
54. HOLE COVER
55. PACKING
56. PACKING
57. BUSHING
58. BUSHING
59. TRUNNION SLEEVE
60. HEXAGONAL NUT

Figure 9-15. Removal and Installation of Camshafts, Bushings, and Timing Gears (Sheet 2 of 2)

c. Inspect and Repair.

WARNING

Dry cleaning solvent PD-680, Type III, or equivalent, is flammable, and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

WARNING

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.

(1) Clean all parts with dry cleaning solvent PD-680, Type III, or equivalent, and blow dry with compressed air.

(2) Check the camshaft journals and lobes for scoring, flaking, and chipping.

(3) Check the journal diameter for wear and out-of-round. Minimum journal diameter shall be in accordance with Table 1-4. Maximum permissible out-of-round is 0.002 inch (0.05 mm). Replace the camshaft if it is worn or out-of-round beyond the permissible limits.

(4) Inspect the camshafts using magnetic particle examination in accordance with MIL-1-6868. No defects are permitted. Replace the camshaft if it is defective.

(5) Check the camshaft thrust plates (32) for scoring. Replace the thrust plates if scored deeper than 0.0003 inch (0.008 mm).

(6) Measure the thickness of the camshaft thrust plates (32). Replace if the minimum thickness is not in accordance with Table 1-4.

(7) Inspect the camshaft gears in accordance with paragraphs 9-17 and 9-18.

(8) Inspect the camshaft bushings and replace as necessary in accordance with paragraph 9-16.

(9) Inspect the timing gear cover in accordance with paragraph 9-17.

(10) Check all threaded fasteners and holes for stripping and thread damage. Replace threaded fasteners that are stripped. Repair minor thread damage by chasing. Repair stripped holes in accordance with paragraph 2-12.

d. Install.

WARNING

Insulated gloves are required to avoid bums when handling heated parts.

(1) If removed, heat the left or right bank camshaft gear (29 or 30, Figure 9-15) at 400*F (204"C) for 1 hour in a preheated oven.

(2) Support the right or left bank camshaft (26 or 27) in a press, coat the camshaft gear hub and thrust plate (32) with anti-seize compound MIL-A-907, and install the thrust plate of the camshaft so that the grooved side of the thrust plate will face the gear.

(3) Install the key (31) in the camshaft (26 or 27). If a new key is used, be sure it is the same part number as the old key.

(4) Press the hot gear on the shaft until it is seated against the shoulder. Maintain a slight pressure on the gear until it cools.

(5) Rotate the engine and align the timing marks on the crankshaft and idler gears (1, 2, 3, and 6, Figure 9-16).

(6) Install the camshaft pilot ST-1 313 on the rear of the camshaft.

(7) Lubricate the camshaft lobes, journals, and thrust plate with lubricating oil MIL-L-2104.

(8) With a second technician to observe and support the rear of the camshaft (26 or 27, Figure 9-15) carefully insert the camshaft. Support the front of the camshaft while inserting, and take care that the camshaft lobes do not score the camshaft bushings.

NOTE

Rotating the camshaft back and forth will aid installation.

(9) Before meshing the camshaft gear with the idler gear, rotate the camshaft to align the timing marks as shown in Figure 9-16.

(10) Using new lock-plates (24, Figure 9-15), install the thrust plate capscrews (25), and tighten to 30 to 35 pound-feet (41 to 47 newton-meters). Bend the tabs on the lock-plates to secure the capscrews.

(11) Remove the camshaft pilot ST-1 313 from the rear of the camshaft.

(12) Install the other camshaft by repeating steps (1) through (11), above.

(13) Check the gear backlash and camshaft end clearance in accordance with paragraph 9-18.

(14) If the backlash or end clearance is unsatisfactory, replace the gears or thrust washers in accordance with paragraph 9-18.

(15) If a new camshaft has been installed, check the injector timing in accordance with paragraph 9-18.

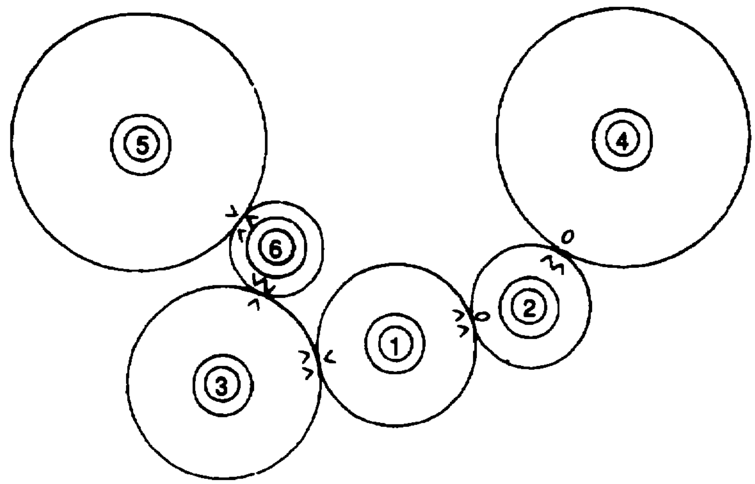
(16) If the injector timing is incorrect, install one of the optional camshaft keys in accordance with paragraph 9-18.

(17) Using new gaskets (23, Figure 9-15), install the rear camshaft covers (22), plain washers (20), lockwashers (21), and capscrews (19). Tighten the capscrews to 30 to 35 pound-feet (41 to 47 newton-meters).

(18) Install the push rods and followers in accordance with paragraph 9-14.

(19) Install the rocker arms in accordance with paragraph 9-10.

(20) Install the timing gear cover in accordance with paragraph 9-18.



REF NO.	PART NAME	BACKLASH* INCHES (mm)	END CLEARANCE*
1	CRANKSHAFT		0.005 TO 0.015 (0.13 TO 0.38)
2	LB CAM IDLER GEAR	0.0003 TO 0.012 (0.076 TO 0.30)	0.005 TO 0.011 (0.13 TO 0.28)
3	WATER PUMP IDLER GEAR	0.0003 TO 0.012 (0.076 TO 0.30)	0.005 TO 0.011 (0.13 TO 0.28)
4	LB CAMSHAFT GEAR	0.003 TO 0.012 (0.076 TO 0.30)	0.006 TO 0.013 (0.15 TO 0.33)
5	RB CAMSHAFT GEAR	0.003 TO 0.012 (0.076 TO 0.30)	0.006 TO 0.013 (0.15 TO 0.33)
6	RB CAM IDLER GEAR	0.003 TO 0.012 (0.076 TO 0.30)	0.005 TO 0.011 (0.13 TO 0.28)

***DIMENSIONS ARE MANUFACTURING TOLERANCES, REFER TO TEXT FOR WORN LIMITS.**

Figure 9-16. Installation of Timing Gears

(21) Install the front engine support in accordance with paragraph 9-36.

(22) Install the radiator in accordance with the Operator and Organizational Maintenance Manual.

CAUTION

Serious engine damage will result If the engine Is started before the lubrication system Is properly filled and primed. Elapsed time between priming the lubrication system and starting the engine shall not exceed 3 hours If, for whatever reason, the engine cannot be started within 3 hours after priming the lubrication system, repeat the entire priming procedure just prior to starting the engine.

(23) Before starting the engine, fill and prime the lubrication system in accordance with the Operator and Organizational Maintenance Manual.

9-16. CAMSHAFT BUSHINGS REPLACEMENT.

a. Inspect

(1) Remove the camshafts in accordance with paragraph 9-15.

(2) Visually inspect the camshaft bushings for burning, flaking, galling, grooving, pitting, or scoring.

(3) if the bushings show evidence of burning, flaking, galling, or grooving, replace them in accordance with steps b and c, below.

(4) If bushings are pitted or scored in excess of 0.002 inch (0.05 mm) deep, replace them in accordance with steps b and c, below.

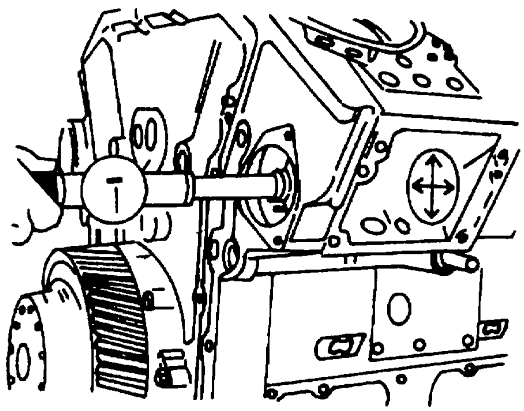


Figure 9-17. Measuring Camshaft Bushing Bore

(5) Using an inside micrometer, or dial bore gage, measure the bore diameter of the bushings in both a vertical and horizontal plane (Figure 9-17).

(6) Replace the bushings in accordance with steps band c, below, if the maximum diameter is beyond the limits given in Table 1-4.

b. Remove.

(1) Assemble the camshaft bushing driver set ST-1228 (Figure 9-18) using the slide hammer, rod, mandrel, extension shaft, guide, and driver as follows:

(a) Install the guide in the bushing bore at the rear of the engine.

(b) Assemble the mandrel and extension shaft and insert them through the guide with the mandrel toward the front of the engine. Push the mandrel and the extension shaft through the guide until the end of the mandrel is in the front cam follower opening.

(c) Install the driver on the mandrel and position the driver in the front camshaft bushing (28, Figure 9-15).

(d) Install the rod (Figure 9-18) and slide hammer in the extension shaft.

(2) Using the slide hammer, drive the front camshaft bushing (28, Figure 9-15) out of the engine block.

(3) Remove the driver (Figure 9-18) from the mandrel, reposition the driver and mandrel behind the next bushing, and drive out the bushing as in step (2), above.

(4) Repeat step (3), above, until the bushings have been removed from the front half of the engine.

(5) Reverse the driver set so that the guide is in the front bushing bore and the driver is positioned in the rear bushing, and remove the bushings from the rear half of the engine in accordance with steps (2) and (3), above.

(6) If any bushing drove out easily, or shows signs of rotation in the bore, measure the bore diameter. If the bore diameter is over 3.1895 inch (81.013 mm), sleeve the bore in accordance with paragraph 9-31.

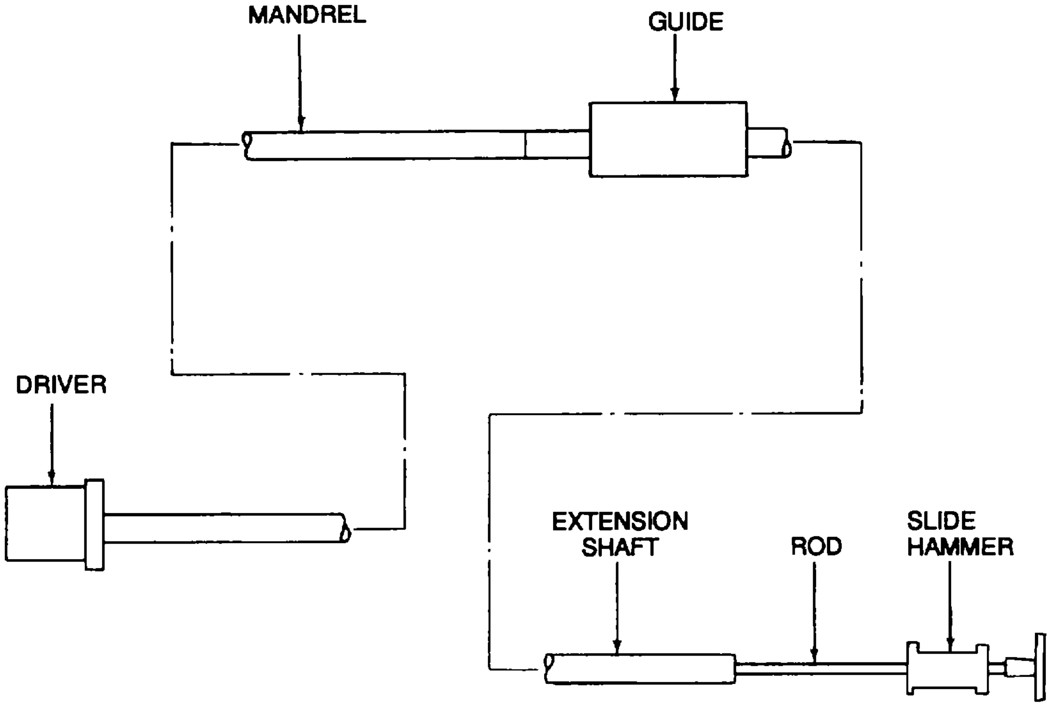


Figure 9-18. Camshaft Bushing Driver Set, ST-1 228

c. Install

CAUTION

In the following steps, be sure the oil holes in the cylinder block bore and bushings are aligned. Severe engine damage will result if the oil holes are blocked.

(1) With the camshaft bushing driver set ST-1 228 in place as in step b(5), above, install new camshaft bushings (28, Figure 9-15) starting at the rear of the cylinder block and working toward the center. Be sure the oil holes in the bushings are aligned with the oil holes in the bushing bore, and drive the bushings into place using the slide hammer until the bushings are flush with the edge of the bore.

(2) After installation, check to make certain that the oil holes in the bushing bores are aligned with the oil holes in the bushings.

(3) Reverse the driver set ST-1 228 in the cylinder block so that the guide is in the rear bushing bore, and replace the bushings in the front half of the engine taking care that the oil holes are aligned as in steps (1) and (2), above.

(4) Replace the camshafts in accordance with paragraph 9-1 5.

9-17. TIMING GEARS AND COVER INSPECTION.

a. Inspect the timing gear cover for cracks, and leaks in the gaskets and seal areas.

b. Remove the timing gear cover in accordance with paragraph 9-18.

c. Visually inspect the left and right bank camshafts gears (29 and 30, Figure 9-15), idler gears (36 and 37), water pump idler gear (40), and crankshaft gear (43) for chipped, cracked, or galled teeth. I the gear teeth are defective, replace the gears in accordance with paragraph 9-18.

d. Visually inspect the gears (29, 30, 36, 37, 40, and 43) for cracks. Pay particular attention to the webbing and keyway areas. If the gears are defective, replace them in accordance with paragraph 9-18. If cracks are suspected, remove the gears and inspect in accordance with paragraph 9-18.

e. Check the gear backlash and end play in accordance with paragraph 9-18.

9-18. TIMING GEARS AND COVER REPLACEMENT.

a. Remove.

(1) Remove the radiator in accordance with the Operator and Organizational Maintenance Manual.

(2) Remove the water pump in accordance with the Operator and Organizational Maintenance Manual.

(3) Remove the accessory drive and fuel pump in accordance with paragraphs 6-9 and 6-27.

(4) Remove the idler pulley assembly in accordance with the Operator and Organizational Maintenance Manual.

(5) Remove the accessory drive pulleys in accordance with paragraph 9-33.

(6) Remove the front engine support in accordance with paragraph 9-36.

(7) Refer to paragraph 9-38, and remove capscrews (18, Figure 9-68), lockwashers (7), and washers (8) securing oil pan (20) to cover.

(8) Remove the hexagon head screws (1, Figure 9-15), capscrews (2 and 3), lockwashers (4), and hexagonal nuts (60).

NOTE
Two persons will be required to perform the following procedure.

(9) Install four capscrews (9/16 inch, 3 inch minimum thread) in the four threaded holes provided in the cover (5) for use as jacking screws.

(10) Tighten each jacking screw 1/2 turn at a time until the cover (5) is free of the dowels (7), and remove the cover.

(11) Remove and discard the gasket (6). Remove the dowels (7) only if damaged.

(12) Remove the capscrew (8), lockwasher (9), and timing pointer (10) from the cover (5) only if damaged.

(13) Remove pipe plugs (16, 17, and 18) from the cover (5) and remove the accessory drive and crankshaft seals in accordance with paragraph 9-33 only if showing evidence of leakage.

(14) Remove the bolts (33) from the right bank and left bank idler assemblies, and remove the washers (34), idler shafts (35), and remove the idler gears (36 and 37) and thrust washers (38) from the idler shafts.

(15) Remove the capscrew (39), washer (34), and remove the water pump idler gear (40), thrust washers (38), and water pump idler shaft (41).

(16) Remove the left and right bank camshaft gears (29 and 30) using puller kit 3376400, and remove the keys (31) only if damaged.

(17) Remove the crankshaft gear (43) as follows:

(a) Attach the puller jaw 3375835, behind the crankshaft gear (43), and attach the puller assembly 3375834 to the puller jaw.

CAUTION
To avoid crankshaft damage, do not exceed 350 pound-feet (475 newton-meters) of torque on the puller screw. If the torque required to move the gear exceeds 350 pound-feet (475 newton-meters), apply heat to the gear. Do not reuse the gear if heated.

(b) Observing the above caution, use a torque wrench to turn the puller screw until the crankshaft gear is free of the shaft and remove the gear (43) and key (44).

NOTE
Because of its size and weight, assistance will be needed to remove the housing.

(18) Remove the capscrews (45) and lockwashers (46). Using a soft hammer, tap the housing (47) loose from the dowels (49), and remove the housing.

(19) Remove and discard the gasket (48). Remove the dowels (49) only if damaged.

WARNING

Dry cleaning solvent PD-0, Type III, or equivalent, Is flammable, and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

b. Cleaning. Clean all parts thoroughly using dry cleaning solvent PD-680, Type III, or equivalent Remove all traces of old gaskets from the mating surfaces, and remove nicks or burrs from the gasket surfaces using a flat mill file.

c. Inspect and Repair.

(1) Visually inspect the camshaft and timing gears in accordance with paragraph 9-1 7. Discard any defective gears.

(2) Inspect the camshaft and timing gears using fluorescent magnetic inspection in accordance with MIL-1-6868.

(3) Inspect the keys (31) for wear or distortion. Replace the keys if defective.

(4) Inspect the thrust plates (32) for scoring and wear. Replace the plates if scored deeper than 0.0003 inch (0.008 mm), or if worn beyond the limits given in Table 1-4.

(5) Check the idler shafts (35 and 41) for scoring and wear. Replace the shafts if they are scored deeper than 0.002 inch (0.05 mm), or if the minimum diameter is less than 1.872 inch (47.55 mm).

(6) Check the idler gear bushings (42) for scoring and wear. Scoring shall not exceed 0.003 inch (0.08 mm) in depth, and maximum diameter shall be 1.8785 inch (47.714 mm).

(7) Replace worn idler gear bushings (42) using standard bushing drivers. Hone or ream the new bushings for a free fit of 0.0015 to 0.0030 inch (0.038 to 0.076 mm) on the shafts (35 and 41).

(8) Check the thrust washers (38) for wear. Replace the thrust washers if the minimum thickness is less than 0.088 inch (2.24 mm).

(9) Check the shaft retainer center bolts (33 and 39) for worn or stripped threads. Repair minor thread damage by chasing. Replace the center bolts i more than three threads are damaged.

(10) Inspect the housing (47) using fluorescent magnetic inspection in accordance with MIL-1-6868. Replace the housing if cracked.

(11) Check the gasket surface of the housing (47) for nicks or burrs. Remove nicks or burrs with a flat mill file.

(12) Check the threaded holes in the housing (47) for stripping. Repair stripped threads in accordance with paragraph 2-12.

(13) Inspect the cover (5) using fluorescent magnetic inspection in accordance with MIL-1-6868. Replace the cover if cracked.

(14) Check the gasket surface of the cover (5) for nicks or burrs. Remove nicks or burrs with a flat mill file.

(15) Check the threaded holes in the cover(5) for stripping. Repair stripped threads in accordance with paragraph 2-12.

(16) Check the bushings (57) in the cover (5) for scoring and wear. Scoring shall not exceed 0.003 inch (0.08 mm) in depth, and maximum diameter shall be 1.571 inch (39.90 mm).

NOTE

If the mating shafts are worm, bushings (57) are available in 0.010 inch (0.25 mm) and 0.020 inch (0.51 mm) undersize. These bushings may be used provided the correct running fit of 0.003 to 0.006 inch (0.08 to 0.15 mm) is maintained.

(17) Replace worn bushings (57) using mandrel ST-598, and ream for a free fit of 0.003 to 0.006 inch (0.08 to 0.15 mm) on the mating shaft.

(18) Check the bushing (58) for scoring and wear. Scoring shall not exceed 0.003 inch (0.08 mm) in depth, and ¾maximum diameter shall be 1.506 inch (38.25 mm).

(19) Install a new bushing (58) using mandrel ST-598.

(20) Check the trunnion sleeve (59) for wear, scoring, or distortion. Remove the damaged sleeve by striking it around the outer diameter with a blunt chisel to relieve the press fit.

(21) Install a new sleeve (59) using a soft drift and a hammer.

d. Install.

NOTE

Because of its size and weight, assistance will be needed to install the housing (47).

(1) If removed, install the dowels (49) in the cylinder block

(2) Fabricate two guide studs (refer to Table 2-2) and install in opposite sides of the cylinder block to support the housing (47, Figure 9-15) during installation.

(3) Apply a light coat of sealing compound MIL-S-45180 to a new gasket (48), and install it over the guide studs and dowels.

(4) Install the housing (47) over the guide studs and tap into place with a soft hammer.

(5) Install the lockwashers (46) and capscrews (45), and crosstighten in three steps to 45 to 55 pound-feet (61 to 75 newton-meters).

WARNING

Insulated gloves are required to avoid bums when handling heated parts.

(6) Heat the left and right bank camshaft gears (29 and 30) at 400°F (204°C) for 1 hour in a preheated oven.

(7) Coat the camshaft gear hub and thrust plate (32) with anti-seize compound MIL-A-907.

(8) Install a new key (31) in each camshaft.

NOTE

When performing the following step, it may be necessary to remove the rear camshaft covers (22) and have an assistant hold the camshaft toward the front of the engine with a heavy, copper back-up bar to ensure that the gear seats against the shoulder.

(9) Using a suitable length and diameter of tubing and a brass hammer, tap the camshaft gear (29 or 30) on the camshaft until it is seated against the shoulder. Be sure the gear remains against the shoulder until it is cool.

(10) Heat the crankshaft gear (43) at 400°F (204°C) for 1 hour in a preheated oven.

(11) Install the key (44) in the crankshaft and coat the crankshaft hub with ant-seize compound MIL-A-907.

(12) Using a suitable length and diameter of tubing and a brass hammer, drive the crankshaft gear (43) on the shaft until it is seated against the shoulder. Be sure the gear remains against the shoulder until cool. When cool, maximum clearance between shoulder and gear shall be 0.015 inch (0.38 mm).

(13) Install the water pump idler gear (40) as follows: (a) Lubricate the idler shaft (41) and thrust washers (38) with lubricating oil MIL-L-21 04.

(b) Position the water pump idler gear shaft (41) into the cylinder block.

(c) Position one idler gear thrust washer (38) on the idler shaft (41) so the grooved thrust face will face the gear (40).

(d) Place the water pump idler gear (40) on the shaft, and index the timing marks (1 and 3, Figure 9-16).

(e) Install the outer thrust washer (38) with the grooved face of the thrust bearing toward the gear.

(f) Lubricate the threads of the center capscrew (39, Figure 9-15) with dean engine lubricating oil, install the center capscrew and washer (39 and 34), and tighten the center capscrew to 175 to 185 pound-feet (237 to 251 newton-meters).

(14) Install the camshaft idler gears (36 and 37) as follows:

(a) Lubricate the idler shafts (35) and thrust washers (38) with lubricating oil MIL-L-9000.

(b) Position one thrust washer (38) on the shaft (35) with the smooth surface (steel back side) toward the shaft retaining collar.

(c) Position the idler gear (36 or 37) on the shaft (35) with the timing marks on the gear toward the shaft retaining collar.

(d) Position the second thrust washer (38) on the shaft (35) with the grooved side toward the gear.

(e) Install the gear, shaft, and bearing assembly into the block indexing the timing marks (2 and 6, Figure 9-16).

(f) Lubricate the threads of the center bolt (33, Figure 9-15) with dean engine lubricating oil, install the center bolt and washer (33 and 34) and tighten to 175 to 185 pound-feet (237 to 251 newton-meters).

(15) Check to be sure that all timing marks are aligned in accordance with Figure 9-16.

(16) Attach a dial indicator (Figure 9-19) to the housing and check the camshaft end clearance. The end clearance shall be 0.006 to 0.013 inch (0.15 to 0.33 mm) on both camshafts. If the end clearance is not within the limits, remove the camshaft gear and change the thrust plate (32, Figure 9-15).

(17) Repeat step NO TAG, above, to measure the end clearance fort he other gears. The end clearances must be within the tolerance given in Figure 9-16.

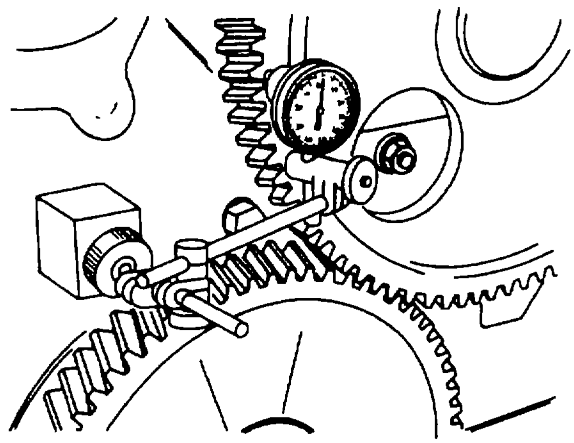


Figure 9-19. Measuring Camshaft End Clearance

(18) Check the gear train backlash as follows:

(a) Attach a dial indicator to the gear housing with the plunger on a tooth of the gear to be checked (Figure 9-20).

(b) Lock the mating gears in position, rotate the gear being checked to take up the backlash, and zero the indicator.

(c) Rotate the gear in the opposite direction, and read the gear backlash on the indicator gage. The backlash should be 0.003 to 0.015 inch (0.076 to 0.38 mm) on all gears.

(d) Move the dial indicator to the next gear and repeat the above procedure for each gear.

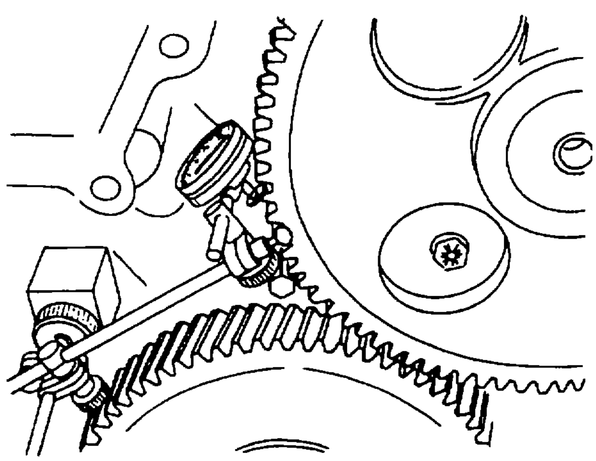


Figure 9-20. Measuring Timing Gear Backlash

NOTE

The backlash indicator reading on the water pump drive gear may not be accurate without the support gear cover and pulley installation. A slight movement between the gears should be felt as the pulley is moved first clockwise then counterclockwise after the installation is complete.

NOTE

Injection timing must be checked whenever a new camshaft or gear is installed. Timing adjustments are made by changing the camshaft keys. Timing the No. 1 cylinder on each bank will accomplish injector timing for all cylinders.

(19) Check and adjust the injector timing as follows:

(a) Remove the fuel injector from No. 1 cylinders in accordance with the Operator and Organizational Maintenance Manual.

(b) Remove the rocker arms from No. 1 cylinders in accordance with paragraph 9-5.

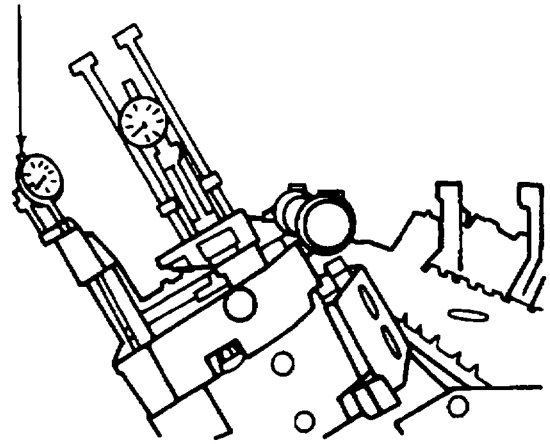


Figure 9-21. Injector Timing Setup

(c) Position the timing fixture 3375522 in the injector well of the cylinder being checked, engaging the push rod indicator in the injector push rod (Figure 9-21). Tighten the hold-downs evenly by hand.

(d) Loosen both of the indicator supports. Rotate the crankshaft in the direction of the engine rotation to TC (top center) on the compression stroke. At TC, the piston travel indicator plunger will be near the full upward position. Adjust both of the indicators to their fully compressed position, and, to prevent damage to the indicators, raise both indicators approximately 0.020 inch (0.05 mm). Lock-them in place with the setscrew.

(e) Rotate the crankshaft back and forth to assure the piston is precisely at TC on the compression stroke (1, Figure 9-22). TC is indicated by the maximum clockwise position of the piston travel indicator pointer. Turn the piston travel indicator face to align the zero with the pointer. Lock the face with the thumbscrew.

NOTE

Both indicators will move in the same direction when the piston is on the compression stroke. I the push tube indicator does not move in the same direction as the piston indicator, rotate the crankshaft one complete revolution to place the piston on the compression stroke and repeat step (g), above.

(f) Rotate the crankshaft in the direction of the engine rotation (2, Figure 9-22) approximately 90 degrees ATC (after top center). Turn the push rod travel indicator face to align the zero with the pointer. Lock the face with the thumbscrew.

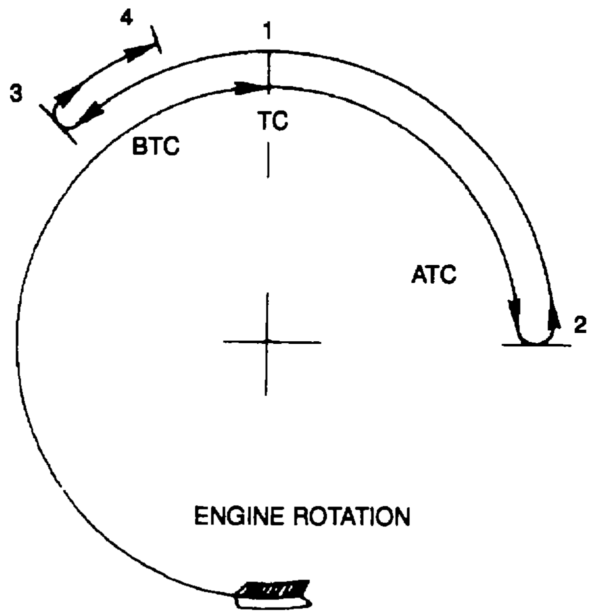


Figure 9-22. Injection Timing Diagram

(g) Rotate the crankshaft back and forth to assure the piston is precisely at TC on the compression stroke (1, Figure 9-22). TC is indicated by the maximum clockwise position of the piston travel indicator pointer. Turn the piston travel indicator face to align the zero with the pointer. Lock the face with the thumbscrew.

NOTE

Both indicators will move in the same direction when the piston is on the compression stroke. f the push tube indicator does not move in the same direction as the piston indicator, rotate the crankshaft one complete revolution to place the piston on the compression stroke and repeat step (g), above.

(h) Rotate the crankshaft in the direction of the engine rotation (2, Figure 9-22) approximately 90 degrees ATC (after top center). Turn the push rod travel indicator face to align the zero with the pointer. Lock the face with the thumbscrew.

(i) Rotate the crankshaft opposite the direction of rotation through TC to 45 degrees BTC (before top center) (3, Figure 9-22).

(j) Rotate the crankshaft in the direction of rotation (4, Figure 9-22) until a reading of 0.2032 inch (5.161 mm) BTC is reached on the piston travel indicator. At this position, the push rod travel indicator should read 0.124 to 0.128 inch (3.15 to 3.25 mm).

(k) If the push rod travel is not within specifications, remove the camshaft gear, select a new key to give the required change in push rod travel (Figure 9-23). Install the selected key and the camshaft gear, and recheck the timing in accordance with steps (d) through j), above.

(l) Check and adjust the timing on No.1 cylinder on the opposite bank in accordance with steps (c) through (k), above.

(20) Install the injectors in No.1 cylinders in accordance with paragraph 6-18.

(21) Install the rocker arms and covers in accordance with paragraph 9-5.

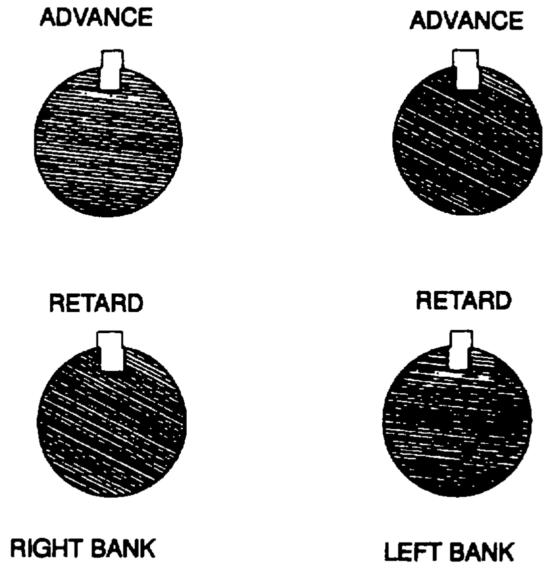
(22) Using new packings (55 and 56, Figure 9-15), install the hole cover (54), lockwashers (53), washers (52), and capscrews (50 and 51). Tighten the capscrews to 45 to 55 pound-feet (61 to 75 newton-meters).

(23) Install the pipe plugs (16, 17, and 18) in the cover (5) and tighten in accordance with Table 1 -2.

(24) Using a new gasket (15), install the hole cover (14), lockwashers (13), washers (12), and capscrews (11). Cross-tighten the capscrews in accordance with Table 1-2.

(25) Install the timing pointer (10), and secure with capscrew (8) and lockwasher (9).

(26) Fabricate two guide studs (refer to Table 2-2) and install them in the upper holes on each side of the housing. If removed, install the dowels (7, Figure 9-15).



POSITION OF THE CAMSHAFT KEY AS SEEN FROM THE GEAR COVER END OF THE CAMSHAFT.

	INJECTION TIMING	
TIMING	PISTON TRAVEL INCHES (mm) PUSH	ROD TRAVEL INCHES (mm)
A.J	-0.2032(5.161)	0.126 ±0.002 (3.20 ±0.05)

PART NUMBER	AMOUNT OF OFFSET INCH (mm)	CHANGE IN PUSH ROD TRAVEL INCH (mm)	ANGLE OF OFFSET DE-GREES MINUTES	
200711	0.0070 (0.178)	0.0033 (0.084)	0	20
200709	0.0150 (0.381)	0.0070 (0.178)	0	42
200704	0.0197 (0.500)	0.0095 (0.241)	0	56
200708	0.0230 (0.584)	0.0110 (0.279)	1	5
200706	0.0238 (0.833)	0.0155 (0.394)	1	33
200714	0.0390 (0.991)	0.0185 (0.470)	1	50
206782	0.0110 (0.279)	0.0055 (0.127)	0	31
216294	0.0035 (0.089)	0.0017 (0.043)	0	10

Figure 9-23. Timing of Camshafts

(27) Coat a new gasket (6) with sealing compound MIL-S451 80, and position the gasket over the guide studs and dowels.

NOTE

Because of its size and weight, assistance will be needed to install the cover.

(28) Align the cover (5) over the guide studs and dowels, and tap it into place using a soft hammer.

CAUTION

The hexagon head screw (1) and capscrews (2 and 3) securing the cover are of different lengths. To avoid thread damage, be sure they are installed In the correct holes.

(29) Using the lockwashers (4) and hexagonal nuts (60), install the screws (1, 2, and 3). Cross-tighten the screws in three stages to 45 to 50 pound-feet (61 to 68 newton-meters).

(30) Check the front cover-to-seal bore alignment as follows: (a) Mount a dial indicator on the face of the crankshaft, and position the indicator button in the seal bore.

(b) Rotate the engine one complete revolution, and check the runout of the seal bore. The TIR shall not exceed 0.010 inch (0.25 mm).

(c) If the TIR is excessive, remove the cover and dean the gasket surfaces thoroughly. Check the gasket surfaces, and remove any nicks or burrs using a flat mill file.

(d) Install the cover, and re-check the runout (31) Install new crankshaft and accessory drive seals in accordance with paragraph 9-33.

(32) Install the front engine support in accordance with paragraph 9-36.

(33) Refer to paragraph 9-38, and install capscrews (18, Figure 9-68), lockwashers (7), and washers (8) which secure the oil pan (20) to the timing gear cover.

(34) Install the accessory drive pulleys in accordance with paragraph 9-33.

(35) Install the idler pulley assembly in accordance with paragraph 7-6.

(36) Install the accessory drive and fuel pump in accordance with paragraphs 6-18 and 6-27.

(37) Install the water pump in accordance with the Operator and Organizational Maintenance Manual.

(38) Install the radiator in accordance with the Operator and Organizational Maintenance Manual.

SECTION IV. MAINTENANCE OF PISTON AND CONNECTING ROD ASSEMBLIES, MAIN AND CONNECTING ROD BEARINGS, AND CYLINDER LINERS

9-19. GENERAL. Before removing or disassembling functional engine components, be sure identifying match-marks are placed on the parts for correct location at reassembly. During disassembly, a brief visual inspection of each part will aid in locating the source of unusual wear. The reassembly area, tools, and parts must be kept dean; dirt grit, or other foreign material will greatly shorten the life of bearings, pistons, rings, and cylinder sleeves. At reassembly, install all re-usable parts in the same location from which they were removed. Pistons, piston pins, and connecting rods are held to dose, individual weight tolerances. They may, however, be replaced individually without upsetting engine balance, provided replacement parts have the same part number and letter Code.

9-20. PISTON AND CONNECTING ROD ASSEMBLIES MAINTENANCE.

a. Inspect. (See Figure 924)

(1) Remove the inspection covers in accordance with paragraph 9-37.

(2) Rotate the engine as necessary, and visually inspect each connecting rod and piston for cracks or evidence of overheating. A connecting rod or piston that has been running too hot will be dry, and will have a varnish-like, baked-on coating of lubricating oil.

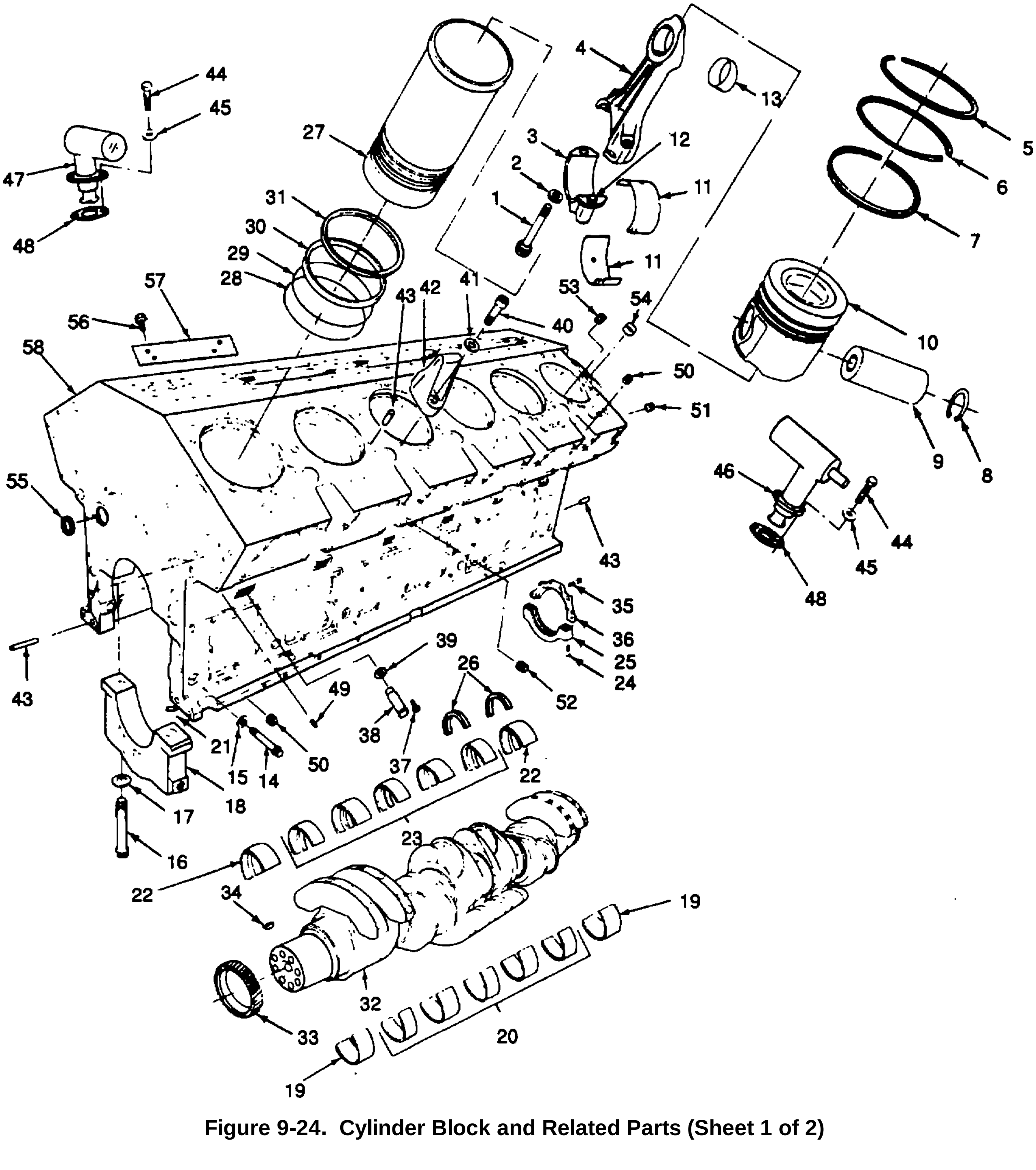


Figure 9-24. Cylinder Block and Related Parts (Sheet 1 of 2)

1. BOLT (CONNECTING ROD)
2. WASHER
3. CONNECTING ROD CAP
4. CONNECTING ROD
5. TOP COMPRESSION RING
6. INTERMEDIATE COMPRESSION RING
7. OIL CONTROL RING AND EXPANDER
8. SNAP RING
9. PISTON RING
10. PISTON
11. CONNECTING ROD BEARING SHELL
12. DOWEL
13. PISTON PIN BUSHING
14. CAPSCREW (MAIN BEARING SIDE-LOCK)
15. LOCKWASHER
16. CAPSCREW
17. WASHER
18. MAIN BEARING CAP
19. LOWER MAIN BEARING SHELLS (1 AND 7)
20. LOWER MAIN BEARING SHELLS (2, 3, 4,5, AND 6)
21. DOWEL
22. UPPER MAIN BEARING SHELLS (1 AND 7)
23. UPPER MAIN BEARING SHELLS (2, 3, 4, 5, AND 6)
24. CAPSCREW
25. RETAINER PLATE
26. THRUST BEARING
27. CYLINDER LINER
28. BOTTOM PACKING (RED)
29. TOP PACKING (BLACK)
30. CREVICE SEAL
31. INSERT-RING
32. CRANKSHAFT
33. CRANKSHAFT GEAR (FRONT)
34. KEY
35. CAPSCREW
36. THRUST BEARING RETAINER
37. CAPSCREW
38. PISTON COOLING NOZZLE
39. PACKING
40. CAPSCREW
41. WASHER
42. LIFTING BRACKET
43. DOWEL
44. CAPSCREW
45. LOCKWASHER
46. REAR CRANKSHAFT BREATHER
47. FRONT CRANKSHAFT BREATHER
48. GASKET
49. DRAIN COCK
50. PIPE PLUG
51. PIPE PLUG
52. PIPE PLUG
53. OIL RESTRICTOR EXPANSION PLUG
54. EXPANSION PLUG
55. EXPANSION PLUG
56. SCREW
57. NAMEPLATE
58. CYLINDER BLOCK

Figure 9-24. Cylinder Block and Related Parts (Sheet 2 of 2)

NOTE

During inspection of connecting rods, look for evidence of nicks or cuts along the ribbed sides of the connecting rod. (Refer to Figure 9-25.) Do not reuse a connecting rod which is nicked, cut, or shows any signs of damage along these ribbed surfaces. Connecting rods damaged in this manner are subject to sudden, violent failure.

(3) If evidence of cracks, overheating, or excessive bearing clearance is found, remove the connecting rods and inspect in accordance with the following steps.

(4) If conditions are satisfactory, replace the inspection covers in accordance with paragraph 9-37.

b. Remove.

(1) Remove the cylinder heads in accordance with paragraph 9-5.

(2) Remove the inspection covers in accordance with paragraph 9-37.

CAUTION

Do not attempt to remove the connecting rod and piston assemblies from the cylinder block before the ridge and carbon accumulation is removed from the cylinder liner. Failure to remove the ridge could result in piston ring-land breakage during removal.

(3) Remove the ridge from top of cylinder liner (27, Figure 9-24) using a sharp knife, and polish using a fine emery cloth P-C-1 673.

(4) Position the crankshaft (32) at BDC for the connecting rod being removed. If Wi connecting rods are being removed, start at No. 1 cylinder.

NOTE

Original equipment connecting rods, caps, and pistons are marked 1L through 6L for the left bank and 1R through 6R for the right bank The numbered side of the piston and rod assemblies face the inspection holes. A replacement connecting rod or piston could, however, be unmarked. Be sure all assemblies are properly marked before removal.

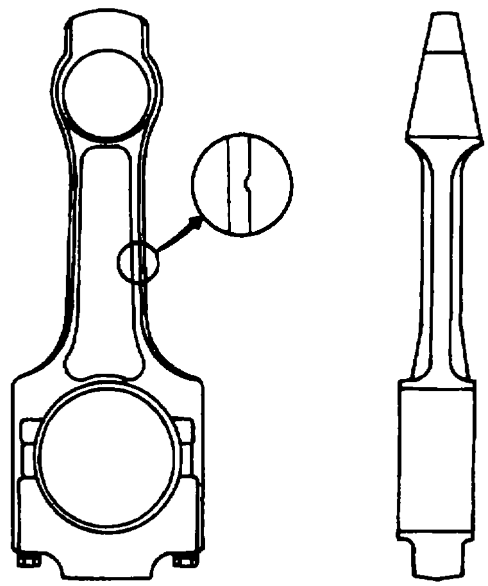


Figure 9-25. Inspection of Connecting Rods

(5) Check for identifying marks on the connecting rod (4) and cap (3). If unmarked, steel-stamp the cylinder number and bank location on the inspection hole side of both connecting rod (4) and cap (3). Be sure all connecting rods and caps are marked before removal.

(6) Loosen the connecting rod bolts (1) approximately 0.5 inch (13 mm) and tap the ends of the bolts alternately with a plastic mallet until connecting rod cap (3) is free of the dowels (12).

CAUTION

During removal, be careful that the crankshaft journals and cylinder liners are not nicked by sharp edges on the connecting rod. Because of insufficient clearance between the crankshaft counter weights, the crankshaft must be turned to allow clearance for removal of the connecting rod assembles, To avoid crankshaft damage Install nylon guide pins In the connecting rod and adhere to the following steps carefully.

NOTE

If the connecting rod bearing shells (11) come out of the connecting rod and cap, remove the bearing shells and tape them together. Mark the bearing shells with a felt pen as to top and bottom, rod number, and bank location.

(7) Remove the connecting rod bolts (1), washers (2), and cap (3). Install nylon guide pins 3375098 in the connecting rod bolt holes.

(8) Turn the crankshaft (32) to TDC, and remove the piston (10) and connecting rod (4) as an assembly.

(9) Replace the cap (3) on the connecting rod (4), and temporarily install the bolts (1) and washers (2) hand-tight to retain the bearing shells (11).

(10) Remove the other piston and connecting rod assemblies following steps (3) through (9), above.

c. Disassemble.

NOTE

Before disassembly, match-mark the piston and connecting rod so that they can be reassembled in the same positions from which they were removed.

(1) Using a 0.006 inch (0.15 mm) feeler gage, check the top, and intermediate piston ring to piston land side groove clearance. If the gage enters freely, either the piston or piston ring is worm. Inspect the piston and piston rings in accordance with step e, below.

CAUTION

Over-expanding a piston ring during removal or Installation will distort the ring and cause ring failure. Do not expand the rings more than necessary during removal or Installation .

(2) Using piston ring expander ST-1269, remove the top compression ring (5, Figure 9-24), intermediate compression ring (6), and oil control ring (7).

CAUTION

To avoid damage to the piston, do not drive, press, or otherwise force the piston pin from the piston. Remove the piston pin using thumb pressure only. If the piston pin Is difficult to remove, heat the piston in hot water, or heat for 15 minutes In an oven set to a maximum of 210°F (99°C).

(3) Remove the snap rings (8) and using thumb pressure only, remove piston pin (9) and piston (10) from the connecting rod (4). Discard the snap rings (8).

(4) Remove the temporarily installed bolts (1) and washers (2), and remove the cap (3) and connecting rod bearing shells (11). Mark the bearings rings relative to top and bottom location, rod number, and bank using a felt tip pen.

d. Cleaning.

WARNING

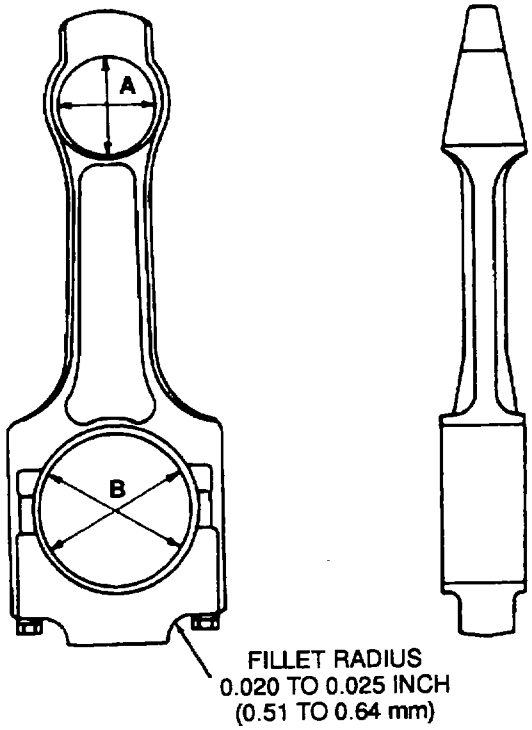
Dry cleaning solvent PD-680, Type III, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

(1) Clean all parts thoroughly using dry cleaning solvent PD-680, Type III, or equivalent, to remove all traces of built-up varnish.

(2) Clean heavy carbon deposits from the top of the pistons using carbon scrapers. Be careful not to gouge the aluminum surface.

(3) Clean all carbon deposits from the ring grooves using a ring groove cleaner, or sections of old piston rings that have been ground to a bevel. Be careful to remove the carbon only. Do not gouge or remove metal from the ring grooves.

(4) Clean the oil drain-back holes in the oil control ring groove using a drill just large enough to remove the carbon. Turn the drill by hand being careful to remove the carbon only.



A- PISTON PIN BUSHING BORE
NEW MINIMUM 2.4010 INCHES (60.985 mm)
NEW MAXIMUM 2.4015 INCHES (60.998 mm)
WORN LIMIT 2.4025 INCHES (61.023 mm)
B - CONNECTING ROD BORE
MINIMUM 4.5017 INCHES (114.343 mm)
MAXIMUM 4.5027 INCHES (114.368 mm)

Figure 9-26. Connecting Rod Inspection

e. Inspect and Repair.

NOTE

During inspection, be sure the connecting rod (4, Figure 9-24) and its mating cap (3) are kept together at all times. If either the connecting rod or cap is found to be defective, replace both rod and cap.

(1) Check the fillet radius where the cap is milled for the bolt head for damage (Figure 9-26). The fillet radius shall be 0.020 to 0.025 inch (0.51 to 0.64 mm) and free of nicks and deep scratches, and the bolt head area must be flat. A maximum of 0.0625 inch (1.588) may be milled from the cap to restore flatness and the radius.

(2) Check the rod and cap for nicks, dents, and scratches. Replace both rod and cap if either has defects over 0.625 inch (1.588 mm) deep. Remove defects under 0.625 inch (1.588 mm) deep by grinding or filling. The ground or filed area must have a radius of at least 0.5 inch (13 mm). Blend and polish the ground or filed area using crocus cloth P-C-458.

(3) Check the connecting rods (4, Figure 9-24), caps (3), and connecting rod bolts (1), for cracks using magnetic particle inspection in accordance with MIL-L-6868. Pay particular attention to the critical areas around the crank pin boss. piston pin boss and radius areas.

(4) Assemble the cap to the rod with the dowels in place and cross tighten the bolts to operating tension in accordance with Table 9-3.

(5) Check the crankpin bore with a dial bore gage or inside micrometer. The bore diameter shall be within 4.5017 to 4.5027 inches (114.343 to 114.368 mm) in the complete circumference of the bore (B, Figure 9-26).
(6) Out-of-roundness or taper in the connecting rod crankshaft bore shall not exceed 0.001 inch (0.03 mm).
(7) Replace the connecting rod if the crankpin bore does not meet the specifications given in steps (5) and (6), above.
(8) Gage the piston pin bushing diameter (13, Figure 9-24) with an inside micrometer or dial bore gage. The maximum bushing diameter shall be in accordance with A, Figure 9-26. Replace a worn bushing in accordance with step (10), below.
(9) Check the connecting rod alignment as follows:
  (a) Calibrate the checking fixture ST-561 for connecting rod size as follows:
    1 Select a new rod that has been checked for the correct absolute center-to-center length of 11.406 inches (289.71 mm) between centers.

NOTE

Production rods may vary from 11.405 to 11.407 inches (289.69 to 289.74 mm).

    2 Assemble the cap to the rod as described in step (4), above.
    3 Insert the piston pin, furnished in the ST-1305 Locating Mandrel Set, into the piston pin bore.
    4 Insert and snug tighten the expanding arbor ST-1331 in the crankpin bore. The locking pin must face down and be on the center line of the connecting rod.
    5 Set the rod in the fixture and zero the dial indicators on the piston pin.
    6 Lift the rod, arbor and pin assembly from the fixture, turn it front-to-back, return it to the fixture, and record the indicator readings at the piston pin. Readjust the dial indicators to divide the difference between the zero setting and the second readings, and zero the indicators. The fixture is now calibrated.

NOTE

The measurements read directly from the dial indicator indicate the comparative length of the connecting rod, and misalignment of the bore. The measurements may be made without the piston pin, bushing installed. If the bushing is badly worm, remove it before checking the alignment.

  (b) Assemble the Locating Mandrel Set in the rod to be checked. Set the rod in the fixture, and be sure the pin in the mandrel is down and locked in position in the center line of the rod.
  (c) Take readings for length (compared to the length set up on calibration of fixture) and misalignment of the crankshaft and piston pin bores (the difference in the readings from one indicator to the other).

Table 9-3. Connecting Rod Bolt Tightening Sequence and Torque

STEP	PROCEDURE FIG. REF. Figure 9-24	TORQUE* POUND-FEET (NEWTON-METERS)
1	Cross-tighten both bolts (1)	70 to 80 (95 to 108)
2	Cross-tighten both bolts (1)	140 to 150 (190 to 203)
3	Cross-tighten both bolts (1)	210 to 220 (285 to 298)
4	Loosen both bolts (1)	Remove all tension
5	Repeat steps 1, 2, and 3, above. connecting rod bolts (1) shall be 210 to 220 pound- feet. (285 to 298 Newton-meters).	Final torque on all

*Before installing connecting rod bolts(1) and washers (2), coat bolt threads, underside of bolt heads, and washers with clean lubricating oil MIL-L-45199.

(d) Turn the rod front-to-back and repeat step (c), above. The total difference in the indicator readings must not exceed 0.008 inch (0.20 mm)without the piston pin bushing, or O.004inch (0.10 mm)with the bushing installed and bored to size. The length must be within tO.001 inch (±O.03 mm) on the gages. Replace defective connecting rods.

(e) Measure the rod twist with a feeler gage between the piston pin and dial holding plate. When the rod does not contain a piston pin bushing, the twist must not exceed 0.020 inch (0.51 mm). The twist must not exceed 0.010 inch (0.025 mm) with the bushing in place and bored to size. Replace defective connecting rods.

(10) Replace a worn piston pin bushing (13, Figure 9-24) as follows:

NOTE

To ensure proper alignment of the piston pin bushing during installation, the connecting rod bore must be chamfered before the old bushing is removed. If the connecting rod bore has been previously chamfered, omit steps (a) through (i), below.

(a) Install guide bushing ST-861-2 (1, Figure 9-27) on the chamfering tool ST-861 (2).

(b) Extend the adjusting screw holder (3) to its longest position (third notch).

(c) Loosen the setscrews (4) and move the tool bit (5) toward the chamfering tool (2).

(d) Loosen the setscrew (6) and turn the adjusting screw (7) in until it extends below the top edge of the tool bit (5).

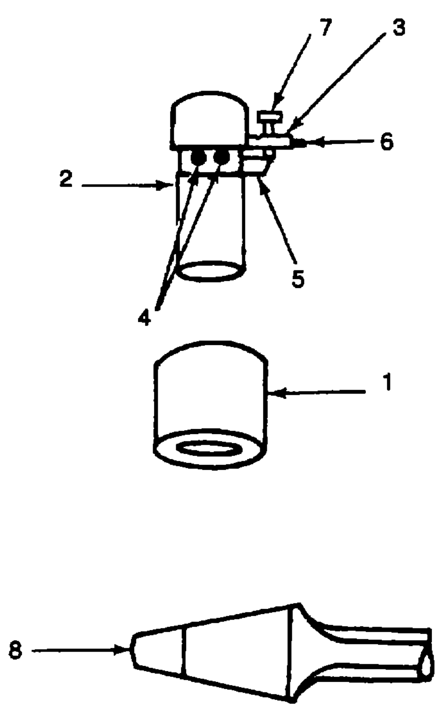
(e) Move the tool bit (5) toward the adjusting screw (7) until the cutting edge of the tool bit just dears the adjusting screw. Lock the tool bit in this position with the setscrews (4), and install the assembly in the connecting rod (8) piston pin bore.

(f) Back out the adjusting screw (7) until the cutting edge of the tool bit (5) just contacts the edge of the bore of the connecting rod (8). Lock the adjusting screw in position with the setscrew (6).

(g) Hold a slight downward pressure on the chamfering tool (2), and use a ratchet wrench to turn the chamfering tool one complete turn.

(h) Remove the chamfering tool assembly, install it in the opposite side of the connecting rod pin bore, and repeat step (g), above.

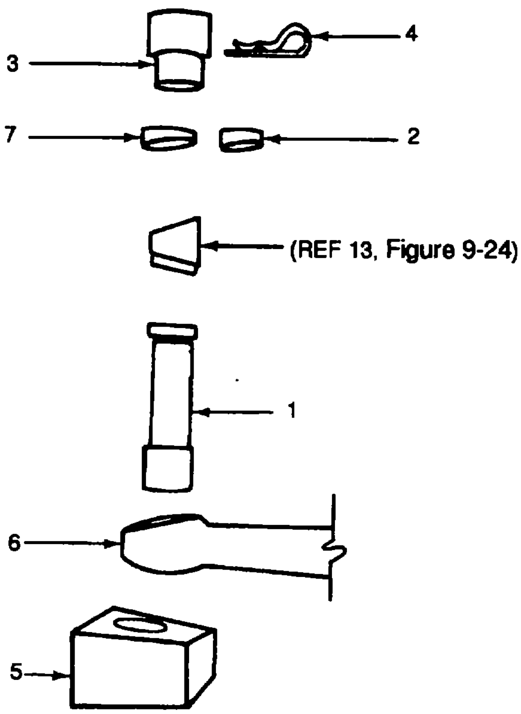
(i) Repeat steps (f) through (h), above, until a uniform pin bore chamfer of 0.040 to 0.060 inch (1.02 to 1.52 mm) deep is achieved on both sides of connecting rod.



1. GUIDE BUSHING (ST-861-2)
2. CHAMFERING TOOL (ST-861)
3. ADJUSTING SCREW HOLDER
4. SETSCREW
5. TOOL BIT
6. SETSCREW
7. ADJUSTING SCREW
8. CONNECTING ROD

Figure 9-27. Chamfering Connecting Rod Piston Pin Bore Using ST-861

(j) Insert the mandrel ST-1 285-3 (1, Figure 9-28) through the bushing in the connecting rod (6).
(k) Install the knock-out ring ST-1285-5 (2) and cup ST-1285-2 (3) on the mandrel (1) and secure the cup with the pin ST-1 285-6 (4).
(l) Insert the large end of the mandrel (1) in the hole of the block ST-1 285-1 (5).
(m) Orient the taper of the knock-out ring (2) and the block (5) with the taper of the connecting rod pin (6), and press out the piston pin bushing (13, Figure 9-24) using an arbor press. Disassemble ST-1 285, and discard the bushing.
(n) Place new bushing over the mandrel (1, Figure 9-28) and install the driver ST-1 285-4(7) and cup (3) on the mandrel. Secure the cup with the pin (4).
(o) Insert the mandrel (1) through the connecting rod piston pin bore (6) into the block (5).
(p) Insert the mandrel ST-1 285-3 (1, Figure 9-28) through the bushing in the connecting rod (6).
(q) Install the knock-out ring ST-1 285-5 (2) and cup ST-1 285-2 (3) on the mandrel (1) and secure the cup with the pin ST-1 285-6(4).
(r) Insert the large end of the mandrel (1) in the hole of the block ST-1 285-1 (5).



1. MANDREL (ST-1285-3)
2. KNOCK-OUT RING (ST-1285-5)
3. CUP (ST-1 285-2)
4. PIN (ST-1285-6)
5. BLOCK (ST-1 285-1)
6. CONNECTING ROD
7. DRIVER (ST-1 285-4)

Figure 9-28. Removal and Installation of Connecting Rod Piston Pin Bushing Using ST-1285

(s) Orient the taper of the knock-out ring (2) and the block (5) with the taper of the connecting rod pin (6), and press out the piston pin bushing (13, Figure 9-24) using an arbor press. Disassemble ST-1 285, and discard the bushing.
(t) Place new bushing over the mandrel (1, Figure 9-28) and install the driver ST-1285-4 (7) and cup (3) on the mandrel. Secure the cup with the pin (4).
(u) Insert the mandrel (1) through the connecting rod piston pin bore (6) into the block (5).
(v) Orient the tapers of the block, connecting rod, bushing, and driver. Press the bushing into connecting rod until the driver is flush with the connecting rod bore surface.
(w) Disassemble ST-1 285, and check to see that the lubrication hole in the bushing is aligned with the lubrication passage in the connecting rod.

(x) Using honing machine MIL-H-45583, size the new piston pin bushing (13, Figure 9-24) to an inside diameter of 2.4010 to 2.4015 inches (60.985 to 60.998 mm).

WARNING

Dry cleaning solvent PD-680, Type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

WARNING

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.

(y) Clean the bushing and oil passage in the connecting rod thoroughly, using dry cleaning solvent P-D-680, Type 11, or equivalent, and blow dry with compressed air.

(z) Re-check the connecting rod alignment in accordance with step (9), above.

(11) Check the bolts and dowels as follows:

(a) Check for bent or distorted bolts. The head of the connecting rod bolt (1, Figure 9-24) must rest squarely on the milled surface of the cap (3), (see step (1), above. Replace bent or distorted connecting rod bolts.

(b) If the connecting rod bolts (1) have been tightened excessively, they may be permanently stretched in the area indicated in Figure 9-29. Replace any bolt if the smallest diameter is less than 0.600 inch (15.24 mm).

(c) Replace any connecting rod bolts (1, Figure 9-24) that have distorted threads.

(d) Remove and discard the dowels (12), if damaged. Check the piston pin (9) outside diameter with a micrometer. Pins shall be replaced if they are out-of-round more than 0.001 inch (0.03 mm), or worn smaller than the minimum diameter given in Table 14.

(12) Check the piston pin (9) outside diameter with a micrometer. Pins shall be replaced if they are out-of-round more than 0.001 inch (0.03 mm), or worn smaller than the minimum diameter given in Table 1-4.

(13) Inspect the pistons (10) as follows:

(a) Visually inspect the piston for signs of erosion, broken ring lands, visible cracks, or severe scoring. Replace defective pistons.

(b) Check the piston ring grooves for wear using wear gage ST-560.If the gage shoulder touches the ring groove lands, replace the piston.

NOTE

Because aluminum pistons have a high coefficient of expansion, all measurements shall be taken at a stabilized piston temperature of 70°F (21°C).

(c) Measure the piston pin bore on both sides of the piston with an inside micrometer. Replace the piston if the pin bore on either side is over the allowable limits given in Table 1-4.

(d) Using an outside micrometer, measure the piston skirt at 90 degrees to the piston pin bore. Replace the piston if the skirt diameter is under the limits given in Table 1-4.

(e) Inspect the piston for cracks using dye penetrant MIL-1-25135 accordance with MIL-1K66. Replace any defective pistons.

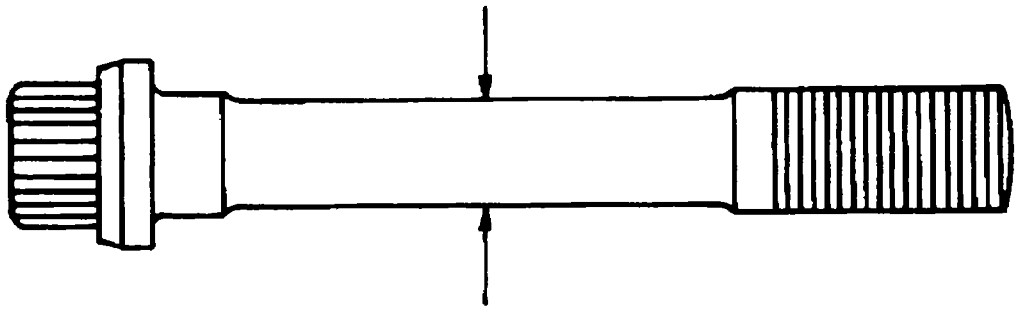


Figure 9-29. Inspection of Connecting Rod Bolt

(14) Inspect the top and intermediate compression rings (5 and 6, Figure 9-24) and oil control ring (7) as follows:
- (a) It the ring side groove clearance, as measured in step c(l), above, exceeded 0.006 inch (0.15 mm), but the piston is OK (see step (13)(b), above), replace the rings.
- (b) Insert each ring (5, 6, or 7) individually in its corresponding cylinder liner (27).
- (c) Using the piston (10), push the ring (5, 6, or 7) into the cylinder liner (27) so that it is seated squarely in the ring travel area of the liner.
- (d) Check the end gap (Figure 9-30) with a feeler gage.
- (e) If the end gap of any ring (5, 6, or 7) is not within specifications shown in Figure 9-30, replace them.

(15) Inspect the cylinder liners (27, Figure 9-24) in accordance with paragraph 9-23.
(16) Inspect connecting rod bearing shells (11) in accordance with paragraph 9-21.
(17) Inspect crankshaft (32) journals in accordance with paragraph 9-21.

f. Assemble and install.

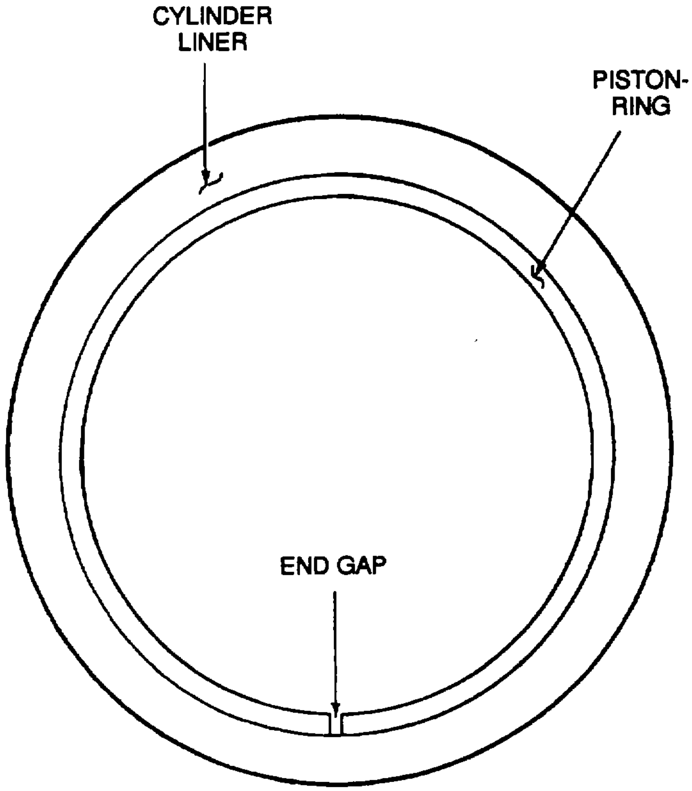
CAUTION

To prevent severe engine damage, and ensure proper Installation, the piston must be assembled to the connecting rod with the piston part number (on top of the piston) and the bearing tang locidng groove In the connecting rod on the same side (or the piston and connecting rod cylinder numbers on the same side). Discard the old snap rings; use new snap rings only.

NOTE

Piston rings must be replaced in sets only.

(1) Install a new piston pin snap ring (8, Figure 9-24) in one groove of the piston pin bore. Heat the piston (10) in boiling water or in an oven at or below 210°F (99°C) for approximately 15 minutes.
(2) Install the pin (9) through the piston (10) and connecting rod (4) pin bores before the piston cools.
(3) Secure the piston (10) with a second new snap ring (8) in the groove at the opposite end of the pin bore.
(4) Install the top and intermediate compression rings (5 and 6), and oil control ring (7) as follows:



RING LOCATION	WEAR LIMIT INCH (mm)	END GAP NEW MIN. INCH (mm)	NEW MAX.* INCH (mm)
TOP	0.052 (1.32)	0.025 (0.64)	0.040 (1.02)
INTERMEDIATE	0.052 (1.32)	0.025 (0.64)	0.040(1.02)
OIL CONTROL	0.042 (1.07)	0.01 5 (0.38)	0.030 (0.76)
*WHEN INSTALLING NEW PISTON RINGS IN USED CYLINDER LINERS, ADD 0.003 INCH (0.08mm) TO NEW MAX END GAP FOR EACH 0.001 INCH (0.03 mm) OF CYLINDER LINER WEAR.			

Figure 9-30. Piston Ring End Gap

CAUTION

To avoid breakage or failure of new piston rings, check each piston ring end gap before Installing them on the piston. Do not file or stone the end gap on chrome plated rings If the end gap Is below minimum specifications, select fit a new ring.

(a) Check the end gap (Figure 9-30) of new piston rings in accordance with step (1 4)(d), above. If necessary, select fit new rings to achieve the proper end gap.

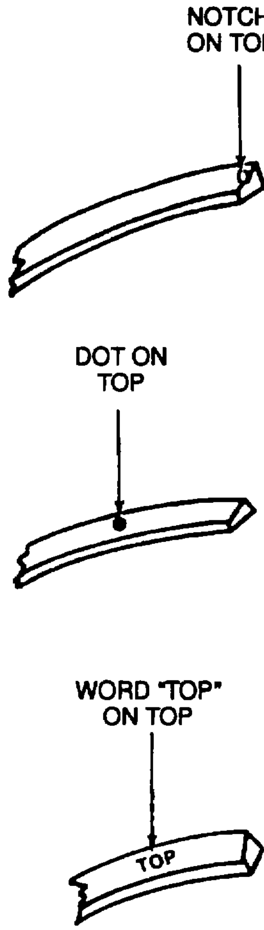


Figure 9-31. Identification of Top Side of Piston Ring

(b) Identify the top of the piston rings in accordance with Figure 9-31.

CAUTION

Over-expanding a piston ring during removal or Installation will distort the ring and cause ring failure. Do not expand the rings more than necessary during removal or Installation.

(c) Making sure that the top of the piston ring faces the top of the piston, use piston ring expander ST-1 269, and install the piston rings (5, 6, and 7, Figure 9-24) as follows:

1 Install the oil control ring (7) in the lower groove of the piston (10) with the gap located 90 degrees from M the piston pin bore.

2 Install the intermediate compression ring (6) in the center groove of the piston (10) with the gap located 180 degrees from the gap in the oil control ring (7).

3 Install the top compression ring (5) in the top groove of the piston (10) with the gap located 180 degrees from the gap in the intermediate compression ring.

(5) Install the piston and connecting rod assemblies as follows:

CAUTION

During assembly and Installation procedures, be sure all parts are kept clean and free of dirt or other foreign materials. Be especially careful when Installing the connecting rod bearing shell halves In the connecting rod and cap. Even a small amount of foreign matter trapped between the bearing shells and the rod or cap, will decrease bearing shell-to-journal clearance and result In premature wear or burned bearing shells. To avoid damage to the crankshaft journals, the services of two technicians will be required when Installing the piston and connecting rod assemblies. Be sure all connecting rods and caps are matched, and are returned to the same cylinder from which they were removed.

(a) Rotate the crankshaft (32) to TDC for the assembly being replaced. If all assemblies are being replaced, start at No. 1 cylinders.
(b) Install the bearing shells (11, Figure 9-24) in the connecting rod (4) and cap (3). Before installing the bearing shells, be sure all traces of oil or other foreign material is removed from the mating surfaces of the rod, cap, and bearing shell.
(c) Lubricate the bearing shell surfaces, piston rings, and cylinder liner surface with dean lubricating oil MIL-L-2104, and install the nylon guide pins 3375098 in the connecting rod bolt holes.
(d) Insert the piston and connecting rod assembly in ring compressor 3375342. Using a second technician to guide the connecting rod over the crankshaft journal, tap the assembly into the cylinder using a wooden block. Be sure the identifying marks on the connecting rod face the camshaft. Continue tapping until the connecting rod is seated on the crankshaft journal.
(e) Repeat steps (a) through (d), above, for the opposite bank.
(f) With an assistant holding the connecting rods in contact with the journal, rotate the crankshaft to BDC.
(g) Working through the inspection holes, remove guide pins 3375098. Check that the identifying marks on the connecting rod cap (3) match with the connecting rod (4).
(h) Check the bearing clearance using Plastigage in accordance with paragraph 9-21.
(i) Remove all traces of Plastigage from the bearing shell (11), lubricate the bearing shell surface with dean lubricating oil MIL-L-9000, and install the connecting rod cap (3) on the connecting rod (4).
(j) Lubricate the connecting rod bolts (1) and washers (2) with dean lubricating oil MIL-L-2104, install the washers and bolts, and crosstighten to 25 pound-feet (34 newton-meters). Do not tighten the connecting rod bolts to their final torque until all connecting rods and caps have been installed.
(k) Turn the crankshaft (32) to the next TDC position, and install the piston and connecting rod assemblies for these cylinders in accordance with steps (a) through 0), above. Continue this procedure until all connecting rods have been installed.
(I) Cross-tighten the connecting rod bolts (1) on each connecting rod in accordance with Table 9-3.
(m) Using a feeler gage, check the connecting rod side clearance. Connecting rod side clearance shall be 0.012 to 0.020 inch (0.30 to 0.51 mm), and rods must be free to move sideways on the crankshaft (32). If the connecting rods do not move freely on the crankshaft, or the clearance is not to specifications, check for improper bearing shell installation or crankshaft thrust surface wear. Rebuild a worn crankshaft in accordance with paragraph 9-28.

(6) Replace the inspection covers in accordance with paragraph 9-37.
(7) Replace the cylinder heads in accordance with paragraph 9-10.

CAUTION

Serious engine damage will result If the engine Is started before the lubrication system Is properly filled and primed. Elapsed time between priming the lubrication system and starting the engine shall not exceed 3 hours. if, for whatever reason, the engine cannot be started within 3 hours after priming the lubrication system, repeat the entire priming procedure just prior to starting the engine.

(8) Prime lubrication system in accordance with the Operator and Organizational Maintenance Manual.

9-21. CONNECTING ROD BEARINGS REPLACEMENT.

a. General. Connecting rod bearing shell consists of two shells, an upper and lower. Both shells have oil holes and grooves for lubrication, and new bearing shells are interchangeable between rod and cap. If used rod bearing shells are serviceable, however, they must be replaced in the same connecting rod and in the same cap from which they were removed.
b. Inspect. Inspection of the connecting rod bearing shell is accomplished during the replacement procedure in accordance with step d, below.
c. Remove.

NOTE

The following procedures are for replacing the connecting rod or main bearing shells without removing the connecting rods or crankshaft. If the engine is undergoing overhaul, the cylinder block should be completely disassembled in accordance with paragraph 9-31

(1) Remove the inspection covers in accordance with paragraph 9-37.
(2) With the crankshaft at BDC, loosen the connecting rod bolts (1, Figure 9-24), and tap the ends of the bolts with a plastic mallet to free the rod cap (3) from the dowels (12).
(3) Remove the bolts (1), washers (2), and remove the connecting rod cap (3). Slip the connecting rod bearing shell (11) from the cap.
(4) Install guide pins 3375098 in the connecting rod (4), and use a wooden block to tap the connecting rod away from the journal far enough to remove the bearing shells (11). Slip the bearing shells from the connecting rod.
(5) Mark the bearing shells (11) with a felt pen as to rod or cap and connecting rod number, and then tape together to prevent a mix-up.
(6) Remove the bearing shells (11) from the other connecting rod on the same crankshaft journal in accordance with steps (2) through (5), above.

CAUTION

To avoid serious crankshaft damage, do not rotate the crankshaft when the connecting rods are disconnected. Install the bearing shells In both connecting rods on each crankshaft journal before proceeding to the next journal.

d. Clean and Inspect.

WARNING

Dry cleaning solvent PD-680, Type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

(1) Being careful not to mix or interchange the bearings shells (11) clean each bearing shell in filtered solvent PD-680, Type II, or equivalent, and dry carefully.

(2) Visually inspect each bearing shell for defects and signs of uneven wear. Interpret bearing shell appearance as follows:
   (a) Bearing shells that have been operating at the correct clearance and with adequate lubrication will have a dull gray color. Bearing shells having a black surface, or showing varnish build-up, have been running at excessive clearance and shall be replaced.
   (b) Bearing shells that show bright shiny spots or areas have been running at insufficient clearance and shall be replaced. If bright areas appear along one edge of the bearing shell misalignment exists. Check the connecting rod for alignment in accordance with paragraph 9-20.
   (c) Bearing shells that are flaked, scored, galled, or show visible embedded dirt particles shall be replaced.

(3) Using a micrometer having a ball anvil, measure each bearing shell. Minimum thickness for connecting rod bearing shells shall be in accordance with Table 1-4. If either shell of a bearing set is under the minimum thickness, replace both shells.

(4) Inspect the crankshaft journal as follows: (a) Visually inspect the journal for cracks, nicks, pitting, scoring, or grooving. Replace the crankshaft in accordance with paragraph 9-27 if cracked. Rebuild the crankshaft in accordance with paragraph 9-28 if surface defects are over 0.003 inch (0.08 mm) deep.
   (b) Using an outside micrometer, check the journal for wear, out-of-round, and taper. Rebuild the crankshaft in accordance with paragraph 9-28 if is worn more than the limits specified in Table 1-4, out-of-round more than 0 .002 inch (0.005 mm), or tapered more than 0.0005 inch (0.013 mm) over the full length of the journal.
   (c) Visually inspect the thrust surfaces for cracks, nicks, pitting, scoring, or grooving. Rebuild the crankshaft in accordance with paragraph 9-28 if surface defects are over 0.003 inch (0.008 mm) deep.

e. Install.

CAUTION

During bearing shell Installation procedures, be sure all parts are kept dean and free of dirt or other foreign materials Be especially careful when Installing the bearing shells in the connecting rod and cap. Even a small amount of foreign matter trapped between the bearing shells and the rod or cap, will decrease bearing shell-to-journal clearance and result in premature wear or burned bearIng shells.

NOTE

Bearing shells must be replaced in sets only.

(1) Remove all traces of oil and foreign material from the mating and bearing surfaces of the connecting rod (4) and cap (3).

(2) Install serviceable or replacement bearing shells (11) in the connecting rod (4) and cap (3). Be sure the bearing shells are firmly seated in the rod and cap.

(3) Pull the connecting rod into position on the journal, and remove the guide pins 3375098 from the connecting rod.

NOTE

Plastigage is available in three clearance ranges: Type PG-1 (green) for a clearance range of 0.001 to 0.003 inch (0.025 to 0.076 mm); Type PR-1 (red) for a clearance range of 0.002 to 0.006 inch (0.051 to 0.152 mm); Type PB1 (blue) for a clearance range of 0.004 to 0.009 inch (0.102 to 0.229 mm). Select the range needed for the clearance being checked in accordance with Table 1-4.

(4) Place a strip of Plastgage across the full width of the bearing shell in the rod cap (A, Figure 9-32).

NOTE

Before installing the connecting rod bolts (1, Figure 9-24) and washers (2), coat the bolt threads, under side of bolt heads, and washers with dean lubricating oil MIL-L-2104.

(5) Being careful not to dislodge the Plastigage, install the bearing cap (3, Figure 9-24) on the connecting rod (4) and retain with washers (2) and bolts (1). Tighten the bolts in accordance with Table 1-3.

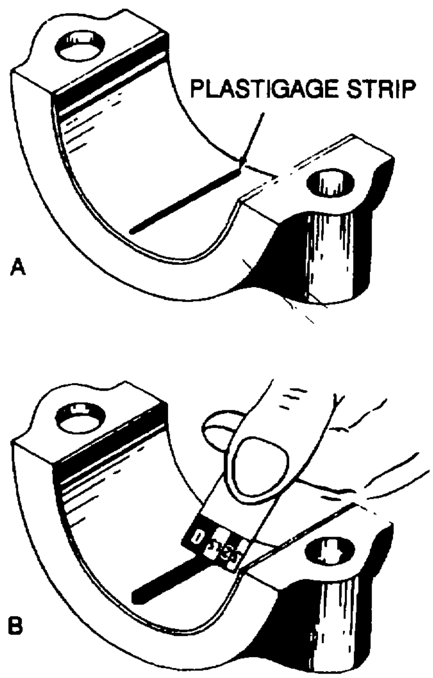


Figure 9-32. Using Plastigage to Determine Bearing Clearance

(6) Remove the bolts (1), washers (2), and connecting rod cap (3). Compare the width of the compressed Plastigage to the graduations on the Plastigage envelope (B. Figure 9-32). This is the connecting rod journal clearance and must conform to the specifications in Table 1-4.

(7) If the clearance is under the specifications given in Table 1-4, remove the bearings shells (11, Figure 9-24) and check for oversize bearing shells, or the presence of foreign matter between the bearing shells and the connecting rod (4) or cap (3).

(8) If the clearance is over the specifications given in Table 1-4,install new bearing shells (11) and re-check the clearance. If the clearance is still excessive, rebuild the crankshaft (32) in accordance with paragraph 9-28.

CAUTION

Before Installing the connecting rod bolts (1) and washers (2), coat the bolt threads, the underside of the bolt heads, and the washers with clean lubricating oil MIL-L-2104. Failure to do so will result In Improper torque and possible engine damage due to loosening of the bolts.

(9) If the clearance is satisfactory, remove all traces of Plastigage from the bearing shell and crankshaft journal, lubricate the bearing shells and journal with a small amount of lubricating oil MIL-L-45199, and reinstall the connecting rod cap (3), washers (2), and bolts (1). Tighten the bolts in accordance with Table 9-3.

(10) Using a feeler gage, check the connecting rod side clearance. Connecting rod side clearance shall be 0.012 to 0.020 inch (0.30 to 0.51 mm), and the rods must be free to move sideways on the crankshaft (32). i the connecting rods do not move freely on the crankshaft, or the clearance is not to specifications, check for improper bearing shell installation or crankshaft thrust surface wear. Rebuild a worn crankshaft in accordance with paragraph 9-28.

(11) Repeat steps c through e, above, for each connecting rod bearing shell to be replaced.

9-22. MAIN BEARINGS REPLACEMENT.

a. General. Main bearings consist of two shells, an upper and lower. Only the upper shells of the main bearing have oil holes and therefore, are not interchangeable. Care must be taken during installation that the main bearing shell containing the oil hole is installed in the cylinder block. If a main bearing shell without an oil hole is inadvertently installed in the cylinder block, lubricating oil will be prevented from reaching the bearing shell. This will result in burned bearing shells and a severely damaged crankshaft. If the main bearing shells are serviceable, replace them in the same main bearing bores from which they were removed. To avoid nicks, scratches, and contamination, keep the handling of bearing shells to a minimum.

b. Inspection. Inspection of main bearing shells is accomplished during the replacement procedure in accordance with step d, below.

c. Remove.

CAUTION

To avoid crankshaft or bearing damage, each main bearing shell must be removed and Installed before proceeding to the next bearing shell. Start at No.1 bearing shell, and match-mark the bearing caps to the cylinder block If necessary.

(1) Remove the main bearing side-lock capscrews (14, Figure 9-24) and lockwashers (15) from both sides of cylinder block (58).
(2) Remove the capscrews (16) and washers (17) securing the main bearing cap (1 8) to the cylinder block (58).
(3) Using main bearing cap puller ST-1116 or a small pry bar, remove the main bearing cap (18).
(4) Remove the lower main bearing shell (19 or 20) from the cap (18) and, if damaged, remove the dowel (21).
(5) Fabricate a removal tool in accordance with Figure 9-33.
(6) Install the removal tool in the lubrication hole in the crankshaft (32, Figure 9-24) and rotate the crankshaft so the flat of the removal tool contacts the edge of the bearing shell (22 or 23) opposite the tang on the bearing shell (Figure 9-33). Rotate the crankshaft to remove the bearing shell.

d. Inspect.

WARNING

Dry cleaning solvent PD-680, Type Ill, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection is required to avoid Injury to personnel.

(1) Being careful not to mix or interchange the bearing shells (19, 20, 22, and 23). Clean each bearing shell in filtered solvent PD-680, Type II, or equivalent, and dry carefully.
(2) Visually inspect each bearing shell for defects and signs of uneven wear. Interpret bearing shell appearance as follows:
   (a) Bearing shells that have been operating at the correct clearance and with adequate lubrication, will have a dull gray color. Bearing shells having a black surface, or showing varnish build-up, have been running at excessive clearance and shall be replaced.
   (b) Bearing shells that show bright shiny spots or areas, have been running at insufficient clearance and shall be replaced. If the bright areas appear along one edge of the bearing shell, misalignment exists. Check the main bearing bores for alignment in accordance with paragraph 9-31.
   (c) Bearing shells that are flaked, scored, galled, or show visible, embedded dirt particles shall be replaced.

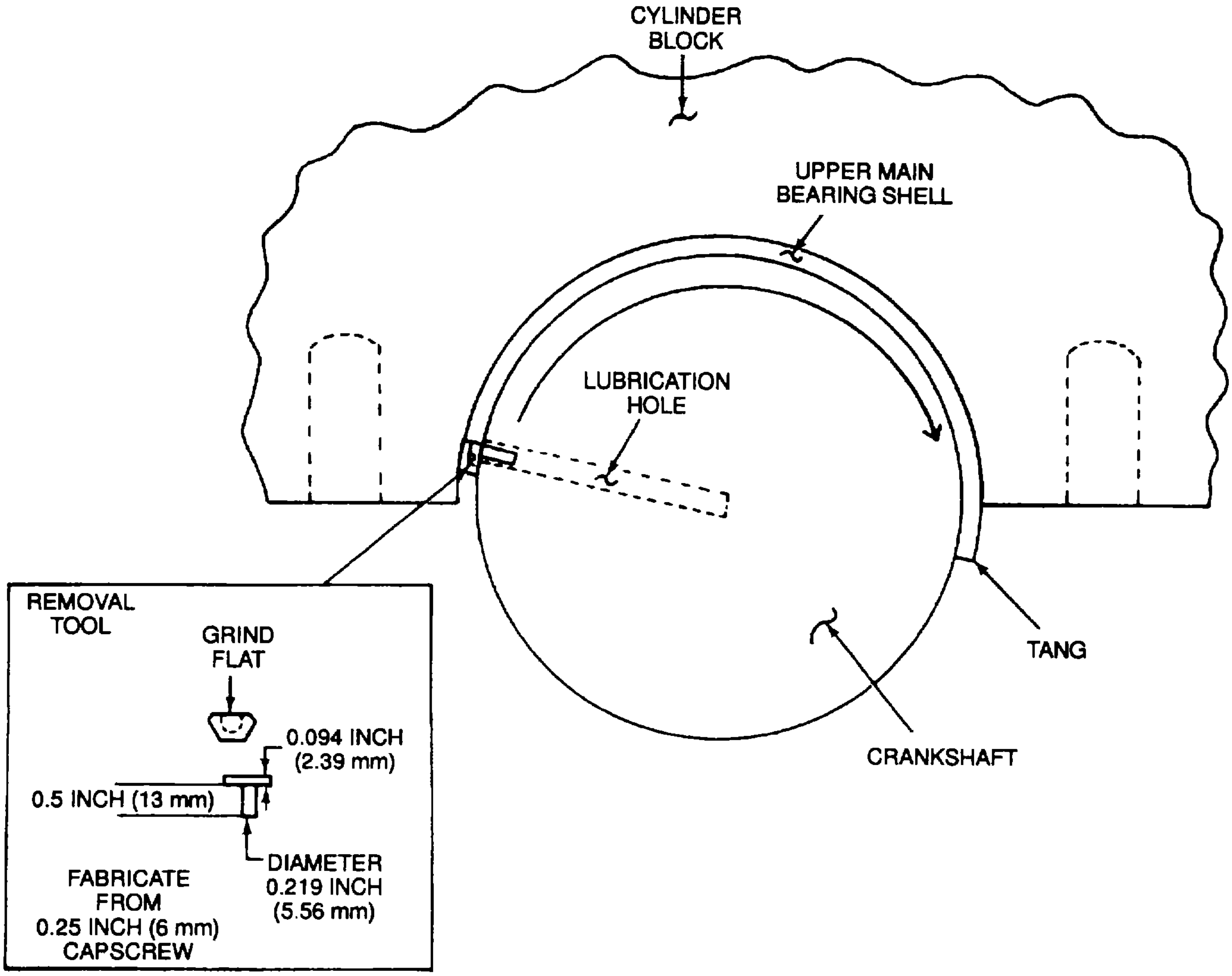


Figure 9-33. Removing Upper Main Bearing Shell with Fabricated Removal Tool

(3) Using a micrometer having a ball anvil, measure each bearing shell. Minimum thickness for main bearing shells shall be in accordance with Table 1-4. If either shell of a bearing set is under the minimum thickness, replace both shells.

(4) Inspect the crankshaft journals and thrust flange as follows:

(a) Visually inspect the journal for cracks, nicks, pitting, scoring, or grooving. Replace the crankshaft in accordance with paragraph 9-27 if cracked. Rebuild the crankshaft in accordance with paragraph 9-28 if surface defects are over 0.003 inch (0.08 mm) deep.

(b) Using a main bearing journal micrometer, check the journal for wear, out-of-round, and taper. Rebuild the crankshaft in accordance with paragraph 9-28 if it is worn more than the limits specified in Table 1-4, out-of-round more than 0.002 inch (0.05 mm), or tapered more than 0.0005 inch (0.013 mm) over the full length of the journal.

e. Install.

CAUTION

To avoid damage to the upper main bearing shells during Installation, the services of two technicians will be required. Be sure the bearing shells are not Interchanged. The upper main bearing shell has a drilled hole to allow passage of lubricating oil, and must be Installed in the cylinder block If the lower, undrilled bearing shell is installed in the block, severe crankshaft damage will result.

(1) Lightly lubricate the crankshaft journal with a small amount of lubricating oil, MIL-L-2104, position the upper main bearing shell (22 or 23) against the crankshaft (32) with the tang of the bearing opposite the tang recess in the cylinder block (58).

(2) Have an assistant slowly rotate the crankshaft (32) counterclockwise (when viewed from the front of engine) while maintaining upward, rotational pressure on the bearing shell (22 or 23).

(3) Work the bearing shell (22 or 23) around the crankshaft (32) by hand while the crankshaft is being turned.

(4) As the bearing shell (22 or 23) approaches its final position, make sure the tang is aligned with the tang slot in the cylinder block (58). If necessary, have the assistant rock the crankshaft back-and-forth while applying side pressure on the bearing shell to align the slot and tang.

(5) If the bearing shell (22 or 23) cannot be completely installed using steps (9), (10), and (11), above, use the removal tool (Figure 9-33) to install the shell as follows:

  (a) Work the main bearing shell (22 or 23, Figure 9-24) around the crankshaft (32) at least 135 degrees. Not more than 2.5 inches (63.5 mm) of the bearing shell should protrude, and the tang must be exactly aligned with the slot.

  (b) Install the removal tool (Figure 9-33) in the crankshaft (32), and have the assistant rotate the crankshaft slowly while holding the installation tool in place. Be extremely careful that the tang and slot remain in alignment as the bearing shell is brought to its final position.

(6) If removed, install the dowel (21) in the main bearing cap (18).

CAUTION

Before Installing the lower bearing shell in the cap, be sure all traces of dirt or foreign material Is removed from both cap and bearing shell. Even a small amount of foreign matter trapped between the bearing and cap will decrease bearing shell-to-journal clearance and will result in premature wear or burned bearings shells.

(7) Install the bearing shell (19 or 20) in the main bearing cap (18). Be sure the bearing is firmly seated in the cap. Do not lubricate the bearing shell at this time.

CAUTION

To avoid a false clearance measurement and subsequent engine damage, the following procedure is necessary when using Plastigage to check bearing shell clearance.

(8) Rotate the crankshaft so that the counterweight next to the main bearing shell being checked is facing down. Using a small hydraulic jack, under the counterweight, support the crankshaft (32) so that it is seated firmly against the upper bearing shell (22 or 23).

NOTE

Plastigage is available in three clearance ranges: Type PG-1 (green) for a clearance range of 0.001 to 0.003 inch (0.025 to 0.076 mm); Type PR-1 (red) for a clearance range of 0.002 to 0.006 inch (0.051 to 0.152 mm); Type PB-1 (blue) for a clearance range of 0.004 to 0.009 inch (0.102 to 0.229 mm). Select the range needed for the clearance being checked in accordance with Table 14.

(9) Place a strip of Plastigage across the entire width of the bearing shell in the cap (see A, Figure 9-32).

NOTE

Before installing the main bearing capscrews (16, Figure 9-24) and washers (17), coat the threads of the capscrews with dean engine lubricating oil, MIL-L-2104, and coat the washers and underside of the bolt heads with SAE 140W lubricant, MIL-L-2105.

(10) Being careful not to dislodge the Plastigage, install the bearing cap (1 8, Figure 9-24), washers (1 7), and capscrews (16). Cross-tighten the capscrews evenly to 120 to 130 pound-feet (163 to 176 newton-meters). Tighten the capscrews completely in accordance with Table 9-4. Do not install the main bearing sidelock capscrews (1 4) at this time.

(11) Remove the capscrews (16), washers (17), and main bearing cap (18), and compare the width of the Plastgage to the graduations on the Plastgage envelope (see B, Figure 9-32). This is the main bearing journal clearance and must conform to the specifications in Table 1-4.

(12) If the clearance is under the specifications given in Table 1 4, remove the bearings shells (19 and 22, or 20 and 23, Figure 9-24) and check the oversize bearing shells, or the presence of foreign matter between the bearing shells and the cap (18) or the bearing bore in the cylinder block (58).

(13) If the clearance is over the specifications given in Table 1-4, install new bearing shells (19 and 22, or 20 and 23) and re-check the clearance. It the clearance is still excessive, rebuild the crankshaft in accordance with paragraph 9-28.

CAUTION

Before Installing the main bearing capscrews (16), washers (17), main bearing side-lock capscrews (14), and lockwashers (15), coat the threads of the capscrews with clean engine lubricating oil MIL-L-9000, and coat the washers and underside of the capscrew heads with SAE 140W lubricant MIL-L-2105. Failure to use lubricant will result In Improper torque and possible engine damage due to loosening of the capscrews.

(14) If the clearance is satisfactory, remove the jack supporting the crankshaft. Remove all traces of Plastigage from the bearing shell and crankshaft journal, lubricate the bearing shell and journal with a small amount of lubricating oil MIL-L-2104, and reinstall the main bearing cap (18) using washers (17) and capscrews (16). Tighten the capscrews (16) and install the side-lock capscrews (14) and lockwashers (15) as follows:

(a) Cross-tighten the main bearing capscrews (16) evenly to 120 to 130 pound-feet (163 to 176 newton-meters).

(b) Install the lockwashers (15), side-lock capscrews (14), and tighten both capscrews to 5 to 10 pound-feet (7 to 14 newton-meters).

(c) Tighten the main bearing capscrews (16) and side-lock capscrews (14) in accordance with Table 9-4.

(15) Check to be sure that the crankshaft (32) rotates freely without binding at any point.

(16) Replace the other main bearing shells (19, 20, 22, and 23) in accordance with steps (a) through (e), above.

Table 9-4. Main Bearing Capscrew Tightening Sequence and Torque

STEP	PROCEDURE FIG. REF. Figure 9-24	TORQUE* POUND-FEET (NEWTON-METERS)
1	Cross-tighten both capscrews (16)	120 to 130 (163 to 176)
2	Install right and left side capscrews (14)	5 to 10 (7 to 14)
3	Cross-tighten both capscrews (16)	190 to 200 (258 to 271)
4	Cross-tighten both capscrews (16)	440 to 450 (597 to 610)
5	Loosen both capscrews (16)	Remove all tension
6	Cross-tighten both capscrews (16)	190 to 200 (258 to 271)
7	Cross-tighten both capscrews (16)	440 to 450 (597 to 610)
8	Tighten all right bank capscrews (1 4)	150 to 160 (203 to 217)
9	Tighten all left bank capscrews (14)	150 to 160 (203 to 217)
10	Tighten all right bank capscrews (14)	325 to 335 (441 to 454)
11	Tighten all left bank capscrews (14)	325 to 335 (441 to 454)

*Before installing capscrews (14 and 16) and washers (15 and 17), coat the threads of the capscrews with dean engine lubricating oil, MIL-L-2104, and coat the washers and underside of the capscrew heads with SAE #140W lubricant, MIL-L-2105.

(17) Attach a dial indicator to the cylinder block (58), and index it on the front of the crankshaft (32). Pry the crankshaft to the front of the engine to remove all end play.

NOTE

To move the crankshaft completely to the front or rear of the engine, it may be necessary to rotate the crankshaft while prying.

(18) Zero the dial indicator, pry the crankshaft (32) toward the rear of the engine to remove all end play, and read the crankshaft end clearance on the dial indicator. Crankshaft end clearance must be in accordance with Table 1 4.

(19) Thrust bearings (26) are available in different thicknesses to correct crankshaft end clearance. If the crankshaft end clearance is not to the specifications shown in Table 1-4 replace the thrust bearings as follows:

(a) Remove the capscrews (24), and remove the retainer plate (25).

(b) Pry the crankshaft (32) toward the rear of the engine, and remove the thrust bearing (26) at the front of the crankshaft thrust flange.

(c) Pry the crankshaft (32) toward the front of the engine, and remove the thrust bearing (26) at the rear of the crankshaft thrust flange.

(d) Visually inspect the thrust flange for cracks, nicks, pitting, scoring, or grooving. Replace the crankshaft in accordance with paragraph 9-27 if cracked. Rebuild the crankshaft in accordance with paragraph 9-28 if surface defects are over 0.003 inch (0.08 mm) deep.

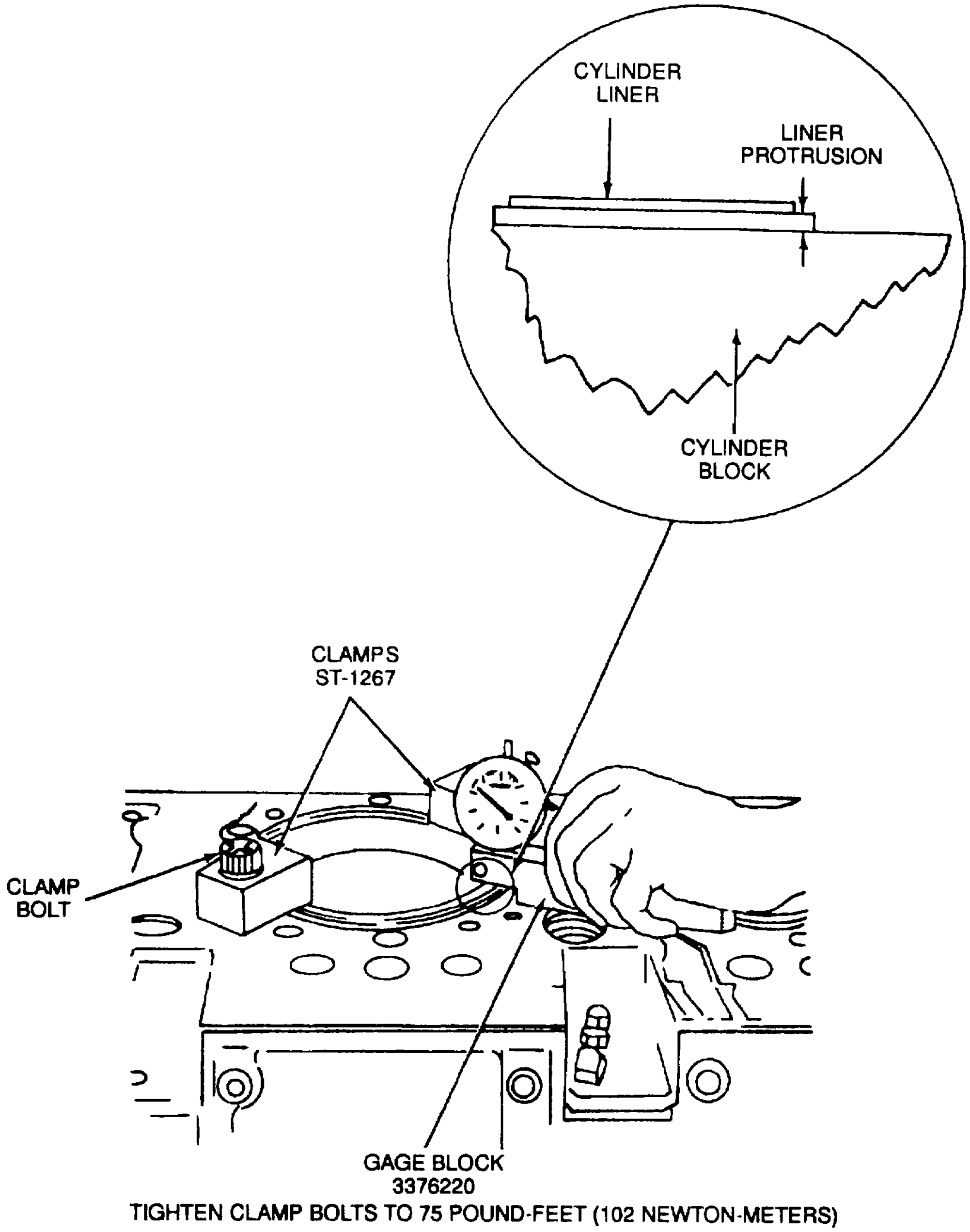


Figure 9-34. Checking Cylinder Liner Protrusion

(e) Using a micrometer caliper, measure the thickness of the thrust bearings (26), and select replacement bearings that will restore crankshaft end clearance to the specifications given in Table 1-4.

(f) Lubricate replacement thrust bearings (26) with lubricating oil, MIL-L-2104, pry the crankshaft (32) toward the front of the engine, and install one thrust bearing (26) at the rear of the crankshaft thrust flange.

(g) Pry the crankshaft (32) toward the rear of the engine, and install the other thrust bearing (26) at the front of the crankshaft thrust flange.

(h) Install the retainer plate (25) using capscrews (24). Tighten capscrews to 20 to 25 pound-feet (27 to 34 newton-meters).

(20) Recheck the crankshaft end clearance in accordance with steps (17) and (18), above.
(21) Install the inspection covers in accordance with paragraph 9-37.

CAUTION

Serious engine damage will result If the engine Is started before the lubrication system Is properly filled and primed. Elapsed time between priming the lubrication system and starting the engine shall not exceed 3 hours. If, for whatever reason, the engine cannot be started within 3 hours after priming the lubrication system, repeat the entire priming procedure just prior to starting the engine.

(22) Prime the lubrication system in accordance with the Operator and Organizational Maintenance Manual.

9-23. CYLINDER LINERS AND SEALS INSPECTION.

a. Remove the cylinder heads in accordance with paragraph 9-5.
b. Rotate the crankshaft so that the piston is at BDC, and visually inspect the liner bore for scoring, grooving, erosion, or pitting. Replace any cylinder liner that shows defects over 0.003 inch (0.08 mm) in depth.
c. Inspect the area near the top flange for evidence of cracking. Replace cracked liners.
d. Check the liner bore for wear, taper, and out-of-round using a dial bore gage or inside micrometer. Replace cylinder liners that are worn larger than the limits specified in Table 1-4.
e. Install the cylinder liner damps ST-1 267 and check the liner protrusion with gage block3376220 as follows (see Figure 9-34):
   (1) Position the damps on the cylinder liner flange 180 degrees apart with the damp holes centered on the threaded capscrews holes in the cylinder block. Install the cylinder damp bolts provided, and tighten evenly to 75 pound-feet (102 newton-meters).
   (2) Zero the dial gage of gage block 3376220 on the cylinder block surface. Be sure to hold the gage block flat on the cylinder block surface while zeroing the gage.
   (3) Move the indicator to index on the outer flange of the liner (Figure 9-34). Holding the gage block flat on the cylinder block surface, read the liner protrusion on the gage. Make three more measurements at 90 degrees intervals around the liner flange.
   (4) If the liner protrusion is not in accordance with Table 1-4, or varies more than 0.001 inch (0.03 mm), check the liner in accordance with paragraph 9-24.
f. If no further repairs are necessary, remove the liner clamps ST-1267 and install the cylinder heads in accordance with paragraph 9-10.

9-24. CYLINDER LINERS AND SEALS REPLACEMENT.

a. Remove.
   (1) Remove the piston and connecting rod assemblies in accordance with paragraph 9-20.
   (2) Wrap the crankshaft journals (32, Figure 9-24) with clean paper strips, and tape in place. This will prevent crankshaft contamination during liner removal and liner bore cleaning operations.
   (3) Remove the cylinder liners (27) using liner puller 3375629 and puller plate ST-1 209-1.
   (4) Remove and discard the bottom (red) packing (28), top (black) packing (29), and crevice seal (30) from the liner (27).
   (5) Remove the shims (if present) and insert-ring (31) from the cylinder liner counterbore in the cylinder block (58).
b. Inspect.
   (1) Inspect the cylinder liner bore in accordance with paragraph 9-23.
   (2) Clean any rust or scale from the outer diameter of the liner, and check for pitting caused by rust or corrosion. Replace the liner if the underside of the flange is pitted to any extent. Replace the liner if the outer diameter in any area (other than the underside of the flange) is pitted deeper than 0.0625 inch (1.59 mm).
   (3) Using an outside micrometer, check the thickness of the outer flange (A, Figure 9-35) at 90 degree intervals. Do not include the bead on top of the liner flange when taking the measurement. Replace the liner if the flange thickness is not in accordance with the dimensions given in Figure 9-35.

NOTE

Two types of cylinder liners may be encountered: On engines manufactured before July 1980, to engine number 33103621 the liners press into the top counterbore of the cylinder block (B, Figure 9-35). On later engines, the liners press into the secondary bore of the cylinderblock (C, Figure 9-35). Accept or reject the cylinder liner in accordance to either step (4) or step (5), below, as applicable.

(4) Check the outer diameter of the cylinder liner flange (B, Figure 9-35). Replace the liner if the diameter is not in accordance with the dimensions given in Figure 9-35.

(5) Check the diameter of the cylinder liner at C, Figure 9-35. Replace the liner if the diameter is not in accordance with the dimensions given in Figure 9-35.

(6) Check the liner for cracks using magnetic particle inspection in accordance with MIL-L-6868; pay particular attention to the comer area under the flange. Replace the liner if cracked.

(7) Check the cylinder block liner counterbore, secondary liner bore, and lower liner bore in accordance with paragraph 9-31.

(8) Clean and prepare cylinder block for liner installation in accordance with paragraph 9-31.

c. Clean.

CAUTION

To avoid scratching the bore, use a fiber brush only. DO NOT use a wire brush to dean the bore.

(1) Clean each new or acceptable liner with detergent and hot water. Scrub the bore thoroughly with detergent solution and a bristle brush, and rinse with hot water.

(2) Oil the bore with dean lubricating oil, and let it stand for 5 minutes.

(3) Wipe the bore with dean white paper towels, and examine the towels for a gray or black deposit I a gray or black deposit is noted, repeat the oiling and wiping procedure until the towels remain dean after wiping.

(4) Re-oil the bore, and store the liner in a dean plastic bag until ready for installation.

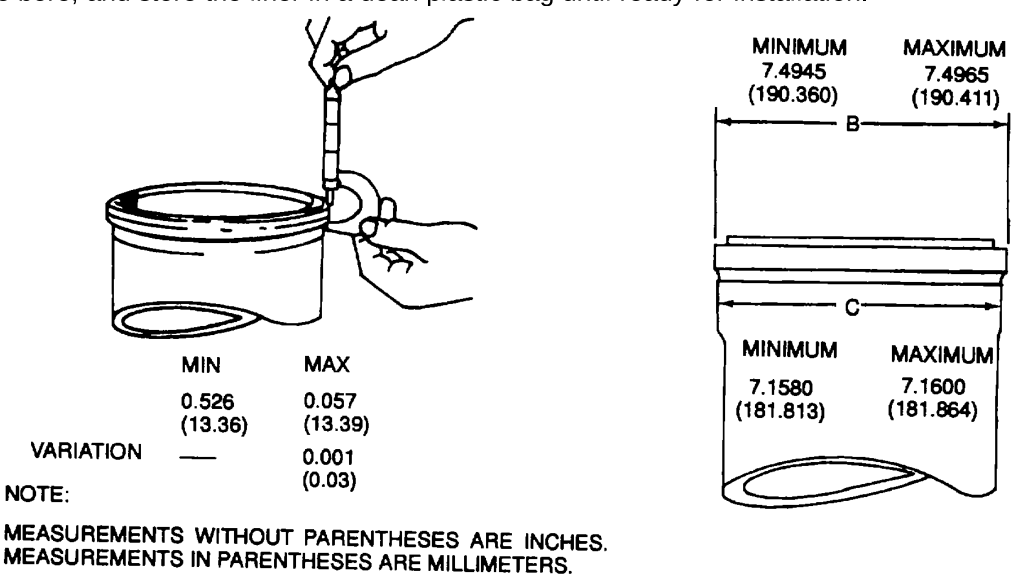


Figure 9-35. Cylinder Liner Measurements

d. Install.

(1) Refer to step (11), below, and install the cylinder liner (27, Figure 9-24) in the cylinder block(58) without the crevice seal or packings, and check the liner-to-block clearance in the lower bore with a feeler gage (see Figure 9-36). It is desirable that the clearance be in accordance with Table 1-4. It is permissible, however, for a new liner to contact with the bore provided that the liner is not warped out-of-round because of heavy contact. I contact is noted, check the liner for out-of-round with a dial bore gage. If the liner is out-of-round over 0.002 inch (0.05 mm) in the packing area, repair the lower bore in accordance with paragraph 9-31.

(2) Remove the cylinder liner (27, Figure 9-24) from the cylinder block (58) in accordance with step a(3), above, and check the counterbore depth (Figure 9-37) in the block using 3376220 or a depth micrometer.

(3) Measure the thickness of the liner flange (A, Figure 9-35), insert ring (31, Figure 9-24), and shims (if used).

(4) Add the thickness of the insert-ring (31) and shims (if used) to the flange thickness of the liner (27), and subtract the depth of the counterbore (insert-ring + shims + liner flange counterbore depth). The obtained is the liner protrusion, and must be 0.005 to 0.007 inch (0.13 to 0.18 mm). Refer to Table 9-5, and add or subtract shims as necessary to obtain the correct liner protrusion.

(5) Apply a 1/16 inch bead of silicone 3801048 in the counterbore of the cylinder block (58), and install the insert-ring (31) in the counterbore of the cylinder block. If necessary, add shims as selected in step (4), above Shims, if used, shall be installed between the insert-ring (31) and the liner flange.

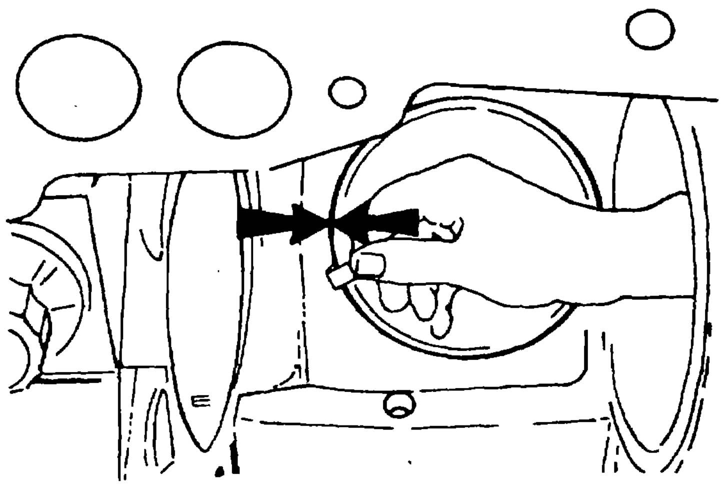


Figure 9-36. Checking Cylinder Liner To Lower Bore Clearance

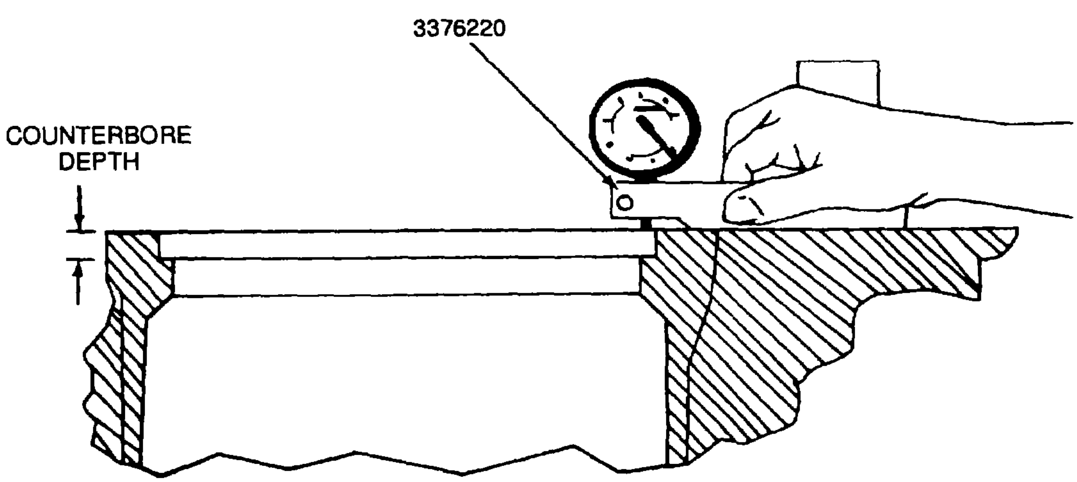


Figure 9-37. Checking Cylinder Block Counterbore Depth

Table 9-5. Cylinder Liner Counterbore Shims

PART NO.	MINIMUM INCH (mm)	MAXIMUM INCH (mm)
205741	0.0063 (0.160)	0.0077 (0.196)
205742	0.0072 (0.183)	0.0088 (0.224)
205743	0.0081 (0.206)	0.0099 (0.251)
205744	0.018 (0.46)	0.022 (0.56)
205745	0.028 (0.71)	0.034 (0.86)
205746	0.056 (1.42)	0.068 (1.73)

NOTE

Just prior to installation, lubricate the crevice seal (30) and packings (28 and 29) with dean lubricating oil, MIL-L-9000.

(6) Install the crevice seal (30) on the liner (27). Be sure the seal is seated squarely and firmly on the liner and the chamfered edge faces toward bottom of liner.

CAUTION

To avoid coolant leaks and subsequent engine damage, do not over stretch or twist the packings during Installation, and be careful to avoid cutting or nicking the packings on sharp edges.

(7) Install the top (black) packing (29) in the top groove of the liner (27) next to the crevice seal (30).
(8) Install the bottom (red) packing (28) in the lower groove of the liner (27).
(9) Observe the mold marks on the packings (28 and 29) to be sure the packings are not twisted. Straighten the packings as required.
(10) Apply 1/16 inch bead of silicone 3801048 to lower flange of cylinder liner (27). Lubricate the liner bore in the cylinder block (58) with dean lubricating oil, MIL-L-2104, and install the liner (27) in the bore. Push the liner down carefully by hand until the packings (28 and 29) enter the lower bore in the block. If difficulty is encountered, remove the liner and check for improper seal or packing installation.
(11) With the liner (27) firmly seated in the bore by hand, use liner installation tool 3375422, and complete the liner installation as follows:
   (a) Position plate 3375424 on top of the liner (27).
   (b) Center the bridge assembly 3375423 over the plate 3375424 and secure it with cylinder head capscrews.

CAUTION

To avoid damage to the tool, liner, or cylinder block, do not tighten the bridge center bolt over 50 pound-feet (68 newton-meters) when seating the liner.

   (c) Tighten the center bolt on the bridge assembly until the liner is seated in the bore. Do not exceed a torque of 50 pound-feet (68 newton-meters) on the bridge center bolt.
   (d) Remove liner installation tool 3375422.

(12) Install hold-down clamps ST-1 267 on the liner (27), and check the liner protrusion in accordance with paragraph 9-23, step e. If necessary, adjust the liner protrusion to 0.005 to 0.007 inch (0.13 to 0.18 mm) using shims selected from Table 9-5. If the liner protrusion is satisfactory remove damps ST-1 267.

(13) Check the liner (27) for out-of-round at several points in the piston travel area. A new liner shall not be out-of-round more than 0.002 inch (0.05 mm) in the packing area, nor more than 0.003 inch (0.08 mm) in the top 1 inch (25 mm) of piston travel.

(14) If the liner (27) is out-of-round over the permissible limits, check the liner-to-block clearance in accordance with step (1), above. If the liner bears against block more than when first checked in step (1), above, remove the liner and check for improper seal or packing installation.

(15) If the liner protrusion and out-of-round is within specifications, remove the protective covering from the crankshaft journals, and install the connecting rod and piston assemblies in accordance with paragraph 9-20.

SECTION V. MAINTENANCE OF CRANKSHAFT

9-25. GENERAL. This section covers the inspection, replacement, and rebuild of the crankshaft. Adhere to the specifications and tolerances given in Table 1-4. Keep all parts dean during assembly; dirt and foreign material are a major cause of crankshaft and other internal part failures.

9-26. CRANKSHAFT INSPECTION. On-engine inspection of the connecting rod and main bearing journals, and thrust flange is accomplished during bearing shell replacement. Inspect the crankshaft journals and thrust flange in accordance with paragraphs 9-21 and 9-22.

9-27. CRANKSHAFT REPLACEMENT.

a. Remove.

(1) Remove the engine from the generator set in accordance with paragraph 2-15.

(2) Install the engine in rebuild stand 3375955.

(3) Remove the timing gears and housing in accordance with paragraph 9-18.

(4) Remove the flywheel in accordance with paragraph 9-34.

(5) Remove the flywheel housing and rear gear housing in accordance with paragraph 9-35.

(6) Remove the oil pan in accordance with paragraph 9-38.

(7) Remove the connecting rod and piston assemblies in accordance with paragraph 9-20.

(8) Remove the main bearing side-lock capscrews (14, Figure 9-24) and lockwashers (1 5) from both sides of the engine.

(9) Remove the main bearing capscrews (16) and washers (17).

NOTE

Before removing the main bearing caps (18), check that they are match-marked to the cylinder block. Caps must be match-marked to ensure installation in the same location as removed.

(10) Using puller ST-1116 or a pry bar, remove the main bearing caps (18).

(11) Remove the capscrews (24) and retainer plate (25), and remove the thrust bearings (26). Mark the thrust bearings as to front or rear location.

WARNING

The weight of the crankshaft Is approximately 850 pounds (383 kg). Use of a lifting device not rated for this weight may result In damage to components or Injury to personnel.

CAUTION

To avoid damage to the crankshaft journals, do not use an unpadded chain or cable sling on the journals. Pad the chain or cable slings with sections of coolant hose of a suitable diameter.

(12) Using a padded sling around a connecting rod journal at each end of the crankshaft (32), lift the crankshaft straight up out of the cylinder block (58) using an overhead hoist.

CAUTION

If at any time during the following procedures work Is suspended, the crankshaft must be stored In a vertical position. Allowing the crankshaft to lie flat with unsupported main bearing journals may cause misalignment.

(13) Remove the crankshaft from the sling, and store it in a vertical position.

NOTE

As the main bearing shells are removed, mark the location on each shell with a felt tip pen, and tape the two halves of each set together.

(14) Remove the main bearing shells (19 and 20) from the cap (18), and the main bearing shells (22 and 23) from the cylinder block (58).

b. Clean and Inspect.

(1) Clean and inspect the crankshaft in accordance with paragraph 9-28.

(2) Clean and inspect the connecting rod and main bearing shells in accordance with paragraphs 9-21 and 9-22.

c. Install.

CAUTION

Improper bearing shell Installation will cause severe engine damage. No.1 and No. 7 bearing sets are 0.125 Inch (3.18 mm) narrower than bearing sets 2, 3, 4, 5, and 6 and must be installed at the number 1 and 7 locations. Upper main bearIng shells (22 and 23, Figure 9-24) have lubrication holes and grooves, and must be Installed In the cylinder block. Before Installing bearing shells, clean all dirt and foreign matter from bearing shells, cylinder block, and bearing caps. Even small amounts of foreign matter trapped between the lower bearing shell and cap or between the upper bearing shell and cylinder block will reduce running clearance and result in bearing failure.

(1) Install the upper bearing shells (22 and 23) in the cylinder block (58). Be sure the bearing shells are firmly seated in the bores, and the lubrication holes are aligned. Lubricate each bearing shell with a light coat of lubricating oil, MIL-L-2104.

WARNING

The weight of the crankshaft Is approximately 850 pounds (383 kg). Use of a lifting device not rated for this weight may result In damage to components or injury to personnel.

CAUTION

To avoid damaging the crankshaft journals, do not use an unpadded chain or cable sling to Install the crankshaft. Chain or cable slings should be padded with sections of coolant hose of a suitable diameter. To prevent damage to bearIngs, the services of two technicians will be required to guide the crankshaft squarely Into place.

(2) Using a padded sling around a connecting rod journal near each end of crankshaft (32), lift the crankshaft with an overhead hoist, and lower it squarely into place in the cylinder block (58). Guide the crankshaft on each end, and ensure that it does not cock, and dislodge or damage the bearing shells during installation.

(3) Install the thrust bearings (26) with the grooved surface facing the flange on the crankshaft (32). Do not install the bearing retainer plate (25) at this time.

(4) Install the lower bearing shells (19 and 20) in the main bearing caps (18). Be sure the bearing shells are firmly seated in the caps.

5) Check the main bearing clearance with Plastigage in accordance with paragraph 9-22.

CAUTION

Before Installing the main bearing capscrews (I6), washers (17), main bearing side-lock capscrews (14), and lockwashers (15), coat the threads of the capscrews with clean engine lubricating oil, MIL-L-2104, and coat the washers and underside of the bolt heads with SAE 140W lubricant, MIL-L-2105. Failure to do so will result In improper torque and possible engine damage due to loosening of the capscrews.

(6) Lubricate the bearing shells (19 and 20) and crankshaft journals with a light coat of engine lubricating oil, MIL-L-2104, and install the main bearing caps (18), washers (17), and capscrews (16). Tighten the capscrews to 120 to 130 pound-feet (162 to 176 newton-meters).

(7) Lubricate and install the lockwashers (15) and side-lock capscrews (14), and tighten to 5 to 10 pound-feet (7 to 14 newton-meters).

NOTE

This is not the final torque on capscrews (16) and sidelock capscrews (14). Install all main bearing caps and check the end clearance before tightening to final torque.

(8) Check the crankshaft end clearance and correct if necessary, in accordance with paragraph 9-22.

(9) Install the retainer plate (25) and secure it with capscrews (24). Tighten the capscrews to 20 to 25 pound-feet (27 to 34 newton-meters).

(10) Torque the main bearing capscrews (16) and side-lock capscrews (14) in accordance with Table 9-4.

(11) Install the connecting rod and piston assemblies in accordance with paragraph 9-20.

(12) Install the flywheel housing and rear gear housing in accordance with paragraph 9-35.

(13) Install the flywheel in accordance with paragraph 9-34.

(14) Install the bearing gear housing and timing gears in accordance with paragraph 9-18.

(15) Remove the engine from the rebuild stand and install it in the generator set in accordance with paragraph 2-15.

CAUTION

Serious engine damage will result If the engine Is started before the lubrication system Is properly filled and primed. Elapsed time between priming the lubrication system and starting the engine shall not exceed 3 hours. If, for whatever reason, the engine cannot be started within 3 hours after priming the lubrication system, repent the entire priming procedure just prior to starting the engine.

(16) Before starting the engine, fill and prime the lubrication system in accordance with the Operator and Organizational Maintenance Manual.

9-28. CRANKSHAFT REBUILD.

a. General. No loss of strength occurs when a crankshaft is properly ground to a standard undersize. It is of extreme importance, however, that the procedures set forth in this paragraph be adhered to as closely as possible. The procedures must also be combined with good judgment and the common sense of the regrind operator in order to produce a reconditioned crankshaft that is dependable. Successful rebuild of crankshafts is dependent upon the following factors: (1) Adequate equipment, and personnel proficient in its use.

(2) Thorough cleaning and inspection prior to rebuilding in order to eliminate those shafts that are damaged beyond rebuilding capabilities

(3) Adherence to rebuilding specifications and limits applying to inspection, alignment, straightening, dimensions, surface finish, balance, and identification of undersizes.

(4) Thorough cleaning after rebuilding operations.

CAUTION

If at any time during the following rebuilding procedures work Is suspended the crankshaft must be stored In a vertical position. Do not allow the crankshaft to lie flat. Allowing the crankshaft to lie flat with unsupported main bearing journals, may cause misalignment. The only exception to this Is when the crankshaft Is mounted to a crankshaft grinding machine, and the main bearing journals are supported by steady rests.

NOTE

Before proceeding with disassembly, cleaning, and major inspection, perform a preliminary inspection in accordance with paragraphs 9-21 and 9-22. If visible cracks are evident, or journals are obviously damaged beyond rebuilding, discard the crankshaft.

b. Disassemble.

(1) If defective, remove the crankshaft gear in accordance with paragraph 9-18.

(2) Remove the pipe plugs (1, Figure 9-38) from the crankshaft oil galleries.

(3) Number and match-mark the counterweights (3) to the crankshaft so that they may be assembled in the same position as removed.

(4) Remove the capscrews (2), and remove the counterweights (3), using a soft hammer.

WARNING

Dry cleaning solvent PD-680, Type III, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

WARNING

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.

c. Clean. Clean the crankshaft and counterweights thoroughly using solvent PD680, Type III, or equivalent. Pay particular attention to the drilled oil passages in the crankshaft. These passages are best cleaned with an electric drill and a valve guide cleaning brush. Flush all passages thoroughly with solvent after several passes with the brush; repeat until the solvent runs clean. After cleaning, blow out the passages with compressed air, and run a small magnet though the oil passages to remove any metal partides that may remain.

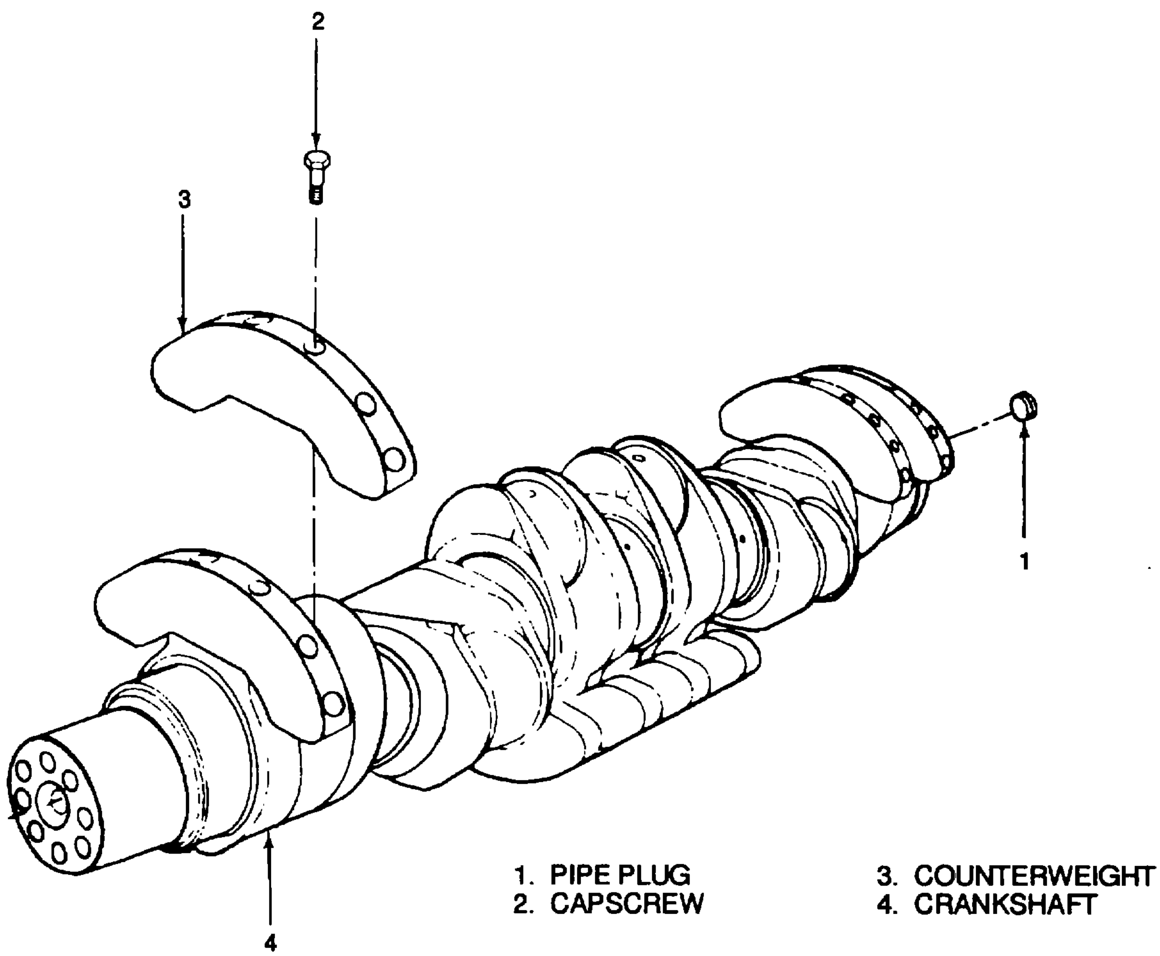


Figure 9-38. Disassembly and Assembly of Crankshaft

d. Inspect.

(1) Support the crankshaft in V blocks and use a dial indicator to check full length alignment (A, Figure 9-39), short bend alignment (B), and nose section and flywheel pilot runout (C).

(2) If the TIR for full length alignment exceeds 0.002 inch (0.05 mm), straighten the crankshaft in accordance with step e, below.

(3) If the TIR between adjacent main bearing journals exceeds O.002 inch (0.005 mm) correct for short bend alignment in accordance with step e, below.

(4) If the TIR of the nose section or flywheel pilot exceeds 0.001 inch (0.03 mm), correct the runout in accordance with step e, below.

(5) If the crankshaft gear was not removed, position the dial indicator on the gear teeth and check the runout. If the TIR exceeds 0.001 inch (0.03 mm), remove the gear in accordance with paragraph 9-18, and check the gear step in accordance with step (6), below.

(6) Visually inspect the gear step for physical damage, and measure the step size (A, Figure 9-40) and keyway width (B).

(7) If the step size and keyway width are not in accordance with the dimensions given in Figure 9-40, the step shall be chrome-plated and ground to size in accordance with step f, below.

(8) Inspect the counterweight capscrew holes and pipe plug holes for damaged or stripped threads. The repair of stripped threads shall be limited to three repairs per crankshaft. Repair stripped holes in accordance with paragraph 2-12.

(9) Inspect the front and rear seal surfaces for grooving caused by the seal lip. If grooving exceeds 0.005 inch (0.13 mm), install a wear sleeve in accordance with paragraph 9-28.

(10) Using an outside micrometer, measure and record the connecting rod and main bearing journal diameters (Figure 9-41). Using these measurements, determine the feasibility of using the crankshaft as is, or grinding to one of the standard undersizes given in Figure 9-41. Grind the journals as necessary in accordance with step f, below.

(11) If any journals show a blue or straw discoloration, heat damage may have occurred. Test these journals using scleroscope hardness tester ST-1196. Crankshaft surface hardness should be 40 to 52 Rockwell, and core hardness is approximately 26 Rockwell. Make several tests in different areas of the suspected journal until consistent readings are obtained. If any area tests below 40 Rockwell, mark that journal for a trial grind and retest. In many cases heat damage is restricted to the surface and the crankshaft can be saved.

(12) Inspect the crankshaft using fluorescent magnetic partide inspection in accordance with MIL-1-6868. Use magnetic inspection unit MIL-M-6867, Type Ill, having a contact head opening of 96 inches (243.8 cm) and a 20 inch (50.8 cm) coil. Mount the crankshaft between the contact heads and inspect as follows:

  (a) Apply at least three successive head shots of 1800 amperes for a duration of 1/2 second each.

  (b) Examine the crankshaft under black light for longitudinal cracks in accordance with A, Figure 9-42. The limits of acceptability shall be in accordance with Figure 9-43. Replace the crankshaft if it is defective.

  (c) Apply at least eight coil shots along the length of the crankshaft using 4500 to 5000 ampere turns.

  (d) Examine the crankshaft under black light for transverse cracks in accordance with B, Figure 9-42. The limits of acceptability shall be in accordance with Figure 943. Replace the crankshaft if it is defective.

  (e) If the crankshaft is acceptable, degauss it by activating the demagnetizing cycle before removing it from the inspection unit. Test for residual magnetism at several locations using a magnetic field indicator. The residual magnetism shall not exceed 3 oersteds (239 A/m).

(13) If the crankshaft is to be returned to service at this point, dean it thoroughly in accordance with step c, above.

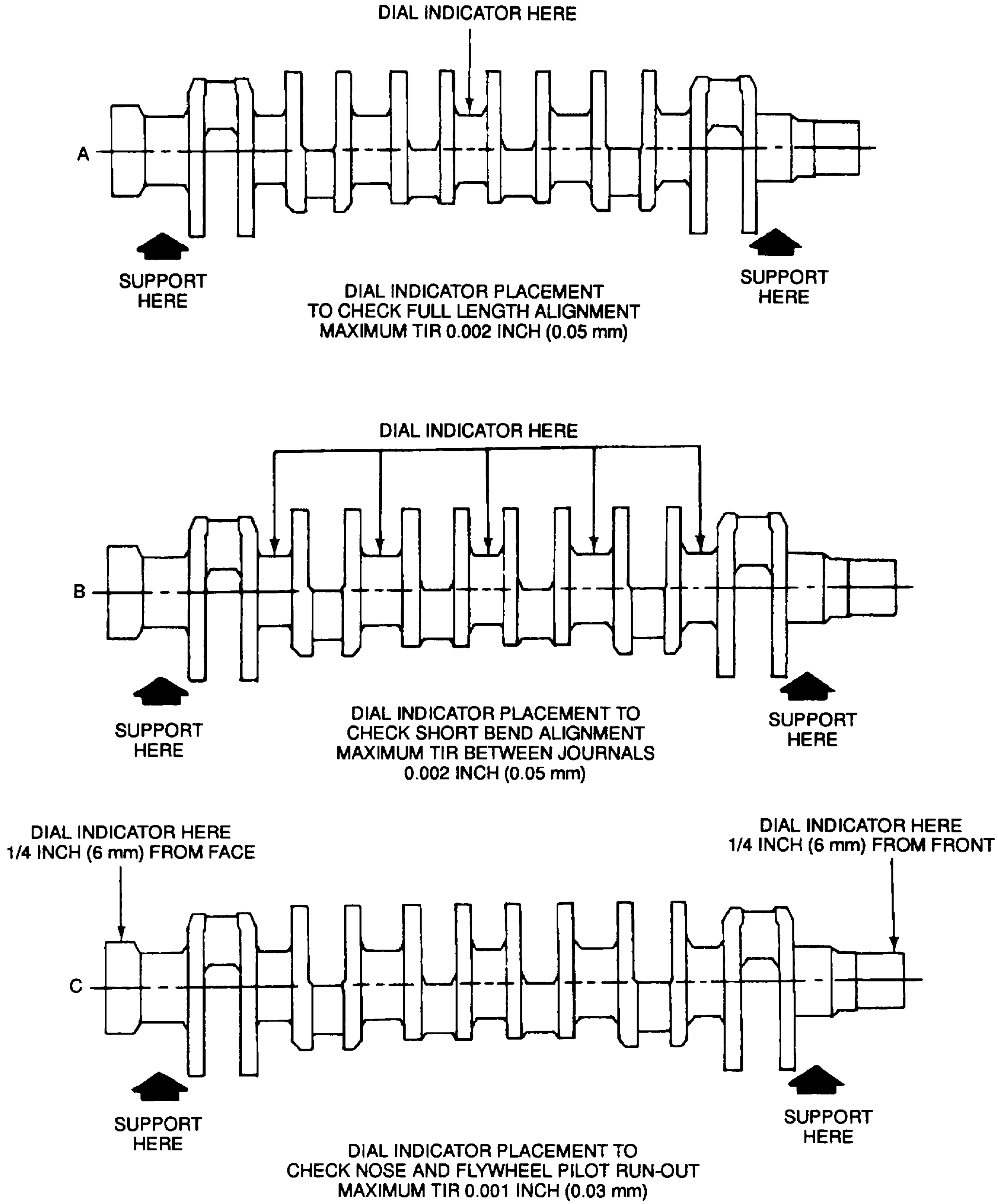


Figure 9-39. Crankshaft Alignment Checks

e. Cold Straightening. Before straightening a crankshaft, a thorough assessment in accordance with step d, above, should be made to determine the location and type of bend. Short bend misalignment, for example, is associated with overheating damage to a rod bearing journal. Several damaged rod bearing journals may cause compound bends, or bends in different directions at different points in the crankshaft. A bend at a rod bearing journal is usually in the plane of the throw. In many cases, this, and other types of misalignment, can be ground out when regrinding the main journals rather than straightening. The amount of misalignment that can be ground out depends on the undersize to which the main journals are to be ground. For example, if a crankshaft is to be ground 0.010 inch (0.25 mm) undersize on the mains, a little less than 0.005 inch (0.13 mm) full length misalignment could be eliminated by grinding rather than straightening. Good judgment must be exercised when straightening a crankshaft. Straightening requires metal deformation, and the risk of cracking or breaking the crankshaft increases with the amount of straightening necessary. It is, therefore, important to weigh this risk before deciding to straighten the crankshaft; straightening shall be held to a minimum. Tests show that a crankshaft with a full length misalignment of up to 0.005 inch (0.13 mm) TIR can be run in an engine with little adverse effect. Thus, unless it is necessary to regrind the main journals, a crankshaft with some misalignment can be reused with less risk than d it is straightened. Straightening should be accomplished using hydraulic straightening press MIL-P-801 78 or an equivalent crankshaft straightening press with a bed that will allow the ram to traverse a length of at least 70 inches (1 78 cm). Straighten a bent crankshaft as follows:

(1) Support the crankshaft in the straightening press on No. 1 and No. 7 main bearing journals (Figure 9-44):

CAUTION

Extreme caution is necessary to prevent over straightening and damage to the crankshaft. Because of spring back, the crankshaft must be deflected considerably more than the amount of the misalignment. It is advisable to add the load slowly and to stop and check frequently to determine the amount of additional straightening required.

(2) Check the runout of each unsupported main bearing journal to find the point of greatest runout. Apply the straightening load at this point in a direction opposite to the misalignment (A and B, Figure 9-44).

(3) Release the straightening load, and check the TIR of the crankshaft. Reapply the straightening load as necessary until the TIR of the crankshaft is within 0.002 inch (0.05 mm) for both full length and short bend alignment (Figure 9-39 and Figure 9-44).

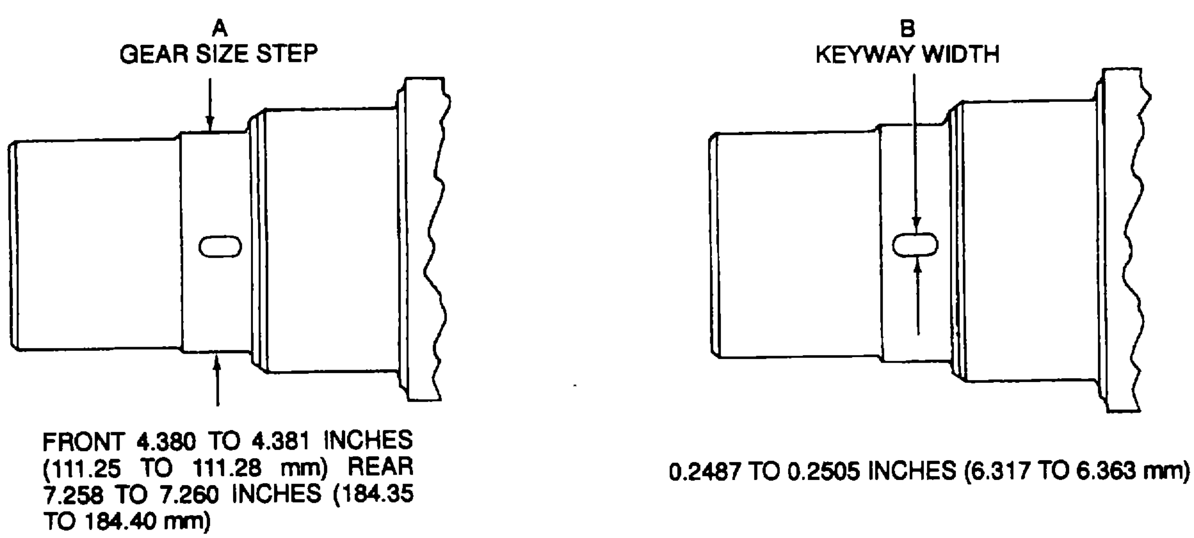
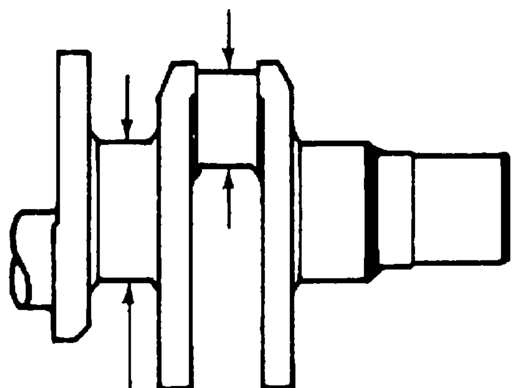


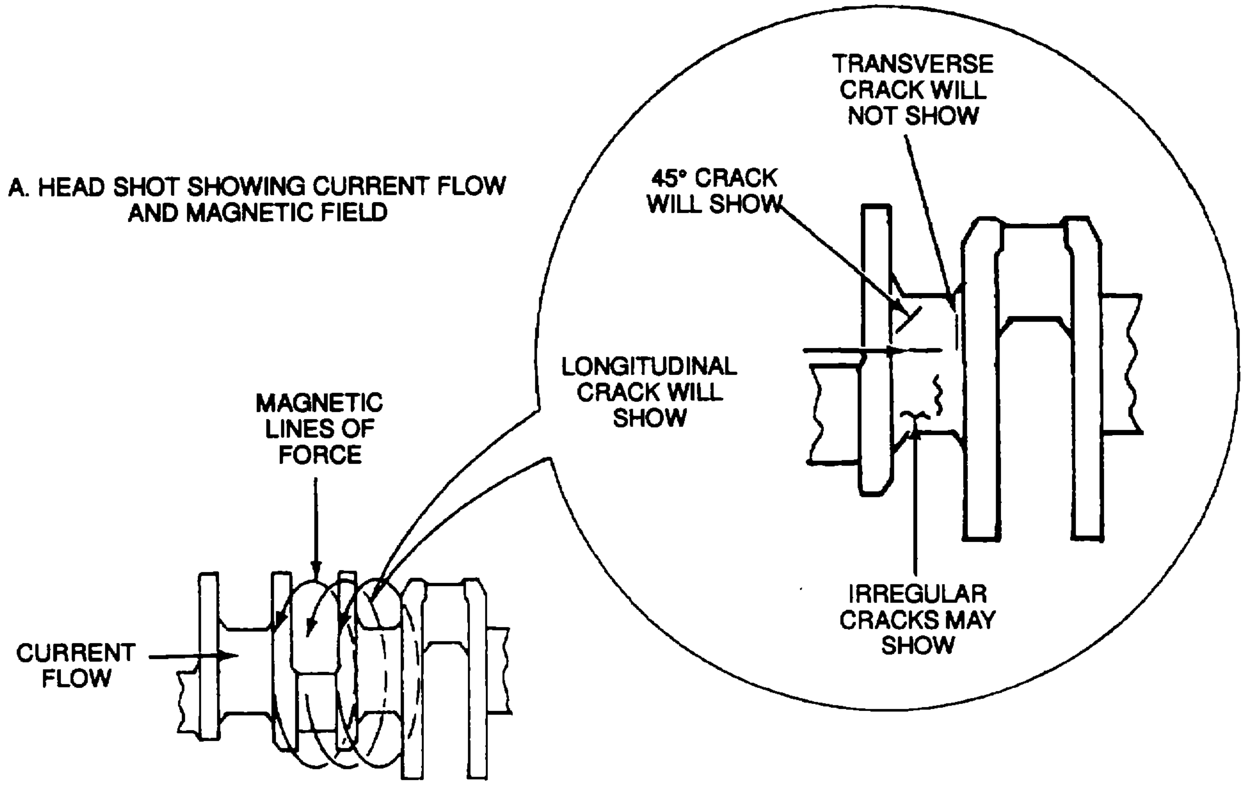
Figure 9-40. Measurement of Gear Step Size and Keyway Width

ROD BEARING JOURNAL DIMENSIONS							
	NEW STANDARD	WEAR LIMIT					
INCH MILLIMETER	4.238 TO 4.250 107.90 TO 107.95	4.246 107.85					
				STANDARD UNDERSIZES			
INCH 0.010 mm 0.25	WEAR LIMIT	INCH 0.020 mm 0.51	WEAR LIMIT	INCH 0.030 mm 0.76	WEAR LIMIT	INCH 0.040 mm 1.02	WEAR LIMIT
4.238 TO 4.240 107.65 TO 107.70	4.236 107.59	4.228 TO 4.230 107.39 TO 107.44	4.226 107.34	4.218 TO 4.220 107.14 TO 107.09	4.216 107.19	4.208 TO 4.210 106.88 TO 106.93	4.206 106.83



MAIN BEARING JOURNAL DIMENSIONS							
	NEW STANDARD	WEAR LIMIT					
INCH MILLIMETER	6.498 TO 6.500 165.05 TO 165.10	6.497 165.02					
				STANDARD UNDERSIZES			
INCH 0.010 mm 0.25	WEAR LIMIT	INCH 0.020 mm 0.51	WEAR LIMIT	INCH 0.030 mm 0.76	WEAR LIMIT	INCH 0.040 mm 1.02	WEAR LIMIT
6.488 TO 6.490 164.80 TO 164.85	6.487 164.77	6.478 TO 6.480 164.54 TO 164.59	6.477 164.52	6.468 TO 6.470 164.29 TO 164.34	6.467 164.26	6.458 TO 6.460 164.03 TO 164.08	6.457 164.01

Figure 9-41. Crankshaft Journal Measurements



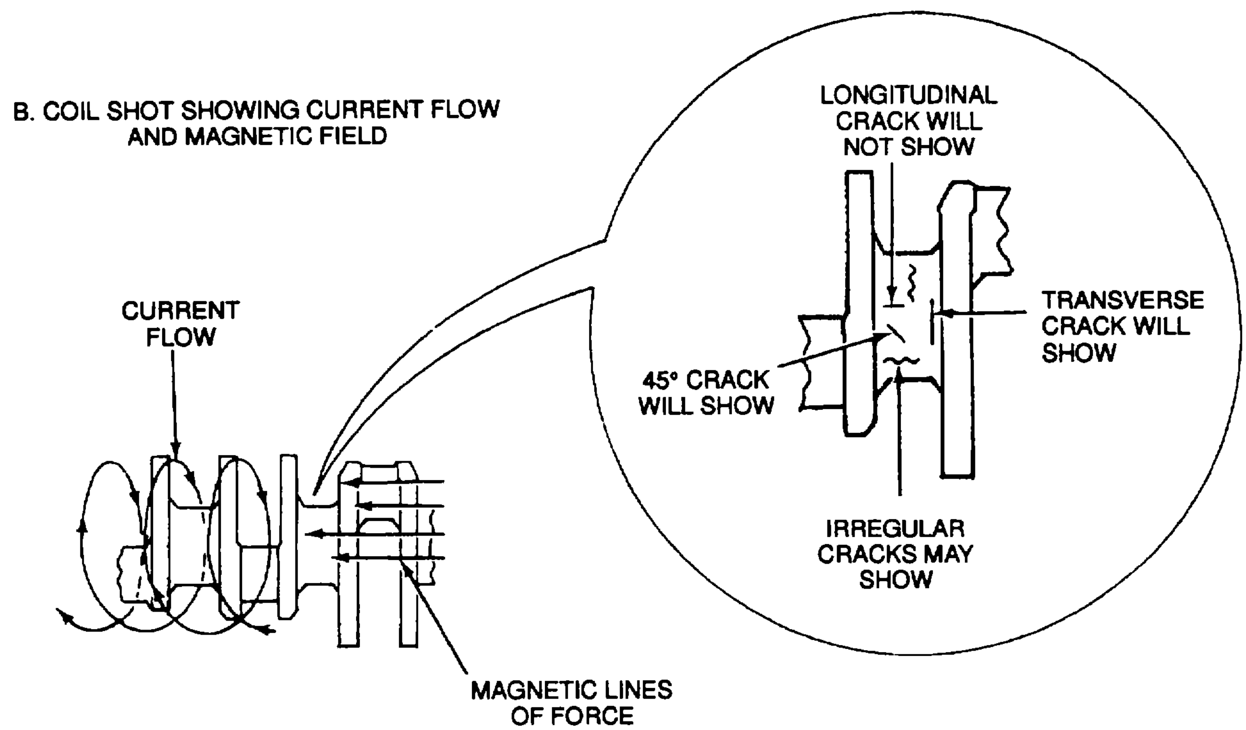
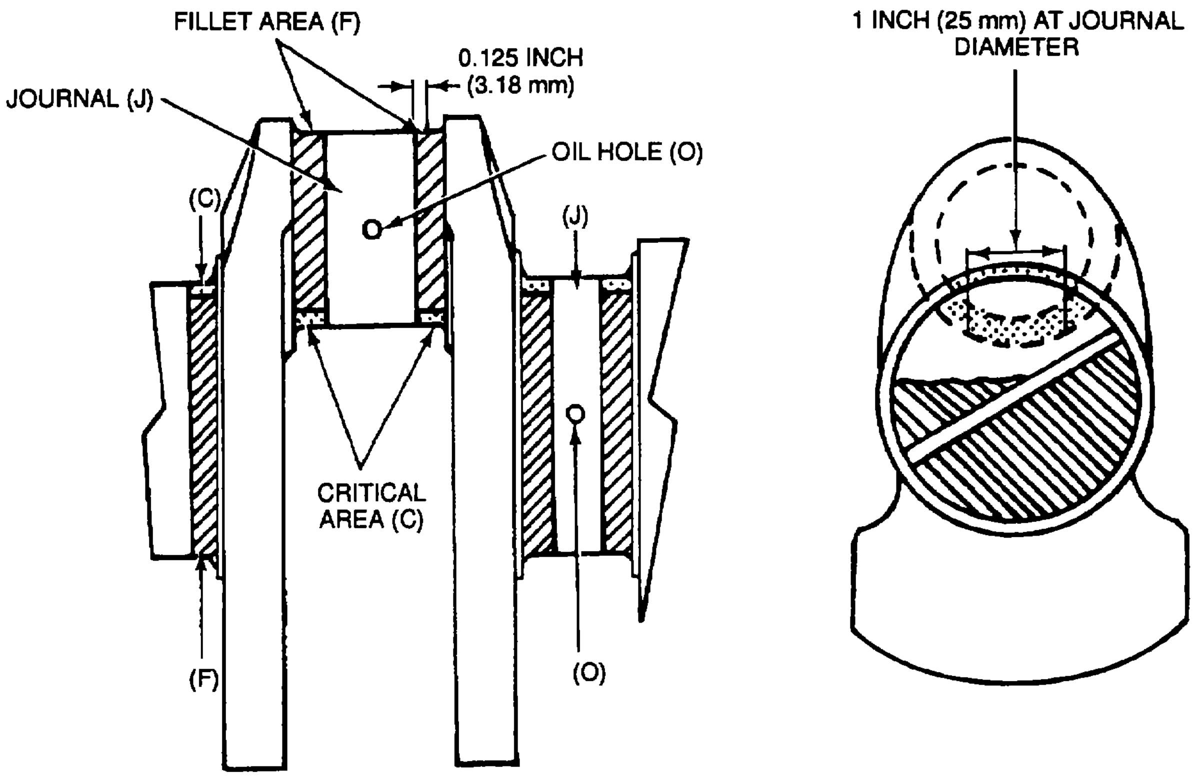


Figure 9-42. Magnetic Inspection of Crankshaft



MAGNETIC INSPECTION LIMITS OF ACCEPTABILITY

CRITICAL AREA (C) - NO CRACKS ARE PERMISSIBLE IN THIS AREA.

FILLET AREA (F) - NO TRANSVERSE OPEN OR SUBSURFACE INDICATIONS ARE PERMISSIBLE IN THIS AREA. SUBSURFACE, LONGITUDINAL CRACKS LESS THAN 0.25 INCH (6.35 mm) MAY BE ACCEPTED.

OIL HOLE (O) - NO CRACKS ARE PERMISSIBLE IN AN AREA OF 0.25 INCH (6.55 mm) RADIUS AROUND THE HOLE.

JOURNAL AREA (J) - OTHER THAN OIL HOLE OR FILLET AREA - NO OPEN INDICATIONS ARE PERMISSIBLE.

NO TRANSVERSE OPEN OR SUBSURFACE INDICATIONS ARE PERMISSIBLE.

LONGITUDINAL SUBSURFACE CRACKS LESS THAN 0.25 INCH (6.35 mm) MAY BE ACCEPTED.

Figure 9-43. Magnetic Inspection Limits of Acceptability

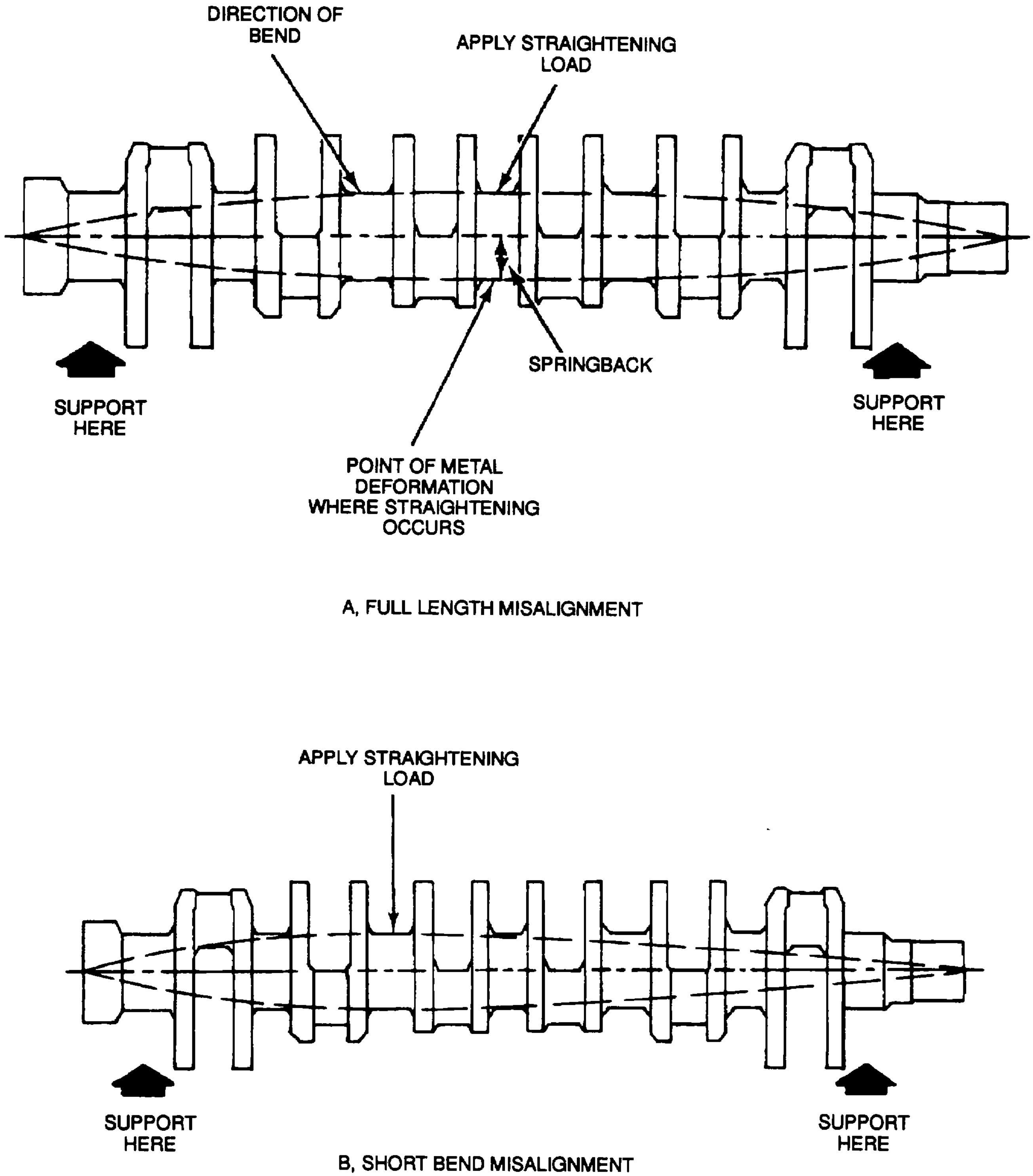


Figure 9-44. Straightening Crankshaft

NOTE

These limits may be exceeded if the remaining misalignment is to be ground out of the main bearing journals.

(4) Crankshaft straightening may cause increased runout of the nose section and flywheel pilot. Excessive runout at these points may be corrected by applying the straightening load to No. 2 main journal to straighten the nose section runout, or No. 6 main journal to straighten the crankshaft pilot runout (Figure 9-45).

(5) After straightening, the TIR of either the nose section or crankshaft pilot shall not exceed 0.001 inch (0.03 mm).

NOTE

In performing any of the straightening operations above, the alignment of other sections of the crankshaft may be adversely affected. Repeat the straightening procedures as necessary until the crankshaft is within acceptable limits.

(6) Inspect the crankshaft in accordance with step dNO TAG, above, to detect cracks which may have been caused by the straightening operation. Replace the crankshaft if unacceptable cracks are detected.

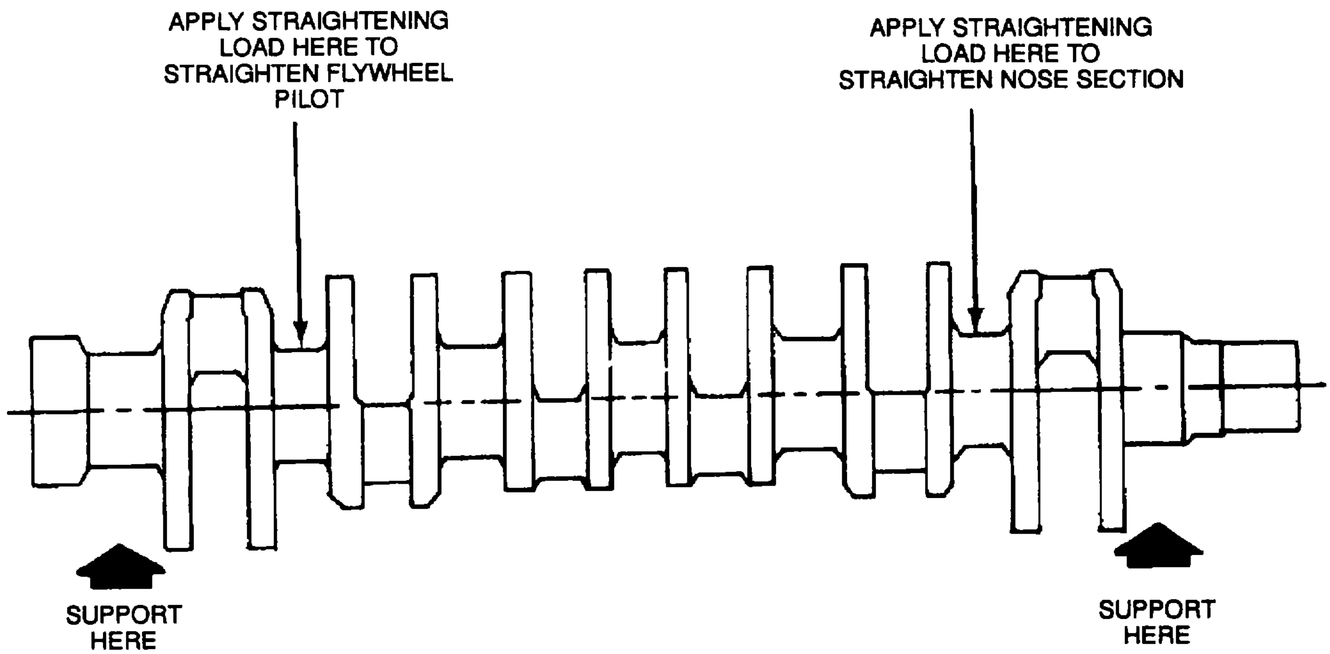


Figure 9-45. Straightening Nose Section and Flywheel Pilot Run-out

f. Grind Journals.

WARNING

The weight of the crankshaft Is approximately 850 pounds (383 kg). Use of a lifting device not rated for this weight may result in damage to components or injury to personnel.

(1) General. A number of precautions should be exercised to hold the risk of grinder bums damage to a minimum. These precautions are necessary in both the choice of equipment, and in the grinding procedure.

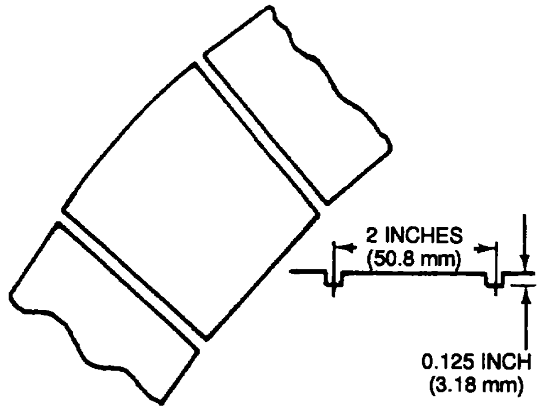


Figure 9-46. Grooved Sidewall Grinding Wheel

(a) Use a grooved grinding wheel to specifications 6A-60K6-V22. Each side wall of the wheel shall have radial grooves approximately 0.125 inch (3.18 m) deep and spaced about 2 inches (50.8 mm) apart at the face (Figure 946). The grooves help prevent grinding wheel loading, and effectively reduce grinding temperatures.

(b) The wheel guard must have an efficient air baffle and side washer equipment (Figure 9-47). Grinding wheels are porous and centrifugal forces tend to pump air through the wheel and blow the coolant away from the grinding area. The air baffles and side washers supply coolant to displace the air being pumped through the wheel.

(c) The grinding machine coolant flow must be sufficient to supply the side washers and main jet with an ample volume of coolant.

(d) The procedural steps, that must be observed to reduce the risk of grinder bum damage are as follows:

1 When feeding the grinding wheel into the journal bossing wall, do not exceed a feed rate of 0.001 inch (0.025 mm) per second.

2 The grinding wheel surface speed shall be 6500 feet (1981 m) per minute with the crankshaft rotating at 50 rpm.

WARNING

Grinding operations create airborne, abrasive dust, and particles. Respiratory and eye protection is required to prevent Injury to personnel.

(2) Dress grinding wheel. Dress the radii of the grinding wheel to blend smoothly with the sides and face of the wheel. Failure to properly dress the radii will result in a small barely visible groove in the wheel. This will form a stress riser in the journal that can lead to breakage of the shaft. Dress the grinding wheel as follows:

(a) Use an industrial diamond in the wheel dresser that has been lapped to a cone having a 75 degrees included angle with a point radius of 0 .005 to 0.025 inch (0.001 to 0.64 mm). The point of the cone is to be on the centerline of the shank (Figure 9-48).

NOTE

The point of the diamond must be on a radial line from the pivot center of the dressing device so that the radii generated on the grinding wheel will blend smoothly to both the side and face of the wheel. The dressing tool must have stops to limit the travel of the diamond point to exactly 90 degrees to the face and sides of the wheel (Figure 9-49).

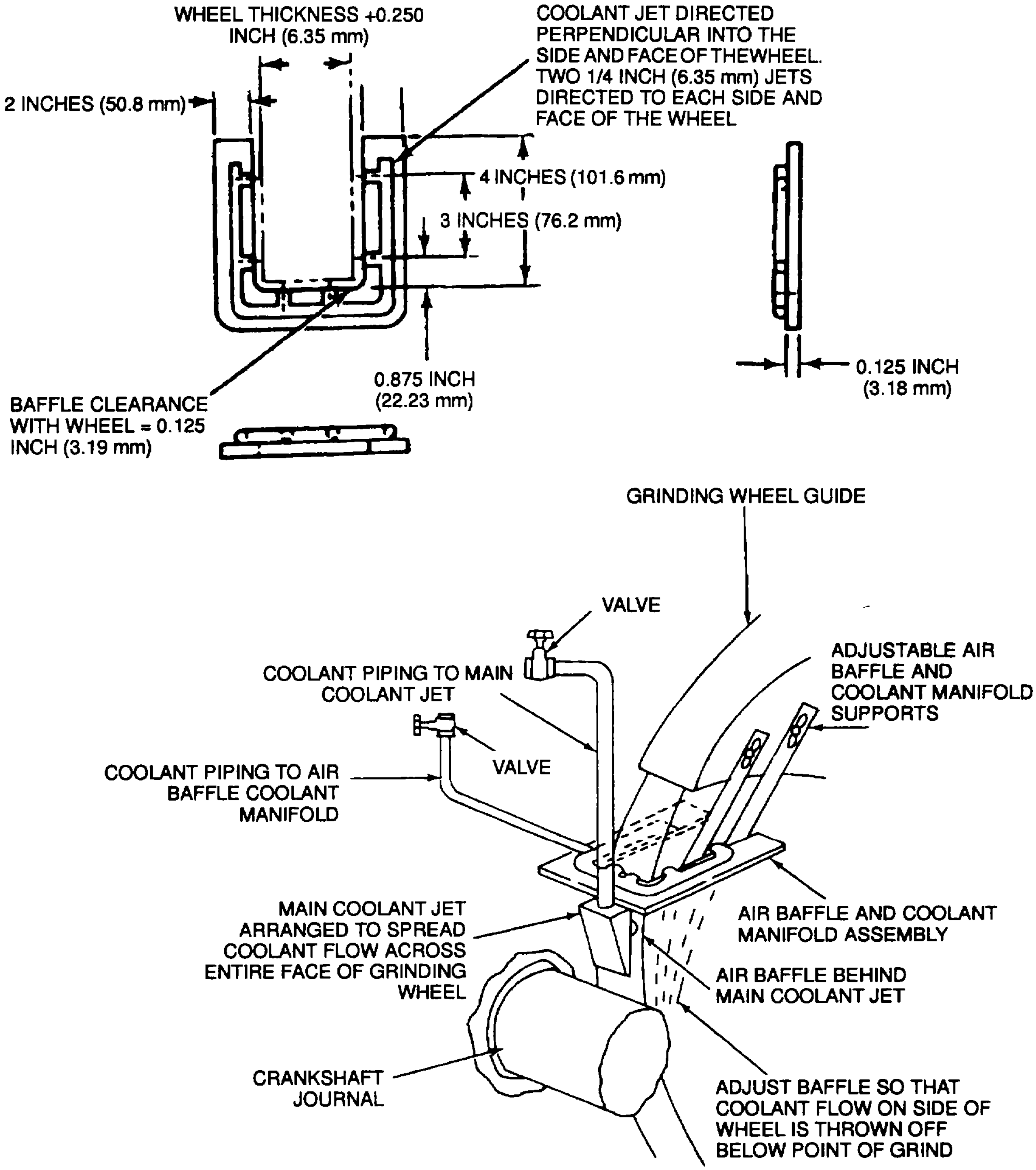


Figure 9-47. Air Baffle and Side Washer Equipment

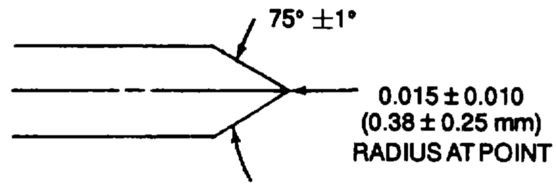


Figure 9-48. Wheel Dressing Tool

(b) Clamp the wheel dressing tool into position on the grinding machine.

(c) Adjust the diamond in the wheel dressing tool to form a radius of 0.270 to 0.230 inch (6.88 to 5.84 mm) on the grinding wheel edges (Figure 9-49).

(d) Bring the grinding wheel dose to the dressing tool, align it with the center of the wheel, turn on the coolant, and start the grinding wheel.

NOTE

The speed at which the grinding wheel is fed across the wheel dressing tool will determine the surface finish on the crankshaft journal. A slow rate of feed will produce a finer surface finish than a fast rate of feed. Do not feed too slowly; a wheel surface that is too fine will increase the risk of grinder bum damage to the crankshaft journal.

(e) Feed the wheel into the dressing tool approximately 0.001 to 0.003 inch (0.03 to 0.08 mm) and traverse the wheel across the dressing tool.

(f) Repeat step (e), above, until smooth and true grinding wheel surface is produced.

(g) After making the final cut, set the index on the feed to 0. This will bring the wheel back to the same position for dressing the radii of the wheel.

(h) Back the wheel out approximately 0.002 inch (0.05 mm) and install pins in the dressing fixture to provide an exact 90 degree sweep of the tool.

(i) Starting with the tool on the side of the wheel, traverse the wheel over until it just contacts the tool, and lock the traverse in this position.

(j) To dress the radius, slowly pivot the tool around the wheel until it contacts the stop. Leave the tool in this position.

(k) Feed the wheel in 0.0005 inch (0.013 mm), and make another cut on the radius. Continue to feed the wheel in 0.0005 inch (0.013 mm) at a time, and dress the radius until the wheel reaches the 0 set point of step (g), above. At this point, the radius should be smooth and properly blended with the side and face of the wheel.

(I) Back the wheel out, and dress the other radius of the wheel in accordance with steps (i), a), and (k), above.

(m) Back the wheel out, turn off the coolant, and remove the dressing tool.

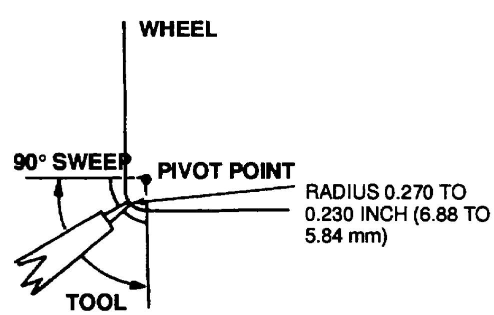


Figure 9-49. Grinding Wheel Edge Radius

(3) Using a dial indicator, check the centers on the head stock and tail stock of the crankshaft grinding machine for runout. Both head stock and tail stock must be on center within 0.001 inch (0.03 mm) TIR.

(4) Adjust the tail stock of the grinding machine to accommodate the length of the crankshaft.

(5) Adjust the crankshaft grinding machine to grind the rod bearing journals by offsetting both the head stock and the tail stock 3.125 inch (79.38 mm). Offsetting the head stock and tail stock allows the rod bearing journals of the crankshaft to turn about the centerline of the grinding machine (B, Figure 9-50).

(6) Because the crankshaft will be offset in the machine while grinding the rod bearing journals, it will be necessary to counterbalance the crankshaft with an equal amount of weight. Adjust the counterweights on the crankshaft grinding machine to counterbalance the crankshaft.

(7) Adjust the indicator on the Arnold gage to the proper journal dimension to monitor the amount of material being removed from the journal.

(8) Mount the crankshaft in the grinding machine. Locate and lock both throw heads at 0 index. Position the crankshaft in the machine with the No.1 throw (or whichever throw is to be ground first) at top center. Use a horizontal vee gage to ensure accuracy, and damp the crankshaft in position. When the throw heads of the machine are released, the crankshaft should center on the rod bearing journals.

(9) Set up the rod bearing journal to be ground using a dial indicator. To obtain an accurate reading, the crankshaft must be rotating in the machine at the speed at which it will be ground. This is important because the weight of the crankshaft is off center, and the crankshaft will tend to bow during rotation. When the grinding machine throw heads are moved to make an adjustment, both heads must be moved the same amount. This will maintain parallelism and taper within specifications. The rod bearing journals shall be on center to within 0.001 inch (0.03 mm) TIR.

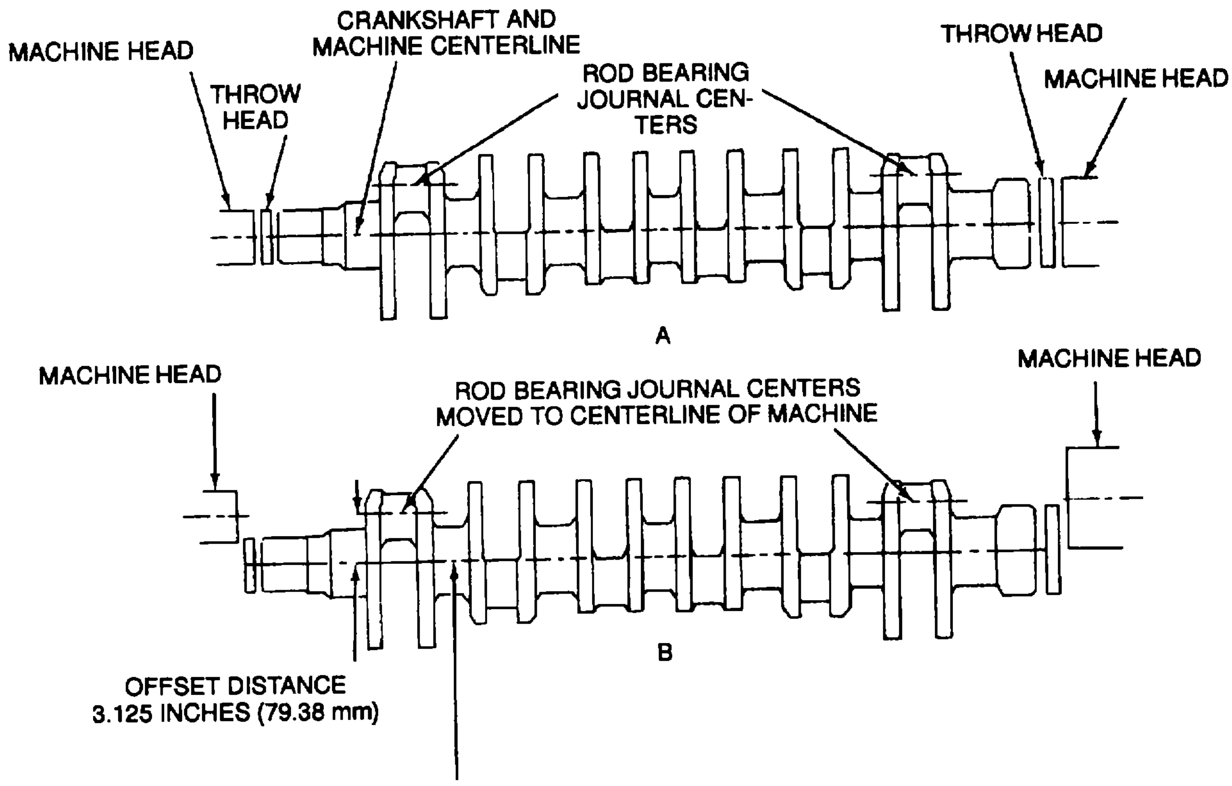


Figure 9-50. Crankshaft Offset To Grind Connecting Rod Bearing Journals

CAUTION

Excessive off-stroking changes the compression ratio of a diesel engine a significant amount. Shortening the stroke reduces the compression ration and can lead to poor ignition, hard starting and severe loss of fuel economy in cold weather. Lengthening the stroke may also cause a loss of fuel economy due to the increased friction and lower amount of air for combustion. Also a lengthened stroke may result in valve to piston interference, and overload the connecting rod bearings. Off-stroking shall be limited to shortening the stroke a maximum of 0.020 inch (0.51 mm). Lengthening the stroke is not permitted.

NOTE

The rod bearing journals may be damaged more deeply on one side than the other. The amount of grinding on these may be reduced by off-stroking or changing the crankshaft throw dimension. This will save one or more of the undersizes, and lengthen the life of the crankshaft. When off-stroking the crankshaft, both heads of the grinding machine shall be offset the same amount to ensure that parallelism and taper specifications are maintained. For smooth and efficient operation of the engine, the stroke of all throws shall be the same within 0.005 inch (0.013 mm).

(10) If the crankshaft is being off-stroked to reduce the amount of grinding needed to remove defects, move each throw head an equal amount to shorten the stroke a maximum of 0.020 inch (0.51 mm). Each additional throw shall be off-stroked the same amount to tolerance of ±0.005 inch (±0.13 mm).

(11) Install steady rests on the journals to stabilize the crankshaft during grinding. Keep a light pressure on the steady rests during grinding to support the crankshaft, but do not apply enough pressure to bow the crankshaft or cause misalignment of the journals.

(12) Using a micrometer, measure the journal to determine the undersize to which the journal should be ground (Figure 9-41). All rod bearing journals shall be ground to the same standard undersize, though not necessarily to the same undersize as the main bearing journals. Rod and main bearing journal out-of-roundness, taper, and parallelism specifications are listed in Table 9-6.

Table 9-6. Rod Bearing Journal Specifications

Out-of-Round	-	0.0005 inch (0.013 mm) TIR maximum.
Journal Taper	-	0.0005 inch (0.013 mm) TIR maximum measurable in length of journal.
Parallelism	-	0.0005 inch (0.013 mm) maximum measurable in length of journal.

(13) Determine how much material needs to be removed for standard undersize desired. For example: if the measurement shows the journal is worn 0.001 inch (0.03 mm) and the desired undersize is 0.010 inch (0.25 mm) under, set the dial indicator to show that 0.009 inch (0.23 mm) of material is to be removed.

(14) Start and adjust the grinding machine for a crankshaft speed of 50 rpm, and a grinding wheel speed of 6500 feet (1981 m) per minute.

(15) Turn on the coolant, center the wheel on the journal, and carefully bring the wheel until it just touches the journal.

(16) Traverse the wheel across the journal until it starts to grind into the fillet area of either journal, and just touches the journal side wall.

NOTE

As the wheel grinds the journal, the tension on the steady rest must be increased because of the decreasing size of the journal. This also stabilizes the journal after any high spots or out-of-round condition has been ground out.

(17) While keeping a careful check on the journal size, slowly feed the wheel in until the correct undersize has been reached, and set the index on the feed indicator to 0. Let the grinding wheel dwell at this point until spark-out occurs; this will improve the surface finish and help prevent grinder bum damage.

(18) Back the wheel out and traverse over to the other side of the journal. Feed the wheel in until it just touches the journal, and then traverse over until it just starts to grind the fillet area, and just touches the journal side wall.

(19) Feed the wheel in slowly until the feed indicator reaches 0, and spark-out has occurred. Back the wheel out, and check the journal. When checked with an outside micrometer, the journal shall be the correct undersize, and have no detectable step at the point of wheel overlap.

CAUTION

Excessive grinding of either bossing wall will allow the connecting rod to boss on the piston rather than on the crankshaft as It should. Such a condition may cause excessive oil consumption, uneven wear, or failure of the connecting rod bearings and possible seizure of the engine. Grinding of the journal bossing surfaces Is permissible as long as the dimensional tolerances (Figure 9-51) are not exceeded.

(20) If the connecting rod bossing surfaces need further grinding, traverse the grinding wheel to remove the defects. When grinding the bossing surfaces, do not exceed the dimensions given in Figure 9-51.

(21) Check the fillet radii using fillet ball gages 3375241 and 3375242 as follows (see Figure 9-52):

(a) Place the 0.230 inch (5.84 mm) ball on the journal close to the fillet, and place a light behind the ball. One dark spot will be noted at the point of contact between the ball and the journal surface.

(b) Move the ball gage toward the fillet. If the fillet is properly blended, and at or above the minimum radius, only one point of contact should show as the ball contacts the fillet area and moves up to the bossing wall (A, Figure 9-52). If two points of contact show at any part of the radius, the radius is undersize.

(c) Check the fillet with the 0.270 inch (6.86 mm) ball gage to ensure that it is not oversize. On this check two points of contact should show: one at the bottom and the other up on the side (B, Figure 9-52). If only one point of contact shows at any part of the radius, the radius is oversize.

(d) If fillet radius is incorrect, the grinding wheel was improperly dressed. Refer to step (2), above, for proper grinding wheel dressing.

NOTE

Alternate each rod bearing journal as to which cut is made first. If, on the first bearing journal, the right side was full width cut, then, on the next rod journal make the full width cut on the left side. This results in a more even breakdown of the grinding wheel and aids in producing a good surface finish on the reground journals.

(22) Grind all other connecting rod journals in accordance with steps (9) through , above.

(23) Crankshaft throw index is the relation of the crankshaft throws to each other and the front crankshaft keyway, and should be 119 degrees 49 minutes to 120 degrees 11 minutes. Any incorrect crankshaft throw index is an indication of twist that may have occurred during machining operations. For inspection purposes, check for crankshaft twist by measuring the difference between the front and rear throws as follows:

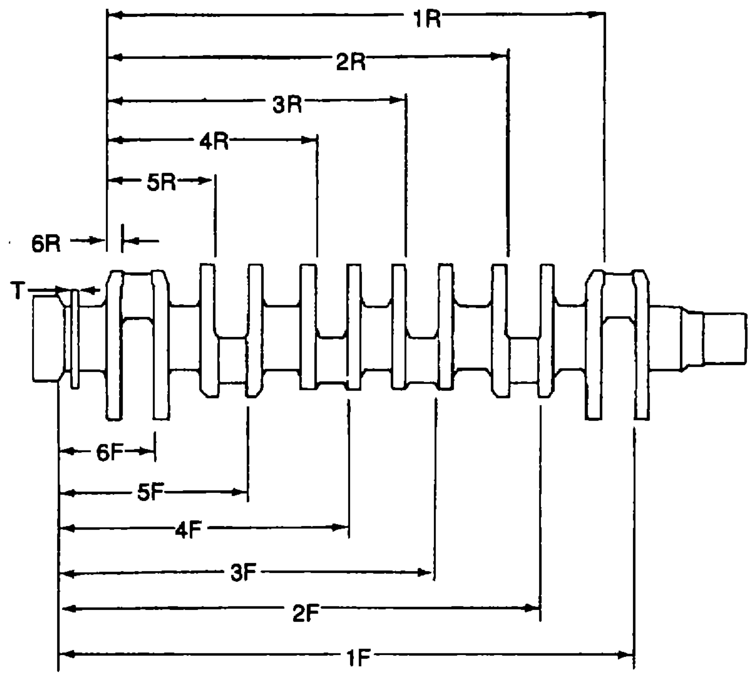
(a) Turn the crankshaft in the grinding machine so that the front throw is at top center as measured with a horizontal vee gage. Lock the crankshaft in this position and note the indicator reading.

(b) Move the horizontal vee gage to the rear throw and note the indicator reading. If the deviation from front to rear throw is over 0.033 inch (0.84 mm), the crankshaft has excessive twist and must be replaced.

NOTE

All main bearing journals on the crankshaft shall be ground to the same undersize.

(24) Move the head stock and tail stock alternately and evenly, and relocate the main bearing centerline of the crankshaft to the centerline of the crankshaft grinding machine (A, Figure 9-50).



LIMIT		1F	1R	2F	2R	3F	3R	4F	4R	5F	5R	6F	6R
NEW	INCHES	57.262	50.118	47.762	40.318	37.962	30.518	28.162	20.718	18.362	10.918	8.562	1.118
	MM	1454.45	1273.00	1213.151	1024.08	964.23	775.16	715.31	562.24	466.39	277.39	217.41	28.40
GRIND	INCHES	57.272	50.108	47.772	40.308	37.972	30.508	28.172	20.708	18.762	10.908	8.572	1.108
	MM	1554.71	1272.74	1213.41	1023.82	964.49	774.90	715.57	525.98	466.64	277.069	217.731	28.14

	T, THRUST FLANGE DIMENSIONS		STANDARD UNDERSIZES*			
	NEW	WEAR-LIMIT	0.010 INCH (0.25 mm)	WEAR LIMIT	0.020 INCH (0.51 mm)	WEAR-LIMIT
INCH	0.498 TO 0.502	0.493	0.478 TO 0.482	0.473	0.458 TO 0.462	0.453
mm	12.65 TO 12.75	12.52	12.14 TO 12.24	12.01	11.63 TO 11.73	11.51

*THESE DIMENSIONS APPLY ONLY IF BOTH SIDES OF THRUST FLANGE ARE GROUND. IF ONLY ONE SIDE IS TO BE GROUND, OR FRONT AND REAR SURFACE OF FLANGE IS TO BE GROUND TO A DIFFERENT UNDERSIZE, GRIND 0.010 INCH (0.25 mm) PER STANDARD UNDERSIZE FROM EITHER FRONT OR REAR FACE.

Figure 9-51. Connecting Rod Bossing Surface Dimensions

(25) Set the counterweights on the grinding machine back to 0 to balance the crankshaft.

(26) Using a dial indicator, set up the front and rear main journals to be on center within 0.001 inch (0.03 mm) TIR.

NOTE

Relaxing of residual stress as the crankshaft is ground will sometimes cause a crankshaft to "bow" in misalignment. If the following check shows the runout to be over 0.002 inch (0.05 mm), straighten the crankshaft in accordance with step e, above.

(27) Check the runout of the center main bearing journal. if the TIR is 0.002 inch (0.05 mm) or less, move the front and rear main bearing journals slightly off center to split the runout with that of the middle journal.

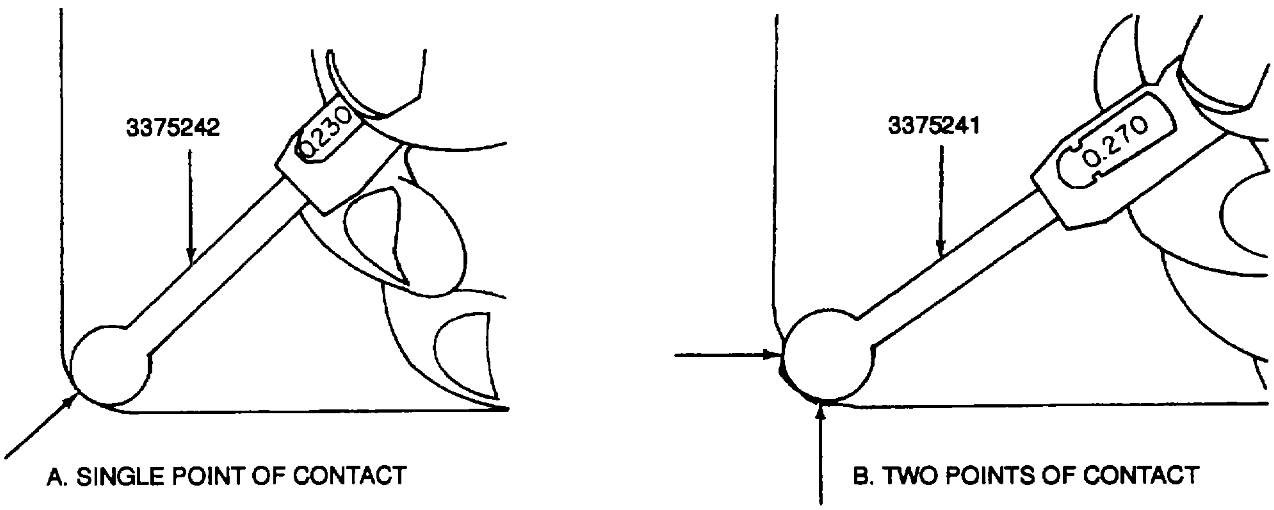


Figure 9-52. Checking Fillet Radius

NOTE

It is preferable to grind the center main bearing journal first. If some other main bearing journal is damaged raising a question as to what undersize is necessary, support the center main bearing journal while the damaged main journal is ground. Before installing the steady rest, the center main bearing journal should be touched with the grinding wheel to dean up and remove any out-of-roundness in the journal. With the indicator set up to show runout and the crankshaft turning slowly, apply support pressure with the steady rest until the indicator shows only the residual out-of-roundness of not more than 0.0001 to 0.0002 inch (0.003 to 0.005 mm). Application of support pressure beyond this point will not further reduce runout, but will push the main bearing journal off center, and cause a taper to be ground in the remaining main bearing journals.

(28) Measure the main bearing journal to determine what standard undersize is required (Figure 9-41). If the journal is worn 0.001 inch (0.03 mm), for example, then 0.009 inch (0.23 mm) must be removed to bring the main bearing journal to 0.010 inch (0.25 mm) undersize.

(29) Start the crankshaft rotating and start the grinding wheel. Then, turn on the coolant and adjust the steady rests to support the crankshaft.

NOTE

Journal width is not as critical on main bearing journals and there is very little wear on these surfaces. Usually only a very light grind on the side wall is necessary to dean up the surface, but make certain that the fillet area is being ground sufficiently to be smoothly blended.

(30) Center the wheel on the main bearing journal, and carefully feed the wheel in until it just touches the journal. Then traverse the wheel to one side until the wheel just starts grinding the fillet. Allow the grinding wheel to remove any out-of-roundness in the journal.

(31) Back the wheel out, and measure the journal with a micrometer to determine how much material must be removed to attain the proper size. Set the feed indicator for this amount.

(32) While keeping a careful check on the journal size, slowly feed the wheel in until the correct undersize has been reached, and set the index on the feed indicator to 0. Let the grinding wheel dwell at this point until spark-out occurs; this will improve surface finish and help prevent grinder bum damage.

(33) Back the wheel out and traverse over to the other side of the journal. Feed the wheel in until it just touches the journal, and traverse over into the fillet area.

(34) Feed the wheel in slowly until the feed indicator reaches 0, and spark-out has occurred. Back the wheel out and check the journal.

(35) When checked with an outside micrometer, the journal shall be the correct undersize, and have no detectable step at the point of wheel overlap.

NOTE

Alternate each main bearing journal as to which cut it made first If, on the first bearing journal, the right side was full width cut, then on the next journal make the full width cut on the left side. The results in a more even breakdown of the grinding wheel and aids in producing a good surface finish on the reground journals.

(36) Grind all other main bearing journals in accordance with steps (30) through (35) above.

NOTE

The crankshaft thrust flange surfaces may be ground to an undersize of 0.010 inch (0.25 mm) or 0.020 inch (0.51 mm). Oversize thrust bearings are available for use with crankshafts which have had the thrust surfaces ground to these sizes. Grind each of the thrust surfaces to dean up grooving, abrasions, nicks, and wear. The front and rear thrust surfaces need not be ground to the same standard size, but the crankshaft must be stamped to show the thrust surface size. For uniform loading of the thrust bearing during engine operation, it is necessary that the thrust surface be ground square with the centerline of the crankshaft within 0.002 inch (0.05 mm) TIR. Squareness of the thrust surfaces should be checked with a dial indicator indexed near the outer edge of the thrust surface. If there is no damage (nicks, grooves, abrasion) to the thrust surface, up to 0.005 inch (0.13 mm) wear may be tolerated and considered as standard. If there is damage, then up to 0.005 inch (0.13 mm) may be removed and the thrust surface may be considered standard. If more than 0.005 inch (0.13 mm) wear is present or if more than 0.005 inch (0.13 mm) must be removed to properly dean up the thrust surface, then it must be ground to accept oversize bearings of 0.010 inch (0.25 mm) or 0.020 inch (0.51 mm). A maximum of 0.020 inch (0.51 mm) on each thrust surface may be removed (Figure 9-51).

(37) Make a visual inspection of the thrust flange, and determine to what extent grinding must be done to dean up any wear or damage.

NOTE

If the thrust flange is within wear limits, and scoring is not over 0.003 inch (0.08 mm) deep, restore the surfaces by polishing, or a very light grinding.

(38) Determine the standard oversize that is needed on the front or rear thrust surface.

WARNING

When grinding, do not traverse the grinding wheel Into the thrust surface. This will cause the side of the grinding wheel to break down, and may cause Injury to personnel, damage to equipment, or grinder bum.

(39) Feed the wheel almost to the journal and then traverse it over until it just touches the thrust surface to be ground. Then, back the wheel away from the journal until it dears the thrust surface.

(40) Traverse the wheel over to make the desired cut. Leave approximately 0.001 to 0.002 inch (0.030 to 0.050 mm) for a final cut. For example: if 0.009 inch (0.23 mm) must be removed from the surface, traverse the wheel over 0.007 inch (0.18 mm) and feed in slowly to make the cut. Back the wheel out and traverse over 0.002 inch (0.05 mm) to make the final cut. Feed the wheel in slowly when making the final cut, and allow the wheel to spark-out at the journal.

(41) If the gear steps have been chrome-plated to remove defects, grind them to size in accordance with Figure 9-40. Be sure to maintain the fillet area radii at 0.270 to 0.230 inch (6.88 to 5.84 mm).

(42) Check the fillet radii of all main bearing journals and gear step areas in accordance with step (21), above.

(43) Using scleroscope hardness tester ST-1196, test the journal hardness in accordance with step d, above. If any journal tests below 40 Rockwell, and journals have been turned to the maximum undersize, replace the crankshaft.

CAUTION

Grinder bum causes softening of the metal from overheating during the grinding process. Rehardening damage causes hard spots from overheating, combined with the quenching action of the grinding coolant. This type of damage Is most likely to occur In the fillet area when the grinding wheel Is traversed or bumped Into the bossing wall of the journal. Grinder bum and rehardening are usually only shallow surface defects, but form stress risers which will lead to breakage of the crankshaft within a relatively short period of operation. Severe grinder bum may be visible In the form of brown or darkened spots or streaks (usually In the fillet or bossing wall area), and sometimes can be seen Immediately after the grinding operation. Lack of visible discoloration, however, Is not proof of freedom from grinder burn damage. The discoloration may have been removed during spark-out or can easily be polished away. Frequently, this damage will be Invisible and can be detected only after an etch check. The crankshaft shall be etch checked after regrinding to ensure that It Is free of grinder bum or rehardening damage.

(44) Conduct an etch check in each fillet area as follows: (a) Thoroughly dean the journals to remove oil and grease.

WARNING

Acids are highly toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection Is required. Keep sodium bicarbonate solution at hand to neutralize spills.

(a) Swab each fillet and side wall generously with a 4 percent solution of nitric acid O-N-350 in water. Apply the solution generously, using chemical tongs and a large ball of cotton. Continue to swab with vigorous scrubbing motions until the treated surface turns very dark, gray, or black.

WARNING

Acetone Is highly flammable and mildly toxic to the skin, eyes, and respiratory tract Use In an adequately ventilated area. Skin, eye, and respiratory protection Is required to prevent Injury to personnel.

WARNING

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.

(b) Rinse with hot water and blow dry. Then swab with acetone O-A-51 and dean cotton swabs and blow dry again.

(c) Etch for15 seconds to 1 minute with a solution of hydrochloric acid (2 percent hydrochloric acid O-H-765 in acetone O-A-51). Use dean cotton swabs for this etch.

(d) Rinse with hot water, then swab with acetone and blow dry with compressed air.

(f) Inspect for grinder bum and rehardening in filet and side wall areas. The etched surface should be a uniform light gray color.

(g) Streaks or spots darker than the light gray background are evidence of grinder burn damage.

(h) Streaks or spots lighter than the gray background are evidence of rehardening.

(i) Grinder bum rehardening or damage is not permissible in the fillet or journal surface area. If damage is present, and the journals have been turned to the maximum undersize, replace the crankshaft.

(j) In case of questionable patterns, polish out the etch coloring and repeat the procedure. Sometimes a pattern will occur from non-uniform swabbing, but if patterns are present, they will reoccur in the same place and pattern with repeated etch checks.

(k) Crankshaft found to have grinder bum or rehardening damage may possibly be salvaged by grinding a few thousandths from the side walls and grinding to the next standard undersize.

(l) After completing the etch check, polish out the etching discoloration on acceptable crankshafts. Thoroughly treat the etched surfaces and oil holes with preservative oil MIL-L-21260.

(45) Check the crankshaft alignment in accordance with step d, above. Remove the crankshaft from grinding machine and straighten as necessary in accordance with step e, above.

(46) Inspect crankshaft using magnetic fluorescent inspection in accordance with step d, above.

(47) Clean the crankshaft in accordance with step c, above, to remove accumulated grinding dust and magnetic inspection compound, and dry thoroughly with compressed air.

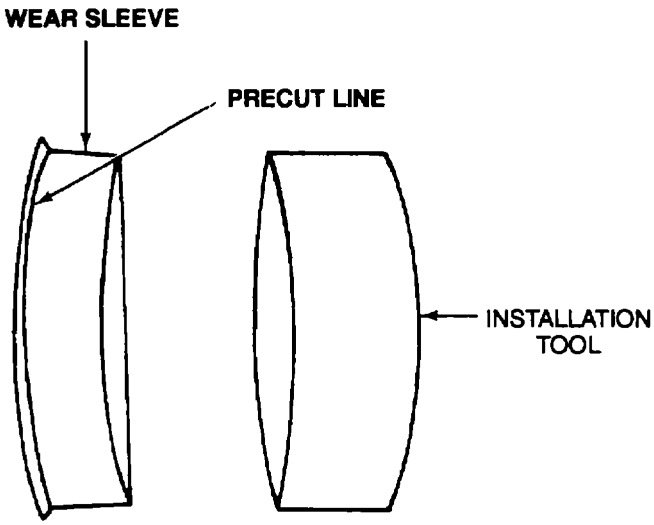


Figure 9-53. Seal Surface Wear Sleeve Kit

(48) If the front or rear seal surface is unacceptable, install a wear sleeve over the worn area as follows (see Figure 9-53):

NOTE

The procedure given below shall be used for either front or rear wear sleeve. For the front seal surface use part number 3006236; for the rear seal surface use part number 3006238. These wear sleeves are to be used only with LDL-TFE oil seals. An installation tool is provided with the wear sleeve.

(a) If a wear sleeve has been previously installed, remove the old wear sleeve using a 0.75 inch (19 mm) chisel and a hammer. Grind a 0.063 inch (1.60 mm) radius on the cutting edge of the chisel. Using moderate blows with the hammer, strike the chisel against the wear sleeve at three to six equidistant points on the outside diameter of the wear sleeve. This will relieve the press fit of the sleeve allowing it to be removed by hand.

(b) Clean the old seal surface thoroughly. File down any burrs and dean up any rough spots.

(c) If the crankshaft seal area is deeply scored, fill the groove with plastic steel, and install the wear sleeve before the filler hardens.

(d) If the groove in the crankshaft does not require filling, apply a light coating of sealant, MIL-S-451 80, to the inner surface of the repair sleeve.

NOTE

If the installation tool supplied with the repair sleeve is too short to install the sleeve to the desired position, a length of tubing or pipe can be substituted as an installation tool. The tubing or pipe substituted for the installation tool should have an inside diameter slightly larger than the crankshaft.

(e) Place the repair sleeve into the end of the installation tool. Using a hammer and large wood block, gently tap the center of the installation tool until the sleeve covers the wear pattern caused by the seal.

(f) Remove the repair sleeve flange at the pre-cut line. Use side cut pliers to cut and pull the flange away from the sleeve twisting it into a coil. The flange will break loose along the pre-cut line.

CAUTION

The crankshaft and repair sleeve must be free of any burrs which might cut the seal lip.

(g) Remove excess sealer, and dean up any burrs that may have been raised during installation.

(49) Polish the crankshaft journals, fillet areas, bossing surfaces, and thrust surfaces as follows:

CAUTION

Improper surface finish of the journal fillets may load to metal fatigue and crankshaft failure. Improper surface finish will also result In rapid wear of the bearing Inserts. Polishing is essential after grinding to attain the proper surface finish.

(a) To prevent the entrance of polishing dust, plug the oil passage holes with soap or heavy grease, and install the pipe plugs (1, Figure 9-38). Snug-tighten the pipe plugs.

(b) Install the crankshaft in the grinder, and set up the head and tail stock as for grinding the rod journals in accordance with steps (5) and (6), above.

(c) Polish and blend the radius around each oil hole using a die grinder A-A-544, and progressively finer polishing stones to 400 grit.

(d) Equip the polishing head with a 400 grit belt. Turn the crankshaft in the direction of rotation clockwise when viewed from the front, and turn the polishing belt in the opposite direction.

(e) Polish the journal bearing surface to a finish of 16 microinch (0.406 micrometer) RMS.

(f) Polish the journal fillets and bossing surfaces to a finish of 30 microinch (0.76 micrometer) RMS.

(g) Set up the grinding machine for polishing the main bearing journals in accordance with steps (24) and (25), above.

(h) Polish the main bearing journals and fillet areas in accordance with steps (e) and (f), above.

(i) Polish the thrust flange surfaces to a finish of 16 microinch (0.41 micrometer) RMS.

(j) Remove the crankshaft from the grinding machine, remove the pipe plugs (1, Figure 9-38), and thoroughly dean the oil passages and journals in accordance with step c, above.

g. Assemble.

(1) Install the pipes plug (1, Figure 9-38) using no more than 3 drops of thread locking compound, MIL-S-46163, and tighten to 5 to 7 pound-feet (7 to 9 newton-meters).

(2) Install the counterweights (3) in the same position from which they were removed using capscrews (2). Crosstighten the capscrews in three steps to 200 to 210 pound-feet (271 to 285 newton-meters).

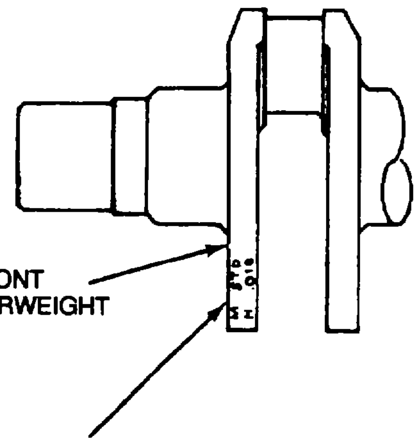


Figure 9-54. Identification of Rod and Main Bearing Journal Sizes

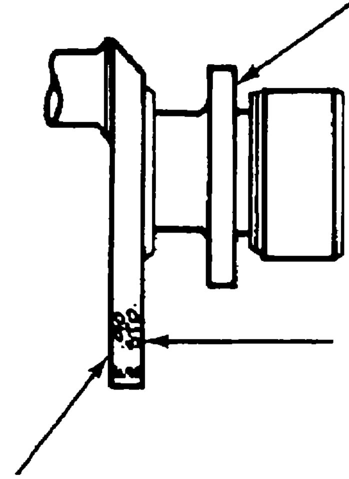


Figure 9-55. Identification of Thrust Surface Sizes

(3) Using steel stamps having 0.125 inch (3.18 mm) characters, stamp the front counterweight to identify the regrind size of both the connecting rod journals, and the main bearing journals (Figure 9-54).

(4) Using steel stamps having 0.125 inch (3.18 mm) characters, stamp the rear counterweight to identify the regrind size of both the front and the rear thrust surface (Figure 9-55).

h. Balance.

(1) After reconditioning involving straightening, regrinding, or other operations which may affect weight distribution of the crankshaft, a dynamic balance check shall be made. Corrections shall be made as necessary to bring the shaft within the maximum unbalance limit of 0.001 ounce/inch (0.720 milligram/meter).

(2) Dynamic balance of the crankshaft shall be checked on a two plane balancing machine which will show the amount of unbalance at each end.

(3) Accurate balancing requires that the crankshaft be held within 0.002 inch (0.05 mm) alignment during the balancing operation. To secure proper support, at least three points of support (front, middle, and rear main bearing journals) shall be used.

(4) Excessive speeds will cause the crankshaft to whip, resulting in incorrect balance indications. The speed of crankshaft rotation shall not exceed 325 rpm during balancing.

NOTE

Bob-weights are not needed on a V-1 2 crankshaft because the throw indexing provides inherent balance. Crankshafts may be balanced with or without the crankshaft gear assembled. When balanced without the gear, compensation shall be made for the gear keyway slot by adding tolerance wax, equal to the weight of the key, to the keyway slot.

(5) Balance corrections shall be made by drilling holes in the counterweight or snag-grinding on the perimeter of the counterweights, removing sufficient weight at the proper location to attain balance.

(6) Not more than 2 ounces (56.79) of weight shall be removed by grinding.

(7) Additional holes may be drilled in the counterweight, but this should be limited to no more than six 0.75 inch (19 mm) holes, 2 inches (51 mm) deep in any one counterweight bay. (A counterweight bay consists of two counterweights at either side of a throw). Maintain at least 0.125 inch (3.18 mm) wall thickness between the hole and the side of the counterweight when drilling balance holes.

(8) Where the limit of metal removed has been reached, balance may be attained by adding weight at another location. Lead may be tamped in an existing balancing hole and held in place by a plug welded in place. All such welds shall be magnetically inspected and must show no cracks.

(9) After balancing, dean the crankshaft in accordance with step (c), above, to remove any grinding dust or metal chips.

i. Preservation and Storage.

(1) Coat the crankshaft thoroughly with dean preservative oil, MIL-L-21260, and seal it in a dean plastic bag to avoid contamination.

CAUTION

The crankshaft must be stored In a vertical position. Allowing the crankshaft to lie flat with unsupported main bearing journals, may cause misalignment.

(2) Store the crankshaft in a vertical position until ready for installation.

SECTION VI. MAINTENANCE OF CYLINDER BLOCK, VIBRATION DAMPER, FRONT AND REAR CRANKSHAFT AND ACCESSORY DRIVE SEALS, FLYWHEEL ASSEMBLY, FLYWHEEL AND REAR GEAR HOUSINGS, FRONT ENGINE SUPPORT, !NSPECTION COVERS, OIL PAN ASSEMBLY, AND PISTON COOLING NOZZLES

9-29. GENERAL. This section covers maintenance of the cylinder block, housings, and related engine parts. Basic inspection procedures are on engine inspections where possible. Complete inspection procedures are given in the replacement and repair procedures. During repair operations, the cylinder block and all parts should be inspected by the applicable magnetic or dye penetrant procedures. Adhere to the specifications and tolerances given in Table 1 -4. Keep all parts dean during assembly; dirt and foreign material are a major cause of crankshaft and other internal part failures.

9-30. CYLINDER BLOCK INSPECTION.

a. Visually inspect the cylinder block for cracks and evidence of coolant or oil leakage at gasket surfaces, expansion plugs, and front and rear crankshaft seals.

b. Repair cracks in the cylinder block in accordance with paragraph 9-31.

c. Replace leaking expansion plugs in accordance with paragraph 2-10.

d. Replace leaking front or rear crankshaft seals in accordance with paragraph 9-33.

e. Leakage from gaskets may be caused by faulty gaskets or mating surfaces. Replace leaking gaskets and check the mating surfaces in accordance with the following paragraphs: (1) Cylinder head, 9-8 and 9-10.

(2) Cylinder block, 9-31.

(3) Oil pan, 9-38.

(4) Flywheel housing, 9-35.

(5) Timing cover and housing, 9-18.

9-31. CYLINDER BLOCK MAINTENANCE

a. Remove and Disassemble. (See Figure 9-24.)

(1) Remove the engine from the generator set in accordance with Chapter 2, and install the engine in rebuild stand 3375955.

(2) Remove the fuel system components in accordance with Chapter 6 and the Operator and Organizational Maintenance Manual.

(3) Remove the cooling system components in accordance with Chapter 7 and the Operator and Organizational Maintenance Manual.

(4) Remove the lubrication system components in accordance with Chapter 8 and the Operator and Organizational Maintenance Manual.

(5) Remove the camshafts in accordance with paragraph 9-15.

(6) Remove the timing gears and housing in accordance with paragraph 9-18.

(7) Remove the camshaft bushings in accordance with paragraph 9-16.

(8) Remove the flywheel in accordance with paragraph 9-34.

(9) Remove the flywheel housing and rear gear housing in accordance with paragraph 9-35.

(10) Remove the connecting rod and piston assemblies in accordance with paragraph 9-20.

(11) Remove the crankshaft in accordance with paragraph 9-27.

(12) Remove the capscrews (35, Figure 9-24) and thrust bearing retainer (36) from the cylinder block (58).

(13) Remove 12 capscrews (37), and remove the 12 piston cooling nozzles (38). Remove and discard the packings (39) from the piston cooling nozzles.

(14) Remove the capscrews (40), washers (41), and lifting brackets (42).

(15) Remove the dowels (43) from the head surface, and from the front and rear of the cylinder block (58) only if damaged or loose.

(16) Remove the capscrews (44), lockwashers (45), front and rear crankcase breathers (46 and 47), and gaskets (48). Discard the gaskets.

(17) Remove the four coolant drain cocks (49) from the cylinder block (58).

(18) Remove 20 pipe plugs (50) from the top and sides of the cylinder block (58).

(19) Remove four pipe plugs (51) from the rear of the cylinder block (58).

(20) Remove 20 pipe plugs (52) from the sides of the cylinder block (58).

(21) Using a sharp punch to penetrate and pry out the plugs, remove the 12 oil restrictor expansion plugs (53) at the cylinder head surface of the cylinder block (58).

(22) Remove 15 expansion plugs (54), and four expansion plugs (55) from the cylinder block (58) in accordance with step (21), above.

(23) Remove the screws (56) and nameplate (57) from the side of the cylinder block (58).

b. Inspect. Perform a complete cylinder block inspection before carrying out repairs or extensive cleaning operations. After determining that the cylinder block is repairable, perform complete cleaning and necessary repair operations in accordance with step c, below. Inspect the cylinder block as follows:

(1) Visually inspect cylinder block (58) in accordance with paragraph 9-30.

(2) Use magnetic particle inspection in accordance with MIL-1-6868, or dye penetrant, MIL-1-25135, for inspection in accordance with MIL-1-6866 at areas of suspected cracks or porosity.

(3) Check the camshaft bore diameters for wear and out-of-round that may have been caused by loose or turned bushings. Install a repair sleeve if any bore is over 0.002 inch (0.05 mm) out-of-round, or worn over a diameter of 3.1895 inch (81.013 mm).

(4) Remove burrs, dirt, and scale from the cylinder liner counterbore, and check the counterbore as follows:

(a) Using 3376220, check the counterbore depth at 90 degrees intervals (A, Figure 9-56), and check the ledge for downward taper toward the center of the bore. Resurface the counterbore ledge if the depth varies over 0.001 inch (0.03 mm), or the ledge tapers downward toward the bore center. Install a counterbore sleeve if the depth of the counterbore is beyond the limit in Table 1-4.

NOTE

On engines manufactured before July 1980, to engine number 33103621, the cylinder liners press into the top counterbore (B, Figure 9-56). On engines manufactured after this, the liners press into the secondary bore (C, Figure 9-56). Select the appropriate inspection and repair procedures accordingly.

(b) Check the secondary cylinder liner bore diameter (C, Figure 9-56). Install a sleeve if the bore diameter is over 7.157 inches (181.79 mm).

(5) Check the cylinder block lower liner bore concentricity using concentricity gage ST-1 252 as follows (see Figure 9-57):

(a) Place the gage flat on the top deck of the cylinder block with the bumper pins against the counterbore inside diameter on cylinder blocks to engine number 33103621. On later engines, index the bumper pins on the secondary bore.

(b) Check the counterbore diameter in the top 0.400 inch (10.16 mm) of the bore (B, Figure 9-56). Install a counterbore sleeve it bore diameter is over 7.4935 inches (190.335 mm).

(c) Raise or lower the bar to position the indicator in the lower bore.

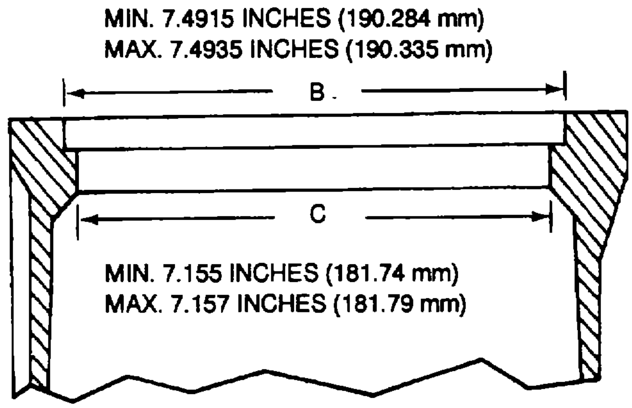
(d) Hold the gage bumper pins firmly against the counterbore or secondary bore inside diameter and zero the indicator.

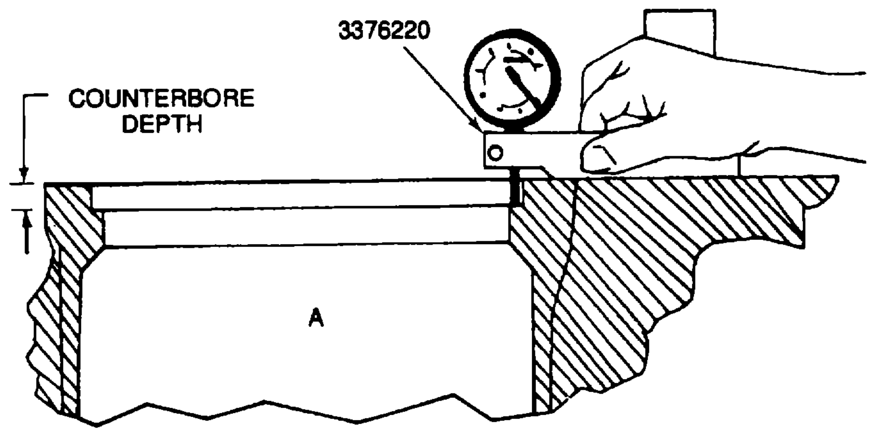
(e) Release the pressure on the bumper pins, and reposition the gage in the same spot to check the indicator adjustment. Re-zero the indicator if necessary.

(f) Move the gage 180 degrees from the original setting position, hold the bumper pins firmly against the counterbore or secondary bore inside diameter, and record the indicator reading.

(g) Move the gage 90 degrees and record the indicator reading.

(h) Replace the cylinder block if the lower liner bore is not concentric within 0.005 inch (0.13 mm) TIR.





COUNTERBORE DEPTH*		
WEAR LIMIT INCH (mm)	MINIMUM INCH (mm)	MAXIMUM INCH (mm)
0.782 (19.86)	0.721 (18.31)	0.723 (18.36)
*COUNTERBORE SHALL NOT TAPER DOWNWARD TOWARD CENTER OF BORE.		

Figure 9-56. Checking Counterbore

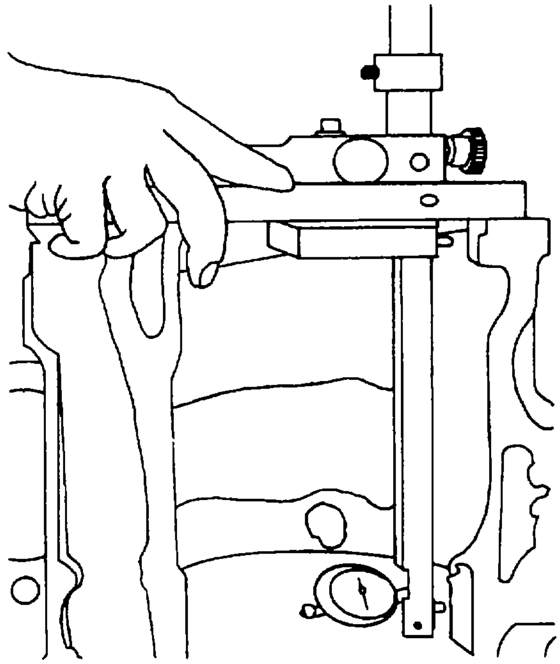


Figure 9-57. Measuring Lower Liner Bore Concentricity Using ST-1252

(6) Check the cylinder block lower liner bore entry chamfer. Repair the chamfer if it is pitted or eroded to the extent that it would cut the packings or prevent proper liner installation.

(7) Temporarily install the main bearing caps. Using the centering rings, bore bar, and checking rings from boring tool kit 3375059, check the main bearing bores for size, taper, out-of-round, and alignment. If any main bearing cap is found to be distorted, install and line bore a new cap or caps.

(8) Inspect the thrust bearing surface at the rear of the cylinder block for scoring or grooving. Refinish the thrust surface if it is grooved, or if it is scored over 0.003 inch (0.07 mm) deep.

(9) Check for damaged or eroded water holes. Install sleeves to repair eroded water holes.

(10) Inspect the cylinder block head gasket surface for flatness using a straight edge and feeler gage. The flatness shall not vary over 0.002 inch (0.05 mm). Up to 0.010 inch (0.25 mm) may be removed from cylinder block head surface to restore flatness or remove defects.

c. Clean and Repair.

WARNING

Dry cleaning solvent PD-680, Type III, or equivalent, is flammable and moderately toxic to the skin, eye, and respiratory protection is required to avoid injury to personnel.

WARNING

Acids used for cleaning purposes are highly toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required. Keep sodium bicabonate solution at hand to neutralize spills.

WARNING

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.

(1) Clean oil and grease deposits from the cylinder block surface using cleaning solvent PD-680, Type III, or equivalent. Use solvent and bristle brushes of suitable size to dean lubrication and fuel passages. Clean rust and scale deposits from water passages using a circulating acid bath and acid MIL-H-1 3528. Rinse the block thoroughly, and blow out all lubrication, fuel, and water passages using compressed air.

WARNING

Grinding operations create airborne, abrasive dust and particles. Respiratory and eye protection Is required to avoid Injury to personnel.

WARNING

Welding operations produce heat, highly toxic fumes, Injurious radiation, metal slag, and airborne particles Welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required to avoid Injury to personnel.

(2) Repair cracks and porosity in the cylinder block by grinding out the defect and welding in accordance with MIL-STD-248.

(3) Repair defective camshaft bushing bores by installing bushings 3376347 using camshaft bore salvage kit 3376345, and main bearing boring tool ST-11 77.

NOTE

If the cylinder block head gasket surface requires machining, postpone counterbore repairs until the machining has been completed.

(4) Resurface a damaged counterbore ledge in the cylinder block using cylinder block counterbore tool ST-1 309.

(5) Repair a damaged or oversize counterbore, or counterbores that have been resurfaced to the maximum depth, by installing a repair sleeve 3376222 using counterbore salvage tool 3375820, liner counterbore tool ST-11 68, cutter assembly 3376219, sleeve driver 3376223, guide plate 3376224, and sleeve driver shaft 3376226.

(6) Repair a damaged secondary bore by installing a sleeve. Bore the cylinder block to accept the sleeve, and bore the sleeve to a diameter of 7.155 to 7.157 inches (181.74 to 181.79 mm).

(7) Repair pits and erosion at the lower liner bore entry chamfer by building up with plastic steel. After drying, sand smooth to the original entry chamfer size using emery cloth P-C-1673.

(8) If a main bearing cap or caps are defective, install and line bore a new cap or caps using main bearing bore kit 337,5059 with main bearing bore tools ST-11 77.

(9) Refinish a damaged thrust bearing surface at the rear of the cylinder block using thrust surface cutter 3375053 with main bearing bore tool ST-11 77.

(10) Water holes that have not eroded more than 0.0625 inch (1.59 mm) from the edge of the hole can be sleeved. Sleeve an eroded water hole as follows:

(a) Fabricate a sleeve from copper tubing with an inside diameter that will restore the eroded hole to its original diameter. Cut the tubing for the sleeve approximately 0.5 inch (13 mm) long and measure the outside diameter with micrometer caliper.

(b) Using ST-1 010, bore and ream the eroded hole 0.002 to 0.005 inch (0.05 to 0.13 mm) smaller than the sleeve.

(c) Coat the sleeve with sealant MIL-S-45180, and install it in the reamed hole using a bushing driver and hammer.

(d) Being careful not to damage the gasket surface, file the sleeve flush with the surface using a flat mill file.

(11) Refinish a damaged cylinder block head gasket surface as follows:

(a) Install the bore bar, centering rings and checking rings from main bearing bore kit3375059. Slide the checking ring to the center of one cylinder bore, and measure the distance from the checking ring to the cylinder block head surface (Figure 9-58). Make several checks on both banks to determine taper, and to serve as a basis for set-up in the resurfacing machine. Up to 0.010 inch (0.25 mm) may be removed from the surface, provided a minimum height of 15.171 inch (385.34 mm) will remain after machining. Remove 3375059 checking fixtures.

(b) Remove sufficient material to restore the surface and remove taper using a milling machine or surface grinder. The machine surface shall be finished to 125 microinch (3.18 micrometer) RMS. An equal amount of material shall be removed from the top surfaces of both cylinder banks.

(c) Recheck the block height in accordance with step (a), above. The block height shall not be less than 15.171 inch (385.34 mm) and shall not vary more than 0.002 inch (0.05 mm) over the length of the block

(d) Resurface the counterbore to obtain the proper liner protrusion by removing the same amount of material from the counterbore ledge that was removed from the top surface (see steps (4) and (5), above).

d. Assemble and Install.

(1) Install the nameplate (57, Figure 9-24) on the side of the cylinder block (58), and secure with screws (56).

(2) Install 15 expansion plugs (54) and four expansion plugs (55) in the cylinder block (58) in accordance with paragraph 2-10.

(3) Install 12 oil restrictor expansion plugs (53) in the cylinder block in accordance with paragraph 2-1 0.

NOTE

Tighten all pipe plugs in accordance with Table 1-2.

(4) Wrap the threads of 20 pipe plugs (52) with anti-seize tape, MIL-T-27730, and install in the sides of the cylinder block (58).

(5) Wrap the threads of four pipe plugs (51) with anti-seize tape, MIL-T-27730, and install in the rear of the cylinder block (58).

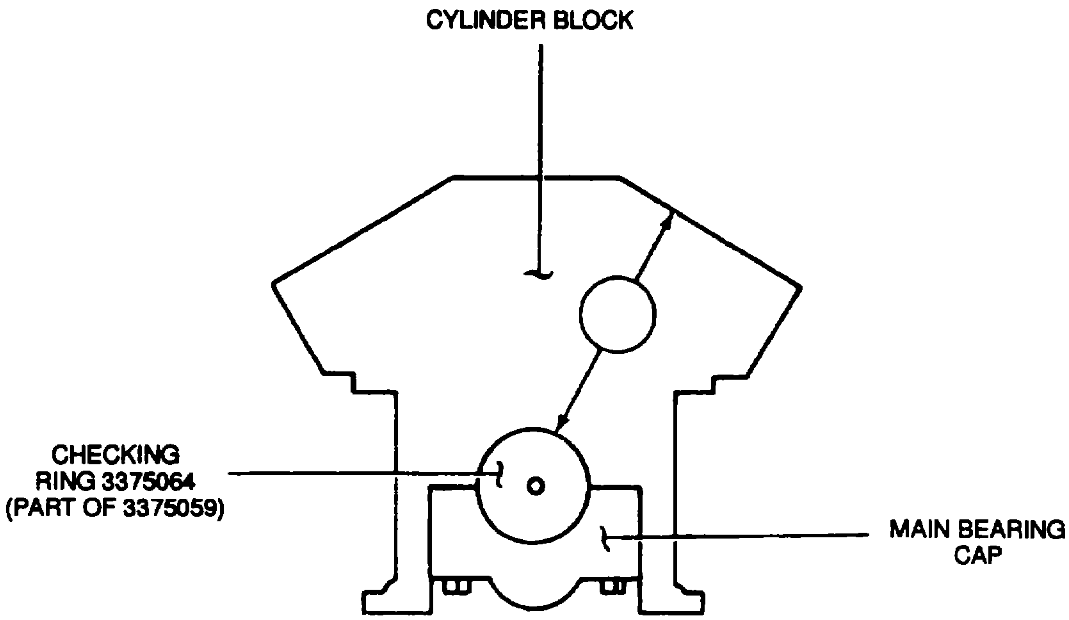
(6) Wrap the threads of 20 pipe plugs (50) with anti-seize tape, MIL-T-27730, and install in the top and sides of the cylinder block (58).

(7) Wrap the threads of four coolant drain cocks (49) with anti-seize tape, MIL-T-27730, and install in the cylinder block (58).

(8) Using new gaskets (48), install the front and rear crankcase breathers (47 and 46) using lockwashers (45) and capscrews (44). Tighten the capscrews to 20 to 30 pound-feet (27 to 41 newton-meters).

(9) Install the dowels (43) in the front, rear, and head surface of the cylinder block (58) if removed.

(10) Install the lifting brackets (42) using washers (41) and capscrews (40). Tighten the capscrews to 190 to 200 pound-feet (258 to 271 newton-meters).



DIMENSION A HEAD SURFACE TO CHECKING RING	LIMIT INCH (mm)	NEW MIN. INCH (mm)	NEW MAX. INCH (mm)
	15.171 (385.34)	15.581 (395.76)	15.5835 (395.821

Figure 9-58. Cylinder Block Height Measurement

(11) Lubricate new packings (39) with lubricating oil, MIL-L-45199, and install in the grooves of the 12 piston cooling nozzles (38). Align the screw head recess in the nozzle with the threaded hole, install the nozzles, and secure them with capscrews (37). Tighten the capscrews to 60 to 96 pound-inches (7 to 11 newton-meters).

(12) Install the thrust bearing retainer (36), and secure it with capscrews (35). Tighten the capscrews to 30 to 35 pound-feet (41 to 47 newton-meters).

(13) Install the crankshaft in accordance with paragraph 9-27.

(14) Install the connecting rod and piston assemblies in accordance with paragraph 9-20.

(15) Install the rear gear housing and flywheel housing in accordance with paragraph 9-35.

(16) Install the flywheel in accordance with paragraph 9-34.

(17) Install the camshaft bushings in accordance with paragraph 9-16.

(18) Install the timing gears and housing in accordance with paragraph 9-18.

(19) Install the camshafts in accordance with paragraph 9-15.

(20) Install the lubrication system components in accordance with Chapter 8 and the Operator and Organizational Maintenance Manual.

(21) Install the cooling system components in accordance with Chapter 7 and the Operator and Organizational Maintenance Manual.

(22) Install the fuel system components in accordance with Chapter 6 and the Operator and Organizational Maintenance Manual.

(23) Remove the engine from the rebuild stand, and install it in the generator set in accordance with paragraph 2-15.

CAUTION

Serious engine damage will result If the engine Is started before the lubrication system Is properly filled and primed. Elapsed time between priming the lubrication system and starting the engine shall not exceed 3 hours. If, for whatever reason, the engine cannot be started within 3 hours after priming the lubrication system, repeat the entire priming procedure just prior to starting the engine.

(24) Before starting the engine, fill and prime the lubrication system in accordance with the Operator and Organizational Maintenance Manual.

9-32. VIBRATION DAMPER REPLACEMENT.

a. Remove.

NOTE

Two persons will be required to perform the following procedure.

(1) Remove the capscrews (1, Figure 9-59), lockplate (2), and crankshaft pulley (3).

CAUTION

The vibration damper Is filled with a viscous fluid. To avoid damage that could render the damper Ineffective, do not hammer or pry on the damper during removal.

(2) Work the vibration damper (4) off of the roll-pin (5) in front of the crankshaft. Remove the rolipin if damaged.

b. Clean and Inspect.

(1) Inspect the vibration damper for indications of fluid leakage. Replace the damper if leaks are detected.

WARNING

Dry cleaning solvent PD-680, Type ill, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

(2) Clean the crankshaft face, vibration damper, and crankshaft pulley thoroughly using cleaning solvent, PD-680, Type ill, or equivalent, and dry with dean shop towels.

(3) Avoiding the area with the stamped lettering, remove the paint from the front and rear surfaces of the vibration damper in four areas 90 degrees apart, and 0.125 inch (3.18 mm) in from the outside edge.

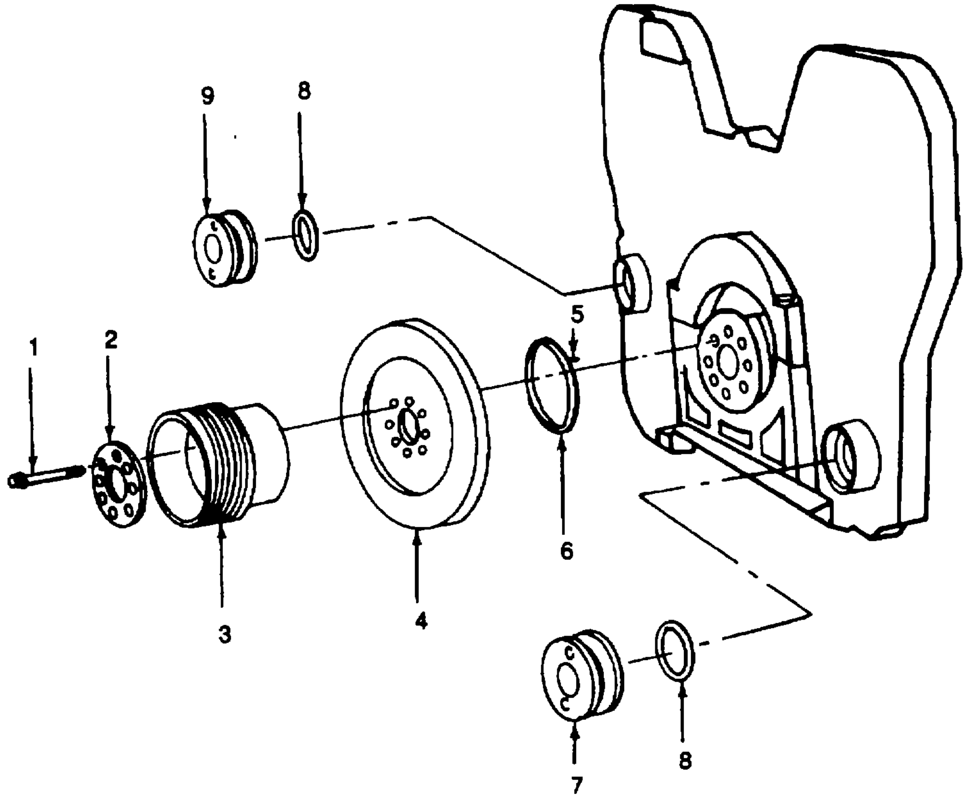
(4) Using an outside micrometer, measure and record the thickness of the vibration damper in the four cleaned spots. Replace the damper if the thickness exceeds 2.574 inches (65.38 mm), or the thickness varies more than 0.010 inch (2.54 mm).

(5) Check the mating surfaces of the crankshaft, vibration damper, and crankshaft pulley for paint, nicks, or burrs that could cause runout and vibration. Remove nicks and burrs from the mating surfaces using a flat mill file; keep the file flat on the mating surface and remove the nick or burr only.

CAUTION

To avoid possible misalignment and vibration, do not paint the crankshaft and pulley mating surfaces of the vibration damper.

(6) Treat and paint an acceptable vibration damper and crankshaft pulley in accordance with, MIL-T-7044, using light gray paint 16492, FED-STD-595.



1. CAPSCREW
2. LOCKPLATE
3. CRANKSHAFT PULLEY
4. VIBRATION DAMPER
5. ROLL-PIN
6. FRONT CRANKSHAFT SEAL
7. ACCESSORY DRIVE PULLEY
8. ACCESSORY DRIVE SEAL
9. ACCESSORY DRIVE PULLEY

Figure 9-59. Removal and Installation of Vibration Damper and Crankshaft Pulley

c. Install.

(1) If removed, install the roll-pin (5, Figure 9-59) in the end of the crankshaft.

(2) Fabricate two guide studs from spare capscrews (1), part number 3023539 (refer to Table 2-2) and install them in the crankshaft 180 degrees apart.

CAUTION

To avoid engine vibration caused by runout, be sure all paint or other foreign material Is removed from the mating surfaces of the crankshaft, vibration damper, and crankshaft pulley prior to Installation.

NOTE

Two persons will be required to perform the following procedure.

(3) Align the roll-in hole in the vibration damper (4, Figure 9-59) with the roll-pin (5) in the crankshaft, and slide the vibration damper over the guide studs.

(4) Align the crankshaft pulley (3) and install it over the guide studs.

(5) Lubricate the capscrews (1) and lockplate (2) with clean lubricating oil, MIL-L-2104, and install the six washers and capscrews through the crankshaft pulley and vibration damper. Run the screws down alternately and evenly so that damper and pulley are pulled evenly into contact with the crankshaft.
(6) Remove the guide studs and install the two remaining washers (2) and capscrews (1). Tighten all capscrews in accordance with the sequence and steps given in Figure 9-60.
(7) Check eccentricity and runout of the vibration damper (4) and crankshaft pulley (3) in accordance with the Operator and Organizational Maintenance Manual. If runout or eccentricity is excessive, check for foreign material trapped between the mating surfaces of the crankshaft, damper, and pulley.

9-33. FRONT AND REAR CRANKSHAFT AND ACCESSORY DRIVE SEALS REPLACEMENT.

a. Front Crankshaft Seal.

(1) Remove the vibration damper (4, Figure 9-59) in accordance with paragraph 9-32.
(2) Using the drill pilot 3375497, and the plate from oil seal puller/installer 3375786, drill three #31 (0.120 inch) holes in the front crankshaft seal (6) to fit the self-tapping puller screws.
(3) Install the puller screws through the plate of 3375786, and thread them into the drilled holes in the seal (6). Turn the center screws of 3375786 to remove the seal.
(4) Using dean shop towels, wipe out the seal recess in the cover, and remove all oil from the crankshaft.
(5) Inspect the crankshaft at the seal lip area. If the crankshaft is grooved. Install a wear sleeve in accordance with paragraph 9-28.

CAUTION

To avoid premature wear of the seal, do not use oil or any other lubricant on LDLTFE (Lay Down Lip-Teflon) seals or the crankshaft. The seal lip and crankshaft must be clean and free of all lubricants.

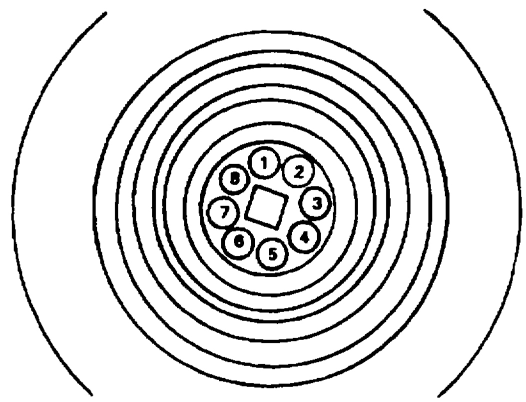
NOTE

LDL-TFE oil seals include an assembly sleeve pre-assembled into the seal lip. Do not remove the assembly sleeve before installation.

(6) Apply a light coat of sealing compound, MIL-S-451 80, to the outer diameter of the seal (Figure 9-61).
(7) Position the large diameter of the assembly sleeve over the crankshaft. Using the body 3375786, push the seal off of the assembly sleeve and onto the crankshaft (Figure 9-61). Remove and discard the assembly sleeve.
(8) Complete the front crankshaft seal (6, Figure 9-59) installation using the oil seal puller/installer 3375786.
(9) Install the vibration damper (4) in accordance with paragraph 9-32.

b. Accessory Drive Seals.

(1) Remove the accessory drive pulley (7, Figure 9-59) using a standard puller ST-647, or equivalent.
(2) Remove the accessory drive pulley (9), using puller NSN 5120-516-3120, or equivalent.
(3) Remove the accessory drive seals (8) using a standard claw-type seal puller.
(4) Using clean shop towels, wipe out the seal recess in the cover, and remove all oil from the pulley hub.
(5) Inspect the pulley hub for wear or grooving caused by the seal lip.
(6) If the pulley hub is damaged, install a wear sleeve, part number 190397, on the pulley hub.



STEP	TORQUE POUND-FEET	TORQUE NEWTON-METERS
1	160 TO 180	217 TO 244
2	260 TO 380	488 TO 515

Figure 9-60.

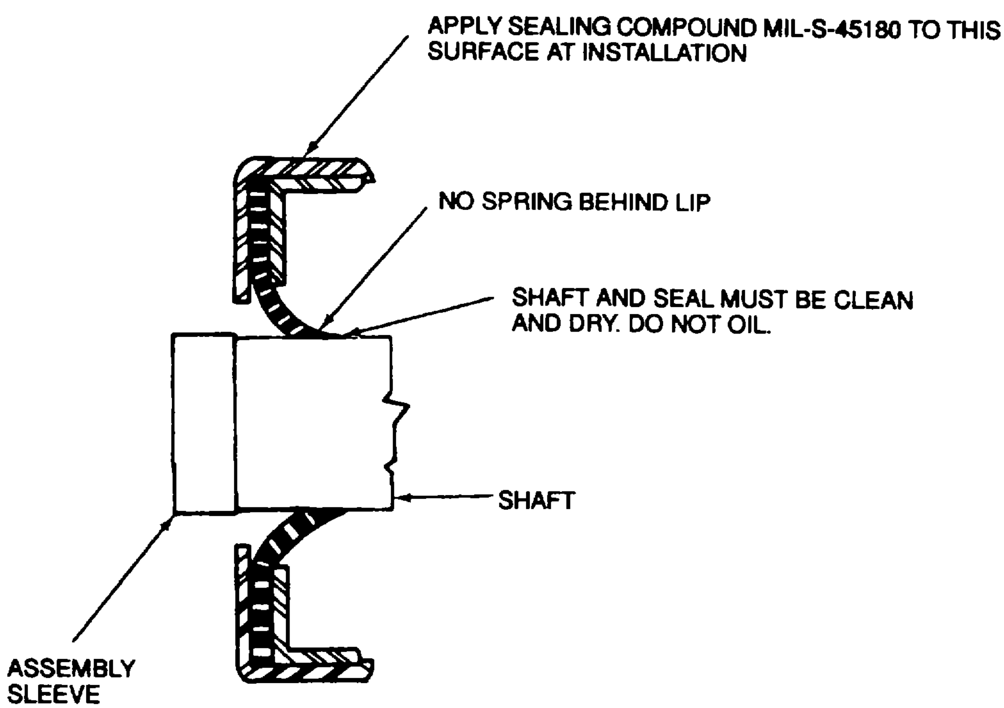


Figure 9-61. LDL-TFE Seal Installation

CAUTION

To avoid premature wear of seals, do not use oil or any other lubricant on LDLTFE (Lay Down Up-Teflon) seals or the pulley hub. The seal lip and pulley hub must be clean and free of all lubricants.

(7) Apply a light coat of sealing compound MIL-S-45180 to the outer diameter of the accessory drive seals (8), and install it in the front cover using a standard seal driver of the correct diameter.

CAUTION

Do not hammer the pulley onto the shaft. Severe damage to the fuel pump or water pump will result.

(8) Start the accessory drive pulley (7) on the shaft by hand Draw the pulley completely onto the shaft using pulley assembly tool ST-386.
(9) Start the accessory drive pulley (9) on the shaft by hand. Using a 1/2 inch inside diameter, 1 1/4 inch outside diameter flat washer, draw the pulley part of the way onto the shaft using a 1/2 inch capscrew, 20 thread, 3 1/2 inches long. Draw the pulley completely onto the shaft using a 1/2 inch capscrew, 20 thread, 2 1/2 inches long.

c. Rear Crankshaft Seal.

(1) Remove the flywheel housing (9, Figure 9-62) in accordance with paragraph 9-35.
(2) Remove the ten capscrews and washers (25), seal retainer (26), and gasket (27). Discard the gasket.
(3) Remove the seal (28) from the seal retainer (26) using a soft drift and hammer. Discard the seal.
(4) Clean the seal retainer (26) and rear gear housing (32) thoroughly to remove all traces of the old gasket (27).
(5) Wipe the crankshaft with a clean shop towel to remove all traces of oil.
(6) Inspect the crankshaft for wear or grooving caused by the seal lip. It the crankshaft is damaged, install a wear sleeve in accordance with paragraph 9-28.
(7) If removed, install the packing (29) in the rear gear housing (32).
(8) Apply a thin coat of sealing compound, MIL-S-45180, to the gasket surface of the rear gear housing (32) and position the gasket (27) on the housing.
(9) Position the rear seal and wear ring driver, ST-1093, on the crankshaft to center the seal retainer (26) during installation.
(10) Apply a thin coat of sealing compound, MIL-S-45180, to the gasket surface of the seal retainer (26), and slide the seal retainer of ST-1 093 into position against the rear gear housing (32).
(11) Install the ten capscrews and washers (25), and cross-tighten to 20 to 25 pound-feet (27 to 34 newton-meters) Remove ST 1 093from the crankshaft.
(12) Mount a dial indicator on the crankshaft using attachment ST-1 325 and check the seal retainer (26) runout. This runout shall not exceed 0.005 inch (0.13 mm) TIR.

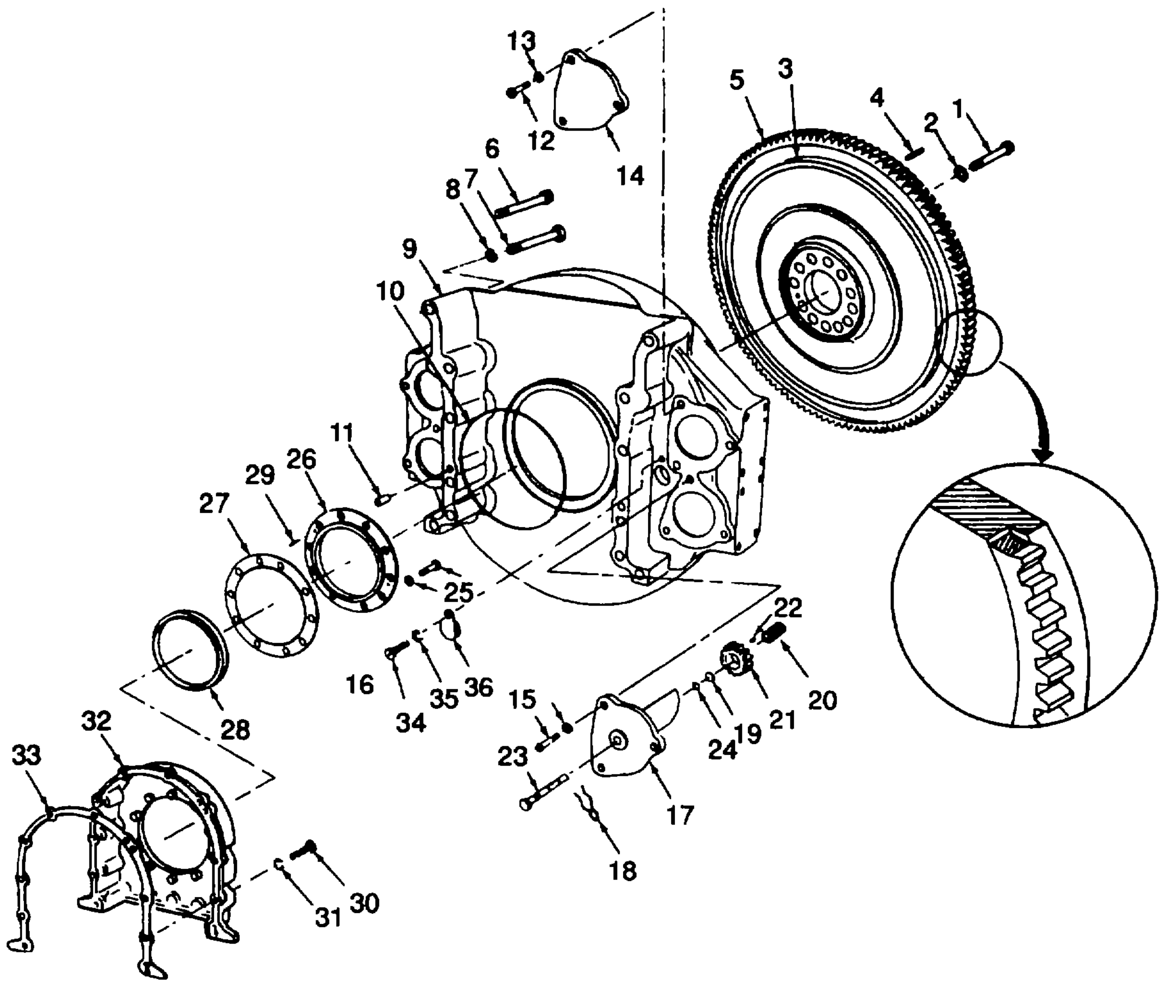
CAUTION

To avoid premature wear of the seal, do not use oil or any other lubricant on LDLTFE (Lay Down Lip-Teflon) seals or the crankshaft. The seal lip and crankshaft must be clean and free of all lubricants.

NOTE

LDL-TFE oil seals include an assembly sleeve pre-assembled into the seal lip. Do not remove the assembly sleeve before installation.

(13) Apply a light coat of sealing compound, MIL-S-45180, to the outer diameter of the seal (Figure 9-61).



1.	CAPSCREW AND WASHER	19.	RETAINING RING
2.	WASHER	20.	SPRING
3.	FLYWHEEL	21.	GEAR
4.	ROLL PIN	22.	LOCK KEY
5.	RING GEAR	23.	SHAFT
6.	CAPSCREW	24.	PACKING
7.	CAPSCREW	25.	CAPSCREW AND WASHER
8.	LOCKWASHER	26.	SEAL RETAINER
9.	FLYWHEEL HOUSING	27.	GASKET
10	DUST SEAL	28.	SEAL
11	DOWEL	29.	PACKING
12	CAPSCREW	30.	CAPSCREW
13	L OCKWASHER	31.	LOCKWASHER
14	FLANGE COVER	32.	REAR GEAR HOUSING
15	CAPSCREW	33.	GASKET
16	LOCKWASHER	34.	SCREW
17	BARRING DEVICE HOUSING	35.	LOCKWASHER
18	COTTER CLAMP	36.	ACCESS HOLE COVER

Figure 9-62. Exploded View of Rear Housing, Flywheel Housing, and Flywheel

(14) Position the large diameter of the assembly sleeve over the crankshaft. Using ST-1093, push the seal off the assembly sleeve and onto the crankshaft (Figure 9-61). Remove and discard the assembly sleeve.
(15) Complete the seal installation using ST-1093 to drive the seal (28, Figure 9-62) into the retainer (26).
(16) Install the flywheel housing (9) in accordance with paragraph 9-35.

9-34. FLYWHEEL ASSEMBLY MAINTENANCE

a. Inspect Installed Flywheel Assembly.

(1) Remove the flange cover (14, Figure 9-62) by removing the capscrews (12) and lockwashers (13).
(2) Use the barring device to rotate the engine slowly while observing the flywheel (3) for indications of cracks, and the ring gear (5) for chipped, cracked, or worn teeth.
(3) Replace the flywheel assembly if it is cracked. If the ring gear is worn or cracked, replace it in accordance with step d, below. If cracks are suspected, remove the flywheel and inspect it in accordance with step c, below.
(4) Replace the flange cover (14) using lockwashers (13) and capscrews (12). Tighten the capscrews in accordance with Table 1-3.

b. Remove.

(1) Remove the generator in accordance with paragraph 2-16.
(2) Remove two capscrews and washer assemblies (1, Figure 9-62) and washers (2) from opposite sides of the flywheel (3).
(3) Refer to Table 2-2. Fabricate two guide studs and install them in the capscrew holes to support the crankshaft during removal.
(4) Bolt a sling to the outer diameter of the flywheel at the 10 and 2 O'clock positions, and attach to an overhead hoist.
(5) Remove the remaining capscrews and washer assemblies (1, Figure 9-62) and washers (2). Remove the flywheel (3) using the overhead hoist.
(6) If damaged, remove roll pins (4).

c. Inspect.

(1) Visually inspect the flywheel assembly in accordance with step a, above.
(2) Inspect the capscrew holes and roll pin holes for elongation. Replace the flywheel if the holes are elongated.
(3) Inspect the mating surfaces of the flywheel and crankshaft for burrs that could cause misalignment. Remove buns using a flat mill file.
(4) Inspect the flywheel and ring gear for cracks using magnetic particle inspection in accordance with MIL-1-6868.
(5) Replace the flywheel if it is cracked. If the ring gear is worn or cracked, replace it in accordance with step d, below.

d. Replace Ring Gear.

(1) Using a blunt chisel, drive the ring gear (5) from the flywheel (3).

WARNING

To avoid bum Injury when handling heated parts, Insulated gloves and protective clothing are required.

CAUTION

To avoid damaging the gear through overheating, do not heat the gear above 660-F (349 °C).

(2) Place the new ring gear in a controlled-heat oven set at 600°F (316°C) for 1 hour.
(3) Remove the heated ring gear from the oven. Working quickly to avoid heating and expanding the flywheel, position the ring gear on the flywheel, and use a soft hammer to drive it in place until it is firmly seated. Be sure the ring gear remains seated until the assembly is cool.

e. Install.

(1) Bolt a sling to the flywheel (3, Figure 9-62) at the 10 and 2 O'clock positions and attach to an overhead hoist.

NOTE

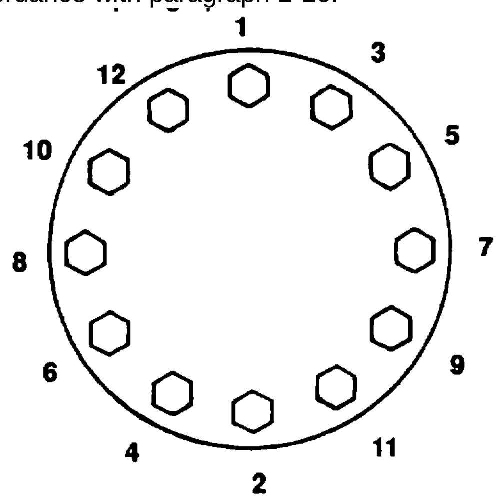
Before installing the flywheel, be sure the mating surfaces of the flywheel and crankshaft are dean, and free of burrs.

(2) Install the roll pins (4) if removed.
(3) Position the flywheel and crankshaft as necessary so that the capscrew holes and roll pin holes are in alignment, and install the flywheel over the guide studs.
(4) Lubricate the threads of the capscrews and washers (1) with lubricating oil, MIL-L-2104, and lubricate the washers (2) with SAE 140 gear lubricant, MIL-L-2105.
(5) Install ten washers (2), and capscrews and washers (1) and tighten them hand tight. Remove the guide studs, and install the remaining two capscrews and washers hand tight.
(6) Tighten all capscrews and washers (1) using the sequence, steps, and torque shown in Figure 9-63.
(7) Attach a dial indicator to the flywheel housing using attachment ST-1 325 and check the pilot bore runout (A, Figure 9-64). The TIR shall not exceed 0.005 inch (0.13 mm).

NOTE

When checking the flywheel face runout, be sure the crankshaft is kept positioned all the way forward to remove all crankshaft end-play.

(8) Move the dial indicator to the flywheel face to indicate a radius of 10 inches (254 mm), and check the face runout (B, Figure 9-64). The TIR shall not exceed 0.010 inch (0.25 mm).
(9) If the pilot bore or face runout is excessive, remove the flywheel and check for dirt or burrs on the mating surface of the flywheel or crankshaft. If the runout is still excessive after removing any dirt or burrs, replace the flywheel.
(10) Install the generator in accordance with paragraph 2-16.



STEP	TORQUE POUND-FEET	TORQUE NEWTON-METERS
1	100 TO 120	136 TO 163
2	200 TO 200	217 TO 244
3	360 TO 380	488 TO 515

Figure 9-63. Flywheel Capscrew Tightening Procedure

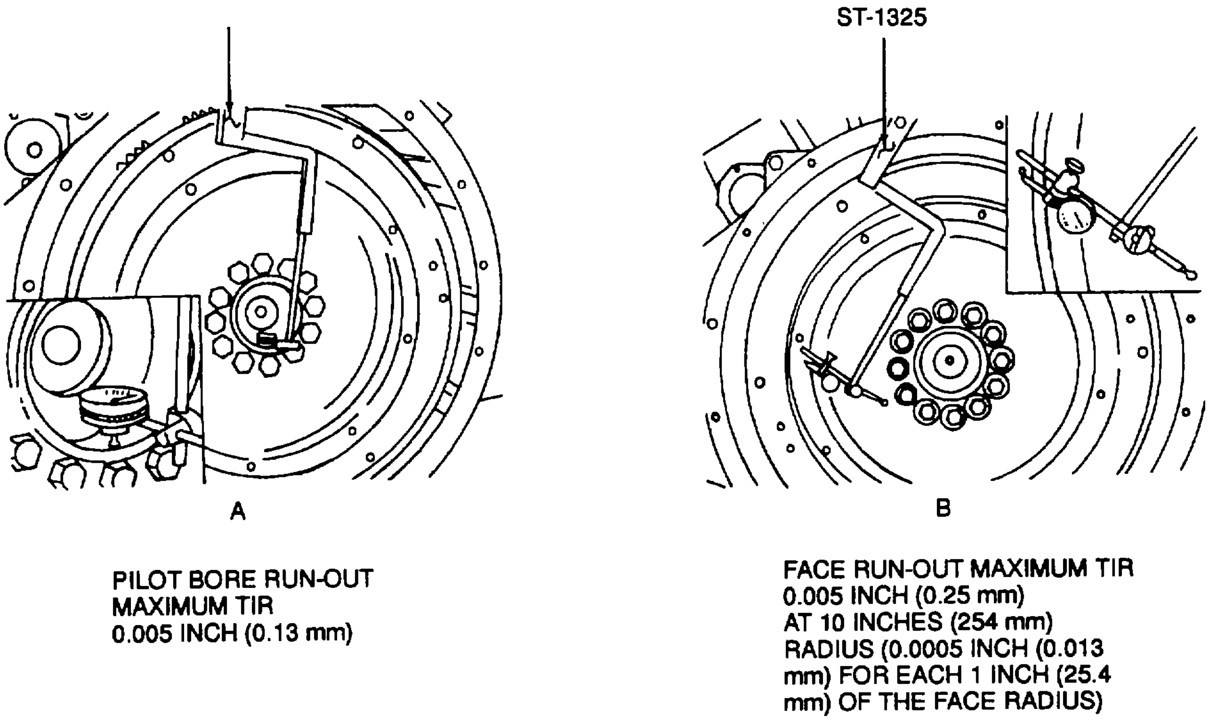


Figure 9-64. Checking Flywheel Runout

9-35. FLYWHEEL AND REAR GEAR HOUSING MAINTENANCE.

a. Inspect Installed Housings.

(1) Visually inspect the flywheel housing (9, Figure 9-62) and rear gear housing (32) for cracks. Replace any cracked housing or housings in accordance with steps b and d, below.

(2) If housing misalignment is suspected, check the alignment in accordance with step d(1 4), below.

(3) If cracks or other physical damage is suspected, remove and inspect the housing in accordance with step (c), below.

b. Remove.

(1) Remove the flywheel in accordance with paragraph 9-34.

(2) Remove the starter motors in accordance with the Operator and Organizational Maintenance Manual.

WARNING

The weight of the flywheel housing Is approximately 385 pounds (173 kg). Use of a lifting device not rated for this weight may result In damage to components or Injury to personnel.

(3) Bolt a sling to the flywheel housing (9, Figure 9-62) at the 10 and 2 O'clock positions, attach to an overhead hoist, and take up slack in the sling and hoist.

(4) Remove the capscrews (6 and 7) and lockwashers (8) from the flywheel housing (9).

(5) Using the sling and hoist, remove the flywheel housing (9) by tapping it free of the dowels (11) using a soft hammer. Remove and discard the dust seal (10), and remove the dowels if damaged.

(6) Remove the capscrews (12), lockwashers (13), and flange cover (14).

(7) Remove the capscrews (1 5), lockwashers (1 6), and remove the barring device housing (17) and attached parts.

(8) Remove the cotter damp (18), retaining ring (19), and remove the spring (20), gear (21), lock key (22), and shaft (23) from the barring device housing (17). Remove and discard the packing (24) from the shaft (23).

(9) Remove the rear crankshaft seal and retainer in accordance with paragraph 9-33.

WARNING

The weight of the rear gear housing Is approximately 32 pounds (14 kg). Use of a lifting device not rated for this weight may result In damage to components or Injury to personnel.

(10) Attach a sling and overhead hoist to the rear gear housing (32), and take up the slack in the hoist and sling.
(11) Remove the capscrews (30) and lockwashers (31). Tap the rear gear housing (32) free of the cylinder block and remove it with the overhead hoist.
(12) Remove and discard the gasket (33).

c. Inspect.
(1) Visually inspect the flywheel and rear gear housings (9 and 32) for cracks or other physical damage.
(2) Inspect the mating surfaces of the housings (9 and 32) for burrs that could cause misalignment. Remove buffs with a flat mill file.
(3) Inspect the housings (9 and 32) for cracks using magnetic particle inspection in accordance with MIL-1-6868. Replace cracked housings.
(4) Inspect the rear gear housing (32) for porosity using dye penetrant, MIL-1-25135, for inspection in accordance with MIL-1-6866. Replace porous housing.
(5) Inspect the barring device components (17 through 23) for wear and defects that would impair operation. Replace all defective parts.

d. Install
(1) Fabricate two guide studs (refer to Table 2-2) and install them in the upper capscrew holes on each bank of the cylinder block
(2) Apply a thin coat of sealing compound, MIL-S-45180, to a new gasket (33), and position the gasket over the guide studs.

WARNING

The weight of the rear gear housing Is approximately 32 pounds (14 kg). Use of a lifting device not rated for this weight may result In damage to components or Injury to personnel.

(3) Using a sling and overhead hoist, position the rear gear housing (32) over tie guide studs.
(4) Install several capscrews (30) and lockwashers (31) hand tight. Remove the guide studs, and install the remaining capscrews (30) and lockwashers (31).
(5) Cross-tighten the capscrews (30) in three steps to 60 to 70 pound-feet (81 to 95 newton-meters).
(6) Install the rear crankshaft seal in accordance with paragraph 9-33.
(7) Install a new packing (24) on the shaft (23), install the shaft through the barring device housing (17), and install the lock key (22), gear (21), and spring (20).
(8) Install the retaining ring (19) on the shaft (23), then pull out on the shaft and install the cotter clamp (18) on the shaft.
(9) Position the barring device housing (17) and assembled parts on the flywheel housing (9), and install the lockwashers (1 6) and capscrews (15). Tighten the capscrews to 90 to 110 pound-feet (122 to 149 newton-meters).
(10) Install the flange cover (14), lockwashers (13), and capscrews (12). Tighten the capscrews in accordance with Table 1-3.
(11) Refer to Table 2-2. Fabricate two guide studs and install them on opposite sides of the cylinder block

WARNING

The weight of the flywheel housing Is approximately 385 pounds (173 kg). Use of a lifting device not rated for this weight may result In damage to components or Injury to personnel.

(12) Using a sling and overhead hoist, lift the fly wheel housing (9), into position over the guide studs and tap it into place over the dowels using a soft hammer.

(13) Install the lockwashers (8), capscrews (6 and 7), and snugtighten the capscrews to approximately 25 pound-inches (3 newton-meters).

(14) Check the flywheel housing (9, Figure 9-62) alignment and tighten the capscrews (6 and 7) as follows:

(a) See Figure 9-65. Attach dial gage attachment, ST-1 325, and dial indicator to the crankshaft, and position the indicator button on the housing bore (A, Figure 9-64).

(b) Draw chalk marks on the flywheel housing at 12, 3, 6, and 9 O'clock

(c) Check the readings at 3 and 9 O'clock. I the TIR exceeds 0.010 inch (0.25 mm), use a soft hammer to tap the housing right or left, as necessary, one-half the distance of the TIR to center the housing horizontally.

(d) Check the readings at 12 and 6 o'clock. If the TIR exceeds 0.010 inch (0.25 mm), use a soft hammer to tap the housing up or down, as necessary, one-half of the TIR to center the housing vertically.

(e) Move the dial indicator to the face of the flywheel housing (B, Figure 9-65).

(f) Push the crankshaft forward to take up the end clearance. Zero the indicator, and rotate the crankshaft 360 decrees to obtain the TIR of the housing face.

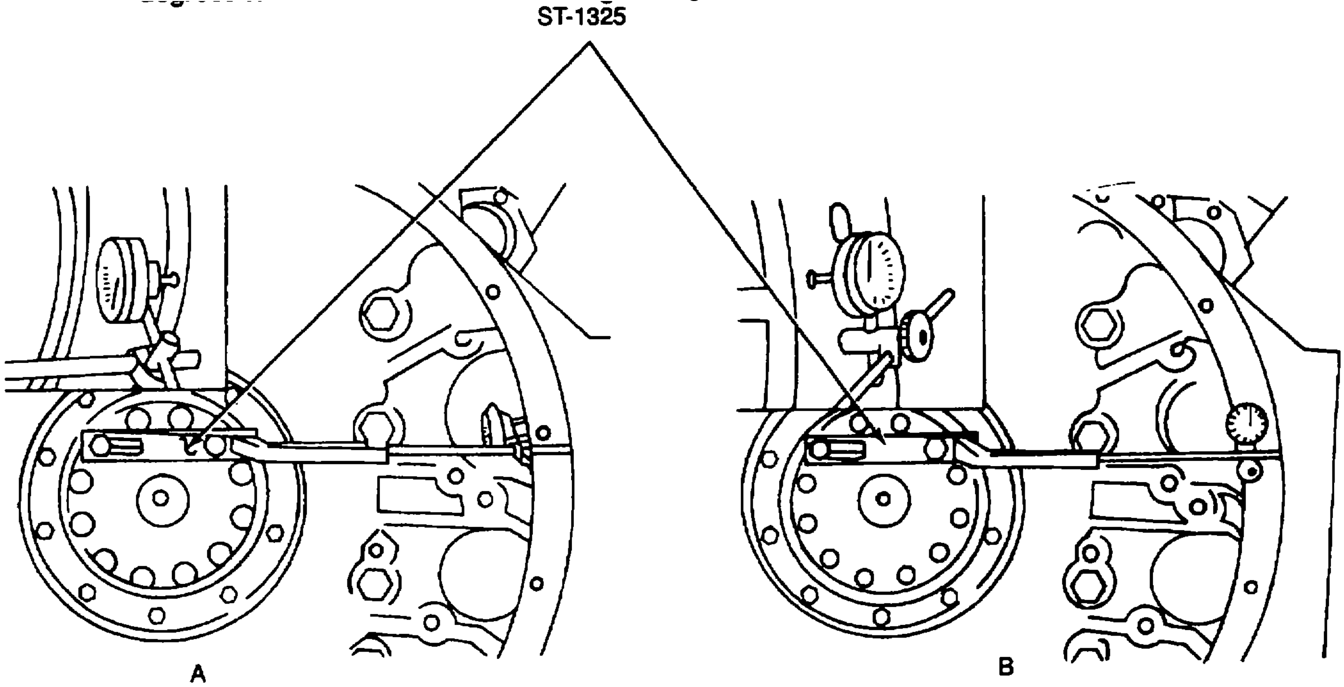


Figure 9-65. Checking Flywheel Housing Alignment

(g) The TIR of the housing face must not exceed 0.010 inch (0.25 mm).

(h) To correct the housing face runout, remove the housing, check the dust seal alignment and remove any burrs or dirt from the mating surfaces. Reinstall and realign the housing. If the alignment is still incorrect. replace the housing.

(i) If the indicator readings are within the limits, cross tighten the capscrews (6 and 7, Figure 9-62) in three steps to 260 to 270 pound-feet (353 to 363 newton-meters).

(15) Install the starter motors in accordance with the Operator and Organizational Maintenance Manual.

(16) Install the flywheel in accordance with paragraph 9-34.

9-36. FRONT ENGINE SUPPORT MAINTENANCE.

a. Remove.

(1) Remove the cooling fan shrouds in accordance with the Operator and Organizational Maintenance Manual.

(2) Remove the hexagon head capscrews (1, Figure 9-66), hexagonal nuts (2), lockwashers (3), and bevel washers (5) securing the front support assembly (6) to the front engine support (5). I damaged, remove the grease fitting (9)

(3) Loosen the hexagon head capscrews (1) and hexagonal nuts (2) at the rear engine support slightly.
(4) Using a wooden block to protect the oil pan, and a hydraulic jack of 5 tons (4.5 t) capacity placed just behind the front support assembly (6), raise the front of the engine slightly.
(5) Remove the hexagon head capscrews (1), hexagonal nuts (2), lockwashers (3), and bevel washers (4) securing the front engine support (5) and skid base.

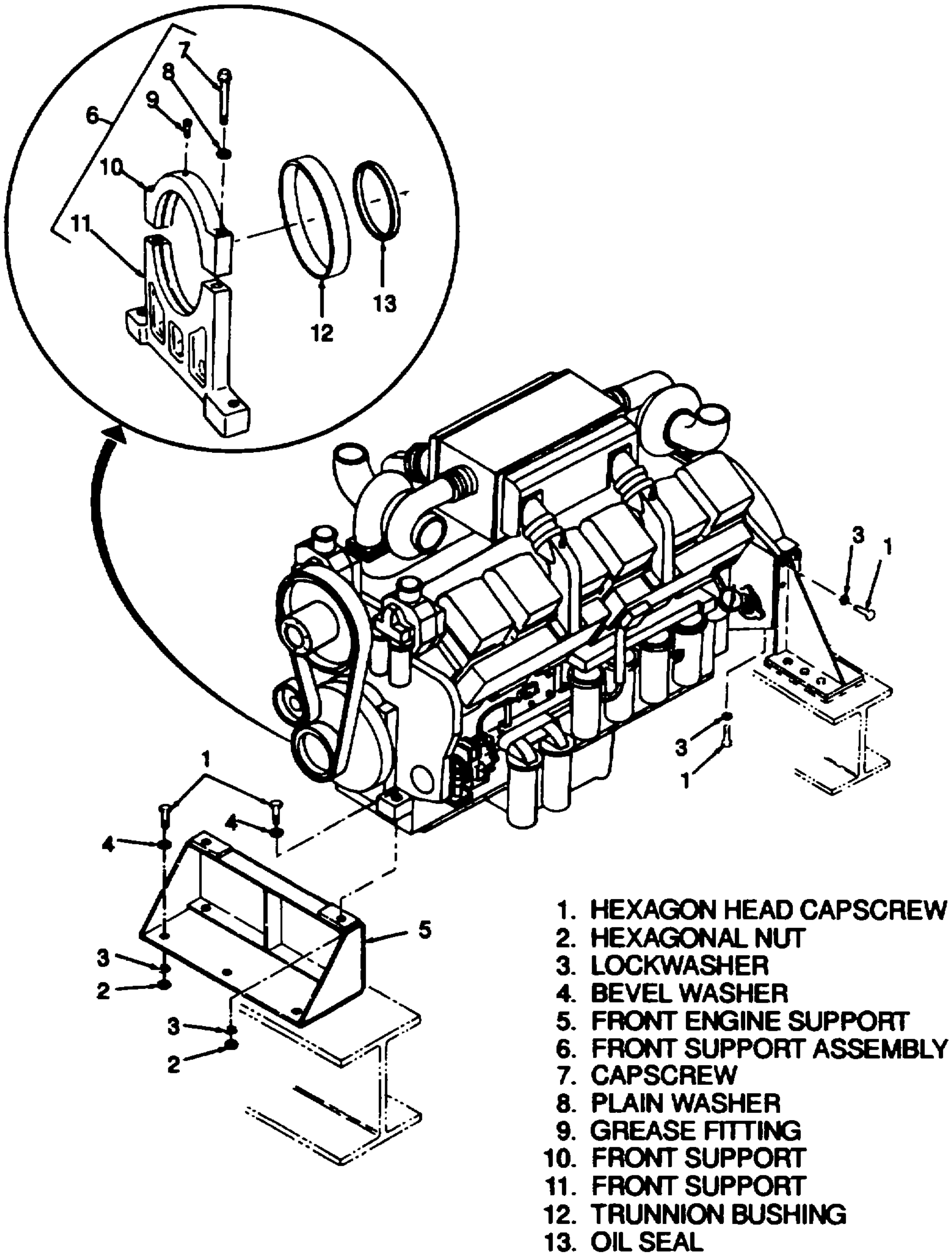


Figure 9-66. Front Support Assembly

(6) Jack up the engine as required, and remove the front engine support (5).
(7) Remove the capscrews (7) and plain washers (8), and separate the front support (10) from the front support (1).
(8) Remove the crankshaft pulley and vibration damper in accordance with paragraph 9-32.
(9) Remove the trunnion bushing (12) and oil seal (13).

b. Repair. Weld cracks in the front supports (10 and 11) in accordance with MIL-STD-248.

c. Install.

(1) Install trunnion bushing (12) and oil seal (13).
(2) Install the crankshaft pulley and vibration damper in accordance with paragraph 9-32.
(3) Position front support (10) and front support (I1) and join with capscrews (7) and plain washers (8). Cross-tighten the hexagon head capscrews (7) to 200 to 220 pound-feet (271 to 298 newton-meters).
(4) Position the front engine support (5) under the engine.
(5) Lower the jack slightly, and install the hexagon head capscrews (1), bevel washers (4), lockwashers (3), and hexagonal nuts (2). Do not tighten at this time.
(6) Lower the engine completely, and remove the jack and wooden bock.
(7) If removed, install the grease fitting (9) in the front engine support (10).
(8) Tighten all hexagon head capscrews (1) and hexagonal nuts (2) to 200 pound-feet (271 newton-meters).
(9) Lubricate the trunnion bushing (12) at the grease fitting (9) using MIL-G-10924.
(10) Install the cooling fan shroud in accordance with the Operator and Organizational Maintenance Manual.

9-37. INSPECTION COVER MAINTENANCE.

a. Remove.

(1) Remove each inspection cover (see Figure 9-67) by removing attaching capscrews and lockwashers.
(2) Remove and discard the gasket. Clean all traces of the old gasket from the inspection cover and cylinder block.

b. Install.

(1) Coat the new gasket with a thin film of sealant, MIL-S-451 80, and install gasket.
(2) Install the inspection cover and secure with lockwashers and capscrews. Cross-tighten the capscrews to 30 to 35 pound-feet (41 to 47 newton-meters).

9-38. OIL PAN ASSEMBLY MAINTENANCE.

a. Remove.

(1) Place a container having a capacity of at least 35 gallons (132 liters) under the overboard drain, open the drain valve (4, Figure 9-68), and allow the oil to drain.
(2) Remove lube oil hoses and fittings associated with the prelube pump B3, oil sight gage, lubricant temperature thermostat S1 01, lube oil heater Hi 13, and lubricant temperature switch OT2 from the oil pan, and remove the on engine duplex fuel filter set and by-pass oil filter set in accordance with the Operator and Organizational Maintenance Manual.
(3) Remove the overboard drain hose from the adapter (4) and the filter return line from the adapter (14).
(4) Place a drain pan under the oil pan assembly to catch any remaining oil, and remove the drain plugs (1), and the drain valve (4) with the adapter (5) attached. Do not remove the threaded inserts (3) unless damaged.
(5) If it is necessary to replace the drain valve (4) remove the adapter (5) from the valve.

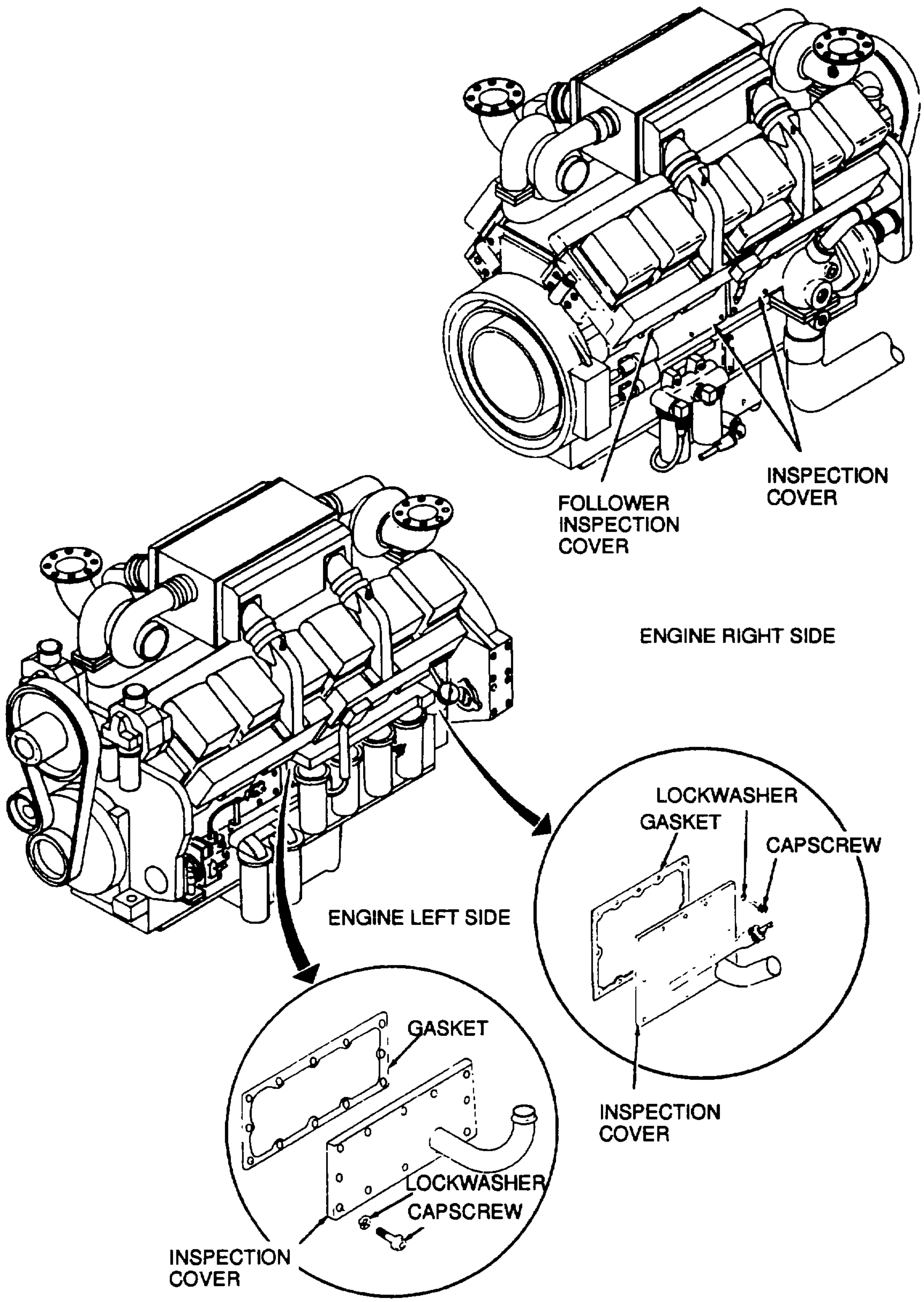


Figure 9-67. Inspection Covers

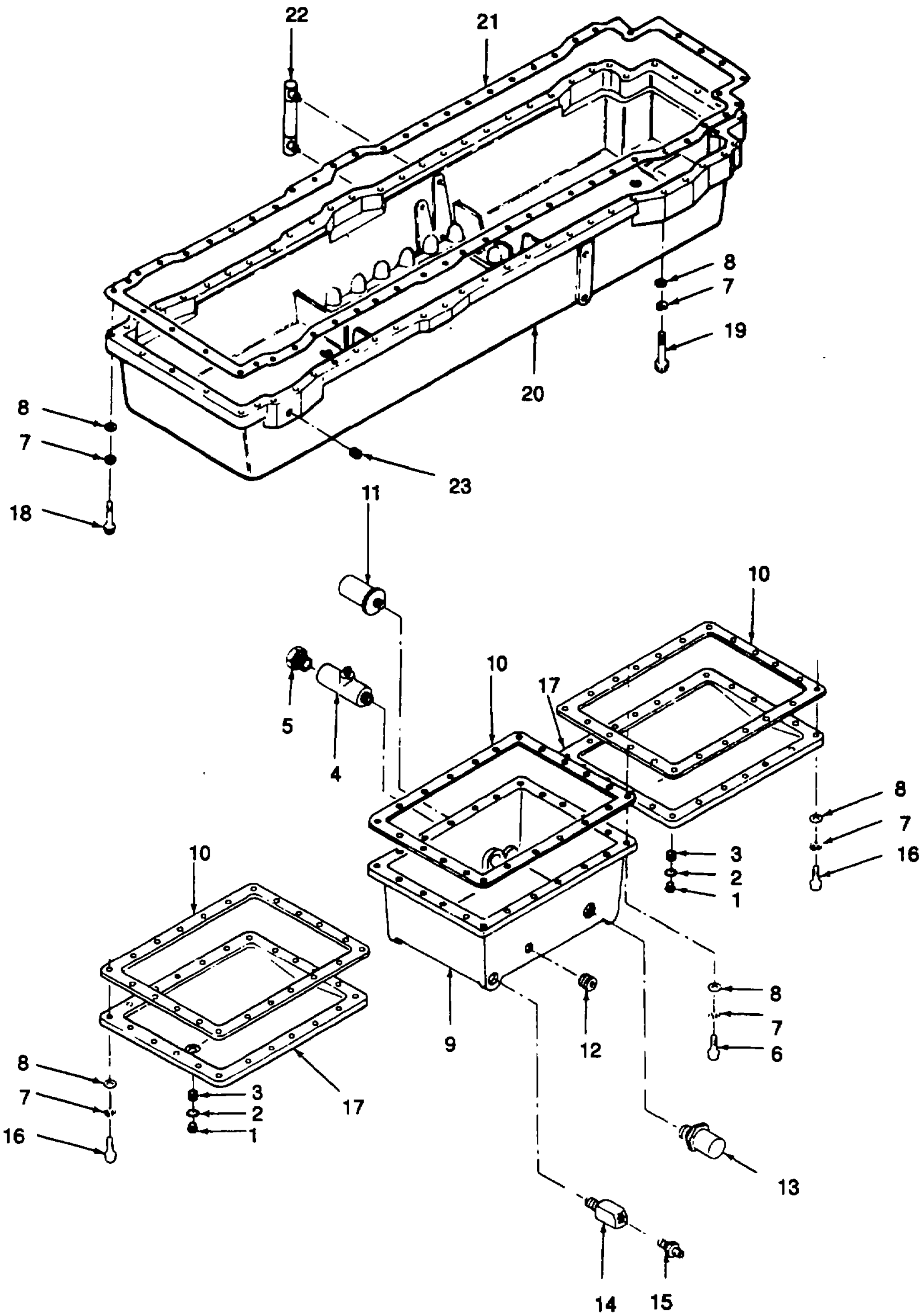


Figure 9-68. Removal and Installation of Oil Pan Assembly (Sheet 1 of 2)

1. DRAIN PLUG
2. RING SPACER
3. THREADED INSERT
4. DRAIN VALVE
5. ADAPTER
6. CAPSCREW
7. LOCKWASHER
8. WASHER
9. OIL PAN
10. GASKET
11. LUBE OIL HEATER H113
12. PIPE PLUG
13. LUBRICANT TEMPERATURE THERMOSTAT S1 01
14. ADAPTER
15. BUSHING
16. CAPSCREW
17. COVER
18. CAPSCREW
19. CAPSCREW
20. OIL PAN ADAPTER
21. GASKET
22. OIL SIGHT GAGE
23. PIPE PLUG

Figure 9-68. Removal and Installation of Oil Pan Assembly (Sheet 2 of 2)

NOTE

It is recommended that a minimum of four persons perform the following procedure.

(6) Remove the capscrews (6), lockwashers (7), washers (8), and remove the oil pan (9). Remove and discard the gasket (10).

(7) Remove the capscrews (16), lockwashers (7), washers (8), and remove the covers (17), if necessary, and remove and discard the gaskets (10).

(8) Remove the capscrews (18 and 19), lockwashers (7), washers (8), and remove the oil pan adapter (20). Remove and discard the gasket (21).

WARNING

Dry cleaning solvent PD-680, Type III, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

b. Clean. Clean all parts thoroughly using dry cleaning solvent PD-680, Type III, or equivalent, and dry with shop towels.

c. Inspect.

(1) Visually inspect the oil pan (9), covers (17), and the oil pan adapter (20) for cracks, warped gasket surfaces, nicks and burrs on the gasket surfaces, and damage to the threaded holes.

(2) Inspect the oil pan (9), covers (17), and oil pan adapter (20) for cracks and porosity using nondestructive tests in accordance with MIL-1-6866 or MIL-1-6868.

(3) Check the threaded holes in the cylinder block (for capscrews 18 and 19) for damaged or stripped threads.

d. Repair.

(1) Repair slightly damaged threaded fittings, plugs, and capscrews by chasing. Replace stripped fitting, plugs, or capscrews.

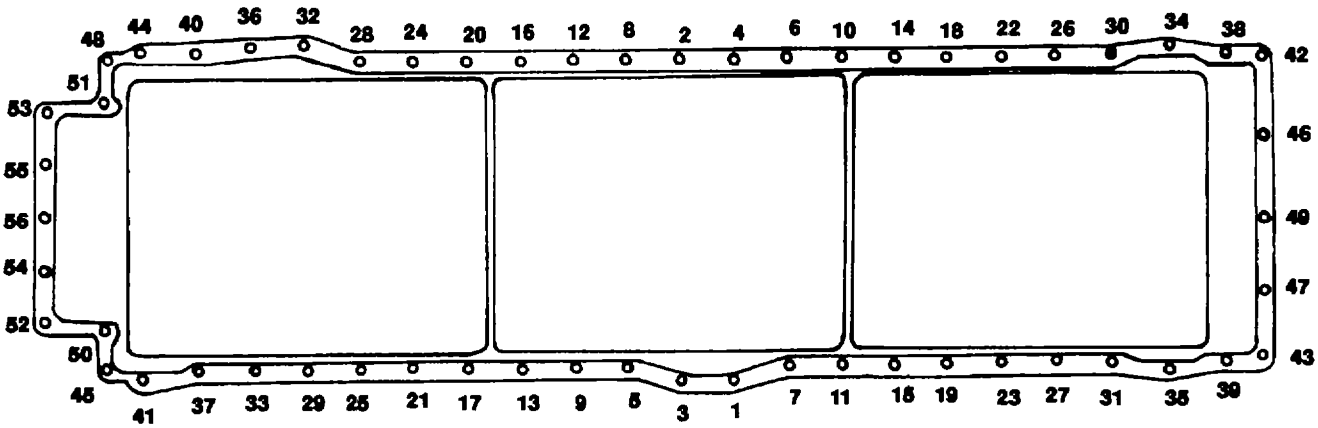
(2) Replace damaged, stripped, or loose threaded inserts and repair stripped threads in accordance with paragraph 2-12.

(3) Remove nicks or burrs on the gasket surfaces of the oil pan (9), covers (17), or oil pan adapter (20) using a flat mill file.

(4) Repair cracks or porosity in the oil pan (9), covers (17), or oil pan adapter (20) by welding in accordance with MIL-STD-248. Reinspect the welded areas in accordance with step c(2), above.

(5) If welding repairs extended into the gasket surfaces, or the gasket surfaces were warped, refinish the gasket surface using a surface grinder.

e. Install. Before installing either the adapter, covers, or oil pan, be sure all traces of old gasket material has been removed. Wrap all pipe plugs and pipe fittings with ant-seize tape, MIL-T-27730, before installing. When installing the oil pan adapter (20, Figure 9-68), be sure to follow the exact torque sequence and torque values given.



STEP		TORQUE IN POUND-FEET (NEWTON METERS)
1	TIGHTEN IN SEQUENCE	10 TO 13 (14 TO 18)
2	TIGHTEN IN SEQUENCE	22 TO 28 (30 TO 38)
3	TIGHTEN IN SEQUENCE TO FINAL TORQUE	32 TO 38 (43 TO 52)

Figure 9-69. Tightening Procedure, Oil Pan Adapter

(1) Fabricate ten guide studs (refer to Table 2-2) for the oil pan adapter (20) and install three studs on each side of the cylinder block, and two on each end.
(2) Coat a new adapter gasket (21) with sealant MIL-S-45180, and install it over the guide studs.
(3) Position the oil pan adapter (20) over the guide studs, and install 46 capscrews (18 and 19) using lockwashers (7) and washers (8). Screw the capscrews in several threads, but do not tighten them at this time.
(4) Remove the guide studs, install the remaining capscrews (18 and 19), using the lockwashers (7) and washers (8).Using the sequence in Figure 9-69, tighten all capscrews until they are snug.
(5) Using the sequence, steps, and torque given in Figure 9-69, tighten all capscrews (18 and 19, Figure 948).
(6) Coat new gaskets (10) with sealant MIL-S-45180, and position them on the covers (17), if removed.
(7) Install the covers (17) on the oil pan adapter (20) using the capscrews (16), lockwashers (7), and washers (8). Cross-tighten the cap screws in three steps to 32 to 38 pound-feet (43 to 52 newton-meters).
(8) Using new ring spacers (2), install the drain plugs (1) in the covers (17), and tighten to 60 to 70 pound-feet (81 to 95 newton-meters).
(9) Install the drain valve (4) in the oil pan (9), and install the adapter (5) in the drain valve, if removed. Tighten the adapter (5) and drain valve (4) in accordance with Table 1-3.
(10) Coat a new gasket (10) with sealant MIL-S451 80, and position it on the oil pan (9).
(11) Install the oil pan (9) on the oil pan adapter (20) using the capscrews (6), lockwashers (7), and washers (8). Cross-tighten the cap screws in three steps to 32 to 38 pound-feet (43 to 52 newton-meters).
(12) Connect the overboard drain hose to the adapter (5) and the filter return line to the adapter (14).

(13) Replace lube oil hoses and fittings associated with the prelube pump B3, oil sight gage, lubricant temperature thermostat S101, lube oil heater H113, and lubricant temperature switch OT2 from the oil pan, and install the engine duplex fuel filter set and by-pass oil filter set in accordance with the Operator and Organizational Maintenance Manual.

CAUTION

Serious engine damage will result If the engine Is started before the lubrication system Is properly filled and primed. Elapsed time between priming the lubrication system and starting the engine shall not exceed 3 hours. If, for whatever reason, the engine cannot be started within 3 hours after priming the lubrication system, repeat the entire priming procedure just prior to starting the engine.

(14) Before starting the engine, fill and prime the lubrication system in accordance with the Operator and Organizational Maintenance Manual.

SECTION VII. MAINTENANCE OF TURBOCHARGERS

9-39. GENERAL The turbochargers increase the pressure of the incoming air before it enters the cylinders. This increases the effective compression pressure and volumetric efficiency, which results in a substantial gain in power. A turbocharger consists of a turbine wheel and compressor wheel mounted on a common shaft and separated by a center housing and back-plate. The center housing and back-plate also serve to separate the turbine housing and compressor housing. During engine operation, exhaust gas enters at the turbine housing, and turns the turbine wheel before exiting through the exhaust system and muffler. Since the compressor wheel and turbine wheel are on a common shaft, the compressor wheel must turn with the turbine wheel. Incoming air from the air cleaner is pulled in by the compressor wheel, compressed between the vanes and housing, and is expelled into the inlet manifold. The compressed air in the manifold enters the cylinders during w the intake stroke of the engine.

9-40. TURBOCHARGER REPAIR AND OVERHAUL.

Remove the turbocharger in accordance with the Operator and Organizational Maintenance Manual, and repair or overhaul as follows:

a. Disassemble.

(1) Match-mark the compressor housing (3, Figure 9-70) and turbine housing (7) to the center housing (18) to facilitate reassembly.

CAUTION

Separate the housings carefully to avoid damage to the Impeller and turbine wheel.

(2) Remove the locknut (1), the V-band (2), and remove the compressor housing (3) from the back-plate (17).

(3) Remove the bolts (4), lockplates (5), and damps (6) and separate the turbine housing (7) from the center housing (18). Discard the lockplates.

CAUTION

When removing or installing the locknut (8), use a flexible socket to help avoid side-loading the shaft. Side-loading could bend the shaft, resulting In excessive runout and vibration problems In the assembled unit.

(4) Place the turbine end of the shaft (10) in a vise equipped with soft jaws to avoid damaging the shaft. Match-mark the impeller (9) and shaft (10), and remove the locknut (8), using a flexible socket and extension on the wrench handle.

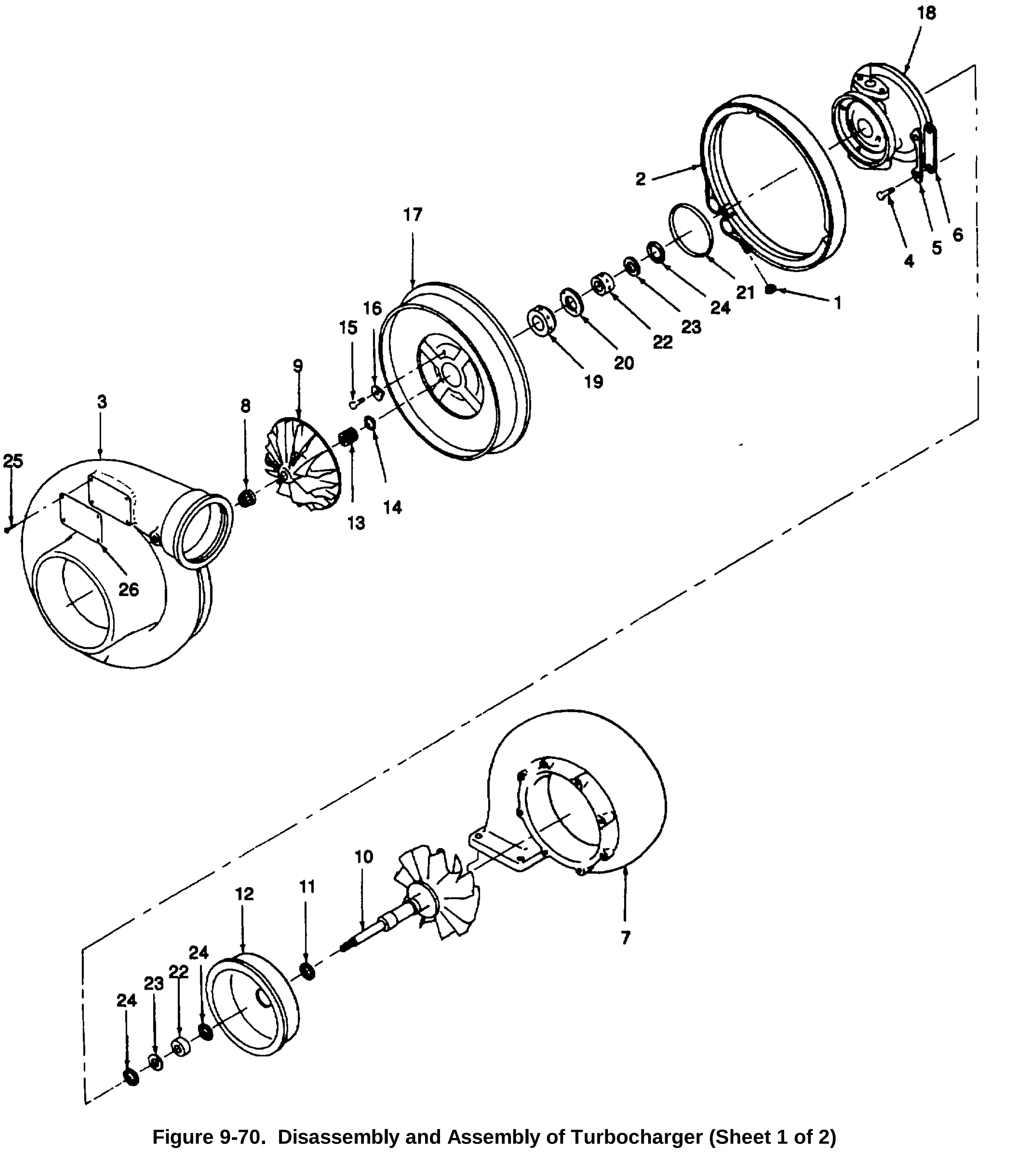


Figure 9-70. Disassembly and Assembly of Turbocharger (Sheet 1 of 2)

1.	LOCKNUT	14.	SEAL RING
2.	V-BAND	15.	BOLT
3.	COMPRESSOR HOUSING	16.	WASHER
4.	BOLT	17.	BACK-PLATE
5.	LOCK PLATE	18.	CENTER HOUSING
6.	CLAMP	19.	THRUST COLLAR
7.	TURBINE HOUSING	20.	THRUST BEARING
8.	LOCKNUT	21.	PACKING
9.	IMPELLER	22.	BEARING
10.	TURBINE WHEEL AND SHAFT	23.	WASHER
11.	SEALING	24.	RETAINING RING
12.	SHROUD	25.	RIVET
13.	THRUST SPACER	26.	NAMEPLATE

Figure 9-70. Disassembly and Assembly of Turbocharger (Sheet 2 of 2)

(5) Remove the turbine wheel and shaft assembly (10) from the impeller (9). If necessary use an arbor press while supporting the assembly at the turbine housing mounting face on the shroud (12). Remove the impeller.

(6) Remove the turbine wheel and shaft assembly (10) from the shroud (12), and remove the seal ring (11) from the shaft.

(7) Separate the shroud (12) from the center housing (18).

(8) Remove the thrust spacer (13), and remove the seal ring (14) from the thrust spacer.

(9) Remove the bolts (15), washers (16), and separate the bate (17) from the center housing (18).

(10) Remove the thrust collar (19), thrust bearing (20), packing (21), bearing (22), washer (23), and retaining ring (24) from the impeller end of the center housing (18). Discard the packing (21) and retaining ring (24).

(11) Remove the retaining ring (24), bearing (22), washer (23), and another retaining ring (24) from the turbine end of the center housing (18). Discard the retaining rings (24).

(12) Remove the nameplate (26) by removing the rivets (25).

b. Clean.

WARNING

Dry leaning solvent PD.60, Type IN, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid injury to personnel.

WARNING

Compressed air used for cleaning or drying can create airborne particles that may enter eyes. Pressure shall not exceed 30 psi (207 kPa). Wearing of goggles Is required to avoid Injury to personnel.

CAUTION

To avoid damage to precision machined parts, do not pile the parts In the cleaning -basket, or use any type of chemical solution that might damage ports Place parts In a divided wire basket , and use dry cleaning solvent PD-610, Type III, or equivalent, or hot water and soap to clean parts. Parts may also be steam cleans Do not use wire brushes or metal scrapers to dean parts

(1) Soak all parts in cleaning solution, and remove built up deposits using a bristle brush and wooden scrapers. Soak " heavily carboned parts for 12 to 24 hours.

(2) Flush the oil passages in the center housing from the drain end using dry cleaning solvent PD-680, Type II, or equivalent.
(3) Steam dean the parts to remove any remaining carbon or grease, and blow dry the parts using filtered, moisture free compressed air.
(4) Place the cleaned parts in compartmented trays, and cover them to avoid contamination.

c. Inspect. Inspect all components and replace defective parts as noted. Repair or replace other defective parts in accordance with step d or e, below.

(1) Inspect the V-band (2, Figure 9-70) for distortion and cracks, and the bolt for damaged threads. Replace the V-band if it is cracked or the bolt threads are stripped.
(2) Check all threaded fasteners and holes for damaged or stripped threads. Replace stripped capscrews. Repair stripped holes in accordance with paragraph 2-12. Check the prevailing torque of the locknuts in accordance with Table 1-3. Replace locknuts that are below the minimum prevailing torque.
(3) Inspect the clamps (6) for bending, distortion, and cracks. Replace defective damps.
(4) Check the compressor housing contour areas for scoring, grooving, and signs of impeller rub, and rust (A, Figure 9-71). Check the mounting flanges (B, Figure 9-71) for cracks.
(5) Check the turbine housing contour area for scoring, grooving, burning, and signs of turbine rub (A, Figure 9-72). Check the mounting flanges (B, Figure 9-72) for cracks or rust.
(6) Check the center housing (18, Figure 9-70) for cracks, burning, and pitting, and check the bearing bores for wear and out-of-round using a telescoping gage and outside micrometer.

NOTE

If the turbocharger is being overhauled, replace the backplate (17) regardless of physical condition.

(7) Check the back-plate (17) for scoring and wear in the area of the thrust collar and impeller.
(8) Check the shroud (12) for scoring, grooving, and turbine rub.
(9) Inspect the compressor housing (3), turbine housing (7), back-plate (1 7), center housing (18), and shroud (12).Replace parts that are cracked or porous.
(10) Check the impeller for cracks, nicks, scoring, and rub damage (Figure 9-73). Replace the impeller if it is cracked.
(11) Inspect the impeller (9, Figure 9-70). Replace the impeller if it is cracked.
(12) Turbine wheel and shaft. (See Figure 9-74.)

(a) Check the turbine wheel for cracks, nicks, scoring, and rub damage. Replace the turbine wheel and shaft if it is cracked.
(b) Check for cracks, scoring, and porosity in the weld area.
(c) Check the shaft diameter in the bearing area for wear, scoring, and out-of-round.
(d) Check the shaft seal ring groove for wear, using a new seal ring and a feeler gage. Maximum clearance shall be 0.008 inch (0.20 mm).
(e) Support the shaft in V-blocks at the bearing journal areas and check the shaft for runout. Replace the turbine wheel and shaft if the runout exceeds 0.0005 inch (0.013 mm).

NOTE

If the turbocharger is being overhauled, replace the thrust spacer (13, Figure 970), thrust collar (19), thrust bearing (20), bearings (22), and washers (23) regardless of physical condition.

(13) Check the thrust spacer (13, Figure 9-70) for scoring or grooving. Check the ring groove clearance using a new seal ring (14) and a feeler gage. Maximum clearance shall be 0.009 inch (0.23 mm).
(14) Check the thrust collar (19) for scoring or grooving. Scoring shall not exceed 0.003 inch (0.08 mm) in depth.

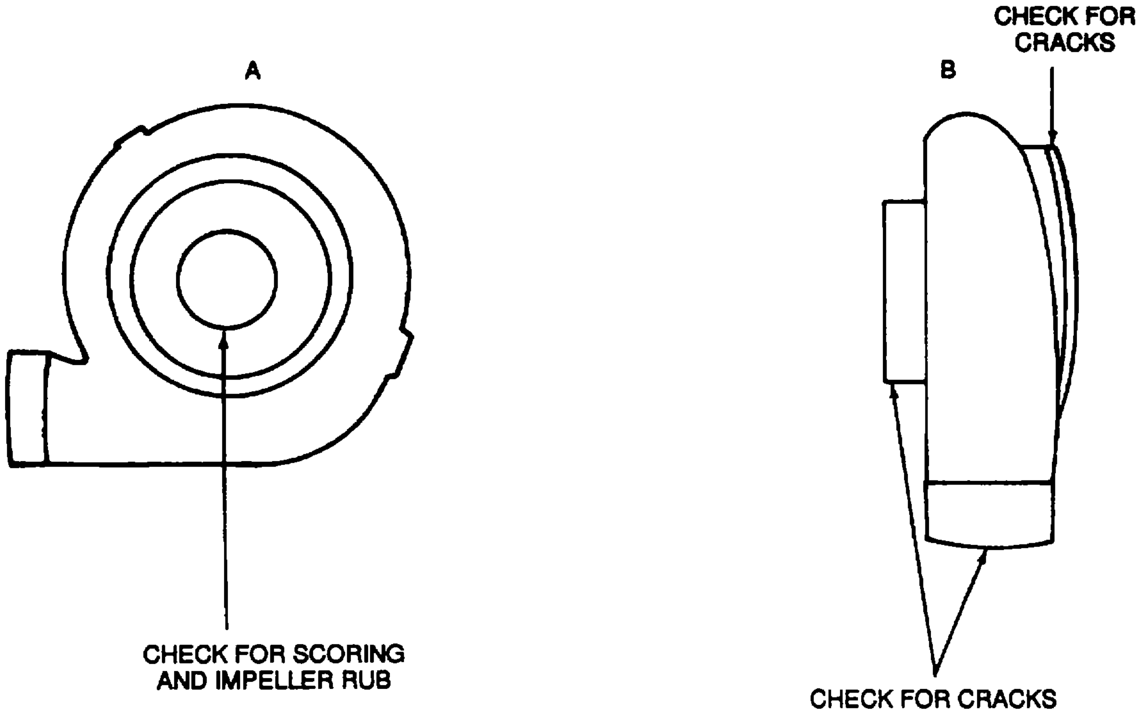


Figure 9-71.

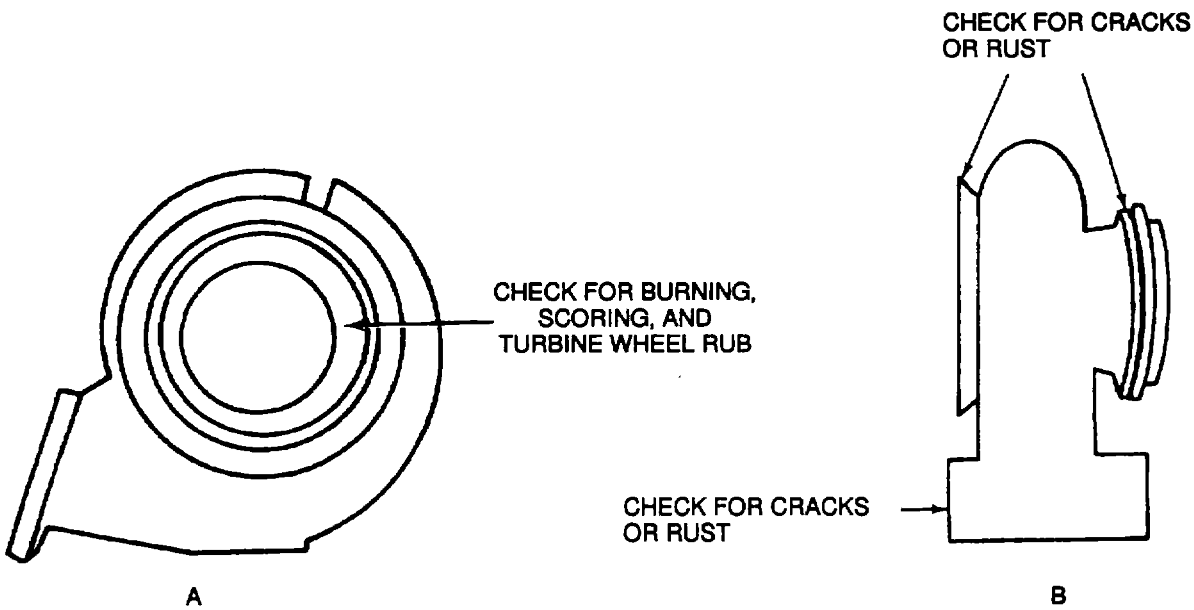


Figure 9-72. Inspection of Turbine Housing

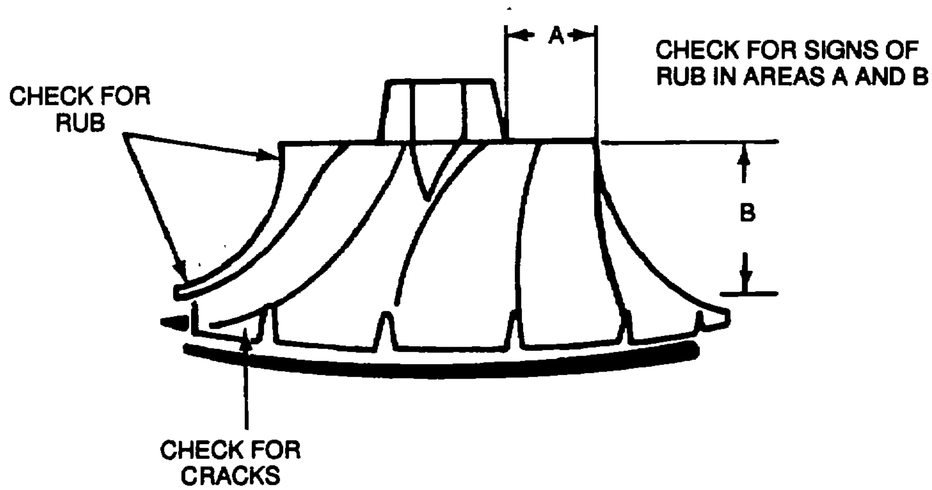


Figure 9-73.

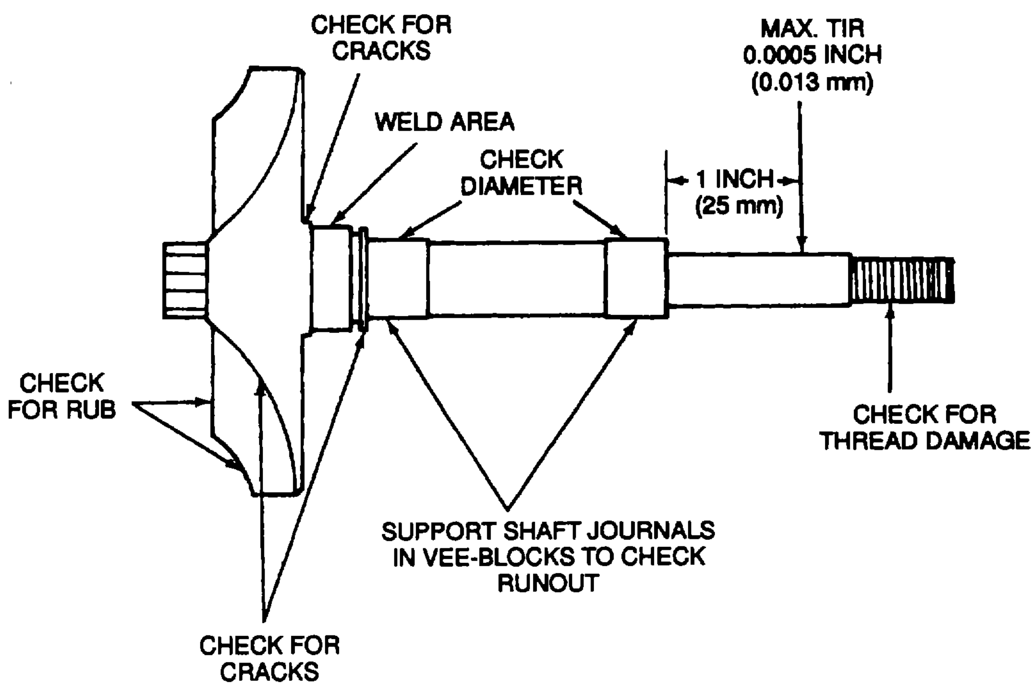


Figure 9-74. Inspection of Turbine Wheel and Shaft

(15) Check the thrust bearing (20) for scoring or grooving, and check the thickness using an outside micrometer. Scoring shall not exceed 0.003 inch (0.08 mm) in depth, and the minimum thickness shall be 0.090 inch (2.29 mm).

(16) Check the bearings (22) for scoring and wear on the inside and outside diameters. Scoring shall not exceed 0.003 inch (0.08 mm) in depth. The maximum inside diameter shall be 0.6272 inch (15.931 mm). The minimum outside diameter shall be 0.9782 inch (24.846 mm).

(17) Check the washers (23) for scoring or grooving. Scoring shall not exceed 0.003 inch (0.08 mm) in depth.

d. Repair.

(1) Replace all defective parts in accordance with the directions in step c, above.

NOTE

In the following repair procedures, minor scoring is defined as shallow scratches that do not exceed 0.003 inch (0.08 mm) in depth. A fingernail will catch and hang up when soaped across an excessively scored surface.

(2) Replace the compressor housing (3) if it is cracked, deeply scored, or grooved in the contour area, or shows signs of heavy impeller rub. Remove minor scoring and rust with crocus cloth, P-C-458.

(3) Replace the turbine housing (7) if it is cracked, deeply scored, or grooved in the contour area, or shows S of heavy turbine rub or burning. Remove minor scoring with crocus cloth, P-C-458.

(4) Replace the center housing (18) if it is cracked, burned, deeply pitted, or if the bearing bore is out-of-round or worn larger the 0.9835 inch (24.981 mm).

(5) Replace the backplate (17) if it is cracked, deeply scored, or grooved. Remove minor scoring' with crocus cloth, P-C458.

(6) Replace the shroud (12) if it is cracked, deeply scored, or grooved. Remove minor scoring with crocus cloth, P-C-458.

(7) Replace the impeller (9) if it is cracked, deeply scored or grooved, or shows heavy rub damage. Remove minor nicks and scoring with cloth, P-C458.

(8) Replace or repair the turbine wheel and shaft as follows:

(a) Replace the turbine wheel if it is cracked, deeply scored or grooved, or shows heavy nib damage. Remove minor nicks and scoring with crocus cloth, P-C458.

(b) Replace if more than one visible hole over 0.080 inch (2.03 mm) in diameter is found in the weld area.

(c) Replace if the weld area is chipped, cracked, or scored.

(d) Porosity in the weld area is acceptable, provided the holes are not over 0.015 inch (0.38 mm) in diameter.

(e) Surface cracks in the weld area are 4zoe . provided the maximum length is 0.375 inch (9.53 mm), no more than three cracks are present and the distance between the cracks is at least 0.250 inch (6.35 mm).

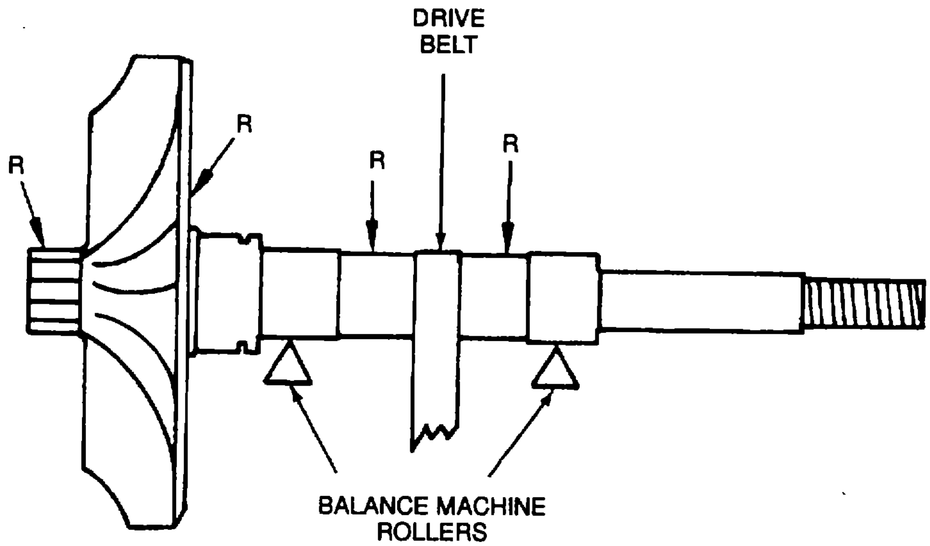
(f) Replace if the seal ring-to-groove clearance exceeds 0.008 inch (0.20 mm), or if the shaft runout exceeds 0.0005 inch (0.013 mm).

(g) Replace if the shaft is worn more than 0.6250 inch (15.875 mm) at either bearing area.

(9) If it was necessary to replace the impeller, or the turbine wheel and shaft the turbine wheel and shaft must be balanced individually, and then balanced with the impeller as an assembly. Balance as follows (see Figure 9-75 and Figure 9-76).

(a) Mount the turbine wheel and shaft in a dynamic balance machine with the rollers centered on the bearing areas, and the drive belt centered between the rollers (see Figure 9-75).

(b) Turn the turbine wheel and shaft at 3000 r/min, and balance to a tolerance of 0.0003 ounce-inch (0.216 mg/m). To achieve balance, use a die grinder and rotary file, and remove metal from the areas indicated in Figure 9-75 as necessary. Smooth and blend the filed areas with crocus cloth, P-C 458.



BALANCE TO 0.0003 OZ/IN (0.216 mg/m), AT 3000 r/m.
REMOVE WEIGHT FROM NON-CRITICAL AREAS AS SHOWN BY ARROWS. ⟵ R

Figure 9-75. Balance of Turbine Wheel and Shaft

(c) When balance is achieved, remove the turbine wheel and shaft from the machine, and add the thrust bearing (20, Figure 9-70), thrust collar (19), and impeller (9) to the shaft.
(d) Match-mark the impeller to the shaft, and install the locknut (1). Tighten the locknut in accordance with Figure 9-77, and reinstall the assembly in the balancing machine (Figure 9-76).
(e) Turn the assembly at 3000 r/min, and balance to a tolerance of 0.0003 ounce-inch (0.216 mg/m). To achieve balance, use a die grinder and rotary file, and remove metal from the areas indicated in Figure 9-76 as necessary. Smooth and blend the filed areas with crocus cloth, P-C-458.
(f) When balance is achieved, remove the assembly from the machine, and remove the locknut, impeller, thrust spacer, thrust collar, and thrust bearing.

e. Overhaul.

(1) In addition to the worn parts that would normally be replaced during repair, replace the following parts at each overhaul:
  (a) Thrust spacer (1 3).
  (b) Back-plate (17).
  (c) Thrust collar (19).
  (d) Thrust bearing (20).
  (e) Bearings (22).
  (f) Washers (23).
(2) Replace the center housing (18) if the bearing bore is worn larger than 0.9835 inch (24.981 mm).
(3) Replace the turbine wheel and shaft (10) if the shaft is worn more than 0.6254 inch (1 5.885 mm) at either bearing area.
(4) Perform all other operations in accordance with step d, above.

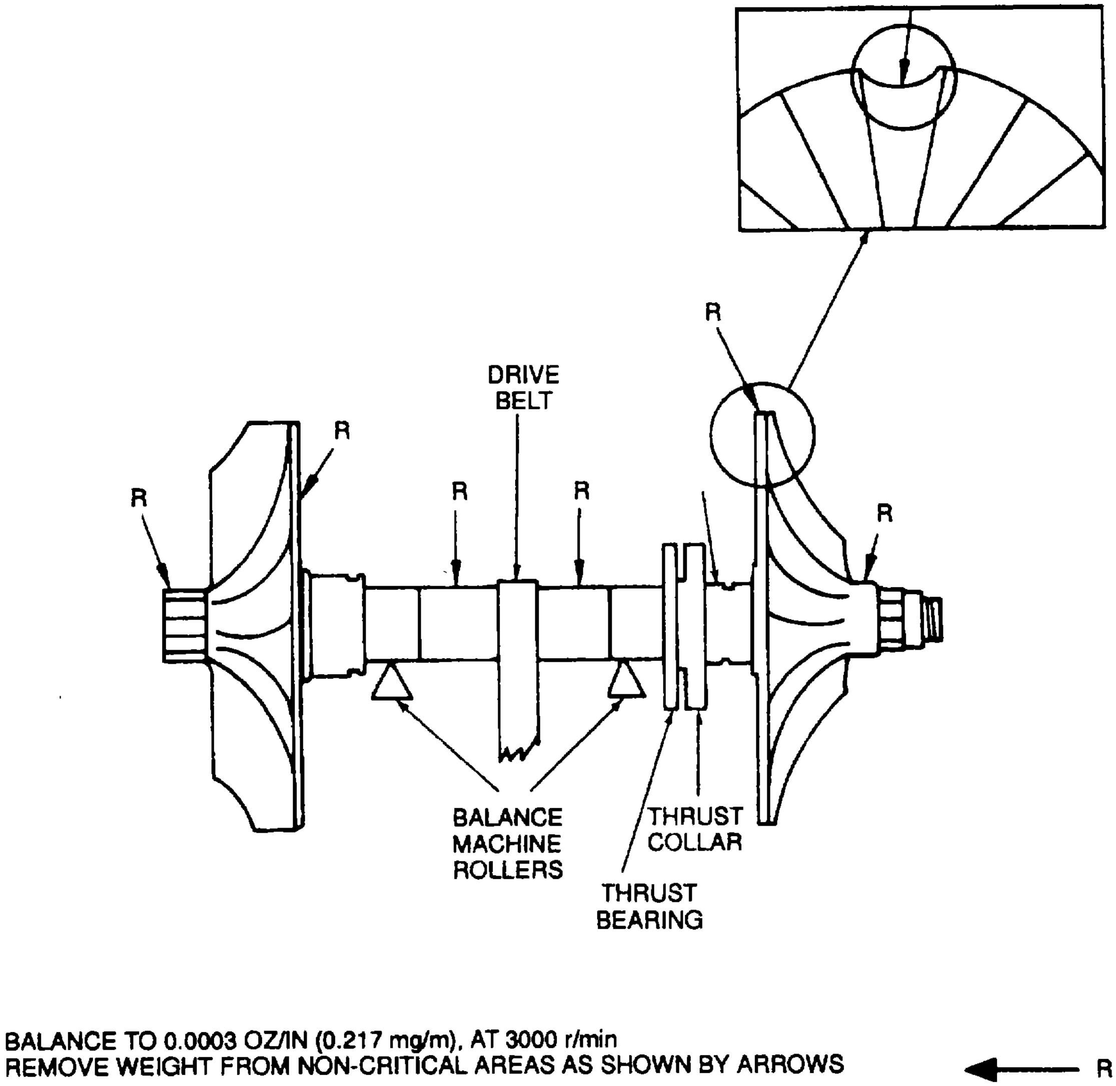


Figure 9-76. Balance of Impeller and Turbine Wheel Shaft Assembly

f. Assemble.

CAUTION

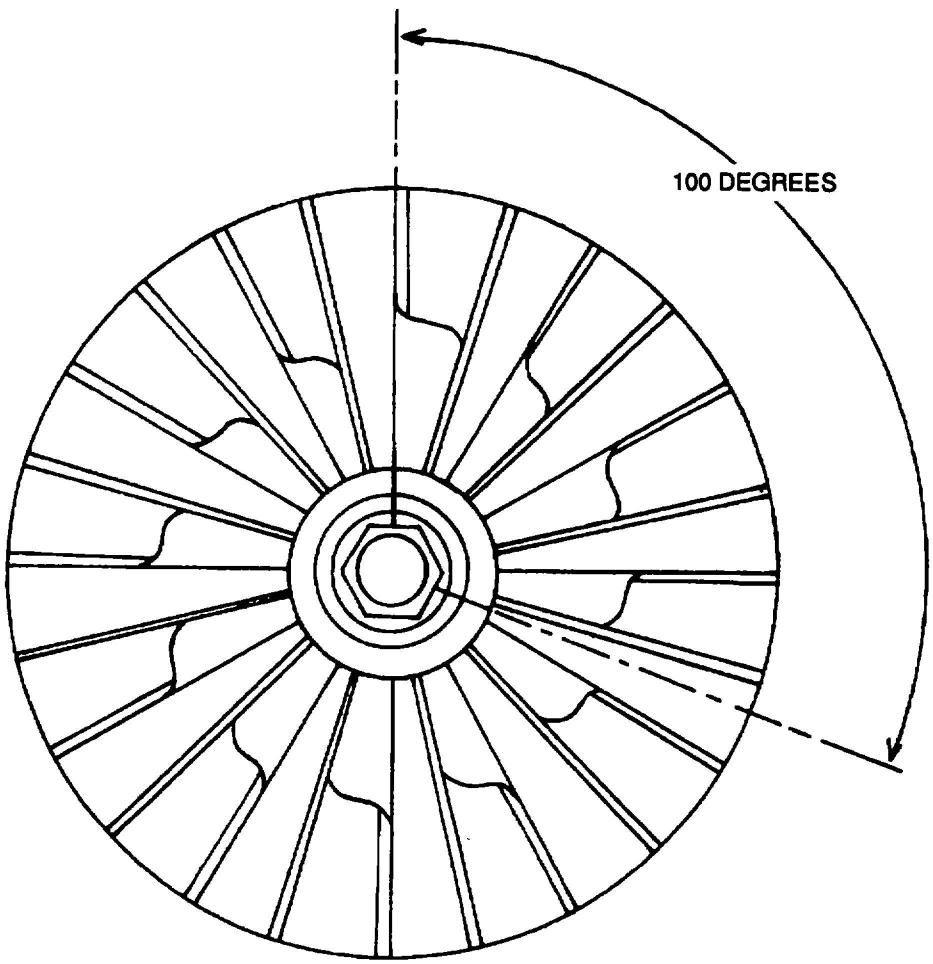
All parts and the work area must be free of grease and oil to avoid attracting dirt and abrasive. Even small amounts of dirt or abrasive material will cause premature wear of the turbocharger. Do not lubricate the bearings and thrust washers until they are ready to be Installed.

NOTE

Just prior to installation, coat the washers (23), bearings (22), thrust bearing (20), thrust collar (19), seal rings (11 and 14), and the thrust spacer (13) with lubricating oil, MIL-L-2104.

(1) Install a new retaining ring (24) at each end of the center housing (18).

(2) At the turbine end of the center housing (18), install a washer (23) against the retaining ring (24), install the bearing (22), and secure with a new retaining ring (24).



1. TIGHTEN TO 125 TO 150 POUND-INCHES (14.13 TO 16.95 NEWTON-METERS).
2. LOOSEN COMPLETELY, AND CHECK THE PREVAILING TORQUE.
3. TIGHTEN TO 35 TO 55 POUND-INCHES (3.96 TO 6.21 NEWTON-METERS) ABOVE THE PREVAILING TORQUE.
4. TIGHTEN AN ADDITIONAL 110 DEGREES.

Figure 9-77. Turbine Locknut Tightening

(3) Position the shroud (12) on the center housing (18).
(4) Install a new seal ring (11) on the turbine shaft, and insert the turbine wheel and shaft assembly (1 0) through the center housing (18).
(5) Install a washer (23) over the compressor end of the shaft, and install the bearing (22), thrust bearing (20), and thrust collar (19) over the shaft.
(6) Install a new packing (21) in the center housing (18).

NOTE

The center housing (18) contains alignment pins so that it may be assembled to the back-plate (17) in only one position. In this position the oil feed holes in the center housing (18) and the back-plate (17) will be properly aligned.

(7) Align the oil feed holes in the center housing (1 8) and back-plate (17), and install the back-plate, washers (16), and bolts (15). Torque the bolts to 90 to 110 pound-inches (10.2 to 12.4 newton-meters).

(8) Install a new seal ring (14) over the thrust spacer (13) and install the thrust spacer over the shaft.
(9) Align the match-marks on the impeller (9) and shaft, and install the impeller on the shaft using an arbor press if necessary.

CAUTION

When removing or Installing the locknut (8), use a flexible socket to help avoid side-loading the shaft. Side-loading could bend the shaft, resulting In excessive runout and vibration problems In the assembled unit.

(10) Install the locknut (8), and tighten in accordance with Figure 9-77.
(11) Position the compressor housing (3) on the center housing (18), aligning the match-marks made during disassembly. Install the V-band (2), and tighten the locknut (1) to 40 to 60 pound-inches (4.5 to 6.8 newton-meters). Using a soft hammer, seat the V-band by tapping around the outer diameter, and re-torque the locknut.
(12) Align the match-marks, and position the turbine housing (7) on the center housing (1 8).
(13) Lubricate the bolts (4) with anti-seize compound, MIL-A-907, and install the damps (6), new lockplates (5), and bolts (4). Cross-tighten the bolts in three steps to 100 to 110 pound-inches (11.3 to 12.4 newton-meters).

NOTE

Do not bend the tabs on the lockplates (5) at this time. The tabs will be bent after the final positioning and installation on the engine.

(14) Check for binding and scraping by pushing in on the impeller as far as possible and rotating it. Repeat this check from the turbine end of the assembly. If binding or scraping is noted, disassemble the unit and check for excessive runout. worn thrust members, or worn bearings.
(15) Check bearing radial clearance:
- (a) Fabricate a dial indicator mounting plate (refer to Table 2-2)
- (b) Fasten a plunger-type dial indicator with 1 inch (25.4 mm) travel and a 2 inch (50.0 mm) extension rod to the turbocharger oil drain mounting pad using the dial indicator mounting plate. Secure the mounting plate and indicator using the bolts which were removed to gain access to the oil drain hole.
- (c) Move the rotating shaft up and down to check radial bearing clearance. Move the shaft in the same direction as the dial indicator travels. Equal pressure should be applied to the shaft at both ends simultaneously. The total dial indicator displacement should be within 0.003 to 0.007 inch (0.08 to 0.18 mm). If the measured movement is greater then 0.007 inch (0.18 mm), the rotating assembly must be repaired or replaced.

(16) Mount a dial indicator on the impeller or turbine housing, zero the indicator on the end of the shaft, and check the total end clearance. The total end clearance shall not exceed 0.009 inch (0-23 mm) for a repaired unit or 0.004 inch (0.10 mm) for an overhauled unit. If the clearance is excessive, disassemble the unit and check the thrust members for wear.
(17) If the turbocharger is to be stored, lubricate the internal parts with preservative oil, MIL-L-21260, and plug all openings.
(18) Install the turbocharger in accordance with the Operator and Organizational Maintenance Manual.

SECTION VII. MAINTENANCE OF AFTERCOOLER, INTAKE AND EXHAUST MANIFOLDS, AND WATER MANIFOLDS

9-41. GENERAL. Each cylinder head exhaust port is connected individually to two three-piece exhaust manifolds. The outlet of each exhaust manifold connects to a turbocharger, where the high pressure exhaust gas is used to turn a turbine wheel and impeller. Compressed air from the turbocharger passes through the aftercooler and intake manifold to the inlet ports of each cylinder head. The aftercooler assembly consists of a housing assembly and two heat exchanger cores which are connected to the engine cooling system. As it emerges from the turbocharger, the compressed air is at a very high temperature. The excess heat is absorbed by the aftercooler to provide denser air for more efficient combustion. Water manifolds connect between each rocker arm housing to carry return coolant from the cylinder heads to the thermostat housing.

9-42. AFTERCOOLER MAINTENANCE.

a. Inspect.

(1) Remove the air crossover housings and connections in accordance with step b, below.
(2) Use a light to visually inspect both cores (30, Figure 9-78) for evidence of leakage. Pay particular attention to where the core tubes connect with the adapter connections (17).
(3) Visually examine the air crossover housings (4), tubes (7), crossover connections (9), covers (28), and housing (34) for cracks and porosity.
(4) Check the mounting plates (36) and supports (40) for cracks.
(5) Inspect all inlet and outlet connections for evidence of coolant leakage.
(6) If defects are found, repair or replace the defective parts in accordance with steps (b) through (i), below.
(7) If no defects are found, install the air crossover housings and connections in accordance with step (i), below.

b. Remove.

(1) Drain the cooling system in accordance with the Operator and Organizational Maintenance Manual.
(2) Remove the turbochargers and the turbocharger oil hose assemblies secured to the aftercooler in accordance with the Operator and Organizational Maintenance Manual.
(3) Remove the air control valve assembly and support channels from the aftercooler and remove the air filter tubing assembly on the engine left side only in accordance with the Operator and Organizational Maintenance Manual.
(4) Remove the ether line tubing and the ether jets and associated fittings from the intake manifold crossover housings in accordance with the Operator and Organizational Maintenance Manual.
(5) Remove the air bleed hose assemblies to the radiator and the aftercooler in accordance with the Operator and Organizational Maintenance Manual.
(6) Remove the capscrews (1, Figure 9-78), lockwashers (2), and washers (3), and remove the crossover housings (4) by slipping them off of the tubes (7). Remove and discard the gaskets (5).
(7) Pull out the tubes (7), and remove and discard the packings (8). Remove and discard insulation from tube (7).
(8) Remove the crossover connection (9), by removing the capscrews (1), lockwashers (2), and washers (3). Remove and discard the gaskets (10).
(9) Remove the capscrews (11) and lockwashers (2) securing the outlet pipes (12) to the outlet connections (14).
(10) Remove the hexagon head screws (19) and washers (2) securing the inlet connections (20).
(11) Remove the capscrews (24) and lockwashers (2), and remove the transfer housing (25), tubes (21), and inlet connections (20) as an assembly. Discard the gasket (26).
(12) Remove the capscrews (35), lockwashers (32), and washers (33), and remove the aftercooler assembly mounting plate (36).

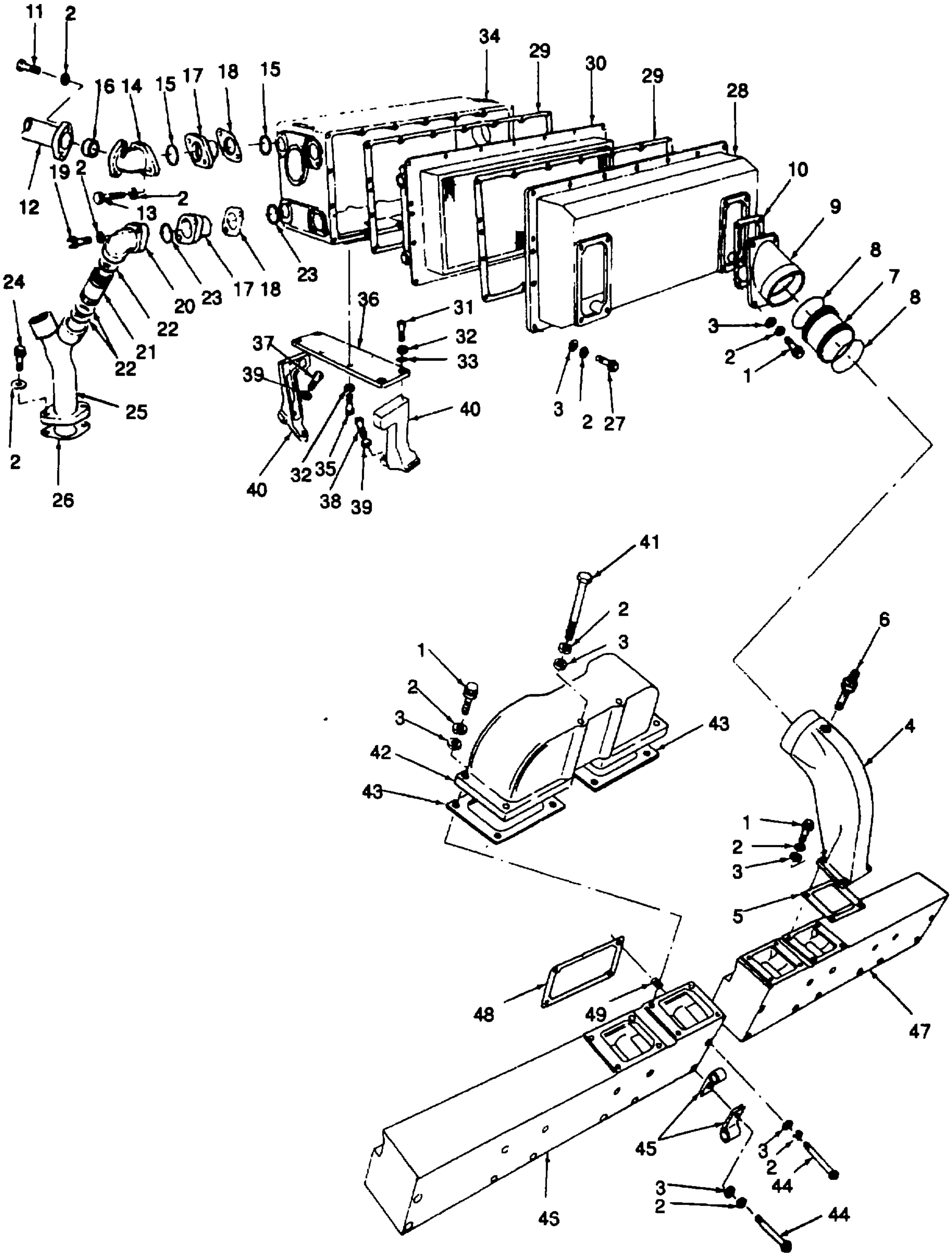


Figure 9-78. Aftercooler and Intake Manifolds (Sheet 1 of 2)

1.	CAPSCREW	26.	GASKET
2.	LOCKWASHER	27.	CAPSCREW
3.	WASHER	28.	COVER
4.	CROSSOVER HOUSING	29.	GASKET
5.	GASKET	30.	CORE
6.	ETHER JET	31.	HEXAGON HEAD SCREW
7.	TUBE	32.	LOCKWASHER
8.	PACKING	33.	WASHER
9.	CROSSOVER CONNECTION	34.	HOUSING
10.	GASKET	35.	CAP SCREW
11.	CAPSCREW	36.	PATE
12.	OUTLET PIPE	37.	PLATRE
13.	CAPSCREW	37.	CAPSCREW
14.	OUTLET CONNECTION	39.	LOCKWASHER
15.	PACKING	40	SUPPORT
16.	SEAL CONNECTION	41.	CAPSCREW
17.	ADAPTER	41.	CAPSCREW
18.	GASKET	42.	AIRBALANCE CONNECTION
19.	HEXAGON HEAD SCREW	43.	GASKET
20.	INLET CONNECTION	44.	CAPSCREW
21.	TUBE	45.	CLAMP
22.	PACKING	46.	INTAKE MANIFOLD
23.	PACKING	47.	INTAKE MANIFOLD
24.	CAPSCREW	48.	GASKET
25.	HOUSING	49.	RUBBER SLEEVE

Figure 9-78. Aftercooler and Intake Manifolds (Sheet 2 of 2)

(13) Remove the hexagon head screws (31), lockwashers (32), washers (33) and remove the mounting plate (36). Remove the capscrews (37 and 38), lockwashers (39), and remove the supports (40) from each side of the cylinder block if necessary.

WARNING

A minimum of two persons will be required to perform the following procedure. Due to the weight of the aftercooler, personal injury may result from failure to comply with this warning.

(14) Remove aftercooler from engine.

c. Disassemble.

(1) Remove the capscrews (13, Figure 9-78), lockwashers (2), and the outlet connections (14). Remove and discard the seals (16) and packings (15). Remove the outlet adapter connections (17), gaskets (18), and remove the packings (15 and 23) from the grooves inside the adapters. Discard the packings and gaskets.
(2) Remove the capscrews (27), lockwashers (2), lockwashers (3), and remove cover (28), two gaskets (29), and an aftercooler core (30) from each side of the housing (34). Discard the gaskets.
(3) Pull the inlet connections (20) from the tubes (21), and pull the tubes from the housing (25). Remove and discard the packings (22).

d. Clean.

WARNING

Dry cleaning solvent PD-680, Type III, or equivalent, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

(1) Clean all parts, except the cores (30, Figure 9-78), in cleaning solvent, PD-680, Type III, or equivalent.

CAUTION

To avoid damaging the cores, apply air pressure gradually and do not exceed a pressure of 30 psi (207 kPa).

(2) Reverse flush the cores (30) thoroughly. Allow the core to fill with water, and flush, using short bursts of air pressure. Apply the air pressure gradually, and allow the core to fill with water between each burst. Continue the flushing procedure until all traces of rust and scale have been removed. This will be evident by dear water flowing from the inlet tube.

e. Inspect.

NOTE

In the following procedure, repair or replace specific parts as instructed. Repair or replace all other parts in accordance with step g, below.

(1) Check all capscrews and threaded holes for damaged or stripped threads. Repair slight thread damage by chasing with a tap set. Repair stripped holes in accordance with paragraph 2-12. Replace stripped capscrews.
(2) Check the outlet connections (14, Figure 9-78), inlet connections (20), adapter connections (17), transfer tube (21), and transfer housing (25) for cracks, warped gasket surfaces, or damaged packing grooves. Replace any defective parts.
(3) Visually inspect the air crossover housings (4), crossover connections (9), and tubes (7) for cracks, and warped or damaged gasket or packing surfaces. If cracks or porosity is suspected, check with dye penetrant, MIL-1-25135, in accordance with MIL-1-6866. Replace cracked or porous components.
(4) Check the covers (28) for damaged or warped gasket surfaces. Check for cracks and porosity using dye penetrant, MIL-1-25135, in accordance with MIL-1-6866.
(5) Check the housing (34) for damaged or warped gasket surfaces. Check for cracks and porosity using dye penetrant, MIL-1-25135, in accordance with MIL-1-6866.
(6) Check the plates (36) and supports (40) for cracks.
(7) Check the cores (30) as follows:
  (a) Check for bent fins, and bent or damaged gasket surfaces.
  (b) Check the inlet and outlet tubes for dents and out-of-roundness. Check the soldered joints for corrosion.
  (c) Check the core tubes for soundness and evidence of internal corrosion. Press lightly against the tube wall; tubes that dent or penetrate easily have been eaten away by internal corrosion.

f. Test the aftercooler cores (30, Figure 9-78) as follows:

(1) Plug or block off either the inlet or outlet tube, and attach a regulated air supply to the other tube.

CAUTION

To avoid damaging or permanently distorting the core, do not exceed an air pressure of 15 psi (103 kPa).

(2) Immerse the core in a water tank and pressurize the core to 10 psi (69 kPa). Escaping air bubbles will show the location of any leak points.

g. Repair.
(1) Repair slightly warped or nicked gasket surfaces on the air crossover housings (4, Figure 9-78) and crossover connections (9) using a flat mill file. Replace the crossovers or connections i they are badly warped.
(2) Refinish a warped gasket surface on the covers (28) or housing (34) using a surface grinder.
(3) Replace the crossover housings (4), covers (28), or housing (34), i porosity or cracks extend through the capscrew holes.
(4) Repair acceptable cracks or porosity in the crossover housings (4), covers (28), or housing (34) by welding in accordance with MIL-STD-248.

(5) Weld cracks in the mounting plates (36) or supports (40) in accordance with MIL-STD-248.
(6) Straighten bent fins on the core (30), and repair damaged gasket surfaces by straightening and filing.
(7) Replace the core (30) if the inlet or outlet tubes are dented or out-of-round in the packing area.
(8) Replace the core if the core tubes are corroded to the extent that they dent easily when pressed lightly.
(9) Repair leaks in soldered joints or core tubes by soldering in accordance with MIL-S-6872. After soldering, test for leaks in accordance with step f, above.

h. Assemble.

(1) Install new packings (22) in the grooves of the tubes (21), and assemble the tubes and inlet connection (20) to the housing (25).
(2) Refer to Table 2-2. Fabricate two guide studs and install them in the upper comers of the housing (34, Figure 9-78).
(3) Coat gaskets (29) with sealing compound, MIL-S-45180, and install a gasket, the core (30), and another gasket over the guide studs.
(4) Install the covers (28) over the guide studs and secure with several capscrews (27) using lockwashers (2) and washers (3). Tighten the capscrews finger tight.
(5) Remove the guide studs, and install the remaining washers (3), lockwashers (2), and capscrews (27). Using the sequence shown in Figure 9-79, tighten the capscrews in three stages to 25 to 30 pound-feet (34to 41 newton-meters).
(6) Check to be sure that the inlet and outlet tubes of the cores (30, Figure 9-78) are centered in the adapter openings of the housing (34). If it is necessary to center the tubes, bend them slightly using a wooden dowel.
(7) Install packings (15 and 23) in the adapter connections (17). Coat gaskets (18) with anti-seize compound, MIL-A-907, and install the gaskets and adapter connections (17) on the housing (34).

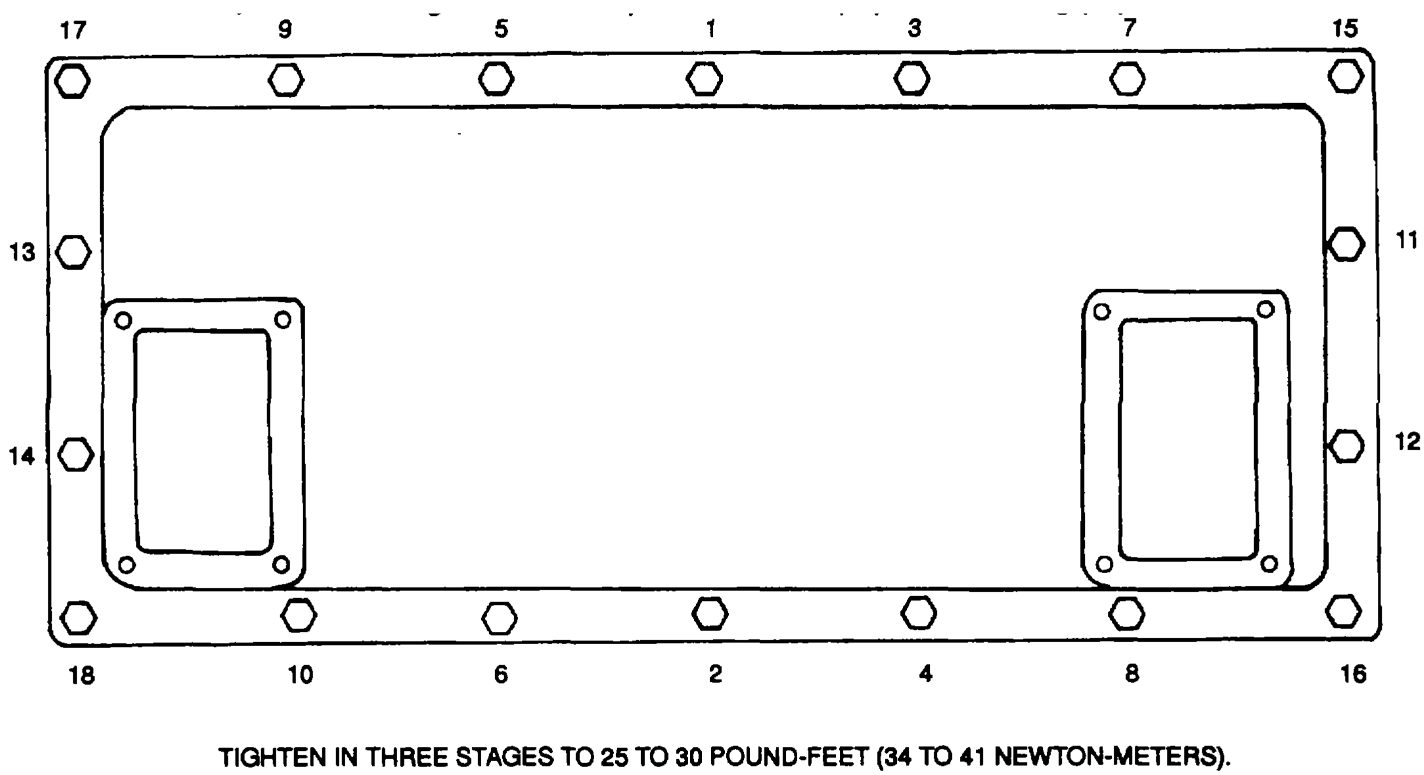


Figure 9-79. Tightening Sequence, Aftercooler Housing Covers

i. Install.

NOTE

To permit shifting the components for alignment, do not tighten any capscrews until instructed to do so. Lubricate all packings just prior to installation using petrolatum W-P-236.

NOTE

Ensure that all water has been removed from core exterior prior to installation.

(1) Install the aftercooler supports (40, Figure 9-78) using lockwashers (39) and chews (37 and 38). Tighten the chews to 90 to 110 pound-feet (122 to 149 newton-meters).

(2) Install the plates (36) on the supports (40) using lockwashers (32), washers (33), and hexagon head screws (31). Tighten the screws to 40 to 50 pound-feet (54 to 68 newton-meters).

WARNING

A minimum of two persons, will be required to perform the following procedure. Due to the weight of the aftercooler, personal Injury may result from failure to comply with this warning.

(3) Position the aftercooler assembly on the plates (36), and install the capscrews (35) and lockwashers (32) finger tight.

(4) Install gasket (26) and packings (23), position the housing (25) and inlet connection (20) assembly to the cylinder block and adapter connections (17). Install the screws (19 and 24) using the lockwashers (2), and tighten the capscrews finger tight.

(5) Install seals (16) and packings (15), position the outlet connection (1 4) to the adapter connections (17) and outlet pipes (12). Install the capscrews (11 and 13) using the lockwashers (2), and tighten the capscrews finger tight.

(6) Install gaskets (10). Install the crossover connections (9), washers (3), lockwashers (2), and capscrews (1).Tighten the capscrews finger-tight.

(7) Install packings (8) and insulation on the tubes (7), and install the tubes in the crossover connections (9).

(8) Apply a small amount of sealant, MI L-S-45180, to the threads of the ether jets (6), and install them in the crossover housings (4). Tighten the jets to 75 to 85 pound-inches (8.5 to 9.6 newton-meters).

(9) Position gasket (5) on the intake manifold (46), slip the crossover housings (4) onto the tubes (7), and install the washers (3), lockwashers (2), and capscrews (1). Tighten the capscrews finger fight.

(10) Check the alignment of all air and water connections. Shift the housings and connections as necessary to achieve alignment, and tighten all loose capscrews alternately and evenly in three stages to the following torque values:

(a) Aftercooler assembly to-plate capscrews (35); 40 to 50 pound-feet (54 to 68 newton-meters).

(b) Outlet housing capscrews (24) and screws (19, 13, and 11); 30 to 35 pound-feet (41 to 47 newton-meters).

(c) Crossover housing and connection capscrews (1); 30 to 35 pound-feet (41 to 47 newton-meters).

(11) Install the air bleed hose assemblies to the radiator and aftercooler in accordance with the Operator and Organizational Maintenance Manual.

(12) Install the ether line tubes, and the ether jets and associated fittings to the intake manifold crossover housings in accordance with the Operator and Organizational Maintenance Manual.

(13) Install the air control valve assembly and support channels to the aftercooler, and install the air filter tubing assembly on the engine left side in accordance with the Operator and Organizational Maintenance Manual.

(14) Install the turbochargers and the turbocharger oil hose assemblies secured to the aftercooler in accordance with the Operator and Organizational Maintenance Manual.

(15) Fill the cooling system in accordance with the Operator and Organizational Maintenance Manual.

j. Test.

(1) Ensure that the cooling system has been filled completely and that the coolant level in the radiator has been adjusted in accordance with the Operator and Organizational Maintenance Manual.

CAUTION
Do not allow test air pressure to exceed 15 psi (104 kPa) during the following test or damage to cooling system components or the after cooler Itself may result.

CAUTION
Do not perform the following test on a hot engine.

(2) Using a radiator cap adapter, pressurize the cooling system to 10 to 15 psi (69 to 104 kPa) for approximately 5 minutes.
(3) Inspect the aftercooler for leaks in accordance with steps (a), (1), (2), (5), and (7).
(4) Tighten leaking lines and fittings, or repair in accordance with steps (b) through (i), above. Repair a leaking core in accordance with steps (b) through (i), above.

9-43. INTAKE MANIFOLDS MAINTENANCE

a. Remove.

(1) Remove aftercooler in accordance with paragraph 9-42.

(2) Remove the capscrews (1 and 41, Figure 9-78), lockwashers (2), and washers (3) securing the air balance connections (42). Remove the air balance connections, and remove and discard the gaskets (43).

(3) Remove the capscrews (1), lockwashers (2), washers (3), raise the crossover housings (4) slightly, and remove and discard the gaskets (5).

(4) Remove the capscrews (44), lockwashers (2), washers (3), and remove the intake manifolds (46 and 47). Leave the damps (45) attached to the harness and ether lines.

(5) Remove and discard the gaskets (48) and rubber sleeves (49).

b. Clean and Inspect.

WARNING
Dry cleaning solvent PD680, Type Ill, or equivalent, Is flammable and moderately toxic to the skin, eyes, and respiratory tract. Assure adequate ventilation. Skin, eye, and respiratory protection Is required to avoid Injury to personnel.

(1) Clean all parts in dry cleaning solvent, PD-680, Type ll, or equivalent Clean all traces of the old gaskets from the mating surfaces.

(2) Inspect the capscrews (1, 41, and 44, Figure 9-78) for damaged or stripped threads. Repair slightly damaged threads by chasing. Replace stripped capscrews.

(3) Inspect the threaded holes in the intake manifolds (46 and 47)for damage or stripping. Repair damaged or stripped holes in accordance with paragraph 2-12.

(4) Visually inspect the intake manifolds (46 and 47) and air balance connections (42) for cracks and warped gasket surfaces. Repair or replace in accordance with step c, below.

(5) Check the intake manifolds (46 and 47) and air balance connections (42) for cracks and porosity using dye penetrate, MIL-1-25135, inspection in accordance with MIL-1-6866. Repair or replace cracked or porous parts in accordance with step c, below.

c. Repair.

(1) Refinish warped gasket surfaces on the intake manifolds (46 and 47), or air balance connections (42) using a surface grinder.
(2) Replace the intake manifolds (46 and 47) or air balance connections (42) if porosity or cracks extend through the capscrew holes.
(3) Repair acceptable porosity or cracks by welding in accordance with MIL-STD-248.

d. Install.

NOTE
To permit shifting the components for alignment, do not tighten the capscrews until instructed to do so.

(1) Refer to Table 2-2. Fabricate six guide studs and install them in the upper cylinder block holes to hold the gaskets (48, Figure 9-78) in place.

NOTE
Three gaskets are used with each manifold.

(2) Coat new gaskets (48) with sealing compound, MIL-S-45180, and install the gaskets over the guide studs.
(3) Coat new rubber sleeves (49) with sealing compound, MIL-S-45180, and install them in the recesses in the intake manifold (46 or 47).
(4) Position the intake manifold (46 or 47) over the guide studs, and install the lockwashers (2) and washers (3) on six of the capscrews (44). Install the capscrews through the damps (45) and intake manifold (46 or 47), and tighten them finger tight.
(5) Remove the guide studs and install the other six washers (3), lockwashers (2), and capscrews (44) finger tight.
(6) Install the guide studs in the cylinder block in accordance with step (1), above, and install the remaining manifold (46 or 47) in accordance with steps (2) through (5), above.
(7) Coat new gaskets (43) with sealing compound MIL-S-45180, and position them on the manifolds (46 and 47).
(8) Install the air balance connections (42) using washers (3), lockwashers (2), and capscrews (1 and 41). See Figure 9-80. Tighten the capscrews (1 and 41, Figure 9-78) in the sequence shown to 10 pound-feet (14 newton-meters). This is not the final torque on the capscrews.
(9) Coat new gaskets (5) with sealing compound MIL-S-45180, position the gaskets under the crossover housings (4), and install the washers (3), lockwashers (2), and capscrews (1). Cross-tighten the capscrews to 10 pound-feet (14 newton-meters); this is not the final torque on the capscrews.
(10) Using the sequence shown in Figure 9-81, tighten the manifold capscrews (44, Figure 9-78) in three stages to 30 to 35 pound-feet (41 to 47 newton-meters).
(11) Using the sequence given in step (8), above, tighten the air balance connection capscrews (1 and 41) in two stages to 30 to 35 pound-feat (41 to 47 newton-meters).
(12) Cross-tighten the crossover housing capscrews (1), in two stages to 30 to 35 pound-feat (41 to 47 newton-meters).

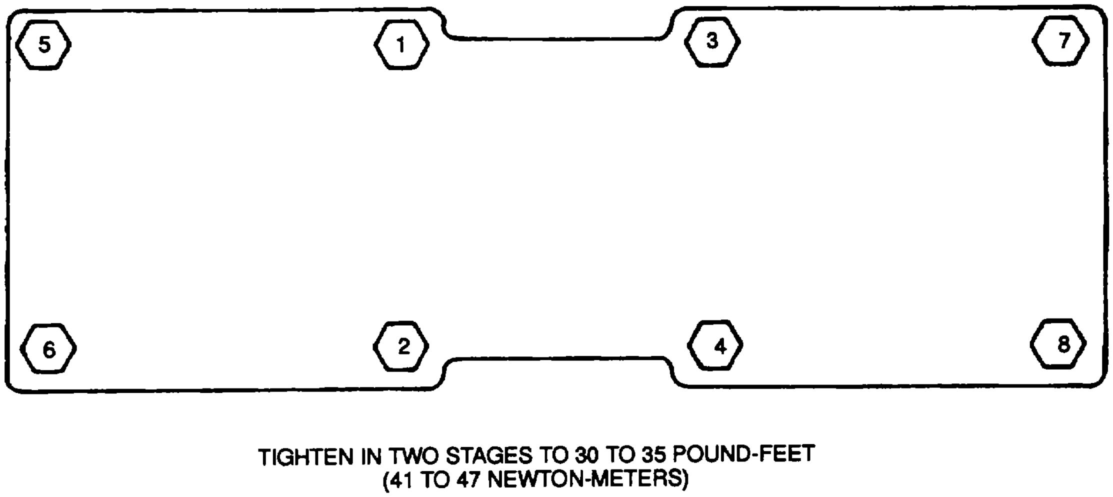


Figure 9-80. Tightening Sequence, Air Balance Connections

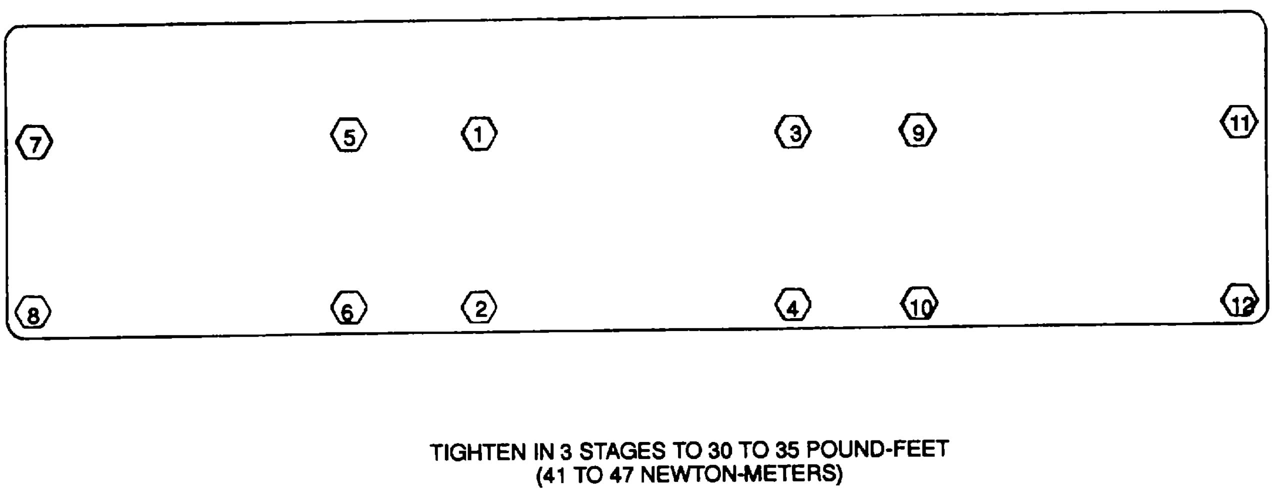


Figure 9-81. Tightening Sequence, Intake Manifolds

9-44. EXHAUST MANIFOLDS MAINTENANCE.

a. Remove.

(1) Remove the aftercooler in accordance with paragraph 9-42.

NOTE

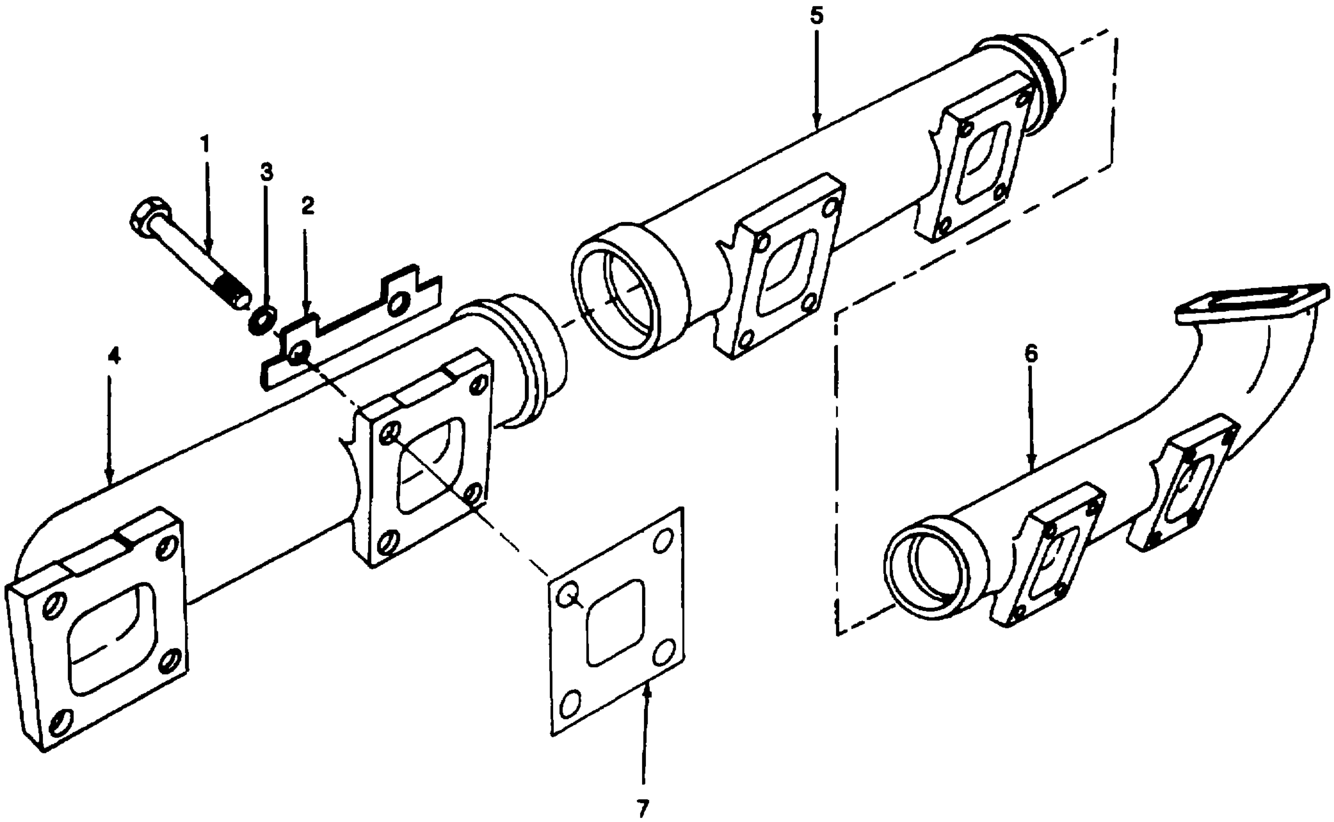
The manifold may be removed in sections if desired. Remove the center section after removing either end section.

(2) Straighten the tabs on the lockplates (2, Figure 9-82), and remove the capscrews (1), lockplates (2), and washers

(3) Discard the lockplates.

(3) Remove the manifold sections, (4, 5, and 6), and remove and discard the gaskets (7).

(4) Disassemble the manifold by twisting and pulling the sections (4,5, and 6).If difficulty is encountered in removing the sections, tap lightly around the slip-joints using a plastic or rawhide mallet.



1. CAPSCREW
2. LOCKPLATE
3. WASHER
4. MANIFOLD SECTION (END)
5. MANIFOLD SECTION (CENTER)
6. MANIFOLD SECTION (TURBOCHARGER END)
7. GASKET

Figure 9-82. Exhaust Manifolds

b. Clean and Inspect.

(1) Clean all traces of the old gaskets (7, Figure 9-82) from the mating surfaces.
(2) Clean all rust, scale, and carbon from the male and female connections of the manifold sections (4, 5, and 6), if separated.
(3) Inspect the capscrews (1) for damaged or stripped threads. Repair slightly damaged threads by chasing; replace stripped capscrews.
(4) Inspect the male and female slip-joints of the manifold connections (4, 5, and 6), if separated for evidence of leakage as indicated by erosion or gas cutting. Replace any manifold section with gas cut or eroded slip-joints.
(5) Inspect the gasket surfaces for warping or gas cutting. Repair or replace the manifolds in accordance with step c, below.
(6) Visually inspect the manifold sections (4, 5, and 6) for cracks. If cracks are suspected, inspect using penetrant, inspect in accordance with MIL-L-6866. Repair or replace a cracked manifold section in accordance with step c, below.

c. Repair.

(1) Replace any manifold section that is cracked through a gasket surface or slip-joint

(2) Repair gas cut or warped gasket surfaces by surface grinding. A maximum of 0.0625 inch (1.588 mm) may be removed to restore the surface. If material is removed from any gasket surface that joins with a cylinder head, an equal amount of material must be removed from the surfaces of all three sections.
(3) Replace any manifold section that is warped or gas cut to the extent that surface grinding in accordance with step NO TAG, above, will not result in an acceptable gasket surface.

d. Install.

(1) Coat the slip-joints of the manifold sections (4, 5, and 6, Figure 9-82) with anti-seize compound, MIL-A-907, and assemble the sections. If necessary, tap the sections together with a plastic or rawhide mallet.
(2) Coat new gaskets (7) with anti-seize compound, MIL-A-907, and position them on the cylinder heads.
(3) Coat the washers (3), lockplates (2), and capscrews (1) with anti-seize compound, MIL-A-907, position the assembled manifold sections (4, 5, and 6) on the cylinder heads, align the gaskets, and install the washers, lockplates, and capscrew.
(4) See Figure 9-81. Starting at the center manifold section (5, Figure 9-82), and working to each end (4 and 6), cross-tighten the capscrews (1) in three stages to 40 to 45 pound-feet (54 to 61 newton-meters), and bend the tabs on the lockplates (2).
(5) Install the aftercooler in accordance with paragraph 942.

9-45. WATER MANIFOLDS AND SEALS MAINTENANCE The water manifolds consist of water transfer tubes and preformed packings that join each rocker arm housing. Repair or replace the components in accordance with Section II, Cylinder Head Assemblies.

CHAPTER 10

MAINTENANCE OF CONTROLS, INSTRUMENTS, AND SWITCHGEAR

SECTION I. ANNUNCIATOR ALARM SYSTEM

10-1. GENERAL. The annunciator alarm system consists of annunciator relay panels A10 and All, the annunciator panel A9, alarm horn LS1, and related parts. Fourteen fault sensors are located throughout the generator set. Each sensor opens or doses a switch if a fault occurs, energizing one of 18 alarm relays on annunciator relay panel Al0 or Al1. Four unused relays on annunciator relay panel All provide for installation of additional fault sensors or for use as spares if any of the original 1 4 relays and related circuits should fail. The following subparagraphs describe the operation of atypical annunciator alarm system circuit.

a. Fault Sensor. Refer to Figure 10-1. Lubricant temperature switch OT2 is a typical fault sensor. Upon an over temperature condition, OT2 will dose. The dosing action of OT2 connects positive dc voltage to alarm relay Al OK4, energizing the relay.

b. Alarm System Self-Latching Relays. Refer to Figure 10-1. Alarm relay Al OK4 is a typical annunciator alarm system self-latching relay. Whenever energized by the single fault sensor connected to it, self-latching contacts dose to ensure the relay remains energized, even if the switch in the fault sensor reopens. Once energized, K4 will remain latched until manually deenergized as described in step f, below.

c. Alarm Relay K26. Refer to Figure 10-1. Whenever a self-latching annunciator alarm system relay such as K4 is energized, alarm relay K26 is energized through the latching contacts of the alarm relay (K4). The contacts of alarm relay K26 dose to apply positive dc voltage to flasher DS1 9 and, through the normally dosed contacts of alarm silence relay K25, to horn LS1. The horn sounds.

d. Flasher DS1 9 and Annunciator Panel A9. Refer to Figure 10-1. Flasher DS1 9 operates at three cycles per second and has a 50 percent duty cycle. Three times per second, flasher relay K24 is energized through flasher DS1 9. Each time K24 is energized, annunciator display light A9D7 is illuminated to provide a visual indication of which fault circuit has tripped the alarm system. Annunciator display light A9D7 is just one of 18 lights in annunciator panel A9. Fourteen of the lights are each associated with one of the 14 fault sensors in the generator set. The remaining four lights are associated with the four unused alarm circuits in the system.

e. Alarm Silence Relay K25. Refer to Figure 10-1. Horn LS1 will continue to sound until ALARM SILENCE pushbutton S16 is manually pressed to energize sell-latching alarm silence relay K25. When relay K25 is energized, its normally closed contacts open, cutting off positive dc voltage from horn LS1. The horn goes dead. Simultaneously, the normally open contacts of relay K25 dose to connect flasher relay K24 directly to positive DC voltage, bypassing flasher DS19. Relay K24, which had been receiving positive dc voltage on and off, three times per second, is now continuously energized. As a result, annunciator display light A9DS4, which had been flashing, is now continuously on.

f. ANNUNCIATOR RESET Pushbutton 12A. Refer to Figure 1 0-1. Annunciator display light A9DS4 will remain on until the annunciator alarm system circuit has been reset via ANNUNCIATOR RESET pushbutton SI 2A When pushbutton S1 2A is pressed, the following occurs:

(1) Positive dc voltage is disconnected from self-latching annunciator alarm system relay Al OK4. The relay deenergizes and unlatches. Annunciator display light A9DS4, which has been receiving battery positive through the latching contacts of Al OK4, goes out.

(2) Alarm relay K26 deenergizes when the latching contacts of Al OK4 open. The normally open contacts of K26 open to disconnect battery positive from flasher DS19 and flasher relay K24.

(3) Pressing pushbutton S1 2A also disconnects battery positive from self-latching alarm silence relay K25. Relay K25 deenergizes and its normally closed contacts reset the horn circuit. The normally open contacts of K25 open to reset the flasher circuit.

g. ANNUNCIATOR TEST Pushbutton S15. Refer to Figure 10-1. ANNUNCIATOR TEST pushbutton SS is used to check annunciator alarm system lights and horn operation. The pushbutton is designed to be used in the absence of a true alarm and works as follows: (1) Pressing pushbutton S15 connects battery positive to horn LS1. The horn will sound as long as the pushbutton is pressed.

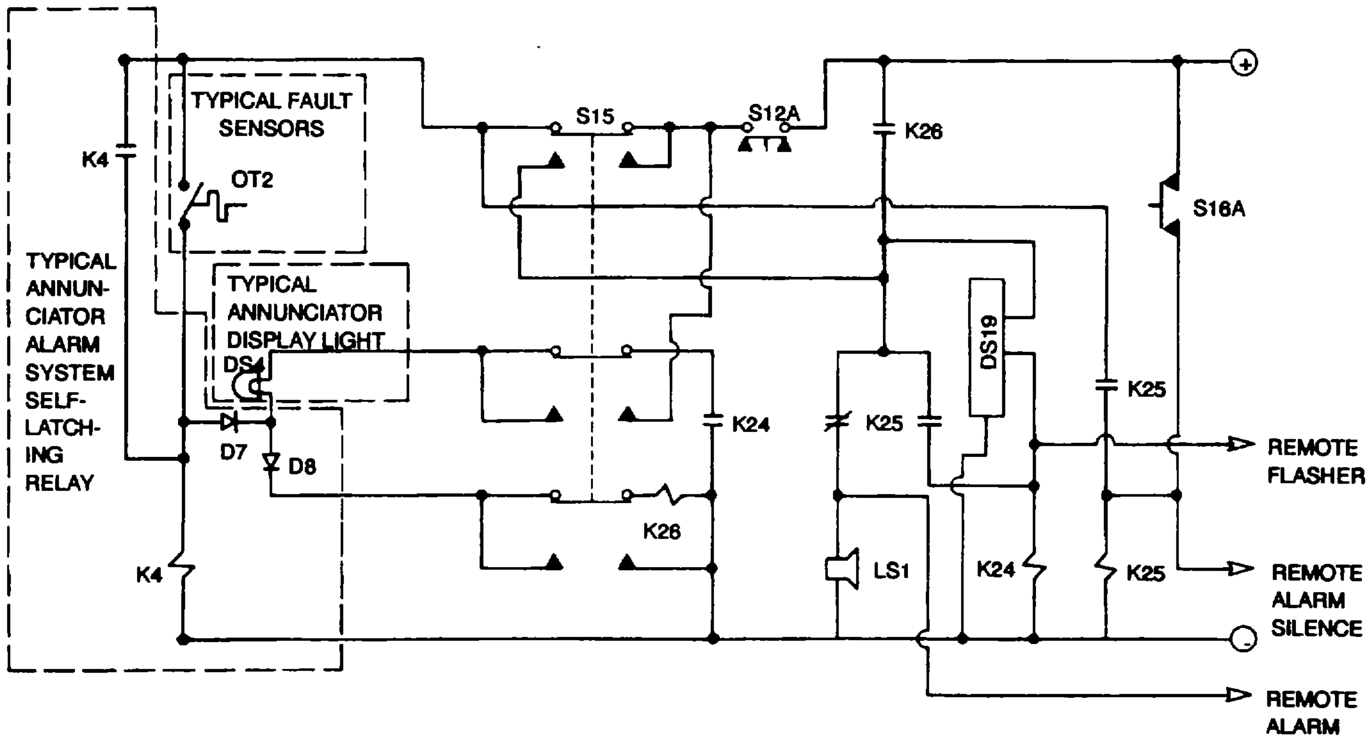


Figure 10-1. Annunciator Alarm System, Simplified Schematic Diagram

(2) Pressing pushbutton S15 also connects battery positive to all annunciator panel A9 lights, while disconnecting alarm relay K26. Disconnecting relay K26 prevents activation of the flasher, which is described in step c, above. All annunciator panel A9 lights will remain constantly lit as long as pushbutton Si5 is depressed.

(3) Releasing pushbutton SI5 disconnects battery positive from the horn and the lights and reconnects alarm relay K26. The horn goes dead, the lights go out, and the alarm system is prepared for normal operation.

h. Engine Shutdown and Load Circuit Breaker CB101 Trip Circuits. Several of the alarm system self-latching relays have additional contact sets in the engine shutdown circuit or the load circuit breaker CB1 01 trip circuit. These contact sets function as follows:

(1) Tripping undervoltage, reverse power, or underfrequency alarm relays Al OK8, Al1 K1, or Al1 K5, respectively, will energize circuit breaker trip relay K30. Relay K30 energizes the trip coil in bad circuit breaker CB1 01, opening the breaker to disconnect generator G1 from the bus. The engine will continue to run, but load circuit breaker CB101 will be uncloseable until the annunciator alarm system is reset via ANNUNCIATOR RESET pushbutton S12.

(2) Tripping overvoltage alarm relay Al 0K7 will energize engine shutdown relays K20A and K20B. Relay K20A deenergizes self-latching engine run relay K1 5B. As a result, engine fuel solenoid L1 loses power, doses, and cuts off fuel to the engine; the engine shuts down. Relay K20B energizes circuit breaker trip relay K30. Relay K30 energizes the trip coil in load circuit breaker CB1 01, opening the breaker to disconnect generator G1 from the bus. The generator set cannot be restarted until the annunciator alarm system is reset via ANNUNCIATOR RESET pushbutton Si2 on the upper door of cabinet A.

i. High and Low Level Fuel Circuits. Two of the alarm system self latching relays have additional contact sets in the high and low fuel level circuits. These contact sets function as follows:

(1) Tripping low fuel level alarm relay Al OK5 energizes low fuel level time delay shutdown relay K23. After a preset time delay (normally 35 minutes), relay K23 will energize fault shutdown relays K20A and K20B. Relays K20A and K20B will shut down the engine and disconnect generator G1 from the load, as described in step h (2), above. Theoretically a generator set shutdown will not occur because the operator will replenish the generator set fuel supply and reset the alarm circuit before the time delay (normally 35 minutes) elapses. Note that if the operator replenishes the fuel supply, but fails to reset the alarm circuit via ANNUNCIATOR RESET pushbutton S1 2, low fuel level time delay relay K23 will still time out and cause a generator set shutdown. The operator will not be able to reset the alarm circuit before replenishing the fuel, but failure to reset the circuit after refueling will result in a shutdown. The purpose of this circuit is to back up the fuel transfer system circuit. I the fuel transfer system circuit is operational and set to AUTO, low fuel level alarm relay L1 OK5 will not trip if the generator set is connected to an adequate external fuel supply.

(2) Tripping high fuel level alarm relay Al OK6 will energize high fuel level fault slave relay K5. Relay K5 will open its normally dosed contacts to deenergize fuel pump contractor K1 3. Contactor K1 3 will open its normally dosed contacts to cut-off 1 20 V ac from fuel transfer solenoid L1 02 and fuel transfer pump contactor K1 06. Contactor K1 06 will deenergize, cutting off 240 V ac from fuel transfer pump motor B1 02. Solenoid valve L1 02, deenergized, will dose to block the fuel inlet line, preventing any more fuel from entering the generator set fuel tank The primary purpose of this protection circuit is to prevent overfilling of the generator set fuel tank by gravity feed (siphoning) from the external fuel supply. Secondarily, the circuit guards against fuel transfer system "runaway" which could occur if high fuel level float switch FL2 failed to open upon a high fuel level condition.

j. Remote Indicator Circuits. Two of the alarm system self-latching relays have additional contact sets used to annunciate faults on the remote control module control panel. These contact sets function as follows: (1) Tripping high coolant temperature alarm relay Al 0K3 will connect battery positive, through the remote control cable assembly, to the RCM viaJ26-q. The voltage is applied to HIGH WATERTEMP indicator light DS23. Ground return to the generator set is via J26-h.

(2) Tripping low oil pressure alarm relay Ai1K2 will connect battery positive, through the remote control cable assembly, to the RCM via J26-AC. The voltage is applied to indicator light DS2, LOW OIL PRESSURE. Ground return to the generator set is via J26-h.

10-2. ANNUNCIATOR ALARM SYSTEM REPAIR . Repair of the annunciator alarm system consists of replacing defective elements in the annunciator alarm system circuit and repairing annunciator box A9 in the event it should fail.

a. Relays. Relays are the most common component of the annunciator alarm system. Refer to Chapter 5, Section VI, for testing and replacement of generator set relays.

b. Wiring. Defective wires and incorrect wiring will result in annunciator alarm system failures. When tracing wiring to detect failures, refer to FO-1, DC Electrical Schematic; FO-2, AC Electrical Schematic; FO-3, Remote Control Module AC and DC Schematic; and FO-4 through FO-39, the generator set and RCM wiring diagrams.

c. Annunciator Panel A9 Repair. When troubleshooting indicates an annunciator panel A9 failure, refer to Figure 10-2 and accomplish repair as follows:

(1) To replace defective lampbulb (2), remove lampsocket (1) from back of the printed circuit board (5), remove and discard lampbulb (2), install good lampbulb in lampsocket (1), and install lampsocket (1) into back of printed circuit board (5).

(2) To replace or change nameplates (4), proceed as follows: (a) Remove screws (3) from comers of printed circuit board (5).

(a) Open printed circuit board (5) on its hinge, like a door.
(b) Remove and replace nameplates (4), as required.
(c) Close printed circuit board (5) on its hinge, like a door.
(d) Install screws (3) in comers of printed circuit board (5).

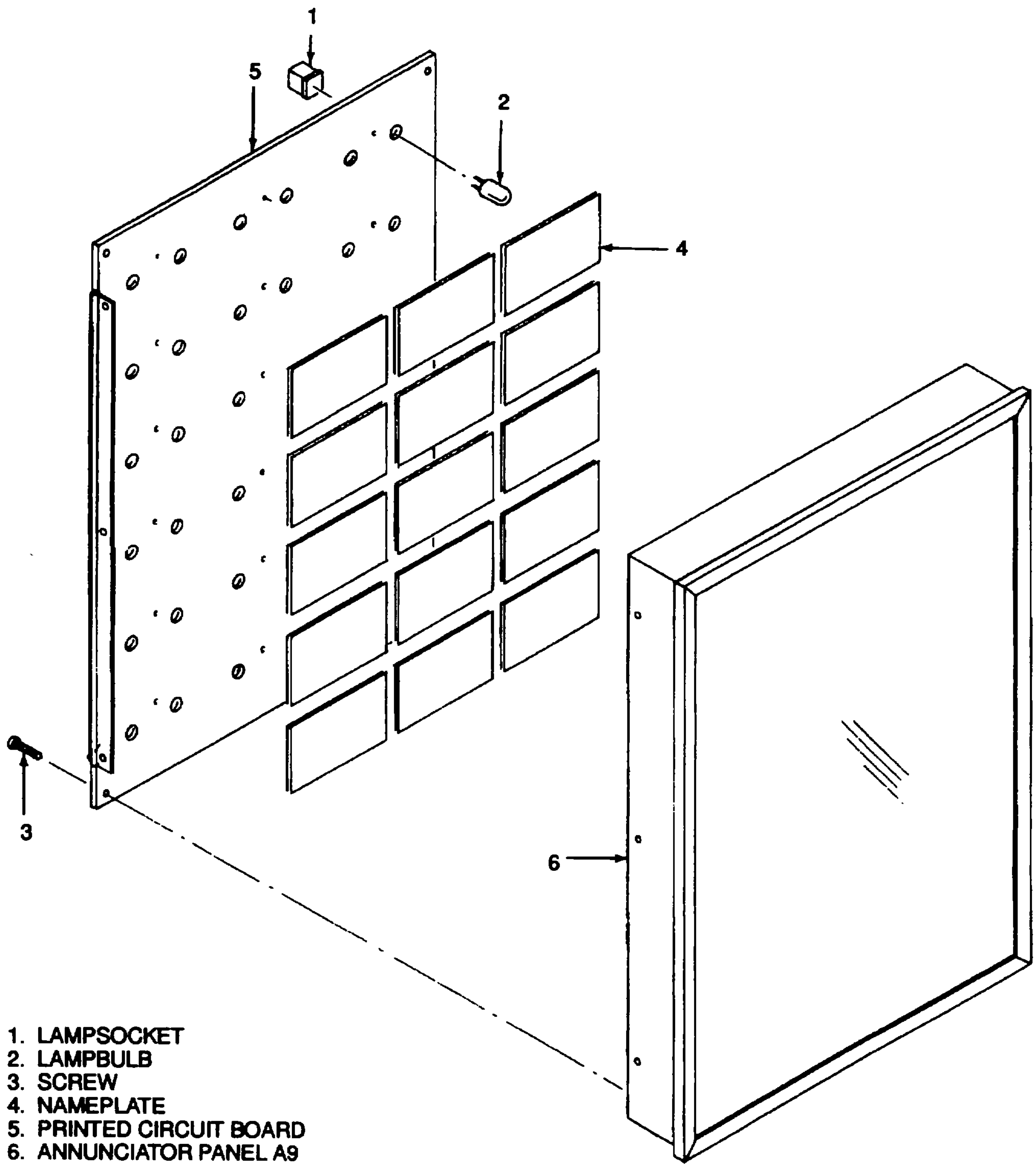


Figure 10-2. Annunciator Panel A9, Exploded View

(3) To replace printed circuit board (5) or annunciator panel A9 (6), proceed as follows:

(a) Tag and disconnect wires from terminals on back of printed circuit board (5).

(b) Disconnect hinge from printed circuit board (5) (if printed circuit board is to be replaced) or from annunciator panel A9 (6).

(c) Remove screws (3) to remove printed circuit board (5).

(d) If printed circuit board (5) is to be replaced, remove any good lamp sockets (1) and lamp bulbs (2) and store in generator set tool box for future use as spares.

(e) If annunciator panel A9 (6) is to be replaced, remove any nameplates (4) that may be useable as future replacements and store them in the generator set tool box.

(f) Install replacement) printed circuit board (5) on (replacement) annunciator panel A9 (6) and secure with screws (3).

(g) Secure hinge to printed circuit board (5) or annunciator panel A9 (6), as required.

(h) Make wiring connections to terminals on the back of the printed circuit board (5), as required.

SECTION II. TRANSFORMERS

10-3. GENERAL. The generator set contains 17 transformers which perform as follows:

a. Current Boost Transformers CT2 and CT3. The current boost transformers are mounted inside the conduit box assembly. CT3 monitors generator G1 line T1. CT2 monitors T2. In each case, the generator line is wrapped three times through the current boost transformer, serving as the 'primary". The "secondaries", the transformers themselves, are cross-connected to the input terminals of current boost system Al 01. Current boost system Al 01 utilizes the input from the current boost transformers CT2 and CT3 to assist voltage regulator VR101 during generator overload conditions and to independently supply the generator exciter field during generator short circuit conditions.

b. Current Transformers CT1 0, CT1 1, and CT1 2. The current transformers are mounted in the lower rear section of Cabinet B, accessible from the generator compartment. They sense the current through generator G1 lines T3, T2, and T1, respectively. The generator lines pass directly through the current transformers with no turns. The induced currents from these transformers is used as input (1, 2, or 3 phases) by current transducer AMT, watt transducer WMT, power factor transducer PFT, AC KILONARS meter Ml 08, reverse power relay K1 09, load sharing panel Al 04, and overcurrent relay K1 14. Current through each transformer varies from 0 (generator set at no load) to 3.71 amperes (750 kW, 0.8 power factor load).

c. Current Transformer CT114. Current transformer CT114 is mounted in the lower rear section of Cabinet B, accessible from the generator compartment. It senses the current through generator G1 line T2. The current output of CT114 varies from 0 (generator set at no load) to 5 amperes (generator set at 750 kW, 0.8 power factor load). Transformer CT1 14 is used during isochronous parallel operation of the generator set to balance the load between all parallel-connected generator sets on the bus. The transformers in each generator set are parallel connected to each other, via the reactive load cable assemblies, and the output of the parallel connected transformer network is applied to the input of the voltage regulator VR101 in each generator set. To trim and match the current output of each CT114 on the network, each generator set has a CROSS CURRENT ADJUST rheostat Ri 05. Zero to 1 ohm Ri 05, in parallel with 5 ohm resistor R107, limits the current applied by any particular transformer CT114 to the transformer network. Whenever the generator set is not in paralleling mode, transformer CT11 4 is shorted out of circuit by normally dosed contacts of paralleling relay K4C.

d. Ground Fault Transformer T100. Ground fault transformer T100 is mounted in the lower rear section of Cabinet A, accessible from the generator compartment. The transformer primary is tied between generator G1 line TO and generator set ground. Hence, the potential across the primary winding will, in normal cases, be zero. A voltage sensing relay (GROUND FAULT relay K1 15) is connected across the secondary to sense the potential across the primary. The GROUND FAULT relay will trap a generator set alarm and shutdown circuit if the voltage across the secondary of T100 exceeds a preset level.

e. Stepdown Transformer T101. Stepdown transformer T101 is located in the lower front section of cabinet C, accessible from the control room. Ti01 is a 10:1 stepdown transformer used to convert 2400 V ac generator G1 power to 240 V ac and 120 V ac for use by generator set circuits. 120 V ac is obtained from a grounded center tap off the secondary of the transformer.

f. Isolation Transformer T1 02. Isolation transformer T1 02 is located in the upper rear section of Cabinet A, accessible from the generator compartment. One half of the primary winding is tied between generator GI lines TO and T2. The other half of the primary is not used. The secondary provides voltage inputs to current boost system Al 01 and voltage regulator VRI01. The input lines to the transformer are protected by fuses F104 and F103.

g. Stepdown Transformer T103. Step-down transformer T1 03 is located in the lower rear section of Cabinet C, accessible W from the generator compartment. The transformer is used in conjunction with UTILITY POWER receptacle Jl01 and connection board TB1 03 to bring in 380 V ac utility power and convert it to 120 and 240 V ac for generator set circuits.

h. Transformers Ti04 and Ti06 through Tb1 0.

(1) Transformers TM04 and Ti06 through T10 are high accuracy (0.6 percent) 20:1 stepdown transformers. The transformers are located in the upper rear section of cabinet A accessible from the generator compartment.
(2) Transformers T1 06, T1 07, and Ti04 are tied to generator GI lines T3, T2, and T1, respectively. All three return through line TO. These three transformers provide potential inputs to watt transducer WMT, powerfactor transducer PFT, AC KILOVARS meter M108 (through KVAR meter transformer T105), reverse power relay K109, load sharing panel Al 04, frequency transducer Al 03, underfrequency relays K1 07 and K1 08, over voltage relay Kil0, undervoltage relay K111, synchronizer A105, GEN TEMP meter M105, AC KILOVOLTS meter M101, and the generator set side of SYNCHROSCOPE MI 06. Transformer T1 06, T1 07, and TM04 primaries are protected by fuses Fl 07, Fl 08, and Fl 06, respectively. The transformer secondaries are protected by Fl 13, Fl 1, and Fl 09, respectively.
(3) Transformers T1 08, T1 09, and T1 10 are connected to load lines LI, L2, and L3, respectively. All three return through line LO. These three transformers provide potential inputs to the bus side of SYNCHROSCOPE Mi06, and to AC KILOVOLTS meter Ml 01. Transformers T1 08, T1 09, and T1 10 primaries are protected by fuses Fl1 4, F116, and F1 8, respectively. The transformer secondaries are protected by F117, F1 9, and Fi21.

i. KVAR Meter Transformer T1 05. Transformer T1 05 is located in upper Cabinet B, accessible from the control room. The transformer receives a potential input from transformers TM04 and T1 06, shifts the phase of the input voltage 90 degrees, then applies the phase-shifted voltage to the input terminals of AC KILOVARS meter M108.

10-4. TRANSFORMER REPLACEMENT.

a. Current Transformers CT1 0, CT11, CT1 2, and CT 1 4. The current transformers are mounted in the lower rear section of cabinet B. Generator GI output leads T1, T2, and T3 pass through current transformers CT1 2, CT11, and CT1 0, respectively. The leads have to be disconnected from load circuit breaker CB1 01 to remove the transformers, then reconnected after transformer installation. Proceed as follows: (1) Remove.

WARNING

Generator set must be shut down and MAINTENANCE LOCK-OUT switch SIOO set to MAINTENANCE during following procedure. Generator GI leads must be momentarily shorted to ground using a fiberglass rod with a grounded metal tip. Failure to observe these safety procedures may result In death by electrocution.

(a) Shut down generator set in accordance with the Operator and Organizational Maintenance Manual. Be sure MAINTENANCE LOCKOUT switch S100 has been set to MAINTENANCE.
(b) Go into generator compartment. Remove cabinet B rear access panel in accordance with the Operator and Organizational Maintenance Manual.
(c) Using a grounding stick with a grounded metal tip, momentarily touch the lugs of generator G1 leads T1, T2, and T3 where they connect to load circuit breaker CB1 01. Refer to Figure 10-3.
(d) Tag and disconnect lugs of leads T1, T2, and T3 from load circuit breaker CB101.
(e) Cut and remove tie wraps, as necessary, to free up generator GI leads along their length from the lugs to the current transformers.

(f) Tag and disconnect wires from transformer terminals.
(g) Refer to Figure 10-4. To remove current transformers CT10 or CT12 (4), remove hexagonal nuts (1), lockwashers (2), and cable insulator spacer (3).
(h) To remove current transformers CT114 (8) or CT11 (9), remove hexagonal nuts (5), lockwashers (6), and cable insulator spacer (7).
(i) Remove cable insulator spacers (10) or threaded rods (11) only if damaged.

(1). Install

(a) Refer to Figure 10-4. Install threaded rods (11) or cable insulator spacers (10), if removed.
(b) Install current transformers CTI1 (9) and CT1 14 (8) over generator lead T2 and secure with cable insulator spacer (7), lockwashers (6), and hexagonal nuts (5).
(c) Install current transformers CT1 0 and/or CT12 (4) over generator leads T3 and/or T1, respectively, and secure with cable insulator spacers (3), lockwashers (2), and hexagonal nuts (1).
(d) Make wiring connections to current transformer terminals as required.
(e) Connect lugs of generator leads T1, T2, and T3 to appropriate terminals on load circuit breaker CB1 01. Refer to Figure 10-3.
(f) Install the wraps as necessary to secure generator leads and relieve stress from their lugs.
(g) Reinstall cabinet B rear access panel in accordance with the Operator and Organizational Maintenance Manual.

b. Ground Fault Transformer Ti00. Ground fault transformer T1 0o is mounted in the lower rear section of cabinet A. The transformer sits on the sheet metal weldment that houses the generator set output terminals. No maintenance shall be done in this cabinet when generator set output power cables are connected to their terminals. The cables should be "parked' on their standoff insulator assemblies to prevent their bringing in lethal voltages from any external, energized bus they may be connected to.

WARNING

Generator set must be shut down and MAINTENANCE LOCK-OUT swatch S1O set to MAINTENANCE during following procedures. Failure to observe this warning may result In death by electrocution.

WARNING

Generator set output power cable assemblies must be disconnected from output terminals and "parked" on standoff Insulator assemblies during following procedures. Failure to do so may result In death by electrocution.

(1) Remove

(a) Shut down generator set in accordance with Operator and Organizational Maintenance Manual. Be sure MAINTENANCE LOCKOUT switch S100 has been set to MAINTENANCE.
(b) Disconnect generator set power output cables from generator set output terminals and "park" the cables on the standoff insulator assemblies.
(c) Go into the generator compartment and remove cabinet A rear access panel in accordance with the Operator and Organizational Maintenance Manual.
(d) Tag and disconnect wires connected to transformer T100 terminals.
(e) Refer to Figure 10-5. Remove hexagon head capscrews (1) and lockwashers (2) to remove ground fault transformer T100 (3).

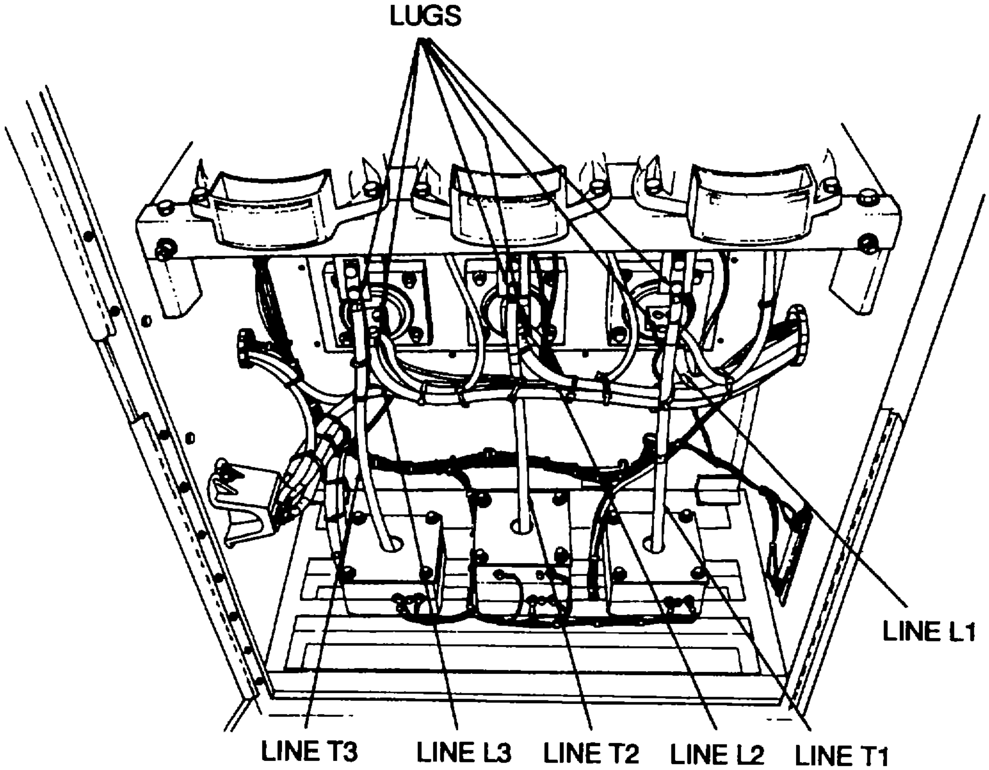


Figure 10-3. Generator G1 Lines T1, T2, T3, L1, L2, and L3.

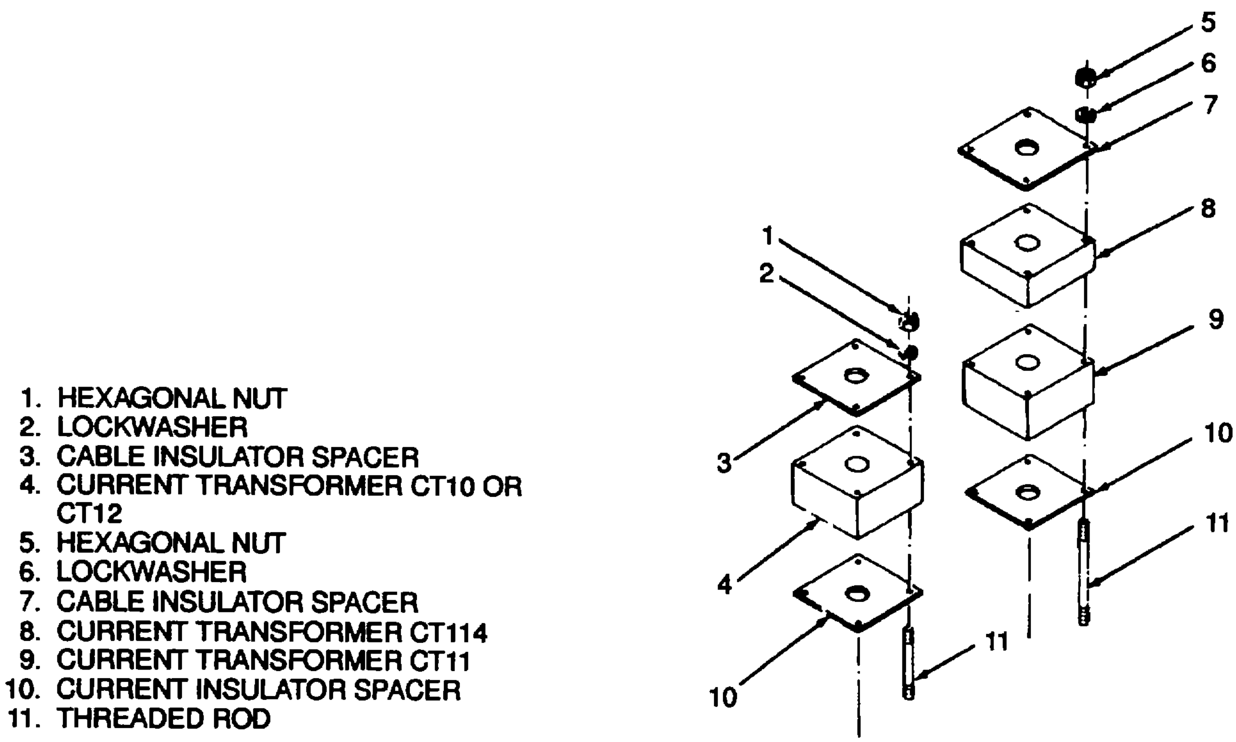


Figure 10-4. Current Transformers CT10, CT11, CT1 2, and CT114, Exploded View

(2) Install

(a) Refer to Figure 10-5. Install ground fault transformer T1 00(3) and secure with lockwashers (2) and hexagon head cap screws (1).
(b) Make wiring connections o transformer T100 terminals as tagged. Remove and discard tags.
(c) Reinstall cabinet A rear access panel in accordance with the Operator and Organizational Maintenance Manual.

c. Stepdown Transformer T1 01. Stepdown transformer Tl01 is mounted in the front section of cabinet C, on the floor. The transformer must be completely isolated before it can be safely worked on. Once isolated, its windings must be momentary grounded to discharge any hazardous potentials on them. Proceed as follows:

WARNING

Generator set must be shut down and MAINTENANCE LOCK-OUT switch S1OO set to MAINTENANCE during following procedures. Failure to observe this warning may result In death by electrocution.

WARNING

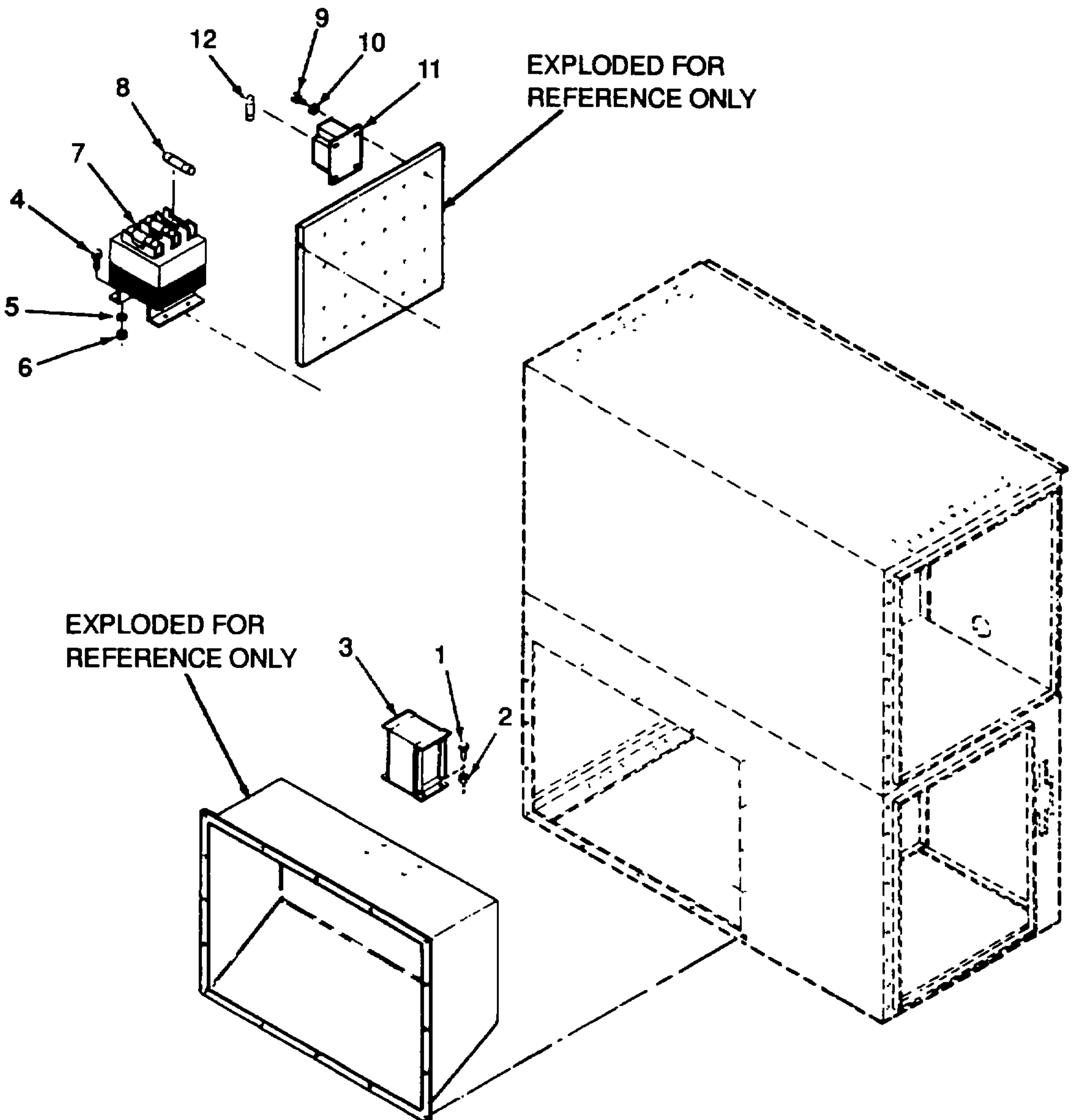
Generator set output power cable assemblies must be disconnected from output terminals and "parked" on standoff Insulator assemblies during following procedures. Failure to do so may result In death by electrocution.

(1) Remove

(a) Shut down generator set in accordance with Operator and Organizational Maintenance Manual. Be sure MAINTENANCE LOCKOUT switch S100 has been set to MAINTENANCE.
(b) Go into the generator compartment and remove cabinet C rear access panel in accordance with the Operator and Organizational Maintenance Manual.
(c) Using a hooked fiberglass rod, pull the hook on the upper end of the fuse Fl 01 out of its dip. (The lower end of the fuse will hinge.) Refer to Figure 10-6.
(d) Reinstall rear door to cabinet C rear access panel.
(e) Go into the control room. Set SET POWER circuit breaker CB124 to OFF Set circuit breaker locking beam such that CBi 24 cannot be set back to ON.
(f) Open Cabinet C door. Using a grounding stick with a grounded metal tip, momentarily touch each terminal of transformer T1 01 to discharge to ground any static charges on the transformer.
(g) Refer to Figure 10-7. Remove hexagon head capscrews (1), flat washers (2), wire terminal shields (3), lockwashers (4), spacers (5), flat washers (6), and hexagonal nuts (7) to gain access to transformer terminal T1 01 hardware.
(h) Tag and disconnect wires from transformer T1 01 terminals.
(i) Remove hexagon head capscrews (8) and lockwashers (9) to remove stepdown transformer T1 01 (10).

(2) Install

(a) Refer to Figure 10-7. Install stepdown transformer T101 (10) and secure with lockwashers (9) and hexagon head capscrews (8).
(b) Make wiring connections to transformer T101 terminals as tagged. Remove and discard tags.
(c) Install hexagonal nuts (7), flat washers (6), spacers (5), lockwashers (4), wire terminal shields (3), flat washers (2), and hexagon head capscrews (1).
(d) Close cabinet C door.



1. HEXAGON HEAD CAPSCREW
2. LOCKWASHER
3. GROUND FAULT TRANSFORMER T100
4. HEXAGON HEAD CAPSCREW
5. LOCKWASHER
6. HEXAGON NUT
7. ISOLATION TRANSFORMER T102
8. FUSE
9. HEXAGON HEAD CAPSCREW
10. LOCKWASHER
11. TRANSFORMERS T104, T106 THROUGH T110
12. FUSE

Figure 10-5. Transformers T100, T102, T104, and T106 through T110, Exploded View

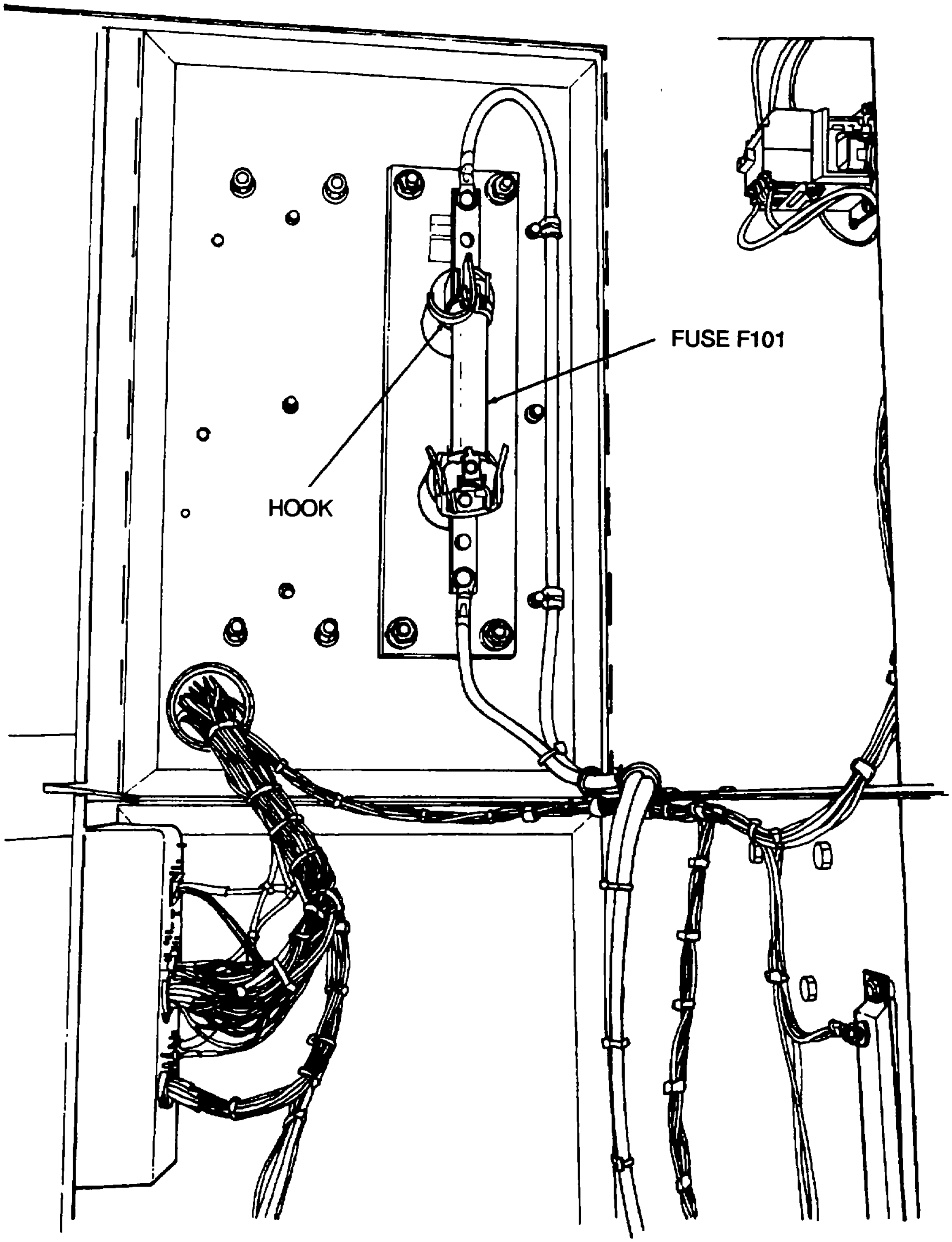
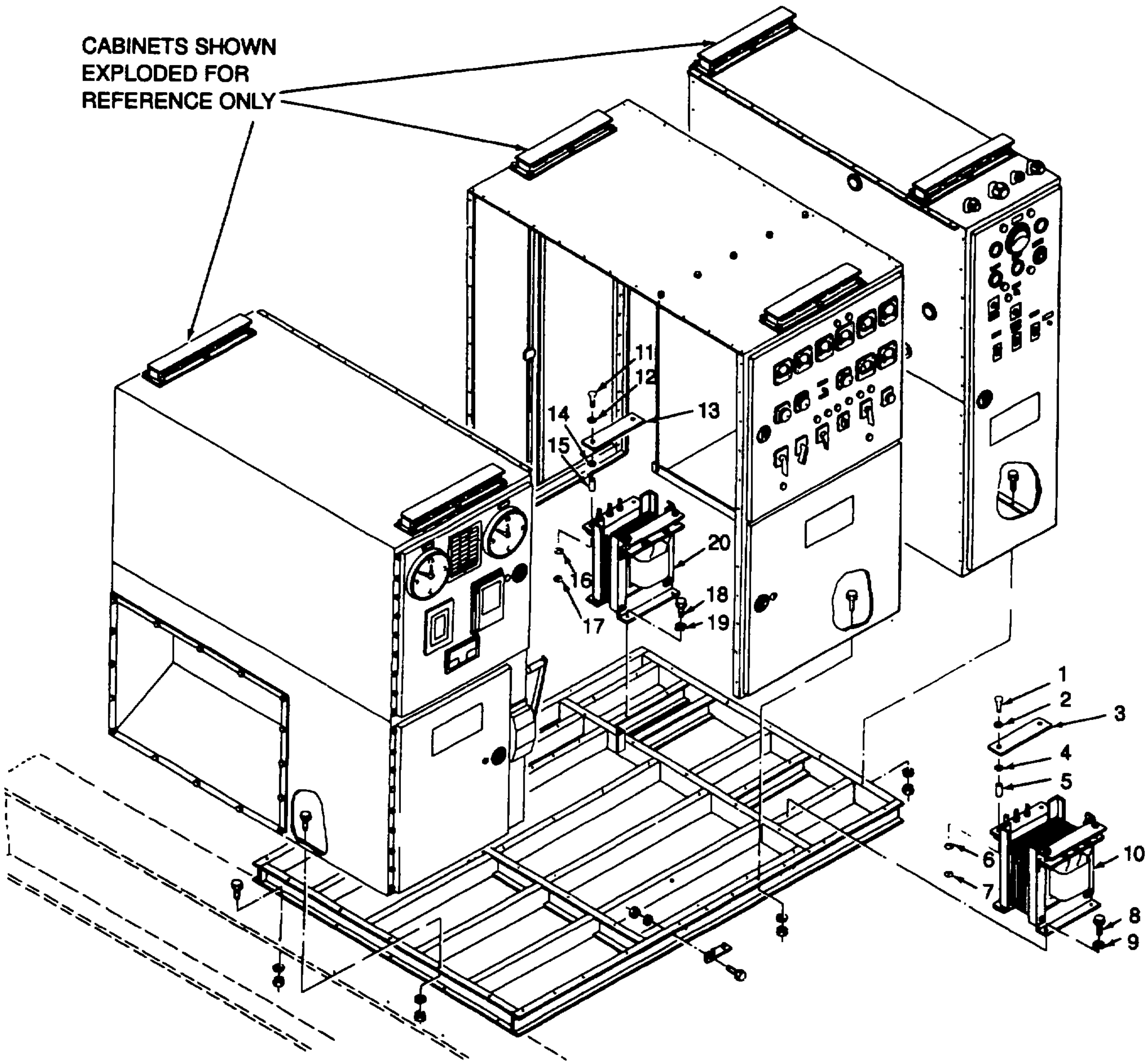


Figure 10-6. Fuse F101



1. HEXAGON HEAD CAPSCREW
2. FLAT WASHER
3. WIRE TERMINAL SHIELD
4. LOCKWASHER
5. SPACER
6. FLAT WASHER
7. HEXAGONAL NUTS
8. HEXAGON HEAD CAPSCREW
9. HEXAGON HEAD CAPSCREW
10. STEPDOWN TRANSFORMER T101
11. HEXAGON HEAD CAPSCREW
12. FLAT WASHER
13. WIRE TERMINAL SHIELD
14. LOCKWASHER
15. SPACER
16. FLAT WASHER
17. HEXAGONAL NUT
18. HEXAGONAL HEAD CAPSCREWS
19. LOCKWASHERS
20. STEPDOWN TRANSFORMER T103

Figure 10-7. Transformers T101 and T103, Exploded View

(e) Set circuit breaker locking beam. SET POWER circuit breaker CB124, and UTILITY POWER circuit breaker CB125 as desired.
(f) Go out of the control room and into the generator compartment. Remove cabinet C rear access panel in accordance with the Operator and Organizational Maintenance Manual.
(g) Use push hook on upper end of fuse Fl 01 to push fuse into fuse dip. See Figure 10-6.
(h) Reinstall cabinet C rear access panel.

d. Isolation Transformer T102. Isolation transformer T102 is mounted in the rear section of Cabinet A Its primary is connected directly to generator G1 lines T2 and TO. Hence, generator G1 must be shut down and discharged prior to working on isolation transformer T102.

WARNING

Generator set must be shut down and MAINTENANCE LOCK-OUT switch SIOO set to MAINTENANCE during following procedures. Generator G1 output lines T1, T2, and T3 must be momentarily grounded to remove static potentials that may be present on lines T1, T2, or T3. Failure to follow these procedures may result In death by electrocution.

WARNING

Generator set output power cable assemblies must be disconnected from output terminals and "parked" on standoff Insulator assemblies during following procedures. Failure to do so may result In death by electrocution.

(1) Remove

(a) Shut down generator set in accordance with Operator and Organizational Maintenance Manual. Be sure MAINTENANCE LOCKOUT switch S100 has been set to MAINTENANCE.
(b) Disconnect generator set power output cables from generator set terminals and Spark" the cables on their standoff insulator assemblies.
(c) Go into the generator compartment and remove cabinet B rear access panel in accordance with the Operator and Organizational Maintenance Manual.
(d) Using a grounding stick with a grounded metal tip, momentarily touch the lugs of generator G1 leads T1, T2, and T3 where they connect to load circuit breaker CB101. See Figure 10-3.
(e) Reinstall rear access panel of cabinet B. Remove cabinet A rear access panel.
(f) Tag and disconnect wires from terminals of isolation transformer T102.
(g) See Figure 10-5. Remove hexagon head capscrews (4), lockwashers (5), and hexagonal nuts (6) to remove isolation transformer T102 (7).
(h) Remove fuses (8), if good, and store in generator set tool box for future use as spares.

(1) Install

(a) See Figure 10-5. Install isolation transformer T102 (7) and secure with hexagonal nuts (6), lockwashers (5), and hexagon head capscrews (4).

NOTE

New replacement isolation transformers (7) come with fuses (8) already installed. H missing, note that only two fuses (Fi04 and Fl 03) are actually required. Fuse Fl05 is never in circuit.

(b) Make wiring connections to transformer T102 terminals as tagged. Remove and discard tags.

(c) Reinstall rear door of cabinet A.

e. Stepdown Transformer T103. Stepdown transformer T103 is mounted in the rear section of cabinet C, on the floor. When UTILITY POWER circuit breaker CB1 25 is set to ON and the station power cable assembly is connected to bring in UTILITY POWER at J101, one or both windings of transformer T103 will be “hot”. Hence, the transformer must be isolated before it can be safely worked on.

WARNING

Station power cable assembly must be disconnected from UTIUTY POWER receptacle J101 and UTILUTY POWER circuit breaker CB125 must be set to OFF before working on stepdown transformer T103. Failure to do so may result In death by electrocution.

WARNING

Hazardous voltages appear at terminals In rear section of Cabinet C when generator set Is running. Do not touch any terminals Inside Cabinet C unless specifically Instructed by the following procedure. Failure to comply with this warning may result In death by electrocution.

(1) Remove

(a) Disconnect station power cable assembly from UTILITY POWER receptacle J101.
(b) Go into the control room. Set UTILITY POWER circuit breaker CB1 25 to OFF and set circuit breaker locking beam such that the circuit breaker cannot be set back to ON.
(c) Go into the generator compartment and remove cabinet C rear access panel in accordance with the Operator and Organizational Maintenance Manual.
(d) See Figure 10-7. Remove hexagon head capscrews (11), flat washers (12), wire terminal shields (13), < lockwashers(14), spacers (15), flatwashers (16), and hexagonal nuts (17)to gain accesstotransformerTi03 terminal hardware.
(e) Tag and disconnect wires from transformer T1 03 terminals.
(f) Remove hexagon head capscrews (18) and lockwashers (19) to remove stepdown transformer T103 (20).

(2) Install

(a) Install stepdown transformer T103 (20) and secure with lock-washers (19) and hexagon head capscrews (1 8).
(b) Make wiring connections to T103 terminals as tagged. Remove and discard tags.
(c) Install hexagonal nuts (15), flat washers (16), spacers (15), lockwashers (14), wire terminal shields (13), flat washers (12), and hexagon head capscrews (11).
(d) Reinstall cabinet C rear access panel in accordance with the Operator and Organizational Maintenance Manual.
(e) Go into control room and set circuit breaker locking beam, SET POWER circuit breaker CB1 24, and UTILITY POWER circuit breaker CB125 as desired.

f. Transformers T104 and T106 through T110. These six transformers are vertically mounted in the upper rear section of Cabinet A. All of them have their primaries tied to generator load lines T1 through T3 or LI through L3. Therefore, the generator set must be shut down, the output power cables must be disconnected, and the load lines must be discharged before the transformers can be safely worked on.

WARNING

Generator set must be shut down and MAINTENANCE LOCKOUT switch S1OO set to MAINTENANCE during following procedures. Generator GI output lines TI, T2, 13, LI. L2, and L3 must be momentarily grounded to remove static potentials that may be present on the lines. Failure to follow these procedures may result In death by electrocution.

WARNING

Generator set output power cable assemblies must be disconnected from output terminals and "parked" on standoff Insulator assemblies during the following procedures. Failure to do so may result In death by electrocution.

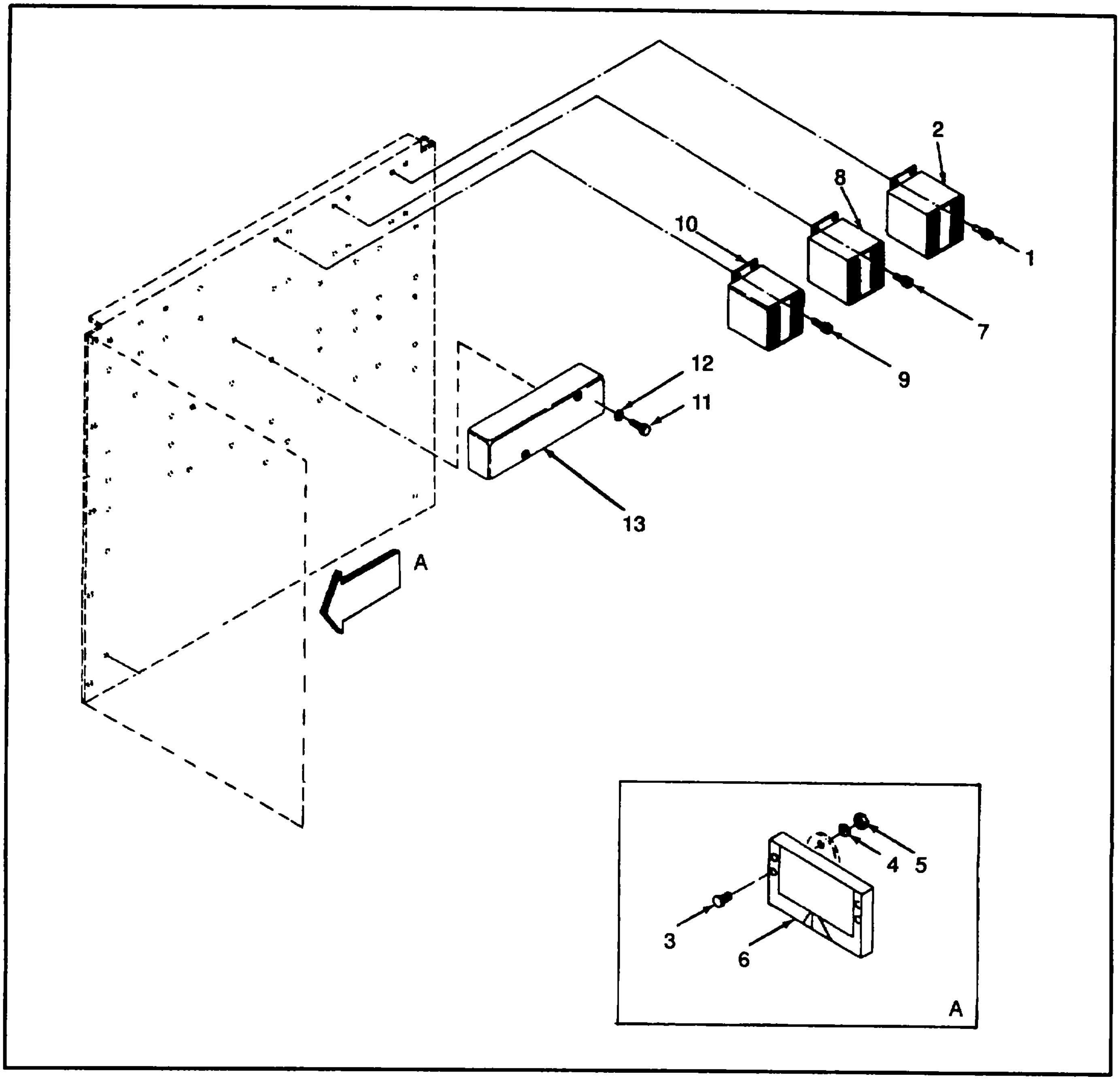
(1) Remove

(a) Shut down generator set in accordance with Operator and Organizational Maintenance Manual. Be sure MAINTENANCE LOCKOUT switch S100 has been set to MAINTENANCE.
(b) Disconnect generator set output power cable assemblies from generator set terminals and apt the cables on their standoff insulator assemblies.
(c) Go into the generator compartment and remove cabinet B rear access panel in accordance with the Operator and Organizational Maintenance Manual.
(d) Using a grounding stick with a grounded metal tip, momentarily touch the lugs of generator G1 leads T1, T2, T3, L1, L2, and L3 where they connect to load circuit breaker CB1 01. See Figure 1 03.
(e) Reinstall rear access panel on cabinet B. Remove cabinet A rear access panel in accordance with the Operator and Organizational Maintenance Manual.
(f) Tag and disconnect wires from terminals of transformer T104 or T106 through T110 to be replaced.
(g) See Figure 10-5. Remove hexagon head capscrews (9) and lockwashers (10) to remove any transformer T104 or Tl06 through T 1 0 (11).
(h) Remove fuse (12), if good, and store in generator set tool box for future use as a spare.

(2) Install

(a) See Figure 10-5. Install transformer T104 or T106 through T1 0 (11) so that fuse dips are on the left and secure with lockwashers (10) and hexagon head capscrews (9).
(b) Install fuse (12) in fuse dips of transformer (11).
(c) Make wiring connections to transformer terminals as tagged. Remove and discard tags.
(d) Reinstall rear access panel on cabinet A.

g. KVAR MeterTransformerTi05. KVAR meter transformer T105 is mounted on the left wall inside the upper front section of cabinet B. Because the transformer receives voltage inputs of 416 V ac from transformers T104 and T106, the generator set must be shutdown before transformer T105 can be safely worked on.



1. SCREW AND CAPTIVE WASHER ASSEMBLY
2. CURRENT TRANSDUCER AMT
3. HEXAGON HEAD CAPSCREW
4. LOCKWASHER
5. HEXAGONAL NUT
6. FREQUENCY TRANSDUCER A103
7. SCREW AND CAPTIVE WASHER ASSEMBLY
8. POWER FACTOR TRANSDUCER PFT
9. SCREW AND CAPTIVE WASHER ASSEMBLY
10. WATT TRANSDUCER WMT
11. HEXAGON HEAD CAPSCREW
12. LOCKWASHER
13. KVAR METER TRANSFORMER T105

Figure 10-8. Transducers and Transformer T105, Exploded View

WARNING

Generator set must be shut down and MAINTENANCE LOCK-OUT switch S1O set to MAINTENANCE during following procedure. Failure to observe this precaution may result In death by electrocution.

(1) Remove

(a) Shut down the generator set in accordance with the Operator and Organizational Maintenance Manual. Be sure MAINTENANCE LOCKOUT switch S100 has been set to MAINTENANCE.
(b) Open upper cabinet B door.
(c) Tag and disconnect wires from transformer T105 terminals.
(d) See Figure 10-8. Remove hexagon head capscrews (11) and lockwashers (12) to remove KVAR meter transformer T105 (13).

(2) Install

(a) See Figure 10-8. Install KVAR meter transformer T105(13) and secure with lockwashers (12) and screws (11).
(b) Make wiring connections to T 05 terminals as tagged. Remove and discard tags.
(c) Close upper cabinet B door.

SECTION III. TRANSDUCERS

10-5. GENERAL. The purpose of any transducer is to accept an input signal, alter the signal, and present the altered form of the signal at the output of the transducer. This output is then used by some external device that could not have used the original, unaltered signal. The generator set contains four transducers: current transducer AMT, frequency transducer Al 03, power factor transducer PFT, and watt transducer WMT. These transducers perform as follows:

a. Current Transducer AMT. Current transducer AMT is located inside the upper part of cabinet B and receives input signals from current transformers CT10, CT11, and CT12. The output of the transducer is applied to AC AMPERES meter M102 through AMMETER switch S114 and LOCAL REMOTE switch S2. Current transformers CT10, CT11, and CT1 2 sense the load current through generator G1 output lines T3, T2, and T1, respectively. At rated load, each output line carries 130 amperes, producing a current of 3.71 amperes in each current transformer. Current transducer AMT monitors this current, and as it varies from 0 (no load) to 3.71 amperes, the transducer generates a corresponding input signal from 0 (no load) to 0.74 (full load) milliampere dc. This signal is applied to AC AMPERES meter Ml 02 and results in an AC AMPERES reading from 0 to 130 amperes. AMMETER switch S114 is used to select phase A (T1), B (T2), or C (T3) for reading. Current transducer AMT processes the current transformer signal of each phase separately. The AMT output for each phase is continuously present; AMMETER switch S114 determines which set of output terminals are connected to AC AMPERES meter Ml 02 at a given time.

b. Frequency Transducer Al 03. Frequency transducer Al 03 is located inside the upper part of cabinet B and receives an input signal from the secondary of potential transformer T104. Transformer T104 is a high accuracy (0.6 percent) 20:1 step-down transformer tied to generator G1 output line T1. Transducer Al 03 produces an output signal to drive the movement of HERTZ meter Ml 03. The transducer and meter are factory calibrated in conjunction with each other and supplied as a matched set.

c. Power Factor Transducer PFT. Power factor transducer PFT is located inside the upper part of Cabinet B and receives a voltage input from potential transformers T106 and Ti07 and a current input from current transformer CT12. Transducer PFT produces a 0 to 500 microampere dc output that is directly proportional to the phase angle difference between the voltage and current at the input. The polarity of the output current indicates whether the phase angle difference is a lead or a lag. The output of transducer PFT is applied through LOCAL REMOTE switch S2 to POWER FACTOR meter Ml 04. Meter Ml 04 indicates from 0.5 power factor lagging to 0.5 power factor leading.

d. Watt Transducer WMT. Watt transducer WMT is located inside the upper part of cabinet B and receives voltage and current inputs from potential transformers T104 and T106 and current transformers CT1 0, CT1 1, and CT1 2. The transducer provides a 0 to 1000 microampere output that is directly proportional to the power flowing through generator GI output lines.

10-6. TRANSDUCER TESTS. This paragraph contains detailed on-equipment and bench tests for transducers AMT, A103. PFT, and WMT. Not all of the transducers have both on equipment and bench tests.

a. Current Transducer AMT On Equipment Test.

WARNING

Do not work on energized equipment Generator set must be shut down. Transducer voltage and current Inputs and outputs are hazardous. Performing maintenance on energized transducers may result In Injury or death.

(1) With the generator set shut down, set LOCAL REMOTE switch S2 to LOCAL and AMMETER switch S114 to “1”.
(2) Open upper cabinet B door. See Figure 10-9. Connect a microammeter into the line connected to AC AMPERES meter M102 terminal "I".
(3) With the generator set connected to a known, balanced load, start the generator set and close it onto the load bus in accordance with the Operator and Organizational Maintenance Manual.
(4) Record the microampere reading at each AMMETER switch setting, i.e., 1", "2, and "X.

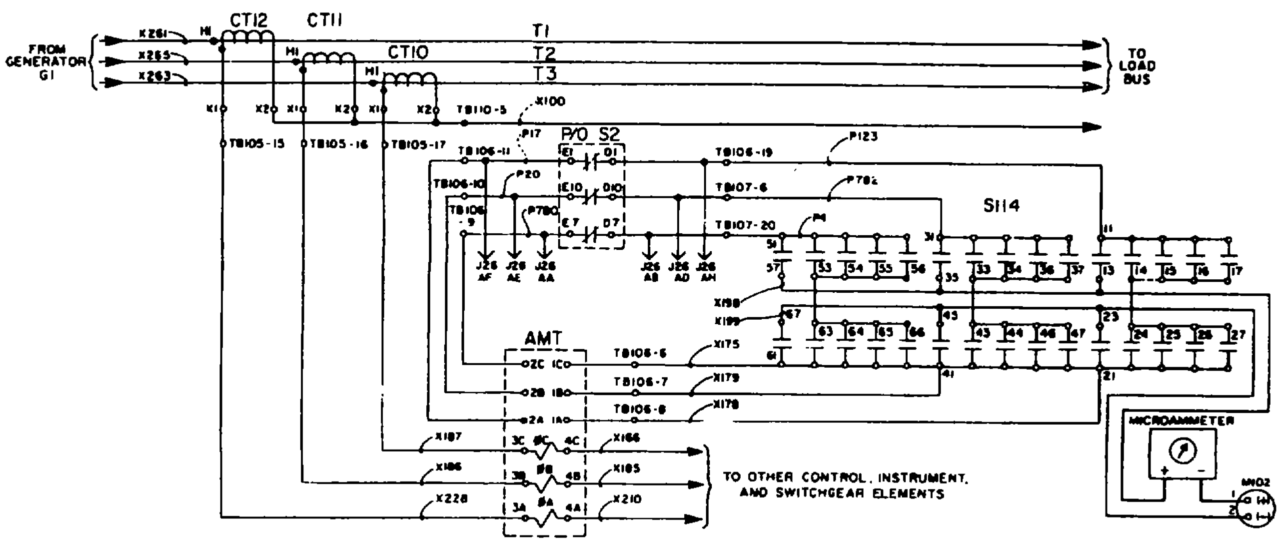


Figure 10-9. Current Transducer AMT, On Equipment Test Setup

(5) Shut down the generator set in accordance with the Operator and Organizational Maintenance Manual.
(6) Compute an expected microammeter reading using the following formula:

æAe =Lk

where **æAe** is the expected microammeter reading in microamperes and Lk is the known load in the generator set in kilowatts.
(7) Compare readings recorded in step (4), above, with expected readings computed in step (6), above.

(a) actual readings agree with expected reading within::2 microamperes, then transducer AMT is functioning properly and AC AMPERES meter Ml 02 should be giving accurate readings at 2 percent accuracy or better.
(b) If actual readings differ with expected readings by more than 2 microamperes, then transducer AMT may be defective. Proceed as follows:

1 Remove transducer AMT in accordance with step b, below.

2 Bench test transducer AMT in accordance with step c, below.

3 Reinstall transducer AMT (or replace, i defective) in accordance with step d, below.

b. Current-Transducer AMT Removal. See Figure 10-8.

WARNING

Do not work on energized equipment Generator set must be shut down. Transducer voltage and current Inputs and outputs are hazardous. Performing maintenance on energized transducers may result In Injury or death.

(1) Tag and disconnect wires from current transducer AMT (2).

(2) Remove screw and captive washer assemblies (1) to remove current transducer AMT (2).

c. Current Transducer AMT Bench Test. See Figure 1-10.

WARNING

Currents and voltages used during test are hazardous If safety precautions are not observed. Do not touch current source leads when they are energized; Injury or death may result.

(1) Connect current transducers AMT into the test setup shown in Figure 10-10.
(2) Apply balanced, three phase AC current, 50 or 60 hertz, at 2, 3, and 4 amperes. Record microampere output readings for each input current level.
(3) Verify that microampere output readings at AMT terminals 2C, 2B, and 2A are always identical for a given current input. For example, when input is 2 amperes, output should be 54 microamperes at 2C, 54 microamperes at 2B, and 54 microamperes at 2A
(4) Verify that microampere output (**æAe**) agrees with current input (lin) as shown in TEST DATA section of Figure 10-10.
(5) If desirable to test at input current levels other than 2, 3, or 4 amperes, use TEST EQUATION section of Figure 10-10 to compute expected microampere output (**æAe**) for a given current input (Iin).
(6) If test results indicate transducer AMT is defective, replace. If not, reinstall. Refer to step d, below.

d. Current Transducer AMT Installation. Refer to Figure 10-8.

(1) Install current transducer AMT (2) and secure with screws and captive washer assemblies (1).

(2) Make wiring connections to current transducer AMT as tagged. Remove and discard tags.

e. Frequency Transducer Al 03 On Equipment Test.

WARNING

Do not work on energized equipment. Generator set must be shut down. Transducer voltage and current Inputs and outputs are hazardous. Performing maintenance on energized transducers may result In Injury or death.

(1) With generator set shut down, open upper cabinet B door. Refer to Figure 10-11. Connect a frequency counter into the line connected to transducer Al 03 terminal 1.
(2) Start the generator set in accordance with the Operator and Organizational Maintenance Manual.
(3) When the engine has reached operating speed, compare the frequency indicated by the frequency counter with the frequency indicated by frequency meter Ml 03 (located on cabinet B door).

(4) If the two frequency indications differ by not more than 1.2 hertz, then there is nothing wrong with the functioning < of transducer Al 03 or Ml 03. Proceed as follows:

(a) Shut down the generator set in accordance with the Operator and Organizational Maintenance Manual.
(b) Disconnect and remove the frequency counter from the generator set circuit.
(c) Restore the generator set circuit by reconnecting the input signal line from T104 to Al 03.

(5) If the two frequency indications differ by more than 1.2 hertz, then frequency transducer Al 03 and frequency meter Ml 03 must be removed and replaced as a matched set Proceed as follows:

(a) Shut down the generator set in accordance with the Operator and Organizational Maintenance Manual.
(b) Disconnect and remove the frequency counter from the generator set circuit
(c) Remove and replace HERTZ meter Ml03 in accordance with the Operator and Organizational Maintenance Manual.
(d) Remove and replace frequency transducer Al 03 in accordance with step f, below.

f. Frequency Transducer Al03 Removal and Installation.

NOTE

Frequency meter M103 and frequency transducer A103 are a factory matched set Replacing transducer requires replacing meter.

(1) Remove. See Figure 1 0R8.

(a) Tag and disconnect wires from frequency transducer Al 03 (6).
(b) Remove hexagon head capsews (3), lockwashers (4), and hexagonal nuts (5) to remove frequency transducer A103 (6).

(2) Install. See Figure 10-8.

(a) Install frequency transducer Al 03 (6) and secure with hexagon head capscrews (3), lockwashers (4), and hexagonal nuts (5).
(b) Make wiring connections to frequency transducer Al 03 (6) as tagged. Remove and discard tags.

g. Power Factor Transducer PFT On Equipment Test.

WARNING

Do not work on energized equipment Generator set must be shut down. reducer voltage and current Inputs and outputs are hazardous. Performing maintenance on energized transducers may result In Injury or death.

(1) With the generator set shut down, interconnect generator set output cable assemblies with a 750 kW load bank having variable resistance and variable reactance. Set the load bank for 750 kW, purely resistive.

(2) With upper cabinet B door dosed, start the generator set and dose it onto the load in accordance with the Operator and Organizational Maintenance Manual.

(3) Verify that POWER FACTOR meter M104 reads "1.0n and that AC AMPERES meter M102 reads 100 to 110 amperes.

(4) Without decreasing load bank resistance, increase the reactance of the load bank until AC AMPERES meter Ml 02 reads 130 amperes.

(5) Verify that POWER FACTOR meter Ml 04 reads 0.78 to 0.82, lagging.

(6) Shut down the generator set in accordance with the Operator and Organizational Maintenance Manual.

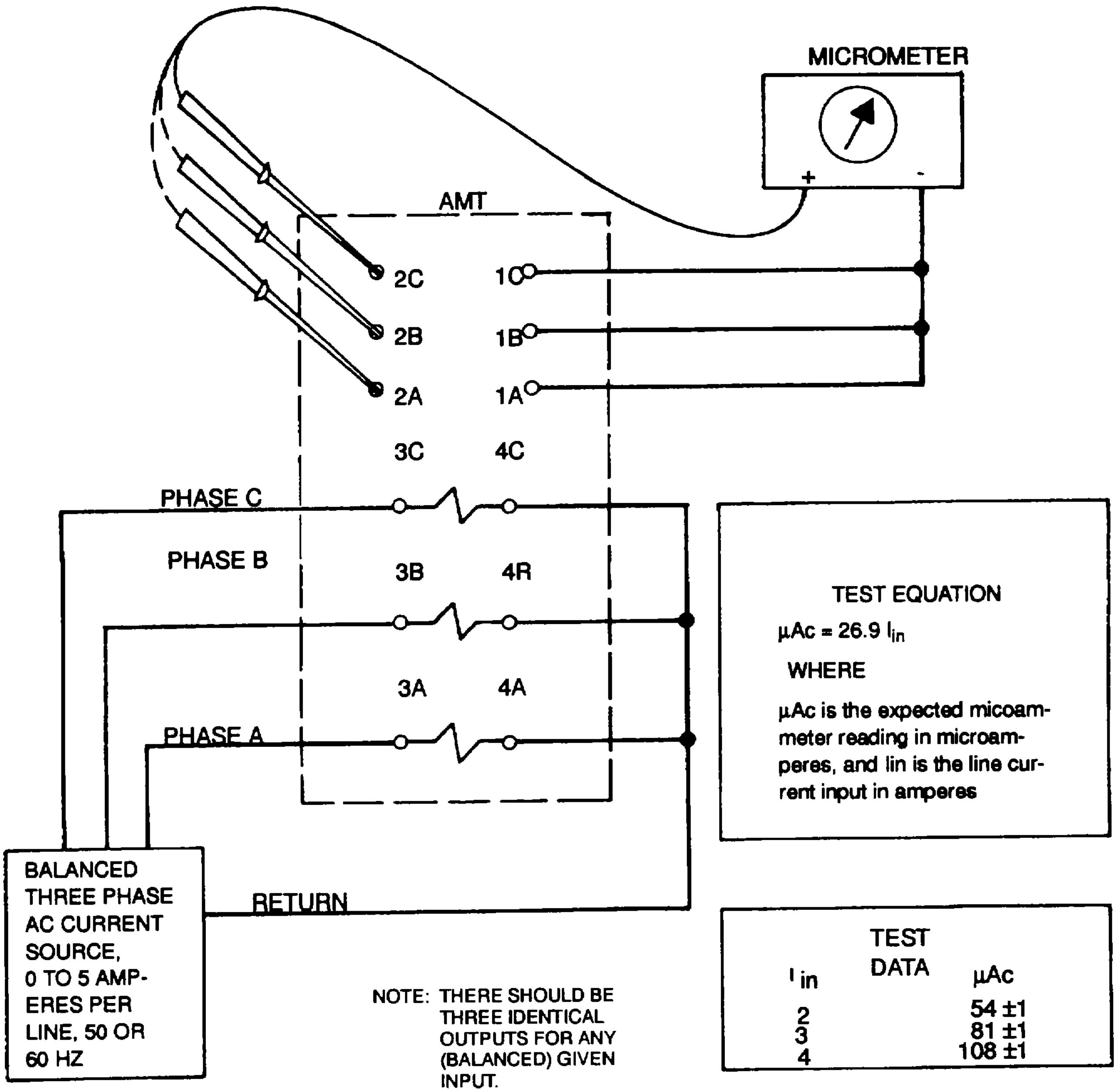


Figure 10-10. Current Transducer AMT, Bench Test Setup

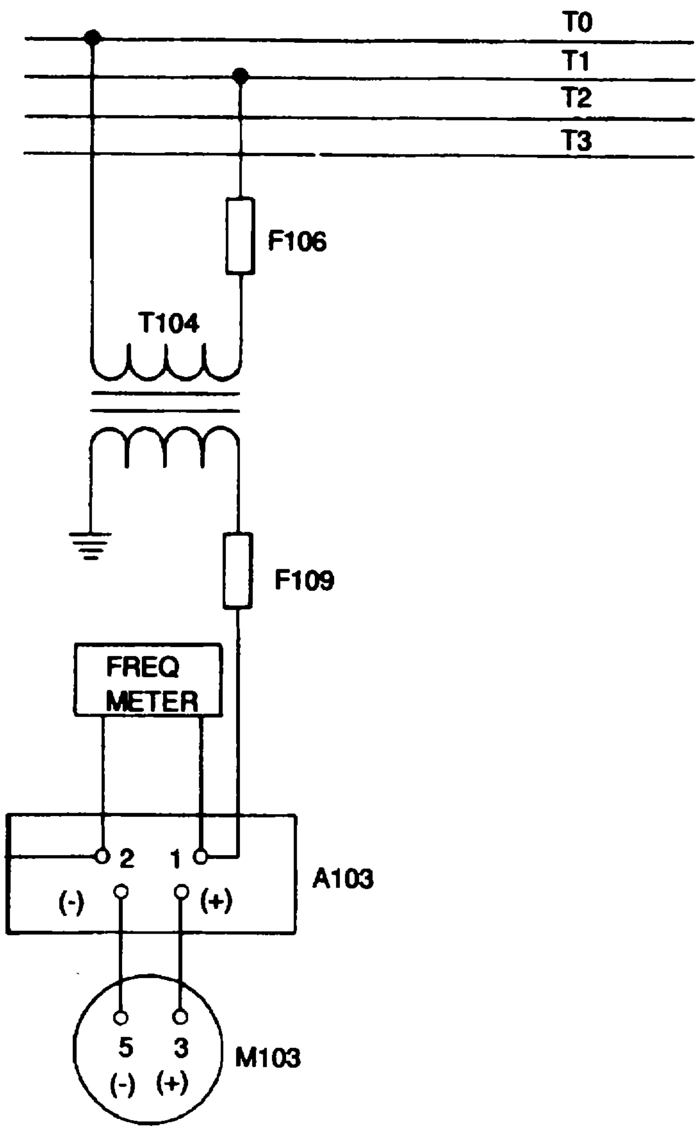


Figure 10-11. Frequency Transducer A103, On Equipment Test Setup

(7) If the conditions of steps (3) and (5), above, have been met, then the power factor transducer PFr is good and the test is over. If conditions have not been met, further testing is required to determine if transducer PFT is defective or it some other related circuit elements are responsible for the unsatisfactory readings. Proceed with step (8), below.

(8) Open upper cabinet B door. Refer to Figure 10-12. Install an ammeter in the line connected to power factor transducer PFT terminal 6. Connect an AC voltmeter across PFT terminals 8 and 12. Connect a microammeter in the line connected to PFT terminal 2.

(9) Perform steps (1) and (2), above.

(10) Verify the following: (a) The voltmeter reads 110 to 130 V ac.

   (a) The ammeter reads 2.95 to 3.00 amperes.
   (b) The microammeter reads zero.

(11) Without decreasing load bank resistance, increase load bank reactance until the ammeter indicates 3.68 to 3.74 amperes.

(12) Verity the following:
  (a) The voltmeter reads 110 to 130 V ac.
  (b) The ammeter reads 3.68 to 3.74 amperes.
  (c) The microammeter reads 195 to 200 microamperes.

(13) If the voltmeter and ammeter readings meet the conditions of steps (10) and (12), above, then power factor transducer PFT is good if micro ammeter readings also meet the stated conditions.

NOTE

If the power factor transducer PFT tests out "good" in accordance with step (13), above, but not in accordance with step (7), above, then there is something wrong with AC AMPERES motor Ml 02 or circuit elements related to it.

(14) If the voltmeter and ammeter readings do not meet the conditions of steps (10) and (12), above, then the test of power factor transducer PFT is inconclusive, indicating only that some other element in circuit with the transducer is defective.

(15) If power factor transducer PFT is found to be defective, replace it in accordance with step h, below.

h. Power Factor Transducer PFT Removal and Installation.

WARNING

Do not work on energized equipment Generator set must be shut down. Transducer voltage and current Inputs and outputs are hazardous Performing maintenance on energized transducers may result In Injury or death.

(1) Remove. See Figure 1 G8.

  (a) Tag and disconnect wires from power factor transducer PFT (8).

  (b) Remove screw and captive washer assemblies (7) to remove power factor transducer PFT (8).

(2) Install. See Figure 10-8.

  (a) Install power factor transducer PFT (8) and secure with screw and captive washer assemblies (7).

  (b) Make wiring connections to power factor transducer PFT (8) as tagged. Remove and discard tags.

i. Watt Transducer WMT On Equipment Test.

WARNING

Do not work on energized equipment Generator set must be shut down Transducer voltage and current Inputs and outputs are hazardous. Performing maintenance on energized transducers may result In Injury or death.

(1) With the generator set shut down, interconnect generator set output cable assemblies with a 750 kW, 0.8 power factor load bank.
(2) Start and operate the generator set in accordance with the Operator and Organizational Maintenance Manual.
(3) Using a stopwatch, verify that KILOWATT HOURS counter CNTR registers 2.4 to 12.6 kilowatt-hours, in 60 seconds, and also that AC KILOWATTS meter MI 07 indicates 735 to 765 kilowatts. If so, then watt transducer WMT is good and test is over. Otherwise, proceed as follows.

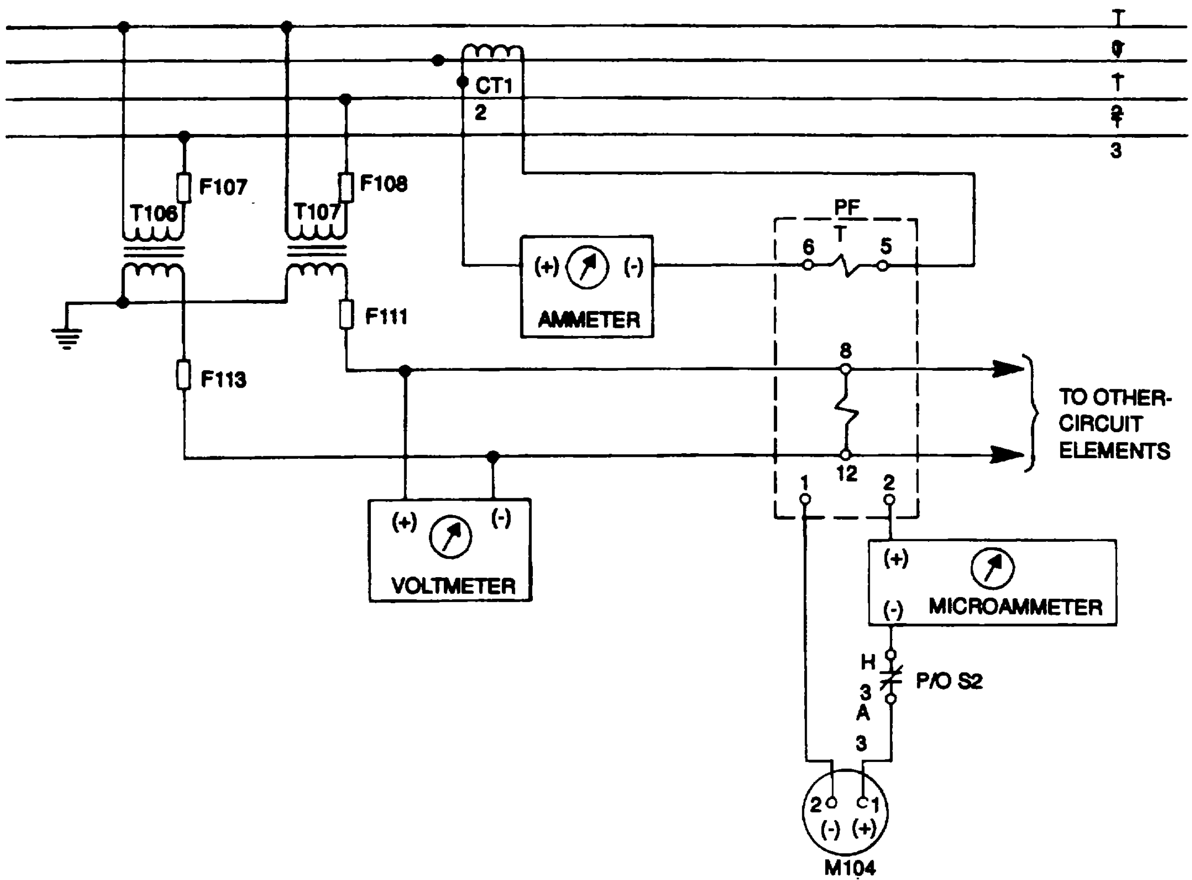


Figure 10-12. Power Factor Transducer PFR, On Equipment Test Setup

(4) Using AMMETER switch S114 and AC AMPERES meter Ml02, verify an indication of 127 to 133 amperes for each phase of generator GI output.

(a) Proper AC AMPERES indications mean watt transducer WMT is receiving correct current input from current transformers CT1 2, CT11, and CT1 0. If indications are OK, proceed with step (5), below.

(b) If the AC AMPERES indication is out of the specified range, then there is some other element in circuit with watt transducer WMT that is causing the problem, and this test is over. Test and troubleshoot as required.

(5) Open upper cabinet B door.

(6) Using an AC voltmeter with insulated leads, check voltage between watt transducer WMT terminals 4 and 12A and between WMT terminals 5 and 6. Verify that voltage is 119 to 121 V ac across each terminal pair.

(a) Proper voltage indication means watt transducer WMT is receiving correct ac voltage inputs from transformers T104 and T105. If indications are satisfactory, proceed with step (7), below.

(b) If ac voltage inputs are out of range, then there is some other element in circuit with watt transducer WMT that is causing the problem, and this test is over. Test and troubleshoot as required.

(7) Shut down the generator set in accordance with the Operator and Organizational Maintenance Manual.

(8) Test LOCAL REMOTE switch S2 in accordance with the Operator and Organizational Maintenance Manual.

(a) If the switch is good, then either watt transducer WMT, AC KILOWATTS meter Ml 07, or KILOWATT HOURS counter CNTR is defective. Proceed with step (9), below.

(b) If the switch is bad, replace it in accordance with the Operator and Organizational Maintenance Manual. Then start this test again, from the beginning.

(9) Test AC KILOWATTS meter M107 and KILOWATT HOURS counter CNTR in accordance with the Operator and Organizational Maintenance Manual.

(a) If either or both are bad, replace in accordance with the Operator and Organizational Maintenance Manual. Then start this test again from the beginning.

(b) If both are good, then replace watt transducer in accordance with step j, below.

j. Watt Transducer WMT Removal and Installation.

WARNING

Do not work on energized equipment Generator set must be shut down. Transducer voltage and current Inputs and outputs are hazardous. Performing maintenance on energized transducers may result In Injury or death.

(1) Remove. See Figure 1 0-8.

(a) Tag and disconnect wires from watt transducer WMT.

(b) Remove screw and captive washer assemblies (9) to remove watt transducer WMT (1 0).

(2) Install. See Figure 10-8.

(a) Install watt transducer WMT (10) and secure with screw and captive washer assemblies (9).

(b) Make wiring connections to watt transducer terminals as tagged. Remove and discard tags.

CHAPTER 11

MAINTENANCE OF THE REMOTE CONTROL SYSTEM

SECTION I. MAINTENANCE OF THE RECEPTACLE CONNECTOR J26

11-1. GENERAL The receptacle connector J26 (6, Figure 11-1) serves as junction between the remote control cable assembly and the remote control module internal wiring harness. Direct support maintenance is limited to replacement of the receptacle connector.

11-2.RECEPTACLE CONNECTOR J26 REPLACEMENT.

a. Remove. See Figure 11-1.

(1) When remote control module is not in use, unplug the remote control cable assembly (1) and remote control module wiring harness (2) from the receptacle connector J26 (6).

(2) Remove the screw and captive washer assembly (3) and nut and captive washer assembly (4) securing the connector cover (5). Remove the connector cover (5).

(3) Remove the remaining screw and captive washer assemblies (3) and nut and captive washer assemblies (4).

(4) Tag and disconnect wiring to the receptacle connector J26 (6) by unsoldering, and remove J26.

b. Install. See Figure 11-1.

(1) Connect wiring to the receptade connector J26 (6) as tagged by soldering.

(2) Position receptade connector J26 (6) and secure with three of the four screw and captive washer assemblies (3) and nut and captive washer assemblies (4).

(3) Attach connector cover (5) with the remaining screw and captive washer assembly (3) and nut and captive washer assembly (4).

(4) Plug wiring harness (2) and remote control cable assembly (1) into receptade connector J26 (6).

SECTION II. MAINTENANCE OF THE REMOTE CONTROL CABLE ASSEMBLY

11-3.GENERAL The remote control cable assembly is a 50-conductor cable providing a means of interconnecting the generator set with a remote control module up to 100 feet (30 meters) away. Direct support maintenance is limited to repair of the remote control cable assembly.

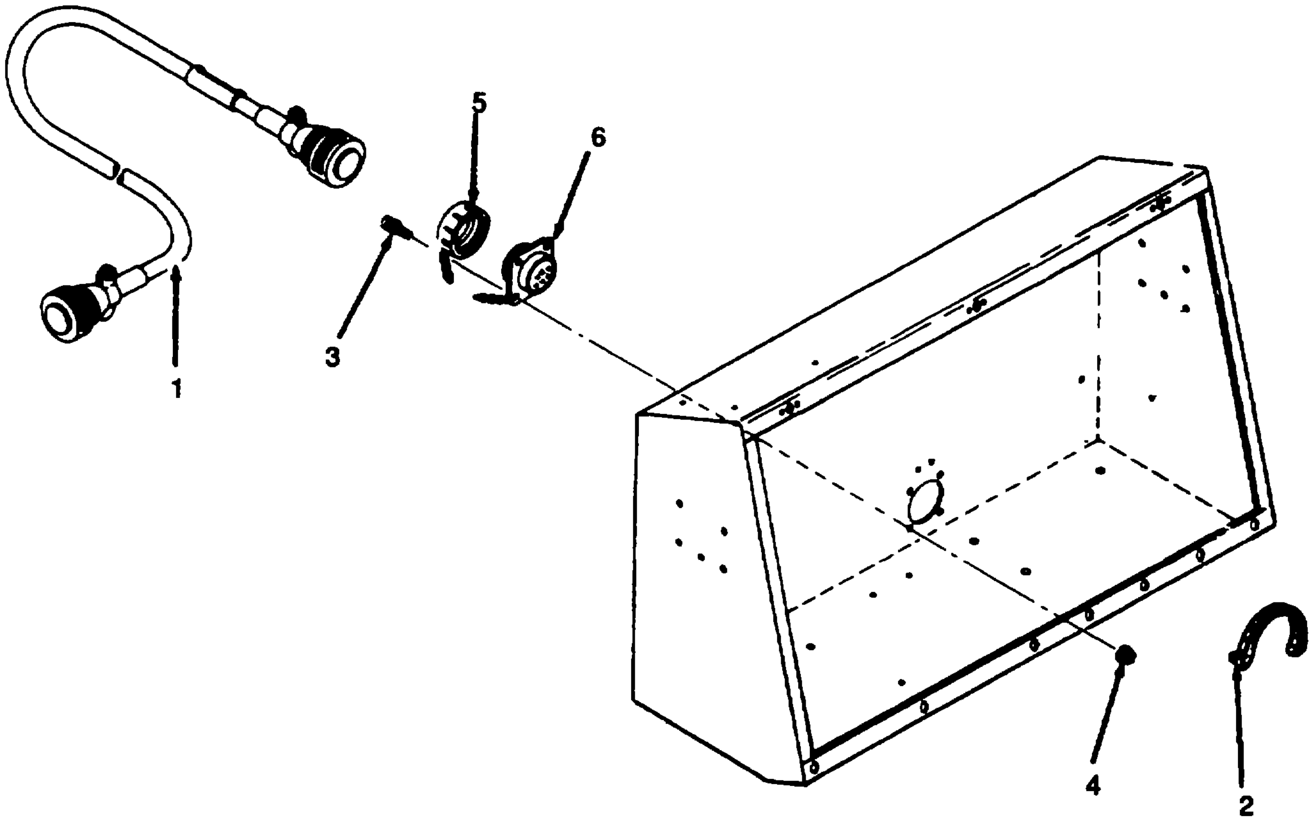
11-4.REMOTE CONTROL CABLE ASSEMBLY REPAIR.

a. Remove damp (1, Figure 11-2).
b. Slide bushing (3) away from plug connector (2) to expose connections.
c. Tag wires and unsolder plug connector (2). Remove bushing (3).
d. Remove marker band (4) from cable (5).
e. Repair the cable as follows:

(1) If less than 30 percent of the wires in the cable (5) are damaged, disconnect and if possible, remove the damaged wire. Replace with a jacketed wire of the same size and type, and transfer the tags from the damaged wire. Secure the new wire to the cable (5) with tape or tiedown straps.

(2) If more than 30 percent of the wires are damaged, repair by replacing the cable (5) with a new length of cable.

f. Repair damaged damps (1), plug connectors (2), bushings (3) or marker band (4) by replacement.
g. Install marker band (4) onto the cable (5).
h. Slide bushings (3) onto the cable (5).
i. Solder plug connectors (2) to cable (5) as tagged and remove tags.
j. Position bushings (3) over the sleeve of plug connectors (2) and secure by installing damps (1).



1. REMOTE CONTROL CABLE ASSEMBLY
2. WIRING HARNESS
3. SCREW AND CAPTIVE WASHER ASSEMBLY
4. NUT AND CAPTIVE WASHER ASSEMBLY
5. CONNECTOR COVER
6. RECEPTACLE CONNECTOR J26

Figure 11-1. Receptacle Connector J26, Removal and installation

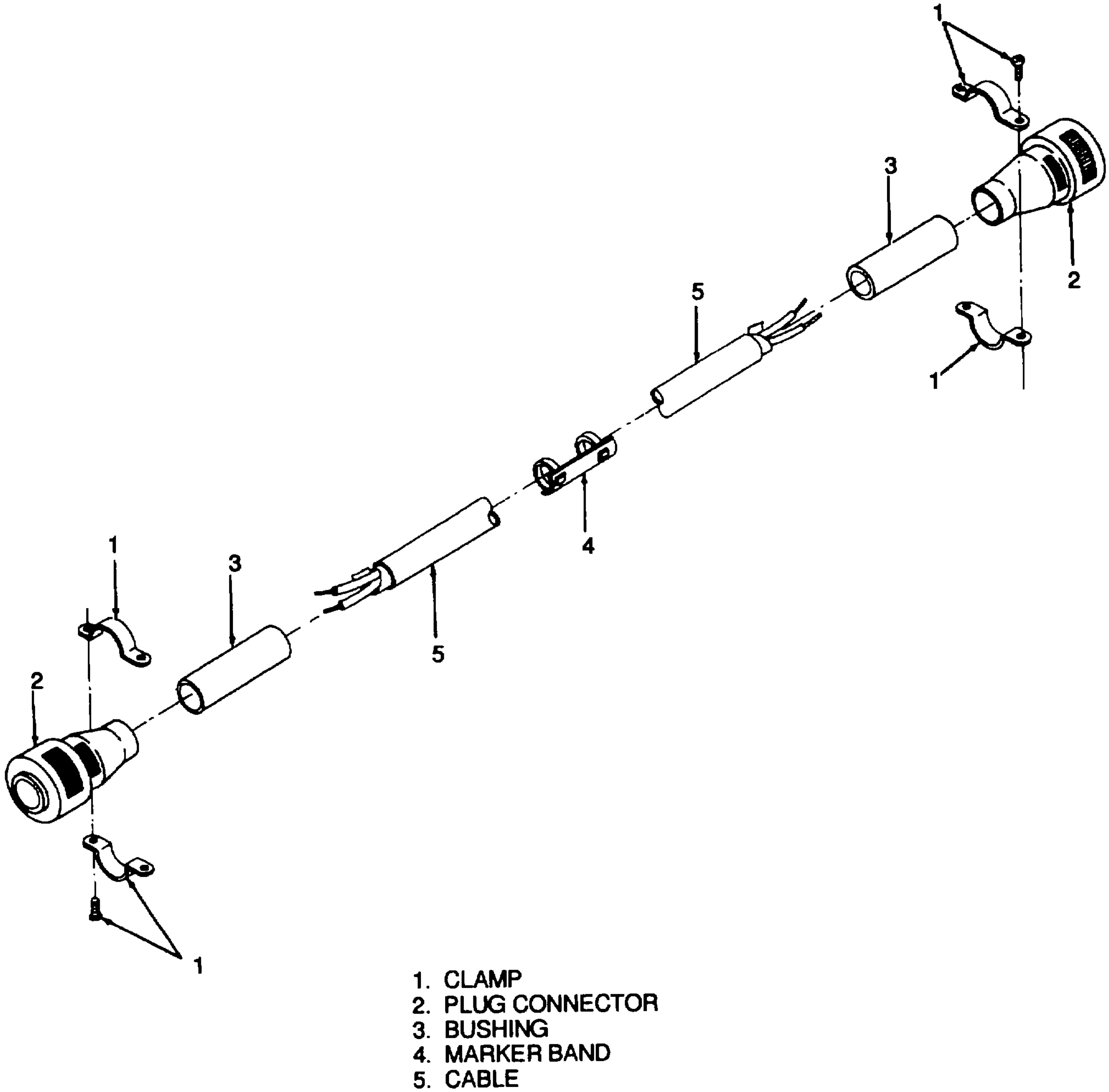


Figure 11-2. Remote Control Cable Assembly

CHAPTER 12
GENERATOR SET TEST AND INSPECTION AFTER REPAIR OR OVERHAUL

SECTION I. GENERAL REQUIREMENTS

12-1. GENERAL. 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. ENGINE RUN-IN AND DYNAMOMETER TEST

12-2. GENERAL. After overhaul, each engine must meet the minimum requirements set forth in paragraph 12-3, below. Complete test data shall be recorded during each run, and performance evaluated at each phase of operation. At the completion of the tests, a copy of the test log shall be attached to the engine. Engine testing shall be carried out with the engine mounted in a separate dynamometer test cell. All brake horsepower (bhp) ratings shall be corrected to SAE standard J816b conditions of 500 feet (152 m) altitude (29.00 inches (736.6 mm) Hg, dry barometer), 85°F (29°C) air intake temperature, and 0.38 inches (9.7 mm) Hg water vapor pressure with number 2 diesel fuel VVF-800. Fuel consumption data shall be based on a specific gravity of number 2 diesel fuel W-F-800 of 7.00 pounds per gallon (0.84 kg/L). At the completion of run-in and testing, the engine shall be mounted in the generator set for operational tests.

12-3. ENGINE RUN-IN AND DYNAMOMETER TEST.

a. Mount the engine to the dynamometer, and connect the test cell instruments and equipment (Figure 12-1). Minimum instrumentation and equipment shall be as follows:

(1) Dynamometer MIL-D-45808.

(2) A manual engine speed control system (see paragraph 12-15).

NOTE

For the instruments listed below, equivalent substitutes may be used provided compatible instrument sending units are used at the appropriate engine pick-up points. The accuracy of all instruments used in testing shall be in accordance with MIL-HDBK-705.

(3) A tachometer to convert the magnetic pick-up PUI signal to rpm.

NOTE

The crankcase blow-by tool 3375767 contains one plug and one Tee fitting. Both the plug and Tee fitting have orifices of 0.354 inch (8.99 mm). Connect the plug and orifice to one breather hose, and the Tee, orifice, and manometer to the other breather hose. Plug all other crankcase openings to atmosphere.

(4) A crankcase pressure manometer ST-1111 -3 and blow-by tool 3375767.
(5) Coolant temperature gage 76-11229.
(6) Two exhaust temperature indicators 80-7612.
(7) Oil temperature gage 76-11228.
(8) Oil pressure gage 76-11227.
(9) Fuel rate measuring device (flow meter) ST-11 90.
(10) Thermometer for recording ambient temperature at the air intake.

b. Connect the fuel tank to the fuel inlet filter system. The fuel used shall be in accordance with VV-F-800.

c. Connect radiator 80-7553, or equivalent, to the engine and fill the cooling system with a mixture of 50 percent water and 50 percent antifreeze MIL-A-11755.

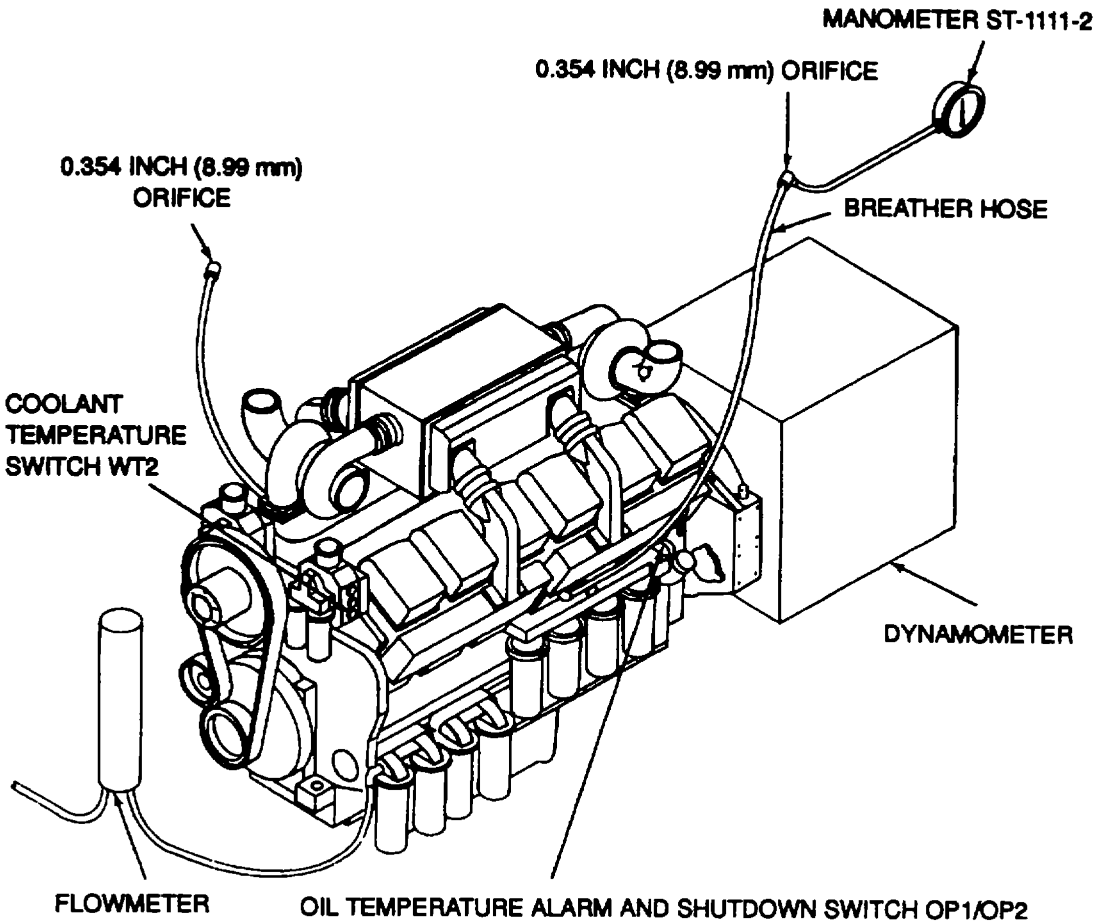


Figure 12-1. Test Equipment Installation Points

d. Connect the engine dc electrical system to four 200 ampere-hour batteries 76-11252, or equivalent connected in series-parallel to provide 24 V.

e. Fill and prime the engine lubrication system as follows:

<u>**CAUTION**</u>

Serious engine damage will result If the engine is started before the lubrication system is properly filled and primed. Elapsed time between priming the lubrication system and starting the engine shall not exceed 3 hours. If, for whatever reason, the engine cannot be started within 3 hours after priming the lubrication system, repeat the entire priming procedure just prior to starting the engine.

(1) Fill the crankcase with lubricating oil, MIL-L-2104, to the L mark on the dipstick or oil level indicator.

(2) Remove the oil inlet lines to the turbochargers and add 2 to 3 ounces (59 to 89 mL) of lubricating oil, MIL-L-21004, to the turbochargers. Reconnect the oil inlet lines.

(3) Connect the prelude pump through a switch to the 24 V dc source.

(4) Operate the prelude pump to obtain a pressure of 30 psi (207 kPa) on the oil pressure gage.

(5) With the prelude pump still operating close the fuel shutoff valve, operate the starter switch, and crank the engine for at least 15 seconds while maintaining an oil pressure of at least 15 psi (103 kPa).

(6) Fill the crankcase to the H mark on the dipstick or level gage with lubricating oil, MIL-L-2104.

f. Remove the fuel pump suction line, wet the gears with dean lubricating oil, and reinstall the suction line.

g. Engine Run-In. For proper lubrication and run-in, it is important that the engine be allowed to run for at least 15 minutes after the initial start. Be sure all preliminary preparation and adjustments have been completed before the initial start is made. Once started, the engine shall not be shut down except for the following conditions: low lubrication oil pressure, high oil temperature, high coolant temperature, high exhaust temperature, no lubricating oil at the turbochargers, and any unusual noise or vibration. Perform the initial start and engine run-in as follows:

(1) Operate the prelude pump until a pressure of 30 psi (207 kPa) is obtained, then shut off the pump.

(2) Start the engine and adjust the speed to 800 to 1000 rpm. Immediately after starting, check the oil pressure, and remove the oil drain line at the turbochargers to check for oil flow. Oil pressure should be at least 20 psi (138 kPa), and oil should flow from the turbocharger drain line within 30 seconds. Shut down the engine immediately, and determine the cause it either the oil pressure or flow is insufficient.

(3) Adjust the dynamometer load to 160 hp (119 Kw) at 900 rpm. Hold this speed and load for at least 15 minutes, or until a coolant temperature of 160° F (71° C) is reached. During this time, continually monitor the instruments, and check for the development of oil leaks, fuel leaks, and unusual noise and vibration. Shut the engine down immediately for any of the following conditions:

(a) Oil pressure falls below 20 psi (138 kPa).
(b) Oil temperature exceeds 225° F (107° C).
(c) Coolant temperature exceeds 200OF (93°C).
(d) Exhaust temperature exceeds 9870 F (531° C).
(e) Oil leakage that would tend to lower oil pressure to the danger point.
(f) Fuel leakage that would present a fire hazard.

(4) With the engine running at the same load and speed as in step (3), above, add coolant and oil as necessary to top-up the cooling and lubrication systems.

(5) If all preliminary checks are satisfactory, and the engine does not have to be shut down for repairs or adjustments, continue with the run-in starting at phase 1, in accordance with Table 12-1, and the following instructions:

(a) During the run-in continue to monitor engine conditions in accordance with steps (3) and (4), above. Record the amount of oil added to the crankcase throughout the run-in.
(b) At each phase of the run-in procedure, record all information on a copy of the test log, Figure 12-2. A copy of the completed test log shall be attached to, and remain with, each engine.

(c) Hold the engine speed and horsepower load at phase 1 for 15 minutes, and any additional time needed to reach an oil temperature of 1 60°F (71°C).
(d) Hold the engine speed and horsepower load at each phase for the time allotted, and any additional time required for the crankcase pressure to descend to 18 inches (457 mm) H_20.
(e) If the crankcase pressure rises above 22 inches (559 mm) H_20 at the start of the next phase, reduce the speed and load to the preceding phase until the crankcase pressure will remain at 18 inches (457 mm) H_20 or lower.
(f) At the completion of phase 5, return the engine to idle speed and no load, and allow it to idle for at least 5 minutes to remove excess heat from the valve train and turbochargers.

(6) Shut the engine down, allow it to cool to 140°F (60°C) or below, and service in accordance with the test log, Figure 12-2.

(7) All test data shall be in accordance with Table 12-2. Make any repairs or adjustments to correct defects found during run-in, and top-up the coolant and lubricant levels as necessary.

RUN-IN PHASE	DURATION OF RUN	TIME START STOP	ENGINE SPEED	HORSE-POWER (bhp)	LUBE OIL PRES-SURE	CRANKCASE PRESSURE	OIL	TEMPERATURES COOLANT EXHAUST AMBIENT (AIR IN-TAKE)	FUEL CONSUMP-TION
1									
2									
3									
4									
5									

SERVICE AFTER RUN-IN

1. TIGHTEN OIL PAN ADAPTER, OIL PAN, AND COVER. ☐
2. TIGHTEN INTAKE MANIFOLDS. ☐
3. TIGHTEN EXHAUST MANIFOLDS. ☐
4. ADJUST VALVE AND INJECTOR ROCKER ARMS. ☐
5. OTHER REPAIRS OR ADJUSTMENTS NEEDED (SPECIFY): ☐

____
____
____
____

DYNA-MOME-TER TEST	DURA-TION OF RUN	TIME START STOP	ENGINE SPEED	HORSE-POWER (bhp)	LUBE OIL PRES-SURE	CRANKCASE PRESSURE	OIL	TEMPERATURES COOLANT EXHAUST AMBIENT (AIR IN-TAKE)	FUEL CONSUMP-TION

OIL CONSUMPTION ____

Figure 12-2. Test Log

Table 12-1. Engine Run-In

PHASE	rpm	bhp (kW)	TIME MINUTES	OIL TEMR ° F (°C)	MAXIMUM CRANKCASE PRESSURE AT END OF RUN INCHES (mm) H_20
1	1600	300 (224)	15	160 Min (71)	18 (457)
2	1600	600 (448)	5	225 Max (107)	18 (457)
3	1800	700 (552)	10	225 Max (107)	18 (457)
4	1800	900 (671)	10	225 Max (107)	18 (457)
5	1800	1085 (809)	5	225 Max (107)	18 (457)

NOTE

1. **Oil pressure throughout the run shall be 45 to 70 psi (310 to 483 ka).**
2. **Maximum coolant temperature throughout the run shall be 200°F (93°C).**
3. **Maximum exhaust temperature throughout the run shall be 987°F (531 °C).**

Table 12-2. Normal Operating Conditions

OIL PRESSURE	IDLE (600 rpm)		RATED SPEED	
psi (kPa)	20 psi (138)		45 to 70 psi (310 to 483)	
OIL TEMPERATURE °F (°C)	160 to 225 (71 to 107)			
OIL CONSUMPTION qts/hr (L/hr)	0.66 (0.62) maximum			
COOLANT TEMPERATURE °F (°C)	160 to 1 90 (71 to 88)			
CRANKCASE PRESSURE inches (mm) H_20	18 (457) maximum			
RATED SPEED .... rpm	bhp .... (kW)		rpm .... bhp	(kW)
AND HORSEPOWER 1800	1085 .... (809)		1500........ 890	(664)
FUEL CONSUMPTION				
bhp (kW) 1200	(895) 1085		(809) 900 (671)	
lb/hr (khr) 419	(190) 380		(172) 315 (143)	

h. Dynamometer Test. With the engine connected to the dynamometer and test cell in accordance with step a, above, conduct a dynamometer test as follows:

(1) Prime the lubrication system if necessary, start the engine, and run at phase 1, Table 12-1, until both the oil and coolant temperatures reach at least 160'F (71 °C).

(2) Gradually increase the speed to 1800 rpm, and the horsepower to 1200 (895 KW) and maintain these settings for 5 minutes.

(3) During the test, continually monitor all instruments, and record all data on the test log. All test data shall be in accordance with Table 12-2.

(4) At the end of the test, return the engine to idle speed and no load for at least 5 minutes before shut-down.

(5) Top-up the crankcase with lubricating oil, total the amount of oil used during the run, and calculate the oil consumption by dividing the quantity of oil used by the elapsed time of the run in hours. In general, the oil consumption should not exceed 0.66 quarts (0.62 L) per hour. During run-in, however, oil consumption in excess of this amount is acceptable provided the crankcase pressure does not exceed 18 inches (457 mm) H20 at the end of the run.

(6) Remove the engine from the dynamometer and test cell, and install it in the generator set in accordance with Chapter 2.

SECTION III. INSPECTION

12-4. GENERAL Athorough 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.

12-5. HOUSING AND FRAME INSPECTION .

a. Check that the tie down points and lifting attachments are all in good condition.
b. Check that the drain holes are open to prevent moisture accumulation.
c. Ensure that all exposed parts are properly treated to resist corrosion.
d. Open and dose the panel doors, engine area doors, and generator area doors and actuate all shutter assemblies to ensure proper installation and freedom of motion.
e. Inspect all movable door gasketing to ensure that it is weatherproof.
f. Check that all caps and covers are equipped with chains or ties to prevent loss.
g. Check all conduits for security.
h. Check that sound attenuation panels are in good condition.

12-6. ENGINE INSPECTION.

a. Check the mounting bolts of all components and accessories to ensure that they are firmly secured.
b. Check all designation and data plates for legibility.
c. Ensure that fuel and oil lines are protected from vibration damage.

12-7. GENERATOR INSPECTION.

a. Ensure that the generator leads are properly identified and protected from vibration damage.
b. Ensure that all inspection openings are protected by screening or protective plates.
c. Check that the engine generator attaching capscrews are firmly secured.
See Table 1-1 for proper torque values.

12-8. ELECTRICAL ACCESSORIES INSPECTION.

a. Check all cable and harness assemblies for secure fastening and protection against chafing and vibration.
b. Ensure that all cable and harness connectors are firmly secured in their proper place.
c. Check Annunciator Alarm System.

(1) Press the ANNUNCIATOR TEST pushbutton Si5 located below the annunciator panel. The alarm shall sound, and all annunciator lamps shall light. Releasing the test button shall silence the alarm, and turn off the lamps.
(2) If the alarm fails to sound, or all lamps do not light, repair the system in accordance with Chapter 10.

SECTION IV. OPERATIONAL TEST

12-9. 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 2400/4160 volt connections, unless otherwise specified.

b. Unless otherwise specified, all test instrumentation will be certified accurate and maintained in accordance with MIL-STD-705. Figure 12-3 shows the test instrumentation hookup to be used for individual instruments.

c. Temperatures will be measured by thermocouples and properly calibrated meters. Barometric pressures will be measured by a mercurial barometer corrected for temperature, vapor pressure, and altitude. Aneroid barometers shall not be used.

d. Generator set operation shall be in accordance with the Operator and Organizational Maintenance Manual.

e. All test results shall be logged on the appropriate form as required.

CAUTION

Before performing any of the operating tests listed In Figure 12-3, ensure that the generator set Is serviced with the correct fuel, oil, and coolant as listed on the data plate.

f. Perfom the operating tests as indicated in Table 12-3.

12-10. MALFUNCTION INDICATOR AND INSTRUMENTS.

a. The malfunction indicator system is electrically isolated 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 11, 12,13,14,15,16, 17, 19, 20, and of Table 12-3.

b. In the event that one of the indicator circuits does not work, verify that the lamp is functional by operating the ANNUNCIATOR TEST push-button S15 located on the generator panel (see paragraph 12-8, step c).

c. During the full load stabilization periods of the following test procedures, record the readings of both the test meters, and the generator set Meters for the highest and lowest readings obtained. At the conclusion of the test, calculate the accuracy of the generator set instruments using the following formula:

$$\text{ACCURACY} = \frac{\text{SET METER} \qquad \text{TEST METER} \times 100}{\text{SET METER FULL SCALE VALUE}}$$

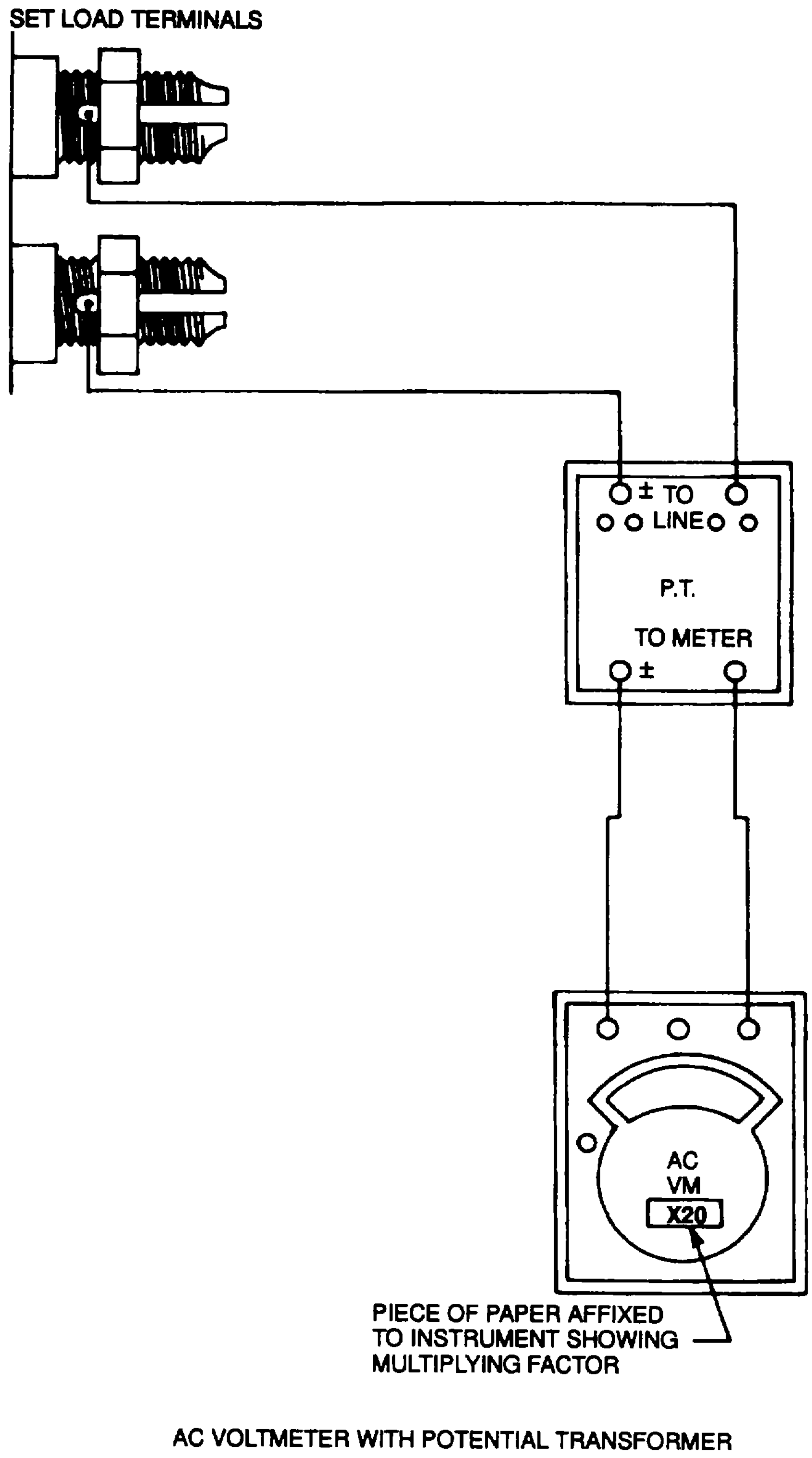
The above procedure shall be repeated for measurements on the remote control module.

Table 12-3. Operational Tests

TEST	PARA	MILSTD705 METHOD	TEST STANDARDS
10. Malfunction Indicator (Annunciation)	12-10		Refer to paragraph 2-10
11. Instruments	12-10		Ammeter-1.5% plus transducer, plus CT. Voltmeter-1.5% plus transformer KWMeter-1.5% plus transformer plus CT., plus potential transformer Frequency Meter 1.5% P.F. Meter 1.5% plus transducer, plus potential transformer KVAR Meter 1.5% plus C.T and potential transformer Regulator Range 60 Hz 3750 to 4575 V line to line; 50 Hz 3420 to 4180 V line to line
12. Oil pressure shutdown switch OP1/OP2	12-11	515.1a	Warning: 37 to 41 psi (255 to 283 kPa) Trip: 28 to 32 psi (193 to 221 kPa)
13. Coolant temperature switch WT2	12-12	515.2a	Warning: 206 to 210°F (97 to 99°C) Trip: 215 to 219°F (102to104°C)
14. Coolant level switch S13IS14	12-13	--	Warning: 5.2 to 5.5 inches (132 to 140mm) Trip: 7.0 to 7.3 inches (178 to 185 mm) Coolant level measured from top of filler neck
15. Low fuel level switch FL3	12-14	155.5	Refer to paragraph 1214.
16. Speed Switch SS1/SS2/SS3	12-15	505.2a	2070 to 2250 rpm
17. Circuit interrupter (short circuit)	12-16	512.1 c	Trip: instantaneous at (short circuit) currents in excess of 300 amps
18. Circuit interrupter	12-17	512.2	Trip: 15 to 25 seconds (overload current) at 130% overload
19. Circuit interrupter to	12-18	512.3c	Trip: overvoltage, 2 to 4 (overvoltage and (overvoltage and second at 234 244 undervoltage) undervoltage) V; undervoltage, 2.5 to 5 second at 161 to 171 V
20. Reverse power protective device	12-19	--	Refer to paragraph 1219
21. Phase sequence (rotation)	12-20	507.1c	L_1, L_2, and L_3
22. Phase balance (voltage) maximum	12-21	508.1c	1% of rated line to neutral voltage,
23. Regulator range	12-22	511.1c	60 Hz: 3750 to 4575 V 50 Hz: 3420 to 4180 V

Table 12-3. Operational Tests (Continued)

TEST	PARA	MILSTD705 METHOD	TEST STANDARDS
24. Frequency and voltage regulation, stability, and transient response	12-23	608.1a	Refer to paragraph 1223 Frequency Regulation: 0.25% Stability: 0.5% Transient: overshoot: 4.0% undershoot: 4.0% Recovery Time: 4 seconds Voltage Regulation: 2.0% Stability: 1.0%
25. Frequency adjustment range and under frequency trip	12-24	511.2b	No load rated load 60 Hz: 57.5 to 62.5 Hz, but not above 65 Hz 50 Hz: 47.5 to 52.5 Hz, but not below 45 Hz Under ferquency trip: 50 Hz: 45.5 to 47.5 Hz 60 Hz: 55.5 to 57.5 Hz
26. Parallel operation (real power)	12-25	--	Refer to paragraph 1225
27. Parallel operation (reactive power)	12-26	--	Refer to paragraph 1226
28. Maximum power	12-27	640.4	A minimum of 110% of rated load for 5 minutes
29. Rated loads at various altitudes	12-27	640.4	60 Hz 750 kW at 1500 ft (457 m) 600 kW at 5000 ft (1524 m) 563 kW at 8000 ft (2438 m) 50 Hz 625 kW at 1500 ft (457 m) 500 kW at 5000 ft (1524 m) 460 kW at 8000 ft (2438 m)
30. Start and stop	12-28	503.1b	Start: 5 minutes maximum Stop: 30 seconds maximum



AC VOLTMETER WITH POTENTIAL TRANSFORMER

Figure 12-3. Meter Hookup (Sheet 1 of 7)

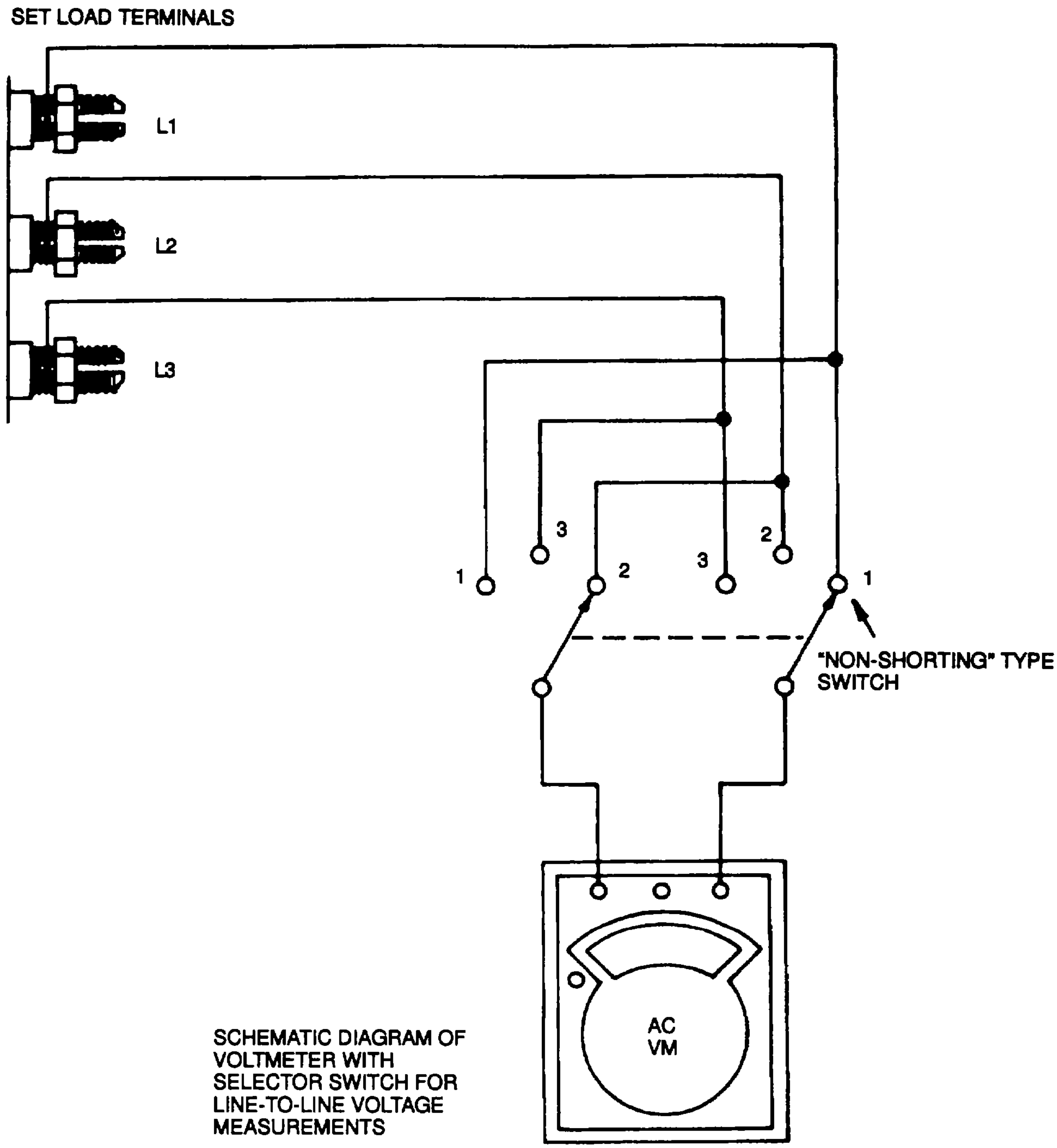


Figure 12-3. Meter Hookup (Sheet 2 of 7)

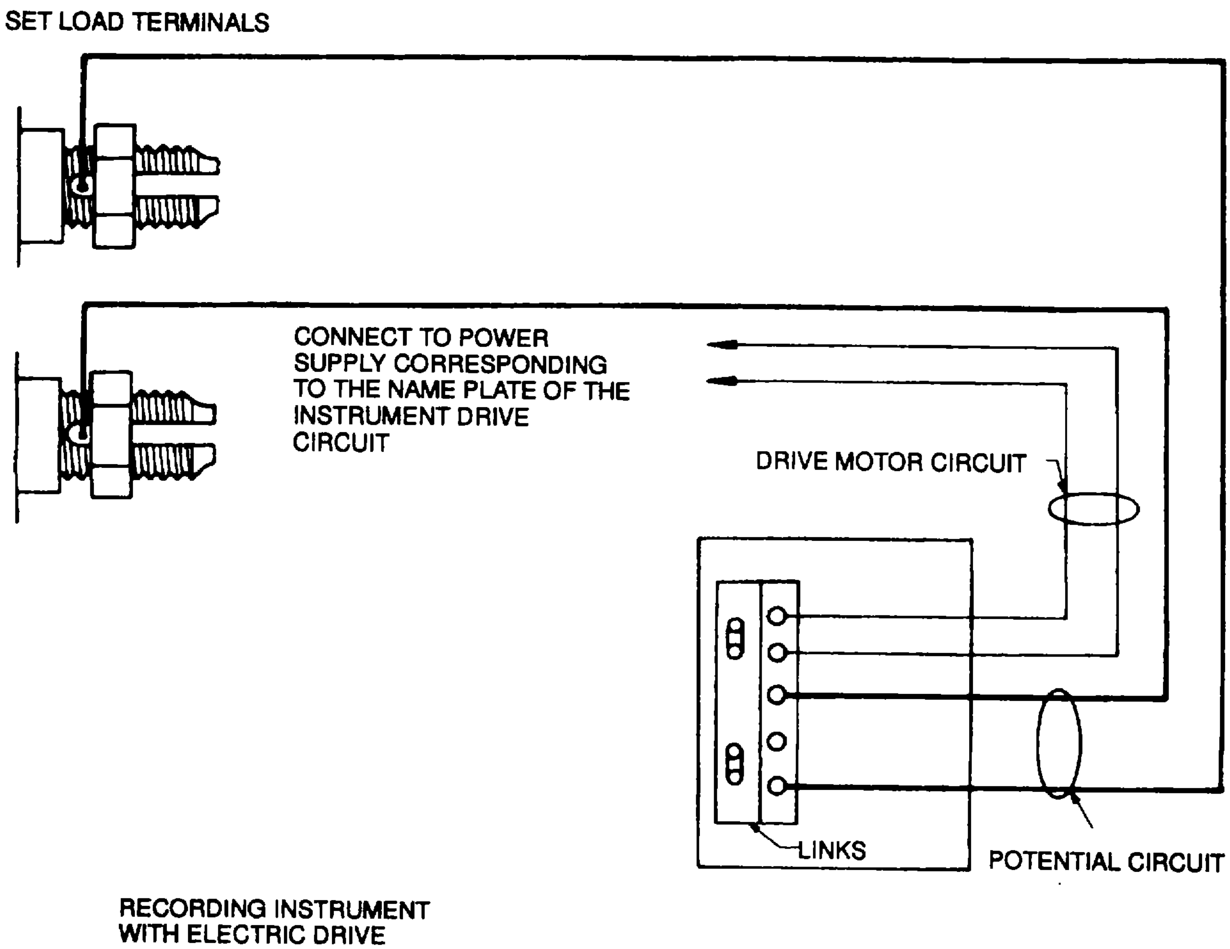


Figure 12-3. Meter Hookup (Sheet 3 of 7)

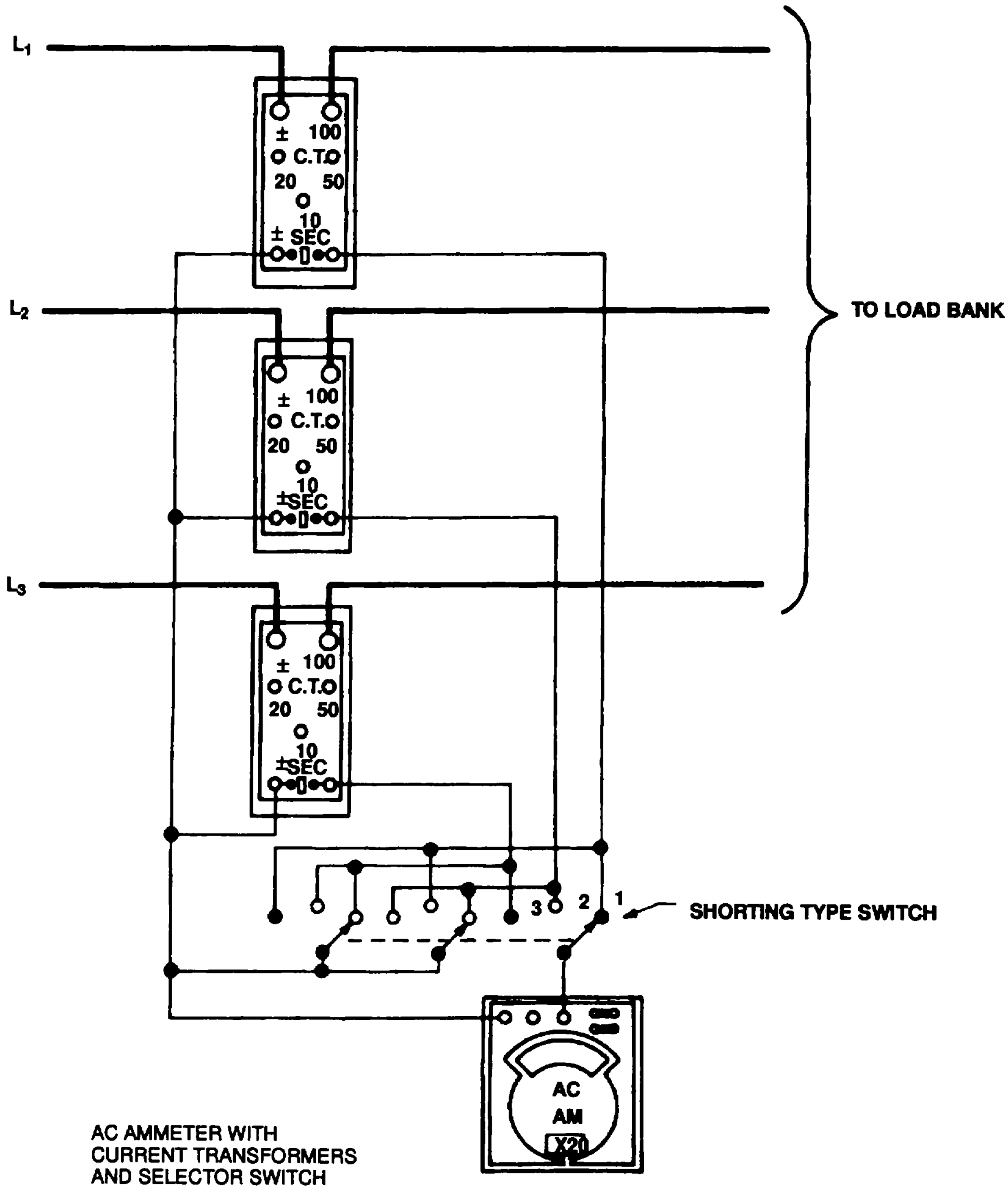
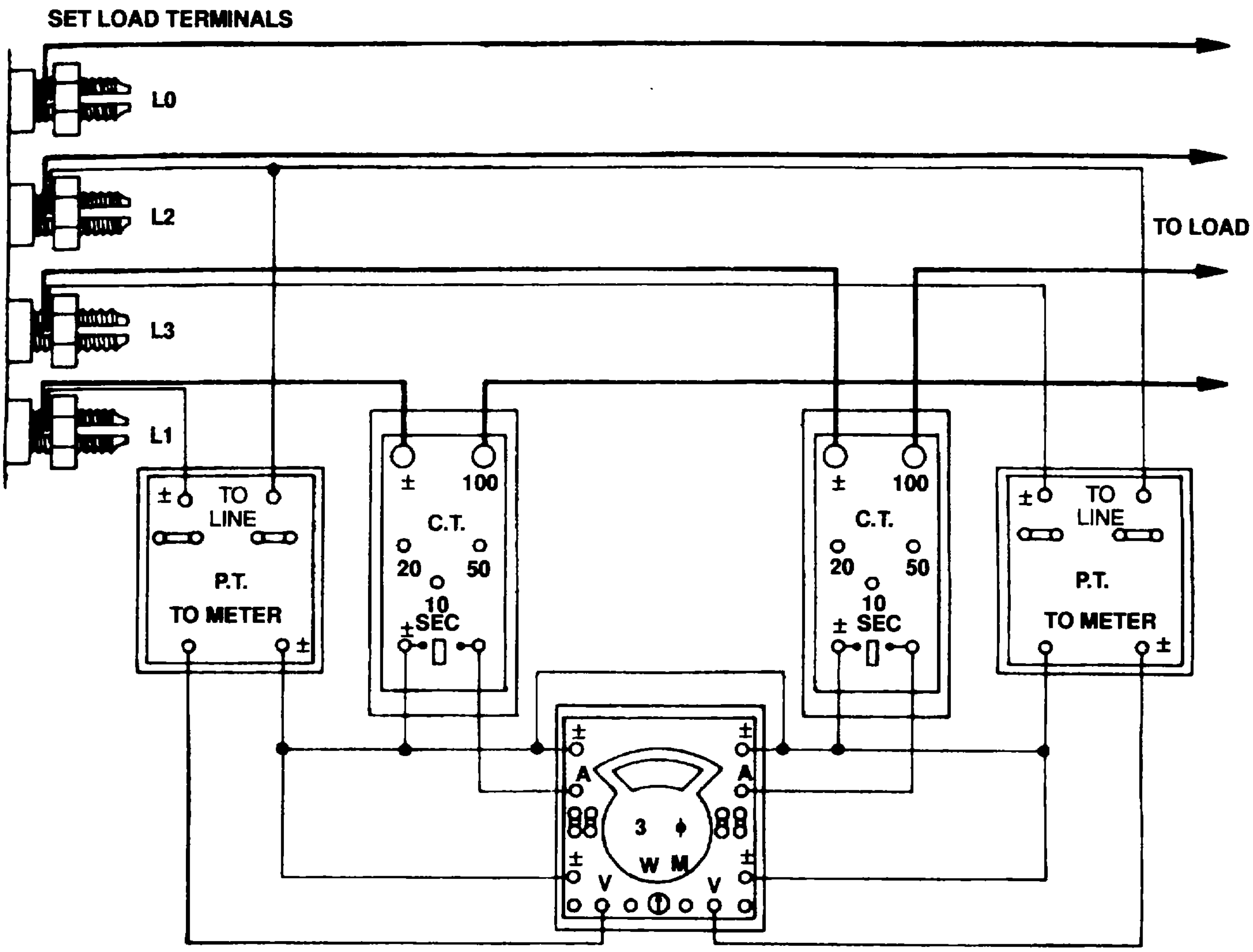


Figure 12-3. Meter Hookup (Sheet 4 of 7)



TWO-ELEMENT, POLYBASE WATTMETER WITH BOTH CURRENT AND POTENTIAL TRANSFORMERS ON BALANCED FOUR-WIRE THREE-PHASE SYSTEM

Figure 12-3. Meter Hookup (Sheet 5 of 7)

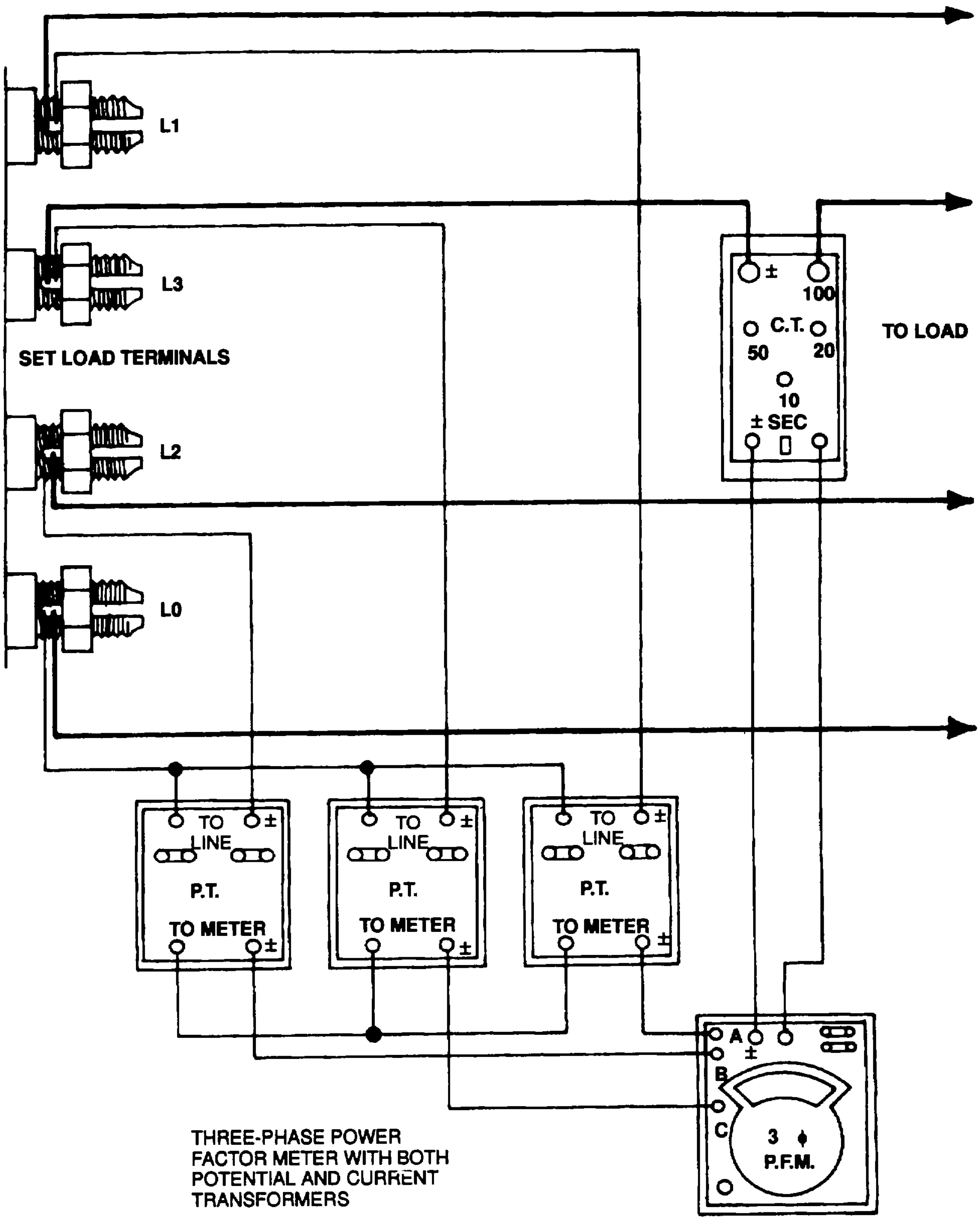


Figure 12-3. Meter Hookup (Sheet 6 of 7)

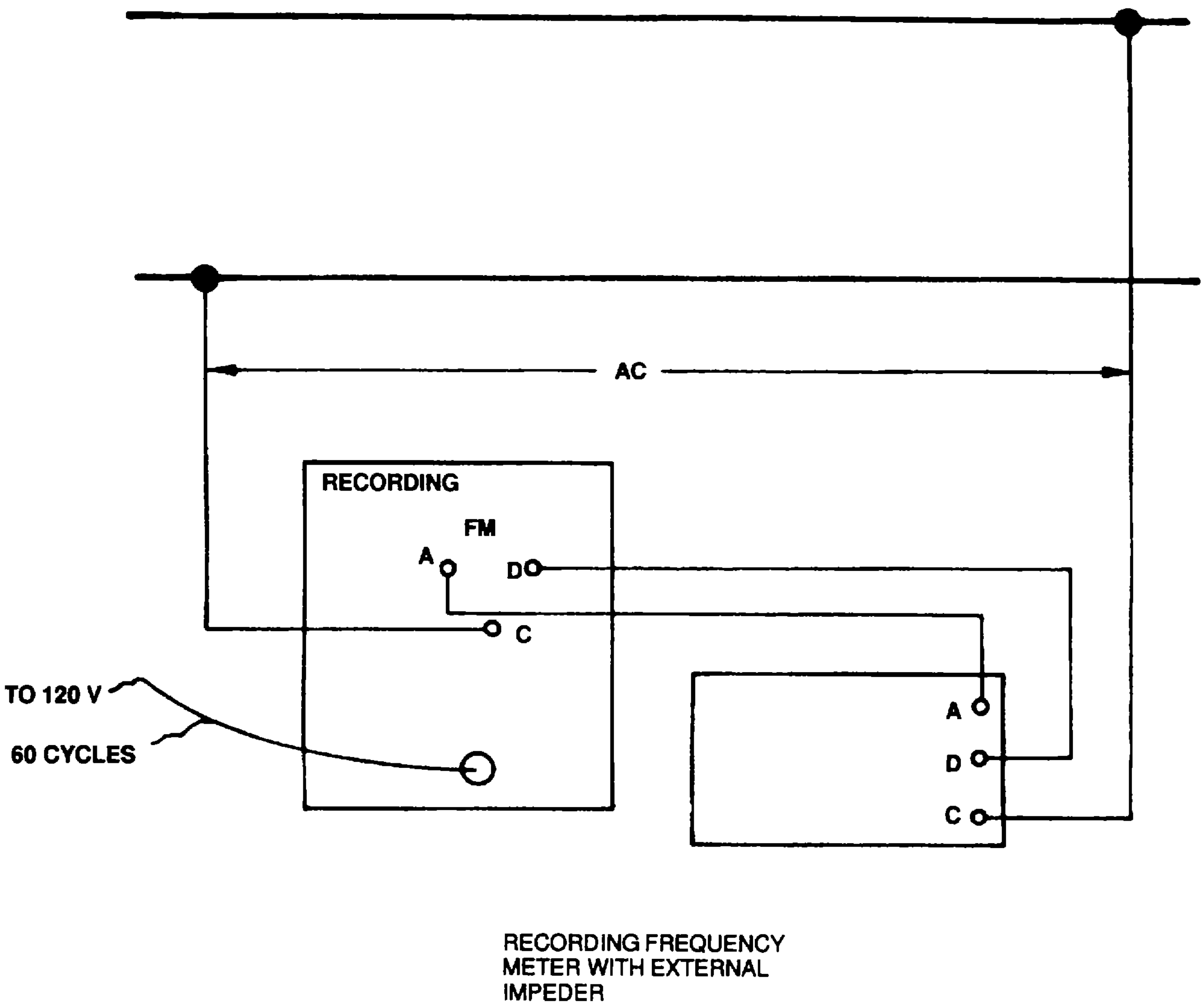


Figure 12-3. Meter Hookup (Sheet 7 of 7)

12-11. OIL PRESSURE ALARM AND SHUTDOWN SWITCH OP1/OP2.

a. General. The oil pressure alarm and shutdown switch OP1 /OP2 shuts down the engine when the oil pressure drops below the safe limit.

b. Apparatus. The following equipment is required to perform this test:

(1) Oil pressure gage accurate to ± percent.
(2) Flexible oil line.
(3) Regulating valves.
(4) Brass fittings.

c. Procedure.

(1) Preparation for test. With set not operating remove OP1/OP2 from the engine block and reconnect as shown in Figure 12-4, with OP1/OP2 and oil pressure gage in approximately the same horizontal plane as OP1/OP2 tap located on the engine (Figure 12-1). Remove the oil filler cap, and insert the open end of the flexible oil line in the filler tube.

(2) Test.

(a) With the bleeder valve dosed and the shut-off valve in the oil pressure line open, start and operate the set at rated speed and 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 test gage.
(d) Almost completely dose the shut-off valve.
(e) Slowly open the bleeder valve until OP1/OP2 actuates the warning light and shuts down the engine. Record the oil pressure when the warning light is actuated, and at the point of set shutdown.

d. Results. Compare the value of the warning and shutdown pressure with the requirement of Table 12-3.

12-12. COOLANT TEMPERATURE SWITCH WT2.

a. General. The coolant temperature switch WT2 must be capable of protecting the engine in the set against overheating for any reason.

b. Apparatus. Instrumentation for measuring engine temperatures and ambient temperatures shall be in accordance with paragraph 12-3.

c. Procedure.

(1) Preparation for test.

(a) Connect the load instrumentation in accordance with 12-5.
(b) Install the thermocouple and gage to measure the same temperature detected by WT2 (Figure 12-1).

(2) Test.

(a) Start and operate the generator set at rated voltage, rated frequency (speed), and rated load.
(b) Close the radiator louvers.

CAUTION

If the engine falls to shut down when the temperature exceeds the maximum trip value specified in Figure 12-3 the test shall be Immediately discontinued.

(c) Continuously monitor the temperature on the thermocouple installed gage. Record the temperature at which the coolant temperature indicator illuminates. Record the temperature at which WT2 actuates.

d. Results. The warning and trip points shall be in accordance with Table 12-3.

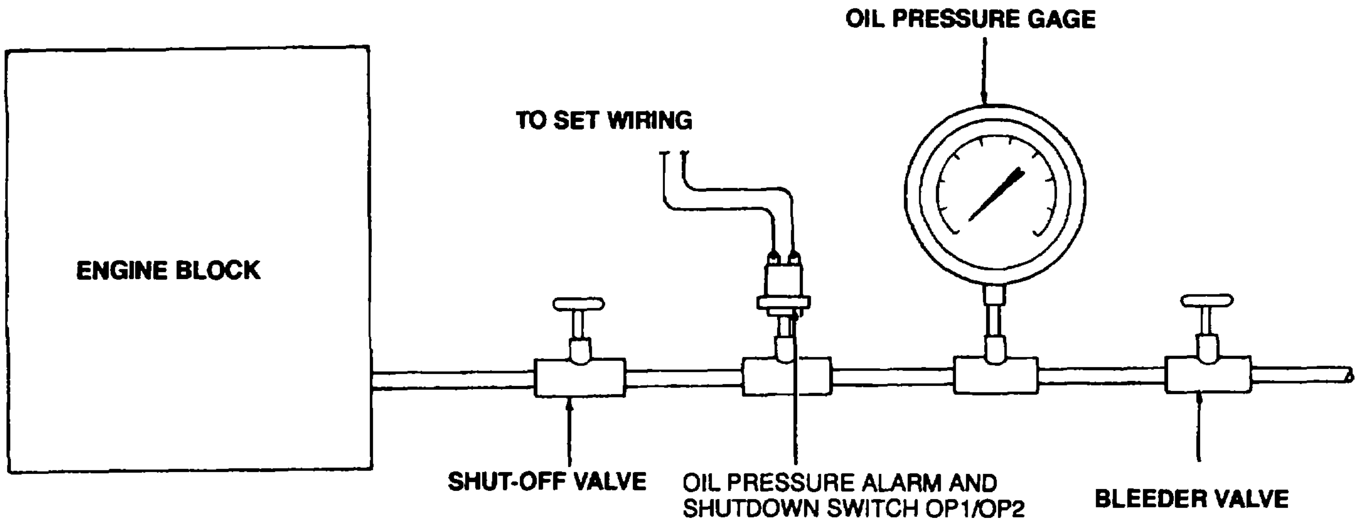


Figure 12-4. Oil Pressure Alarm and Shutdown Switch OP1/OP2 Test Setup

12-13. COOLANT LEVEL SWITCH S13/S14.

a. General. Two identical sensors, located at different levels in the radiator top tank are used to detect coolant loss. The upper sensor activates the annunciator system, and the lower sensor trips the engine shutdown system.

b. Apparatus. A clean, 20 gallon (76 L) container to catch the drained coolant.

c. Procedure.

(1) Preparation.

(a) Check that the coolant is at the proper level in the radiator. If necessary, add coolant to bring the level to approximately 2.5 inches (63.5 mm) from the top of the filler neck

(b) Operate the set at rated speed and no load until normal operating temperature is reached.

(2) Test.

CAUTION

To avoid overheating the engine during the following tests, do not drain more than 20 gallons (76 L) of coolant from the radiator. If the coolant level protection system falls to activate at this point, discontinue the test and repair the system as necessary.

(a) Open the coolant drain valve until the annunciator system activates, and dose the drain valve.

(b) Measure and record the distance from the top of the filler neck to the coolant level in the tank

(c) Reopen the drain valve until the engine shuts down, and dose the valve.

(d) Measure and record the distance from the top of the filler neck to the coolant level in the tank

(e) Return the drained coolant to the radiator.

(3) Results.

(a) The annunciator system shall activate at a coolant level of 5.2 to 5.5 inches (132 to 140 mm) measured from the top of the filler neck

(b) Engine shutdown shall occur at a coolant level of 7.0 to 7.3 inches (178 to 185 mm) measured from the top of the filler neck

(c) If either system failed to activate, or activated at the wrong coolant level, troubleshoot the system in accordance with Chapter 2.

12-14. LOW FUEL LEVEL SWITCH FL3.

a. To conduct the low fuel level switch FL3 test, the load instrumentation and a stopwatch are required.

b. Test FL3 as follows:

(1) Connect the load instrumentation in accordance with Figure 12-5.

(2) Level the generator set.

(3) Fill the generator set fuel tank using the fuel transfer pump.

(4) Disconnect the auxiliary fuel lines from the external fuel tank

(5) Start and operate the generator set at rated load, voltage, and frequency. Simultaneously start the stopwatch.

(6) Note the exact time the LOW FUEL ENG FAULT indicator lights up. This should indicate that there is enough fuel in the fuel tank to operate the set at rated load and frequency for 35 minutes.

(7) Continue operating the set for approximately 35 minutes until the low fuel level switch FL3 shuts down the generator set. Record the time when FL3 actuates and shuts down the set.

(8) If FL3 does not actuate within 35 minutes after the LOW FUEL ENGINE fault indicator lights up, FL3 is faulty or the timer on time delay (low fuel level shutdown) relay K23 is set too high. Shut down the generator set immediately and reset the timer, or replace FL3.

12-15. SPEED SWITCH SS1/SS2/SS3.

a. Apparatus. Digital tachometer 3375631.

b. Procedure.

(1) Remove left hand fan shroud associated with the radiator in accordance with the Operator and Organizational Maintenance Manual.

(2) Install digital tachometer 3375631 on accessory drive pulley (9, Figure 9-59).

(3) In order to provide for manual speed control of the engine, perform the following:

(a) Remove the two electrical wires from the fuel pump actuator (4, Figure 6-5).

(b) Remove the rivets (42, Figure 6-11) and remove the throttle shaft cover (43).

NOTE

Do not change the setting of the adjusting screw (55) located toward the front of the fuel pump housing (66).

(c) Loosen the hexagonal nut (54) and back out the adjusting screw (55) located toward the rear of the fuel pump housing (66).

(d) Lightly damp a pair of locking pliers on the splined end of the throttle shaft (45) to be used as a lever.

NOTE

The throttle shaft (45, Figure 6-11) located in the fuel pump housing (66) turns counter-clockwise to open.

(e) Engine speed may now be controlled manually by rotation of the throttle shaft (45).

(f) After completion of testing, remove the locking pliers installed in step (d), above. Turn in the adjusting screw (55) located toward the rear of the fuel pump housing (66) until the control end (51) is locked between the adjusting screws. Tighten the hexagonal nut (54) and Install the throttle shaft cover (43) using rivets (42).

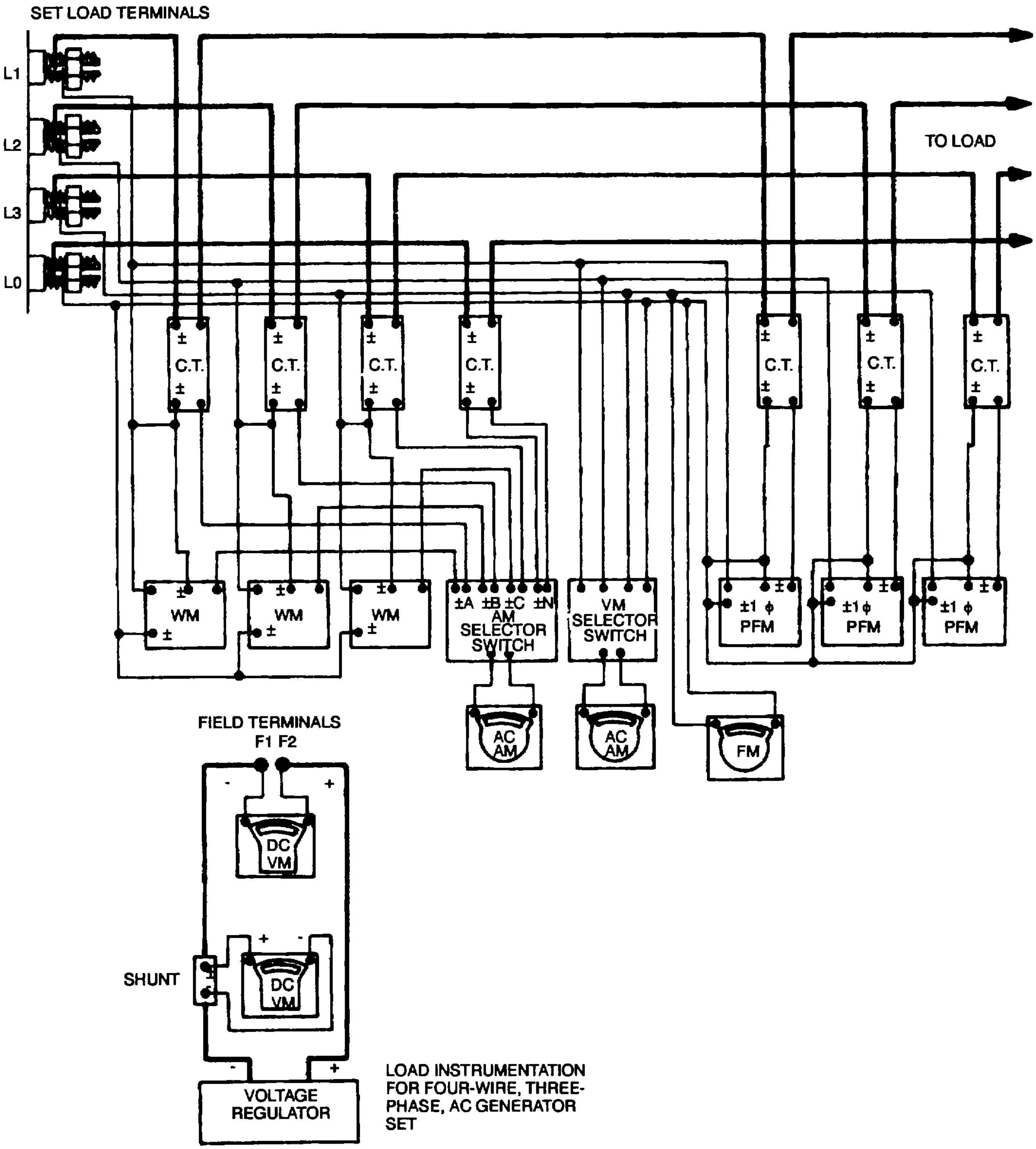


Figure 125. Load Instrumentation (Sheet 1 of 2)

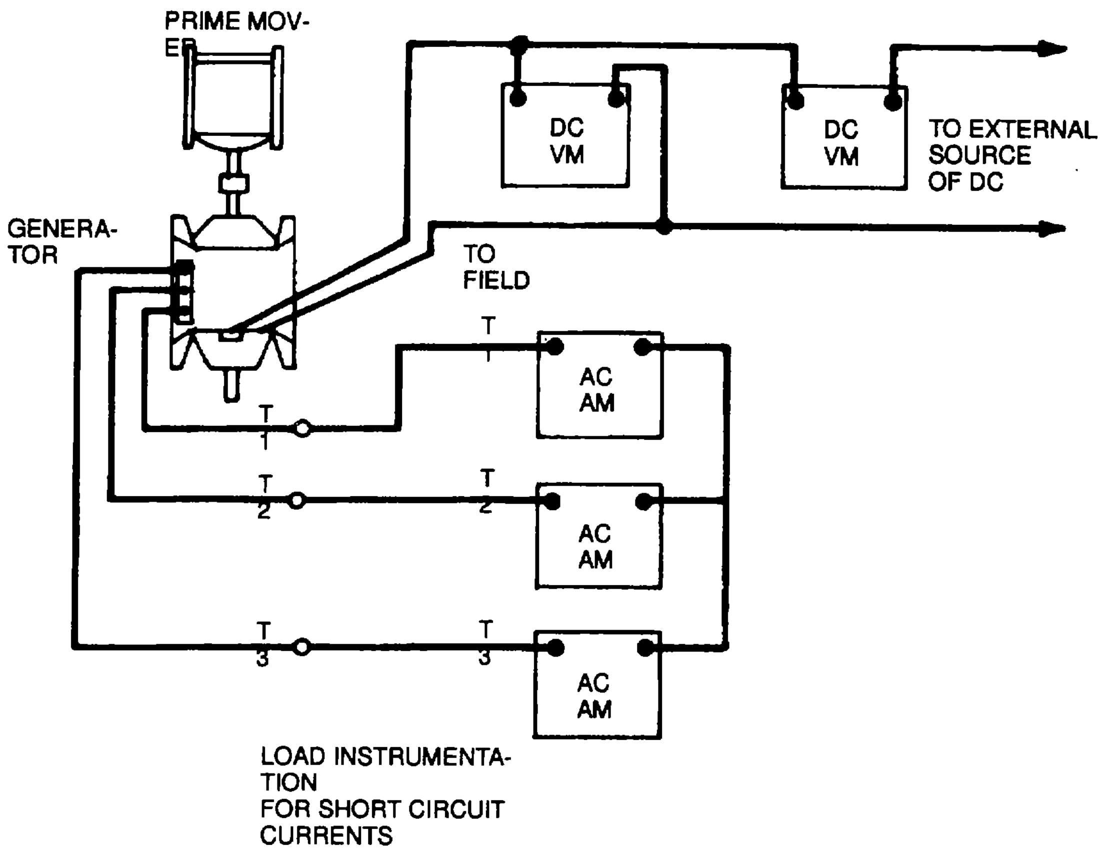


Figure 12-5. Load Instrumentation (Sheet 2 of 2)

NOTE
Two persons may be required to perform the following procedure.

(4) Start the generator set and operate it at 60 Hz, rated voltage, and no load.

WARNING
Exercise caution when working In the vicinity of rotating engine components.
Failure to exercise caution during the following procedure may result In Injury to personnel.

CAUTION
To avoid damage to the generator set do not exceed an engine speed of 2300 rpm.

(5) Using digital tachometer 3375631 to check engine rpm, gradually increase the engine speed by rotating the throttle shaft (45) counterclockwise until the overspeed device actuates. Record the rpm at the shut down point.

(6) Test the reset circuit by attempting to start the generator set without pressing the reset button. If the set does not start, press the reset button, and manually reset both air box solenoids.

(7) Repeat steps (4) through (6), above, two more times.

c. Results

(1) The overspeed protective device shall shut down the generator set each time an engine speed of 2070 to 2250 rpm is obtained, and the generator set shall not restart until the reset button is pressed, and both air boxes reset.

(2) If the generator set does not shut down at the prescribed rpm, or can be started after a shut down without pressing the reset button, troubleshoot the overspeed protection circuit in accordance with Chapter 2.

12-16. CIRCUIT INTERRUPTER (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 illustrated in Figure 12-5. In addition, a noninductive shunt, a short-circuiting switch, a galvanometer matching network an oscillograph, and galvanometers having a flat frequency response (flat within plus or minus 5 percent) from DC to 3,000 Hz will be required.

c. Procedure.

(1) Preparation for Test.

(a) Connect the load and instrumentation in accordance with Figure 12-5 and Figure 12-6, for one voltage and frequency.

(b) Connect the shunt, galvanometer matching network, oscillograph, and short-circuiting switch across the load terminals of the phase being tested.

(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 second or use a 60 Hz timing trace. Set the chart speed so 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 (13 mm).

(c) Before dosing the short-circuiting switch, record a portion of the steady-state load for calibration. With the same load conditions record all instrument readings.

CAUTION

If the circuit Interrupter fails to operate within the specified time, open the short circuit switch to prevent damage. Note the failure to operate on the data sheet.

(d) With the oscillograph still recording the steady-state current, dose the short-circuiting switch.

(e) The generator set contains an overload malfunction indicator; check and record its indication.

(f) Restart the generator set, and test the time delay by momentarily dosing and opening the short circuit switch. When performing this test, the short circuit switch shall not be dosed longer than 9 seconds.

(g) Repeat steps (a) through (e), above, for each possible short circuit (L_1-L_0, L_2-L_3, L_1-L_2-, L_3, etc.)

(h) Repeat steps (a) through (g), above, for all voltage connections.

d. Results.

(1) From the oscillograms taken in step (2)(d), above, determine the time between the indicated closure of the short-circuiting switch and the opening of the circuit interrupter. See Figure 12-7.

(2) Calculate the short-circuit current using the peak-to-peak amplitudes of the current trace and the steady-state ammeter reading prior to application of the short circuit.

(3) Use the oscillograms taken in step (e), above, and determine if the circuit interrupter actuated upon application of the momentary short circuit.

(4) Tabulate the above results for each line connection, and compare the results with the requirements in Table 12-3.

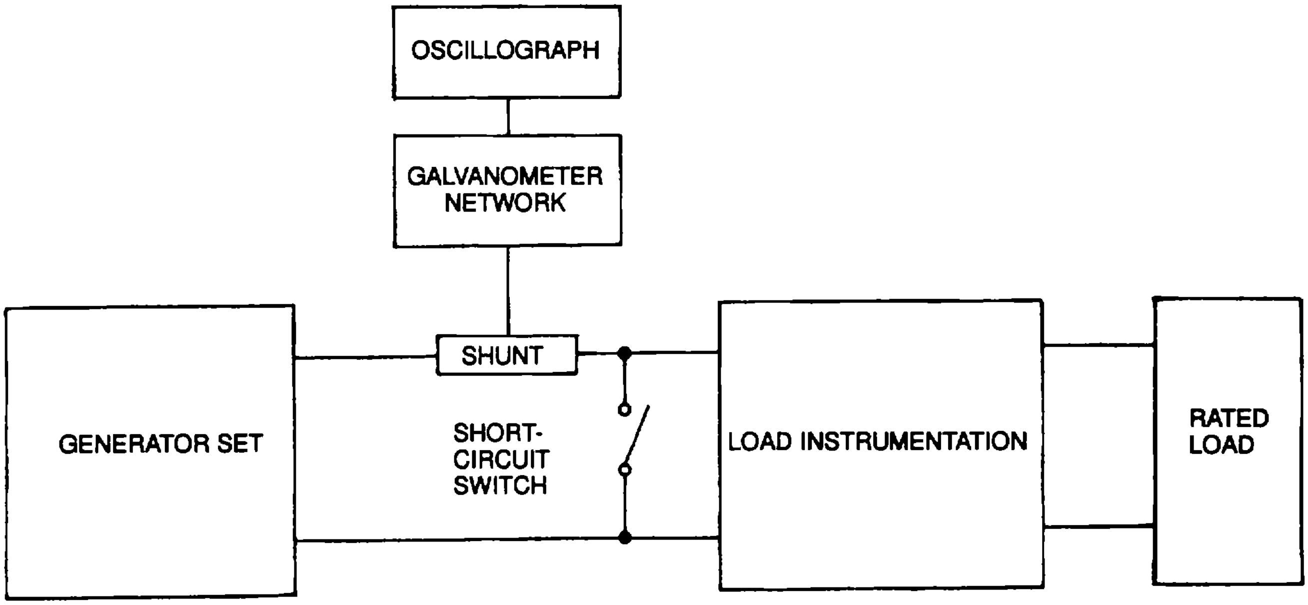


Figure 12-6. Apparatus Connection for Circuit Breaker (Short Circuit) Test

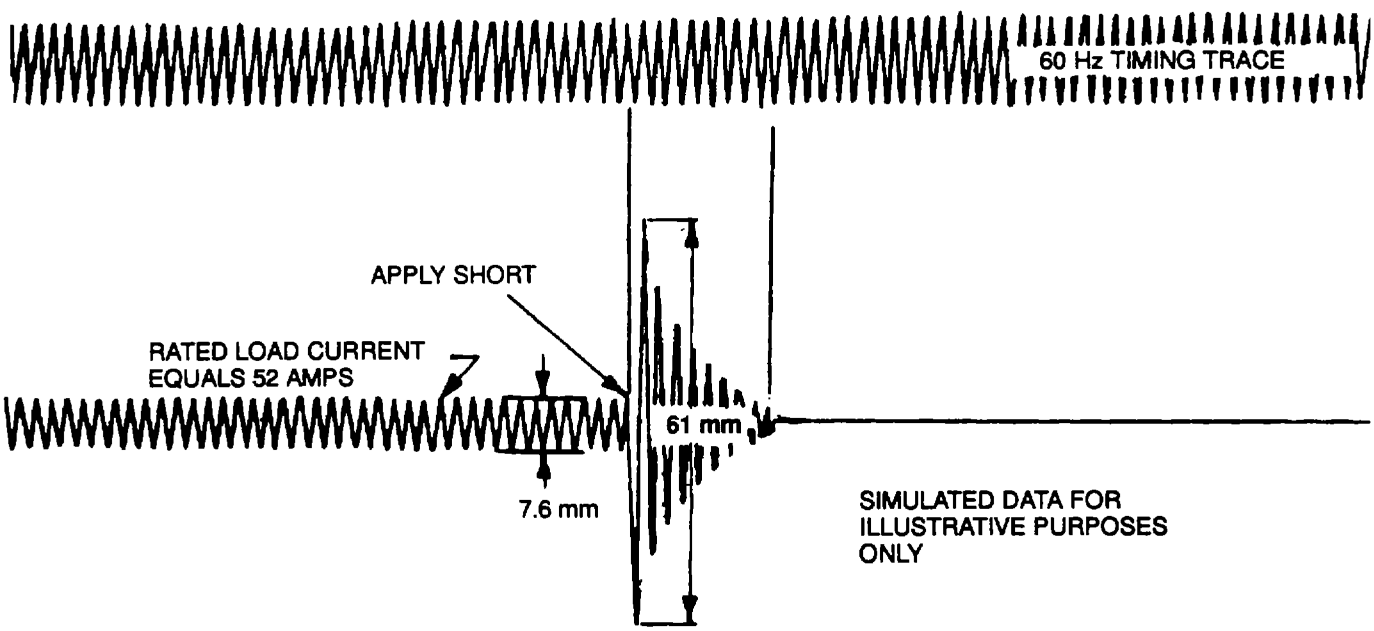


Figure 12-7. Portion of an Oscillogram Showing Circuit Interrupter Operation and Calculations

12-17. CIRCUIT INTERRUPTER (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 illustrated in Figure 12-5. In addition, a stopwatch or an oscillograph with galvanometer matching network and a noninductive shunt, and galvanometers having a flat frequency respond (within plus or minus 5 percent) from DC to 3,000 Hz are required.

c. Procedure.

(1) Preparation for test. Connect the load and field instrumentation in accordance with Figure 12-3 and Figure 12-5, for one voltage and frequency.

CAUTION

If the circuit Interrupter falls to operate within the time specified in Table 12-3 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 the rated load at the 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 12-3 (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, and the load current shall be kept constant and balanced equally among the phases.

(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), above, except that the load current is increased to the overload current value in phase A only. Phases B and C remain at the rated load current value.

(h) Repeat step (g), above, 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), above, 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 times required for the interrupter to operate, the indication of the malfunction indicator, the overload conditions and the stabilization data. Compare this data with the requirements of Table 12-3.

12-18. CIRCUIT INTERRUPTER (OVER-VOLTAGE AND UNDERVOLTAGE).

a. General. To protect the load from generator malfunction (for example, over voltage or under voltage) 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 over voltage or an under voltage condition occurs.

b. Apparatus. Instrumentation for measuring voltage shall be as described and illustrated in Figure 12-8.

c. Procedure I (Overvoltage).

(1) Preparation for bench test.

(a) Locate and disconnect the input circuit to the input terminals of the overvoltage protective sensing circuit, and connect the apparatus in accordance with Figure 12-8.

(b) Select curve "A" on both the undervoltage and overvoltage relays.

(2) Test.

(a) Close S1 (A, Figure 12-8), and start, operate the set at rated frequency and no load, and adjust R1 for 2400/4160 V.

(b) Set the oscillograph chart speed such that the individual waveform peaks are dearly visible. Set the timing lines to a minimum of 0.01 second per line or use a 60 Hz time trace. Adjust the trace peak-to-peak amplitude to a minimum of 1 inch (25.4 mm).

(c) Read and record both voltmeter readings.

(d) With the oscillograph recording and the circuit breaker closed, adjust R1 (A) until the circuit breaker trips on overvoltage.

(e) The generator set contains an overvoltage malfunction indicator. Check and record its indication.

(f) Record whether or not the set shuts down.

(g) Open S1, and readjust R1 for 2400/4160 V. The voltage difference between S1 open and S1 dosed is the difference between rated voltage and overvoltage.

(h) Repeat steps (b) through (g), above, two additional times.

d. Procedure II (Undervoltage). Prepare for the test in accordance with step c, above.

(1) Close S1 (A, Figure 12-8), and start and operate the set at rated frequency and no load, and adjust R1 for 2400/4160 V.

(2) Set the oscillograph chart speed such that the individual waveform peaks are dearly visible. Set the timing lines to a minimum of 0.01 second per line or use a 60 Hz timing trace. With S1 open, adjust the trace peak-to-peak amplitude to a minimum of 1 inch (25.4 mm).

(3) With the set operating and the circuit breaker and S1 open, read and record both voltmeter readings.

(4) Close S1 and circuit breaker.

(5) With the oscillograph recording, open S1, and adjust R1 until the circuit breaker trips on undervoltage.

(6) Check and record the indication of the undervoltage malfunction indicator.

(7) The voltage difference between S1 open and S1 closed is the difference between the rated voltage and undervoltage.

(8) Repeat steps (2) through (7), above, two additional times.

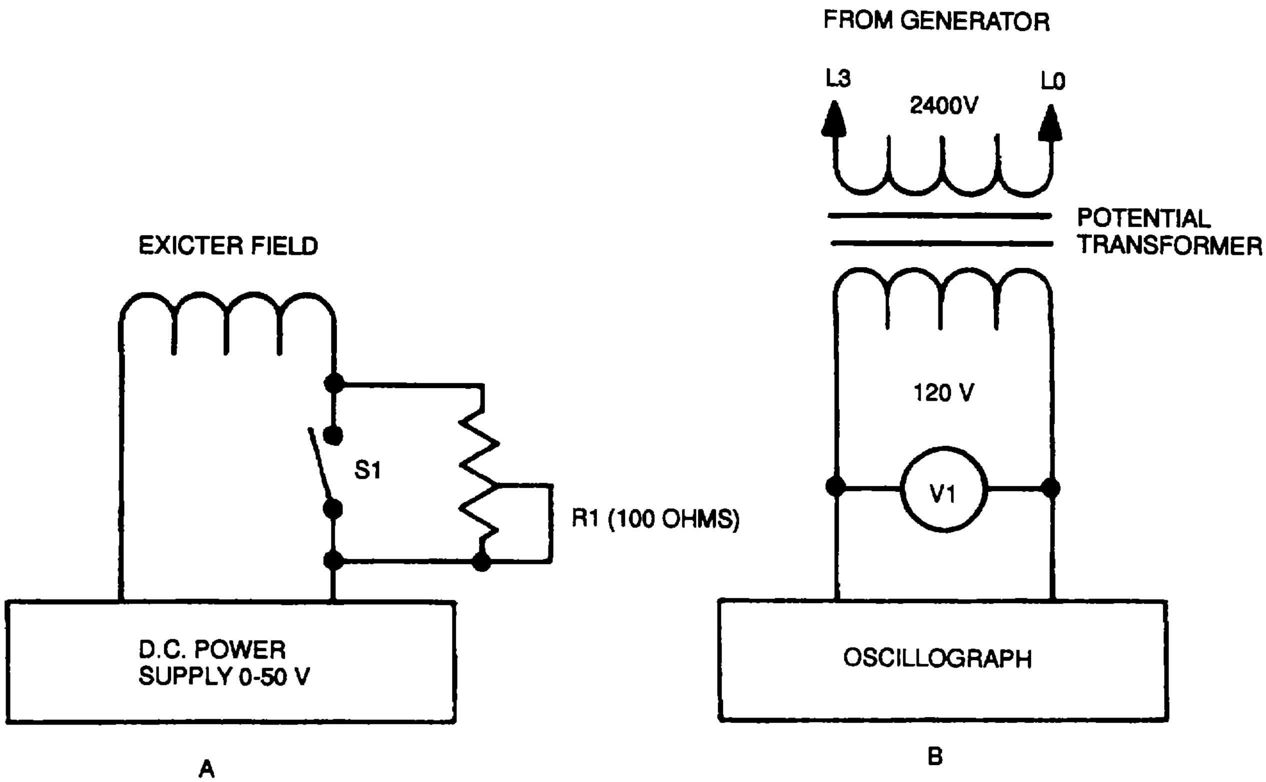


Figure 12-8. Voltage Divider Transformer Network

e. Results.

(1) From the oscillograrns made in step c, above, 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 step d, above, 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 12-3.

12-19. REVERSE POWER PROTECTIVE DEVICE.

a. Reverse the wires on K109 terminals 5 and 6.
b. Start the generator set and apply a 20 ±3 percent load.
c. The reverse power relay should activate and open the load connector.
d. Return the wires on K109 terminals 5 and 6 to their original location.

12-20. PHASE SEQUENCE (ROTATION).

a. General. Unless the phase sequence (rotation) of the load terminals of a three-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, or a three-phase motor whose direction of operation in relation to phase sequence is known.

c. Procedure.

WARNING

To avoid injury to personnel, no electrical component shall be worked on while energized. When It Is necessary to work In the vicinity of energized equipment, all safety precautions shall be followed, such as use of rubber blankets for Insulation, use of rubber gloves, and use of Insulating tools and equipment. All Insulating tools such as rubber gloves and blankets shall be tested regularly. Disconnect all power before servicing. Residual voltage Is present at the generator leads even with the regulator turned off . Residual voltages can reach several hundred volts on this generator. Proper Insulation and Isolation of metering equipment shall be observed when testing the generator.

(1) Connect the generator set load terminal to the phase sequence test apparatus for one of the three-phase voltage connections. Recheck the connections to ensure the L1, L2, and L3 of the generator set are connected to L1, L2, and L3 of the test apparatus.

(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 the direction of rotation if a three-phase motor is used. Record the results.

(4) Phase sequence can also be checked by placing the PHASE SEQUENCE switch, located on the generator panel, to the GEN position. The 1-2-3 lamp should illuminate.

(5) Place the AC PWR CKT BKR, located on the generator panel, to the dose position and the PHASE SEQUENCE switch to the BUS position. The 1-2-3 lamp should illuminate.

d. Results. The phase sequence (rotation) as indicated by the test shall be checked against the wiring diagram for L1, L2, and L3.

12-21. PHASE BALANCE (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 damaged or improperly repaired.
b. Apparatus. Arms indicating ac voltmeter, having an accuracy of ±0.1 percent of the reading is required.
c. Test.

WARNING

To avoid Injury to personnel, no electrical component shall be worked on while energized. When It Is necessary to work In the vicinity of energized equipment, all safety precautions shall be followed, such as use of rubber blankets for insulation, use of rubber gloves, and use of Insulating tools and equipment All Insulating tools such as rubber gloves and blankets shall be tested regularly. Disconnect all power before servicing. Residual voltage Is present at the generator leads even with the regulator turned off. Residual voltages can reach several hundred volts on this generator. Proper Insulation and Isolation of metering equipment shall be observed when testing the generator.

(1) Connect the generator set for one of the operating voltages and frequencies.

(2) Connect the voltmeter to read the ac output.

NOTE

The same voltmeter shall be used to measure all ac output voltages.

(3) Start and operate the generator set at no load.

(4) Adjust a regulated phase voltage (line-to-neutral) to rated voltage.

(5) Read and record the generator frequency, and all line to neutral voltages.

(6) Compute the voltage unbalance (VU) for each voltage and frequency test using the following formula:

$$VU\ (L\text{-}N) = \frac{V\ MAX - V\ MIN}{V\ RATED} \times 100$$

d. Results. The maximum voltage unbalance in the three line-to-neutral voltages shall not exceed 1 percent of the rated line to neutral voltage.

12-22. REGULATOR RANGE

a. General. The voltage adjust device, associated with the voltage regulator provided with the generator set, must have an 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 must also be capable of providing an operating voltage other than rated voltage for special types of equipment, and to compensate for external line drop.

b. Apparatus. Instrumentation or measuring load conditions, ambient temperature, and the generator field (or exciter field) voltage and current shall be as illustrated in Figure 12-5.

c. Procedure.

(1) Preparation for test.

(a) Connect the load and field instrumentation in accordance with Figure 12-5, for one voltage and frequency.

(2) Test

(a) Start and operate the generator set. Allow the set to stabilize at rated load, rated voltage, and rated frequency (60 Hz). During this period record all instrument readings, including thermal instrumentation, at minimum A 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. When utilizing the 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 the 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 of 4575 V, line-to-line.

(g) Record all instrument readings.

CAUTION

At voltages above rated values, the generator will be supplying less than rated current; at voltages below rated values, the generator will be supplying greater than rated current. To avoid damage to Instrumentatlon and load banks do not by-pass the voltage and current protection devices.

(h) Apply the rated load.

(i) Record all Instrument readings (after transients have subsided).

(j) Remove the load and adjust the voltage to the maximum attainable 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 the rated load.

(m) Record all instrument readings (after transients have subsided).

(n) Adjust the voltage to the minimum specified value of 3750 V, line-to-line at the rated load.

(o) Record all instrument readings (after transients have subsided).

(p) Remove the load.

(q) Record all instrument readings (after transients have subsided).

(r) Adjust the voltage to the minimum attainable just prior to activation of the undervoltage protection device.

(s) Record all instrument readings (after transients have subsided).

d. Sample Calculations. Regulation (droop) is defined for the purpose of this method as the no-load value (NLV), minus the rated load value (RLV), divided by the rated load value expressed in percent regulation:

$$\% \text{ Regulation} = \frac{\text{NLV-RLV}}{\text{RLV}} \quad \text{X } 100$$

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, 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). The regulation as calculated in step d, above, shall not exceed 2 percent, and the range shall be in accordance with Table 12-3.

12-23. FREQUENCY AND VOLTAGE REGULATION, STABILITY, AND TRANSIENT RESPONSE (SHORT TERM).

a. General. The frequency regulation (droop), or voltage regulation of a generator set is the maximum difference between the no load value and the value at any load up to and including the rated load. The frequency difference is expressed as a percentage of the rated frequency of the generator set. The voltage regulation is expressed as the rms value of the voltage. Stability describes the tendency of the frequency or voltage to remain at a constant value. Generally, the instantaneous value 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 or voltage is observed. Another term, bandwidth, describes the limits of these variations. Bandwidth is expressed as a percentage of the rated frequency or voltage of the generator set. Transient response describes the reaction of the frequency and voltage to a sudden change in some condition, such as the load change on a generator set. This response consists of the amount of surge 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 or voltage 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 or voltage of the generator set. The recovery time is expressed in seconds.

b. Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as illustrated in Figure 12-5. In addition, recording meter(s) for recording voltage and frequency shall be required.

c. Procedure.

WARNING

To avoid Injury to personnel, no electrical component shall be worked on while energized. When Is necessary to work In the vicinity of energized equipment, all safety precautions shall be followed, such as use of rubber blankets for Insulation, use of rubber gloves, and use of Insulating tools and equipment. All Insulating tools such as rubber gloves and blankets shall be tested regularly. Disconnect all power before servicing. Residual voltage Is present at the generator leads even with the regulator turned off. Residual voltages can reach several hundred volts on this generator. Proper Insulation and Isolation of metering equipment shall be observed when testing the generator.

(1) Preparation for test.

(a) Connect the load and field instrumentation in accordance with Figure 12-5, 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 chart speed(s) to a minimum of 6 inches (152.4 mm) per hour. The following items shall be recorded on both the data sheets and recording chart(s): 1 The date a The serial number(s) of the recording meter(s) a Generator set identification 4 The recording chart speed(s) 5 The data reading number.

(c) Place all instrumentation referred to in step b, above, in operation.

(2) Test

(a) Start and operate the generator set and allow the set to stabilize at rated bad, rated voltage, and rated frequency. During this period, operate the recording meter(s) at a chart speed of not less than 6 inches (152.4 mm) 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 the rated load at the 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 set 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 to the bad, voltage, or frequency has been made.

(b) After stabilization has occurred, drop the bad to no bad, and reapply the rated load in 50 percent load increments three times 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 step d(7), below. If any adjustments are necessary, step (a), above, must be repeated. Reapply the rated load.

(c) The recording meter chart speed(s) shall be 12 inches (305 mm) per minute throughout the remainder of this test. a each of the following load conditions, operate the set for a minimum of 40 seconds. During each load condition read and record all instrument readings except thermal 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	½ rated load
3	No load
4	½ rated load
5	No load
6	½ rated load
7	No load
8	½ rated load
9	¼ rated load
10	3/4 rated load
11	1/4 rated load
12	3/4 rated load
13	1/4 rated load
14	3/4 rated load
15	1/4 rated load
16	3/4 rated load
17	1/2 rated load
18	4/4 rated load
19	1/2 rated load
20	4/4 rated load
21	1/2 rated load
22	4/4 rated load
23	1/2 rated load
24	4/4 rated load

(d) Repeat steps (a) through (c), above, for 50 Hz operation.

d. Results.

(1) Prepare a chart for each load change giving the momentary overshoot or undershoot, and the recovery time. For each constant load, give the maximum voltage variation.

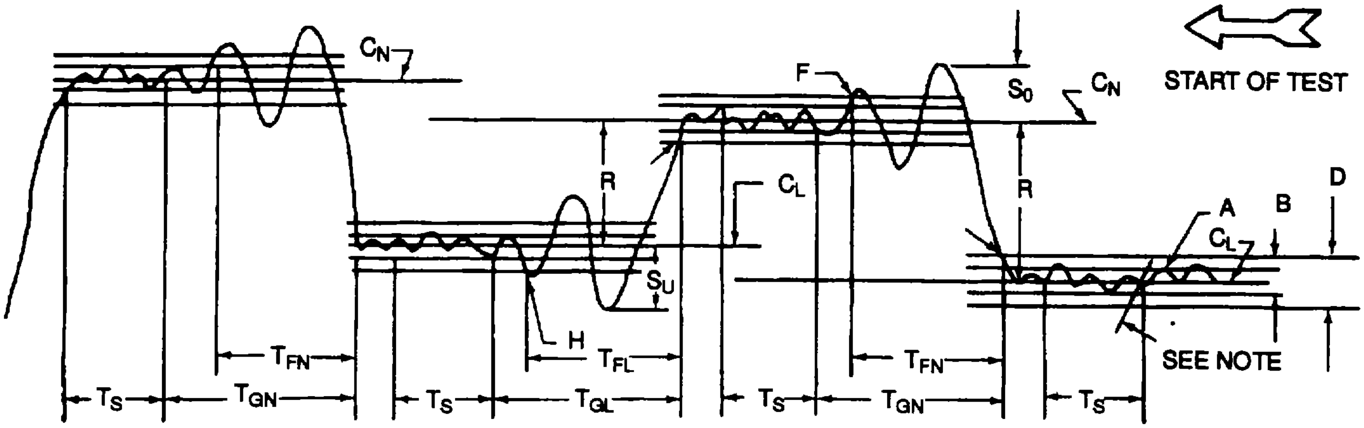
(2) Referring to Figure 12-9, begin by determining the observed (B), and steady-state (D) voltage bandwidths.

(a) Numerically mark the stabilizations occurring after each load change, starting with the stabilization obtained before the first load change.

(b) Determine the observed voltage band with (B) by marking the maximum trace excursion and minimum trace excursion in the stabilized portion. Draw two lines parallel to the axis of the 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 step b, above.

(d) Using the rated voltage of the generator, and the given requirements of Table 12-3, calculate the steady-state 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.



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 OF 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 LOA D 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 DATE.
T_{FN}	OBSERVED RECOVERY TIME, LOAD TO NO LOAD.
T_G	MAXIMUM ALLOWABLE RECOVERY TIME.
T_GL	MAXIMUM ALLOWABLE RECOVERY TIME, NO LOAD TO NO LOAD.
T_{GN}	MAXIMUM ALLOWABLE RECOVERY TIME, LOAD TO NO LOAD.
T_s	PRESCRIBED SHORT-TERM SAMPLE TIME FOR DETERMINING STABILITY.

Figure 12-9. Overshoot and Undershoot Chart Recording

(3) The maximum voltage variation to constant load is determined as follows:

(a) One-half the observed voltage bandwidth (B) is the plus or minus value of the voltage deviation at constant load.

(b) Divide each of the values obtained in step (a), above, by the rated voltage of the generator, and multiply by 100 to convert to percentage.

(4) Determine the maximum overshoot and undershoot at each load step, express as a percentage of its rated voltage, as follows:

(a) From the meter recording charts, determine the maximum amount that the voltage trace goes beyond the line (C, Figure 12-9) of the observed voltage band following the load change.

(b) Divide the result obtained in step (a), above, by the rated voltage (as given on the generator nameplate), then multiply by 100 to convert to percentage.

NOTE

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) Determine the time required to restore stable voltage conditions after each load change (recovery time) as follows:

(a) The prescribed steady-state voltage bandwidth, extended to the point at which the voltage trace leaves the prescribed steady-state 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 is the voltage recovery time, in seconds.

(6) Determine the voltage regulation for all load changes (for example, rated load to no ad, 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), above).

NOTE

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 in step (a), above, to a percentage of rated voltage by dividing them by the rated voltage, and multiplying by 100. This is the voltage regulation expressed in percent.

(c) Repeat step d(1), above, substituting frequency for voltage.

(7) The results of the data tabulated above, shall agree with the following requirements:

(a) Frequency regulation. The frequency regulation for zero droop shall not exceed one-fourth of 1 percent of the rated frequency for each load change up to, and including, rated load.

(b) Frequency stability. At each constant load, frequency shall be held within a bandwidth equal to 0.5 percent of the rated frequency. Hunting shall not be permitted within the 0.5 percent band.

(c) Frequency transient response. Overshoot and undershoot shall not exceed 4 percent of the rated frequency, and the circuit breaker shall not trip when the load is suddenly decreased from rated load to no load in one step.

(d) Voltage regulation. Voltage regulation shall not exceed 2 percent of the rated voltage.

(e) Voltage stability. The voltage shall remain within a bandwidth equal to 1 percent of the rated voltage at every constant load.

(f) Voltage transient response.

1 The instantaneous ms voltage shall not drop to less than 80 percent of the rated voltage, and shall reach stable condition within 3 seconds with sudden changes from no load to half load, and half load to full load. Overshoot or undershoot of the final voltage shall not exceed the initial voltage transient in amplitude.

2 The instantaneous rms voltage shall not rise to more than 130 percent of the rated voltage, and shall reach stable conditions within 3 seconds with sudden changes from half load to no load. Overshoot or undershoot of the final voltage shall not exceed the initial voltage transient in amplitude.

3 When a balanced three-phase 0.4 pf, or less, lagging static load with an impedance of 0.5 per unit is applied to the output terminals of the set. Operating at no load, rated voltage, and rated frequency, the instantaneous ms voltage shall not drop to less than 60 percent of the rated voltage.

12-24. FREQUENCY ADJUSTMIENT RANGE AND UNDERFREQUENCY TRIP.

a. General. The frequency of the generator set must be adjustable to provide rated frequency at various load conditions, 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 illustrated in Figure 12-3 and Figure 12-5.

c. Procedure

(1) Preparation for test. Connect the load and field instrumentation in accordance with Figure 12-3 and Figure 12-5.

(2) Test.

(a) Start and operate the generator set and allow it 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 the rated load at the rated voltage and frequency. Adjustments to the voltage and frequency, however, shall be limited to those available to the operator: specifically, adjustments to the voltage and frequency adjust devices. Adjustments to 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 conditions 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 subsequency instrument readings.

(d) Adjust the generator set frequency for the specified minimum frequency (57.5 at 60 Hz, 47.5 at50 Hz) 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 acutates, read and record all instrument readings just prior to the point of actuation, and note on the data sheet that the protection device actuated.

(g) Adjust the generator set frequency for the minimum attainable frequency. Read and record all instrument readings, and trip point.

(h) Repeat steps c(1) and (2), for each frequency.

d. Results. The data sheet shall show the maximum and minimum frequencies attained at rated load, the maximum and minimum frequencies attained at no load, and actuation of the protection devices. Compare these results with the requirements of Table 12-3.

12-25. PARALLEL OPERATION (REAL POWER).

a. For 0% Droop Sets.

(1) Place the ISOCHRONOUS/FREQUENCY DROOP switch in the ISOCHRONOUS position.

(2) With the rated (750 kW, 0.8 pF lagging) load on the generator set, measure the dc voltage across pins A and B of one of the paralleling receptacles. Adjust the GAIN potentiometer, located on load sharing panel A101, until 5 V dc is indicated. Ensure that pin A is positive. For decrease in load, voltage will decrease proportionately.

b. For 3% Droop Sets.

(1) Place ISOCHRONOUS/FREQUENCY DROOP switch, located on control panel B, in the DROOP position.

(2) Adjust the DROOP potentiometer, located on load sharing panel A101, for 3 percent frequency droop between no load and rated load.

12-26. PARALLEL OPERATION (REACTIVE POWER).

a. Remove the shorting plug.
b. With the rated load (750 kW. 0.8 pF lagging) on the generator set, and the PARALLEL switch, located on the generator control panel, in the PARALLEL position, adjust the voltage ADJ rheostat R105, located in cabinet A, until 7.2 V ac is indicated across pins A and B of one of the paralleling receptacles. For a decrease in load, the voltage will decrease proportionately.
c. Install the shorting plug.
d. With a 750 kW, 0.8 power factor lagging load applied, the voltage change from no load should be approximately 3 percent. Adjust R105 accordingly.

12-27. MAXIMUM POWER TEST.

a. General. The maximum power of a generator set is a function of the ambient condition (temperature and altitude) and the mechanical condition of the engine at any particular time. See Table 12-3 for test parameters for various altitudes.
b. Apparatus. Instrumentation for measuring load conditions, pressures, and temperatures shall be as illustrated in Figure 12-3 and Figure 12-5.
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 Figure 12-3 and Figure 12-5 for one voltage and frequency.
(b) Install appropriate thermocouples to measure the following temperatures:
1 Lubricating oil sump.
2 Engine intake air (located at the inlet of the intake manifold).
(c) Obtain and record the barometric water vapor pressures (see MIL-HDBK-705, Method 220.2).
(d) Connect the set to a source of fuel containing number 2 diesel fuel VV-F-800.

(2) Test.

(a) Start and operate the generator set in droop mode and allow it to stabilize at rated load, rated voltage, and rated frequency (speed). During this period, readings of all engine control panel instruments and 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; but adjustments to the voltage and frequency shall be limited to the operator voltage and frequency adjust devices. No other adjustments to the voltage and frequency control systems should be made. Adjustments to the load, voltage, or frequency control systems shall be recorded on the data sheet. Stabilization will be considered to have occurred when three consecutive readings of the lubricating oil temperature have remained constant at the rated load. Minor variations in temperature are permissible provided that a continued increase or decrease does not take place.

(b) Perform this test using a resistive load only. Remove the reactive portion of the load after stabilization.

(c) Load the set to the maximum attainable load, and adjust the frequency to the rated value. Maintain the load for 5 minutes.

(d) Record all instrument readings.

(e) Allow the set to cool at rated load for 10 minutes.

d. Results. Compare the maximum power value obtained to the values and conditions listed in Table 12-3.

12-28. START AND STOP TEST.

a. General. The generator set must start and stop without erratic operation when following the operating instructions on the set. The start and stop test may be run concurrently with any of the above tests that meet the requirements of step c, below.

b. Apparatus. A stopwatch is required.

c. Procedure. The following steps shall be repeated three times:

(1) Using the watch and the operating instructions on the set, record the time required to start the set and bring it to rated speed.

(2) With the circuit breaker closed, operate the set at rated voltage, rated frequency, and no load for 5 minutes.

(3) Using the stopwatch and the operating instructions on the set, record the time required to stop the set.

d. Results.

(1) The set shall come up to rated speed in 5 minutes.

(2) The set shall stop without prolonged run-on in a maximum of 30 start and seconds.

APPENDIX A

REFERENCES

A-1 Fire Protection.	
TB 5-4200-200-10	Hand Portable Fire Extinguishers Approved by Army Users.
A-2 Lubrication Order.	
LO 9-6115-604-12	Generator Set, Diesel Engine Driven Air Transportable Skid Mtd., 750 kW, 3 Phase, 4 Wire, 2400/4160 and 2200/3800 Volts
A-3 Painting.	
TM 43-0139	Painting Instructions for Army Material.
A-4 Radio Suppression.	
MIL-STD-461	Radio Interference Suppression.
TM 11-483	Radio Interference Suppression.
A-5 Maintenance.	
MIL-HDBK-705	Generator Sets, Electrical, Measurement and Instrumentation Methods.
MIL-STD-705	Generator Sets, Engine Driven Methods of Test and Instructions Reviewer: AS AT GS MC Ml TE.
TB 750-651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems.
DA Pam 738-750	The Army Maintenance Management System.(TAMMS)
TM 9-6115-604-12 NAVFAC P-8-633-12	Operator and Organizational Maintenance Manual.
TM 9-6115-604-34 NAVFAC P-8-633-34	Direct Support, General Support and Depot Level Maintenance Manual.
TM 9-6115-604-24P NAVFAC P-8-633-24P	Unit, Direct and General Support and Depot Maintenance Repair Parts and Special Tools List.
A-6 Shipment and Storage.	
TB 740-97-2	Preservation of USAMECOM Mechanical Equipment for Shipment and Storage.
TM 740-90-1	Administrative Storage of Equipment.
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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LETTER DESIGNATIONS

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A9	ANNUNCIATOR PANEL	SEE BELOW	
A9DS1-6	OVERSPEED FAULT LIGHT	6-B6	80-7863
A9DS2-5	LOW LUBE OIL PRESS FAULT LIGHT	6-B6	80-7863
A9DS3-1	HIGH COOLANT TEMP FAULT LIGHT	6-C6	80-7863
A9DS4-4	HIGH LUBE OIL TEMP FAULT LIGHT	6-C6	80-7863
A9DS5-7	LOW FUEL LEVEL FAULT LIGHT	6-C7	80-7863
A9DS6-8	HIGH FUEL LEVEL FAULT LIGHT	6-C8	80-7863
A9DS7-9	OVERVOLTAGE FAULT LIGHT	5-B3	80-7863
A9DS8-12	UNDERVOLTAGE FAULT LIGHT	6-C4	80-7863
A9DS9-10	OVERCURRENT FAULT LIGHT	5-B4	80-7863
A9DS10-11	REVERSE POWER FAULT LIGHT	5-B5	80-7863
A9DS11-13	GROUND FAULT LIGHT	5-B5	80-7863
A9DS12-2	SPARE FAULT LIGHT	5-B6	80-7863
A9DS13-3	EXCESSIVE CRANKING FAULT LIGHT	5-B6	80-7863
A9DS14-15	UNDERFREQUENCY FAULT LIGHT	6-C5	80-7863
A9DS15-14	LOW COOLANT LEVEL FAULT LIGHT	5-B7	80-7863
A9DS16-18	SPARE FAULT LIGHT	5-B8	80-7863
A9DS17-17	SPARE FAULT LIGHT	5-C3	80-7863
A9DS18-16	SPARE FAULT LIGHT	5-C4	80-7863
A9-C	COMM	5-B3	80-7863
A9-C	COMM	5-C4	80-7863
A10	ANNUNCIATOR RELAY PANEL	SEE BELOW	
A10D1-A10D4	BLOCKING DIODE	6-B6	80-7862
A10D5-A10D8	BLOCKING DIODE	6-C6	80-7862
A10D9-A10D11	BLOCKING DIODE	6-C7	80-7862
A10D12	BLOCKING DIODE	6-C8	80-7862
A10D13-A10D14	BLOCKING DIODE	5-B3	80-7862
A10D15-A10D16	BLOCKING DIODE	6-C4	80-7862
A10D17-A10D18	BLOCKING DIODE	5-B4	80-7862
A10K1-2&7 COIL	OVERSPEED ALARM RELAY	6-A5	80-7862
A10K1-4&6	OVERSPEED ALARM RELAY	6-B5	80-7862
A10K2-2&7 COIL	OIL PRESSURE ALARM RELAY	6-A6	80-7862
A10K2-4&6	OIL PRESSURE ALARM RELAY	6-B6	80-7862
A10K2-3&5	OIL PRESSURE ALARM RELAY	6-D5	80-7862
A10K3-2&7 COIL	COOLANT TEMP ALARM RELAY	6-C5	80-7862
A10K3-4&6	COOLANT TEMP ALARM RELAY	6-D5	80-7862
A10K3-3&5	COOLANT TEMP ALARM RELAY	6-D5	80-7862
A10K4-2&7 COIL	OIL TEMP ALARM RELAY	6-C6	30-7362
A10K4-4&6	OIL TEMP ALARM RELAY	6-D6	80-7862
A10K5-2&7 COIL	LOW FUEL ALARM RELAY	6-C7	80-7862
A10K5-3&5	LOW FUEL ALARM RELAY	4-B3	80-7862
A10K5-4&6	LOW FUEL ALARM RELAY	6-D7	80-7862
A10K6-2&7 COIL	HIGH FUEL LEVEL ALARM RELAY	6-C7	80-7862
A10K6-3&5	HIGH FUEL LEVEL ALARM RELAY	4-B4	80-7862
A10K6-4&6	HIGH FUEL LEVEL ALARM RELAY	6-D7	80-7862
A10K7-2&7	OVERVOLTAGE FAULT-ALARM RELAY	5-A3	80-7862
A10K7-3&5	OVERVOLTAGE FAULT-ALARM RELAY	4-B5	80-7862
A10K7-4&6	OVERVOLTAGE FAULT-ALARM RELAY	5-B3	80-7862
A10K8-2&7 COIL	UNDER VOLTAGE FAULT-ALARM RELAY	6-C3	80-7362
A10K8-3&5	UNDERVOLTAGE FAULT-ALARM RELAY	3-D5	80-7862
A10K8-4&6	UNDERVOLTAGE FAULT-ALARM RELAY	6-D4	80-7862
A10K9-2&7 COIL	OVERCURRENT ALARM RELAY	5-A4	80-7362
A10K9-4&6	OVERCURRENT ALARM RELAY	5-B4	80-7862
A10TB1-1	TERMINAL BLOCK	5-C3	80-7862
A10TB1-1	TERMINAL BLOCK	6-A7	80-7862
A10TB1-4	TERMINAL BLOCK	5-A4	80-7862
A10TB1-4	TERMINAL BLOCK	6-A6	80-7862
A10TB1-5	TERMINAL BLOCK	5-B4	80-7862
A10TB1-6	TERMINAL BLOCK	6-C3	80-7862
A10TB1-7	TERMINAL BLOCK	5-B3	80-7862
A10TB1-8	TERMINAL BLOCK	6-D8	30-7862
A10TB1-9	TERMINAL BLOCK	6-D7	80-7962
A10TB1-10	TERMINAL BLOCK	6-C6	80-7862
A10TB1-11	TERMINAL BLOCK	6-C5	80-7862
A10TB1-12	TERMINAL BLOCK	6-B6	80-7862
A10TB1-13	TERMINAL BLOCK	6-B5	80-7862
A10TB1-14	TERMINAL BLOCK	3-D3	80-7862

DESIG - TRM	DESCRIPTION	LOC	WD
A10TB2-1	TERMINAL BLOCK	4-B5	80-7862
A10TB2-6	TERMINAL BLOCK	3-D5	80-7862
A10TB2-7	TERMINAL BLOCK	3-D5	80-7362
A10TB2-8	TERMINAL BLOCK	6-D5	80-7862
A10TB2-9	TERMINAL BLOCK	6-D5	80-7862
A10TB2-10	TERMINAL BLOCK	6-D5	80-7862
A10TB2-11	TERMINAL BLOCK	4-B3	80-7862
A10TB2-14	TERMINAL BLOCK	6-D5	80-7862
A10TB2-15	TERMINAL BLOCK	6-D5	80-7862
A10TB2-16	TERMINAL BLOCK	4-B4	80-7362
A10TB2-17	TERMINAL BLOCK	4-B4	80-7862
A10TB3-1	TERMINAL BLOCK	6-C6	80-7862
A10TB3-2	TERMINAL BLOCK	6-B6	80-7862
A10TB3-3	TERMINAL BLOCK	6-B6	80-7862
A10TB3-4	TERMINAL BLOCK	6-C7	80-7862
A10TB3-5	TERMINAL BLOCK	6-C7	80-7862
A10TB3-6	TERMINAL BLOCK	6-C6	80-7862
A10TB3-7	TERMINAL BLOCK	5-B4	80-7862
A10TB3-8	TERMINAL BLOCK	6-C4	80-7862
A10TB3-9	TERMINAL BLOCK	5-B3	80-7862
A10TB3-10	TERMINAL BLOCK	5-B4	80-7862
A10TB3-11	TERMINAL BLOCK	6-C7	80-7862
A10TB3-12	TERMINAL BLOCK	5-B4	80-7862
A10TB3-13	TERMINAL BLOCK	5-B4	80-7362
A10TB3-14	TERMINAL BLOCK	6-A6	80-7862
A11	ANNUNCIATOR RELAY PANEL	SEE BELOW	
A11D1	ANNUNCIATOR RELAY PANEL	5-B4	80-7862
A11D1-A11D4	BLOCKING DIODE	5-B5	80-7862
A11D5-A11D8	BLOCKING DIODE	5-B6	80-7862
A11D9-A11D10	BLOCKING DIODE	6-C5	30-7862
A11D11-A11D14	BLOCKING DIODE	5-B7	80-7862
A11D15-A11D17	BLOCKING DIODE	5-C3	80-7862
A11D18 COIL	BLOCKING DIODE	5-C4	80-7862
A11K1-2&7	REVERSE POWER FAULT-ALARM RELAY	5-A4	80-7862
A11K1-3&5	REVERSE POWER FAULT-ALARM RELAY	3-D6	80-7862
A11K1-4&6	REVERSE POWER FAULT-ALARM RELAY	5-B4	80-7862
A11K2-2&7COIL	GROUND FAULT-ALARM RELAY	5-A5	80-7862
A11K2-4&7	GROUND FAULT-ALARM RELAY	5-B5	80-7862
A11K3-2&7COIL	SPARE	5-A6	80-7362
A11K3-4&6	SPARE	5-B6	80-7862
A11K4-2&7COIL	EXCESSIVE CRANKING ALARM RELAY	5-A6	80-7862
A11K4-4&6	EXCESSIVE CRANKING ALARM RELAY	5-A6	80-7862
A11K5-2&7COIL	UNDERCURRENT FAULT-ALARM RELAY	6-C5	80-7862
A11K5-3&5	UNDERCURRENT FAULT-ALARM RELAY	3-D5	80-7862
A11K5-4&6	UNDERCURRENT FAULT-ALARM RELAY	6-D5	80-7862
A11K6-2&7COIL	COOLANT LEVEL ALARM RELAY	5-A7	80-7862
A11K6-4&6	COOLANT LEVEL ALARM RELAY	5-B7	80-7862
A11K7-2&7 COIL	SPARE	5-A7	80-7862
A11K7-4&6	SPARE	5-B7	80-7862
A11K8-2&7 COIL	SPARE	5-C3	80-7862
A11K8-4&6	SPARE	5-D3	80-7862
A11K9-2&7 COIL	SPARE	5-C3	80-7862
A11K9-4&6	SPARE	5-D3	80-7862
A11TB1-1	TERMINAL BLOCK	5-A7	80-7862
A11TB1-1	TERMINAL BLOCK	6-A7	80-7862
A11TB1-2	TERMINAL BLOCK	5-B4	80-7862
A11TB1-3	TERMINAL BLOCK	5-B5	80-7862
A11TB1-4	TERMINAL BLOCK	5-A7	80-7862
A11TB1-5	TERMINAL BLOCK	5-D4	80-7862
A11TB1-6	TERMINAL BLOCK	5-D3	80-7862
A11TB1-7	TERMINAL BLOCK	5-B8	80-7862
A11TB1-8	TERMINAL BLOCK	5-B7	80-7862
A11TB1-9	TERMINAL BLOCK	6-C5	80-7862
A11TB1-10	TERMINAL BLOCK	5-B6	80-7862
A11TB1-11	TERMINAL BLOCK	5-B6	80-7862
A11TB1-12	TERMINAL BLOCK	5-B5	80-7862
A11TB1-13	TERMINAL BLOCK	5-B5	80-7862

DESIG - TRM	DESCRIPTION	LOC	WD
A11TB2-4	TERMINAL BLOCK	3-D5	80-7862
A11TB2-10	TERMINAL BLOCK	3-D5	80-7862
A11TB2-11	TERMINAL BLOCK	3-D5	80-7862
A11TB3-1	TERMINAL BLOCK	5-B6	80-7862
A11TB3-2	TERMINAL BLOCK	5-B5	80-7862
A11TB3-3	TERMINAL BLOCK	5-B5	80-7862
A11TB3-4	TERMINAL BLOCK	5-B7	80-7862
A11TB3-5	TERMINAL BLOCK	6-C5	80-7862
A11TB3-6	TERMINAL BLOCK	5-B6	80-7862
A11TB3-7	TERMINAL BLOCK	5-C4	80-7862
A11TB3-8	TERMINAL BLOCK	5-C3	80-7862
A11TB3-9	TERMINAL BLOCK	5-B8	80-7862
A11TB3-10	TERMINAL BLOCK	5-D4	80-7862
A11TB3-11	TERMINAL BLOCK	5-A4	80-7862
A11TB3-11	TERMINAL BLOCK	5-C4	80-7862
A11TB3-12	TERMINAL BLOCK	5-D4	80-7862
A11TB3-13	TERMINAL BLOCK	5-D4	80-7862
A104	GOVERNOR/LOAD SHARING	3-A5	80-7861
A105	SYNCHRONIZER	3-A6	80-7861
B1 & B2	STARTER MOTOR	2-C7	80-7688
B3	PRE-LUBE PUMP	4-C7	80-7688
BC1-1&2	BATTERY CHARGER	2-C5	80-7688
BC1-(+)	BATTERY CHARGER	2-D6	80-7688
BC1-(-)	BATTERY CHARGER	2-C6	80-7688
BT1	BATTERY 12V	2-D8	80-7688
BT2	BATTERY 12V	2-D7	80-7688
BT3	BATTERY 12V	2-C8	80-7688
BT4	BATTERY 12V	2-C8	80-7688
CB1	CKT BRKR-DC CONTROL	2-D4	80-7860
CB2	CKT BRKR-EMERGENCY LIGHTS	2-D5	80-7860
CB101	CKT BRKR-GENERATOR LOAD	2-A7	80-7861
CB101	CKT BRKR-GENERATOR LOAD	2-C4	80-7861
CB116-2	CKT BRKR BATTERY CHARGER	2-C5	80-7494
CR1 & CR2	BLOCKING DIODE FUEL PUMP	3-C3	80-7860
CR3	DIODE SURGE SUPPRESSOR	4-B4	80-7688
CR4	DIODE SURGE SUPPRESSOR	4-A4	80-7688
CR5	BLOCKING DIODE	6-B7	80-7860
DS19	FLASHER	5-D6	80-7860
DS20	EMERGENCY LIGHT	2-C5	80-7494
DS21	EMERGENCY LIGHTS	2-C5	80-7494
DS22	EMERGENCY LIGHT	2-C4	80-7494
DS23	EMERGENCY LIGHT	2-C4	80-7494
DS26	ENGINE PANEL LIGHT	2-C4	80-7860
DS27	ENGINE PANEL LIGHT	2-C3	80-7860
DS28	ENGINE PANEL LIGHT	2-C3	80-7860
DS29	ENGINE PANEL LIGHT	2-C3	80-7860
DS33	CKT BRKR OPEN LIGHT	2-B6	80-7866
DS34	CKT BRKR CLOSED LIGHT	2-B6	80-7866
DS35	PARALLEL LIGHT	2-B3	80-7866
DS36	SINGLE UNIT LIGHT	2-B3	80-7866
FL1	SWITCH - PUMP CONTROL	3-D3	80-7866
FL2	SWITCH - PUMP CONTROL	3-C4	80-7866
FL3	SWITCH - LOW FUEL LEVEL	6-D7	80-7866
FL4	SWITCH - HIGH FUEL LEVEL	6-D8	80-7866

LEGEND FOR LOC WD

X-XX 80-XXXX

APPLICABLE WIRING DIAGRAM DRAWING NO. (SUFFIX)

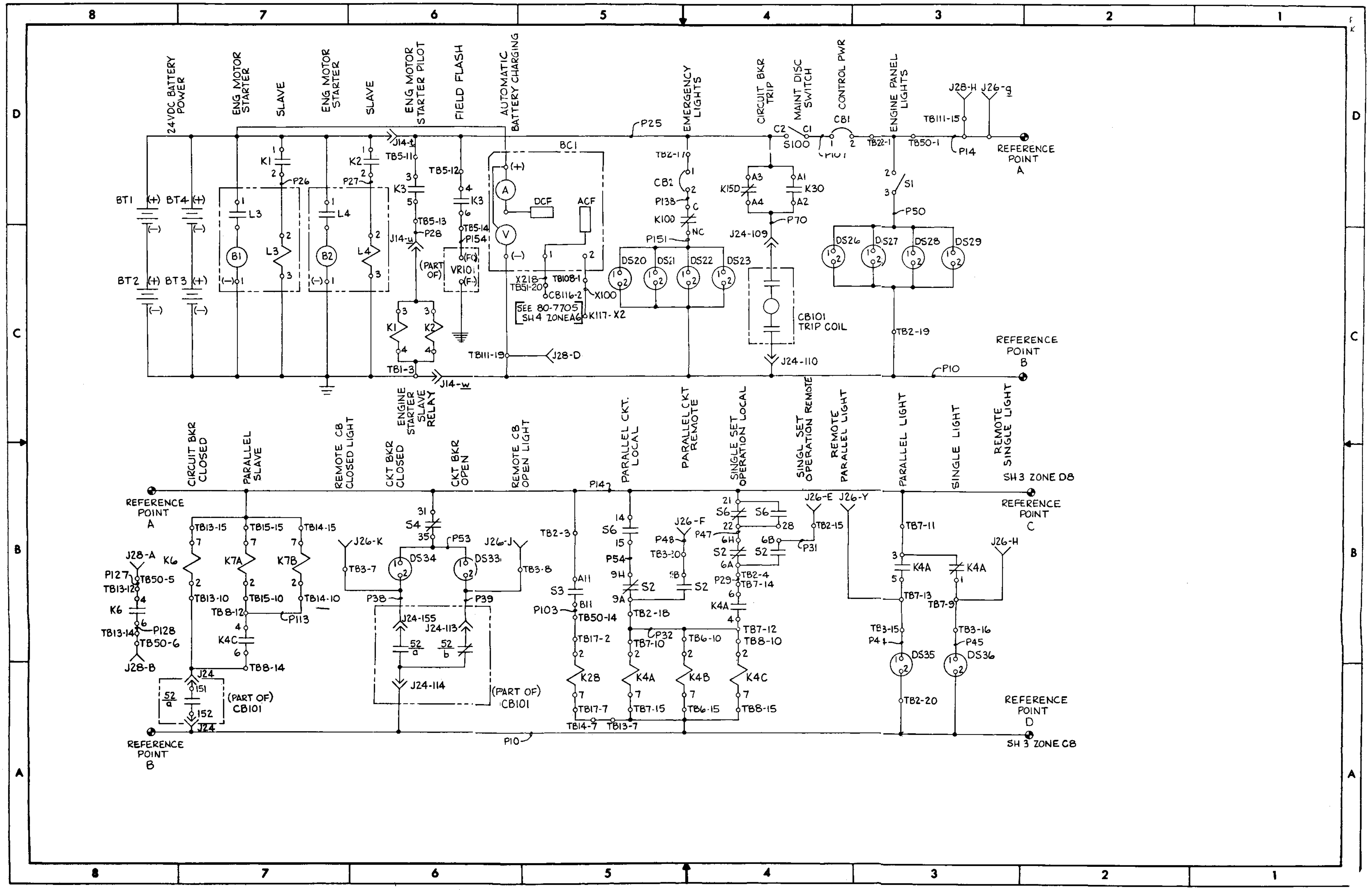
HORIZONTAL DWG.ZONE

VERTICAL DWG. ZONE

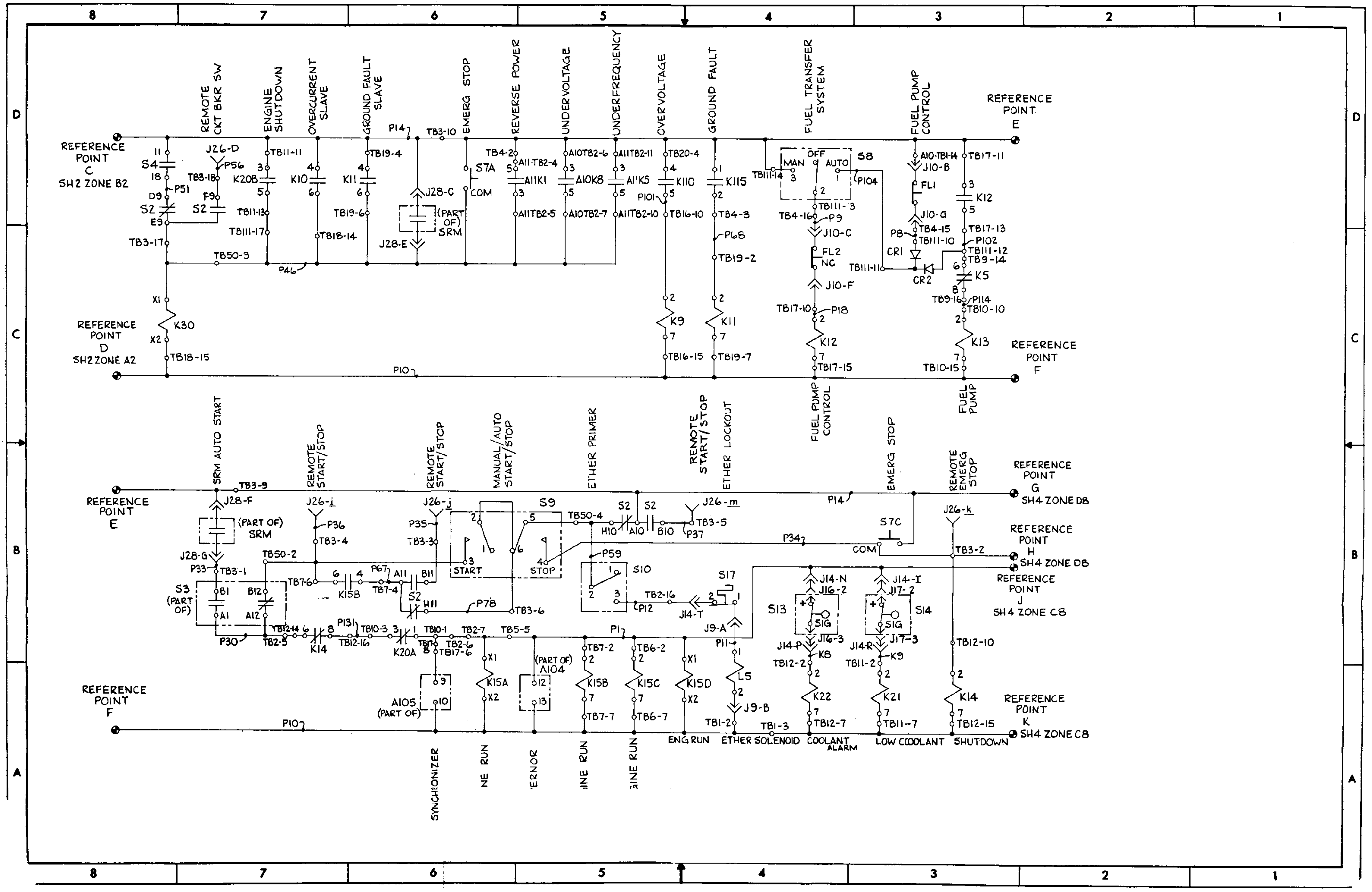
SHEET NO. OF THIS DWG.

LETTER DESIGNATIONS CONTINUED ON SH 7

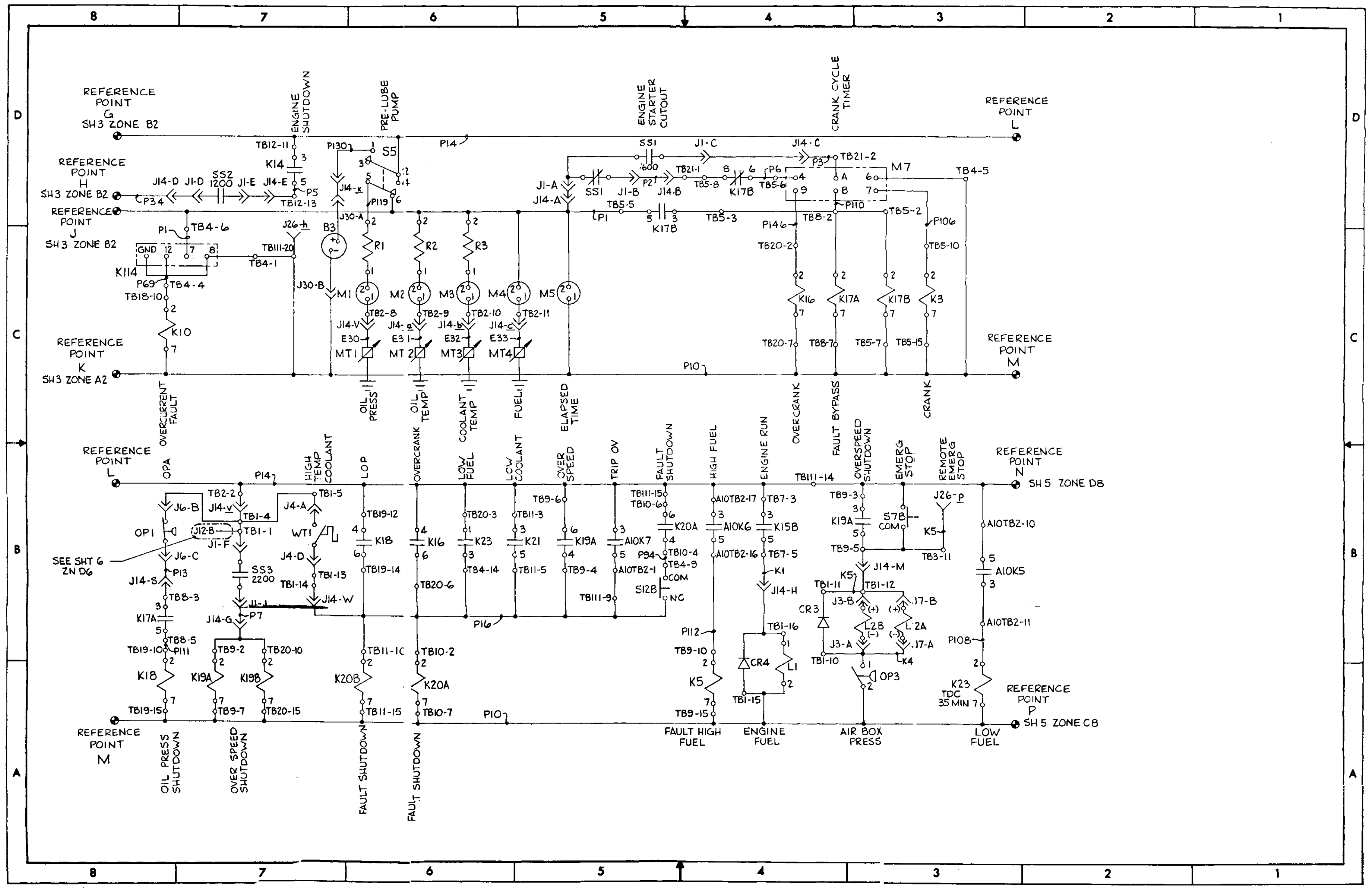
FO-1. DC Schematic Diagram (Sheet 1 of 8)



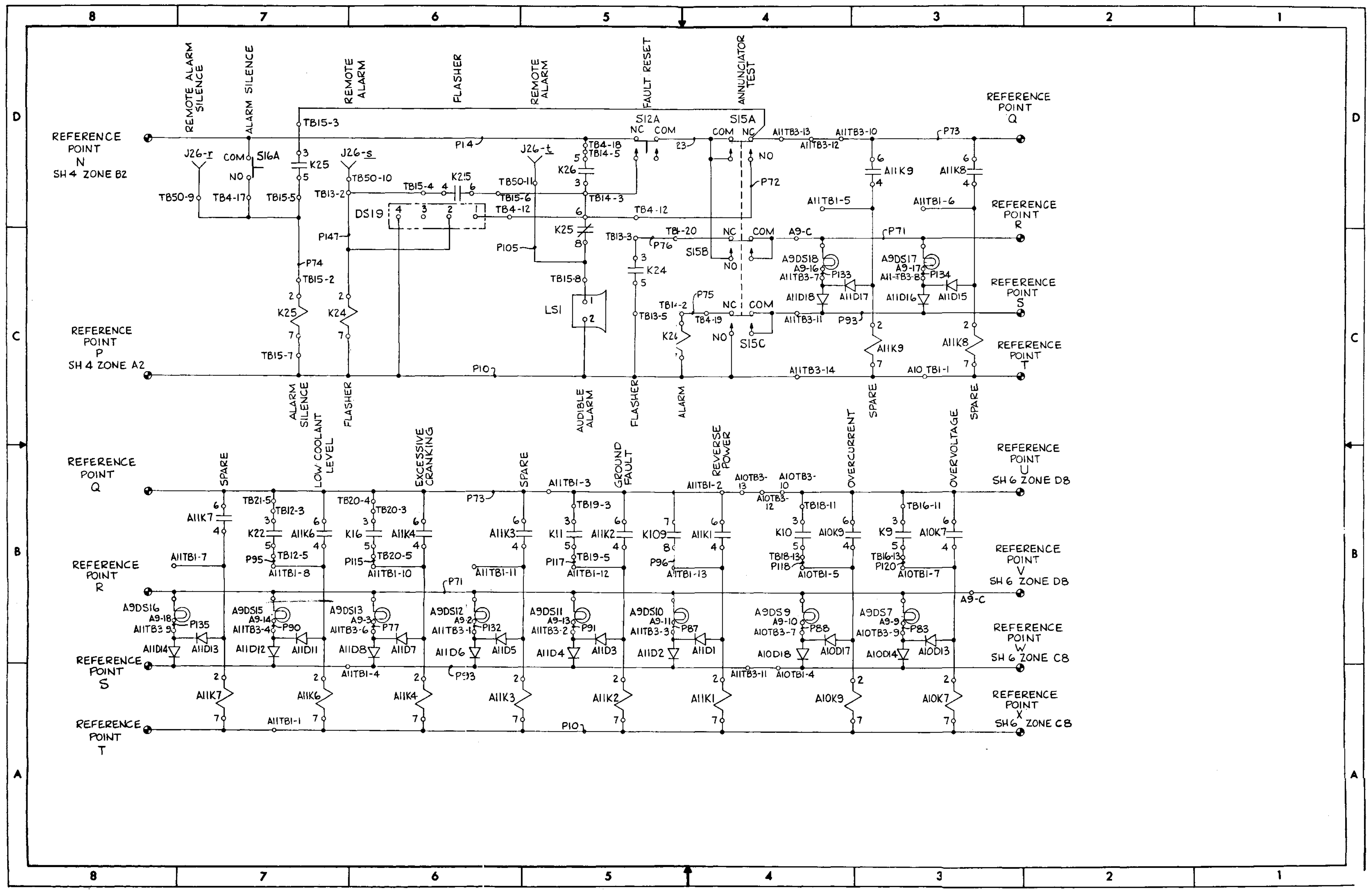
FO-1. DC Schematic Diagram (Sheet 2 of 8)



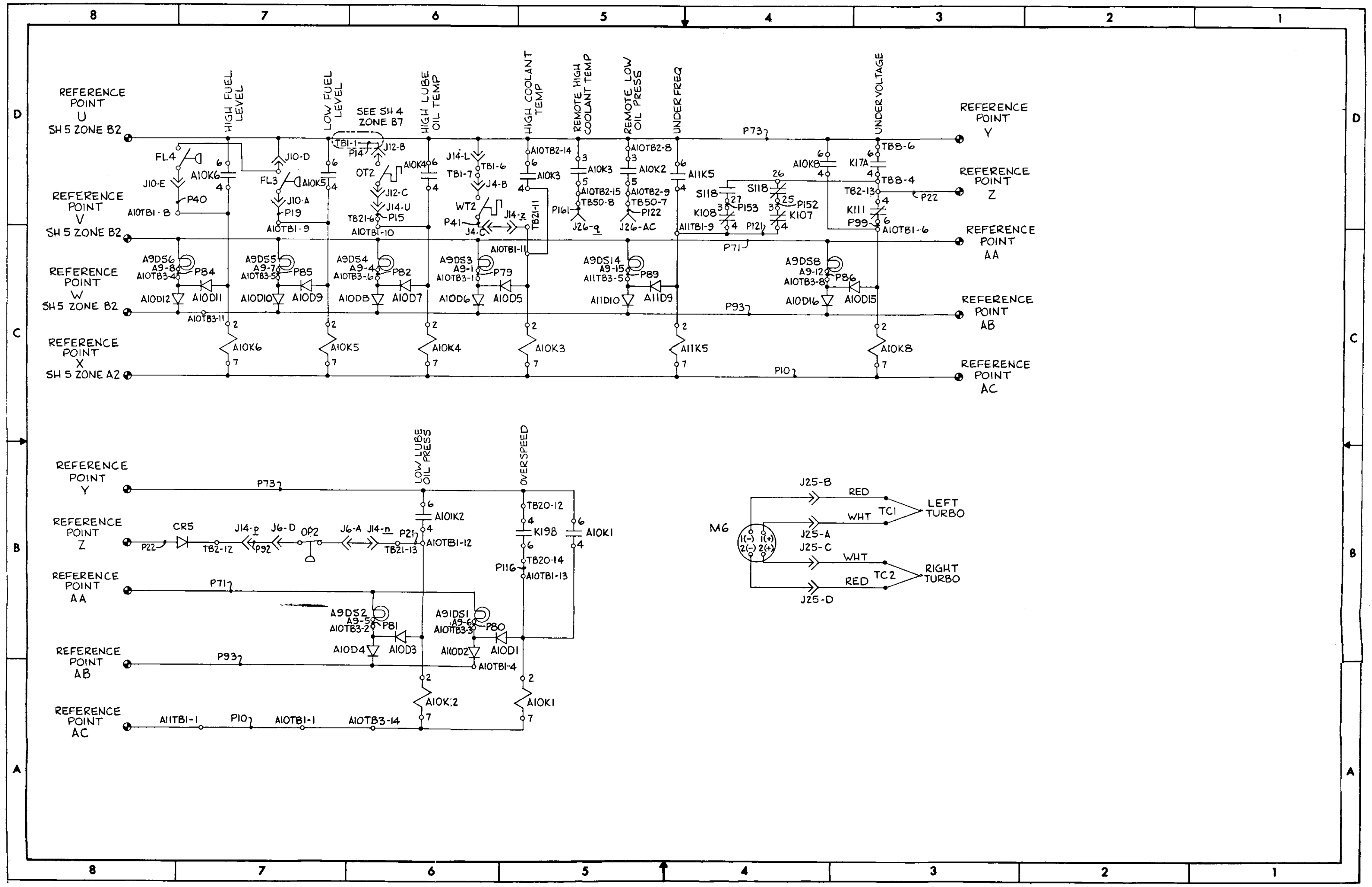
FO-1. DC Schematic Diagram (Sheet 3 of 8)



FO-1. DC Schematic Diagram (Sheet 4 of 8)



FO-1. DC Schematic Diagram (Sheet 5 of 8)



FO-1. DC Schematic Diagram (Sheet 6 of 8)

DESIG - TRM	DESCRIPTION	LOC	WD
J1A-B	CONN - SPEED SWITCH	4-D5	80-7688
J1-C	CONN - SPEED SWITCH	4-D4	80-7688
J1D-E	CONN - SPEED SWITCH	4-D7	80-7688
J1F-J	CONN - SPEED SWITCH	4-B7	80-7688
J3A-B	CONN - AIR BOX SOLENOID LT	4-B3	80-7688
J4A	CONN - COOLANT TEMP SW.	4-B7	80-7688
J4B	CONN - COOLANT TEMP SW.	6-D6	80-7688
J4D	CONN - COOLANT TEMP SW.	4-B7	80-7688
J6A	CONN OIL PRESS WRN-SHT DN SW.	6-B6	80-7688
J6B-C	CONN OIL PRESS WRN-SHT DN SW.	4-B8	80-7688
J6D	CONN OIL PRESS WRN-SHT DN SW.	6-B7	80-7688
J7A-B	CONN AIR BOX SOLENOID SW.	4-B3	80-7688
J9A	CONN ETHER SOLENOID	3-B4	80-7688
J9B	CONN ETHER SOLENOID	3-A4	80-7688
J10A	CONN FUEL TANK FLOAT SW.	6-D7	80-7688
J10C	CONN FUEL TANK FLOAT SW.	3-C4	80-7688
J10D	CONN FUEL TANK FLOAT SW.	6-D7	80-7688
J10E	CONN FUEL TANK FLOAT SW.	6-D8	80-7688
J10-F	CONN FUEL TANK FLOAT SW.	3-C4	80-7688
J10G	CONN FUEL TANK FLOAT SW.	3-D3	80-7688
J12	CONN OIL TEMP SW.	6-D6	80-7688
J12B	CONN OIL TEMP SW.	4-B7	80-7688
J12B-C	CONN OIL TEMP SW.	6-D6	80-7688
J14A-D	CONN ENGINE ROOM	4-D5	80-7860
J14E	CONN ENGINE ROOM	4-D7	80-7860
J14G	CONN ENGINE ROOM	4-B7	80-7860
J14H	CONN ENGINE ROOM	4-B4	80-7860
J14I	CONN ENGINE ROOM	3-B3	80-7860
J14L	CONN ENGINE ROOM	6-D6	80-7860
J14M	CONN ENGINE ROOM	4-B3	80-7860
J14N-P	CONN ENGINE ROOM	3-B4	80-7860
J14R	CONN ENGINE ROOM	3-B3	80-7860
J14S	CONN ENGINE ROOM	4-B8	80-7860
J14T	CONN ENGINE ROOM	3-B4	80-7860
J14U	CONN ENGINE ROOM	6-D6	80-7860
J14V	CONN ENGINE ROOM	4-C6	80-7860
J14W	CONN ENGINE ROOM	4-B7	80-7860
J14a-c	CONN ENGINE ROOM	4-C6	80-7860
J14n	CONN ENGINE ROOM	6-B6	80-7860
J14p	CONN ENGINE ROOM	6-B7	80-7860
J14t-u	CONN ENGINE ROOM	2-C6	80-7860
J14v	CONN ENGINE ROOM	4-B7	80-7860
J14w	CONN ENGINE ROOM	2-C6	80-7860
J14x	CONN ENGINE ROOM	4-D7	80-7860
J14z	CONN ENGINE ROOM	6-D6	80-7860
J16 2-3	CONN COOL LEVEL WRN SW.	3-B4	80-7688
J17 2-3	CONN COOL LEVEL SHT DN SW.	3-B3	80-7688
J24-109-110	CONN - MAIN CKT BRKR DISCONN.	2-C4	80-7861
J24-113	CONN - MAIN CKT BRKR DISCONN.	2-B6	80-7861
J24-114	CONN - MAIN CKT BRKR DISCONN.	2-A6	80-7861
J24-151-152	CONN - MAIN CKT BRKR DISCONN.	2-A6	80-7861
J24-155	CONN - MAIN CKT BRKR DISCONN.	2-B6	80-7861
J25A-D	CONN, THERMOCOUPLE	6-B4	80-7688
J26D	CONN REMOTE	3-D7	80-7860
J26E	CONN REMOTE	2-B4	80-7860
J26F	CONN REMOTE	2-B4	80-7860
J26H	CONN REMOTE	2-B3	80-7860
J26i	CONN REMOTE	3-B7	80-7860
J26J-K	CONN REMOTE	2-B6	80-7860
J26Y	CONN REMOTE	2-B4	80-7860
J26AC	CONN REMOTE	6-D5	80-7860
J26g	CONN REMOTE	2-D3	80-7860
J26h	CONN REMOTE	4-C7	80-7860
J26j	CONN REMOTE	3-B6	80-7860
J26k	CONN REMOTE	3-B3	80-7860
J26m	CONN REMOTE	3-B4	80-7860
J26p	CONN REMOTE	4-B3	80-7860
J26r	CONN REMOTE	5-D7	80-7860
J26s	CONN REMOTE	5-D6	80-7860
J26t	CONN REMOTE	5-D5	80-7860
J28A-B	CONN - SRM	2-B8	80-7860
J28C	CONN - SRM	3-D6	80-7860
J28E	CONN - SRM	3-C6	80-7860
J28F-G	CONN - SRM	3-B7	80-7860
J28H	CONN - SRM	2-D3	80-7860
J30A	CONN - PRE LUBE PUMP	4-D7	80-7688
J30B	CONN - PRE LUBE PUMP	4-C7	80-7688

DESIG - TRM	DESCRIPTION	LOC	WD
K1 COIL	RELAY STARTER SLAVE	2-C6	80-7688
K1	RELAY STARTER SLAVE	2-D7	80-7688
K2 COIL	RELAY STARTER SLAVE	2-C6	80-7688
K2	RELAY STARTER SLAVE	2-D6	80-7688
K3 COIL	RELAY CRANK	4-C3	80-7860
K3	RELAY CRANK	2-D6	80-7860
K4A COIL	RELAY PARALLEL	2-A5	80-7860
K4A	RELAY PARALLEL	2-B3	80-7860
K4A	RELAY PARALLEL	2-B4	80-7860
K4B COIL	RELAY PARALLEL	2-A4	80-7860
K4C COIL	RELAY PARALLEL	2-A4	80-7860
K4C	RELAY PARALLEL	2-B7	80-7860
K5 COIL	RELAY HIGH FUEL LEVEL SLAVE	4-A4	80-7860
K5	RELAY HIGH FUEL LEVEL SLAVE	3-C3	80-7860
K6 COIL	RELAY CKT BRKR CLOSED	2-B7	80-7862
K6	RELAY CKT BRKR CLOSED	2-B8	80-7862
K7A COIL	RELAY PARALLEL SLAVE	2-B7	80-7862
K7B COIL	RELAY PARALLEL SLAVE	2-B7	80-7862
K9 COIL	RELAY OVERVOLTAGE FAULT SLAVE	3-C5	80-7862
K9	RELAY OVERVOLTAGE FAULT SLAVE	5-B3	80-7862
K10 COIL	RELAY OVERCURRENT FAULT SLAVE	4-C8	80-7862
K10	RELAY OVERCURRENT FAULT SLAVE	5-B4	80-7862
K10	RELAY OVERCURRENT FAULT SLAVE	3-D7	80-7862
K11 COIL	RELAY GROUND FAULT SLAVE	3-C4	80-7862
K11	RELAY GROUND FAULT SLAVE	3-D6	80-7862
K11	RELAY GROUND FAULT SLAVE	5-B5	80-7862
K12 COIL	RELAY FUEL PUMP SLAVE	3-C4	80-7862
K12	RELAY FUEL PUMP SLAVE	3-D3	80-7862
K13 COIL	CONTACTOR FUEL PUMP	3-C3	80-7860
K14 COIL	RELAY - SHUTDOWN	3-A3	80-7860
K14	RELAY - SHUTDOWN	3-B7	80-7860
K14	RELAY - SHUTDOWN	4-D7	80-7860
K15A COIL	RELAY - ENGINE RUN	3-A6	80-7860
K15B COIL	RELAY - ENGINE RUN	3-A5	80-7860
K15B	RELAY - ENGINE RUN	3-B6	80-7860
K15B	RELAY - ENGINE RUN	4-B4	80-7860
K15C COIL	RELAY - ENGINE RUN	3-A5	80-7860
K15D COIL	RELAY - ENGINE RUN	3-A4	80-7860
K15D	RELAY - ENGINE RUN	2-D4	80-7860
K16 COIL	RELAY - EXCESSIVE CRANKING	4-C4	80-7862
K16	RELAY - EXCESSIVE CRANKING	4-B6	80-7862
K16	RELAY - EXCESSIVE CRANKING	5-B6	80-7862
K17A COIL	RELAY - EXCESSIVE CRANKING	4-C3	80-7860
K17A	RELAY - EXCESSIVE CRANKING	4-B8	80-7860
K17A	RELAY - EXCESSIVE CRANKING	6-D3	80-7860
K17B COIL	RELAY - EXCESSIVE CRANKING	4-C3	80-7860
K17B	RELAY - EXCESSIVE CRANKING	4-D5	80-7860
K17B	RELAY - EXCESSIVE CRANKING	4-D4	80-7860
K18	RELAY OIL PRESSURE SHUTDOWN	4-A8	80-7862
K18	RELAY OIL PRESSURE SHUTDOWN	4-B6	80-7862
K19A COIL	RELAY OVERSPEED SHUTDOWN	4-A7	80-7860
K19A	RELAY OVERSPEED SHUTDOWN	4-B3	80-7860
K19A	RELAY OVERSPEED SHUTDOWN	4-B5	80-7860
K19B COIL	RELAY OVERSPEED SHUTDOWN	4-A7	80-7862
K20A COIL	RELAY FAULT SHUTDOWN	4-A6	80-7860
K20A	RELAY FAULT SHUTDOWN	3-B6	80-7860
K20B COIL	RELAY FAULT SHUTDOWN	4-A6	80-7860
K20B	RELAY FAULT SHUTDOWN	3-D7	80-7860
K21 COIL	RELAY - LOW COOL SHT DN	3-A3	80-7860
K21	RELAY - LOW COOL SHT DN	4-B5	80-7860
K22 COIL	RELAY - COOL LEVEL ALARM SLAVE	2-A4	80-7860
K22	RELAY - COOL LEVEL ALARM SLAVE	5-B7	80-7860
K23 COIL	RELAY LOW FUEL LEVEL SHT DN	4-A3	80-7862
K23	RELAY LOW FUEL LEVEL SHT DN	4-B6	80-7862
K24 COIL	RELAY FLASHER	5-C7	80-7862
K24	RELAY FLASHER	5-C5	80-7862
K25 COIL	RELAY - ALARM SILENCE	5-C7	80-7862
K25	RELAY - ALARM SILENCE	5-C5	80-7862
K25	RELAY - ALARM SILENCE	5-D6	80-7862
K26 COIL	RELAY ALARM	5-C5	80-7862
K26	RELAY ALARM	5-D5	80-7862
K28 COIL	RELAY SYNCHRONIZER POWER	2-A5	80-7862
K30 COIL	RELAY CKT BRKR TRIP	3-C8	80-7862
K30	RELAY CKT BRKR TRIP	2-D4	80-7862
K100	RELAY EMERGENCY LIGHT	2-D5	80-7860
K107	RELAY - UNDERFREQUENCY 60 Hz	6-D4	80-7861
K108	RELAY - UNDERFREQUENCY 50 Hz	6-D4	80-7861

DESIG - TRM	DESCRIPTION	LOC	WD
K109	RELAY - REVERSE POWER MOTOR	5-B5	80-7861
K110	RELAY - OVERVOLTAGE FAULT	3-D5	80-7861
K111	RELAY - UNDERVOLTAGE FAULT	6-D3	80-7861
K114 COIL	RELAY - OVERCURRENT	4-C8	80-7863
K115	RELAY - GROUND FAULT	3-D4	80-7863
L1 COIL	SOLENOID - ENGINE FUEL	4-A4	80-7688
L2A	SOLENOID - AIR BOX	4-B3	80-7688
L2B	SOLENOID - AIR BOX	4-B3	80-7688
L3 COIL	SOLENOID - STARTER	2-C7	80-7688
L4 COIL	SOLENOID - STARTER	2-C6	80-7688
L5	SOLENOID COIL - ETHER	3-A4	80-7688
LS1	ALARM HORN	5-C5	80-7860
M1	GAUGE - OIL PRESSURE	4-C6	80-7860
M2	GAUGE - OIL TEMPERATURE	4-C6	80-7860
M3	GAUGE - COOLANT TEMP	4-C6	80-7860
M4	GAUGE - FUEL LEVEL	4-C6	80-7860
M5	METER - ELAPSE TIME	4-C5	80-7860
M6	METER - EXHAUST TEMP	6-B4	80-7860
M7	CRANK CYCLE TIMER	4-D3	80-7862
MT1	TRANSMITTER OIL PRESSURE	4-C6	80-7688
MT2	TRANSMITTER OIL TEMPERATURE	4-C6	80-7688
MT3	TRANSMITTER COOLANT TEMP.	4-C6	80-7688
MT4	TRANSMITTER FUEL LEVEL	4-C6	80-7688
OP1	LOW OIL PRESSURE SHT DN SW.	4-B8	80-7688
OP2	LOW OIL PRESSURE WRN SW	6-B7	80-7688
OP3	AIR BOX DISCONNECT PRESSURE SW	4-A3	80-7688
OT2	HIGH OIL TEMP SW.	6-D6	80-7688
R1	RESISTOR-VOLTAGE DROPPING	4-C6	80-7860
R2	RESISTOR-VOLTAGE DROPPING	4-C6	80-7860
R3	RESISTOR-VOLTAGE DROPPING	4-C6	80-7860
S1	SWITCH - ENGINE PANEL LIGHT	2-D3	80-7860
S2	SWITCH - LOCAL - REMOTE	2-B4	80-7866
S2	SWITCH - LOCAL - REMOTE	2-B5	80-7866
S2	SWITCH - LOCAL - REMOTE	3-B5	80-7866
S2	SWITCH - LOCAL - REMOTE	3-B6	80-7866
S2	SWITCH - LOCAL - REMOTE	3-B7	80-7866
S2	SWITCH - LOCAL - REMOTE	3-D8	80-7866
S3	SWITCH, AUTOMATIC - MANUAL	2-B5	80-7866
S3	SWITCH, AUTOMATIC - MANUAL	3-B7	80-7866
S4	SWITCH MAIN CKT BRKR CONT.	2-B6	80-7866
S4	SWITCH MAIN CKT BRKR CONT.	3-D8	80-7866
S5	SWITCH, OIL PRE-LUBE	4-D6	80-7860
S6	SWITCH PARALLEL OPER.	2-B4	80-7866
S6	SWITCH PARALLEL OPER.	2-B5	80-7866
S7A	SWITCH EMERGENCY STOP	3-D6	80-7860
S7B	SWITCH EMERGENCY STOP	4-B3	80-7860
S7C	SWITCH EMERGENCY STOP	3-B3	80-7860
S8	SWITCH FUEL TRANSFER PUMP	3-D4	80-7860
S9	SWITCH STOP	3-B5	80-7860
S10	SWITCH ETHER PRIME	3-B5	80-7860
S12A	SWITCH FAULT RESET	5-D5	80-7863
S12B	SWITCH FAULT RESET	5-B5	80-7863
S13	SWITCH COOL LEVEL WRN	3-B4	80-7688
S14	SWITCH COOL LEVEL SHT DN	3-B3	80-7688
S15A	SWITCH FAULT TEST	5-D4	80-7863
S15B	SWITCH FAULT TEST	5-C4	80-7863
S15C	SWITCH FAULT TEST	5-C4	80-7863
S16A	SWITCH ALARM SILENCE	5-D7	80-7863
S17	SWITCH ETHER LOCK-OUT	3-B4	80-7688

DESIG - TRM	DESCRIPTION	LOC	WD
S100	SWITCH - MAINT DISCONNECT	2-D4	80-7860
S118	SWITCH - FREQ. SELECT 50/60 Hz	6-D4	80-7862
SS1	SWITCH - STARTER CUTOUT	4-D5	80-7688
SS2	SWITCH - STOP RELAY RESET	4-D7	80-7688
SS3	SWITCH - OVERSPEED	4-B7	80-7688
SRM	SIGHT REQ. MODULE	SEE J28	

LETTER DESIGNATIONS CONTINUED ON SH 8

FO-1 DC Schematic Diagram
(Sheet 7 of 8)

DESIG - TRM	DESCRIPTION	LOC	WD
TB1-1	TERMINAL BLOCK - ENGINE	4-B7	80-7688
TB1-1	TERMINAL BLOCK - ENGINE	3-A4	80-7688
TB1-1	TERMINAL BLOCK - ENGINE	6-D7	80-7688
TB1-2	TERMINAL BLOCK - ENGINE	4-A4	80-7688
TB1-2	TERMINAL BLOCK - ENGINE	3-A4	80-7688
TB1-3	TERMINAL BLOCK - ENGINE	4-A4	80-7688
TB1-3	TERMINAL BLOCK - ENGINE	2-C6	80-7688
TB1-4	TERMINAL BLOCK - ENGINE	4-B7	80-7688
TB1-5	TERMINAL BLOCK - ENGINE	4-B7	80-7688
TB1-6	TERMINAL BLOCK - ENGINE	6-D6	80-7688
TB1-7	TERMINAL BLOCK - ENGINE	6-D6	80-7688
TB1-10	TERMINAL BLOCK - ENGINE	4-B4	80-7688
TB1-11	TERMINAL BLOCK - ENGINE	4-B4	80-7688
TB1-12	TERMINAL BLOCK - ENGINE	4-B3	80-7688
TB1-13	TERMINAL BLOCK - ENGINE	4-B7	80-7688
TB1-14	TERMINAL BLOCK - ENGINE	4-B7	80-7688
TB1-15	TERMINAL BLOCK - ENGINE	4-A4	80-7688
TB1-16	TERMINAL BLOCK - ENGINE	4-B4	80-7688
TB2-1	TERMINAL BLOCK - CABINET C	2-D3	80-7860
TB2-2	TERMINAL BLOCK - CABINET C	4-B7	80-7860
TB2-3	TERMINAL BLOCK - CABINET C	2-B5	80-7860
TB2-4	TERMINAL BLOCK - CABINET C	2-B4	80-7860
TB2-5	TERMINAL BLOCK - CABINET C	3-B7	80-7860
TB2-6	TERMINAL BLOCK - CABINET C	3-B6	80-7860
TB2-7	TERMINAL BLOCK - CABINET C	3-B6	80-7860
TB2-8	TERMINAL BLOCK - CABINET C	4-C6	80-7860
TB2-9	TERMINAL BLOCK - CABINET C	4-C6	80-7860
TB2-10	TERMINAL BLOCK - CABINET C	4-C6	80-7860
TB2-11	TERMINAL BLOCK - CABINET C	4-C5	80-7860
TB2-12	TERMINAL BLOCK - CABINET C	6-B7	80-7860
TB2-13	TERMINAL BLOCK - CABINET C	6-D3	80-7860
TB2-15	TERMINAL BLOCK - CABINET C	2-B4	80-7860
TB2-16	TERMINAL BLOCK - CABINET C	3-B5	80-7860
TB2-18	TERMINAL BLOCK - CABINET C	2-B5	80-7860
TB2-19	TERMINAL BLOCK - CABINET C	2-C3	80-7860
TB2-20	TERMINAL BLOCK - CABINET C	2-A3	80-7860
TB3-1	TERMINAL BLOCK - CABINET C	3-B7	80-7860
TB3-2	TERMINAL BLOCK - CABINET C	3-B3	80-7860
TB3-3	TERMINAL BLOCK - CABINET C	3-B6	80-7860
TB3-4	TERMINAL BLOCK - CABINET C	3-B7	80-7860
TB3-5	TERMINAL BLOCK - CABINET C	3-B4	80-7860
TB3-6	TERMINAL BLOCK - CABINET C	3-B6	80-7860
TB3-7	TERMINAL BLOCK - CABINET.C	2-B6	80-7860
TB3-8	TERMINAL BLOCK - CABINET C	2-B5	80-7860
TB3-9	TERMINAL BLOCK - CABINET C	3-B7	80-7860
TB3-11	TERMINAL BLOCK - CABINET C	4-B3	80-7860
TB3-15	TERMINAL BLOCK - CABINET C	2-B3	80-7860
TB3-16	TERMINAL BLOCK - CABINET C	2-B3	80-7860
TB3-17	TERMINAL BLOCK - CABINET C	3-C8	80-7860
TB3-18	TERMINAL BLOCK - CABINET C	3-D7	80-7860
TB4-1	TERMINAL BLOCK - CABINET A	4-C7	80-7862
TB4-2	TERMINAL BLOCK - CABINET A	3-D6	80-7862
TB4-3	TERMINAL BLOCK - CABINET A	3-D4	80-7862
TB4-4	TERMINAL BLOCK - CABINET A	4-C8	80-7862
TB4-5	TERMINAL BLOCK - CABINET A	4-D3	80-7862
TB4-6	TERMINAL BLOCK - CABINET A	4-C7	80-7862
TB4-9	TERMINAL BLOCK - CABINET A	4-B5	80-7862
TB4-12	TERMINAL BLOCK - CABINET A	5-D5	80-7862
TB4-14	TERMINAL BLOCK - CABINET A	3-D4	80-7862
TB4-16	TERMINAL BLOCK - CABINET A	4-B6	80-7862
TB4-17	TERMINAL BLOCK - CABINET A	5-D7	80-7862
TB4-18	TERMINAL BLOCK - CABINET A	5-D5	80-7862
TB4-19	TERMINAL BLOCK - CABINET A	5-C4	80-7862
TB4-20	TERMINAL BLOCK - CABINET A	5-C5	80-7862
TB5-2	TERMINAL BLOCK - CABINET C	4-D3	80-7860
TB5-3	TERMINAL BLOCK - CABINET C	4-D4	80-7860
TB5-5	TERMINAL BLOCK - CABINET C	3-B6	80-7860
TB5-6	TERMINAL BLOCK - CABINET C	4-D4	80-7860
TB5-7	TERMINAL BLOCK - CABINET C	4-C3	80-7860
TB5-8	TERMINAL BLOCK - CABINET C	4-D4	80-7860
TB5-10	TERMINAL BLOCK - CABINET C	4-C3	80-7860
TB5-11	TERMINAL BLOCK - CABINET C	2-D6	80-7860

DESIG - TRM	DESCRIPTION	LOC	WD
TB5-13	TERMINAL BLOCK - CABINET C	2-D6	80-7860
TB5-14	TERMINAL BLOCK - CABINET C	2-C6	80-7860
TB5-15	TERMINAL BLOCK - CABINET C	4-C3	80-7860
TB6-2	TERMINAL BLOCK - CABINET C	3-B5	80-7860
TB6-7	TERMINAL BLOCK - CABINET C	3-A5	80-7860
TB6-10	TERMINAL BLOCK - CABINET.C	2-B4	80-7360
TB7-2	TERMINAL BLOCK - CABINET C	3-B5	80-7860
TB7-3	TERMINAL BLOCK - CABINET C	4-B4	80-7860
TB7-4	TERMINAL BLOCK - CABINET C	3-B6	80-7860
TB7-5	TERMINAL BLOCK - CABINET C	4-B4	80-7860
TB7-6	TERMINAL BLOCK - CABINET C	3-B7	80-7360
TB7-7	TERMINAL BLOCK - CABINET C	3-A5	80-7860
TB7-9	TERMINAL BLOCK - CABINET C	2-B3	80-7860
TB7-10	TERMINAL BLOCK - CABINET C	2-B5	80-7860
TB7-11	TERMINAL BLOCK - CABINET C	2-B3	80-7860
TB7-12	TERMINAL BLOCK - CABINET C	2-B4	80-7360
TB7-13	TERMINAL BLOCK - CABINET C	2-B3	80-7860
TB7-14	TERMINAL BLOCK - CABINET C	2-B4	80-7360
TB7-15	TERMINAL BLOCK - CABINET C	2-B4	80-7860
TB8-2	TERMINAL BLOCK - CABINET C	4-D4	80-7860
TB8-3	TERMINAL BLOCK - CABINET C	4-B8	80-7860
TB8-4	TERMINAL BLOCK - CABINET C	6-D3	80-7860
TB8-5	TERMINAL BLOCK - CABINET C	4-B8	80-7860
TB3-6	TERMINAL BLOCK - CABINET C	6-D3	80-7860
TB3-7	TERMINAL BLOCK - CABINET C	4-C4	80-7860
TB8-10	TERMINAL BLOCK - CABINET C	2-B4	80-7360
TB8-10	TERMINAL BLOCK - CABINET C	4-C8	80-7360
TB8-12	TERMINAL BLOCK - CABINET C	2-B7	80-7860
TB8-14	TERMINAL BLOCK - CABINET C	2-A7	80-7360
TB9-2	TERMINAL BLOCK - CABINET C	4-B7	80-7860
TB9-3	TERMINAL BLOCK - CABINET C	4-B3	80-7860
TB9-4	TERMINAL BLOCK - CABINET C	4-B3	80-7860
TB9-5	TERMINAL BLOCK - CABINET C	4-B5	80-7860
TB9-7	TERMINAL BLOCK - CABINET C	4-A7	80-7860
TB9-10	TERMINAL BLOCK - CABINET C	4-B4	80-7860
TB9-14	TERMINAL BLOCK - CABINET.C	3-C3	80-7860
TB9-15	TERMINAL BLOCK - CABINET C	4-A4	80-7860
TB9-16	TERMINAL BLOCK - CABINET C	3-C3	80-7860
TB10-1	TERMINAL BLOCK - CABINET C	3-B6	80-7860
TB10-2	TERMINAL BLOCK - CABINET C	4-B6	80-7860
TB10-3	TERMINAL BLOCK - CABINET C	3-B6	80-7860
TB10-4	TERMINAL BLOCK - CABINET C	4-B6	80-7360
TB10-6	TERMINAL BLOCK - CABINET C	4-B5	80-7860
TB10-7	TERMINAL BLOCK - CABINET C	4-A6	80-7360
TB10-10	TERMINAL BLOCK - CABINET C	3-C3	80-7860
TB10-15	TERMINAL BLOCK - CABINET C	3-C3	80-7860
TB11-2	TERMINAL BLOCK - CABINET C	3-B3	80-7860
TB11-3	TERMINAL BLOCK - CABINET C	4-B5	80-7860
TB11-5	TERMINAL BLOCK - CABINET C	4-B5	80-7860
TB11-7	TERMINAL BLOCK - CABINET C	3-A3	80-7860
TB11-10	TERMINAL BLOCK - CABINET C	4-B6	80-7860
TB11-13	TERMINAL BLOCK - CABINET C	4-D7	80-7860
TB11-15	TERMINAL BLOCK - CABINET C	4-A6	80-7360
TB12-2	TERMINAL BLOCK - CABINET C	3-B4	80-7860
TB12-3	TERMINAL BLOCK - CABINET C	5-B7	80-7860
TB12-5	TERMINAL BLOCK - CABINET C	5-B7	80-7860
TB12-7	TERMINAL BLOCK - CABINET C	3-A4	80-7860
TB12-10	TERMINAL BLOCK - CABINET C	3-B4	80-7860
TB12-11	TERMINAL BLOCK - CABINET C	4-D7	80-7860
TB12-13	TERMINAL BLOCK - CABINET C	4-D7	80-7860
TB12-14	TERMINAL BLOCK - CABINET C	3-B7	80-7860
TB12-15	TERMINAL BLOCK - CABINET C	3-A3	80-7860
TB12-16	TERMINAL BLOCK - CABINET C	3-B6	80-7860

DESIG - TRM	DESCRIPTION	LOC	WD
TB13-2	TERMINAL BLOCK - CABINET A	5-D7	80-7862
TB13-3	TERMINAL BLOCK - CABINET A	5-C5	80-7862
TB13-5	TERMINAL BLOCK - CABINET A	5-C5	80-7862
TB13-7	TERMINAL BLOCK - CABINET A	2-A5	80-7862
TB13-10	TERMINAL BLOCK - CABINET A	2-B7	80-7862
TB13-12	TERMINAL BLOCK - CABINET A	2-B8	80-7862
TB13-14	TERMINAL BLOCK - CABINET A	2-B8	80-7862
TB13-15	TERMINAL BLOCK - CABINET A	2-B7	80-7862
TB14-2	TERMINAL BLOCK - CABINET A	5-C5	80-7862
TB14-3	TERMINAL BLOCK - CABINET A	5-D5	80-7862
TB14-5	TERMINAL BLOCK - CABINET A	5-D5	80-7862
TB14-7	TERMINAL BLOCK - CABINET A	2-A5	80-7862
TB14-10	TERMINAL BLOCK - CABINET A	2-B7	80-7862
TB14-15	TERMINAL BLOCK - CABINET A	2-B7	80-7862
TB15-2	TERMINAL BLOCK - CABINET A	5-C7	80-7862
TB15-3	TERMINAL BLOCK - CABINET A	5-D7	80-7862
TB15-4	TERMINAL BLOCK - CABINET A	5-D6	80-7862
TB15-5	TERMINAL BLOCK - CABINET A	5-D7	80-7862
TB15-6	TERMINAL BLOCK - CABINET A	5-D6	80-7862
TB15-10	TERMINAL BLOCK - CABINET A	2-B7	80-7862
TB15-15	TERMINAL BLOCK - CABINET A	2-B7	80-7862
TB16-10	TERMINAL BLOCK - CABINET A	3-D5	80-7862
TB16-11	TERMINAL BLOCK - CABINET A	5-B3	80-7862
TB16-13	TERMINAL BLOCK - CABINET A	5-B3	80-7862
TB16-15	TERMINAL BLOCK - CABINET A	3-C5	80-7862
TB17-2	TERMINAL BLOCK - CABINET A	2-B5	80-7862
TB17-6	TERMINAL BLOCK - CABINET A	3-B6	80-7862
TB17-7	TERMINAL BLOCK - CABINET A	2-A5	80-7862
TB17-8	TERMINAL BLOCK - CABINET A	3-B6	80-7862
TB17-10	TERMINAL BLOCK - CABINET A	3-C4	80-7862
TB17-11	TERMINAL BLOCK - CABINET A	3-D3	80-7862
TB17-15	TERMINAL BLOCK - CABINET A	3-C4	80-7862
TB18-11	TERMINAL BLOCK - CABINET A	5-B4	80-7862
TB18-13	TERMINAL BLOCK - CABINET A	5-B4	80-7862
TB18-15	TERMINAL BLOCK - CABINET A	3-C8	80-7862
TB19-2	TERMINAL BLOCK - CABINET A	3-C4	80-7862
TB19-4	TERMINAL BLOCK - CABINET A	3-D6	80-7862
TB19-5	TERMINAL BLOCK - CABINET A	5-B5	80-7862
TB19-6	TERMINAL BLOCK - CABINET A	3-D6	80-7862
TB19-7	TERMINAL BLOCK - CABINET A	3-C4	80-7862
TB19-10	TERMINAL BLOCK - CABINET A	4-B8	80-7862
TB19-12	TERMINAL BLOCK - CABINET A	4-B6	80-7862
TB19-14	TERMINAL BLOCK - CABINET A	4-B6	80-7862
TB19-15	TERMINAL BLOCK - CABINET A	4-A8	80-7862
TB20-2	TERMINAL BLOCK - CABINET A	4-C4	80-7862
TB20-3	TERMINAL BLOCK - CABINET A	4-B6	80-7862
TB20-3	TERMINAL BLOCK - CABINET A	5-B6	80-7862
TB20-4	TERMINAL BLOCK - CABINET A	3-D5	80-7862
TB20-4	TERMINAL BLOCK - CABINET A	5-B6	80-7862
TB20-5	TERMINAL BLOCK - CABINET A	5-B6	80-7862
TB20-6	TERMINAL BLOCK - CABINET A	4-B6	80-7862
TB20-7	TERMINAL BLOCK - CABINET A	4-C4	80-7862
TB20-10	TERMINAL BLOCK - CABINET A	4-B7	80-7862
TB20-12	TERMINAL BLOCK - CABINET A	6-B5	80-7862
TB20-14	TERMINAL BLOCK - CABINET A	6-B5	80-7862
TB20-15	TERMINAL BLOCK - CABINET A	4-A7	80-7862

DESIG - TRM	DESCRIPTION	LOC	WD
TB21-1	TERMINAL BLOCK - CABINET C	4-D4	80-7860
TB21-2	TERMINAL BLOCK - CABINET C	4-D4	80-7860
TB21-5	TERMINAL BLOCK - CABINET C	5-7B	80-7860
TB21-6	TERMINAL BLOCK - CABINET C	6-D6	80-7860
TB21-11	TERMINAL BLOCK - CABINET C	6-D5	80-7860
TB21-13	TERMINAL BLOCK - CABINET C	6-B6	80-7860
TB21-17	TERMINAL BLOCK - CABINET C	2-D5	80-7860
TB50-1	TERMINAL BLOCK - CABINET C	2-D3	80-7860
TB50-2	TERMINAL BLOCK - CABINET C	3-B7	80-7860
TB50-5	TERMINAL BLOCK - CABINET C	2-B8	80-7860
TB50-7	TERMINAL BLOCK - CABINET C	6-D5	80-7860
TB50-8	TERMINAL BLOCK - CABINET C	6-D5	80-7860
TB50-9	TERMINAL BLOCK - CABINET C	5-D7	80-7860
TB50-10	TERMINAL BLOCK - CABINET.C	5-D6	80-7860
TB50-11	TERMINAL BLOCK - CABINET C	5-D5	80-7860
TB50-14	TERMINAL BLOCK - CABINET C	2-B5	80-7860
TB51-20	TERMINAL BLOCK - CABINET C	2-C5	80-7860
TB108-1	TERMINAL BLOCK - CABINET C	2-C5	80-7860
TB108-15	TERMINAL BLOCK - CABINET C	2-C6	80-7860
TB111-9	TERMINAL BLOCK - CABINET C	4-B5	80-7860
TB111-10	TERMINAL BLOCK - CABINET C	3-C3	80-7360
TB111-11	TERMINAL BLOCK - CABINET C	3-C3	80-7860
TB111-12	TERMINAL BLOCK - CABINET C	3-C3	80-7860
TB111-13	TERMINAL BLOCK - CABINET C	3-D4	80-7860
TB111-14	TERMINAL BLOCK - CABINET C	3-D4	30-7860
TB111-15	TERMINAL BLOCK - CABINET C	2-D3	80-7860
TB111-15	TERMINAL BLOCK - CABINET C	4-B5	80-7860
TB111-17	TERMINAL BLOCK - CABINET C	3-C7	80-7860
TB111-19	TERMINAL BLOCK - CABINET C	2-C5	80-7360
TB111-20	TERMINAL BLOCK - CABINET C	4-C7	80-7860
TC1	THERMOCOUPLE EXHAUST GAS	6-B3	80-7494
TC2	THERMOCOUPLE EXHAUST GAS	6-B3	30-7494
VR101	VOLTAGE REGULATOR	2-C6	80-7861
WT1	SWITCH COOLANT TEMP SHT DWN	4-B7	30-7688
WT2	SWITCH COOLANT TEMP WRN	6-D6	80-7688

FO-1 DC Schematic Diagram
(Sheet 8 of 8)

LETTER DESIGNATIONS

DESIG - TRM	DESCRIPTION	LOC	WD
AMT	AMMETER TRANSDUCER	5-C5	80-7861
AT	ISOLATOR	7-D4	80-7862
A101	CURRENT BOOST MODULE	2-CT	80-7861
A103	TRANSDUCER - FREQ. METER	7-C7	80-7861
A104	LOAD SHARING MODULE/GOVERNOR	6-B6	80-7861
A104	LOAD SHARING MODULE/GOVERNOR	6-C6	80-7861
A104	LOAD SHARING MODULE/GOVERNOR	6-D6	80-7861
A105	SYNCHRONIZER	6-A2	80-7861
A105	SYNCHRONIZER	6-B2	80-7861
A105	SYNCHRONIZER	6-C2	80-7861
A105-13	SYNCHRONIZER	3-B6	80-7861
A105-14	SYNCHRONIZER	3-B6	80-7861
B102	FUEL TRANSFER PUMP	4-B4	80-7688
B103	EXHAUST FAN	3-B3	80-7494
BC1	BATTERY CHARGER	4-A7	80-7868
C101	SURGE CAPACITOR/GENERATOR	3-D6	80-7861
C102	CAPACITOR/PHASE SEQUENCE	7-B3	80-7866
CB2	CKT BKR EMERGENCY LIGHT	3-A5	80-7860
CB101	CKT BKR GENERATOR LOAD	7-D5	80-7861
CB101	CKT BKR GENERATOR LOAD	2-B3	80-7861
CB102	CKT BKR CONTROL ROOM RECEPT	3-C4	80-7494
CB103	CKT BKR CONTROL ROOM RECEPT	3-B4	80-7494
CB104	CKT BKR CONTROL ROOM LIGHTING	3-B4	80-7494
CB105	CKT BKR STATION POWER RELAY	3-B4	80-7494
CB106	CKT BKR ENGINE ROOM RECEPT.	3-C3	80-7494
CB107	CKT BKR ENGINE ROOM RECEPT.	3-B3	80-7494
CB108	CKT BKR ENGINE ROOM LIGHTING	3-B3	80-7494
CB109	CKT BKR CONTROL ROOM FAN	3-B3	80-7494
CB110	CKT BKR COOLANT HEATER	4-C6	80-7494
CB111	CKT BKR SPARE	4-C6	80-7494
CB112	CKT BKR HUMIDISTAT	4-B6	80-7494
CB113	CKT BKR SWITCHGEAR HEATERS	4-B6	80-7494
CB114	CKT BKR SPARE	4-B6	80-7494
CB116	CKT BKR BATTERY CHARGER	4-A6	80-7494
CB117	CKT BKR COOLANT HEATER	4-C6	80-7494
CB118	CKT BKR CONTROL RM HEATERS	4-C6	80-7494
CB119	CKT BKR SPARE	4-B6	80-7494
CB120	CKT BKR GENERATOR HEATERS	4-B6	80-7494
CB121	CKT BKR FUEL XFR PUMP MOTOR	4-B6	80-7494
CB122	CKT BKR FUEL XFR PUMP CONTROL	4-A6	80-7494
CB123	CKT BKR MAIN CKT BKR CLOSED	2-B5	80-7860
CB124	CKT BKR SET STATION POWER	3-C6	80-7494
CB125	CKT BKR UTILITY STATION POWER	3-C6	80-7494
CNTR	KILOWATT HOUR COUNTER	5-A2	80-7863
CT2-X	CURRENT BOOST CT	2-C7	80-7356
CT2-H	CURRENT BOOST CT	2-D7	80-7356
CT3-X	CURRENT BOOST CT	2-C7	80-7356
CT3-H	CURRENT BOOST CT	2-D7	80-7356
CT10	TRANSFORMER INSTRUMENT	5-D6	80-7861
CT11	TRANSFORMER INSTRUMENT	5-D7	80-7861
CT12	TRANSFORMER INSTRUMENT	5-D7	80-7861
CT114	TRANSFORMER PARALLELING	2-D5	80-7861
DP1	DISTRIBUTION PANEL 100 AMP	3-C3	80-7494
DP2	DISTRIBUTION PANEL 200 AMP	4-C6	80-7494
DS22	EMERGENCY LIGHT CONTROL ROOM	3-A5	80-7494
DS101	LIGHT CONTROL ROOM	3-B5	80-7494
DS102	LIGHT CONTROL ROOM	3-B4	80-7494
DS103	LIGHT ENGINE COMPARTMENT	3-A2	80-7494
DS104	LIGHT ENGINE COMPARTMENT	3-A2	80-7494
DS105	LIGHT ENGINE COMPARTMENT	3-A3	80-7494
DS106	LIGHT ENGINE COMPARTMENT	3-A3	80-7494
DS107	LIGHT FUEL XRF PUMP	4-B2	80-7860
DS110	LIGHT SYNCHRONIZING	7-C2	80-7866
DS111	LIGHT SYNCHRONIZING	7-C1	80-7866
DS112	LIGHT PHASE ROTATION	7-B3	80-7866
DS113	LIGHT PHASE ROTATION	7-B3	80-7866

DESIG - TRM	DESCRIPTION	LOC	WD
E101	LIGHTNING ARRESTOR	3-D4	80-7861
E102	LIGHTNING ARRESTOR	3-D5	80-7861
E103	LIGHTNING ARRESTOR	3-D5	80-7861
F101	FUSE DISCONNECT SW.	2-C3	80-7860
F103	FUSE VOLTAGE REGULATOR	2-D5	80-7862
F104	FUSE VOLTAGE REGULATOR	2-D6	80-7862
F105	FUSE VOLTAGE REGULATOR	2-D6	80-7862
F106	FUSE GEN. TRANSF. PRIMARY	4-D6	80-7862
F107	FUSE GEN. TRANSF. PRIMARY	4-D7	80-7862
F108	FUSE GEN. TRANSF. PRIMARY	4-D7	80-7862
F109	FUSE GEN. TRANSF. SECONDARY	4-D6	80-7862
F111	FUSE GEN. TRANSF. SECONDARY	4-D6	80-7862
F113	FUSE GEN. TRANSF. SECONDARY	4-D6	80-7862
F114	FUSE BUS TRANSF. PRIMARY	7-D4	80-7862
F115	FUSE BUS TRANSF. PRIMARY	7-D4	80-7862
F116	FUSE BUS TRANSF. PRIMARY	7-D4	80-7862
F117	FUSE BUS TRANSF. SECONDARY	7-C3	80-7862
F119	FUSE BUS TRANSF. SECONDARY	7-C4	80-7862
F121	FUSE BUS TRANSF. SECONDARY	7-C4	80-7862
G1	GENERATOR MAIN	2-D8	80-7356
H101	HEATER COOLANT	4-C4	80-7688
H102	HEATER COOLANT	4-C7	80-7688
H103	HEATER CONTROL ROOM	4-B4	80-7494
H104	HEATER CONTROL ROOM	4-B4	80-7494
H105	HEATER SWITCHGEAR	4-B7	80-7860
H106	HEATER SWITCHGEAR	4-B7	80-7860
H107	HEATER SWITCHGEAR	4-B7	80-7860
H109	HEATER GENERATOR	4-B3	80-7356
H110	HEATER GENERATOR	4-B3	80-7356
H113	HEATER LUBE OIL	4-C5	80-7688
J8 (A,B)	CONNECTOR MAGNETIC PICKUP	6-C5	80-7688
J14(t)	CONNECTOR ENGINE ROOM	4-B8	80-7688
J14(J,K)	CONNECTOR ENGINE ROOM	6-B5	80-7688
J14(A,$\underline{w}$)	CONNECTOR ENGINE ROOM	6-C6	80-7688
J14($\underline{s}$,$\overline{r}$)	CONNECTOR ENGINE ROOM	6-C6	80-7688
J18($\overline{A}$,$\overline{B}$,C)	CONNECTOR GOVERNOR PARALLEL	6-C4	80-7860
J19(A,B,C)	CONNECTOR GOVERNOR PARALLEL	6-C4	80-7860
J20(A)	CONNECTOR GOVERNOR PARALLEL	6-C5	80-7860
J20(B)	CONNECTOR GOVERNOR PARALLEL	6-C4	80-7860
J20(C)	CONNECTOR GOVERNOR PARALLEL	6-C3	80-7860
J21(A)	CONNECTOR REACTIVE CURRENT PAR	2-B5	80-7860
J21(B)	CONNECTOR REACTIVE CURRENT PAR	2-B4	80-7860
J22(A)	CONNECTOR REACTIVE CURRENT PAR	2-B5	80-7860
J22(B)	CONNECTOR REACTIVE CURRENT PAR	2-B4	80-7860
J23(A,B)	CONNECTOR REACTIVE CURRENT PAR	2-B4	80-7860
J24(105,106)	CONNECTOR MAIN CK BKR DISCON	2-C3	80-7861
J26(N)	CONNECTOR REMOTE CONTROL	2-B5	80-7860
J26(P)	CONNECTOR REMOTE CONTROL	2-B6	80-7860
J26(A,B)	CONNECTOR REMOTE CONTROL	3-B7	80-7860
J26(R)	CONNECTOR REMOTE CONTROL	5-A2	80-7860
J26(X)	CONNECTOR REMOTE CONTROL	5-A4	80-7860
J26(S)	CONNECTOR REMOTE CONTROL	5-B2	80-7860
J26(W)	CONNECTOR REMOTE CONTROL	5-B4	80-7860
J26(AB,AD,AH)	CONNECTOR REMOTE CONTROL	5-C5	80-7860
J26(AA,AE,AF)	CONNECTOR REMOTE CONTROL	5-C6	80-7860
J26($\underline{z}$)	CONNECTOR REMOTE CONTROL	6-B7	80-7860
J26($\overline{x}$,$\underline{y}$)	CONNECTOR REMOTE CONTROL	6-C7	80-7860
J26($\overline{V}$,$\overline{T}$,U)	CONNECTOR REMOTE CONTROL	7-C4	80-7860
J26($\underline{a}$,$\underline{b}$,$\underline{c}$,$\underline{h}$)	CONNECTOR REMOTE CONTROL	7-D6	80-7860
J28($\overline{L}$)	CONNECTOR SRM	2-B7	80-7860
J28(J,N)	CONNECTOR SRM	2-C4	80-7860
J28(K,M,T)	CONNECTOR SRM	2-C7	80-7860
J28(R)	CONNECTOR SRM	6-B3	80-7860
J28(S)	CONNECTOR SRM	6-C3	80-7860
J28(P,U,V,W)	CONNECTOR SRM	7-D5	80-7860

DESIG - TRM	DESCRIPTION	LOC	WD
J29(A)	CONNECTOR SRM	6-B6	80-7860
J29(C,D)	CONNECTOR SRM	6-C5	80-7860
J101	RECEPTACLE STATION POWER	3-C3	80-7860
J102	RECEPTACLE CONT RM CONVEN.	3-C4	80-7494
J103	RECEPTACLE CONT RM CONVEN.	3-C4	80-7494
J104	RECEPTACLE CONT RM CONV.	3-B4	80-7494
J105	RECEPTACLE CONT RM CONV.	3-B4	80-7494
J106	RECEPTACLE ENG RM	3-C3	80-7494
J107	RECEPTACLE ENG RM	3-C2	80-7494
J108	RECEPTACLE ENG RM	3-B3	80-7494
J109	RECEPTACLE ENG ROOM	3-B2	80-7494
K4B	RELAY PARALLEL	3-B6	80-7860
K4B	RELAY PARALLEL	3-B8	80-7860
K4C	RELAY PARALLEL	2-C5	80-7860
K6	RELAY CKT BKR CLOSED	6-B3	80-7862
K7A	SLAVE RELAY PARALLEL	2-C4	80-7860
K7B	SLAVE RELAY PARALLEL	6-C4	80-7860
K13	CONTACTOR FUEL PUMP	4-B2	80-7860
K13	CONTACTOR FUEL PUMP	4-A2	80-7860
K15A	RELAY ENGINE RUN	4-B5	80-7860
K15C	RELAY ENGINE RUN	4-B1	80-7860
K20B	RELAY FAULT SHUTDOWN	6-B4	80-7860
K28	RELAY SYNCHRONIZER	6-B3	80-7862
K30	RELAY CKT BKR TRIP	3-A7	80-7862
K100	RELAY EMERGENCY LIGHTS	3-B4	80-7860
K104A COIL	CONTACTOR COOLANT HEATER	4-B1	80-7860
K104A	CONTACTOR COOLANT HEATER	4-C4	80-7860
K104B COIL	CONTACTOR COOLANT HEATER	4-B1	80-7860
K104B	CONTACTOR COOLANT HEATER	4-C7	80-7860
K106	CONTACTOR FUEL TRANSFER PUMP	4-B2	80-7860
K106	CONTACTOR FUEL TRANSFER PUMP	4-B4	80-7860
K107 COIL	RELAY UNDERFREQUENCY 60 Hz	7-D7	80-7861
K107	RELAY UNDERFREQUENCY 60 Hz	3-A7	80-7861
K108 COIL	RELAY UNDERFREQUENCY 50 Hz	7-C6	80-7861
K108	RELAY UNDERFREQUENCY 50 Hz	3-A6	80-7861
K109	RELAY REVERSE POWER	5-C6	80-7861
K110	RELAY OVERVOLTAGE	7-C6	80-7861
K111	RELAY UNDERVOLTAGE	7-C5	80-7861
K114	RELAY OVERCURRENT	6-D5	80-7861
K115	RELAY GROUND FAULT	7-C3	80-7861
K116	RELAY SYNCHRONIZING CHECK	3-A6	80-7861
K116	RELAY SYNCHRONIZING CHECK	7-B2	80-7861
K117	CONTACTOR SWITCHGEAR HEATER	4-B7	80-7860
L101	ACTUATOR GOVERNOR	6-B5	80-7688
L102	SOLENOID FUEL TRANSFER	4-B2	80-7688
M101	VOLTMETER	7-B6	80-7866
M102	AMMETER	5-C2	80-7866
M103	FREQUENCY METER	7-B7	80-7866
M104	POWER FACTOR METER	5-A4	80-7866
M105	GENERATOR TEMP METER	6-B5	80-7866
M106	SYNCHROSCOPE	7-C1	80-7866
M107	KILOWATT METER	5-A3	80-7866
M108	KVAR METER	5-C7	80-7866
M110	CLOCK 60 Hz	7-D7	80-7866
M111	CLOCK 50 Hz	7-D6	80-7866
PFT	POWER FACTOR TRANSDUCER	5-C4	80-7861
PUI	MAGNETIC PICK-UP GOVERNOR	6-C5	80-7688

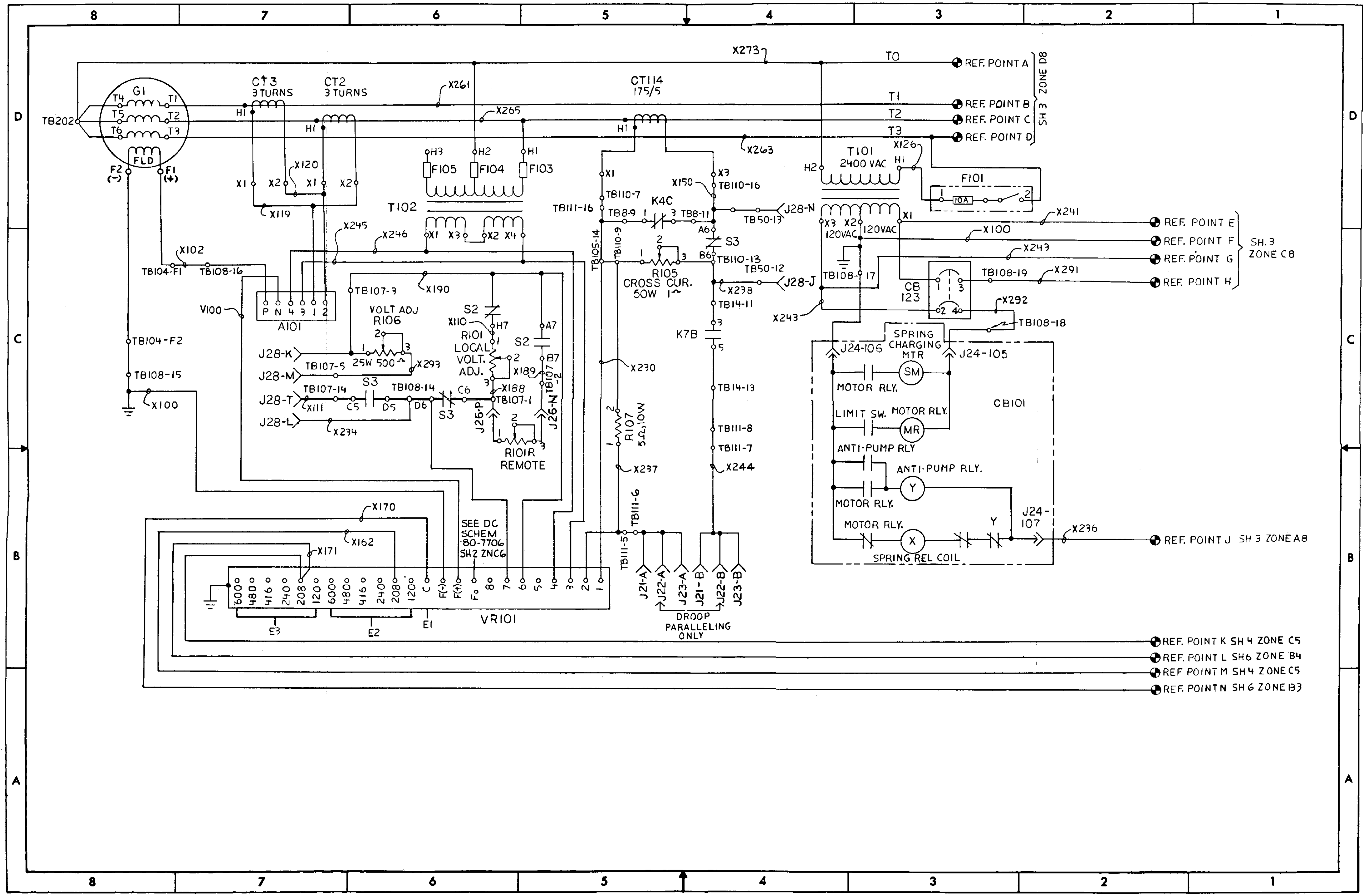
LEGEND FOR LOC WD

X-XX 80-XXXX

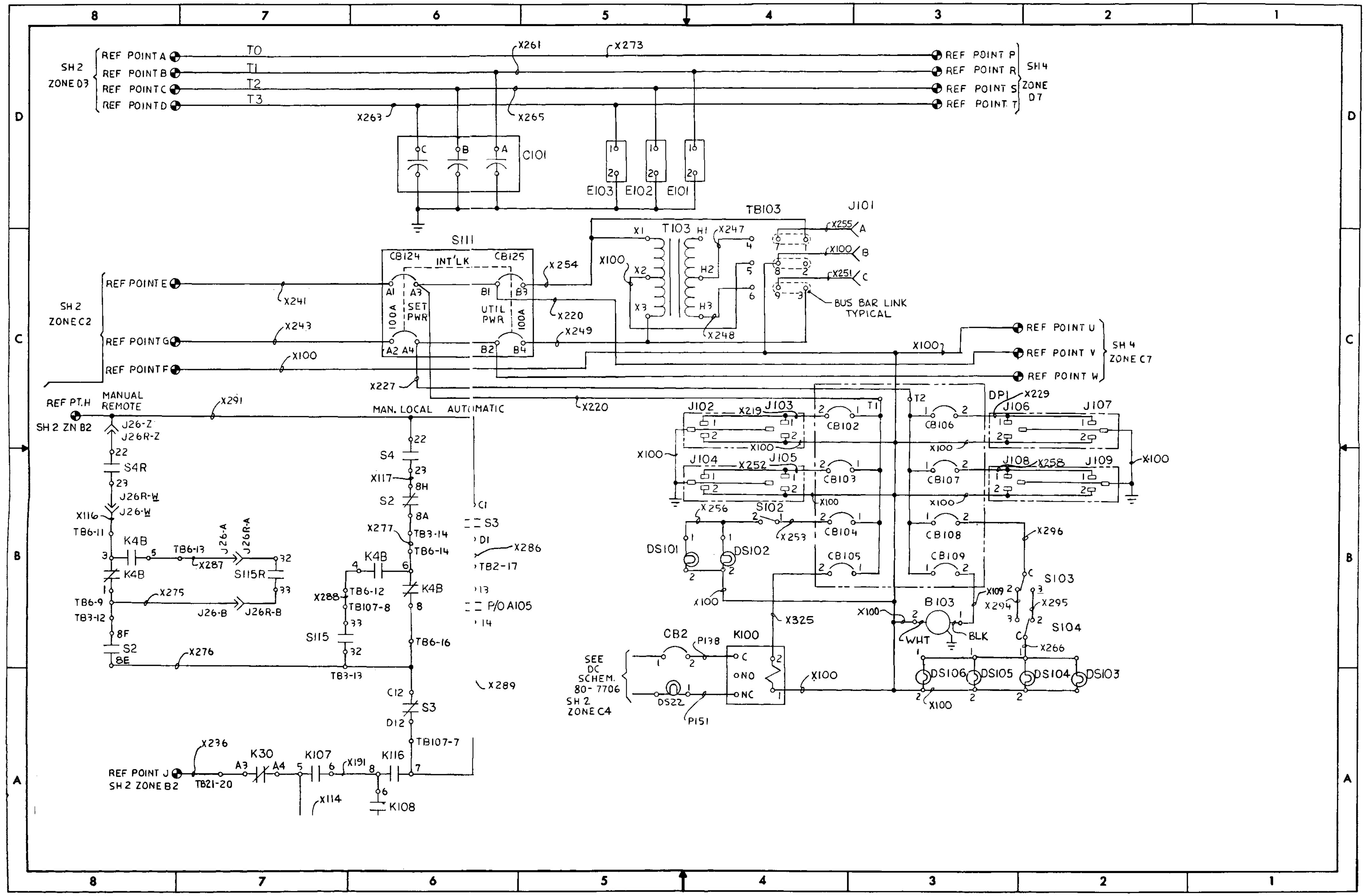
80-XXXX — APPLICABLE WIRING DIAGRAM DRAWING NO. (SUFFIX)
HORIZONTAL DWG.ZONE
VERTICAL DWG. ZONE
SHEET NO. OF THIS DWG.

LETTER DESIGNATIONS CONTINUED ON SHEET 8

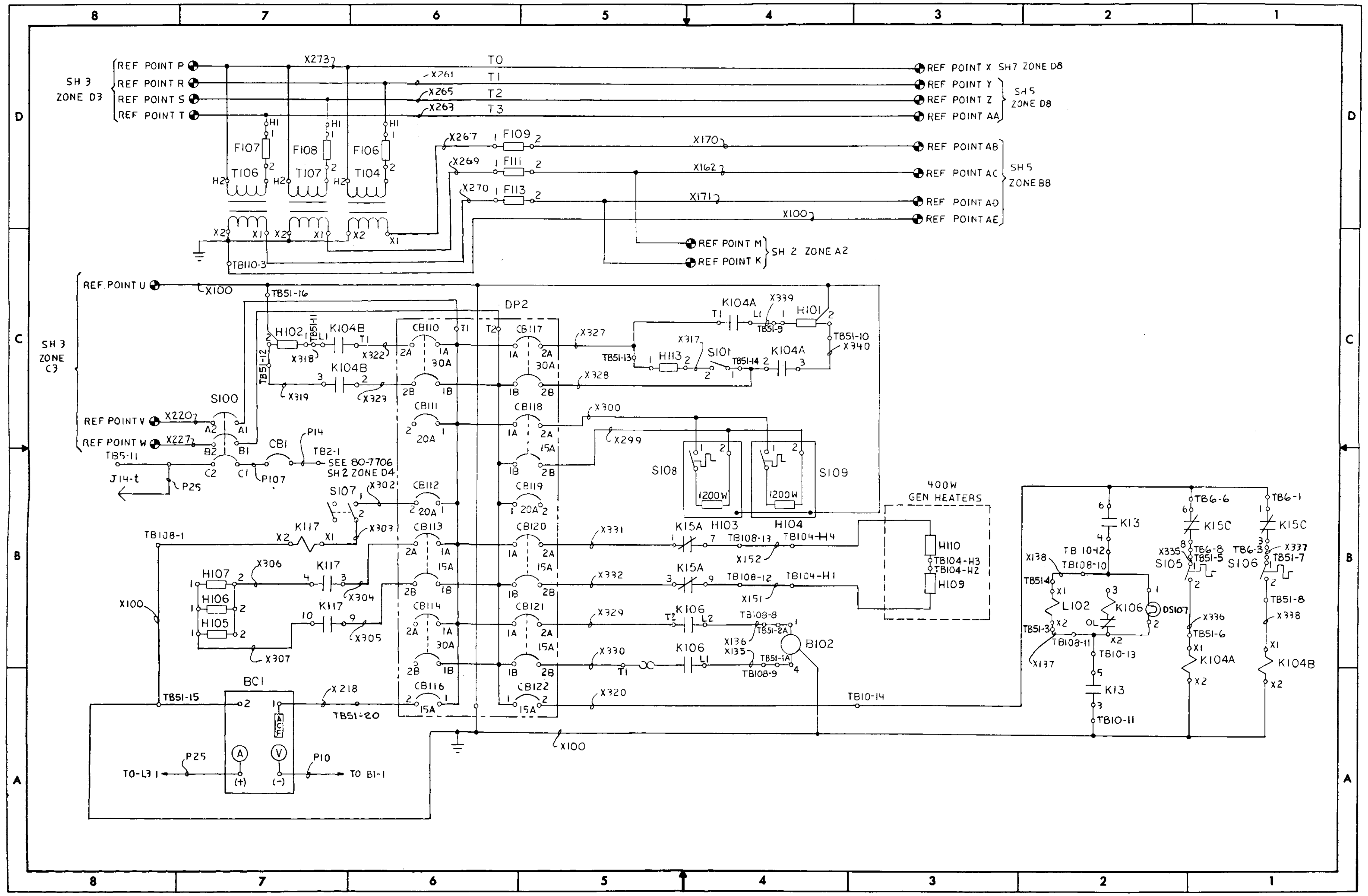
FO-2 AC Schematic Diagram
(Sheet 1 of 8)



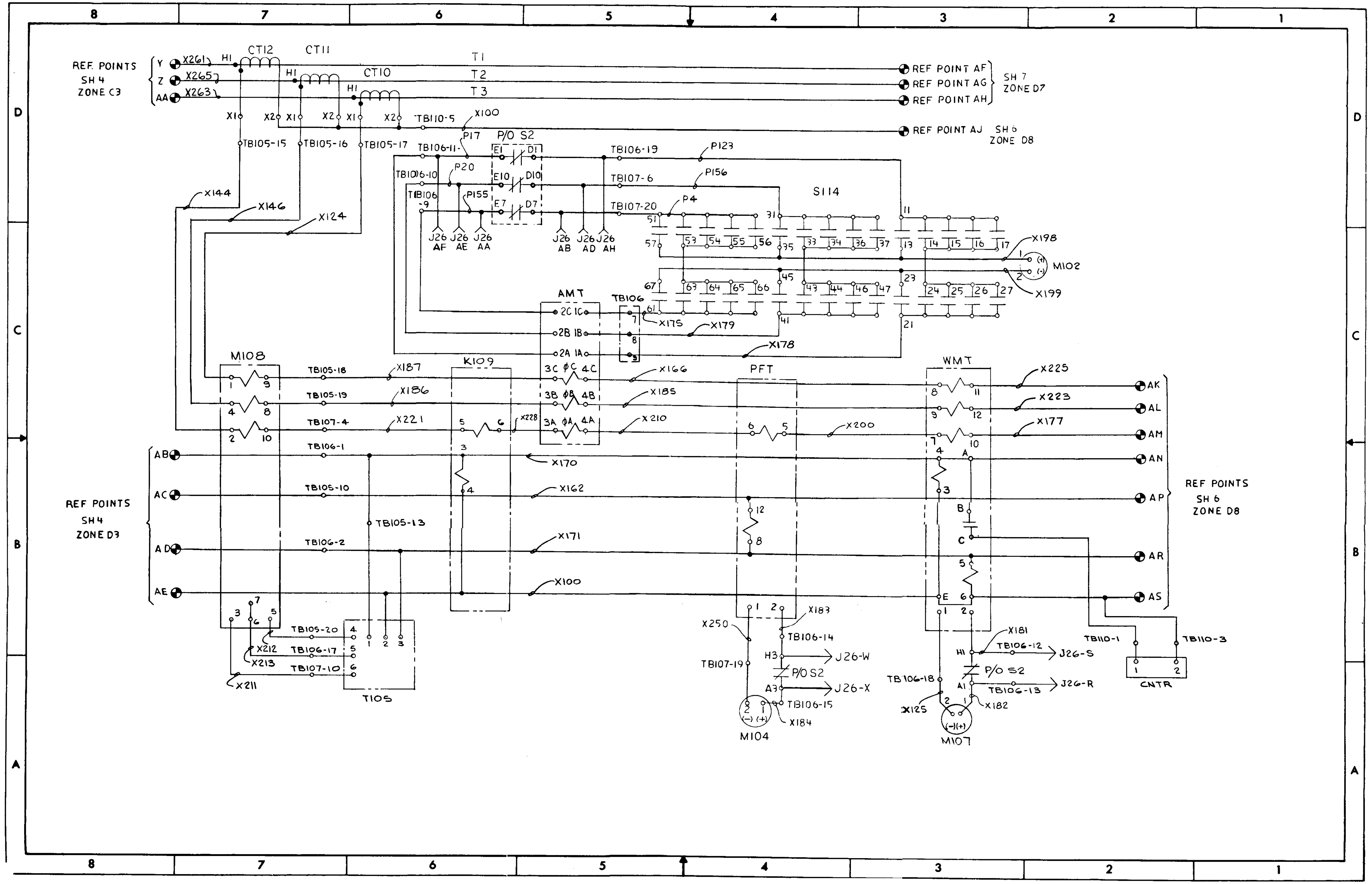
FO-2 AC Schematic Diagram
(Sheet 2 of 8)
FO-19/(FO-20 blank)



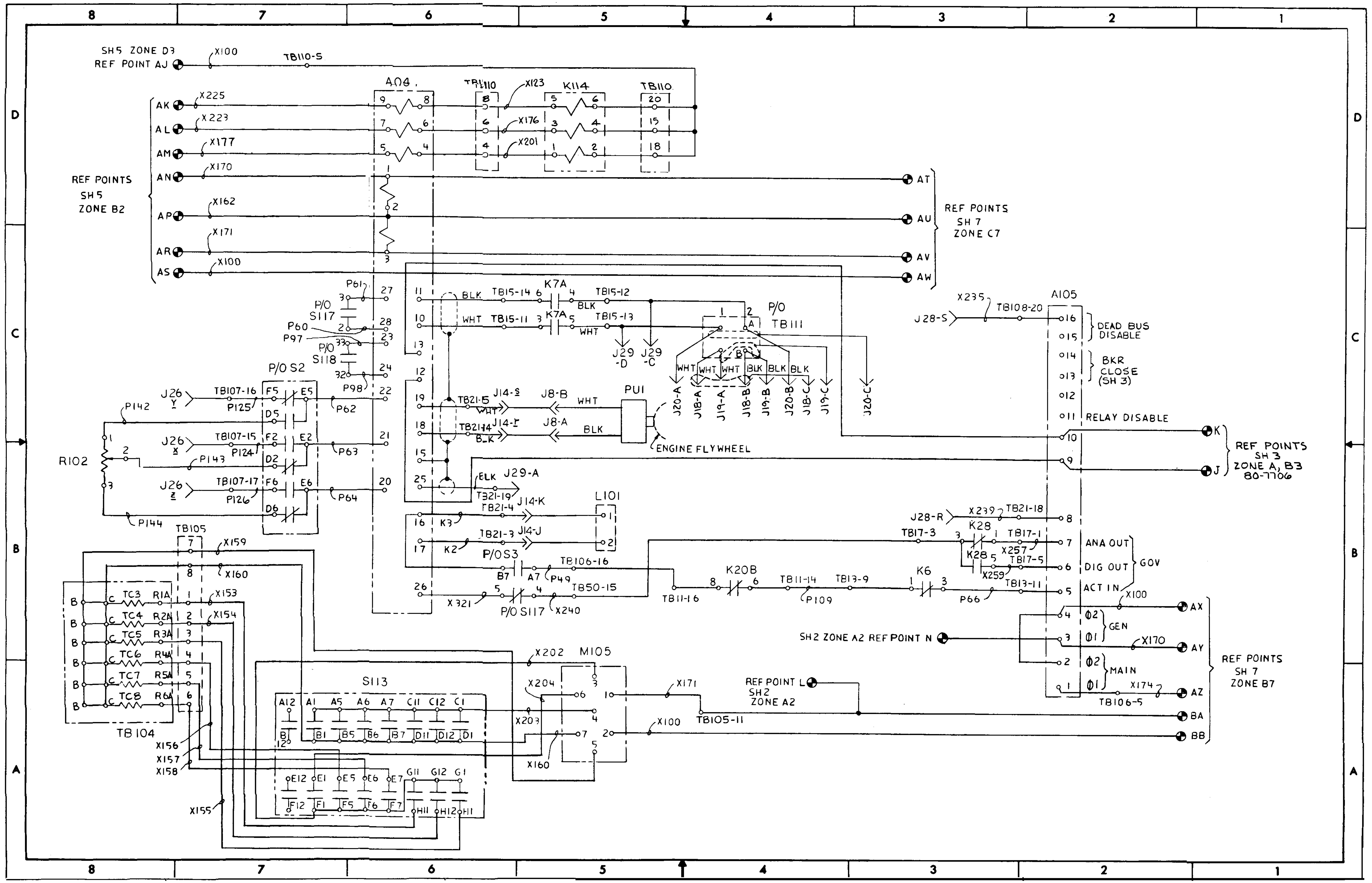
FO-2 AC Schematic Diagram
(Sheet 3 of 8)
FO-21/(FO-22 blank)



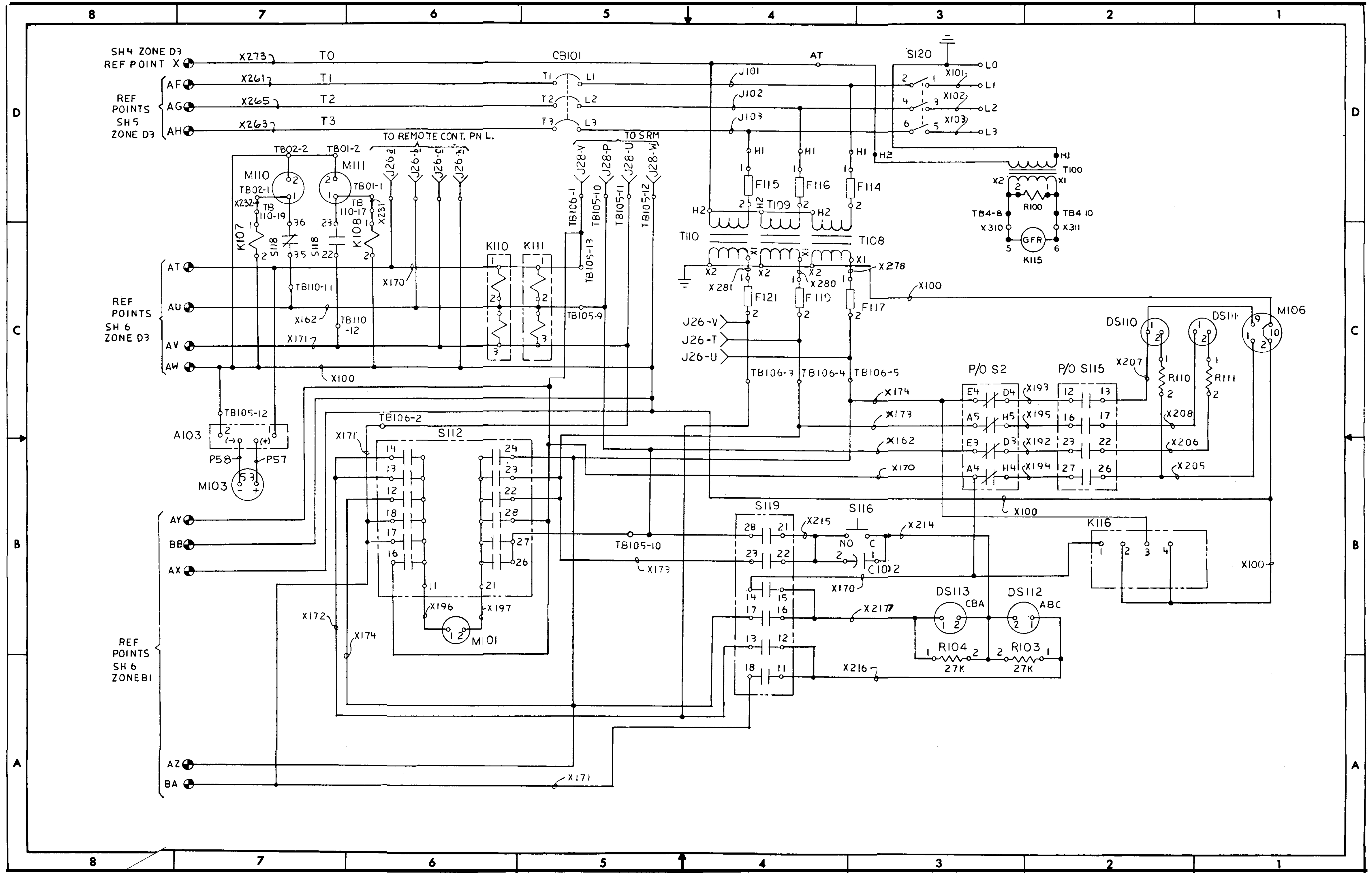
FO-2 AC Schematic Diagram
(Sheet 4 of 8)
FO-23/(FO-24 blank)



FO-2 AC Schematic Diagram
(Sheet 5 of 8)



FO-2. AC Schematic Diagram
(Sheet 6 of 8)



FO-2 AC Schematic Diagram
(Sheet 7 of 8)

LETTER DESIGNATIONS (CONTD FROM SH 1)

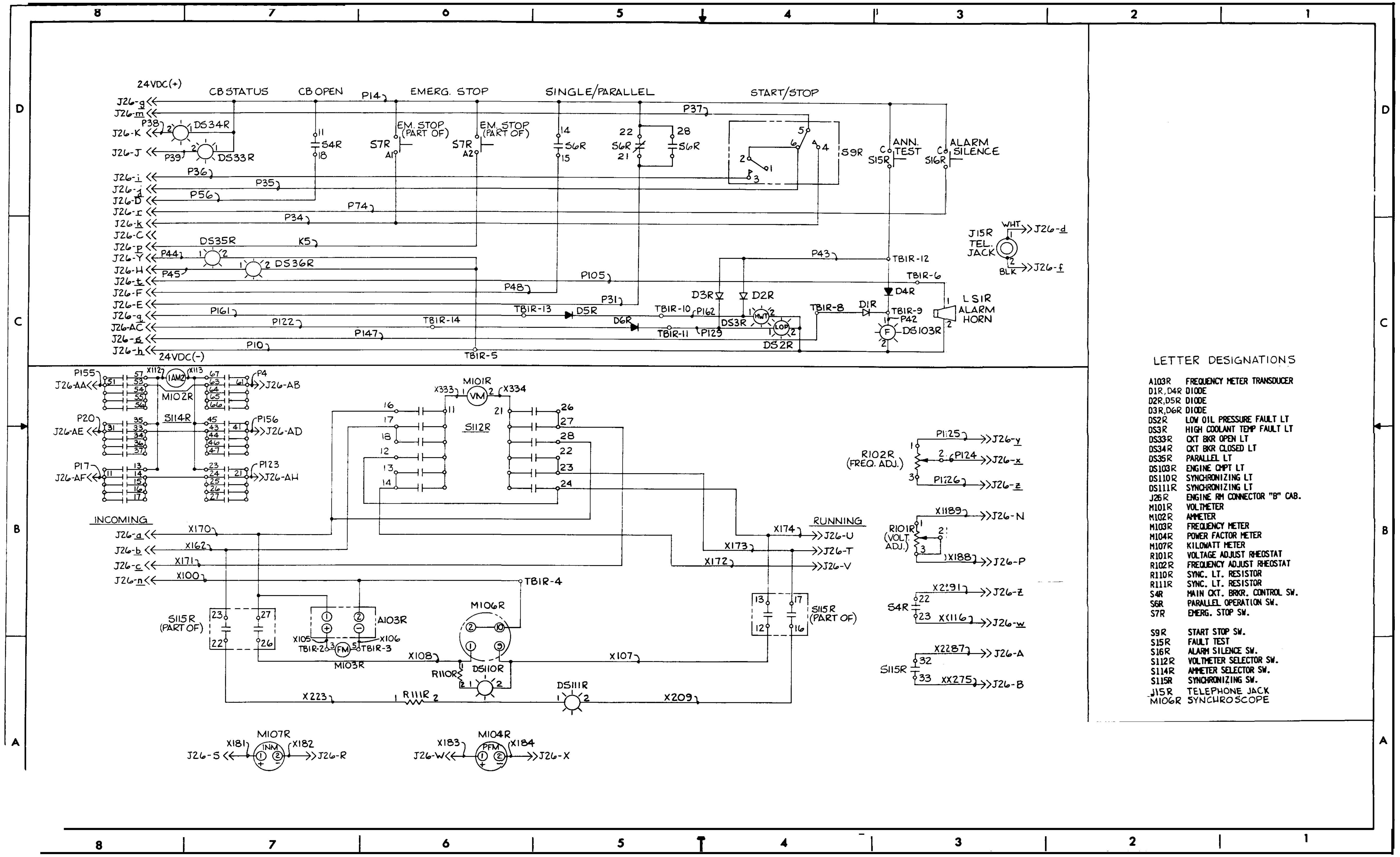
DESIG - TRM	DESCRIPTION	LOC	WD
R100	RESISTOR GROUND FAULT	7-D3	80-7862
R101	RHEOSTAT VOLTAGE ADJUST	2-C6	80-7866
R101R	RHEOSTAT VOLTAGE ADJUST	2-B5	80-7866
R102	RHEOSTAT FREQUENCY ADJUST	6-B8	80-7866
R103	RESISTOR PHASE SEQUENCE LIGHT	7-B2	80-7866
R104	RESISTOR PHASE SEQUENCE LIGHT	7-B3	80-7866
R105	RHEOSTAT REACTIVE CURRENT	2-C5	80-7862
R106	RHEOSTAT REMOTE VOLT. ADJ.	2-C6	80-7861
R107	RESISTOR REACTIVE CURRENT	2-B5	80-7861
R110	RESISTOR SYNCH LIGHT	7-C2	80-7866
R111	RESISTOR SYNCH LIGHT	7-C1	80-7866
S2	SWITCH LOCAL-REMOTE	2-C5	80-7866
S2	SWITCH LOCAL-REMOTE	2-C6	80-7866
S2	SWITCH LOCAL-REMOTE	3-B6	80-7866
S2	SWITCH LOCAL-REMOTE	3-B8	80-7866
S2	SWITCH LOCAL-REMOTE	5-A3	80-7866
S2	SWITCH LOCAL-REMOTE	5-A4	80-7866
S2	SWITCH LOCAL-REMOTE	5-D6	80-7866
S2	SWITCH LOCAL-REMOTE	6-C7	80-7866
S2	SWITCH LOCAL-REMOTE	7-C3	80-7866
S3	SWITCH AUTOMATIC MANUAL	2-C6	80-7866
S3	SWITCH AUTOMATIC MANUAL	2-C4	80-7866
S3	SWITCH AUTOMATIC MANUAL	3-B6	80-7866
S3	SWITCH AUTOMATIC MANUAL	3-A6	80-7866
S3	SWITCH AUTOMATIC MANUAL	6-B6	80-7866
S4	SWITCH MAIN CKT BKR CONTROL	3-B6	80-7866
S4R	SWITCH MAIN CKT BKR CONTROL	3-B8	80-7493
S100	SWITCH MAINT DISCONNECT	4-C7	80-7860
S101	THERMOSTAT LUBE OIL HEATER	4-C4	80-7688
S102	SWITCH CONTROL ROOM LT	3-B4	80-7494
S103	SWITCH ENGINE ROOM LT	3-B2	80-7494
S104	SWITCH ENGINE ROOM LT	3-B2	80-7494
S105	THERMOSTAT COOLANT HTR	4-B2	80-7688
S106	THERMOSTAT COOLANT HTR	4-B1	80-7688
S107	HUMIDISTAT SWITCH	4-B7	80-7860
S108(H103)	SWITCH CONTROL ROOM HTR	4-B5	80-7494
S109(H104)	SWITCH CONTROL ROOM HTR	4-B4	80-7494
S111	BREAKER SET/UTILITY CIRCUIT	3-C6	80-7494
S112	SWITCH VOLTMETER SELECT	7-C6	80-7866
S113	SWITCH GENERATOR TEMP SELECT	6-A6	80-7866
S114	SWITCH AMMETER SELECTOR	5-D4	80-7866
S115R	SWITCH SYNCHRONIZING	3-B7	80-7866
S115	SWITCH SYNCHRONIZING	3-B7	80-7866
S115	SWITCH SYNCHRONIZING	7-C2	80-7866
S116	SWITCH PHASE SEQUENCE TEST	7-B3	80-7866
S117	SWITCH DROOP ISOCH.	6-B5	80-7866
S117	SWITCH DROOP ISOCH.	6-C7	80-7866
S118	SWITCH 50/60 Hz SELECT	6-C7	80-7862
S118	SWITCH 50/60 Hz SELECT	6-D7	80-7862
S119	SWITCH PHASE SEQUENCE	7-B4	80-7862
S120	SWITCH GENERATOR DISCONNECT	7-D3	80-7862
T100	TRANSFORMER GROUND FAULT	3-D7	80-7862
T101	TRANSFORMER SET STATION PWR	2-D3	80-7860
T102	TRANSFORMER VOLTAGE REG.	2-D6	80-7862
T103	TRANSFORMER UTILITY STA. PWR	3-C5	80-7860
T104	TRANSFORMER GEN INSTRUMENT	4-D6	80-7862
T105	TRANSFORMER PHASE SHIFT	5-A6	80-7862
T106	TRANSFORMER GEN INSTRUMENT	4-D7	80-7862
T107	TRANSFORMER GEN INSTRUMENT	4-D7	80-7862

DESIG - TRM	DESCRIPTION	LOC	WD
T108	TRANSFORMER BUS INSTRUMENT	7-C3	80-7862
T109	TRANSFORMER BUS INSTRUMENT	7-D4	80-7862
T110	TRANSFORMER BUS INSTRUMENT	7-C4	80-7862
TB01-1	TERMINAL BLOCK	7-D7	80-7863
TB01-2	TERMINAL BLOCK	7-D7	80-7863
TB2-1	TERMINAL BLOCK	4-B7	80-7862
TB2-6	TERMINAL BLOCK	6-C6	80-7862
TB2-17	TERMINAL BLOCK	3-B6	80-7862
TB2-19	TERMINAL BLOCK	6-C6	80-7862
TB2-20	TERMINAL BLOCK	6-C5	80-7862
TB3-12	TERMINAL BLOCK	3-B8	80-7862
TB3-13	TERMINAL BLOCK	3-A7	80-7862
TB3-14	TERMINAL BLOCK	3-B6	80-7862
TB4-6	TERMINAL BLOCK	6-B3	80-7862
TB4-8	TERMINAL BLOCK	7-D3	80-7862
TB4-10	TERMINAL BLOCK	7-D3	80-7862
TB5-11	TERMINAL BLOCK	4-B8	80-7860
TB6-1	TERMINAL BLOCK	4-B1	80-7860
TB6-3	TERMINAL BLOCK	4-B1	80-7860
TB6-6	TERMINAL BLOCK	4-B1	80-7860
TB6-8	TERMINAL BLOCK	4-B1	80-7860
TB6-9	TERMINAL BLOCK	3-B8	80-7860
TB6-12	TERMINAL BLOCK	3-B6	80-7860
TB6-13	TERMINAL BLOCK	3-B7	80-7860
TB6-16	TERMINAL BLOCK	3-B6	80-7860
TB8-9	TERMINAL BLOCK	2-C5	80-7860
TB8-11	TERMINAL BLOCK	2-C4	80-7860
TB10-11	TERMINAL BLOCK	4-A2	80-7860
TB10-12	TERMINAL BLOCK	4-B2	80-7860
TB10-13	TERMINAL BLOCK	4-B2	80-7860
TB10-14	TERMINAL BLOCK	4-B3	80-7860
TB11-14	TERMINAL BLOCK	6-B4	80-7860
TB13-9	TERMINAL BLOCK	6-B4	80-7862
TB13-11	TERMINAL BLOCK	6-B3	80-7862
TB14-11	TERMINAL BLOCK	2-C4	80-7862
TB14-13	TERMINAL BLOCK	2-C4	80-7862
TB15-11	TERMINAL BLOCK	6-C6	80-7862
TB15-12	TERMINAL BLOCK	6-C5	80-7862
TB15-13	TERMINAL BLOCK	6-C5	80-7862
TB15-14	TERMINAL BLOCK	6-C6	80-7862
TB17-1	TERMINAL BLOCK	6-B3	80-7862
TB17-3	TERMINAL BLOCK	6-B3	80-7862
TB17-5	TERMINAL BLOCK	6-B3	80-7862
TB17-6	TERMINAL BLOCK	6-B3	80-7862
TB17-8	TERMINAL BLOCK	6-B3	80-7862
TB21-3	TERMINAL BLOCK	6-B6	80-7860
TB21-4	TERMINAL BLOCK	6-B6	80-7860
TB21-14	TERMINAL BLOCK	6-C6	80-7860
TB21-15	TERMINAL BLOCK	6-C6	80-7860
TB21-18	TERMINAL BLOCK	6-B3	80-7860
TB21-19	TERMINAL BLOCK	6-B6	80-7860
TB21-20	TERMINAL BLOCK	3-A7	80-7860
TB50-12	TERMINAL BLOCK	2-C4	80-7861
TB50-13	TERMINAL BLOCK	2-C4	80-7861
TB50-15	TERMINAL BLOCK	6-B5	80-7861
TB51-1	TERMINAL BLOCK	4-B4	80-7860
TB51-2	TERMINAL BLOCK	4-B4	80-7860
TB51-3	TERMINAL BLOCK	4-B2	80-7860
TB51-4	TERMINAL BLOCK	4-B2	80-7860
TB51-5	TERMINAL BLOCK	4-B1	80-7860
TB51-6	TERMINAL BLOCK	4-B1	80-7860
TB51-7	TERMINAL BLOCK	4-B1	80-7860
TB51-8	TERMINAL BLOCK	4-B1	80-7860
TB51-9	TERMINAL BLOCK	4-C4	80-7860
TB51-10	TERMINAL BLOCK	4-C4	80-7860
TB51-11	TERMINAL BLOCK	4-C7	80-7860
TB51-12	TERMINAL BLOCK	4-C7	80-7860
TB51-13	TERMINAL BLOCK	4-C5	80-7860
TB51-14	TERMINAL BLOCK	4-C4	80-7860
TB51-15	TERMINAL BLOCK	4-A8	80-7860
TB51-16	TERMINAL BLOCK	4-C7	80-7860
TB51-20	TERMINAL BLOCK	4-A7	80-7860

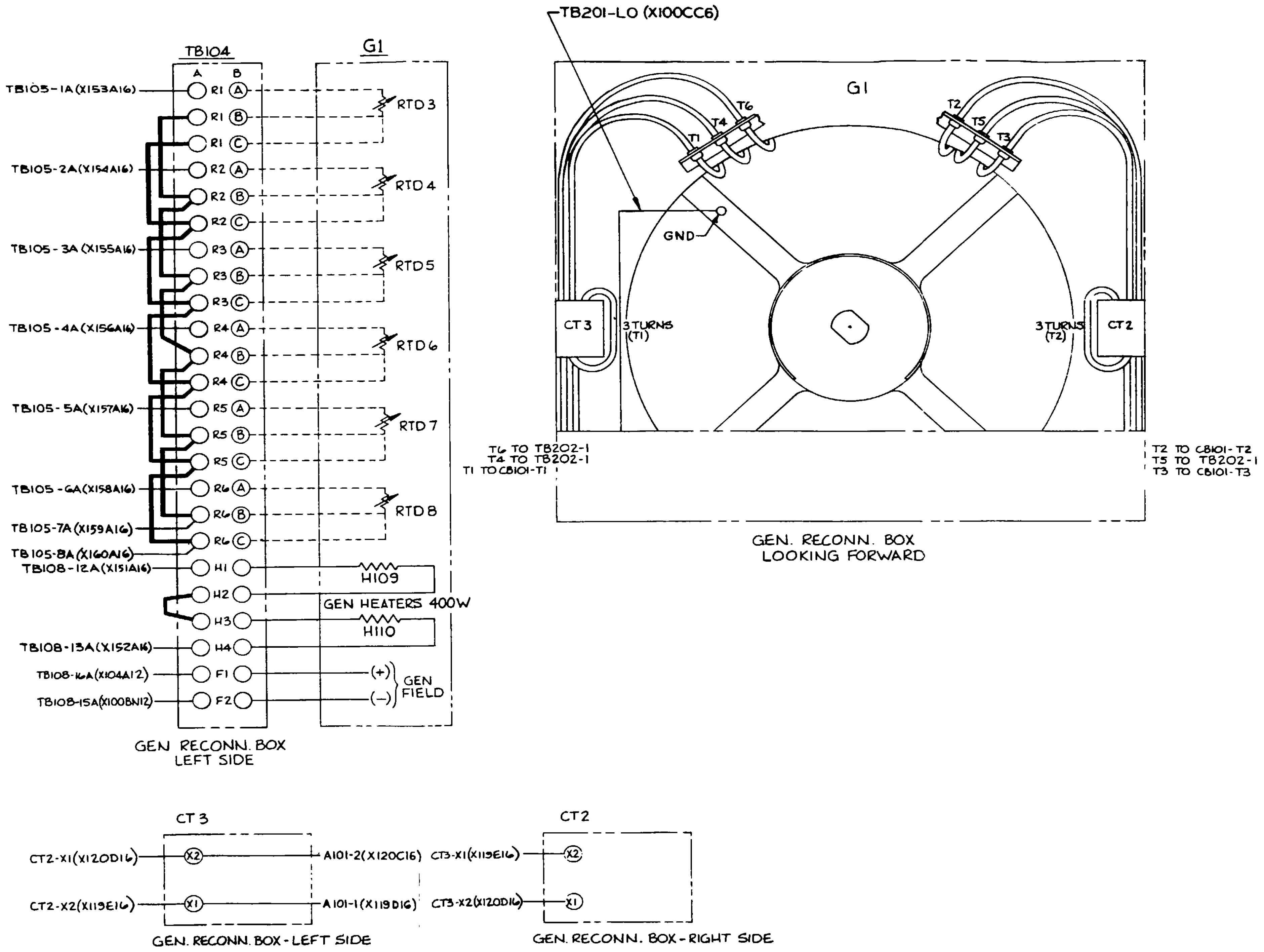
DESIG - TRM	DESCRIPTION	LOC	WD
TB103	TERMINAL BLOCK	3-C4	80-7860
TB104	TERMINAL BLOCK	6-A8	80-7356
TB104-F1	TERMINAL BLOCK	2-C8	80-7356
TB104-F2	TERMINAL BLOCK	2-C8	80-7356
TB104-H1	TERMINAL BLOCK	4-B4	80-7356
TB104-H2	TERMINAL BLOCK	4-B3	80-7356
TB104-H3	TERMINAL BLOCK	4-B3	80-7356
TB104-H4	TERMINAL BLOCK	4-B4	80-7356
TB105	TERMINAL BLOCK	6-B7	80-7861
TB105-9	TERMINAL BLOCK	7-C5	80-7861
TB105-10	TERMINAL BLOCK	7-B5	80-7861
TB105-10	TERMINAL BLOCK	7-D5	80-7861
TB105-10	TERMINAL BLOCK	5-B7	80-7861
TB105-11	TERMINAL BLOCK	7-D5	80-7861
TB105-11	TERMINAL BLOCK	6-A4	80-7861
TB105-12	TERMINAL BLOCK	7-D5	80-7861
TB105-12	TERMINAL BLOCK	6-C7	80-7861
TB105-13	TERMINAL BLOCK	7-C5	80-7861
TB105-13	TERMINAL BLOCK	5-B6	80-7861
TB105-14	TERMINAL BLOCK	2-C5	80-7861
TB105-15	TERMINAL BLOCK	5-D7	80-7861
TB105-16	TERMINAL BLOCK	5-D7	80-7861
TB105-17	TERMINAL BLOCK	5-D6	80-7861
TB105-18	TERMINAL BLOCK	5-C7	80-7861
TB105-19	TERMINAL BLOCK	5-C7	80-7861
TB105-20	TERMINAL BLOCK	5-B7	80-7861
TB106	TERMINAL BLOCK	5-C5	80-7861
TB106-1	TERMINAL BLOCK	5-B7	80-7861
TB106-1	TERMINAL BLOCK	7-D5	80-7861
TB106-2	TERMINAL BLOCK	5-B7	80-7861
TB106-2	TERMINAL BLOCK	7-C6	80-7861
TB106-3	TERMINAL BLOCK	7-C4	80-7861
TB106-4	TERMINAL BLOCK	7-C4	80-7861
TB106-5	TERMINAL BLOCK	7-C3	80-7861
TB106-5	TERMINAL BLOCK	6-A7	80-7861
TB106-9	TERMINAL BLOCK	5-D6	80-7861
TB106-10	TERMINAL BLOCK	5-D6	80-7861
TB106-11	TERMINAL BLOCK	5-D6	80-7861
TB106-12	TERMINAL BLOCK	5-B3	80-7861
TB106-13	TERMINAL BLOCK	5-A3	80-7861
TB106-14	TERMINAL BLOCK	5-B4	80-7861
TB106-15	TERMINAL BLOCK	5-A4	80-7861
TB106-16	TERMINAL BLOCK	6-B5	80-7861
TB106-17	TERMINAL BLOCK	5-B7	80-7861
TB106-18	TERMINAL BLOCK	5-A3	80-7861
TB106-19	TERMINAL BLOCK	5-D5	80-7861
TB107-2	TERMINAL BLOCK	2-C5	80-7861
TB107-3	TERMINAL BLOCK	2-C6	80-7861
TB107-4	TERMINAL BLOCK	5-C7	80-7861
TB107-5	TERMINAL BLOCK	2-C7	80-7861
TB107-6	TERMINAL BLOCK	5-D5	80-7861
TB107-7	TERMINAL BLOCK	3-A6	80-7861
TB107-8	TERMINAL BLOCK	3-B6	80-7861
TB107-10	TERMINAL BLOCK	5-A7	80-7861
TB107-14	TERMINAL BLOCK	2-C7	80-7861
TB107-15	TERMINAL BLOCK	6-C7	80-7861
TB107-16	TERMINAL BLOCK	6-C7	80-7861
TB107-17	TERMINAL BLOCK	6-B7	80-7861
TB107-19	TERMINAL BLOCK	5-A4	80-7861
TB107-20	TERMINAL BLOCK	5-D5	80-7861

DESIG - TRM	DESCRI'ION	LOC	WD
TB108-1	TERMINAL BLOCK	4-B8	80-7861
TB108-5	TERMINAL BLCCK	2-C8	80-7861
TB108-8	TERMINAL BLOCK	4-B4	80-7861
TB108-9	TERMINAL BLOCK	4-A4	80-7861
TB108-10	TERMINAL BLOCK	4-B2	80-7861
TB108-11	TERMINAL BLOCK	4-B2	80-7861
TB108-12	TERMINAL BLOCK	4-B4	80-7861
TB108-13	TERMINAL BLOCK	4-B4	80-7861
TB108-14	TERMINAL BLOCK	2-C6	80-7861
TB108-16	TERMINAL BLOCK	2-C7	80-7861
TB108-18	TERMINAL BLOCK	2-C3	80-7861
TB108-20	TERMINAL BLOCK	6-C3	80-7861
TB110	TERMINAL BLOCK	6-D5	80-7862
TB110-1	TERMINAL BLOCK	5-B2	80-7862
TB110-3	TERMINAL BLOCK	5-B2	80-7862
TB110-3	TERMINAL BLOCK	4-C7	80-7862
TB110-5	TERMINAL BLOCK	5-D6	80-7862
TB110-5	TERMINAL BLOCK	2-C5	80-7862
TB110-5	TERMINAL BLOCK	6-D7	80-7862
TB110-7	TERMINAL BLOCK	2-C5	80-7862
TB110-9	TERMINAL BLOCK	2-C5	80-7862
TB110-11	TERMINAL BLOCK	7-C7	80-7862
TB110-12	TERMINAL BLOCK	7-C6	80-7862
TB110-13	TERMINAL BLOCK	2-C4	80-7862
TB110-16	TERMINAL BLOCK	2-C4	80-7862
TB110-17	TERMINAL BLOCK	7-D6	80-7862
TB110-19	TERMINAL BLOCK	7-D7	80-7862
TB111	TERMINAL BLOCK	6-C4	80-7860
TB111-6	TERMINAL BLOCK	2-C5	80-7860
TB111-7	TERMINAL BLOCK	2-B4	80-7860
TB111-8	TERMINAL BLOCK	2-B4	80-7860
TB111-16	TERMINAL BLOCK	2-C5	80-7860
TB202	TERMINAL BLOCK	2-D8	80-7861
VR101	VOLTAGE REGULATR	2-A6	80-7861
WMT	WATTMETER/WATTHR TRANSDUCER	5-C3	80-7861

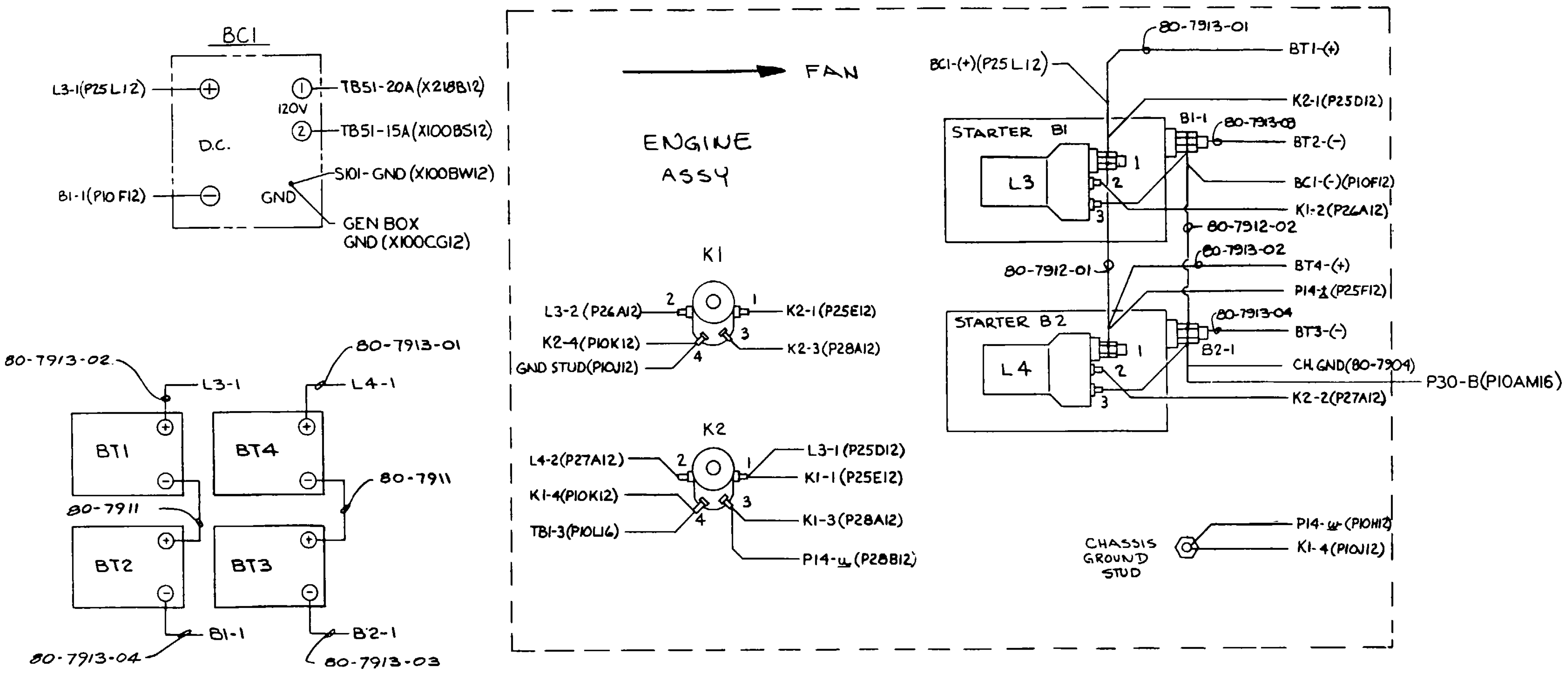
FO-2 AC Schematic Diagram
(Sheet 8 of 8)



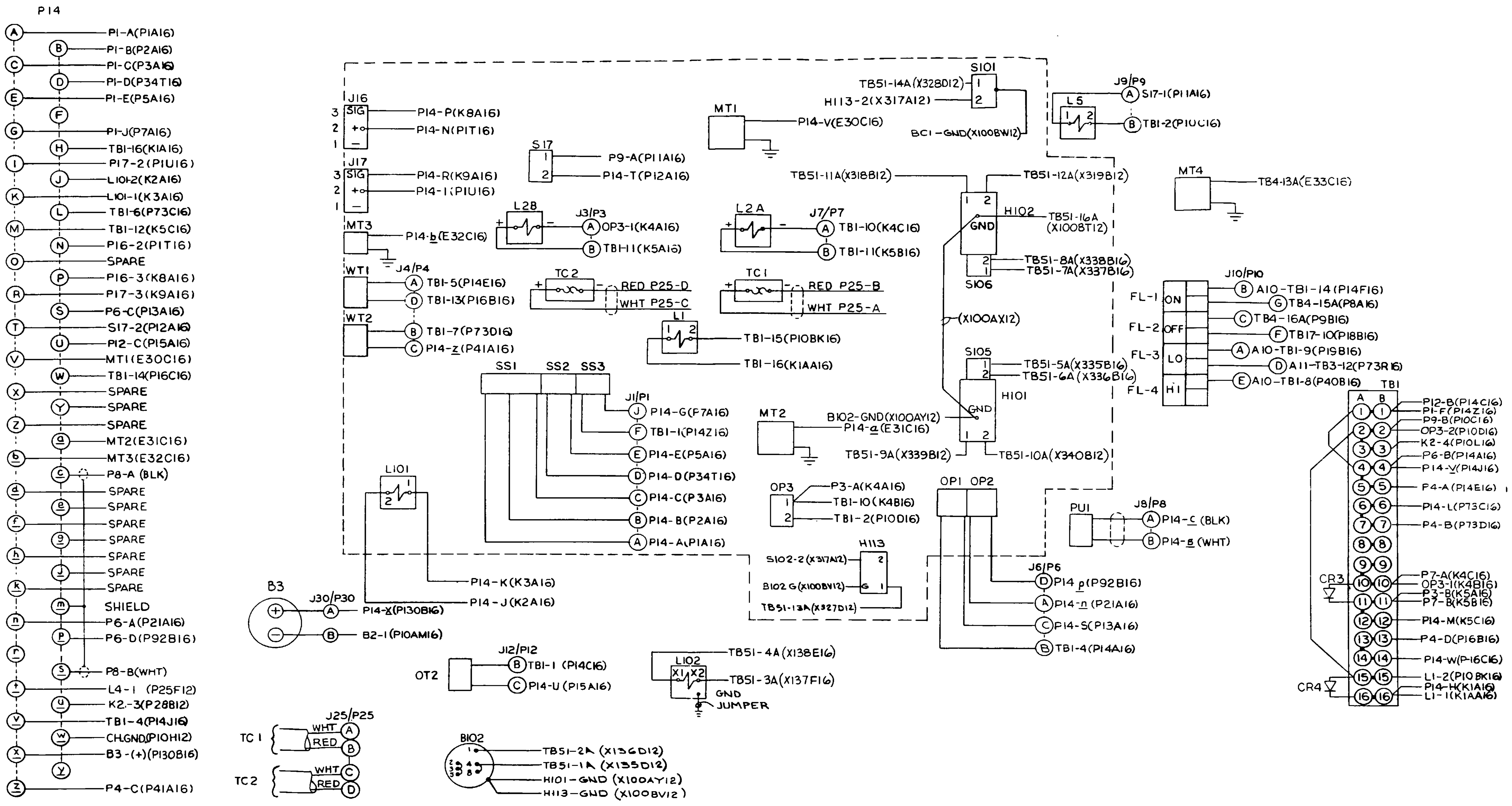
FO-3. Remote Control Module AC and DC Schematic Diagram



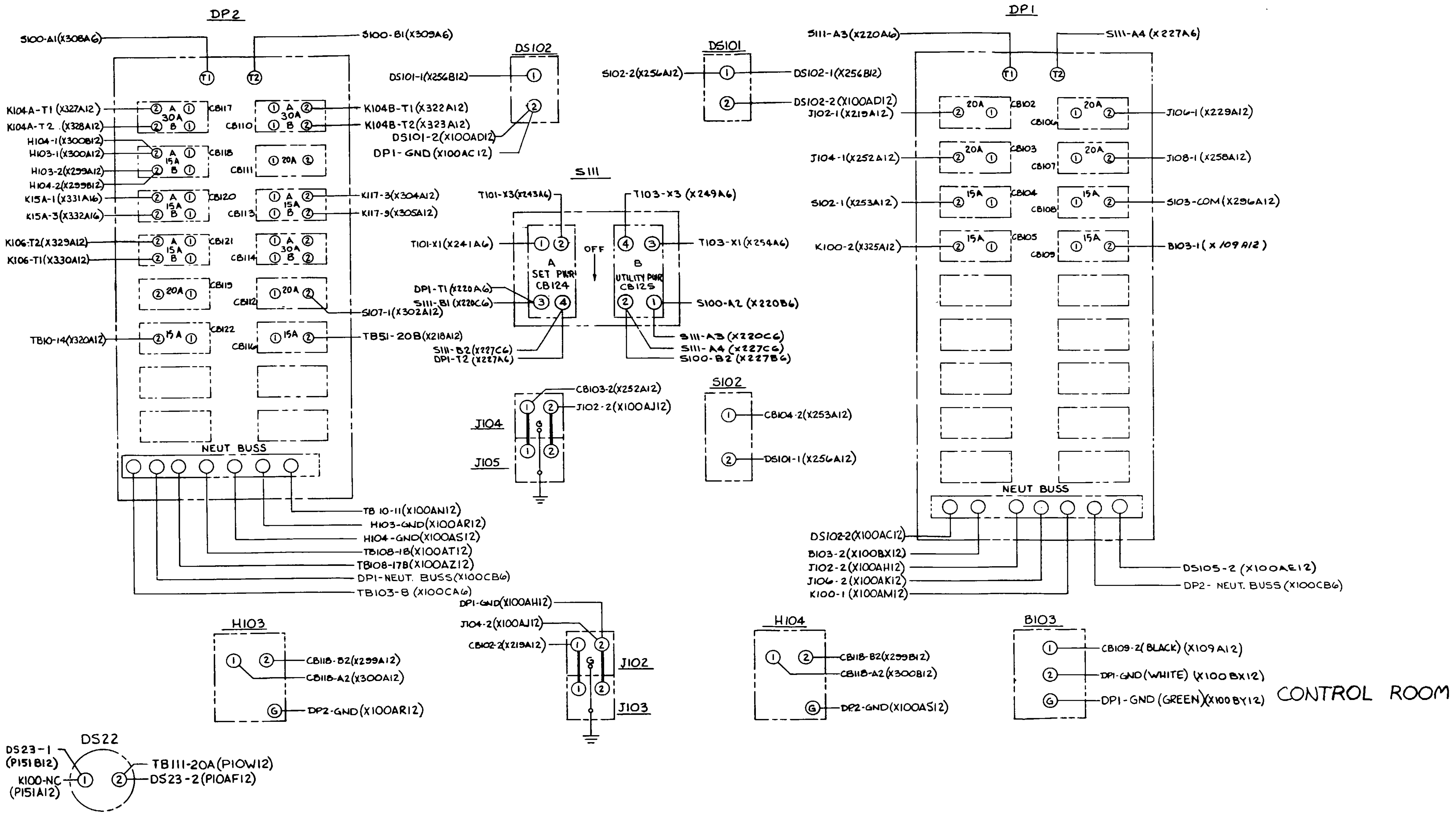
FO-4 Generator Connection Box Wiring Diagram



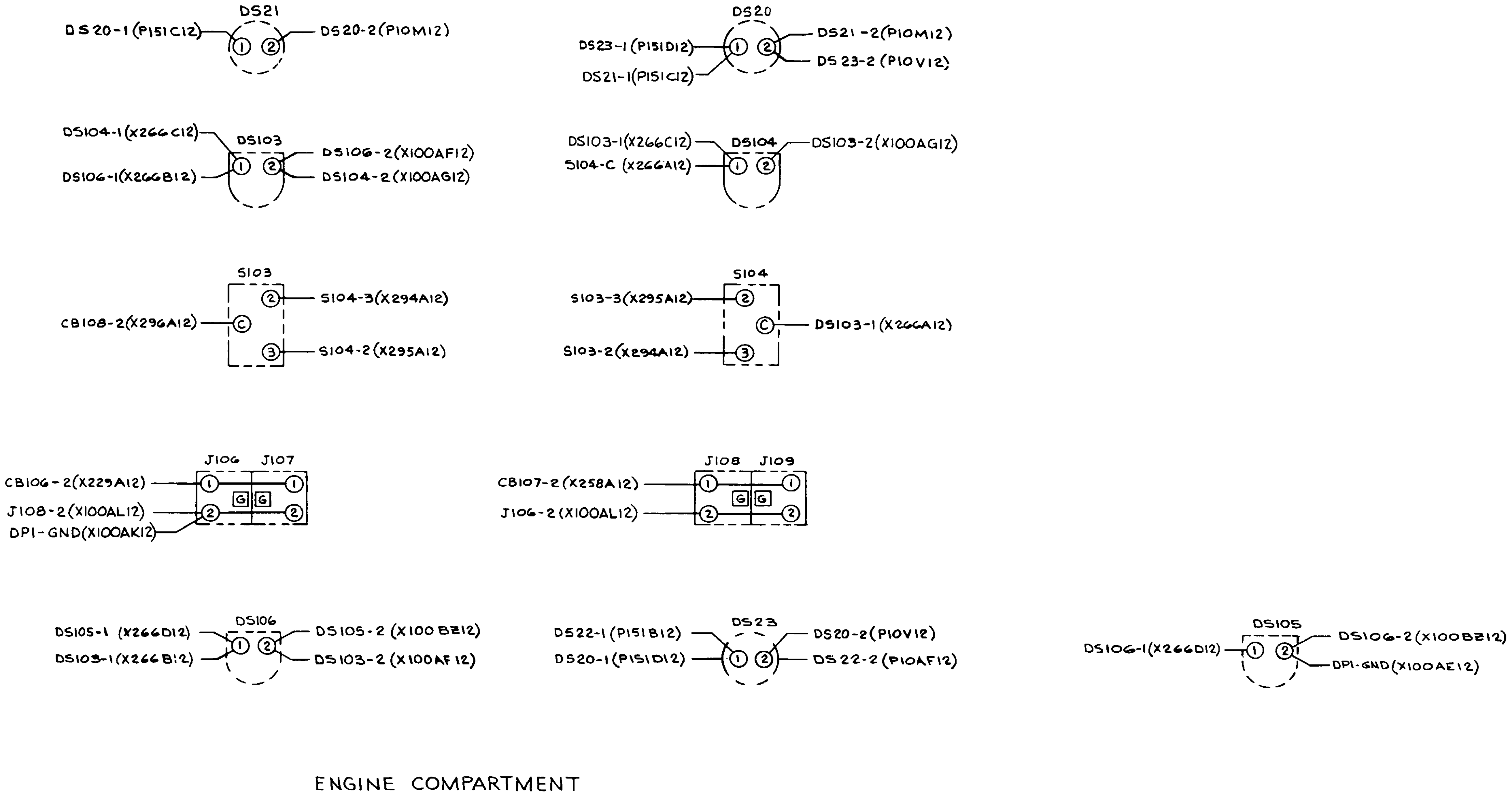
FO-5 Engine Accessories Wiring Diagram (Sheet 1 of 2)



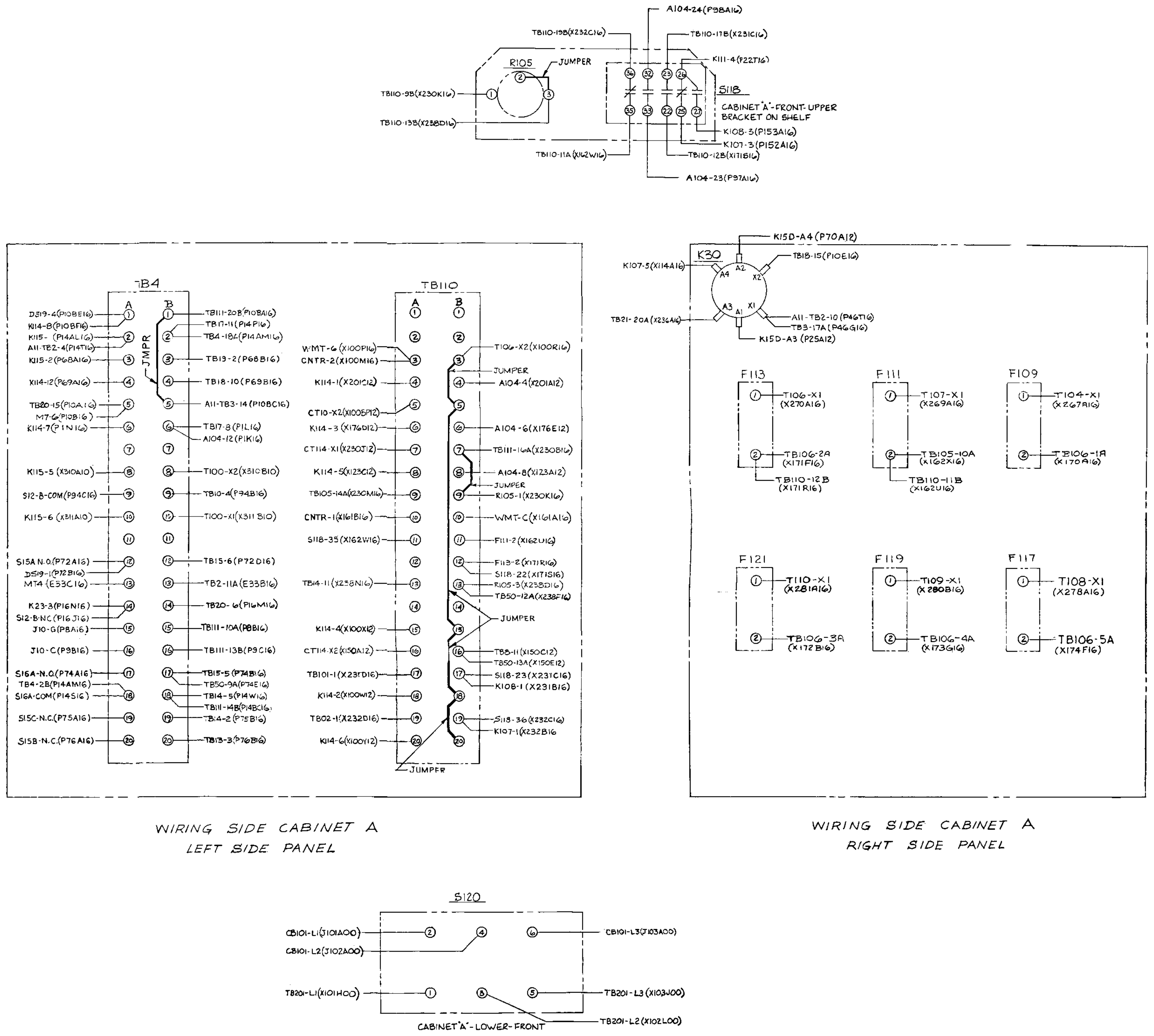
FO-5 Engine Accessories Wiring Diagram (Sheet 2 of 2)
FO-39/(FO-40 blank)



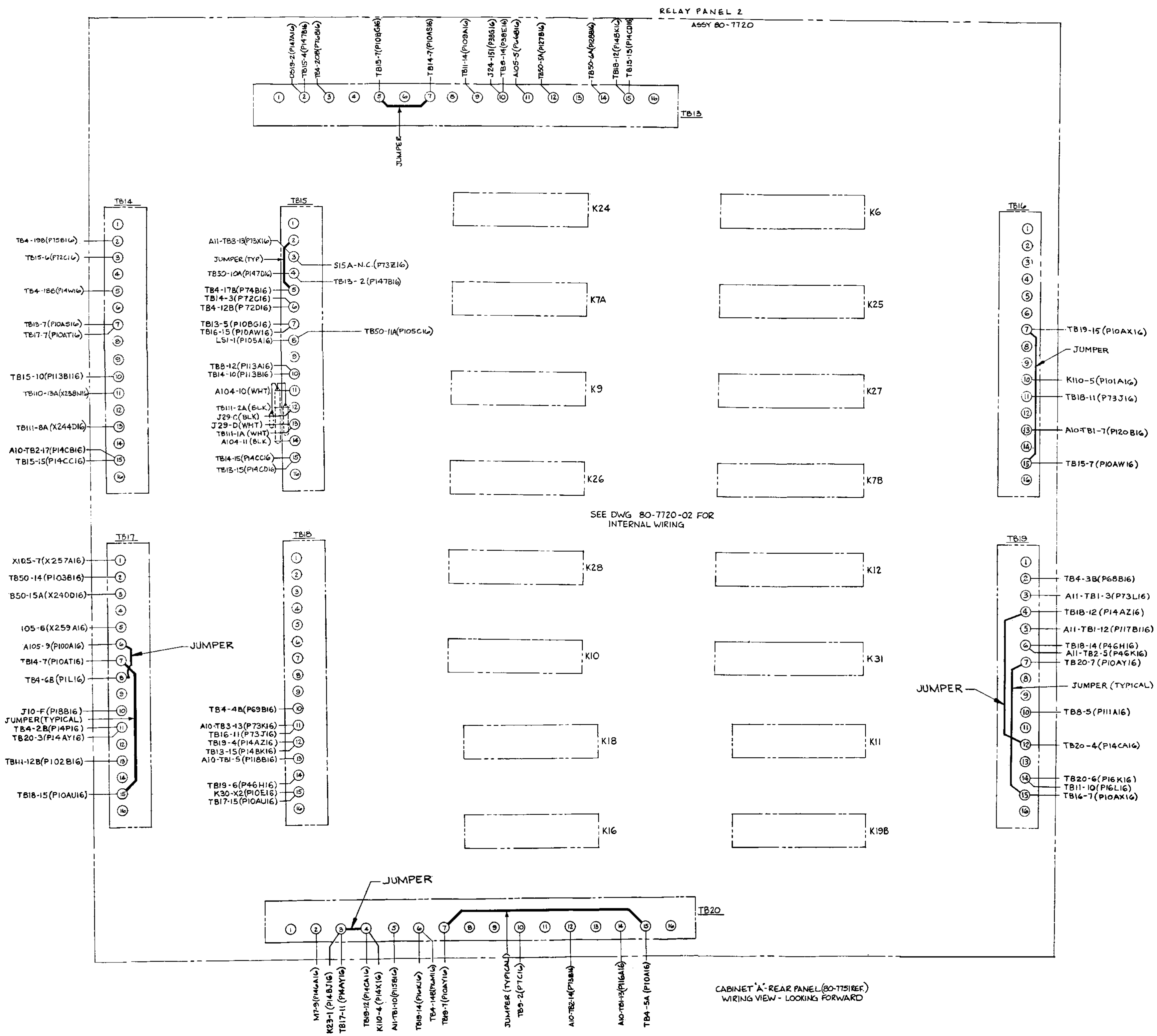
FO-6 Control Room Wiring Diagram
(Sheet 1 of 2)
FO-41/(FO-42 blank)



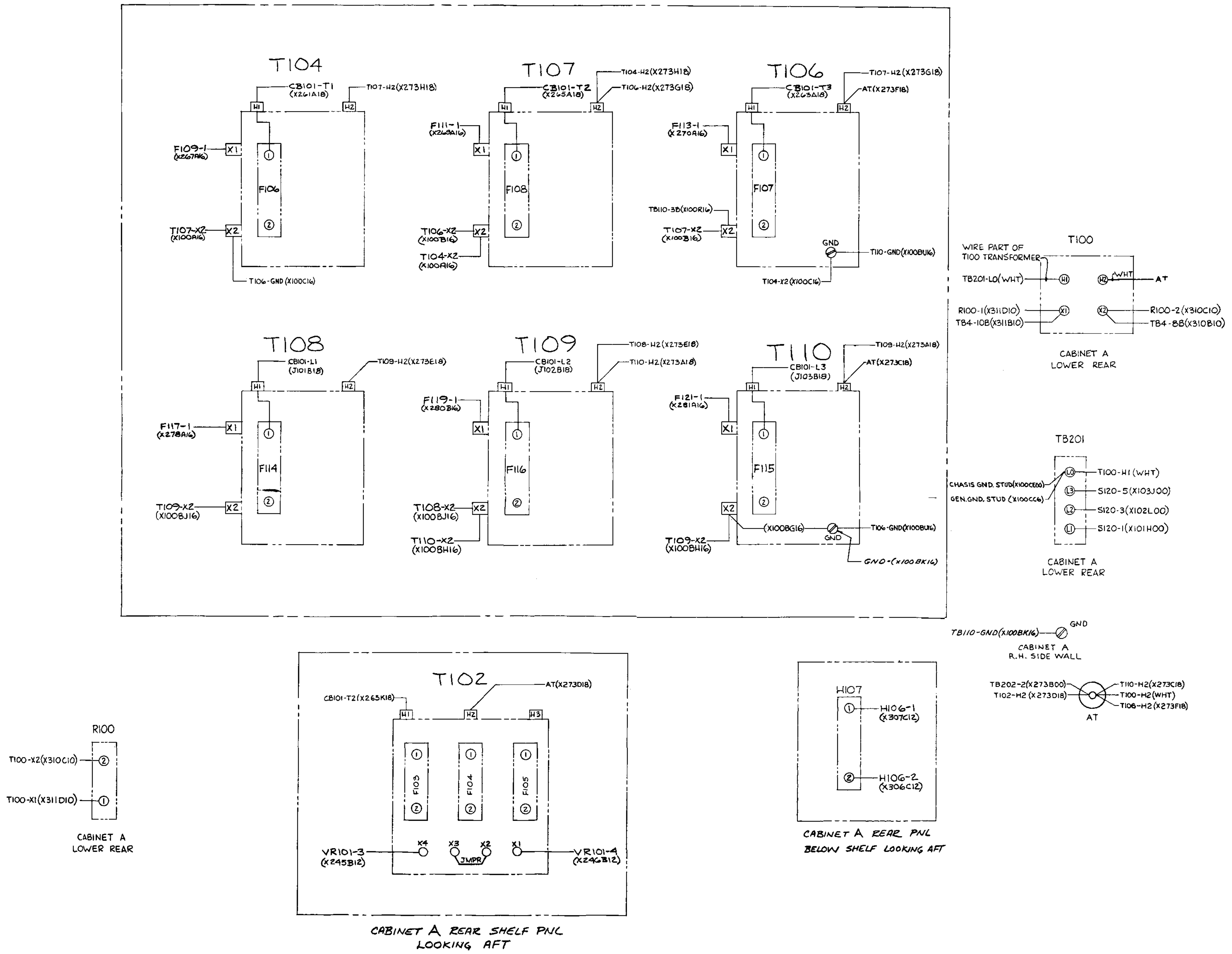
FO.6 Control Room Wiring Diagram
(Sheet 2 of 2)



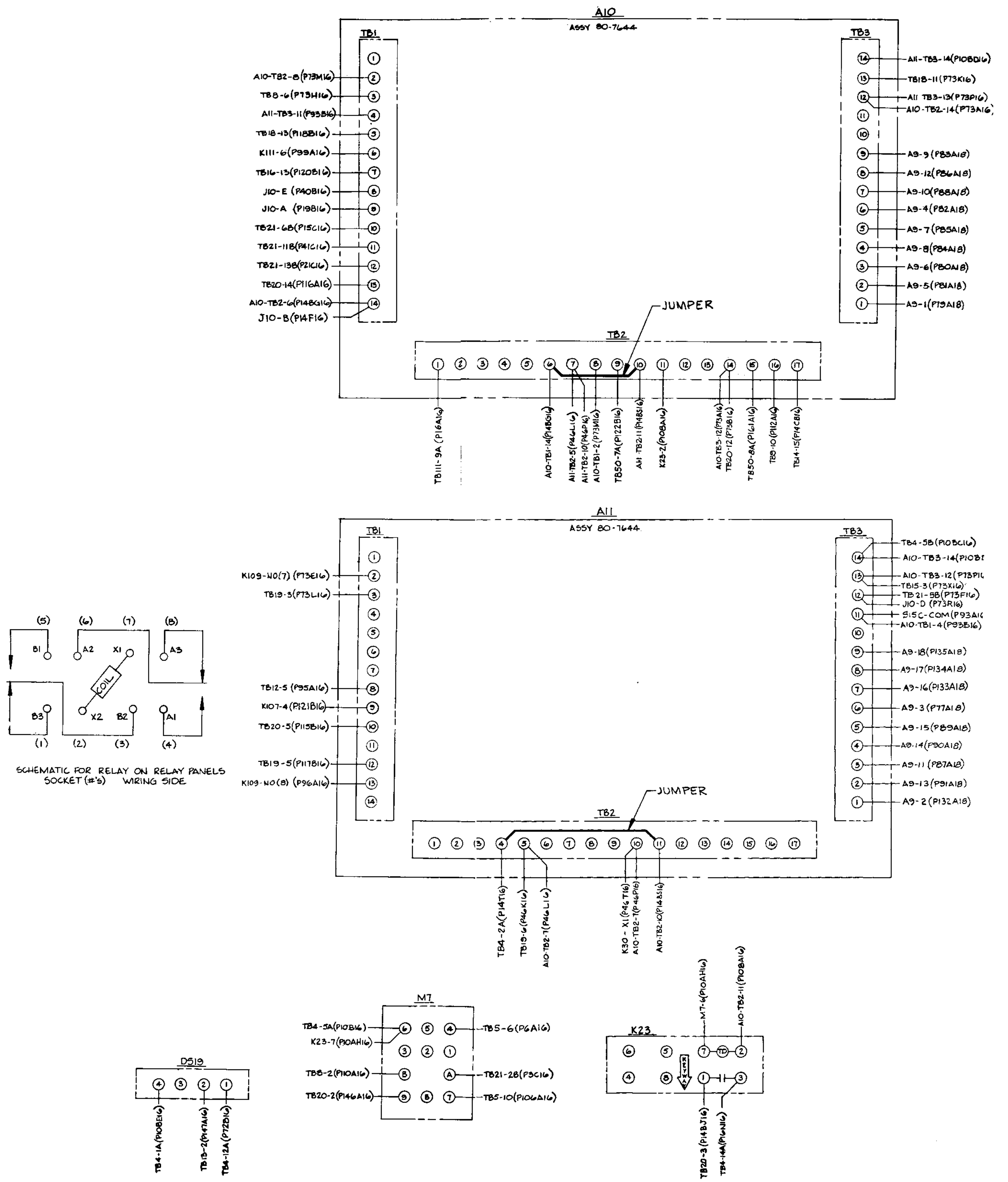
FO-7. Cabinet A Wiring Diagram (Sheet 1 of 4)



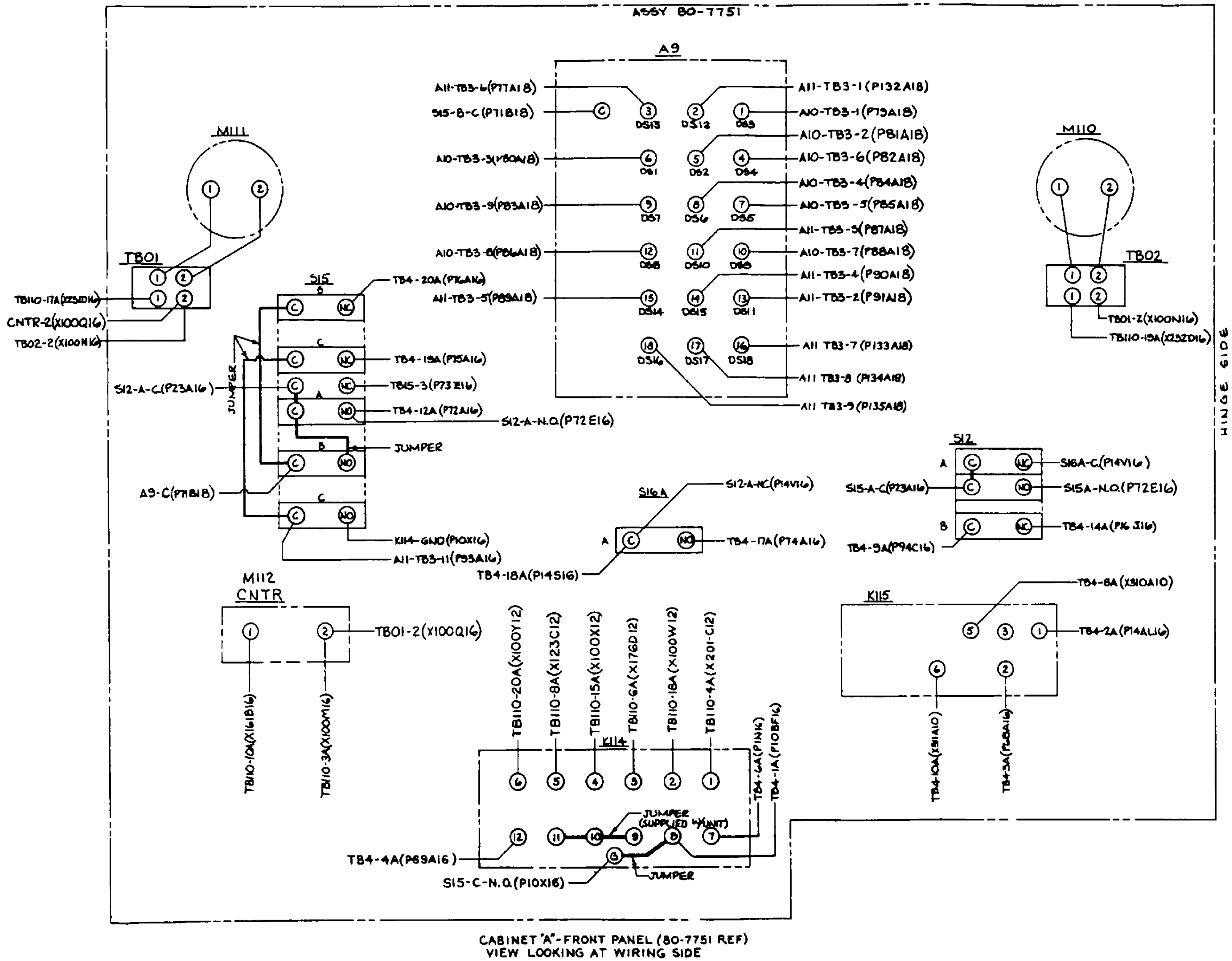
FO-7. Cabinet A Wiring Diagram (Sheet 2 of 4)



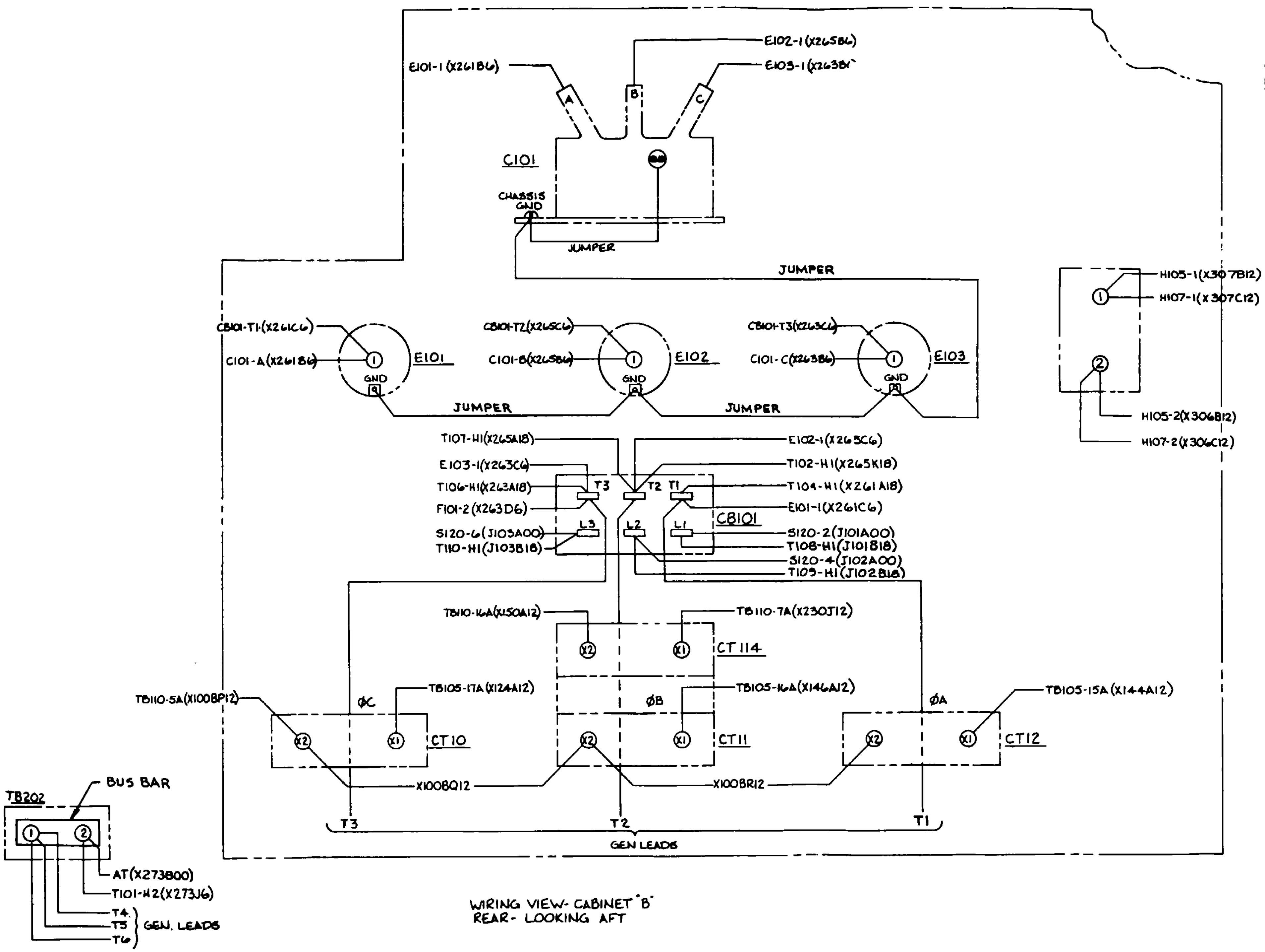
FO-7. Cabinet A Wiring Diagram (Sheet 3 of 4)



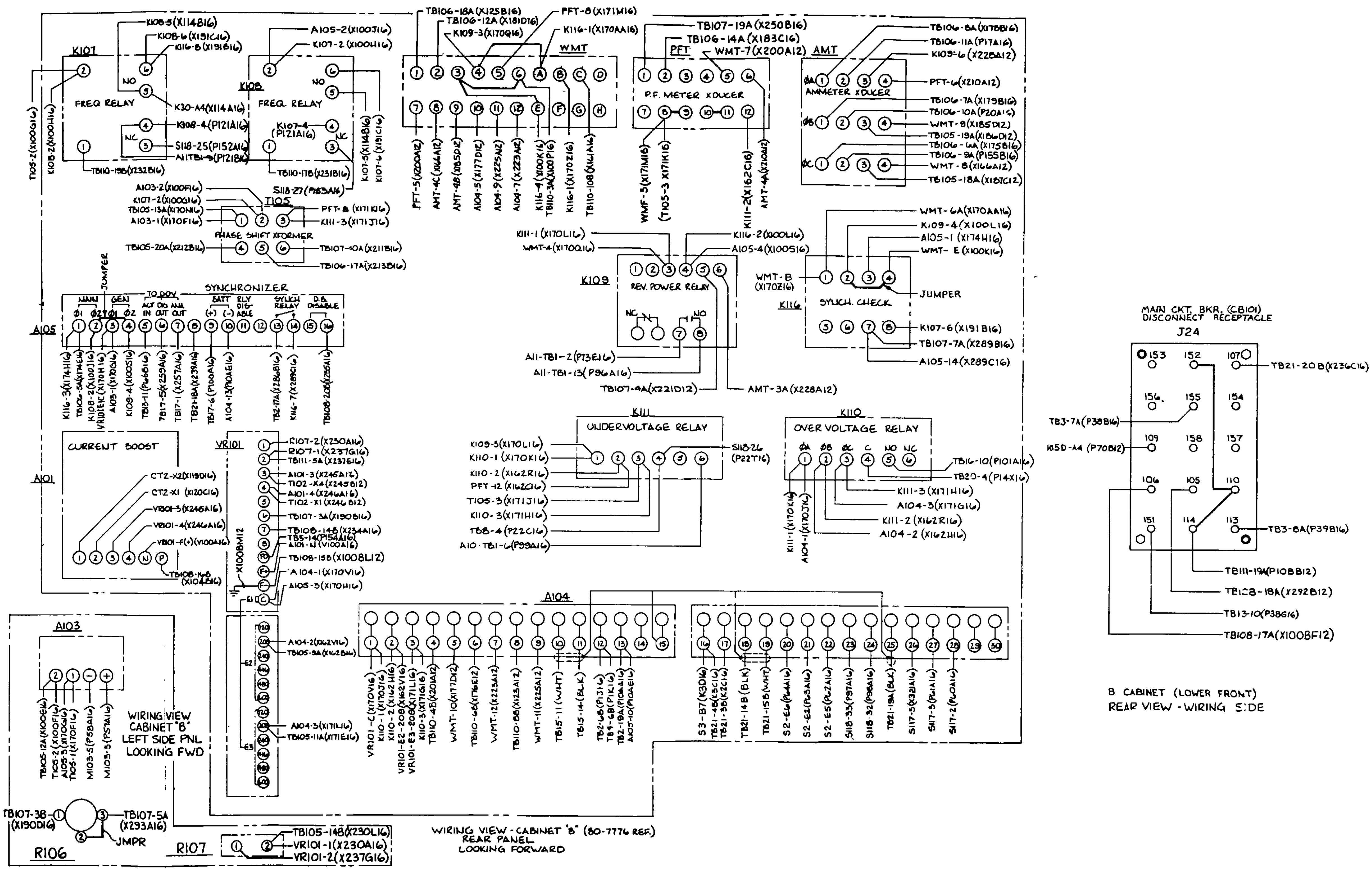
FO-7. Cabinet A Wiring Diagram (Sheet 4 of 4)



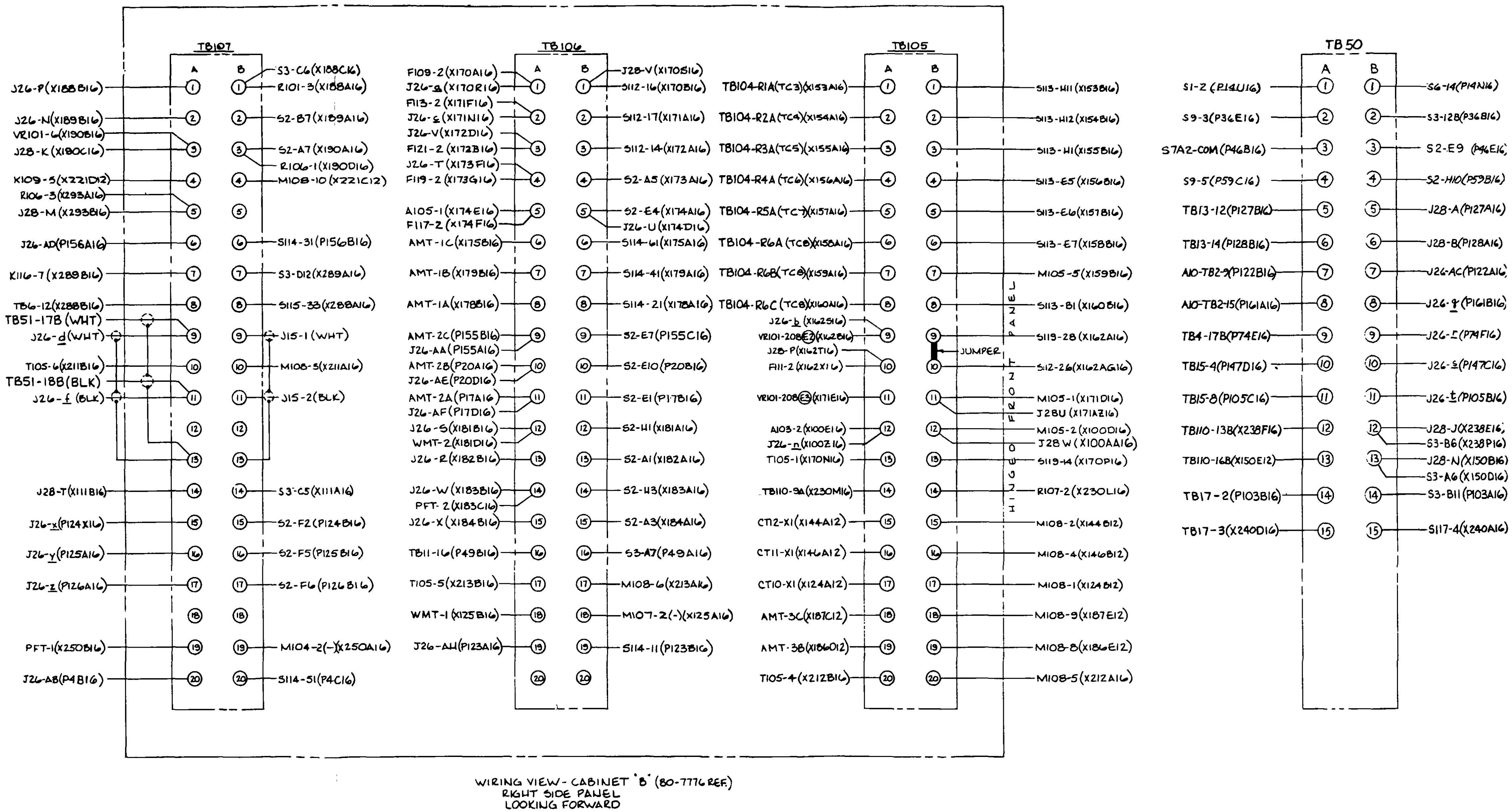
FO-8. Cabinet A Door Wiring Diagram



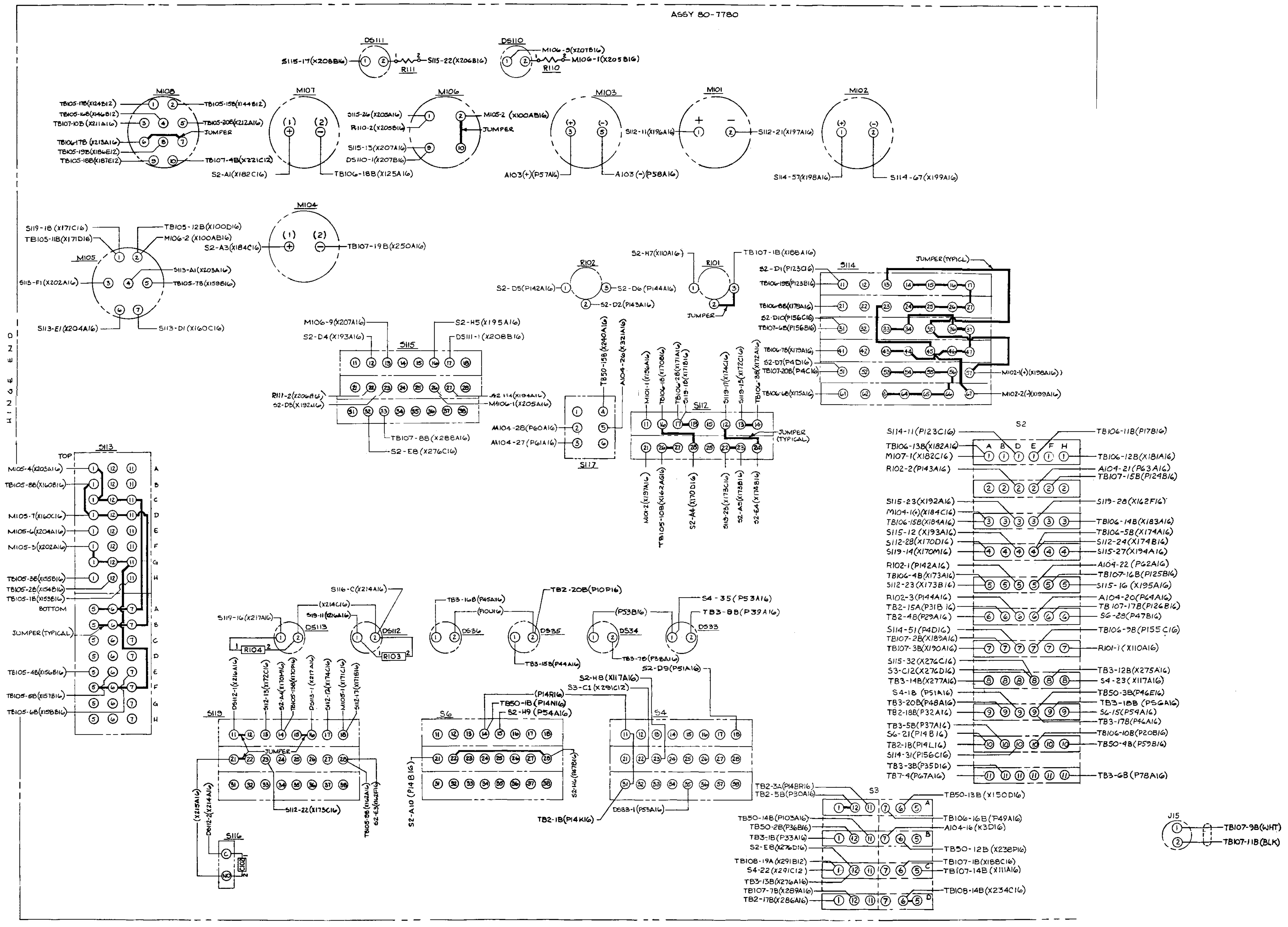
FO-9. Cabinet B Wiring Diagram (Sheet 1 of 3)



FO-9. Cabinet B Wiring Diagram (Sheet 2 of 3)

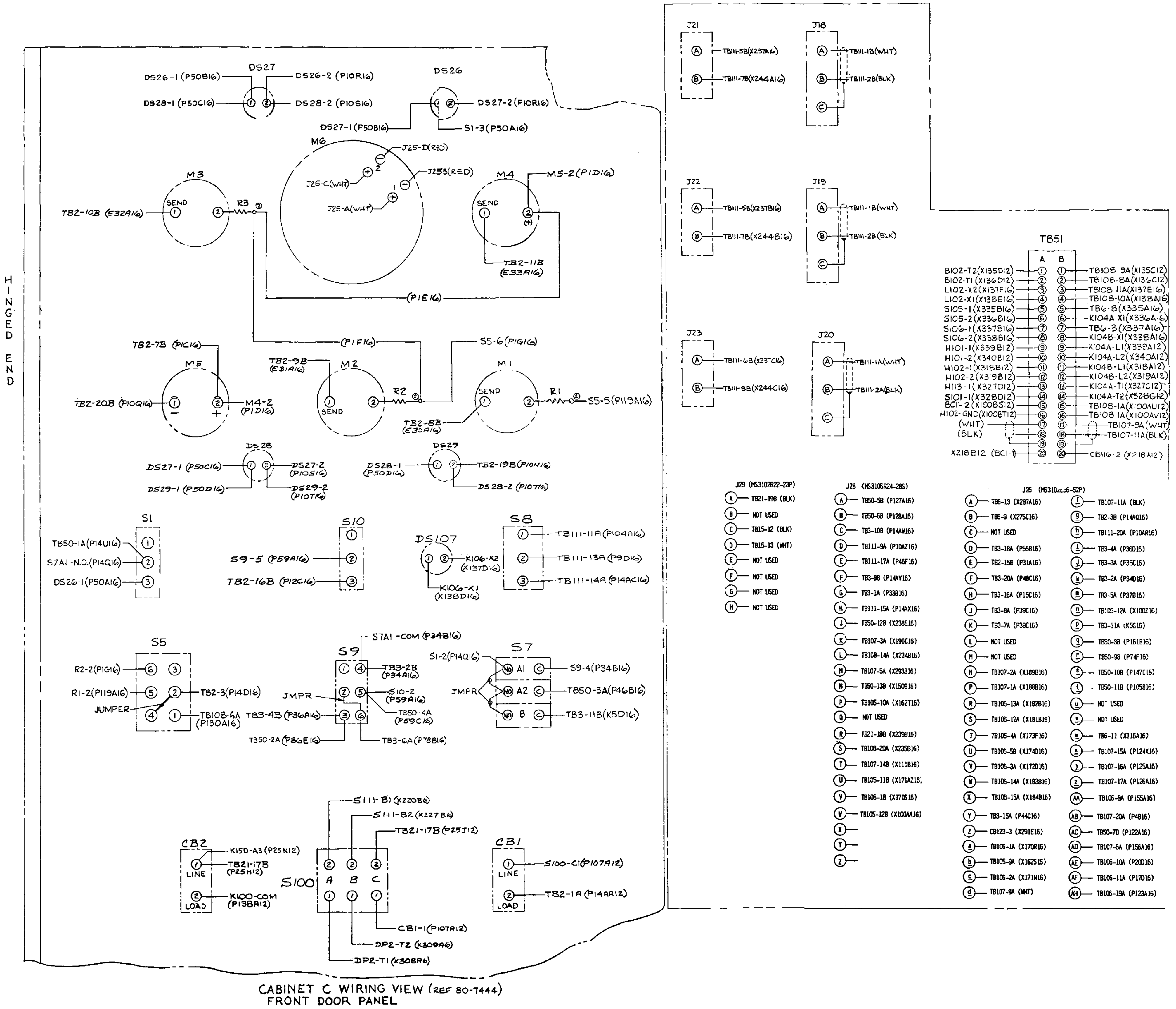


FO-9. Cabinet B Wiring Diagram (Sheet 3 of 3)

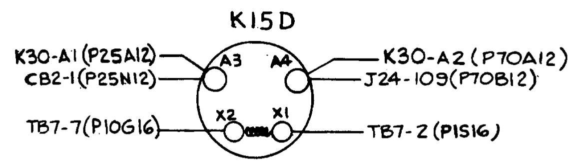


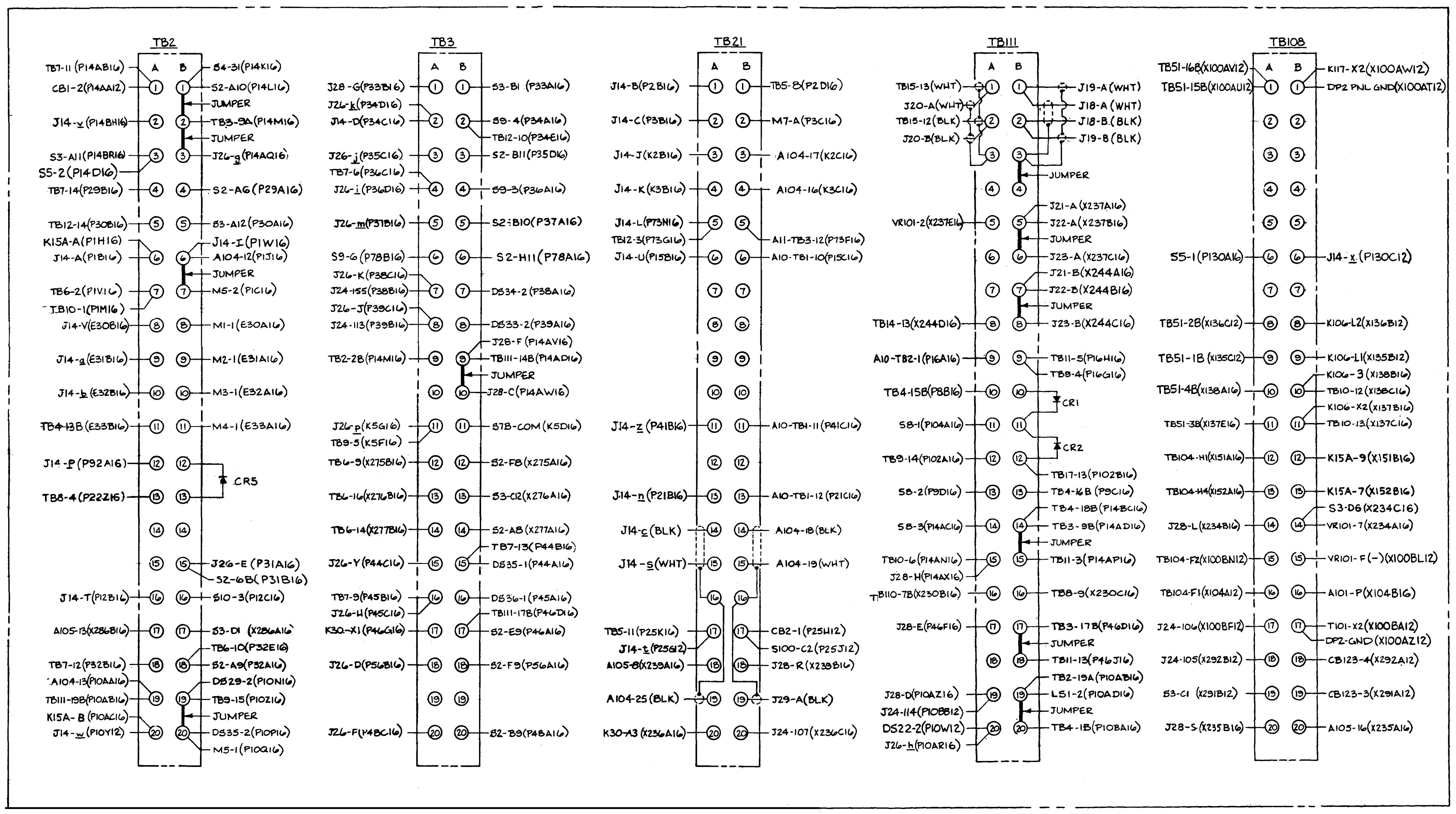
WIRING VIEW- CABINET "B"
FRONT PANEL

FO-10. Cabinet B Door Wiring Diagram

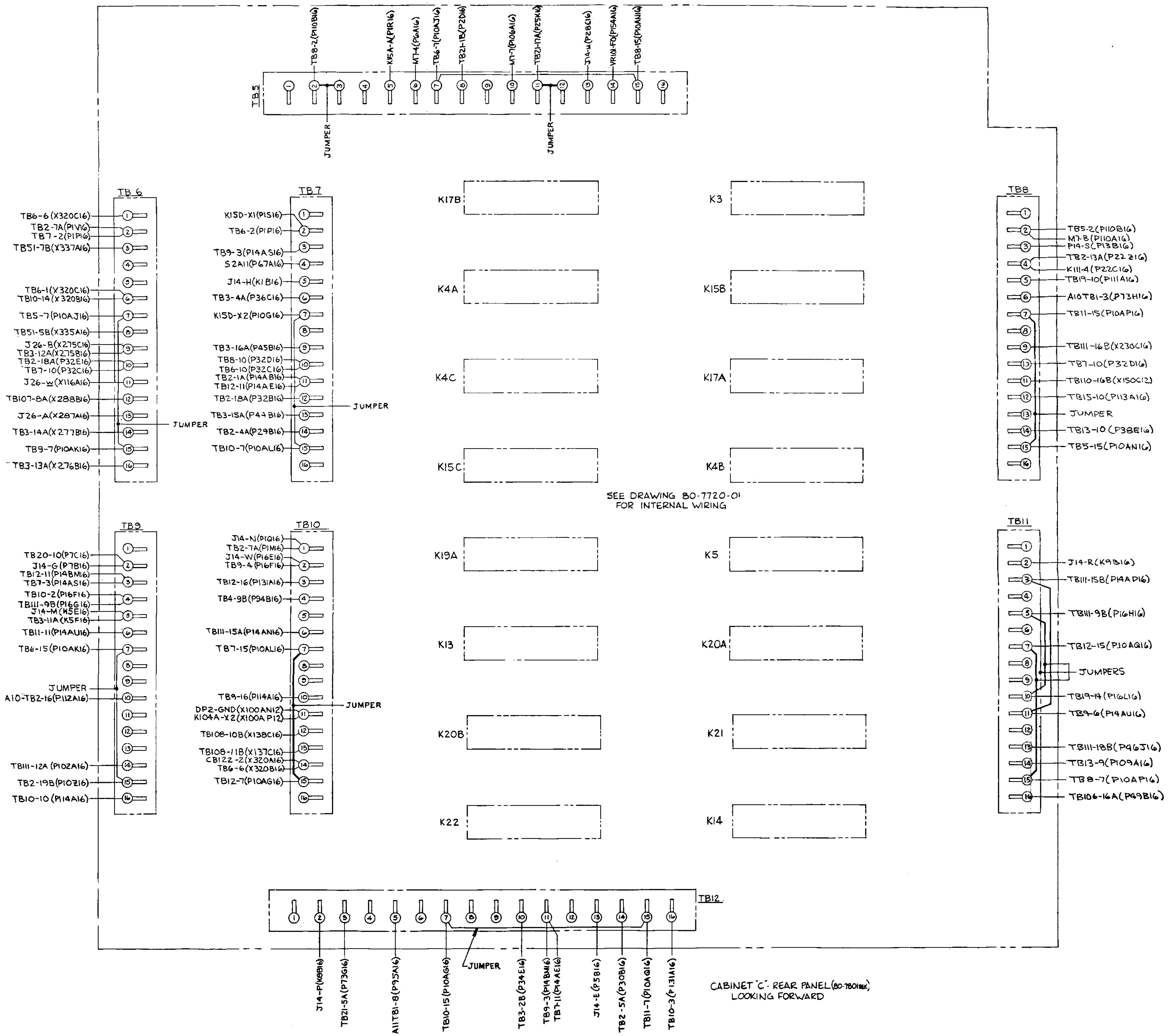


FO-11. Cabinet C wiring Diagram (Sheet 1 of 5)

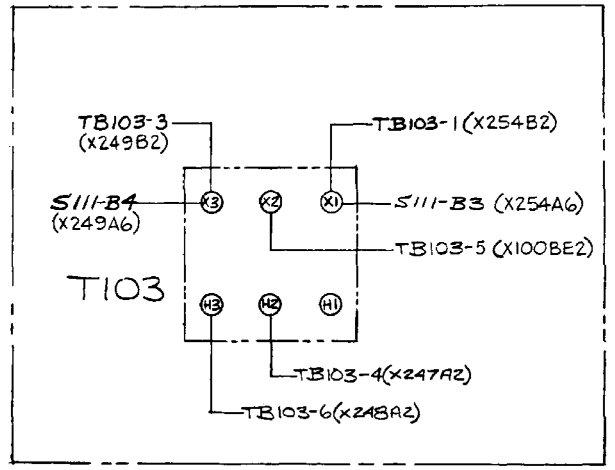




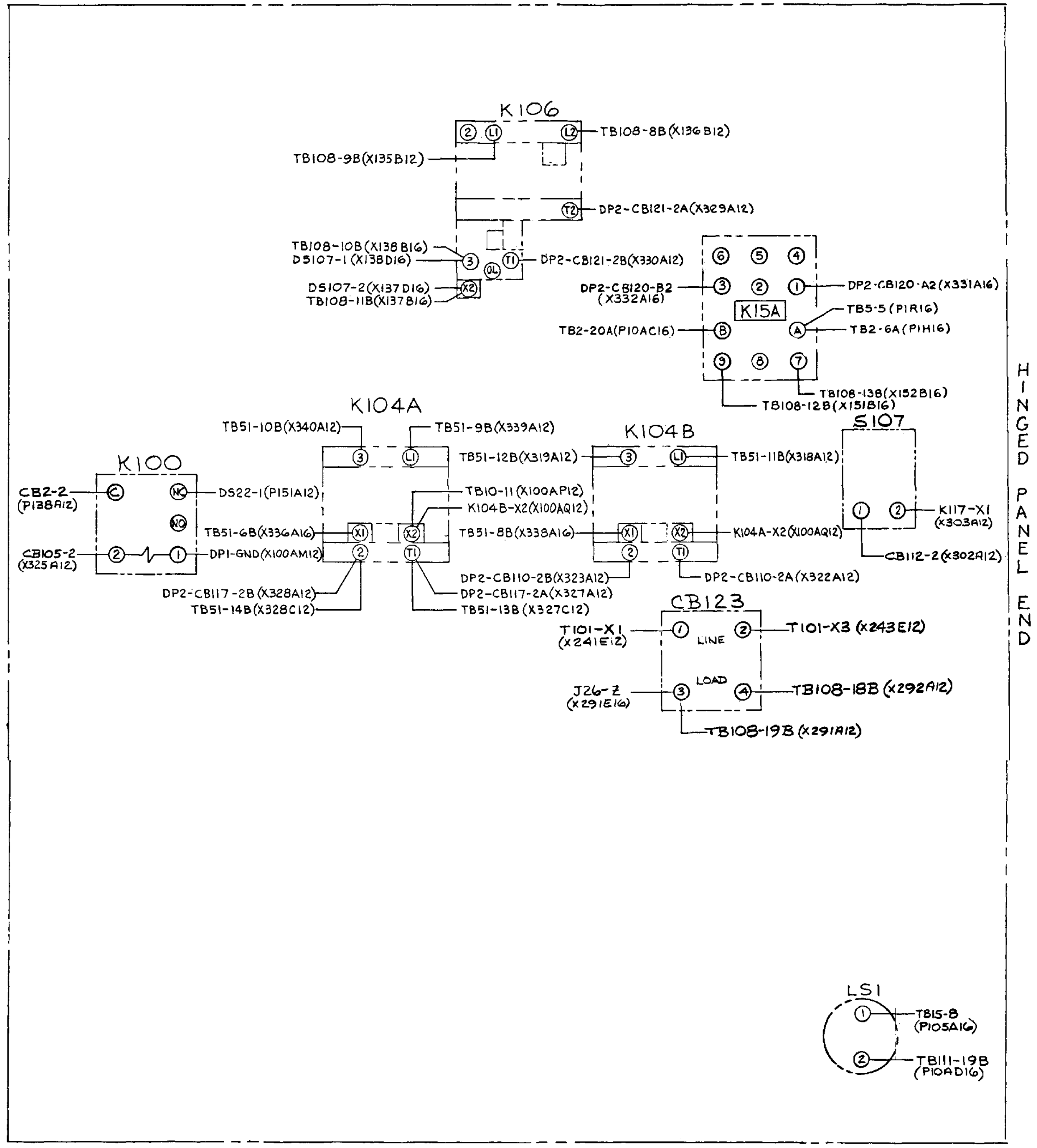
WIRING VIEW - CABINET "C" (80-7801 REF.) LEFT SIDE PANEL - LOOKING FORWARD
FO-11. Cabinet C Wiring Diagram (Sheet 2 of 5)



FO-11. Cabinet C Wiring Diagram (Sheet 3 of 5)

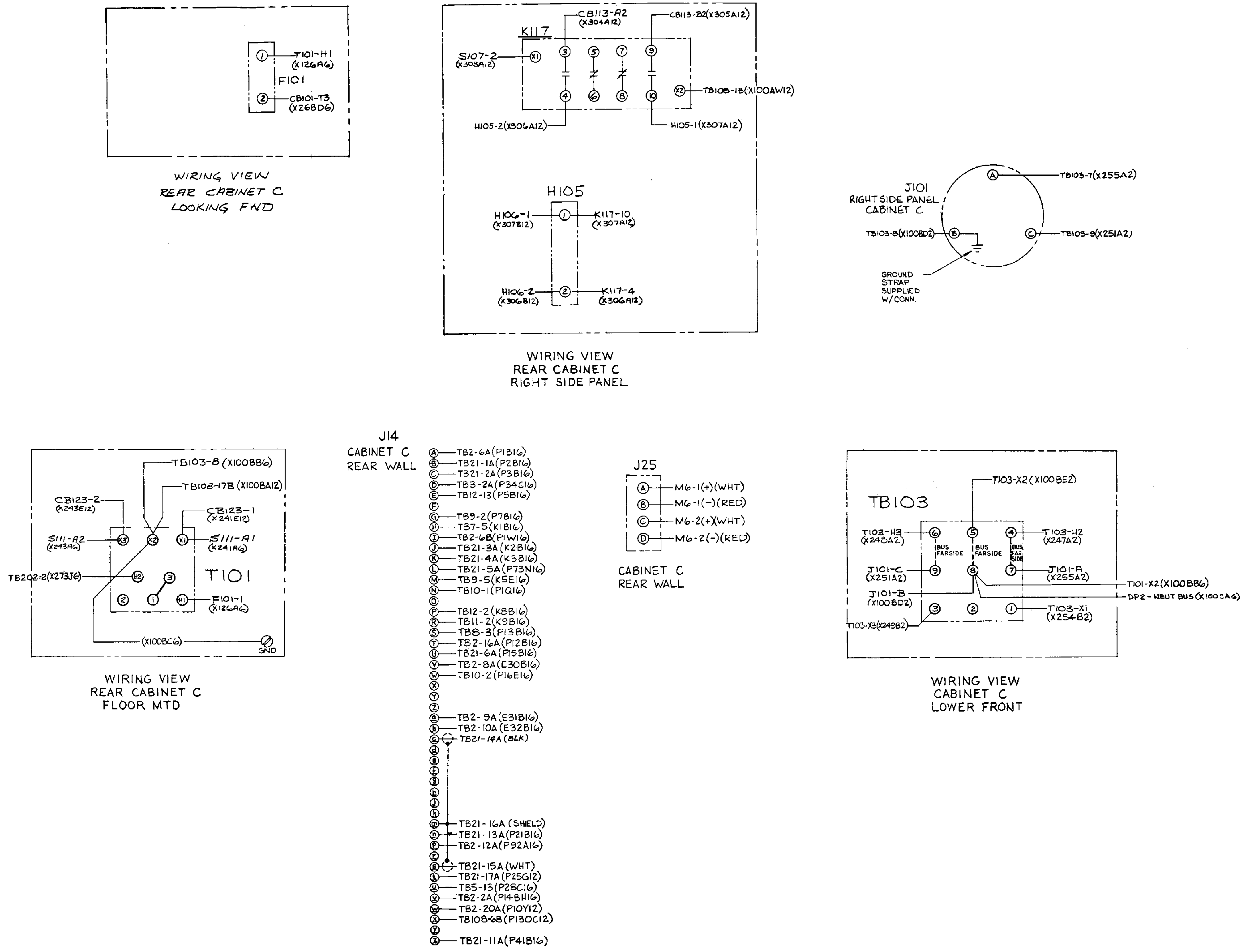


CABINET C WIRING VIEW
FLOOR LEVEL LOOKING FWD

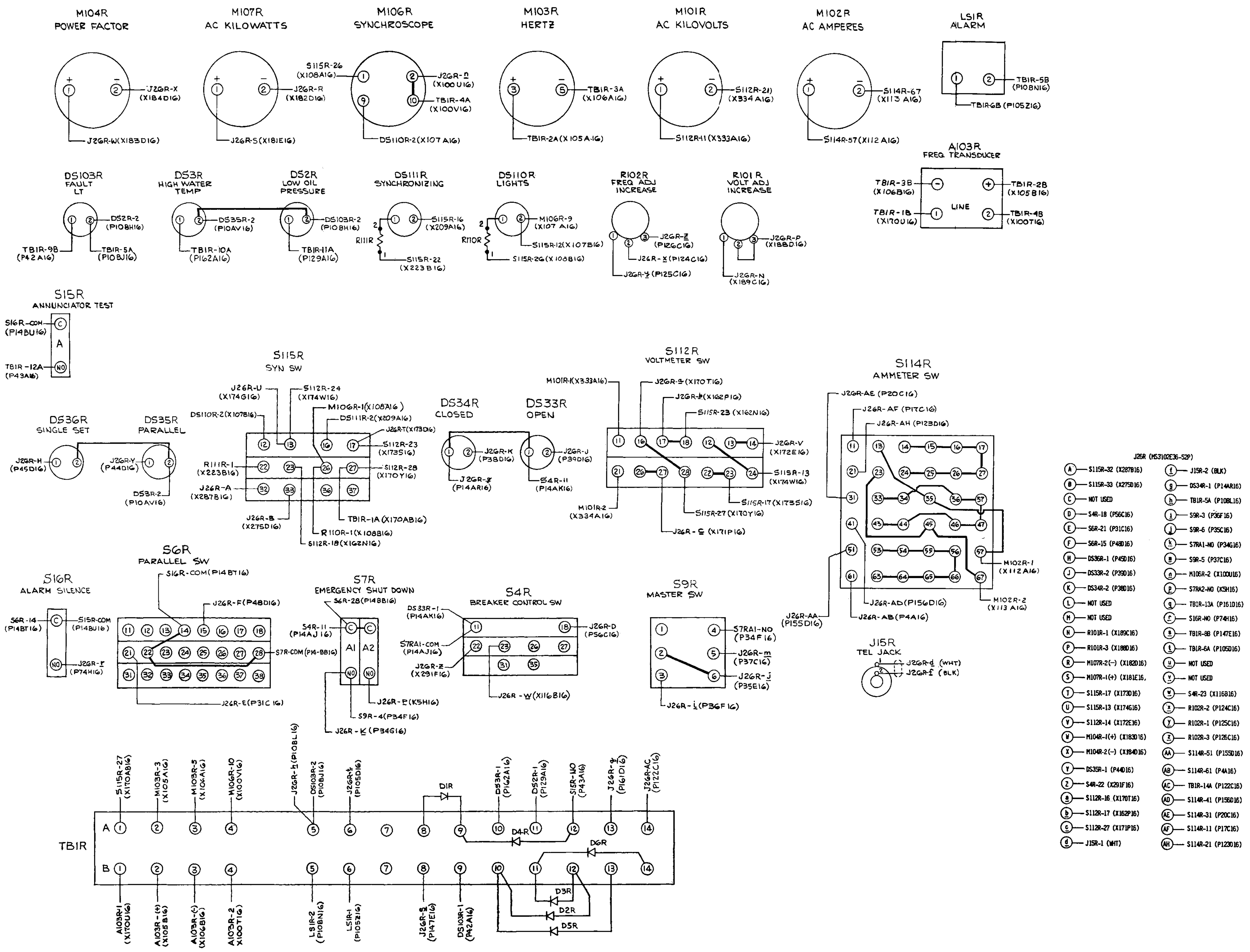


CABINET C WIRING VIEW
RIGHT SIDE PANEL
LOOKING FWD

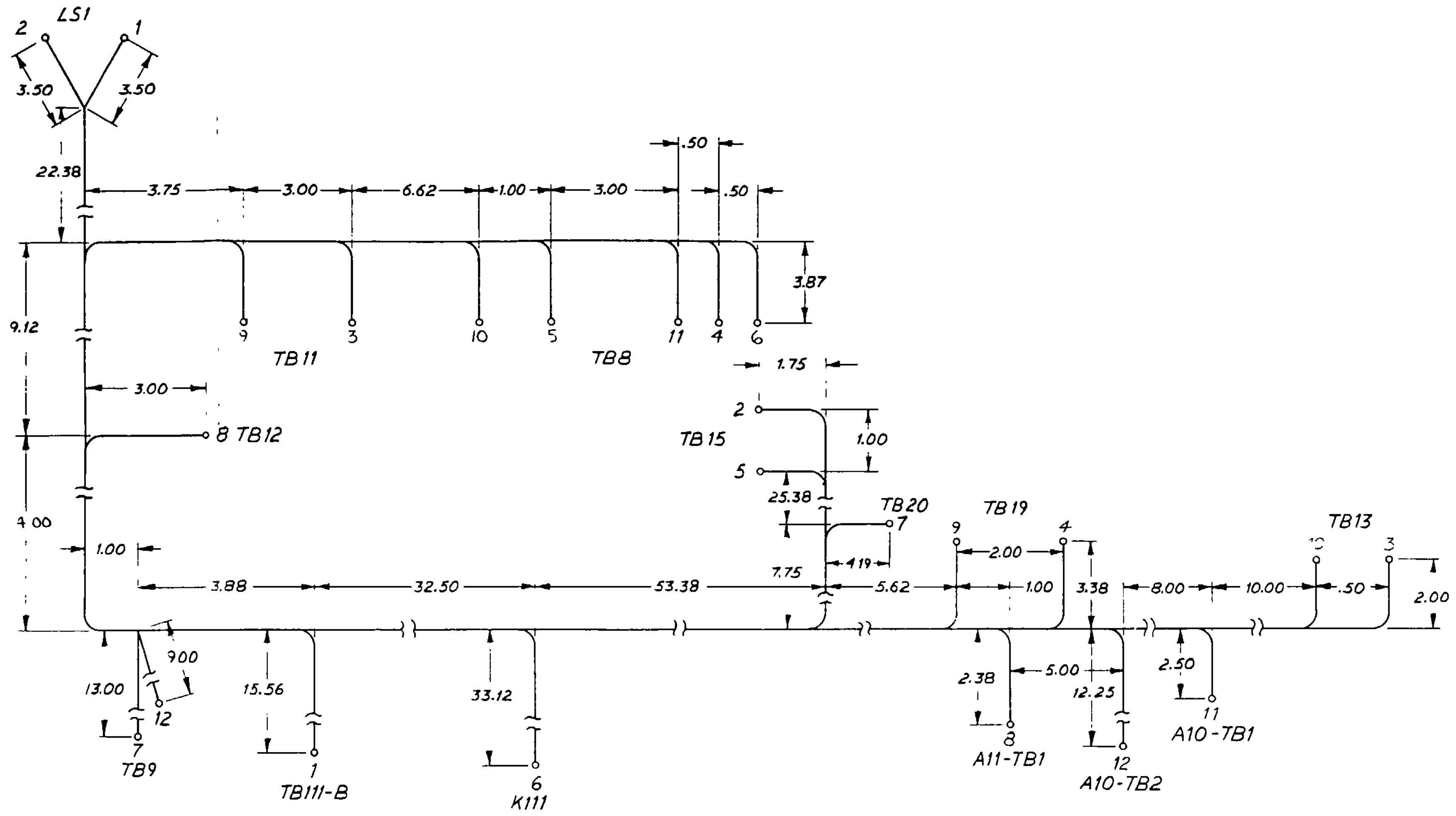
FO-11. Cabinet C Wiring Diagram (Sheet 4 of 5)



FO-11. Cabinet C Wiring Diagram (Sheet 5 of 5)



FO-12. Remote Control Module Wiring Diagram



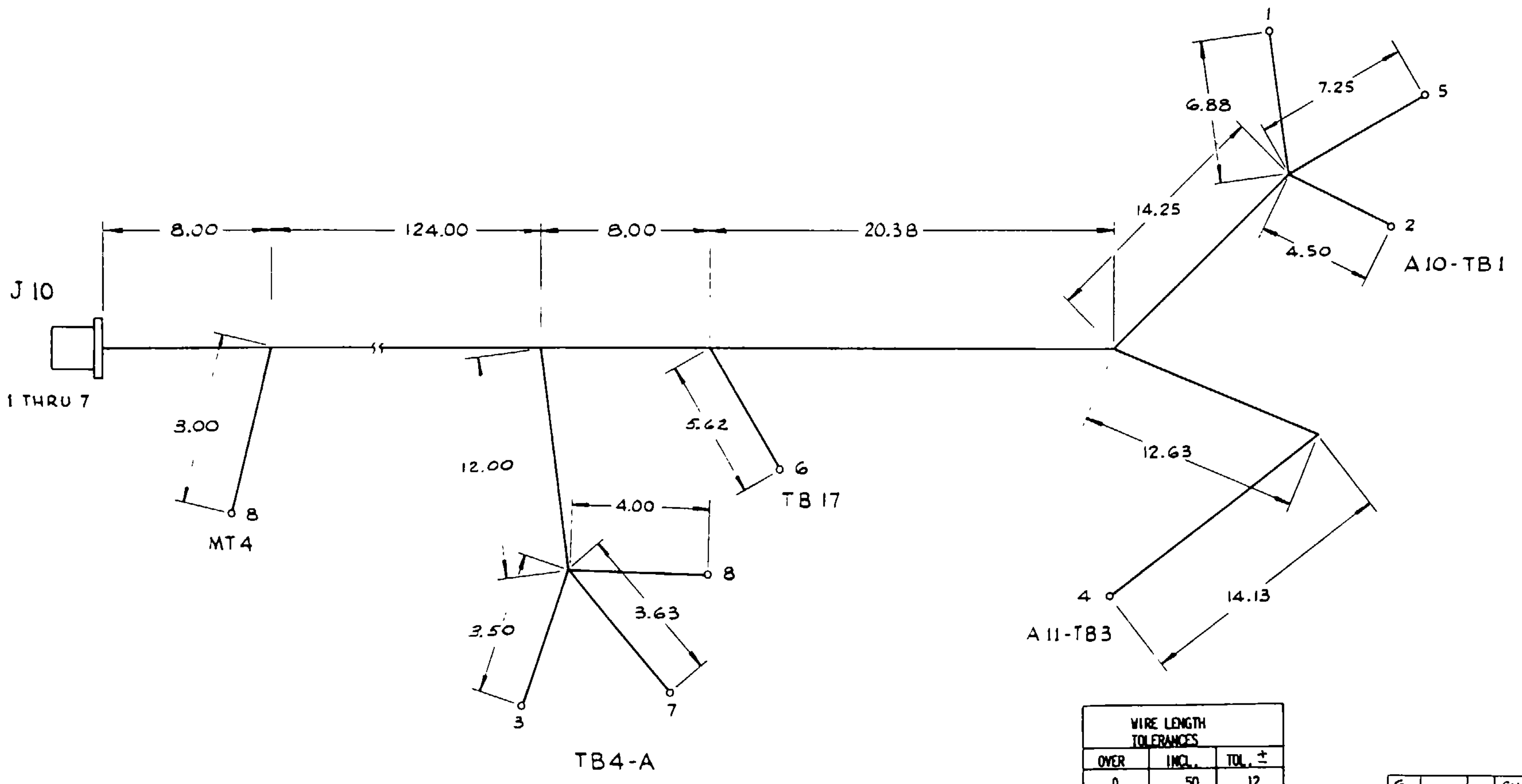
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	RED	P10AD16	LS1-2	1	TB111-19B	2	60.00	3
2	RED	P105A16	LS1-1	1	TB15-8	2	168.50	3
3	RED	P109A16	TB11-14	2	TB13-9	2	146.00	3
4	RED	P111A16	TB19-10	2	TB8-5	2	136.00	3
5	RED	P113A16	TB15-10	2	TB8-12	2	158.00	3
6	RED	P22C16	K111-4	2	TB8-4	2	105.00	3
7	RED	P7C16	TB20-10	2	TB9-2	2	116.00	3
8	RED	P95A16	A11-TB1-8	2	TB12-5	2	109.00	3
9	RED	P16L16	TB11-10	2	TB19-14	2	125.00	3
10	RED	P38E16	TB13-10	2	TB8-14	2	154.00	3
11	RED	P73H16	A10-TB1-3	2	TB8-6	2	147.00	3
12	RED	P112A16	A10-TB2-16	2	TB9-10	2	125.00	3

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
5			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
4			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
3			MS086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
2			MS25036-106	22	TERMINAL LUG		
1			MS25036-108	2	TERMINAL LUG		

PARTS LIST

FO-13. Cabinet A Interconnect Wiring Harness



WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	RED	P19B16	J10-A	Strip	A10-TB1-9	1	182.00	2
2		P14F16	J10-B		A10-TB1-14	1	180.00	2
3		P9B16	J10-C		TB4-16A	1	150.25	2
4		P73R16	J10-D		A11-TB3-12	1	188.00	2
5		P40B16	J10-E		A10-TB1-8	1	182.50	2
6		P18B16	J10-F		TB17-10	1	147.25	2
7		P8A16	J10-G		TB4-15A	1	150.00	2
8	RED	E33C16	MT4-1	Strip	TB4-13A	1	149.25	2

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
6			SN60WRMAP2	AR	SOLDER	QQ-S-571	
5			MS3106R16S-1S	1	CONNECTOR J10		
4			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
3			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
2			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
1			MS25036-106	8	TERMINAL LUG		

PARTS LIST

FO-14. Fuel Monitor Wiring Harness

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	BLK	X287B16	J26R-A	STRIP	S115R-32	3	30.50	5
2	BLK	X275D16	J26R-B		S115R-33	3	29.25	5
3	RED	P56C16	J26R-D		S4R-18	3	23.25	5
4	RED	P31C16	J26R-E		S6R-21	1	24.25	5
5	RED	P48D16	J26R-F		S6R-15	1	24.00	5
6	RED	P45D16	J26R-H		DS36R-1	STRIP	27.25	5
7	RED	P39D16	J26R-J		DS33R-2	1	28.00	5
8	RED	P38D16	J26R-K		DS34R-2	1	33.00	5
9	BLK	X189C16	J26R-N		R101R-1	STRIP	31.00	5
10	BLK	X188D16	J26R-P		R101R-3	STRIP	30.50	5
11	BLK	X182D16	J26R-R		M107R-1(+)	4	37.00	5
12	BLK	X181E16	J26R-S		M107R-2(-)	4	37.50	5
13	BLK	X173D16	J26R-T		S115R-17	3	37.00	5
14	BLK	X174G16	J26R-U		S115R-13	3	29.00	5
15	BLK	X172E16	J26R-V		S112R-14	3	30.50	5
16	BLK	X183D16	J26R-W		M104R-2(-)	4	36.75	5
17	BLK	X184D16	J26R-X		M104R-1(+)	4	37.50	5
18	RED	P44D16	J26R-Y		DS35R-1	STRIP	28.00	5
19	BLK	X291F16	J26R-Z		S4R-22	3	25.25	5
20	BLK	X170T16	J26R-a		S112R-16	3	28.00	5
21	BLK	X162P16	J26R-b		S112R-17	3	28.50	5
22	BLK	X171P16	J26R-c		S112R-27	3	30.50	5
23	NO	WHITE 16	J26R-d		J15R-1	STRIP	38.00	5
24	NO	BLACK 16	J26R-f		J15R-2	STRIP	38.00	5
25	RED	P14AR16	J26R-g		DS34R-1	1	34.00	5
26	RED	P108L16	J26R-h		TB1R-5A	1	21.00	5
27	RED	P36F16	J26R-i		S9R-3	1	23.50	5
28	RED	P35E16	J26R-j		S9R-6	1	26.00	5
29	RED	P34G16	J26R-k		S7RA1-NO	1	25.50	5
30	RED	P37C16	J26R-m		S9R-5	1	24.00	5
31	BLK	X100U16	J26R-n		M106R-2	2	45.00	5
32	RED	K5H16	J26R-p		S7RA2-NO	1	26.00	5
33	RED	P161D16	J26R-q		TB1R-13A	1	25.00	5
34	RED	P74H16	J26R-r		S16R-NO	1	20.50	5
35	RED	P147E16	J26R-s		TB1R-8B	1	20.00	5
36	RED	P105D16	J26R-t		TB1R-6A	1	21.50	5
37	BLK	X116B16	J26R-w		S4R-23	3	27.50	5
38	RED	P124C16	J26R-x		R102R-2	STRIP	33.00	5
39	RED	P125C16	J26R-y		R102R-1	STRIP	33.50	5
40	RED	P126C16	J26R-z	STRIP	R102R-3	STRIP	33 50	5
41	RED	P155D16	J26R-AA	STRIP	S114R-51	3	33.50	5
42	RED	P4A16	J26R-AB		S114R-61	3	34.00	5
43	RED	P122C16	J26R-AC		TB1R-14A	1	25.00	5
44	RED	P156D16	J26R-AD		S114R-41	3	33.50	5
45	RED	P20C16	J26R-AE		S114R-31	3	33.00	5
46	RED	P17C16	J26R-AF		S114R-11	3	32.50	5
47	RED	P123D16	J26R-AH	STRIP	S114R-21	3	32.25	5
48	BLK	X170AB16	TB1R-1A	1	S115R-27	3	38.00	5
49	BLK	X105A16	TB1R-2A	1	M103R-3	2	52.00	5
50	BLK	X106A16	TB1R-3A	1	M103R-5	2	52.00	5
51	BLK	X100V16	TB1R-4A	1	M106R-10	2	50.00	5
52	RED	P108J16	TB1R-5A	1	DS103R-2	1	38.00	5
53	RED	P162A16	TB1R-10A	1	DS3R-1	1	38.00	5
54	RED	P129A16	TB1R-11A	1	DS2R-1	1	43.00	5
55	RED	P43A16	TB1R-12A	1	S15R-NO	1	36.50	5
56	BLK	X170U16	TB1R-1B	1	A103R-1	3	30.00	5
57	BLK	X105B16	TB1R-2B	1	A103R-(+)	3	32.00	5
58	BLK	X106B16	TB1R-3B	1	A103R-(-)	3	33.00	5
59	BLK	X100T16	TB1R-4B	1	A103R-2	3	22.50	5
60	RED	P108N16	TB1R-5B	1	LS1R-2	3	28.00	5

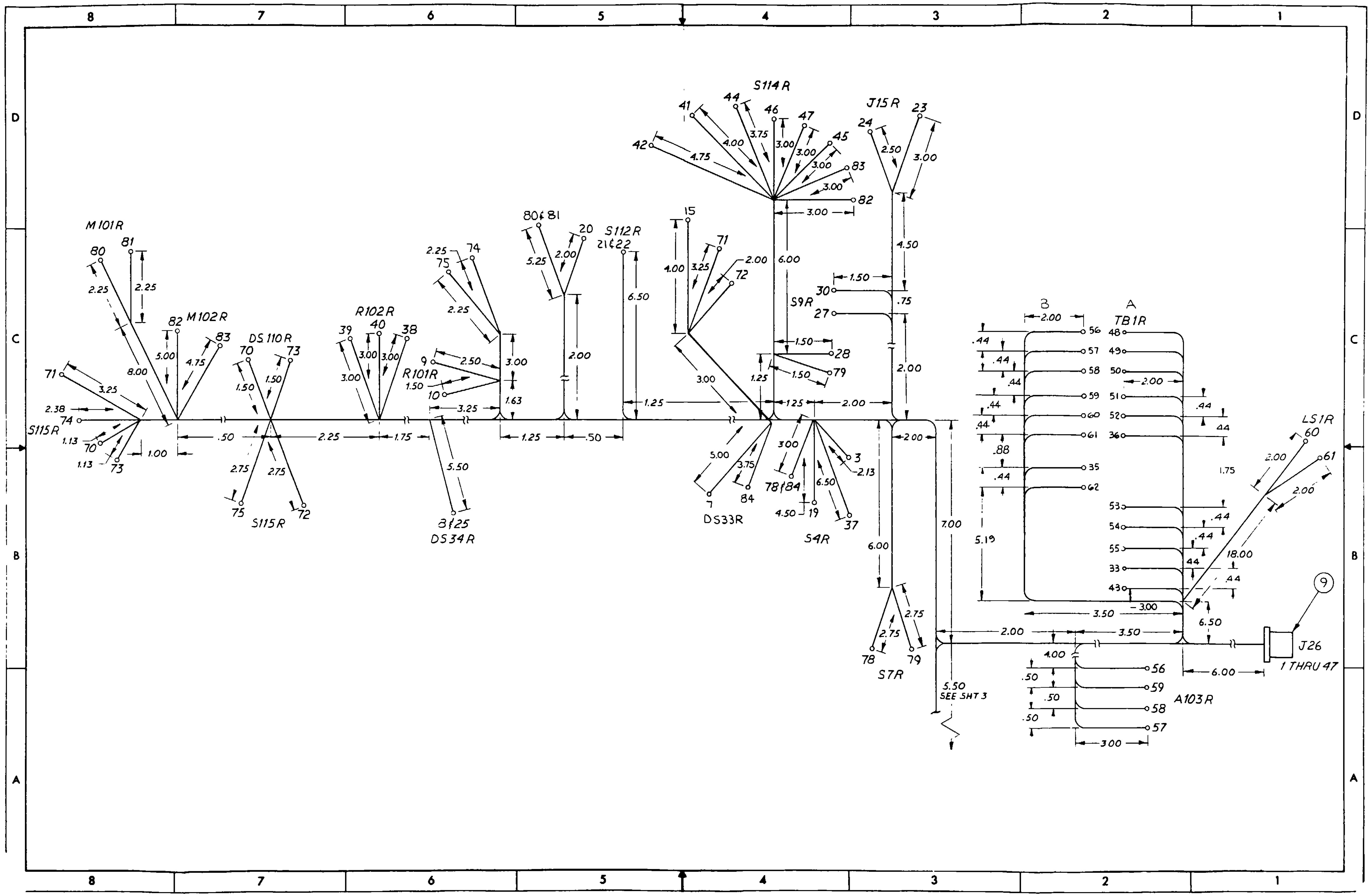
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
61	RED	P105Z16	TB1R-6B	1	LS1R-1	3	28.00	5
62	RED	P42A16	TB1R-9B	1	DS103R-1	1	37.00	5
63	BLK	X107A16	M106R-9	2	DS110R-2	1	14.00	5
64	BLK	X108A16	M106R-1	2	S115R-26	1	34.00	5
65	RED	P108H16	DS103R-2	1	DS2R-2	1	18.00	5
66	RED	P10AV16	DS3R-2	1	DS35R-2	STRIP	15.00	5
67	BLK	X209A16	DS111R-2	1	S115R-16	3	12.00	5
68	BLK	X223B16	DS111R-1	1	S115R-22	3	9.00	5
69	RED	P14BU16	S15R-A-C	1	S16R-COM	1	6.25	5
70	BLK	X107B16	S115R-12	3	DS110R-2	1	4 50	5
71	BLK	X174W16	S115R-13	3	S112R-24	3	19.00	5
72	BLK	X173S16	S115R-17	3	S112R-23	3	16.00	5
73	BLK	X108B16	S115R-26	3	DS110R-1	1	4 .50	5
74	BLK	X162N16	S115R-23	3	S112R-14	3	16.00	5
75	BLK	X170Y16	S115R-27	3	S112R-28	3	14.50	5
76	RED	P14BT16	S16R-COM	1	S6R-14	1	10.00	5
77	RED	P14BB16	S6R-28	1	S7R-COM	1	9.00	5
78	RED	P14AJ16	S7R-COM	1	S4R-11	1	14.50	5
79	RED	P34F16	S7R-NO	1	S9R-4	1	15.50	5
80	BLK	X333A16	M101R-1	2	S112R-11	3	22.00	3
81	BLK	X334A16	M101R-2	2	S112R-21	3	22.00	5
82	BLK	X113A16	M102R-2	4	S114R-67	3	33.00	5
83	BLK	X112A16	M102R-1	4	S114R-57	3	33.00	5
84	RED	P14AK16	DS33R-1	1	S4R-11	3	8.50	5

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

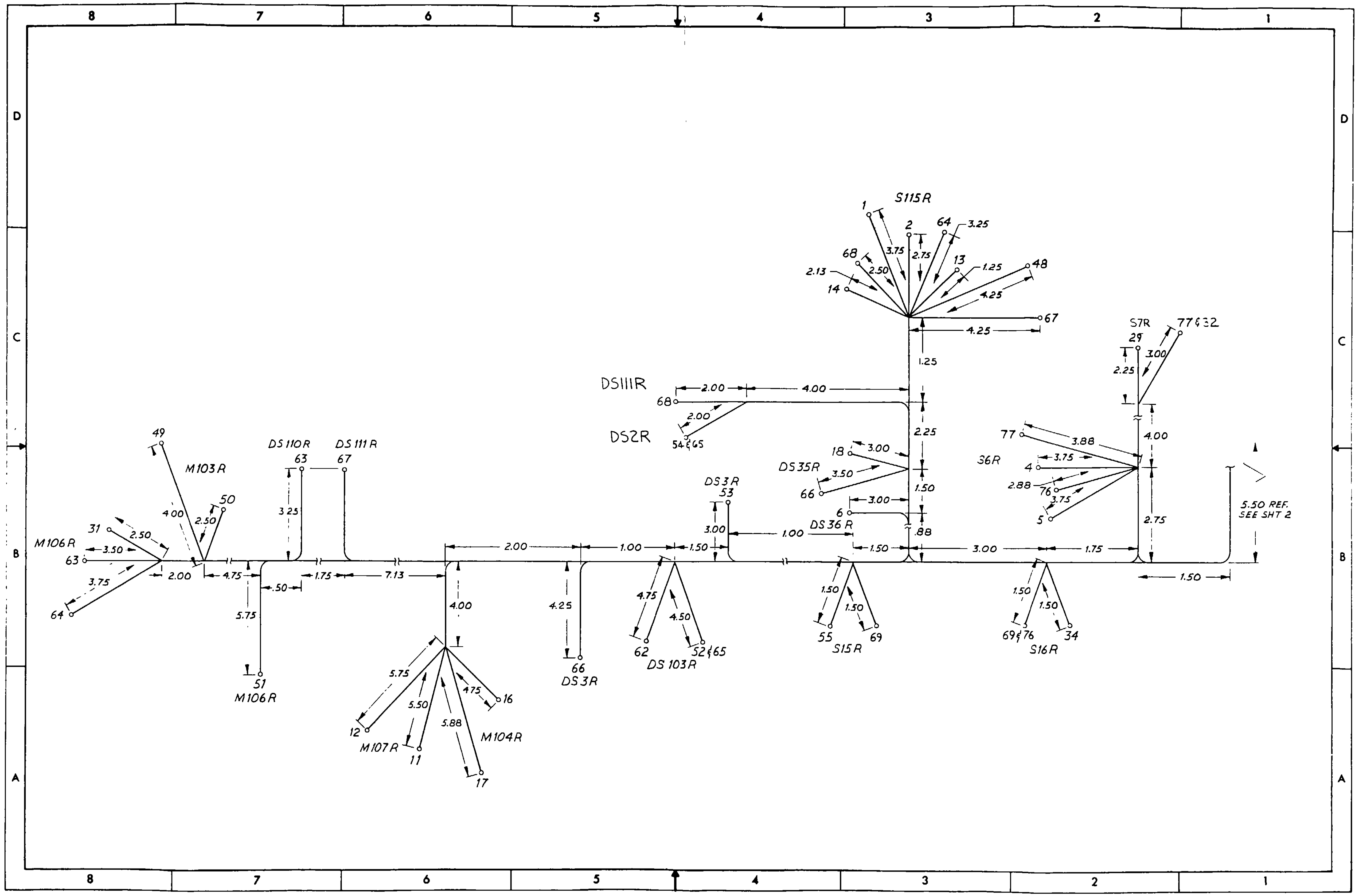
FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
9			MS3102R36-52P	1	CONNECTOR, J26		
8			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
7			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
6			SN60RPMAP-2	AR	SOLDER	QQ-S-571	
5			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
4			MS25036-154	6	TERMINAL LUG		
3			MS25036-153	41	TERMINAL LUG		
2			MS25036-108	8	TERMINAL LUG		
1			MS25036-106	56	TERMINAL LUG		

PARTS LIST

FO-15. Remote Control Module Wiring Harness (Sheet 1 of 3)



FO-15. Remote Control Module Wiring Harness (Sheet 2 of 3)



FO-15. Remote Control Module Wiring Harness (Sheet 3 of 3)

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	WIRE MARKING IDENTIFICATION NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	WIRE LENGTH	WIRE FIND NO.
1	BLK	X150C12	TB110-16B	1	TB8-11	1	144.00	7
2	BLK	X124A12	TB105-17A	1	CT10-X1	2	163.00	7
3	BLK	X146A12	TB105-16A	1	CT11-X1	2	173.00	7
4	BLK	X144A12	TB105-15A	1	CT12-X1	2	184.00	7
5	BLK	X123A12	TB110-8B	1	A104-8	1	94.00	7
6	BLK	X176E12	TB110-6B	1	A104-6	1	93.00	7
7	BLK	X201A12	TB110-4B	1	A104-4	1	94.00	7
8	BLK	X100BR12	CT12-X2	2	CT11-X2	2	26.00	7
9	BLK	X100BQ12	CT11-X2	2	CT10-X2	2	25.50	7
10	BLK	X100BP12	TB110-5A	1	CT10-X2	2	231.50	7
11	BLK	X150A12	TB110-16A	1	CT114-X2	2	241.00	7
12	BLK	X230J12	TB110-7A	1	CT114-X1	2	248.00	7
13	RED	P94B16	TB4-9B	3	TB10-4	3	132.00	6
14	RED	P148C16	TB4-18B	3	TB111-14B	3	116.00	6
15	RED	P108A16	TB4-1B	3	TB111-20B	3	129.00	6
16	RED	P1K16	TB4-6B	3	A104-12	3	99.00	6
17	BLK	X230M16	TB110-9A	3	TB105-14A	3	127.00	6
18	BLK	X100P16	TB110-3A	3	WHT-6	4	126.00	6
19	BLK	X231B16	TB110-17B	3	K108-1	3	126.00	6
20	BLK	X232B16	TB110-19B	3	K107-1	3	130.50	6
21	BLK	X311B10	TB4-10B	1	T100-X1	5	116.00	8
22	BLK	X310B10	TB4-8B	1	T100-X2	2	116.00	8
23	BLK	X100R16	TB110-3B	3	T106-X2	4	148.00	6
24	BLK	X230B16	TB110-7B	3	TB111-16A	3	120.00	6

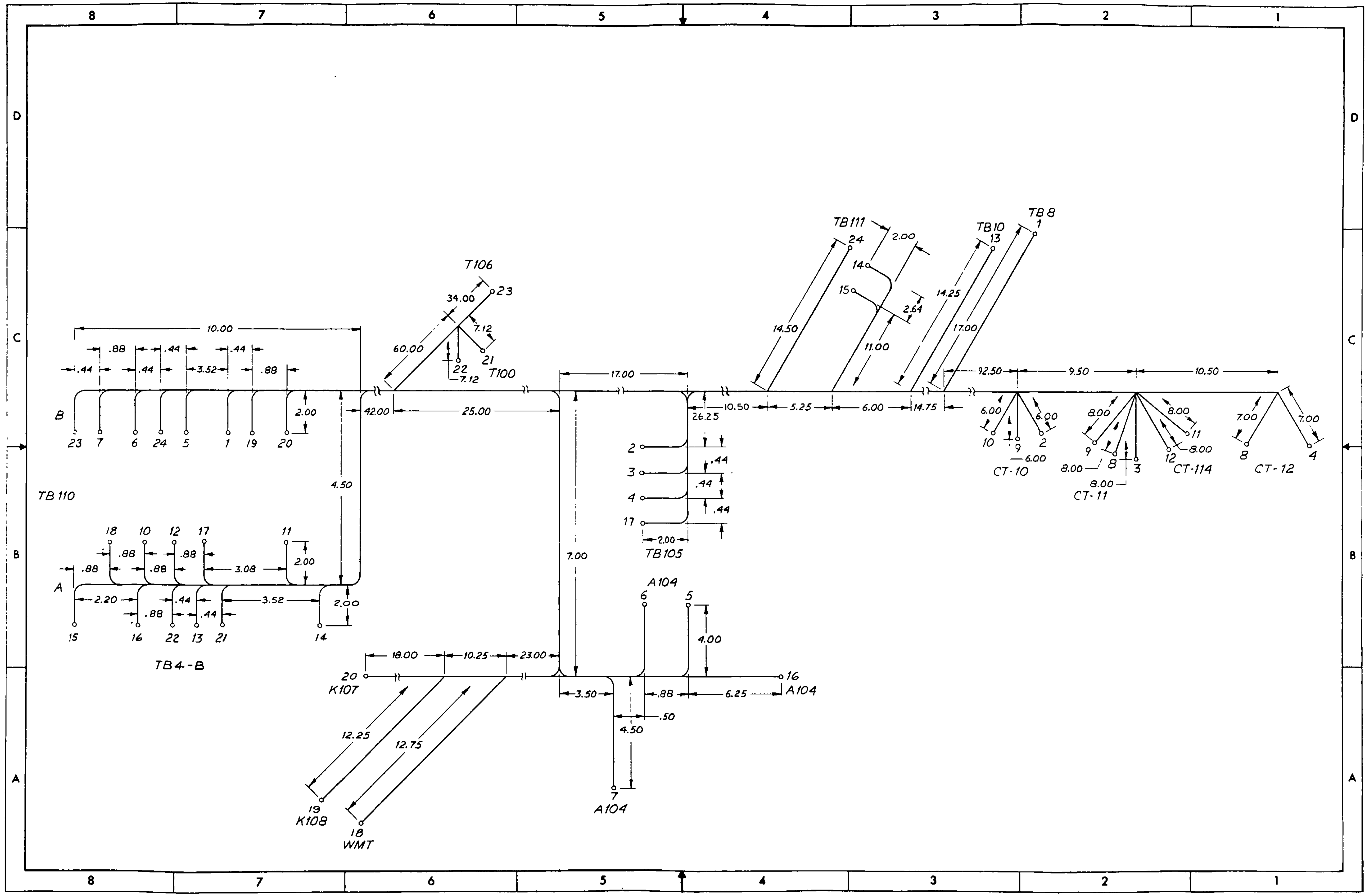
WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
11			MS3367-1-4	AR	STRAP CABLE ADJUSTABLE		
10			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
9			SN60WRMAP2	AR	SOLDER		
8			M5086/2-10-9	AR	WIRE 10 AN	MIL-W-5086/2	
7			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
6			M5086/2-16-9	AR	WIRE #16	MIL-W-5086/2	
5			MS17143-9	1	TERMINAL LUG		
4			MS25036-108	2	TERMINAL LUG		
3			MS25036-106	18	TERMINAL LUG		
2			MS25036-112	11	TERMINAL LUG		
1			MS17143-6	16	TERMINAL LUG		

PARTS LIST

F-85/(F-86 Blank)

FO-16. Cabinet B Rear Wiring Harness (Sheet 1 of 2)



FO-16. Cabinet B Rear Wiring Harness (Sheet 2 of 2)

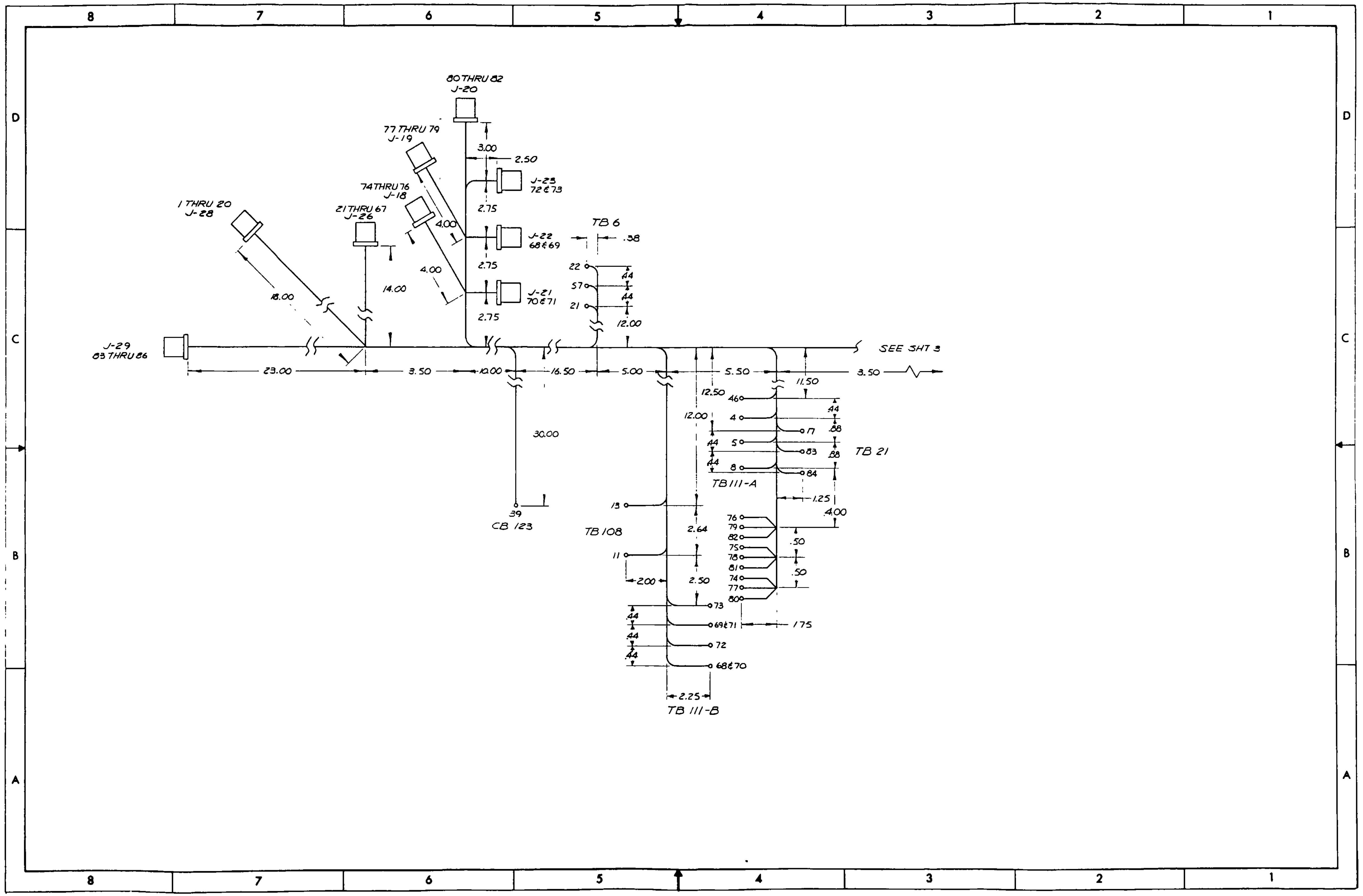
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	WIRE MARKING IDENTIFICATION NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	RED	P127A16	J28-A	STRIP	TB50-5B	1	89.00	2
2	RED	P128A16	J28-B		TB50-6B	1	89.50	2
3	RED	P14AW16	J28-C		TB3-10 B	1	80.00	2
4	RED	P10AZ16	J28-D		TB111-19A	1	69.25	2
5	RED	P46F16	J28-E		TB111-17A	1	69.50	2
6	RED	P14AV16	J28-F		TB3-9B	1	80.00	2
7	RED	P33B16	J28-G		TB3-1A	1	88.25	2
8	RED	P14AX16	J28-H		TB111-15A	1	71.75	2
9	BLK	X238E16	J28-J		TB50-12B	1	92.75	2
10	BLK	X190C16	J28-K		TB107-3A	1	91.50	2
11	BLK	X234B16	J28-L		TB108-14A	1	66.00	2
12	BLK	X293B16	J28-M		TB107-5A	1	90.50	2
13	BLK	X235B16	J28-S		TB108-20A	1	63.50	2
14	BLK	X150B16	J28-N		TB50-13B	1	93.00	2
15	BLK	X111B16	J28-T		TB107-14A	1	87.25	2
16	BLK	X162T16	J28-P		TB105-10A	1	93.50	2
17	BLK	X239B16	J28-R		TB21-18B	1	70.00	2
18	BLK	X100AA16	J28-W		TB105-12B	1	97.25	2
19	BLK	X171AZ16	J28-U		TB105-11B	1	97.25	2
20	BLK	X170S16	J28-V		TB106-1B	1	98.00	2
21	BLK	X287A16	J26-A		TB6-13	1	54.75	2
22	BLK	X275C16	J26-B		TB6-9	1	57.25	2
23	RED	P56B16	J26-D		TB3-18A	1	76.75	2
24	RED	P31A16	J26-E		TB2-15B	1	77.25	2
25	RED	P48C16	J26-F		TB3-20A	1	74.75	2
26	RED	P45C16	J26-H		TB3-16A	1	77.75	2
27	RED	P39C16	J26-J		TB3-8A	1	80.75	2
28	RED	P38C16	J26-K		TB3-7A	1	82.00	2
29	BLK	X189B16	J26-N		TB107-2A	1	86.75	2
30	BLK	X188B16	J26-P		TB107-1A	1	86.00	2
31	BLK	X182B16	J26-R		TB106-13A	1	82.50	2
32	BLK	X181B16	J26-S		TB106-12A	1	82.00	2
33	BLK	X173F16	J26-T		TB106-4A	1	85.00	2
34	BLK	X174D16	J26-U		TB106-5B	1	89.75	2
35	BLK	X172D16	J26-V		TB106-3A	1	85.25	2
36	BLK	X183B16	J26-W		TB106-14A	1	81.75	2
37	BLK	X184B16	J26-X		TB106-15A	1	80.25	2
38	RED	P44C16	J26-Y		TB3-15A	1	77.25	2
39	BLK	X291E16	J26-Z		CB123-3	1	55.00	2
40	BLK	X170R16	J26-a		TB106-1A	1	87.00	2
41	BLK	X162S16	J26-b		TB105-9A	1	87.00	2
42	BLK	X171N16	J26-c		TB106-2A	1	86.00	2
43	BLK	WHITE shield16	J26-d		TB107-9A	1	82.50	2
44	BLK	BLACK wire 16	J26-f		TB107-11A	1	82.50	3
45	RED	P14AQ16	J26-g		TB2-3B	1	81.00	2
46	RED	P10AR16	J26-h		TB111-20A	1	62.25	2
47	RED	P36D16	J26-i		TB3-4A	1	82.00	2
48	RED	P35C16	J26-j		TB3-3A	1	81.25	2
49	RED	P34D16	J26-k		TB3-2A	1	82.25	2
50	RED	P37B16	J26-m		TB3-5A	1	81.75	2
51	BLK	X100Z16	J26-n		TB105-12A	1	86.00	2
52	RED	K5G16	J26-p		TB3-11A	1	78.75	2
53	RED	P161B16	J26-q		TB50-8B	1	86.25	2
54	RED	P74F16	J26-r		TB50-9B	1	88.25	2
55	RED	P147C16	J26-s		TB50-10B	1	86.75	2
56	RED	P105B16	J26-t		TB50-11B	1	86.75	2
57	BLK	X116A16	J26-w		TB6-11	1	57.50	2
58	RED	P124X16	J26-x		TB107-15A	1	81.50	2
59	RED	P125A16	J26-y		TB107-16A	1	81.25	2
60	RED	P126A16	J26-z	STRIP	TB107-17A	1	81.25	2
61	RED	P155A16	J26-AA	STRIP	TB106-9A	1	83.25	2
62	RED	P4B16	J26-AB		TB107-20A	1	79.25	2
63	RED	P122A16	J26-AC		TB50-7B	1	86.50	2
64	RED	P156A16	J26-AD		TB107-6A	1	86.50	2
65	RED	P20D16	J26-AE		TB106-10A	1	84.50	2
66	RED	P17D16	J26-AF		TB106-11A	1	83.25	2
67	RED	P123A16	J26-AH		TB106-19A	1	80.50	2
68	BLK	X237B16	J22-A		TB111-5B	1	63.25	2
69	BLK	X244B16	J22-B		TB111-7B	1	63.00	2
70	BLK	X237A16	J21-A		TB111-5B	1	59.25	2
71	BLK	X244A16	J21-B		TB111-7B	1	59.50	2
72	BLK	X237C16	J23-A		TB111-6B	1	66.25	2
73	BLK	X244C16	J23-B		TB111-8B	1	65.00	2
74	WHT	WHITE 16	J18-A		TB111-1B	1	66.00	3
75	BLK	BLACK 16	J18-B		TB111-2B	1	66.00	3
76	NO	SHIELD 16	J18-C		TB111-3B	1	66.00	3
77	WHT	WHITE 16	J19-A		TB111-1B	1	68.00	3
78	BLK	BLACK 16	J19-B		TB111-2 B	1	68.00	3
79	NO	SHIELD	J19-C		TB111-3 B	1	68.00	3
80	WHT	WHITE 16	J20-A		TB111-1A	1	70.00	3
81	BLK	BLACK 16	J20-B		TB111A-2A	1	70.00	3
82	NO	SHIELD	J20-C		TB111A-3A	1	70.00	3
83	BLK	BLACK 16	J29-A		TB21-19B	1	92.00	3
84	NO	Shield	J29-B		TB21-16B	1	92.00	3
85	BLK	BLACK 16	J29-C		TB15-12	1	180.00	3
86	WHT	WHITE 16	J29-D	STRIP	TB15-13	1	180.00	3

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

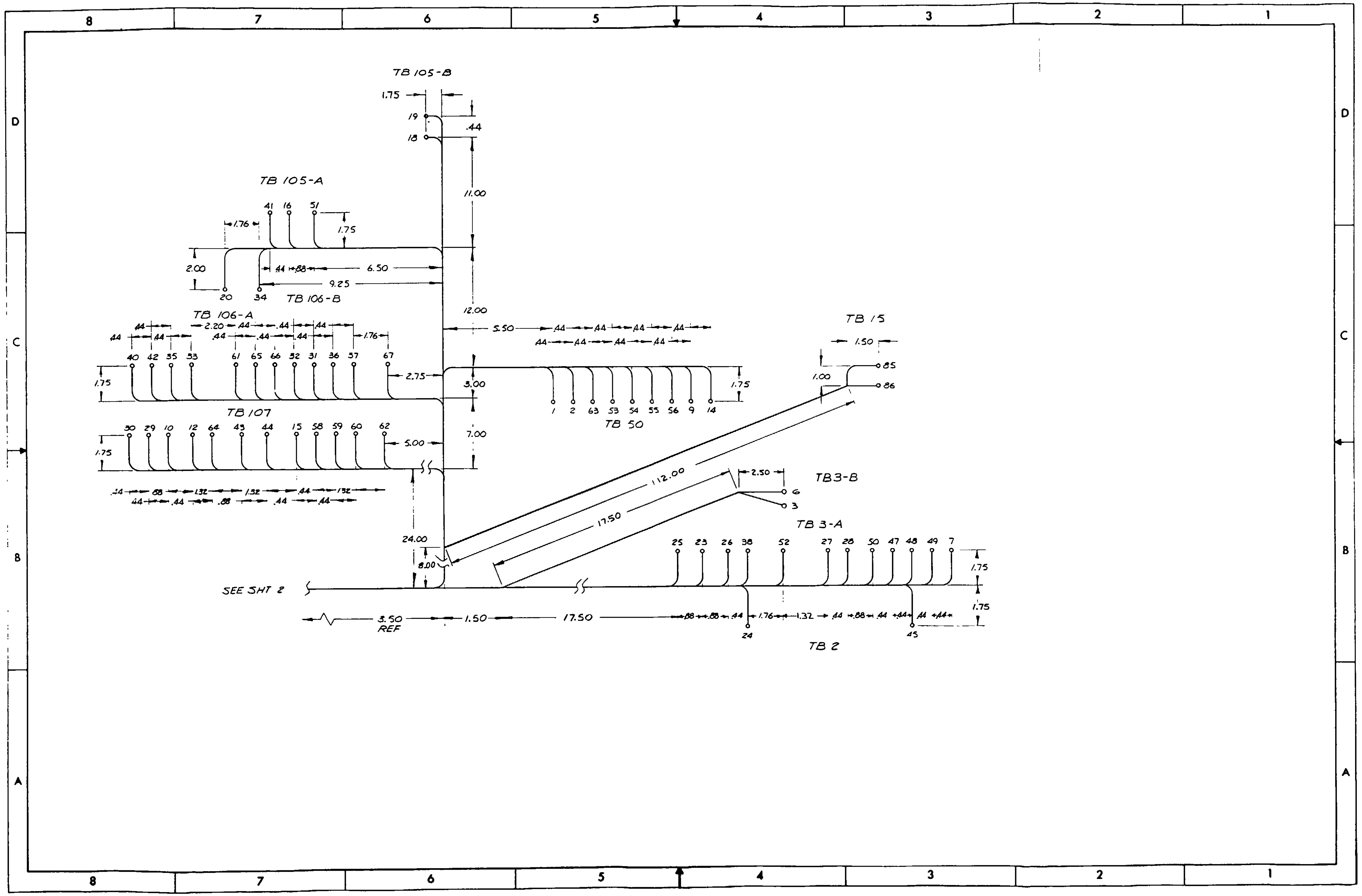
FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
13			MS3102R22-23P	1	CONNECTOR J29		
12			MS3102R24-28P	1	CONNECTOR J28		
11			MS3102R36-52P	1	CONNECTOR J26		
10			MS3102R12S-3S	3	CONNECTOR J21, J22, J23		
9			MS3102R10SL-3S	3	CONNECTOR J18, J19, J20		
8			M23053/5-104-0	AR	INSUL. SLEEVE .125 DIA. BLACK	MIL-I-23053CL1	
7			M23053/5-105-0	AR	INSUL. SLEEVE .187 DIA. BLACK	MIL-I-23053CL1	
6			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
5			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
4			SN60WRMAP2	AR	SOLDER		
3		B	76-11253	AR	SHIELDED WIRE		
2			M5086/2-16-9	AR	WIRE #16	MIL-W-5086/2	
1			MS25036-106	86	TERMINAL LUG		

PARTS LIST

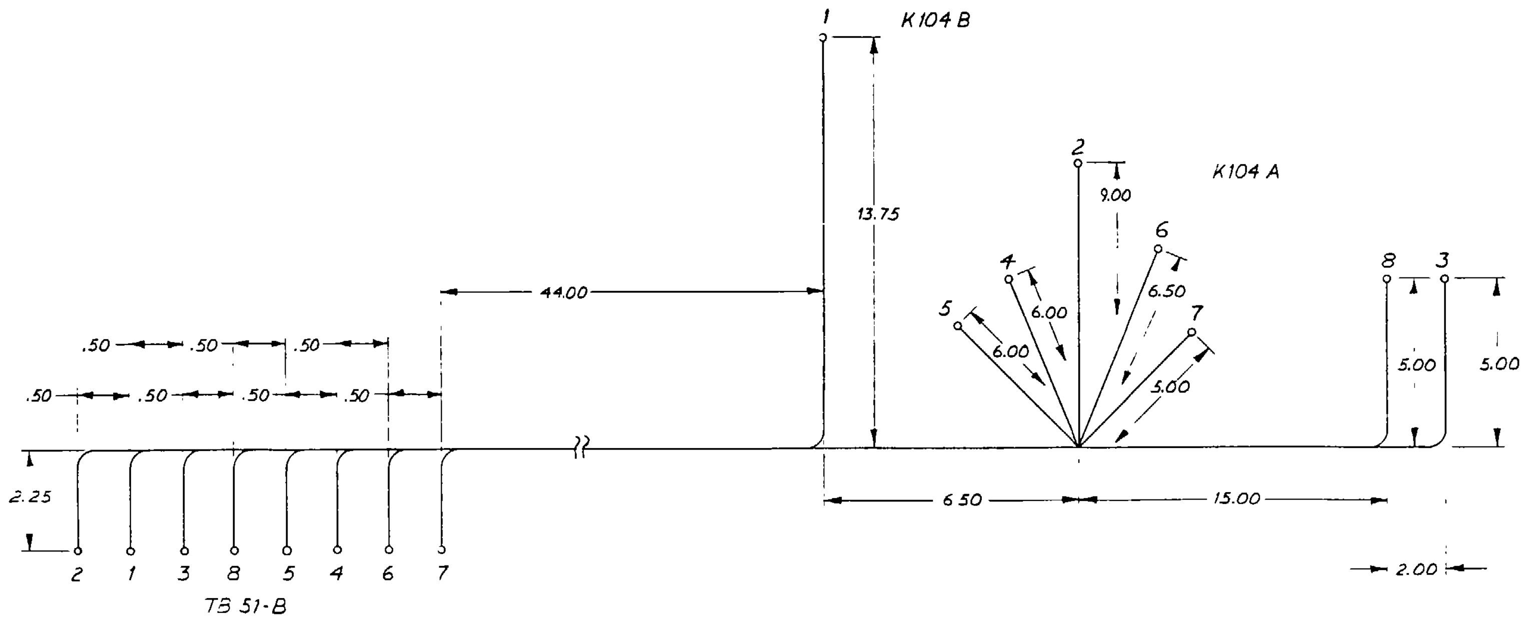
FO-17. Cabinet C Connectors Wiring Harness (Sheet 1 of 3)



FO-17. Cabinet C Connectors Wiring Harness (Sheet 2 of 3)



FO-17. Cabinet C Connectors Wiring Harness (Sheet 3 of 3)



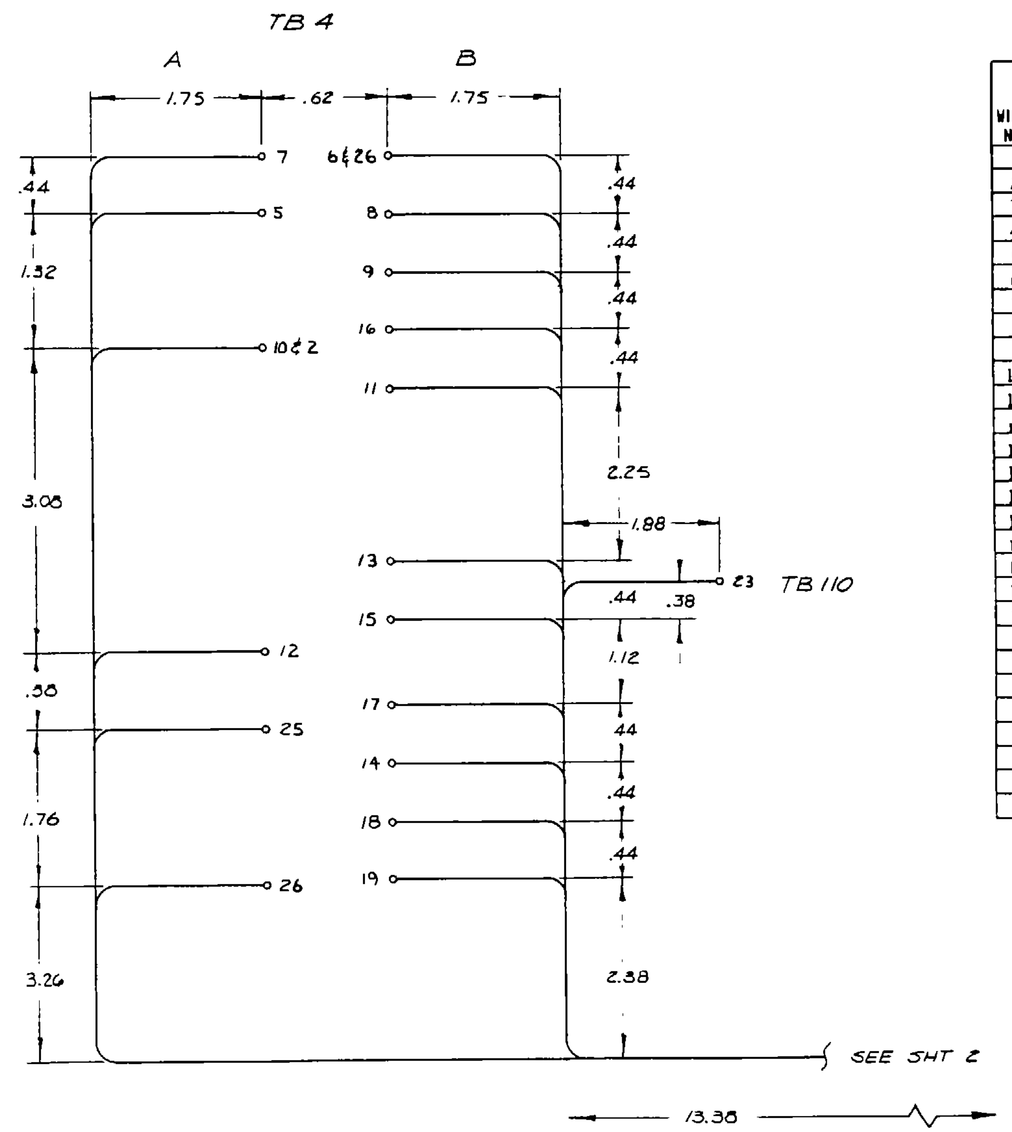
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	WIRE LENGTH	WIRE FIND NO.
1	BLK	X338A16	TB51-8B	1	K104B-X1	1	64.50	4
2	BLK	X336A16	TB51-6B	1	K104A-X1	1	69.50	4
3	BLK	X339A12	TB51-9B	2	K104A-L1	3	77.50	5
4	BLK	X319A12	TB51-12B	2	K104B-L2	3	64.00	5
5	BLK	X318A12	TB51-11B	2	K104B-L1	3	65.00	5
6	BLK	X327C12	TB51-13B	2	K104A-T1	3	64.50	5
7	BLK	X328C12	TB51-14B	2	K104A-T2	3	62.00	5
8	BLK	X340A12	TB51-10B	2	K104A-L2	3	76.00	5

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
7			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
6			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
5			MS086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
4			MS086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
3			MS25036-112	6	TERMINAL LUG		
2			MS17143-6	6	TERMINAL LUG		
1			MS25036-106	4	TERMINAL LUG		

PARTS LIST

FO-18. Cabinet C Forward Wiring Harness



WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	WIRE LENGTH	WIRE FIND NO.
1	RED	P3C16	M7-A	1	TB21-2B	1	106.50	2
2		P10B16	M7-6	1	TB4-5A	1	52.50	2
3		P106A16	M7-7	1	TB5-10	1	128.50	2
4		P146A16	M7-9	1	TB20-2	1	29.00	2
5		P14T16	TB4-2A	1	A11-TB2-4	1	58.00	2
6		P14P16	TB4-2B	1	TB17-11	1	30.50	2
7		P108E16	TB4-1A	1	DS19-4	5	48.00	2
8		P68B16	TB4-3B	1	TB19-2	1	57.50	2
9		P69B16	TB4-4B	1	TB18-10	1	33.00	2
10		P10A16	TB4-5A	1	TB20-15	1	45.50	2
11		P1L16	TB4-6B	1	TB17-8	1	29.50	2
12		P72B16	TB4-12A	1	DS19-1	5	44.00	2
13		P72D16	TB4-12B	1	TB15-6	1	39.50	2
14		P14W16	TB4-13B	1	TB14-5	1	34.50	2
15		P16M16	TB4-14B	1	TB20-6	1	33.50	2
16		P108C16	TB4-5B	1	A11-TB3-14	1	68.00	2
17		P74B16	TB4-17B	1	TB15-5	1	38.00	2
18		P75B16	TB4-19B	1	TB14-2	1	35.00	2
19		P76B16	TB4-20B	1	TB13-3	1	70.50	2
20		P110A16	M7-B	1	TB8-2	1	132.00	2
21		P148J16	K23-1	1	TB20-3	1	34.50	2
22	RED	P108A16	K23-2	1	A10-TB2-11	1	33.00	2
23	BLK	X238N16	TB110-13A	1	TB14-11	1	34.00	2
24	RED	P147A16	TB13-2	1	DS19-2	5	45.00	2
25	RED	P16N16	K23-3	1	TB4-14A	1	55.00	2
26	RED	P14AM16	TB4-2B	1	TB4-18A	1	21.50	2
27	RED	P10AH16	M7-6	1	K23-7	1	11.50	2
28	RED	P6A16	M7-4	1	TB5-6	1	122.50	2

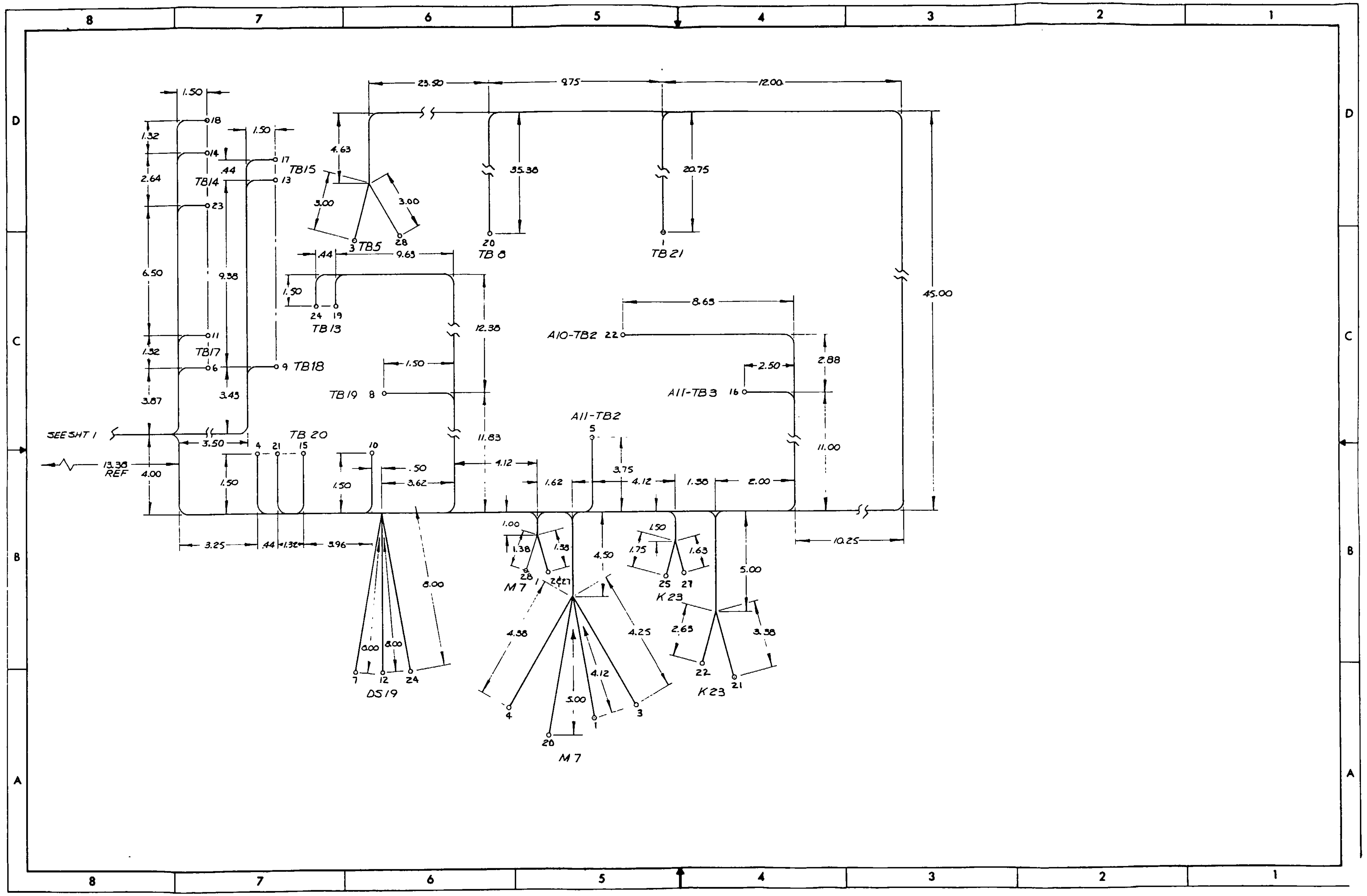
WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
5		B	80-7981	3	TERMINAL LUG	
4			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE	
3			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE	
2			MS086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2
1			MS25036-107	56	TERMINAL LUG	

PARTS LIST

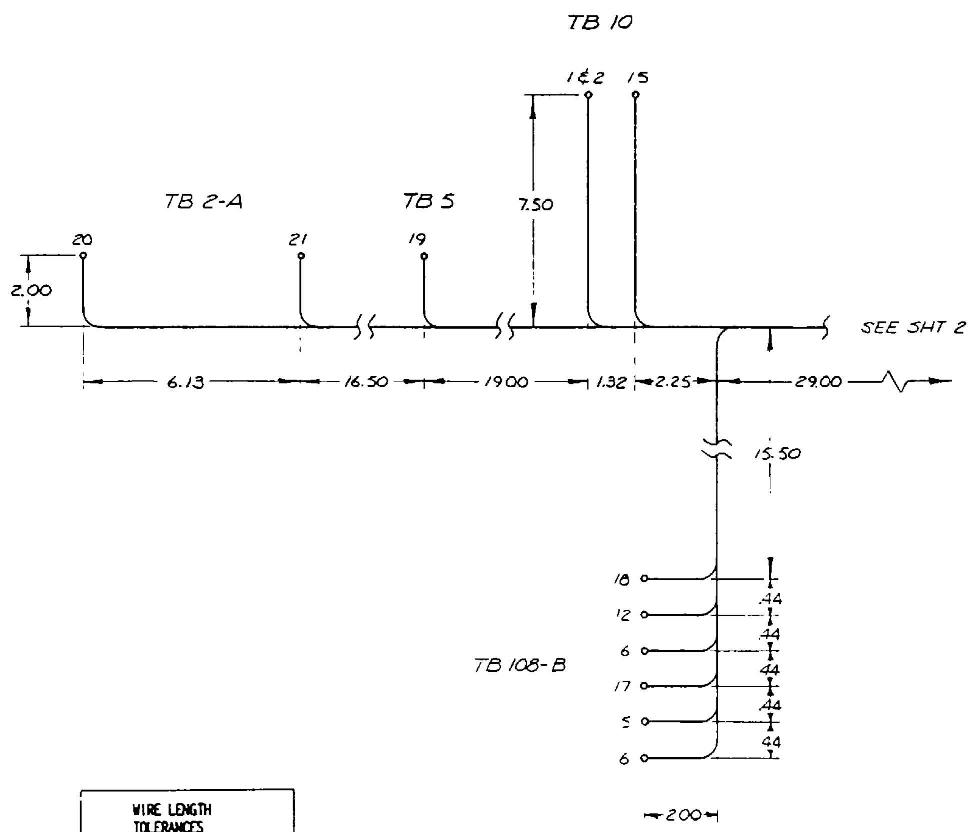
F-97/(F-98 Blank)

FO-19. Cabinet A Divider Wiring Harness
(Sheet 1 of 2)



**FO-19. Cabinet A Divider Wiring Harness
(Sheet 2 of 2)**

WIRE NO.	WIRE MARKING IDENTIFICATION		FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	WIRE LENGTH	WIRE FIND NO.
	COLOR	NUMBER						
1	BLK	X100AP12	K104A-X2	10	TB10-11	2	56.50	4
2		X100AN12	TB10-11	2	DP2-GND	¼ Strip	240.00	4
3		X100AO12	K104B-X2	10	K104A-X2	10	32.50	4
4		X100AM12	K100-1	1	DP1-GND	¼ Strip	317.00	4
5		X135B12	TB108-9B	2	K106-L1	2	86.00	4
6		X136B12	TB108-8B	2	K106-L2	2	87.00	4
7		X325A12	K100-2	1	CB105-2	¼ strip	318.50	4
8		X327A12	K104A-T1	1	CB117-2A		192.00	4
9		X328A12	K104A-T2	1	CB117-2B		194.50	4
10		X329A12	K106-T2	10	CB121-A2		198.50	4
11		X330A12	K106-T1	10	CB121-B2		197.50	4
12		X151B16	TB108-12B	3	K15A-T2		80.00	5
13		X331A16	K15A-L1	3	CB120-A2		168.00	5
14		X332A16	K15A-L2	3	CB120-B2		204.00	5
15		X320A12	TB10-14	2	CB122-2	¼ strip	232.00	5
16		X137B16	TB108-11B	3	K106-X2	3	73.50	5
17	BLK	X138B16	TB108-10B	3	K106-X1	3	74.00	5
18	BLK	X152B16	TB108-13B	3	K15A-T1	3	78.00	5
19	RED	P1R16	TB5-5	3	K15A-X1	3	89.00	5
20	RED	P1H16	TB2-6A	3	K15A-X1	3	105.50	5
21	RED	P10AC16	TB2-20A	3	K15A-X2	3	100.00	5

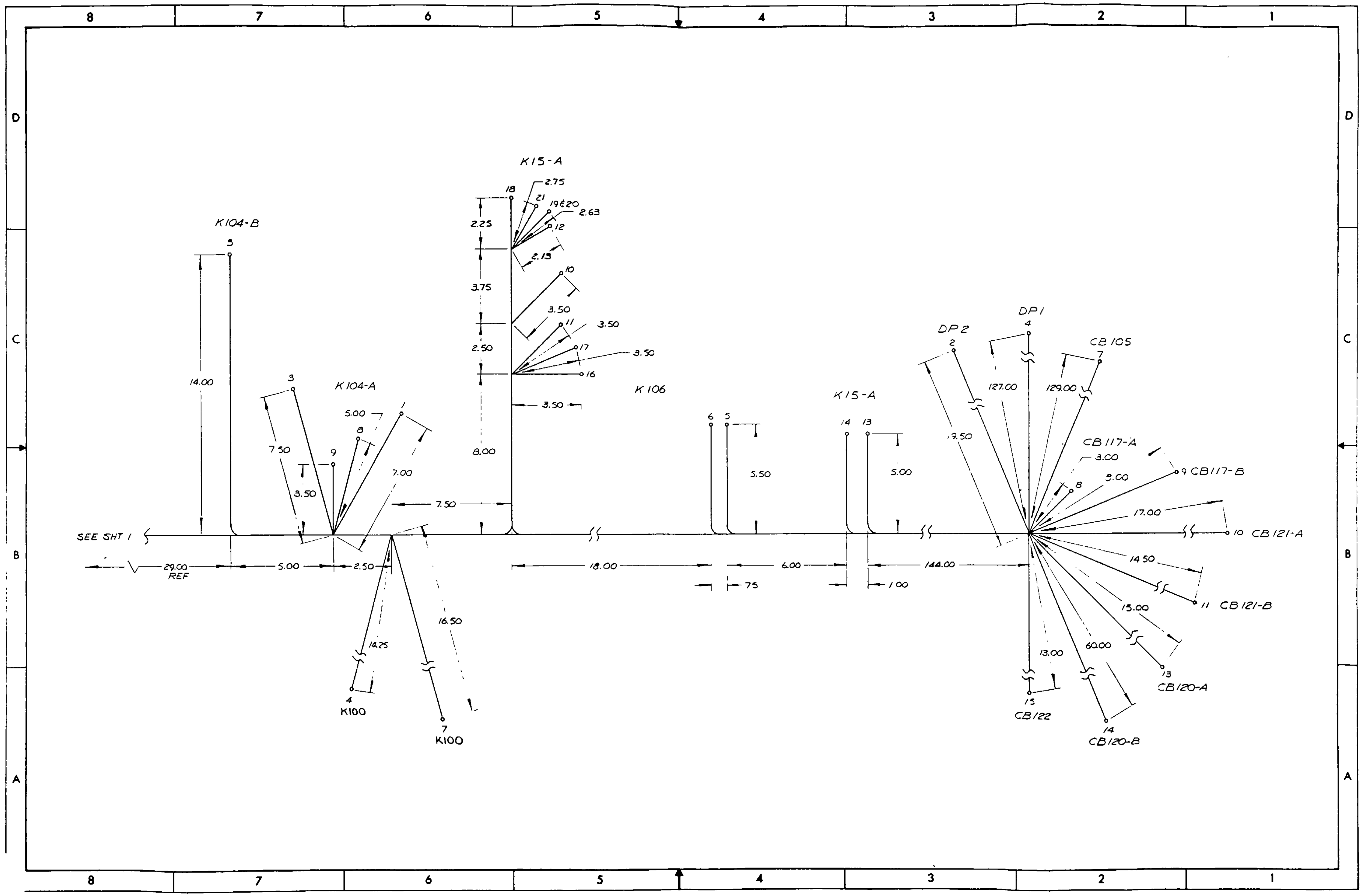


WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
10		B	71-4924	5	TERMINAL LUG	
9			MS25036-111	3	TERMINAL LUG	
8			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE	
7			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE	
6			SN60WRMAP2	AR	SOLDER	
5			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2
4			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2
3			MS25036-106	15	TERMINAL LUG	
2			MS17143-6	9	TERMINAL LUG	
1			MS25036-112	4	TERMINAL LUG	

PARTS LIST

FO-20. Cabinet C Divider Panel Wiring Harness
(Sheet 1 of 2)



FO-20. Cabinet C Divider Panel Wiring Harness
(Sheet 2 of 2)
FO-103/(FO-104 blank)

WIRE NO.	WIRE MARKING IDENTIFICATION		FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	WIRE LENGTH	WIRE FIND NO.
	COLOR	NUMBER						
1	BLK	X292B12	J24-105	1	TB108-18A	3	99.75	5
2	BLK	X100BF12	J24-106	1	TB108-17A	3	97.50	5
3	RED	P108B12	J24-114	1	TB111-19A	3	104.50	5
4	RED	P70B12	J24-109	1	K15D-A4	3	114.00	5
5	RED	P39B16	J24-113	2	TB3-8A	4	121.75	6
6	RED	P38B16	J24-155	2	TB3-7A	4	124.00	6
7	RED	P38G16	J24-151	2	TB13-10	4	204.25	6
8	BLK	X236C16	J24-107	2	TB21-20B	4	108.75	6

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO.	FSCM	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
8			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE	
7			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE	
6			M5086/2-16-9	AR	WIRE, 16 AN	MIL-W-5086/2
5			M5086/2-12-9	AR	WIRE, 12 AN	MIL-W-5086/2
4			MS25036-106	4	TERMINAL LUG	
3			MS17143-6	4	TERMINAL LUG	
2			MS25036-153	4	TERMINAL LUG	
1			MS25036-156	4	TERMINAL LUG	

PARTS LIST

FO-21. Load Circuit Breaker
CB101 Wiring Harness

WIRE NO.	WIRE MARKING IDENTIFICATION		FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
	COLOR	NUMBER						
1	BLK	X182C16	S2-A1	1	M107-1	6	50.00	7
2	BLK	X182A16	S2-A1	1	TB106-13B	1	58.25	7
3	RED	P123C16	S2-D1	1	S114-11	5	58.00	7
4	RED	P17B16	S2-E1	1	TB106-11B	1	53.00	7
5	BLK	X181A16	S2-H1	1	TB106-12B	1	55.63	7
6	RED	P143A16	S2-D2	1	R102-2	¼strip	43.00	7
7	RED	P63A16	S2-E2	1	A104-21	1	90.00	7
8	RED	P124B16	S2-F2	1	TB107-15B	1	57.50	7
9	BLK	X184C16	S2-A3	1	M104-1(+)	6	41.00	7
10	BLK	X184A16	S2-A3	1	TB106-15B	1	55.75	7
11	BLK	X192A16	S2-D3	1	S115-23	5	45.00	7
12	BLK	X162F16	S2-E3	1	S119-28	1	27.75	7
13	BLK	X183A16	S2-H3	1	TB106-14B	1	55.25	7
14	BLK	X170D16	S2-A4	1	S112-28	5	45.50	7
15	BLK	X170M16	S2-A4	1	S119-14	1	33.75	7
16	BLK	X193A16	S2-D4	1	S115-12	5	45.00	7
17	BLK	X174A16	S2-E4	1	TB106-5B	1	57.00	7
18	BLK	X174B16	S2-E4	1	S112-24	5	42.50	7
19	BLK	X194A16	S2-H4	1	S115-27	5	38.00	7
20	BLK	X173A16	S2-A5	1	TB106-4B	5	60.75	7
21	BLK	X173B16	S2-A5	1	S112-23	5	42.75	7
22	RED	P142A16	S2-D5	1	R102-1	¼strip	42.75	7
23	RED	P62A16	S2-E5	1	A104-22	1	85.00	7
24	RED	P125B16	S2-F5	1	TB107-16B	1	57.00	7
25	BLK	X195A16	S2-H5	1	S115-16	5	38.25	7
26	RED	P29A16	S2-A6	1	TB2-4B	1	81.50	7
27	RED	P31B16	S2-B6	1	TB2-15B	1	85.50	7
28	RED	P144A16	S2-D6	1	R102-3	¼strip	39.75	7
29	RED	P64A16	S2-E6	1	A104-20	1	91.00	7
30	RED	P126B16	S2-F6	1	TB107-17B	1	56.00	7
31	RED	P47B16	S2-H6	1	S6-28	1	29.75	7
32	BLK	X190A16	S2-A7	1	TB107-3B	5	66.00	7
33	BLK	X189A16	S2-B7	1	TB107-2B	5	71.25	7
34	RED	P4D16	S2-D7	1	S114-51	5	58.00	7
35	RED	P155C16	S2-E7	1	TB106-9B	1	82.00	7
36	BLK	X110A16	S2-H7	1	R101-1	¼strip	50.00	7
37	BLK	X277A16	S2-A8	1	TB3-14B	1	76.50	7
38	BLK	X276C16	S2-E8	1	S115-32	5	35.50	7
39	BLK	X275A16	S2-F8	1	TB3-12B	1	75.00	7
40	BLK	X117A16	S2-H8	1	S4-23	5	24.00	7
41	RED	P32A16	S2-A9	1	TB2-18B	1	75.50	7
42	RED	P48A16	S2-B9	1	TB3-20B	1	76.00	7
43	RED	P56A16	S2-F9	1	TB3-18B	1	78.00	7
44	RED	P46E16	S2-E9	1	TB50-3B	1	55.00	7
45	RED	P46A16	S2-E9	1	TB3-17B	1	71.50	7
46	RED	P51A16	S2-D9	1	S4-18	5	18.00	7
47	RED	P54A16	S2-H9	1	S6-15	1	27.25	7
48	RED	P14B16	S2-A10	1	S6-21	1	33.00	7
49	RED	P14L16	S2-A10	1	TB2-1B	1	82.75	7
50	RED	P37A16	S2-B10	1	TB3-5B	1	84.50	7
51	RED	P156C16	S2-D10	1	S114-31	5	58.00	7
52	RED	P20B16	S2-E10	1	TB106-10B	1	54.25	7
53	RED	P59B16	S2-H10	1	TB50-4B	1	62.50	7
54	RED	P67A16	S2-A11	1	TB7-4	1	103.00	7
55	RED	P35D16	S2-B11	1	TB3-3B	1	84.00	7
56	RED	P78A16	S2-H11	1	TB3-6B	1	83.00	7
57	BLK	X276D16	S2-E8	1	S3-C12	5	19.75	7
58	BLK	X153B16	TB105-1B	1	S113-H11	5	41.25	7
59	BLK	X154B16	TB105-2B	1	S113-H12	5	41.00	7
60	BLK	X155B16	TB105-3B	1	S113-H1	5	40.75	7
61	BLK	X156B16	TB105-4B	1	S113-E5	5	39.25	7
62	BLK	X157B16	TB105-5B	1	S113-E6	5	50.00	7
63	BLK	X158B16	TB105-6B	1	S113-E7	5	36.00	7
64	BLK	X159B16	TB105-7B	1	M105-5	5	65.75	7
65	BLK	X160B16	TB105-8B	1	S113-B1	5	36.25	7
66	BLK	X162A16	TB105-9B	1	S119-28	1	36.50	7
67	BLK	X162AG16	TB105-10B	1	S112-26	5	58.50	7
68	BLK	X171D16	TB105-11B	1	M105-1	5	65.50	7
69	BLK	X100D16	TB105-12B	1	M105-2	5	65.50	7
70	BLK	X170P16	TB105-13B	1	S119-14	1	35.75	7
71	BLK	X144B12	TB105-15B	2	M108-2	4	72.50	8
72	BLK	X146B12	TB105-16B	2	M108-4	4	71.25	8
73	BLK	X124B12	TB105-17B	2	M108-1	4	72.75	8
74	BLK	X187E12	TB105-18B	2	M108-9	4	68.25	8
75	BLK	X186E12	TB105-19B	2	M108-8	4	68.00	8
76	BLK	X212A16	TB105-20B	1	M108-5	5	69.75	7
77	BLK	X170B16	TB106-1B	1	S112-16	5	65.00	7
78	BLK	X171A16	TB106-2B	1	S112-17	5	65.25	7
79	BLK	X172A16	TB106-3B	1	S112-14	5	69.00	7
80	BLK	X175A16	TB106-6B	1	S114-61	5	70.75	7
81	BLK	X179A16	TB106-7B	1	S114-41	5	69.00	7
82	BLK	X178A16	TB106-8B	1	S114-21	5	69.00	7
83	RED	P49A16	TB106-16B	1	S3-A7	5	53.25	7
84	BLK	X213A16	TB106-17B	1	M108-6	5	74.25	7

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO.	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
10			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
9			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
8			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
7			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
6			MS25036-154	6	TERMINAL LUG		
5			MS25036-108	75	TERMINAL LUG		
4			MS25036-112	8	TERMINAL LUG		
3			MS25036-153	11	TERMINAL LUG		
2			MS17143-6	7	TERMINAL LUG		
1			MS25036-106	175	TERMINAL LUG		

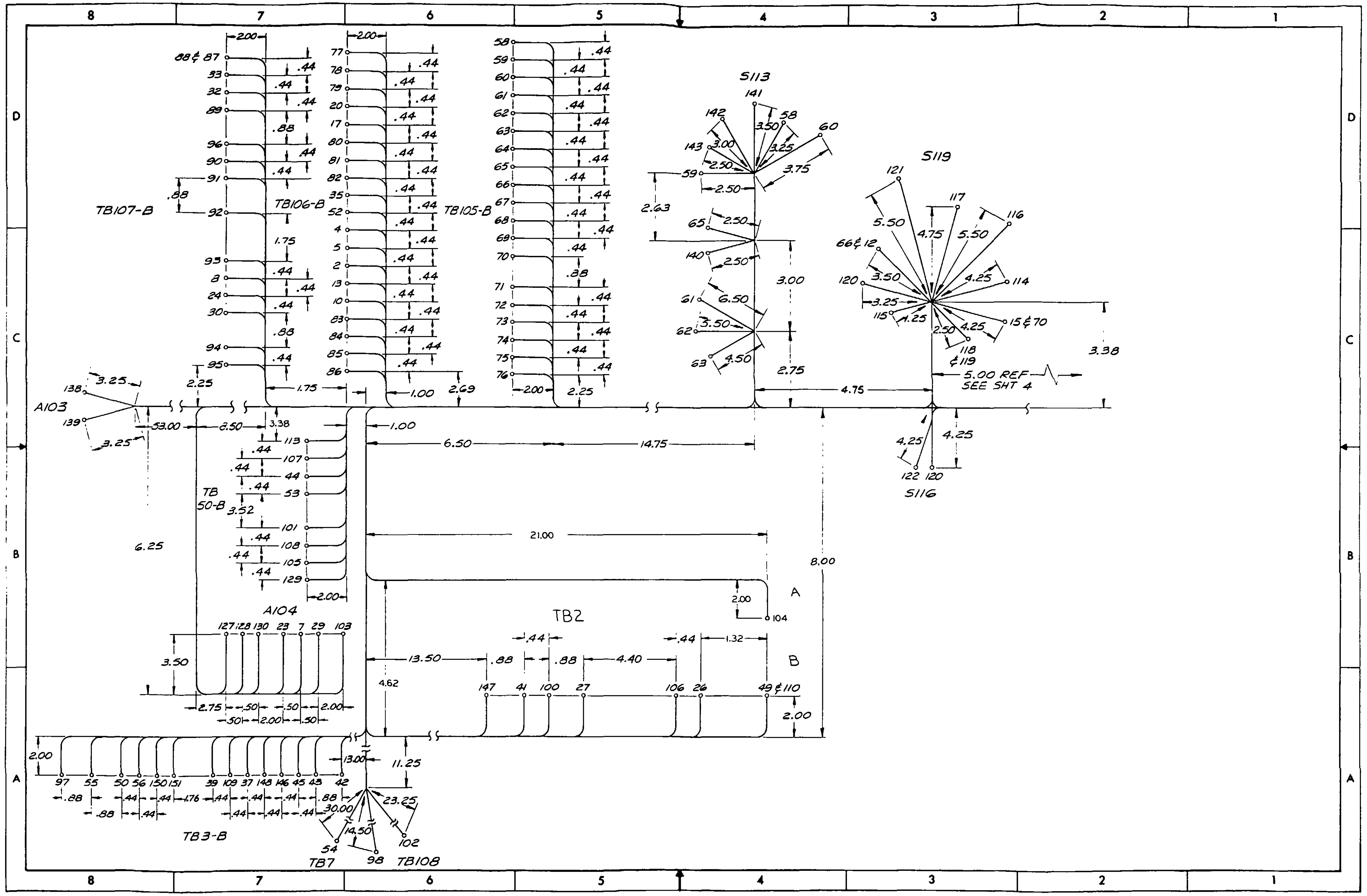
PARTS LIST

FO-22. Cabinet B Door
Wiring Harness
(Sheet 1 of 8)

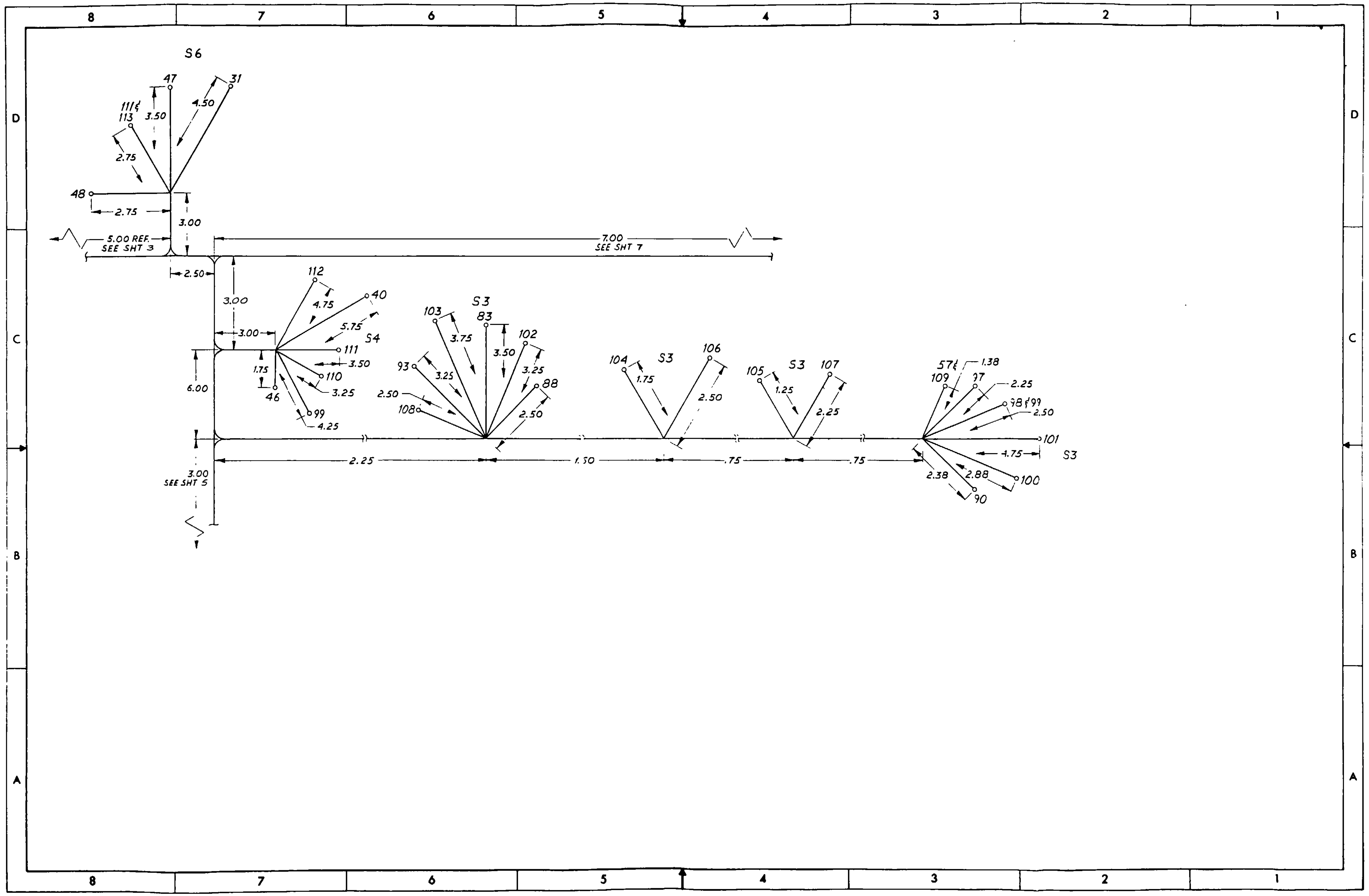
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
85	BLK	X125A16	TB106-18B	1	M107-2(-)	6	66.25	7
86	RED	P123B16	TB106-19B	1	S114-11	5	64.00	7
87	BLK	X188A16	TB107-1B	1	R101-3	¼ strip	78.00	7
88	BLK	X188C16	TB107-1B	1	S3-C6	5	64.00	7
89	BLK	X221C12	TB107-4B	1	M108-10	4	82.75	8
90	BLK	X289A16	TB107-7B	1	S3-D12	5	64.25	7
91	BLK	X288A16	TB107-8B	1	S115-33	5	59.25	7
92	BLK	X211A16	TB107-10B	1	M108-3	5	83.00	7
93	BLK	X111A16	TB107-14B	1	S3-C5	5	59.75	7
94	BLK	X250A16	TB107-19B	1	M104-2(-)	6	62.25	7
95	RED	P4C16	TB107-20B	1	S114-51	5	69.75	7
96	RED	P156B16	TB107-6B	1	S114-31	5	79.00	7
97	RED	P33A16	S3-B1	3	TB3-1B	1	82.50	7
98	BLK	X291B12	S3-C1	4	TB108-19A	2	86.50	8
99	BLK	X291C12	S3-C1	4	S4-22	2	24.50	8
100	BLK	X286A16	S3-D1	3	TB2-17B	1	88.00	7
101	BLK	X238P16	S3-B6	3	TB50-12B	1	62.00	7
102	BLK	X234C16	S3-D6	3	TB108-14B	1	92.25	7
103	RED	K3D16	S3-B7	3	A104-16	1	90.00	7
104	RED	P148R16	S3-A11	3	TB2-3A	1	79.00	7
105	RED	P103A16	S3-B11	3	TB50-14B	1	62.00	7
106	RED	P30A16	S3-A12	3	TB2-5B	1	79.00	7
107	RED	P36B16	S3-B12	3	TB50-2B	1	56.50	7
108	BLK	X150D16	S3-A6	3	TB50-13B	1	59.00	7
109	BLK	X276A16	S3-C12	3	TB3-13B	1	77.75	7
110	RED	P14K16	S4-31	5	TB2-1B	1	73.50	7
111	RED	P14R16	S4-11	5	S6-14	5	17.00	7
112	RED	P53A16	S4-35	5	DS33-1	¼ strip	28.00	7
113	RED	P14N16	S6-14	1	TB50-1B	1	42.50	7
114	BLK	X174C16	S119-17	1	S112-12	5	38.50	7
115	BLK	X216A16	S119-11	1	DS112-1	¼ strip	34.25	7
116	BLK	X172C16	S119-13	1	S112-13	5	39.00	7
117	BLK	X217A16	S119-16	1	DS113-1	¼ strip	39.25	7
118	BLK	X171C16	S119-18	1	M105-1	5	43.00	7
119	BLK	X171B16	S119-18	1	S112-17	5	32.25	7
120	BLK	X215A16	S119-21	1	S116-NO	¼ strip	12.50	7
121	BLK	X173C16	S119-23	1	S112-22	5	38.25	7
122	BLK	X214A16	S116-C	1	DS112-2	¼ strip	33.00	7
123	BLK	X207A16	S115-13	1	M106-9	5	20.75	7
124	BLK	X208B16	S115-17	1	DS111-1	1	33.50	7
125	BLK	X206B16	S115-22	1	R111-2	¼ strip	29.25	7
126	BLK	X205A16	S115-26	5	M106-1	¼ strip	30.75	7

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
127	RED	P60A16	S117-2	1	A104-28	1	79.25	7
128	RED	P61A16	S117-3	1	A104-27	1	83.00	7
129	BLK	X240A16	S117-4	1	TB50-15B	1	60.50	7
130	BLK	X321A16	S117-5	1	A104-26	1	85.50	7
131	BLK	X196A16	S112-11	5	M101-1	5	36.00	7
132	BLK	X197A16	S112-21	5	M101-2	5	36.00	7
133	BLK	X198A16	S114-57	5	M102-1(+)	6	49.25	7
134	BLK	X199A16	S114-67	5	M102-2(-)	6	49.50	7
135	BLK	X205B16	M106-1	5	R110-2	¼ strip	20.00	7
136	BLK	X100AB16	M106-2	1	M105-2	5	39.25	7
137	BLK	X207B16	M106-9	5	DS110-1	1	17.25	7
138	RED	P57A16	M103-3(+)	5	A103(+)	1	125.50	7
139	RED	P58A16	M103-5(-)	5	A103(-)	1	128.00	7
140	BLK	X203A16	M105-4	5	S113-A1	5	49.00	7
141	BLK	X202A16	M105-3	5	S113-F1	5	52.25	7
142	BLK	X204A16	M105-6	5	S113-E1	5	49.50	7
143	BLK	X160C16	M105-7	5	S113-D1	5	48.75	7
144	BLK	X214C16	DS113-2	¼ strip	DS112-2	¼ strip	16.50	7
145	RED	P10U16	DS35-2	¼ strip	DS36-2	¼ strip	16.00	7
146	RED	P45A16	DS36-1	¼ strip	TB3-16B	1	79.00	7
147	RED	P10P16	DS35-2	¼ strip	TB2-20B	1	74.00	7
148	RED	P44A16	DS35-1	¼ strip	TB3-15B	1	75.50	7
149	RED	P53B16	DS34-1	¼ strip	DS33-1	strip	16.00	7
150	RED	P38A16	DS34-2	¼ strip	TB3-7B	1	79.00	7
151	RED	P39A16	DS33-2	¼ strip	TB3-8B	1	80.50	7
152	RED	JUMPER 16	DS112-1	1	R103-1	strip	8.00	7
153	RED	JUMPER 16	DS112-2	1	R103-2	strip	5.00	7
154	RED	JUMPER 16	DS113-1	1	R104-1	strip	8.00	7
155	RED	JUMPER 16	DS113-2	1	R104-2	strip	5.00	7

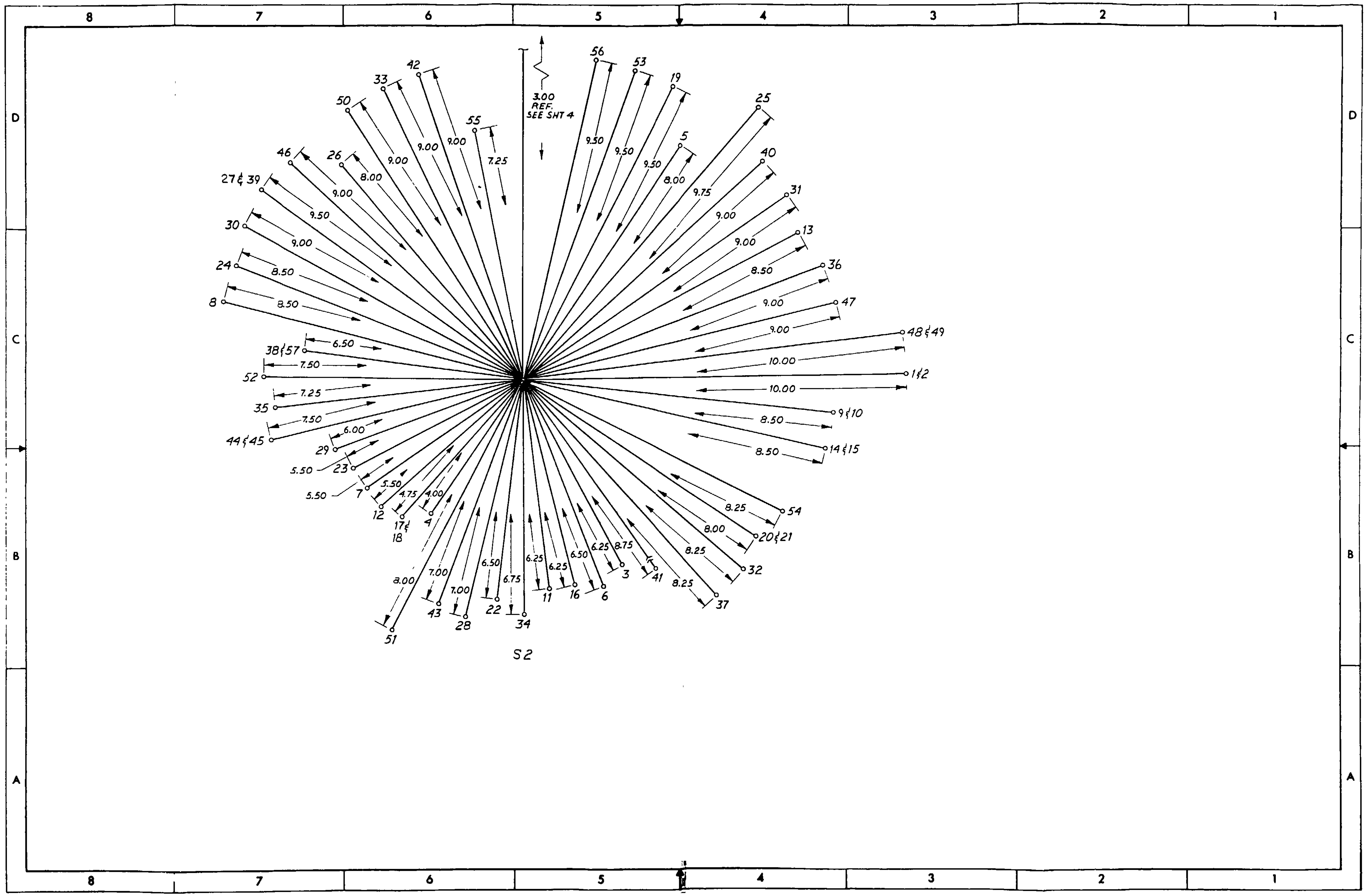
FO-22. Cabinet B Door
Wiring Harness
(Sheet 2 of 8)
FO-109/(FO-110 blank)



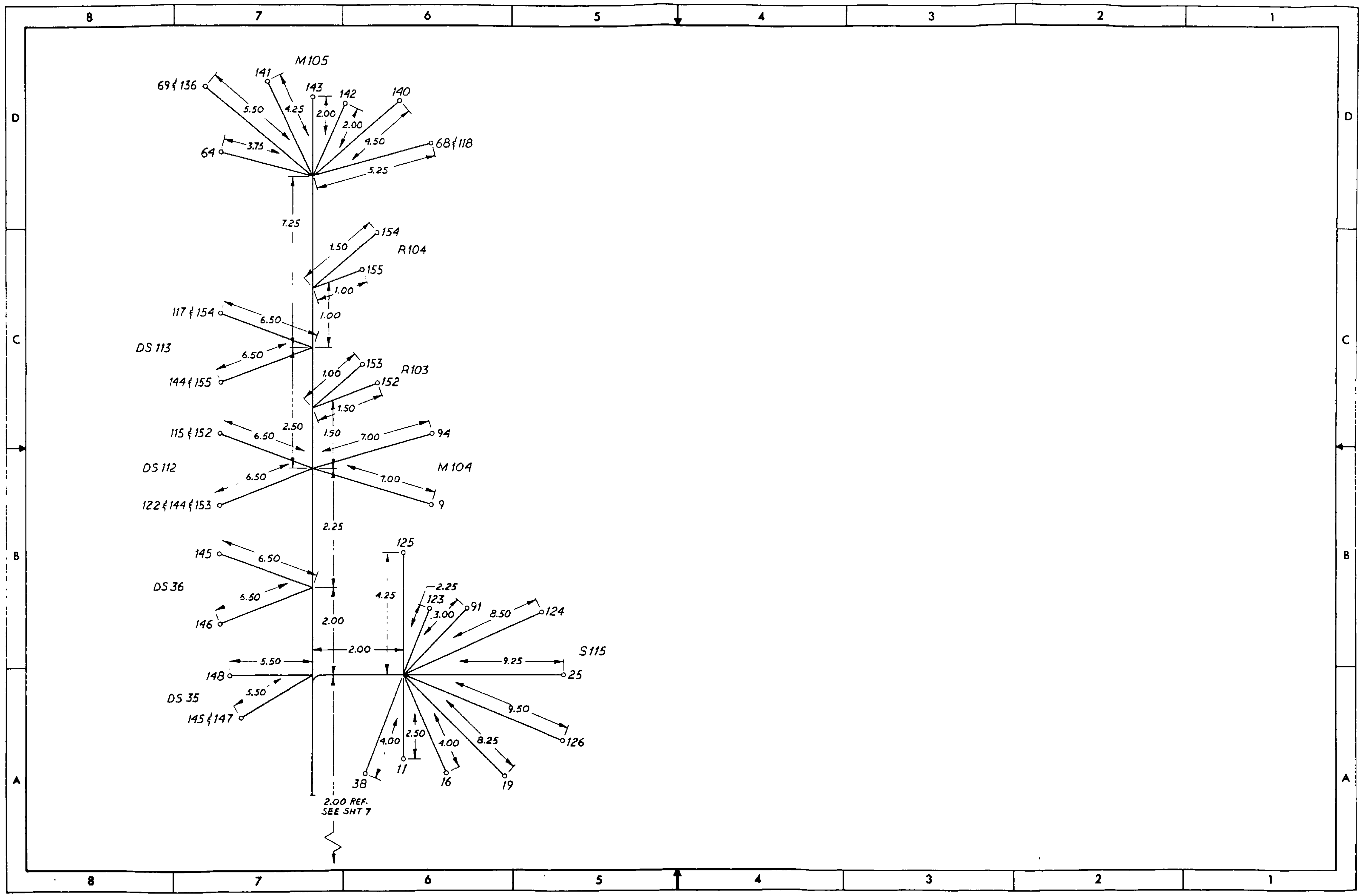
FO-22. Cabinet B Door
Wiring Harness
(Sheet 3 of 8)
FO-111/(FO-112 blank)



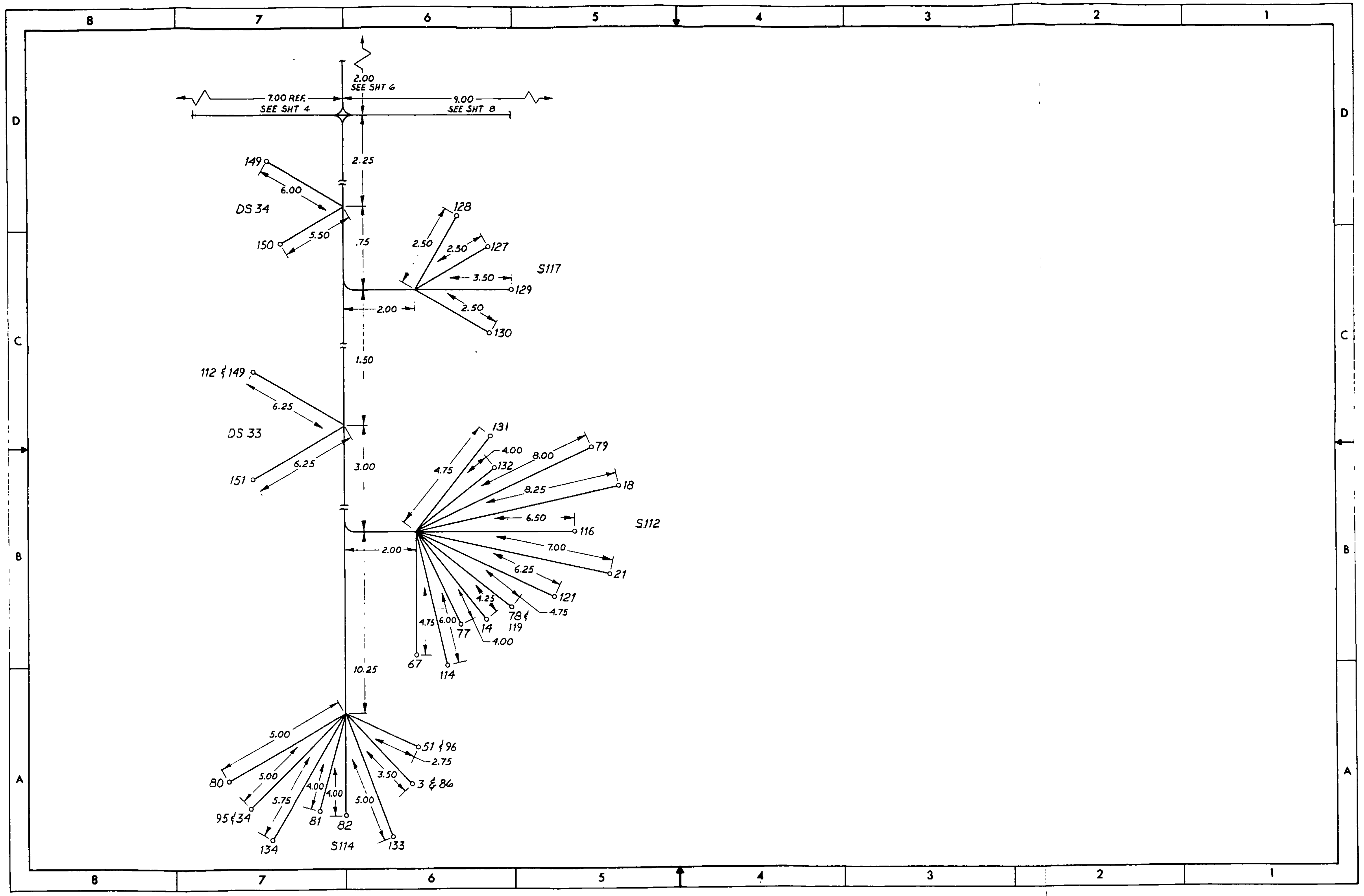
FO-22. Cabinet B Door
Wiring Harness
(Sheet 4 of 8)
FO-113/(FO-114 blank)



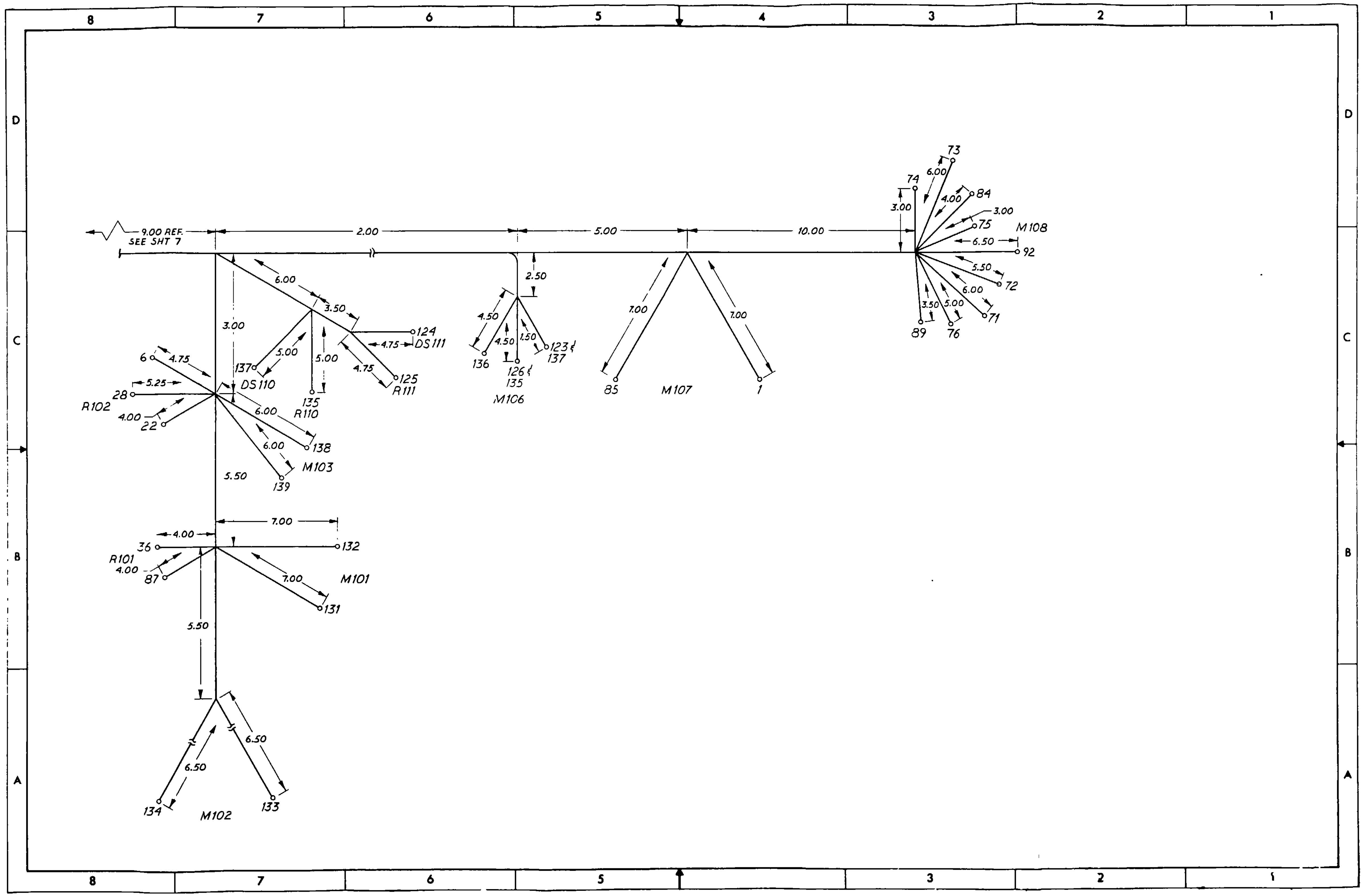
FO-22. Cabinet B Door
Wiring Harness
(Sheet 5 of 8)
FO-115/(FO-116 blank)



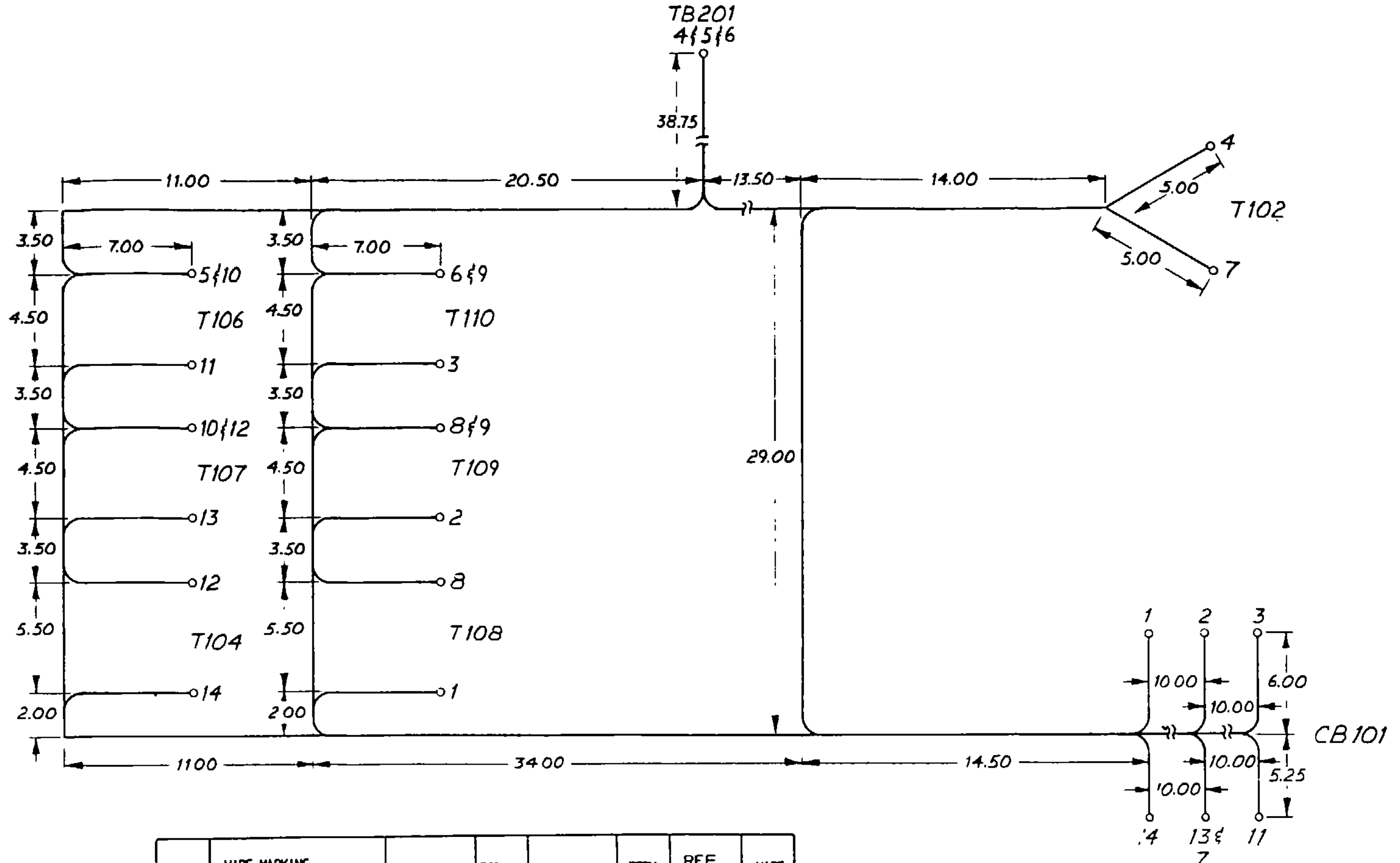
FO-22. Cabinet B Door
Wiring Harness
(Sheet 6 of 8)
FO-117/(FO-118 blank)



FO-22. Cabinet B Door
Wiring Harness
(Sheet 7 of 8)
FO-119/(FO-120 blank)



FO-22. Cabinet B Door
Wiring Harness
(Sheet 8 of 8)
FO-121/(FO-122 blank)



WIRE NO.	WIRE MARKING IDENTIFICATION		FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
	COLOR	NUMBER						
1	BLK	J101B18	T108-H1	1	CB101-L1	3	64.75	4
2	BLK	J102B18	T109-H1	1	CB101-L2	3	83.25	4
3	BLK	J103B18	T110-H1	1	CB101-L3	3	98.75	4
4	BLK	X273D18	T102-H2	1	TB201-L0	2	69.25	4
5	BLK	X273F18	T106-H2	1	TB201-L0	2	78.25	4
6	BLK	X273C18	T110-H2	1	TB201-L0	2	67.00	4
7	BLK	X265K18	T102-H1	1	CB101-T2	3	73.00	4
8	BLK	X273E18	T108-H2	1	T109-H2	1	24.25	4
9	BLK	X273A18	T109-H2	1	T110-H2	1	23.50	4
10	BLK	X273G18	T107-H2	1	T106-H2	1	22.25	4
11	BLK	X263A18	T106-H1	1	CB101-T3	3	110.00	4
12	BLK	X273H18	T107-H2	1	T104-H2	1	22.25	4
13	BLK	X265A18	T107-H1	1	CB101-T2	3	91.50	4
14	BLK	X261A18	T104-H1	1	CB101-T1	3	74.25	4

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

6			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
5			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
4		B	80-7978	AR	WIRE, RED, HIGH TENSION, 18 GA.		
3			MS20659-161	7	TERMINAL LUG		
2			MS20659-125	3	TERMINAL LUG		
1			MS20659-102	18	TERMINAL LUG - NON INSULATED		
FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL

PARTS LIST

FO-23. Cabinet A XFMR Panel
High Tension Wiring Harness

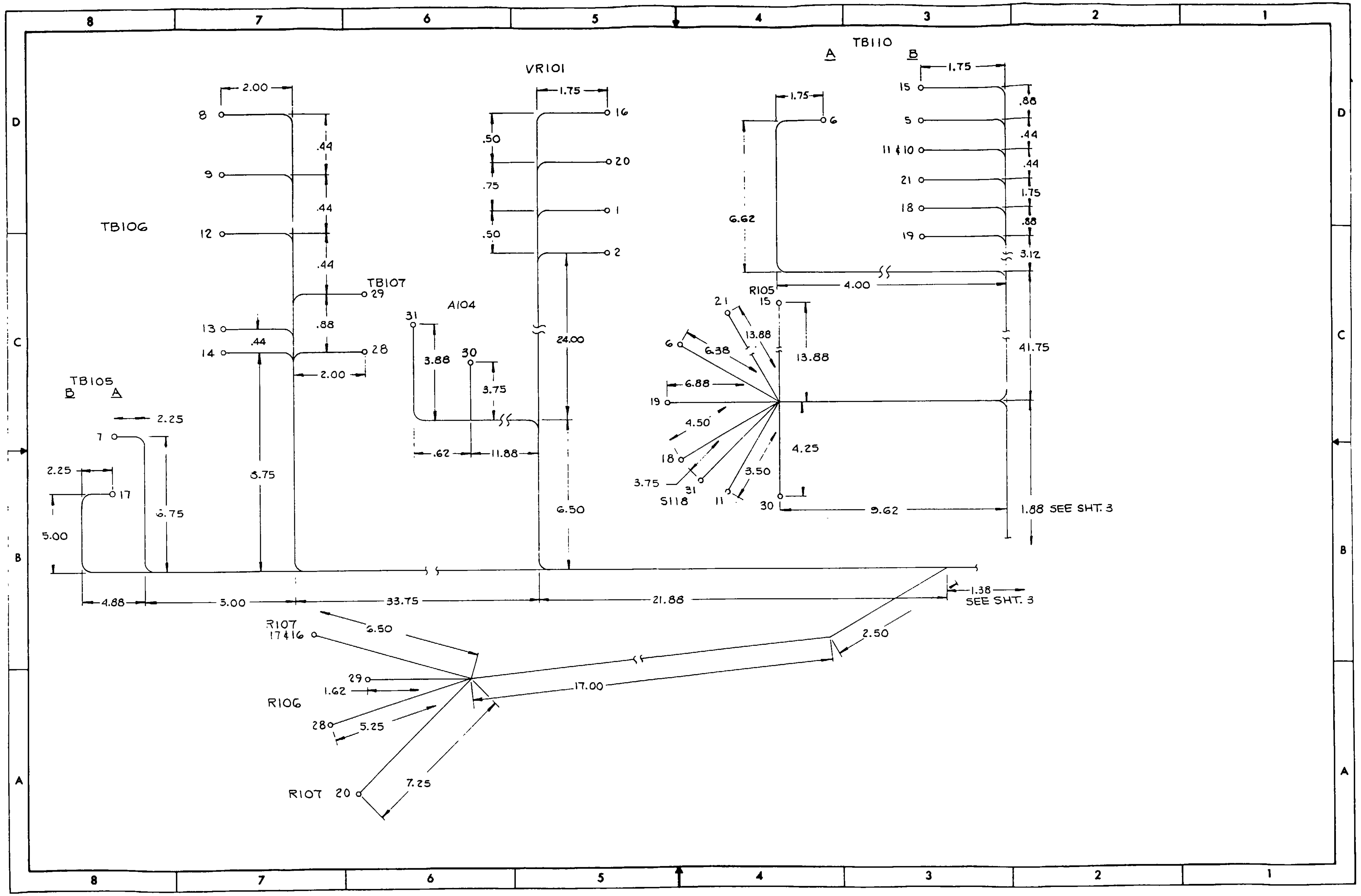
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	WIRE MARKING IDENTIFICATION NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	BLK	X245B12	VR101-3	2	T102-X4	5,	152.50	6
2		X246B12	VR101-4	2	T102-X2	5	149.50	6
3		X310C10	R100-2	1	T100-X2	5	98.00	7
4		X311D10	R100-1	1	T100-X1	5	76.00	7
5		X162U16	TB110-11B	3	F111-2	4	75.75	8
6		X162W16	TB110-11A	3	S118-35	3	69.50	8
7		X162X16	TB105-10A	3	F111-2	4	90.00	8
8		X170A16	TB106-1A	3	F109-2	4	92.00	8
9		X171F16	TB106-2A	3	F113-2	4	85.00	8
10		X171R16	TB110-12B	3	F113-2	4	72.50	8
11		X171S16	TB110-12B	3	S118-22	3	63.00	8
12		X172B16	TB106-3A	3	F121-2	4	79.00	8
13		X173G16	TB106-4A	3	F119-2	4	83.00	8
14		X174F16	TB106-5A	3	F117-2	4	87.00	8
15		X230K16	TB110-9B	3	R105-1	STRIP	74.50	8
16		X230A16	VR101-1	3	R107-2	STRIP	81.00	8
17		X230L16	TB105-14B	3	R107-2	STRIP	99.00	8
18		X231C16	TB110-17B	3	S118-23	3	62.00	8
19		X232C16	TB110-19B	3	S118-36	3	64.00	8
20	BLK	X237G16	VR101-2	3	R107-1	STRIP	82.00	8
21	BLK	X238D16	TB110-13B	3	R105-3	STRIP	73.50	8
22		X267A16	T104-X1	4	F109-1	4	145.00	8
23		X269A16	T107-X1	4	F111-1	4	132.00	8
24		X270A16	T106-X1	4	F113-1	4	118.00	8
25		X278A16	T108-X1	4	F117-1	4	128.00	8
26		X280B16	T109-X1	4	F119-1	4	116.00	8
27		X281A16	T110-X1	4	F121-1	4	104.00	8
28		X293A16	TB107-5A	3	R106-3	STRIP	91.00	8
29	BLK	X190D16	TB107-3B	3	R106-1	STRIP	91.00	8
30	RED	P97A16	S118-33	3	A104-23	3	63.00	8
31	RED	P98A16	S118-32	3	A104-24	3	63.00	8

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO.	FSCM	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
10			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
9			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
8			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
7			M5086/2-10-9	AR	WIRE 10 AN	MIL-W-5086/2	
6			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
5			MS25036-112	4	TERMINAL LUG		
4			MS25036-108	20	TERMINAL LUG		
3			MS25036-106	27	TERMINAL LUG		
2			MS17143-6	2	TERMINAL LUG		
1			MS25036-113	2	TERMINAL LUG		

PARTS LIST

FO-24. Cabinet A Forward
Wiring Harness
(Sheet 1 of 3)



FO-24. Cabinet A Forward
Wiring Harness
(Sheet 2 of 3)
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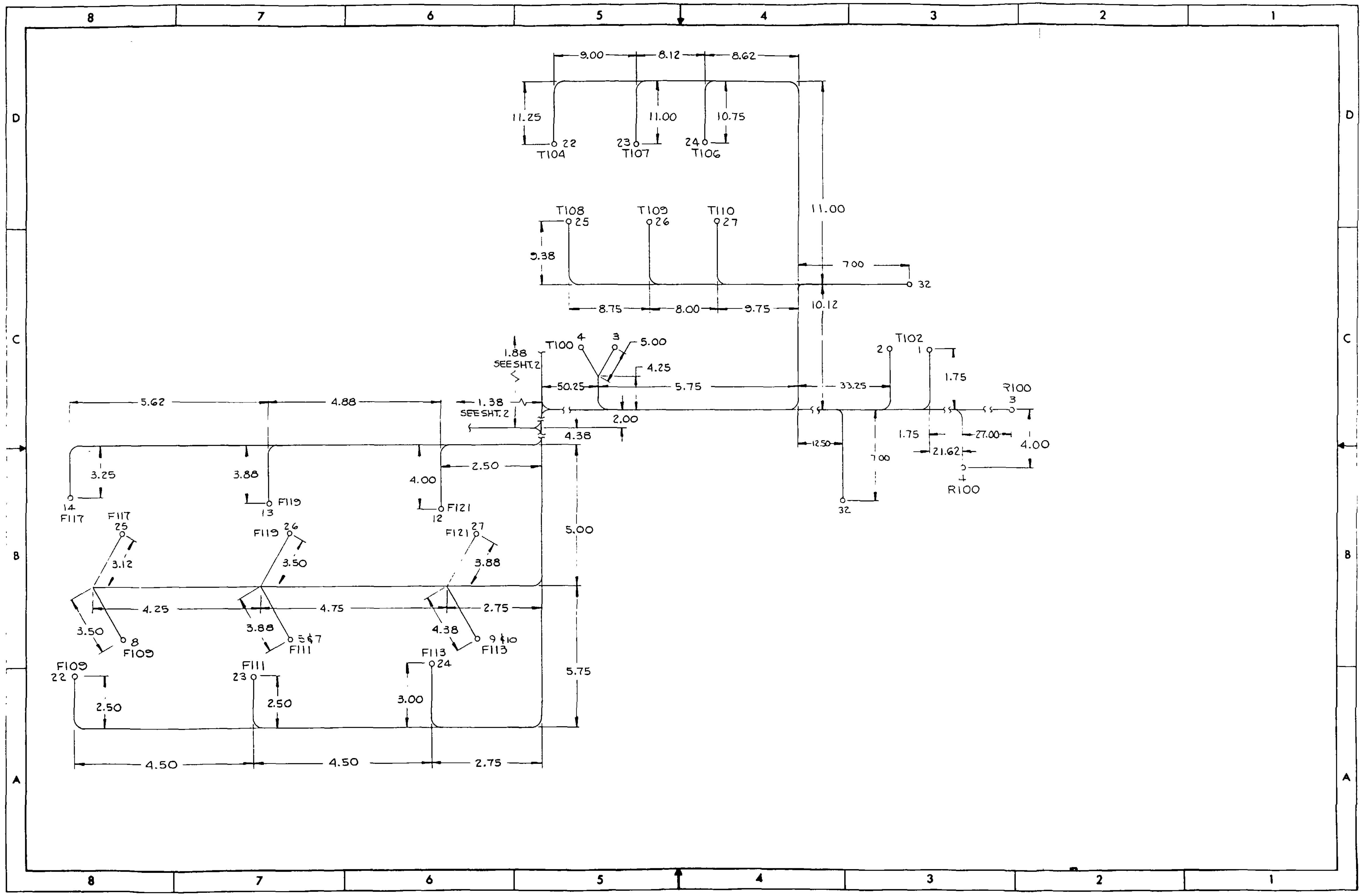


**FO-24. Cabinet A Forward
Wiring Harness
(Sheet 3 of 3)**

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	WIRE LENGTH	WIRE FIND NO.
1	RED	P79A18	A9-1	¼ strip	A10-TB3-1	1	118.25	5
2	RED	P132A18	A9-2		A11-TB3-1	1	110.00	5
3		P77A18	A9-3		A11-TB3-6	1	115.50	5
4		P71B18	A9-C		S15-B-C	1	36.00	5
5		P80A18	A9-6		A10-TB3-3	1	123.00	5
6		P81A18	A9-5		A10-TB3-2	1	120.00	5
7		P82A18	A9-4		A10-TB3-6	1	120.50	5
8		P83A18	A9-9		A10-TB3-9	1	124.00	5
9		P84A18	A9-8		A10-TB3-4	1	119.00	5
10		P85A18	A9-7		A10-TB3-5	1	118.50	5
11		P86A18	A9-12		A10-TB3-8	1	121.50	5
12		P87A18	A9-11		A11-TB3-3	1	107.00	5
13		P88A18	A9-10		A10-TB3-7	1	117.50	5
14		P89A18	A9-15		A11-TB3-5	1	110.00	5
15		P90A18	A9-14		A11-TB3-4	1	105.50	5
16		P91A18	A9-13		A11-TB3-2	1	104.00	5
17		P133A18	A9-16		A11-TB3-7	1	103.00	5
18		P134A18	A9-17		A11-TB3-8	1	108.00	5
19	RED	P135A18	A9-18	¼ strip	A11-TB3-9	1	113.00	5
20	BLK	X231D16	TB01-1	1	TB110-17A	1	61.50	6
21	BLK	X100N16	TB01-2	1	TB02-2	1	22.50	6
22	BLK	X232D16	TB02-1	1	TB110-19A	1	43.00	6
23	RED	P76A16	S15B-NC	1	TB4-20A	1	53.50	6
24		P75A16	S15C-NC	1	TB4-19A	1	53.00	6
25		P73Z16	S15A-NC	1	TB15-3	1	86.00	6
26		P23A16	S15A-C	1	S12A-C	1	16.50	6
27		P72A16	S15A-NO	1	TB4-12A	1	55.00	6
28		P93A16	S15C-C	1	A11-TB3-11	1	110.00	6
29		P10X16	S15C-NO	1	K114-GND	2	49.00	6
30		P14S16	S16A-C	1	TB4-18A	1	49.50	6
31		P74A16	S16A-NO	1	TB4-17A	1	50.00	6
32		P14V16	S16A-C	1	S12A-NC	1	14.75	6
33		P94C16	S12B-C	1	TB4-9A	1	51.50	6
34		P16J16	S12B-NC	1	TB4-14A	1	49.50	6
35		P14AL16	K115-1	2	TB4-2A	1	44.50	6
36	RED	P68A16	K115-2	2	TB4-3A	1	42.50	6
37	BLK	X310A10	K115-5	3	TB4-8A	1	40.50	7
38	BLK	X311A10	K115-6	3	TB4-10A	4	39.50	7
39	BLK	X201C12	K114-1	3	TB110-4A	4	52.00	8
40	BLK	X100W12	K114-2	3	TB110-18A	4	47.00	8
41	BLK	X176D12	K114-3	3	TB110-6A	4	52.50	8
42	BLK	X100X12	K114-4	3	TB110-15A	4	48.50	8

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	WIRE LENGTH	WIRE FIND NO.
43	BLK	X123C12	K114-5	3	TB110-8A	4	51.00	8
44	BLK	X100Y12	K114-6	3	TB110-20A	4	45.00	8
45	RED	P1N16	K114-7	2	TB4-6A	1	50.00	6
46	RED	P108F16	K114-8	2	TB4-1A	1	51.00	6
47	RED	P69A16	K114-12	2	TB4-4A	1	49.50	6
48	BLK	X161B16	CNTR-1	1	TB110-10A	1	54.00	6
49	BLK	X100H16	CNTR-2	1	TB110-3A	1	57.00	6
50	RED	P72E16	S15A-NO	1	S12A-NO	1	16.00	6
51	BLK	X100Q16	TB01-2	1	CNTR-2	1	56.50	6

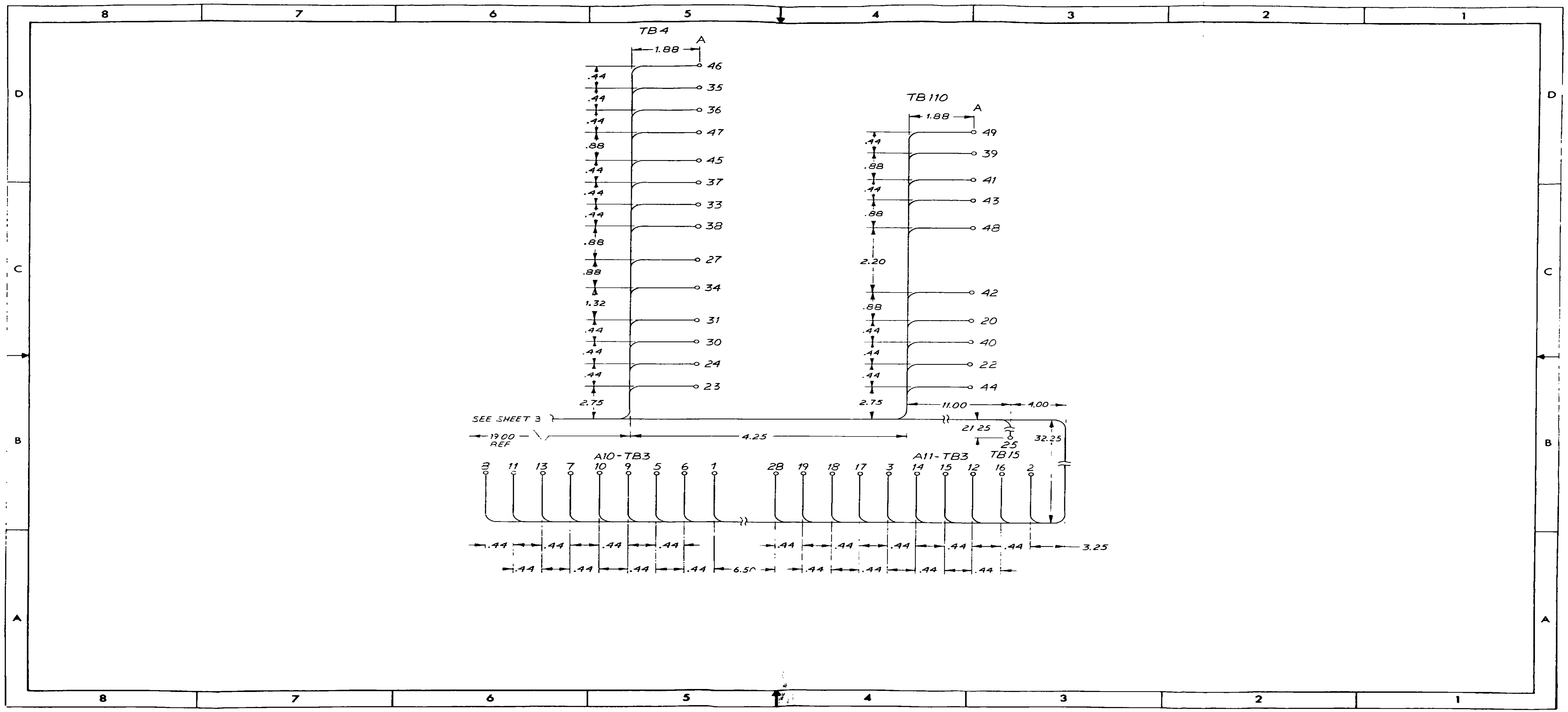
WIRE LENGTH TOLERANCES

OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
11			MS3367-2-9	AR	STRAP CABLE ADJUSTABLE		
10			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
9			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
8			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
7			M5086/2-10-9	AR	WIRE 10 AN	MIL-W-5086/2	
6			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
5			M5086/2-18-9	AR	WIRE 18 AN	MIL-W-5086/2	
4			MS25036-112	8	TERMINAL LUG		
3			MS17143-9	8	TERMINAL LUG		
2			MS25036-108	6	TERMINAL LUG		
1			MS25036-106	61	TERMINAL LUG		

PARTS LIST

FO-25. Cabinet A Door
Wiring Harness
(Sheet 1 of 3)



FO-25. Cabinet a Door
Wiring Harness
(Sheet 2 of 3)

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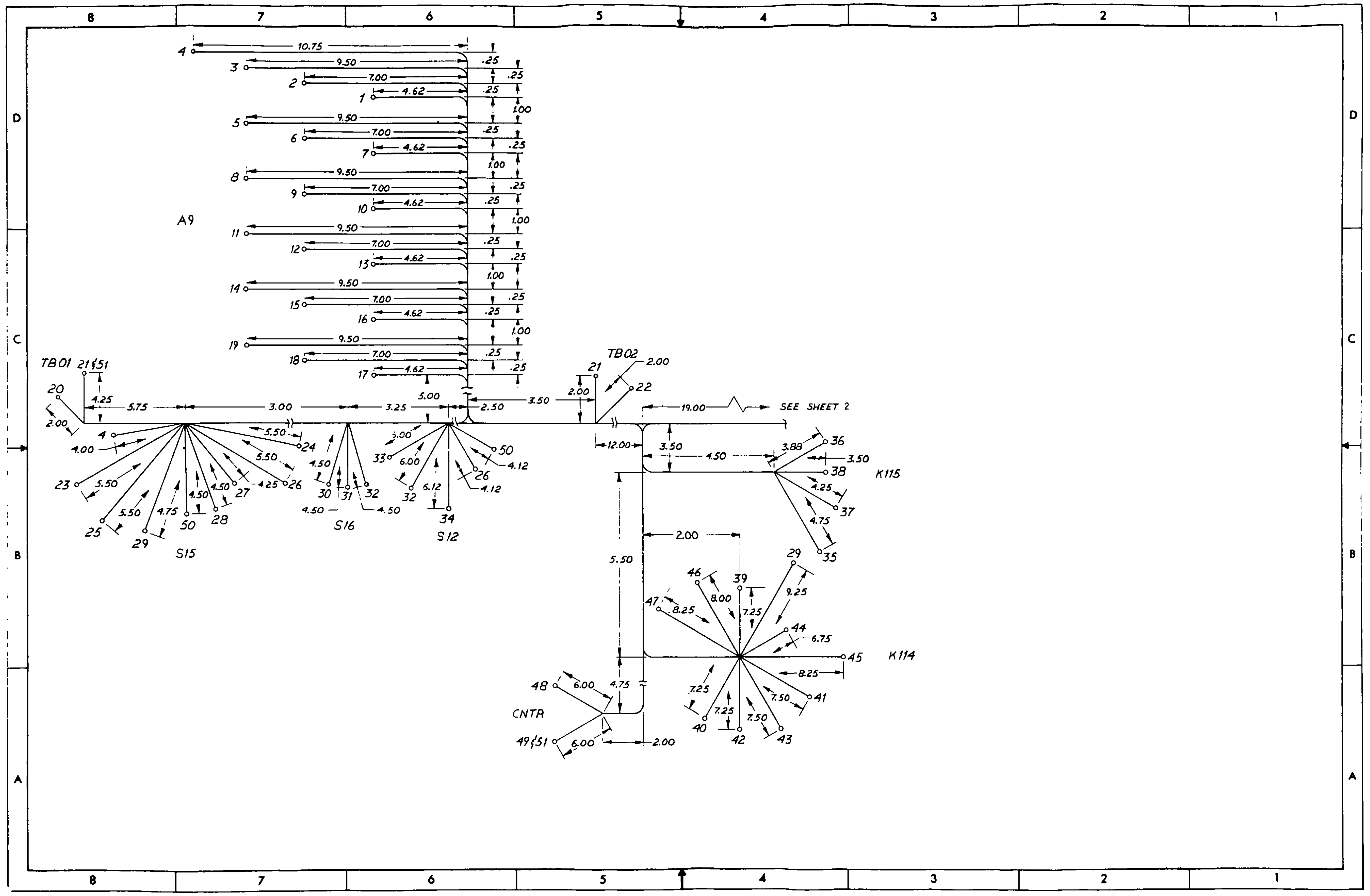
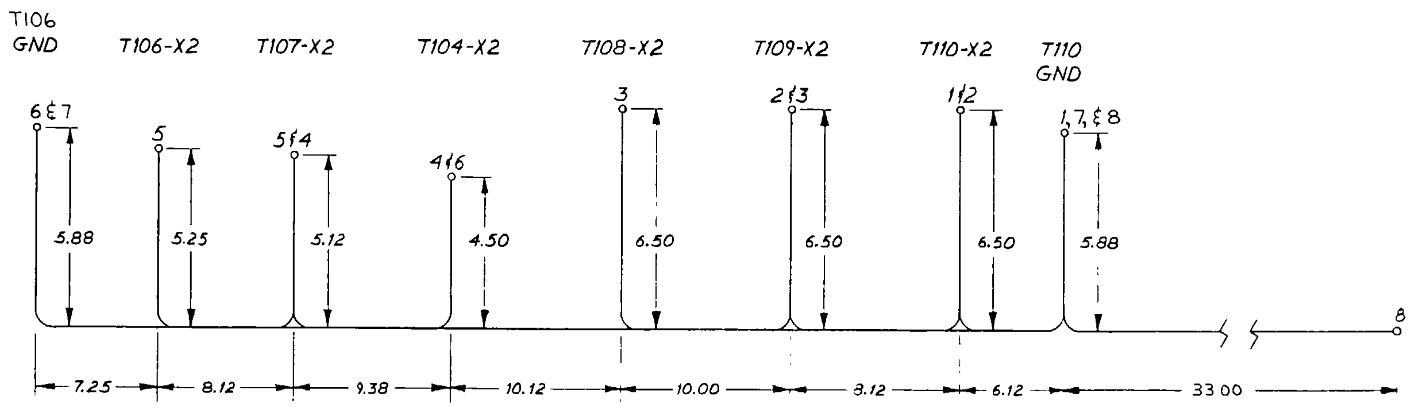


FO-25. Cabinet A Door Wiring Harness (Sheet 3 of 3)



WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	WIRE LENGTH	WIRE FIND NO.
1	BLK	X100BG16	T110-X2	2	T110-GND	1	18.00	3
2	BLK	X100BH16	T109-X2	2	T110-X2	2	18.50	3
3	BLK	X100BJ16	T108-X2	2	T109-X2	2	18.50	3
4	BLK	X100A16	T104-X2	2	T107-X2	2	22.25	3
5	BLK	X100B16	T107-X2	2	T106-X2	2	21.00	3
6	BLK	X100C16	T104-X2	2	T106-GND	1	36.00	3
7	BLK	X100BU16	T106-GND	1	T110-GND	1	70.50	3
8	BLK	X100BK16	T110-GND	1	CHASSIS GND	1	38.00	3

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1.00
100	200	1.50
200	UP	2.00

5			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
4			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
3			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
2			MS25036-108	10	TERMINAL LUG		
1			MS25036-154	6	TERMINAL LUG		
FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL

PARTS LIST

FO-26 Cabinet A Rear Transfer Wiring Harness

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	RED	P1A16	P14-A	strip	P1-A	strip	280.00	9
2	RED	P2A16	P14-B		P1-B		280.00	9
3	RED	P3A16	P14-C		P1-C		280.00	9
4	RED	P34T16	P14-D		P1-D		280.00	9
5	RED	P5A16	P14-E		P1-E		280.00	9
6	RED	P7A16	P14-G		P1-J	strip	280.00	9
7	RED	K1A16	P14-H		TB1-16B	2	233.00	9
8	RED	P1U16	P14-I		P17-2	strip	400.00	9
9	RED	K2A16	P14-J		L101-2	B	300.00	9
10	RED	K3A16	P14-K		L101-1	B	300.00	9
11	RED	P73C16	P14-L		TB1-6B	2	229.25	9
12	RED	K5C16	P14-M		TB1-12B	2	235.25	9
13	RED	P1T16	P14-N		P16-2	strip	400.00	9
14	RED	K8A16	P14-P		P16-3	strip	400.00	9
15	RED	K9A16	P14-R		P17-3	strip	400.00	9
16	RED	P13A16	P14-S		P6-C	strip	215.25	9
17	RED	P12A16	P14-T		S17-2	8	251.00	9
18	RED	P15A16	P14-U		P12-C	strip	274.00	9
19	RED	E30C16	P14-V		MT1	6	215.25	9
20	RED	P16C16	P14-W		TB1-14B	2	234.00	9
21	RED	E31C16	P14-a	strip	MT2	6	229.00	9
22	RED	E32C16	P14-b	strip	MT3	6	282.50	9
23	RED	P21A16	P14-n		P6-A	strip	214.25	9
24	RED	P92B16	P14-p		P6-D	strip	214.00	9
25	RED	P25F12	P14-t		L4-1	5	185.75	10
26	RED	P28B12	P14-u		K2-3	3	182.75	10
27	RED	P10H12	P14-v		CHASSIS GND	4	230.00	10
28	RED	P130B16	P14-x		P30-A	strip	300.00	10
29	RED	P14J16	P14-y		TB1-4B	2	228.00	9
30	RED	P41A16	P14-z	strip	P4-C	strip	289.25	9
31	BLK	X135D12	TB51-1A	1	B102-T2	22/	300.00	10
32	BLK	X136D12	TB51-2A	1	B102-T1	22/	297.25	10
33	BLK	X339B12	TB51-9A	1	H101-1	22/	297.25	10
34	BLK	X340B12	TB51-10A	1	H101-2	22/	293.75	10
35	BLK	X319B12	TB51-12A	1	H102-2	22/	265.50	10
36	BLK	X318B12	TB51-11A	1	H102-1	22/	263.75	10
37	BLK	X327D12	TB51-13A	1	H113-1	22/	307.00	10
38	BLK	X328D12	TB51-14A	1	S101-1	22/	271.50	10
39	BLK	X100BT12	TB51-16A	1	H102-GND	22/	266.50	10
40	BLK	X100AX12	H101-GND	14strip	H102-GND	14strip	175.00	10
41	BLK	X100AY12	B102-GND	22/strip	H101-GND	22/strip	82.25	10
42	BLK	X317A12	H113-2	22/strip	S101-2	22/strip	197.50	10
43	BLK	X138E16	TB51-4A	2	L102-X1	strip	327.25	9
44	BLK	X137F16	TB51-3A	2	L102-X2	strip	328.75	9
45	BLK	X336B16	TB51-6A	2	S105-2	22/strip	308.50	9
46	BLK	X335B16	TB51-5A	2	S105-1	22/strip	308.00	9
47	BLK	X337B16	TB51-7A	2	S106-1	22/strip	262.75	9
48	BLK	X338B16	TB51-8A	2	S106-2	22/strip	263.75	9
49	RED	P11A16	S17-1	8	P9-A	strip	145.50	9
50	RED	K4A16	P3-A	strip	OP3-1	6	107.25	9
51	RED	K1AA16	TB1-16B	2	L1-1	6	88.00	9
52	RED	P108K16	TB1-15B	2	L1-2	6	86.75	9
53	RED	P16B16	TB1-13B	2	P4-D	strip	115.75	9
54	RED	P73D16	TB1-7B	2	P4-B	strip	113.00	9
55	RED	P14E16	TB1-5B	2	P4-A	strip	111.50	9
56	RED	P14A16	TB1-4B	2	P6-B	strip	38.50	9
57	RED	P10L16	TB1-3B	2	K2-4	6	81.75	9
58	RED	P10C16	TB1-2B	2	P9-B	strip	122.25	9
59	RED	P10D16	TB1-2B	2	OP3-2	6	38.25	9
60	RED	P14Z16	TB1-1B	2	P1-F	strip	102.00	9
61	RED	P14C16	TB1-1B	2	P12-B	strip	95.25	9
62	RED	K5B16	TB1-11B	2	P7-B	strip	86.50	9
63	RED	P10K12	K2-4	3	K1-4	3	13.50	10
64	RED	P10J12	CHASSIS GND	4	K1-4	3	80.50	10
65	RED	P28A12	K2-3	3	K1-3	3	13.50	10
66	RED	P25E12	K2-1	4	K1-1	4	16.50	10
67	RED	P25D12	K2-1	4	L3-1	5	33.25	10
68	RED	P27A12	K2-2	4	L4-2	3	39.25	10
69	RED	P10F12	B1-1	5	BC1-(-)	4	121.25	10
70	RED	P25L12	L3-1	5	BC1-(+)	4	114.25	10
71	RED	P26A12	K1-2	4	L3-2	3	21.00	10
72	RED	K5A16	TB1-11B	2	P3-B	strip	125.75	9
73	RED	K4C16	TB1-10B	2	P7-A	strip	86.00	9
74	RED	K4B16	TB1-10B	2	OP3-1	6	42.00	9
75	RED	RED	P25-B	strip	TC1-(-)	2	220.00	11
76	RED	RED	P25-D	strip	TC2-(-)	2	240.00	11
77	WHT	WHITE	P25-A	strip	TC1-(+)	2	220.00	11
78	WHT	WHITE	P25-C	strip	TC2-(+)	2	240.00	11
79	BLK	BLACK	P14-c	strip	P8-A	strip	214.00	20
80	WHT	WHITE	P14-s	strip	P8-B	strip	214.00	20
81	NO	SHIELD	P14-m	—	Shell-Gnd(Ref)	—	214.00	20
82	RED	P10AM16	B2-1	5	P30-B	strip	80.00	10
83	BLK	X100BW12	BC1-GND	3	S101-GND	22/strip	185.00	10
84	BLK	X100BV12	B102-GND	strip	H113-GND	22/strip	163.00	10
85	BLK	X100CG12	BC1-GND	3	GEN BOX GND.	4	48.00	10

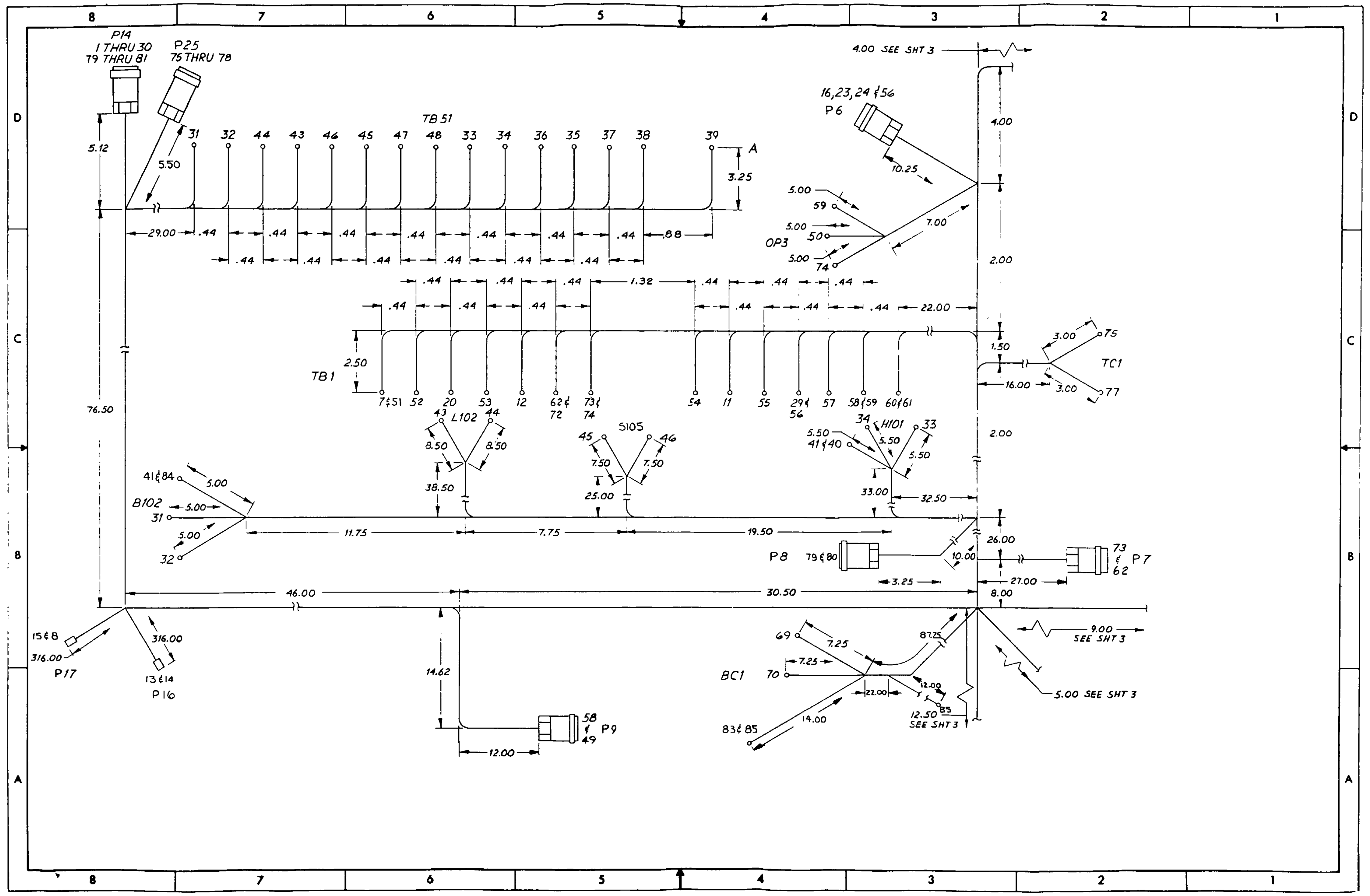
WIRE LENGTH TOLERANCES

OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

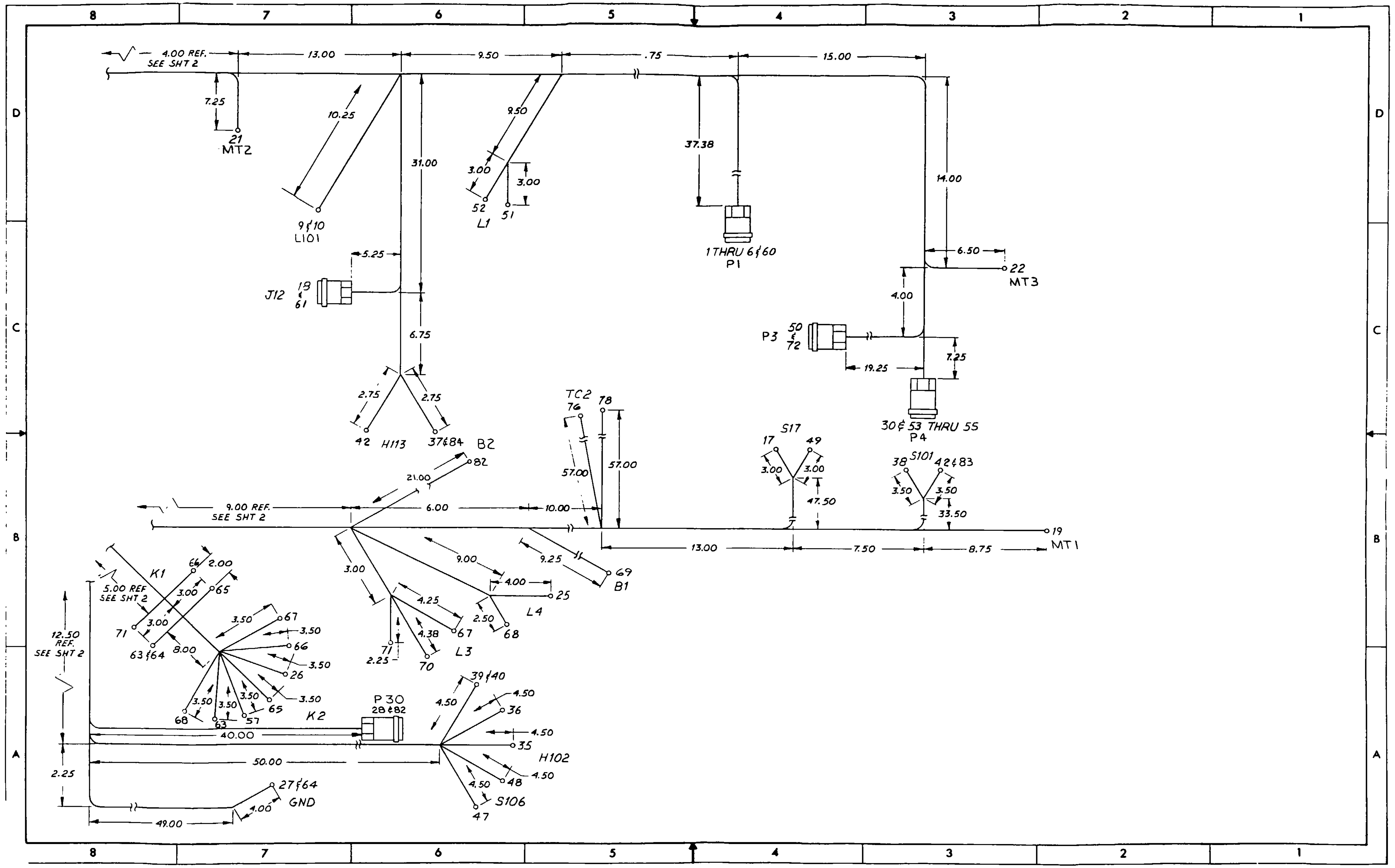
FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
22		B	76-11119	19	CONNECTOR, WIRE NUT		
21		C	80-7824	2	CONNECTOR, SEALED BEAM, P16, P17		
20		B	76-11253	AR	SHIELDED WIRE		
19			MS3106R18-15S	1	CONNECTOR P25		
18			MS3106R14S-2S	3	CONNECTOR P4, P6, P12		
17			MS3106R10SL-4S	5	CONNECTOR P3, P7, P9, P8, P30		
16			MS3106R18-1S	1	CONNECTOR P1		
15			MS3106R36-7P	1	CONNECTOR P14		
14			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
13			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
12			SN60WRMAP2	AR	SOLDER		
11		C	80-7878	AR	I-C WIRE, THERMOCOUPLE		
10			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
9			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
8		B	80-7981	4	TERMINAL LUG (FEMALE QUICK DISCONNECT)		
7							
6			MS25036-108	8	TERMINAL LUG		
5			MS25306-158	4	TERMINAL LUG		
4			MS25036-113	8	TERMINAL LUG		
3			MS25036-112	10	TERMINAL LUG		
2			MS25036-106	29	TERMINAL LUG		
1			MS17143-6	9	TERMINAL LUG		

PARTS LIST

FO-27. Engine to Cabinet Wiring Harness (Sheet 1 of 3)



FO-27. Engine to Cabinet
Wiring Harness
(Sheet 2 of 3)



FO-27. Engine to Cabinet
Wiring Harness
(Sheet 3 of 3)

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	WIRE MARKING IDENTIFICATION NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	BLK	X162B16	VR101-E2-208	1	TB105-9A	1	74.25	7
2	BLK	X171E16	VR101-E2-208	1	TB105-11A	1	71.25	7
3	BLK	X100E16	TB105-12A	1	A103-2	6	110.00	7
4	BLK	X170N16	TB105-13A	1	T105-1	6	88.50	7
5	BLK	X187C12	AMT-3C	2	TB105-18A	3	95.25	8
6	BLK	X186D12	TB105-19A	3	AMT-3B	2	97.50	8
7	BLK	X212B16	T105-4	1	TB105-20A	6	90.25	7
8	BLK	X174E16	TB106-5A	1	A105-1	1	79.50	7
9	BLK	X175B16	TB106-6A	1	AMT-1C	4	96.25	7
10	BLK	X179B16	TB106-7A	1	AMT-1B	4	96.25	7
11	BLK	X178B16	TB106-8A	1	AMT-1A	4	96.75	7
12	BLK	X181D16	WMT-2	4	TB106-12A	1	86.75	7
13	BLK	X183C16	TB106-14A	1	PFT-2	4	90.25	7
14	BLK	X213B16	TB106-17A	1	T105-5	6	85.50	7
15	BLK	X125B16	TB106-18A	1	WMT-1	4	83.50	7
16	BLK	X190B16	TB107-3A	1	VR101-6	1	76.25	7
17	BLK	X221D12	TB107-4A	3	K109-5	3	88.75	8
18	BLK	X289B16	K116-7	1	TB107-7A	1	91.25	7
19	BLK	X211B16	TB107-10A	1	T105-6	6	88.75	7
20	BLK	X250B16	TB107-19A	1	PFT-1	4	88.75	7
21	BLK	X171L16	A104-3	1	VR101-E3-208	1	29.25	7
22	BLK	X162V16	VR101-E2-208	1	A104-2	1	33.00	7
23	BLK	X170V16	VR101-E1-C	1	A104-1	1	32.75	7
24	BLK	X170H16	VR101-E1-C	1	A105-3	1	54.50	7
25	BLK	X246A16	A101-4	1	VR101-4	1	67.25	7
26	BLK	X245A16	A101-3	1	VR101-3	1	67.00	7
27	BLK	X177D12	WMT-10	5	A104-5	3	42.25	8
28	BLK	X223A12	WMT-12	3	A104-7	5	43.50	8
29	BLK	X225A12	WMT-11	3	A104-9	5	43.50	8
30	BLK	X171G16	K110-3	1	A104-3	1	39.50	7
31	BLK	X162H16	K110-2	1	A104-2	1	39.00	7
32	BLK	X170J16	K110-1	1	A104-1	1	38.00	7
33	BLK	X100F16	T105-2	4	A103-2	1	68.00	7
34	BLK	X170F16	T105-1	4	A103-1	1	67.50	7
35	BLK	X170G16	A103-1	1	A105-3	1	38.50	7
36	BLK	X100S16	K109-4	1	A105-4	1	30.25	7
37	BLK	X100J16	K108-2	1	A105-2	1	42.00	7
38	BLK	X289C16	K116-7	1	A105-14	1	32.75	7
39	BLK	X162C16	K111-2	1	PFT-8	4	31.75	7
40	BLK	X170L16	K111-1	1	K109-3	1	31.50	7
41	BLK	X170K16	K111-1	1	K110-1	1	17.00	7
42	BLK	X171H16	K111-3	1	K110-3	1	16.50	7
43	BLK	X162R16	K111-2	1	K110-2	1	16.75	7
44	BLK	X171J16	K111-3	1	T105-3	6	41.50	7
45	BLK	X191B16	K116-8	1	K107-6	1	43.75	7
46	BLK	X100G16	K107-2	1	T105-2	6	23.50	7
47	BLK	X171K16	T105-3	4	PFT-12	4	35.50	7
48	BLK	X100H16	K108-2	1	K107-2	1	18.75	7
49	BLK	X191C16	K107-6	1	K108-6	1	17.00	7
50	BLK	X100K16	K116-4	1	WMT-E	4	32.75	7
51	BLK	X200A12	WMT-7	5	PFT-5	5	30.50	8
52	BLK	X166A12	WMT-8	5	AMT-4C	5	33.00	8
53	BLK	X185D12	WMT-9	5	AMT-4B	5	34.50	8
54	BLK	X210A12	AMT-4A	5	PFT-6	5	17.75	8
55	BLK	X228A12	K109-6	5	AMT-3A	3	20.00	8
56	BLK	X170Z16	K116-1	1	WMT-B	4	24.00	7
57	BLK	X170Q16	K109-3	1	WMT-4	4	15.50	7
58	BLK	X170AA16	K116-1	1	WMT-A	4	23.00	7
59	BLK	X171M16	PFT-12	6	WMT-5	4	15.25	7
60	BLK	X100L16	K116-2	1	K109-4	1	17.25	7
61	BLK	X174H16	K116-3	1	A105-1	1	40.00	7
62	RED	P155B16	TB106-9A	1	AMT-2C	4	93.75	7
63	RED	P20A16	TB106-10A	1	AMT-2B	4	95.25	7
64	RED	P17A16	TB106-11A	1	AMT-2A	4	96.75	7
65	RED	P10AE16	A105-10	1	A104-13	1	35.00	7
66	RED	V100A16	A101-N	1	VR101-F.	1	65.50	7
67								
68	BLK	JUMPER	WMT-4	1	WMT-A	1	3.50	7
69	BLK	JUMPER	WMT-3	1	WMT-6	1	3.50	7
70	BLK	JUMPER	WMT-3	1	WMT-E	1	3.75	7

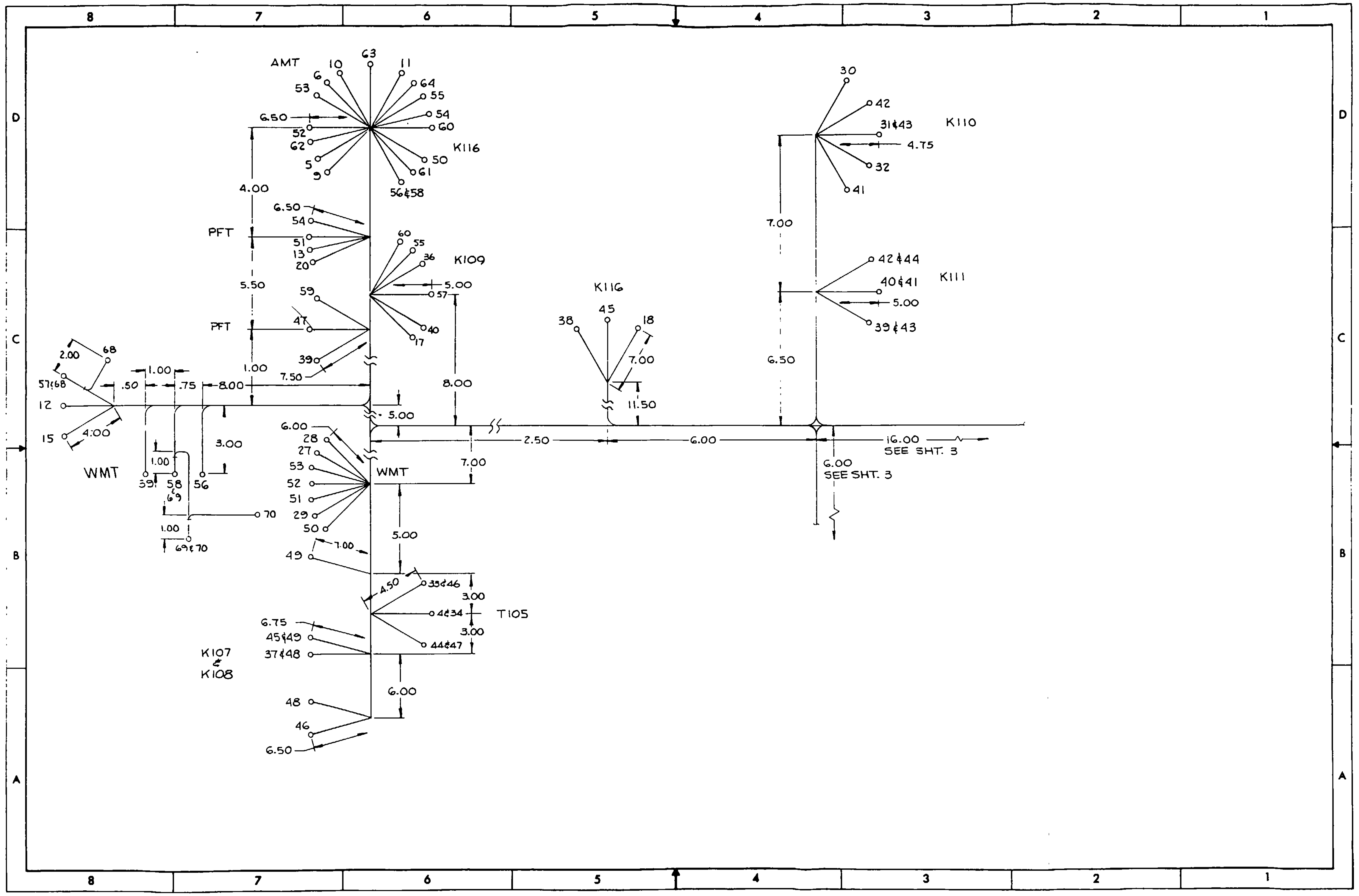
WIRE LENGTH TOLERANCES

OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO.	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
10			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
9			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
8			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
7			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
6			MS25036-108	8	TERMINAL LUG		
5			MS25036-156	12	TERMINAL LUG		
4			MS25036-153	20	TERMINAL LUG		
3			MS17143-6	8	TERMINAL LUG		
2			MS17143-9	1	TERMINAL LUG		
1			MS25036-106	90	TERMINAL LUG		

PARTS LIST

FO-28. Cabinet B Divider Panel Wiring Harness (Sheet 1 of 3)



FO-28. Cabinet B Divider
Panel Wiring Harness
(Sheet 2 of 3)
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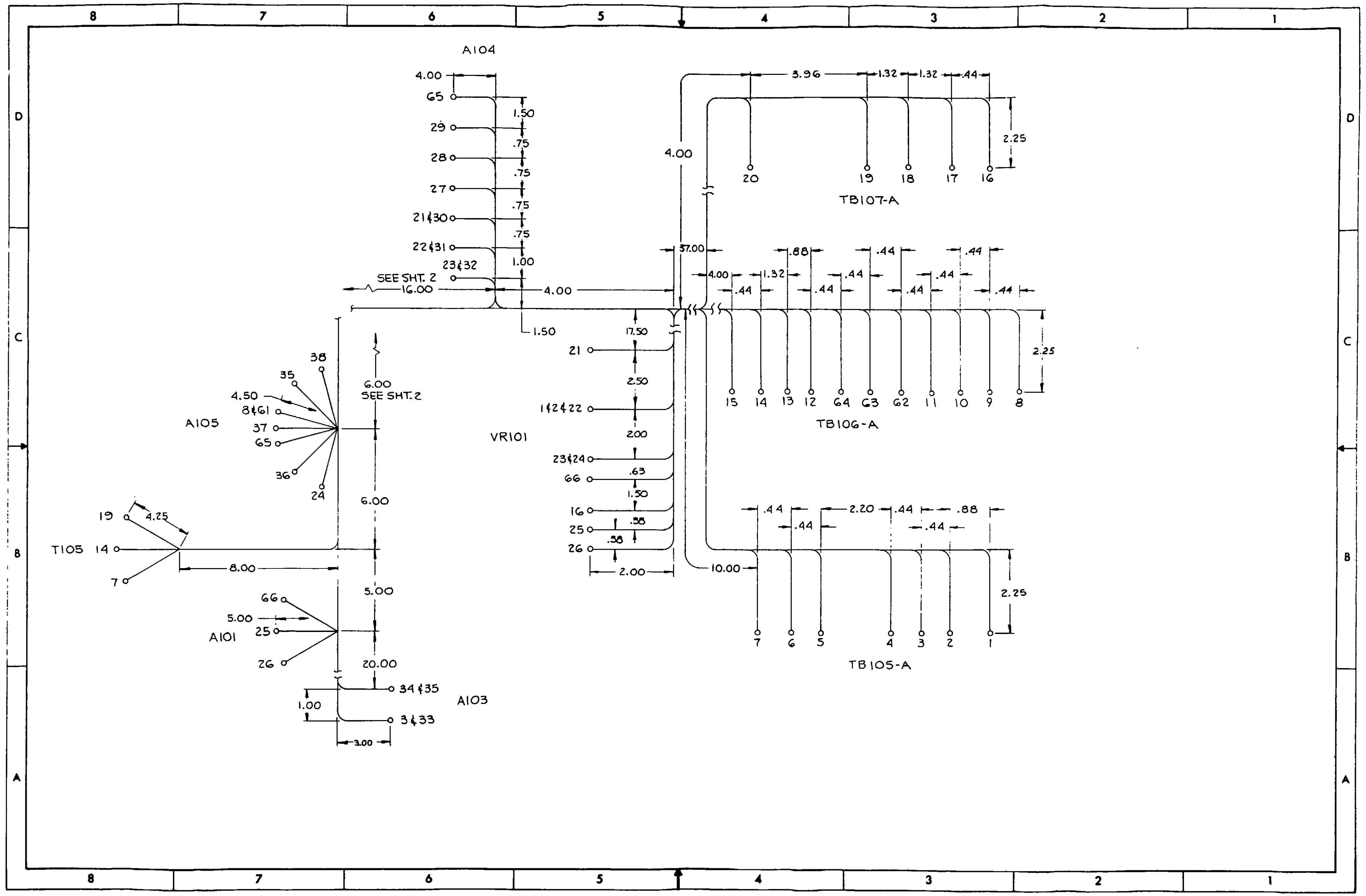


FO-28. Cabinet B Divider Panel Wiring Harness (Sheet 3 of 3)

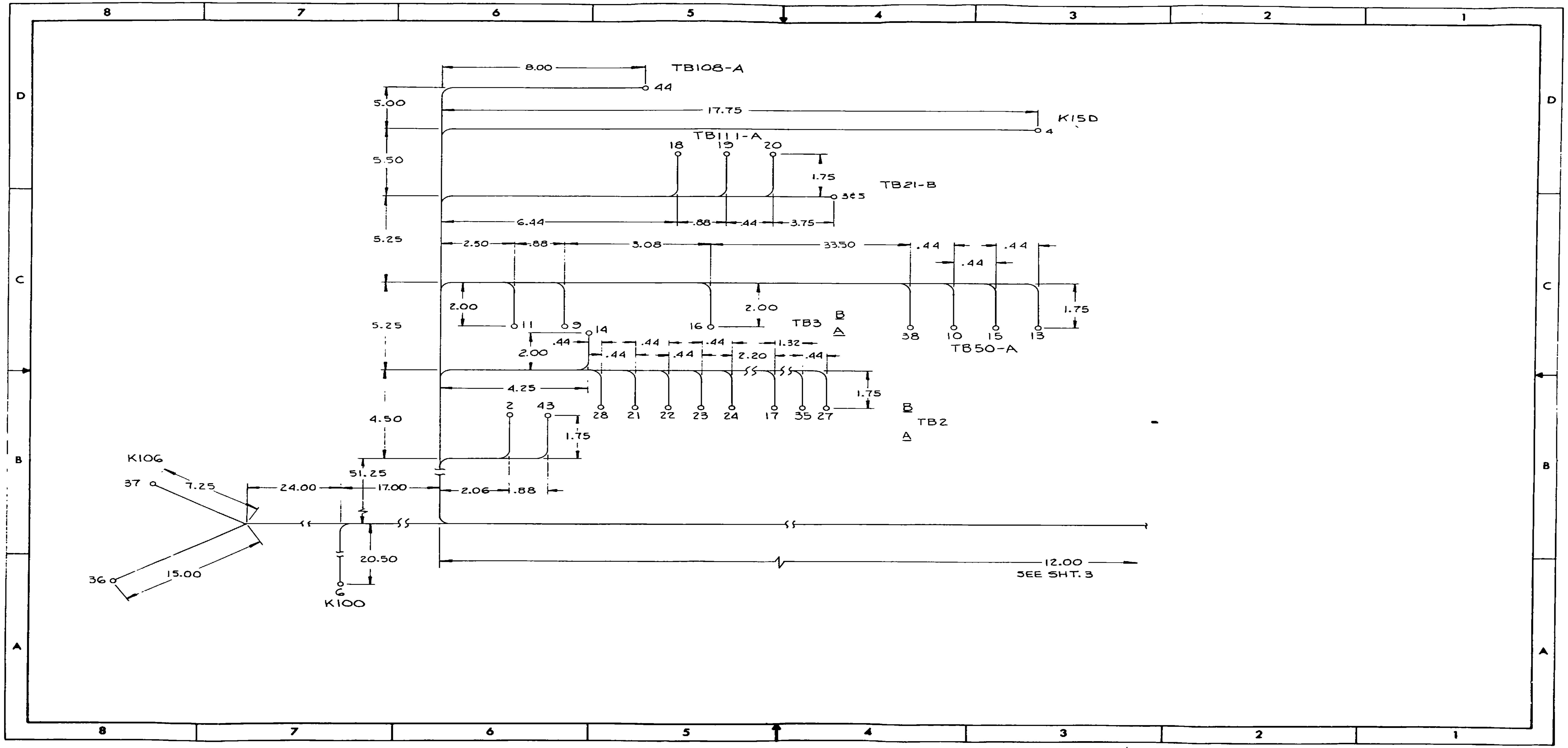
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	WIRE MARKING IDENTIFICATION NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	RED	P107A12	CB1-1	1	S100-C1	2	37.00	7
2		P14AA12	CB1-2	1	TB2-1A	5	85.00	7
3		P25J12	S100-C2	2	TB21-17B	5	108.00	7
4		P25N12	CB2-1	1	K15D-A3	5	110.00	7
5		P25H12	CB2-1	1	TB21-17B	5	101.00	7
6		P138A12	CB2-2	1	K100-COM	6	55.00	7
7		P14Q16	S1-2	3	S7A1-NO	3	31.00	8
8		P50A16	S1-3	3	DS26-1	3	32.00	8
9		P36A16	S9-3	3	TB3-4B	3	95.00	8
10		P36F16	S9-3	3	TB50-2A	3	132.00	8
11		P34A16	S9-4	3	TB3-2B	3	93.00	8
12		P59A16	S9-5	3	S10-2	3	30.00	8
13		P59C16	S9-5	3	TB50-4A	3	134.00	8
14		P78B16	S9-6	3	TB3-6A	3	91.00	8
15		P46B16	S7A2-C	3	TB50-3A	3	142.00	8
16		K5D16	S7B-COM	3	TB3-11B	3	103.00	8
17		P12C16	S10-3	3	TB2-16B	3	102.00	8
18		P104A16	S8-1	3	TB111-11A	3	114.50	8
19		P9D16	S8-2	3	TB111-13A	3	111.50	8
20		P14AC16	S8-3	3	TB111-14A	3	123.00	8
21		E30A16	M1-1	4	TB2-8B	3	109.00	8
22		E31A16	M2-1	4	TB2-9B	3	108.00	8
23		E32A16	M3-1	3	TB2-10B	3	108.00	8
24		E33A16	M4-1	3	TB2-11B	3	119.00	8
25		P1D16	M4-2(+)	4	M5-2(+)	3	29.50	8
26		P1E16	M4-2(+)	4	R3-2	4	19.00	8
27		P100D16	M5-1(-)	3	TB2-20B	3	108.00	8
28		P1C16	M5-2(+)	3	TB2-7B	3	100.00	8
29		P50B16	DS27-1	3	DS26-1	4	13.50	8
30		P50C16	DS27-1	3	DS28-1	4	27.50	8
31		P10R16	DS27-2	3	DS26-2	3	13.50	8
32		P10S16	DS27-2	3	DS28-2	3	28.00	8
33		P50D16	DS28-1	3	DS29-1	3	13.50	8
34		P10T16	DS28-2	3	DS29-2	3	13.50	8
35	RED	P10N16	DS29-2	3	TB2-19B	3	105.00	8
36	BLK	X138D16	DS107-1	3	K106-X1	¼Strip	98.00	8
37	BLK	X137D16	DS107-2	3	K106-X2	¼Strip	89.50	8
38	RED	P14U16	S1-2	3	TB50-1A	3	136.00	8
39	RED	P34B16	S9-4	3	S7A1-C	3	15.50	8
40	RED	P1G16	S5-6	3	R2-2	3	13.50	8
41	RED	P1F16	R2-2	4	R3-2	4	23.50	8
42	RED	P119A16	R1-2	4	S5-5	3	50.00	8
43	RED	P14D16	S5-2	3	TB2-3A	3	94.50	8
44	RED	P130A16	S5-1	3	TB108-6A	3	25.50	8

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

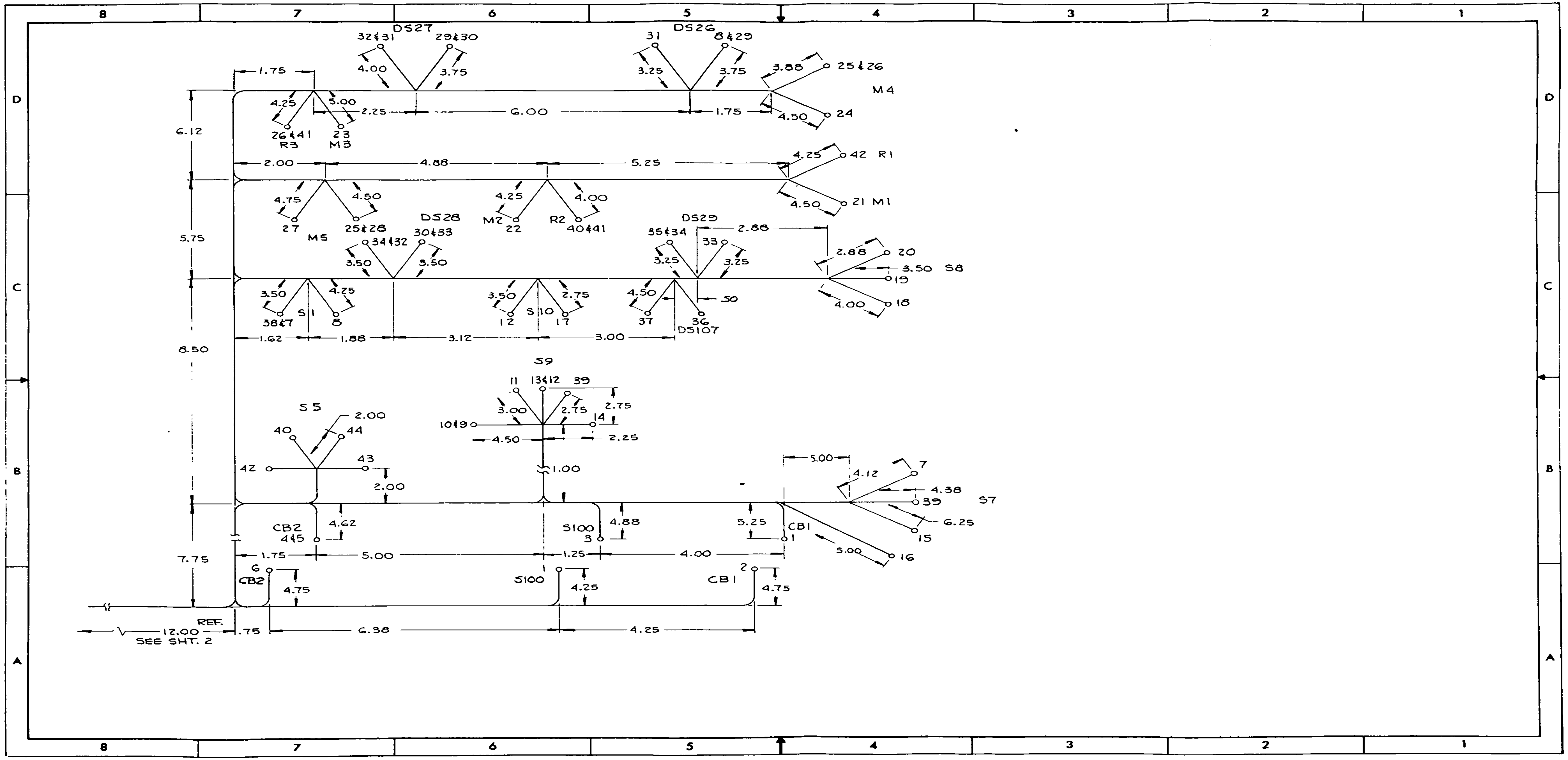
FIND NO.	FSCM	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
10			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
9			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
8			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
7			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
6			MS25036-157	1	TERMINAL LUG		
5			MS17143-6	4	TERMINAL LUG		
4			MS25036-108	10	TERMINAL LUG		
3			MS25036-106	64	TERMINAL LUG		
2			MS25036-113	2	TERMINAL LUG		
1			MS25036-112	5	TERMINAL LUG		

PARTS LIST

FO-29. Cabinet C Door
Wiring Harness
(Sheet 1 of 3)

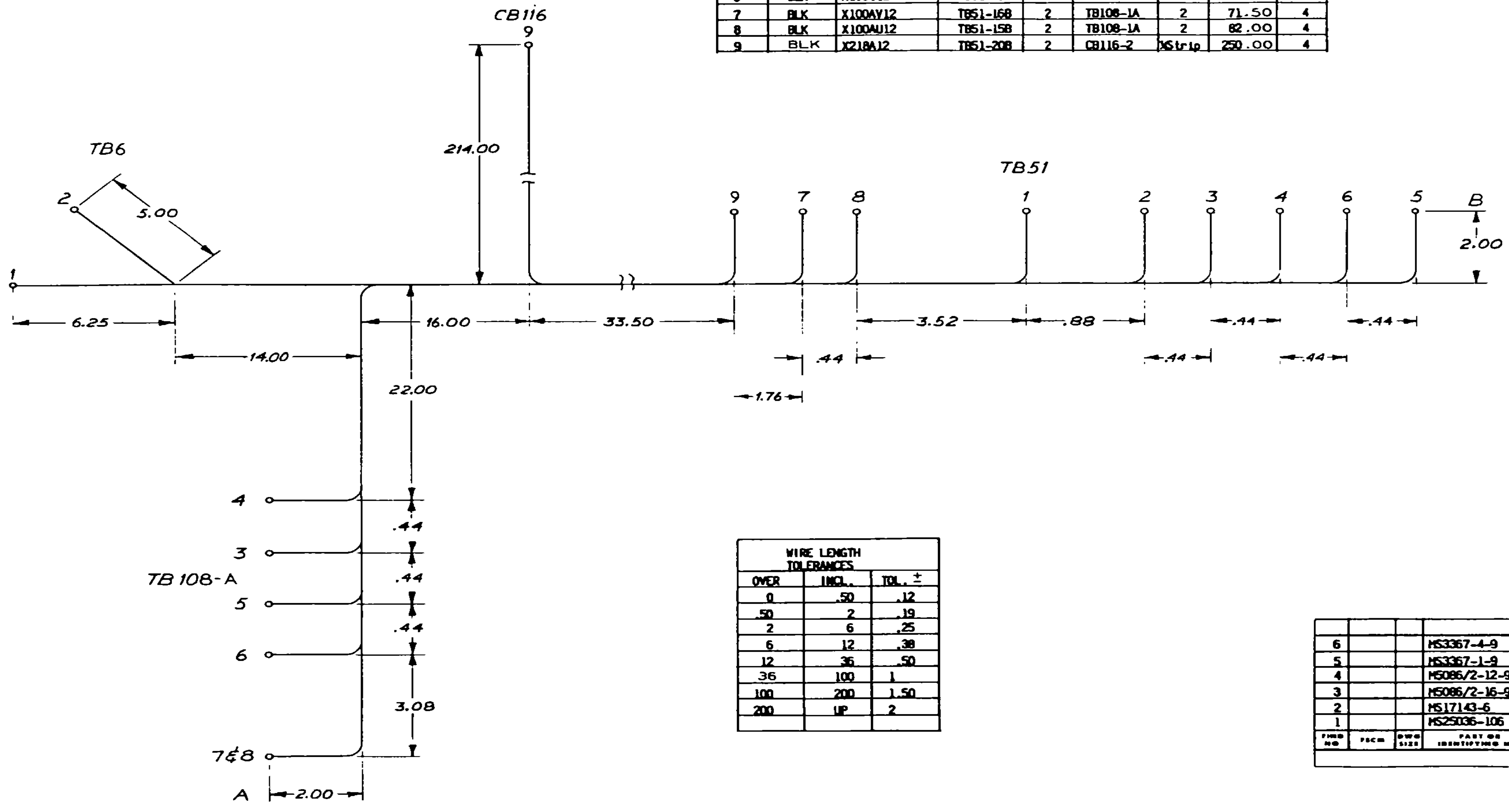


FO-29. Cabinet C Door
Wiring Harness
(Sheet 2 of 3)



FO-29. Cabinet C Door
Wiring Harness
(Sheet 3 of 3)

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	BLK	X337A16	TB51-7B	1	TB6-3	1	77.00	3
2	BLK	X335A16	TB51-5B	1	TB6-8	1	76.50	3
3	BLK	X138A16	TB51-4B	1	TB108-10A	1	83.00	3
4	BLK	X137E16	TB51-3B	1	TB108-11A	1	84.50	3
5	BLK	X135C12	TB51-1B	2	TB108-9A	2	84.50	4
6	BLK	X136C12	TB51-2B	2	TB108-8A	2	84.50	4
7	BLK	X100AV12	TB51-16B	2	TB108-1A	2	71.50	4
8	BLK	X100AU12	TB51-15B	2	TB108-1A	2	82.00	4
9	BLK	X218A12	TB51-20B	2	CB116-2	½Strip	250.00	4



WIRE LENGTH TOLERANCES OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
6			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
5			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
4			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
3			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
2			MS17143-6	9	TERMINAL LUG		
1			MS25036-106	8	TERMINAL LUG		

PARTS LIST

FO-30. Cabinet C Forward
Wiring Harness

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	BLK	X300A12	CB118-2A	STRIP	H 103-1	1	120.00	5
2		X300B12	CB118-2A		H 104-1	1	240.00	
3		X299A12	CB118-2B		H 103-2	1	120.00	
4		X299B12	CB118-2B		H 104-2	1	240.00	
5		X100AR12	DP2-GND		H103-G	1	80.50	
6		X100AS12	DP2-GND		H104-G	1	240.00	
7		X100AT12	DP2-GND		TB108-18	4	200.50	
8		X100AZ12	DP2-GND		TB108-17B	4	190.00	
9		X219A12	CB102-2		J102-1	1	50.25	
10		X252A12	CB103-2		J104-1	1	167.00	
11		X253A12	CB104-2		S102-1	1	124.50	
12		X229A12	CB106-2		J106-1	1	502.00	
13		X258A12	CB107-2		J108-1	1	562.00	
14		X296A12	CB108-2		S103-COM	1	502.00	
15		X100AC12	DP1-GND		DS102-2	STRIP	168.00	
16		X100AH12	DP1-GND		J102-2	1	41.00	
17		X100AK12	DP1-GND		J106-2	1	502.00	
18		X256A12	DS101-1		S102-2	1	100.00	
19		X256B12	DS101-1		DS102-1	STRIP	70.00	
20		X100AD12	DS101-2		DS102-2	STRIP	70.00	
21		X100AE12	DP1-GND	STRIP	DS105-2	STRIP	300.00	
22	BLK	X100AJ12	J104-2	1	J102-2	1	187.00	
23	RED	P10W12	DS22-2	2	TB111-20A	3	106.00	
24		P10AF12	DS22-2	2	DS23-2	2	200.00	
25		P151C12	DS20-1	3	DS21-1	3	130.00	
26		P10M12	DS20-2	3	DS21-2	3	130.00	
27		P10V12	DS20-2	3	DS23-2	3	201.00	
28	RED	P151D12	DS20-1	3	DS23-1	3	203.00	
29	BLK	X266A12	DS104-1	3	S104-C	3	252.00	
30		X266B12	DS103-1	3	DS106-1	3	150.00	
31		X100AF12	DS103-2	3	DS106-2	3	150.00	
32		X100AG12	DS104-2	3	DS103-2	3	70.00	
33		X266C12	DS104-1	3	DS103-1	3	70.00	
34		X294A12	S103-2	1	S104-3	1	172.00	
35		X295A12	S103-3	1	S104-2	1	172.00	
36		X100AL12	J106-2	STRIP	J108-2	STRIP	204.00	
37		X100BX12	B103-2(WHT)	STRIP	DP1-GND	STRIP	96.00	
38		X109A12	B103-1(BLK)	STRIP	CB109-2	STRIP	96.00	
39	BLK	X100BY12	B103-(GRN)	STRIP	DP1-GND	STRIP	96.00	
40	RED	P151B12	DS22-1	3	DS23-1	3	240.00	
41	RED	P151A12	DS22-1	3	K100-NC	4	150.00	
42	BLK	X266D12	DS105-1	3	DS106-1	3	65.00	
43	BLK	X100BZ12	DS105-2	3	DS106-2	3	65.00	5

WIRE LENGTH TOLERANCES

OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO.	FSCM	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
6			MS3367-1-9	50	STRAP, TIEDOWN		
5			M5086/2-12-9	AR	WIRE, #12 AN	MIL-W-5086/2	
4			MS17143-6	3	TERMINAL LUG		
3			MS25036-111	26	TERMINAL LUG		
2			MS25036-156	3	TERMINAL LUG		
1			MS25036-112	21	TERMINAL LUG		

PARTS LIST

FO-31. Control Center
Wiring Harness

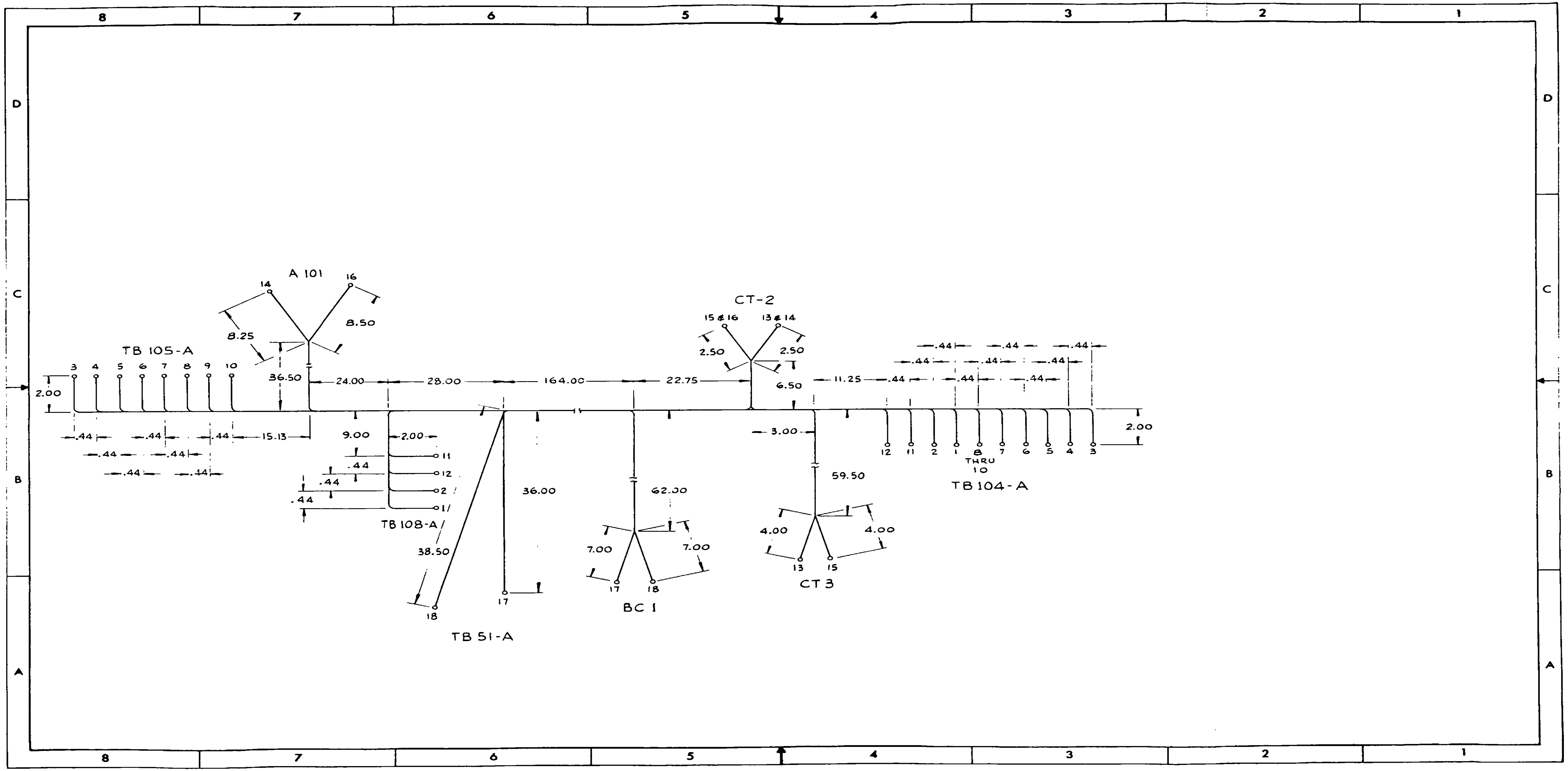
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	BLK	X151A16	TB104-H1-A	1	TB108-12A	1	241.75	3
2		X152A16	TB104-H4-A	1	TB108-13A	1	242.00	3
3		X153A16	TB104R1-A	1	TB105-1A	1	282.75	3
4		X154A16	TB104-R2-A	1	TB105-2A	1	281.25	3
5		X155A16	TB104-R3-A	1	TB105-3A	1	279.25	3
6		X156A16	TB104-R4-A	1	TB105-4A	1	277.25	3
7		X157A16	TB104-R5-A	1	TB105-5A	1	275.50	3
8		X158A16	TB104-R6-A	1	TB105-6A	1	273.50	3
9		X159A16	TB104-R6-A	1	TB105-7A	1	273.25	3
10		X160A16	TB104-R6-A	1	TB105-8A	1	272.00	3
11		X104A12	TB104-F1-A	2	TB108-16A	2	240.00	4
12		X100BN12	TB104-F2-A	2	TB108-15A	2	240.00	4
13		X119E16	CT3-X1	8	CT2-X2	8	71.25	3
14		X119D16	CT2-X2	8	A101-1	1	291.00	3
15		X120D16	CT3-X2	8	CT2-X1	8	71.50	3
16		X120C16	CT2-X1	8	A101-2	1	291.50	3
17		X218B12	BC1-1	7	TB51-20A	2	269.50	4
18	BLK	X100BS12	BC1-2	7	TB51-15A	2	272.00	4

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

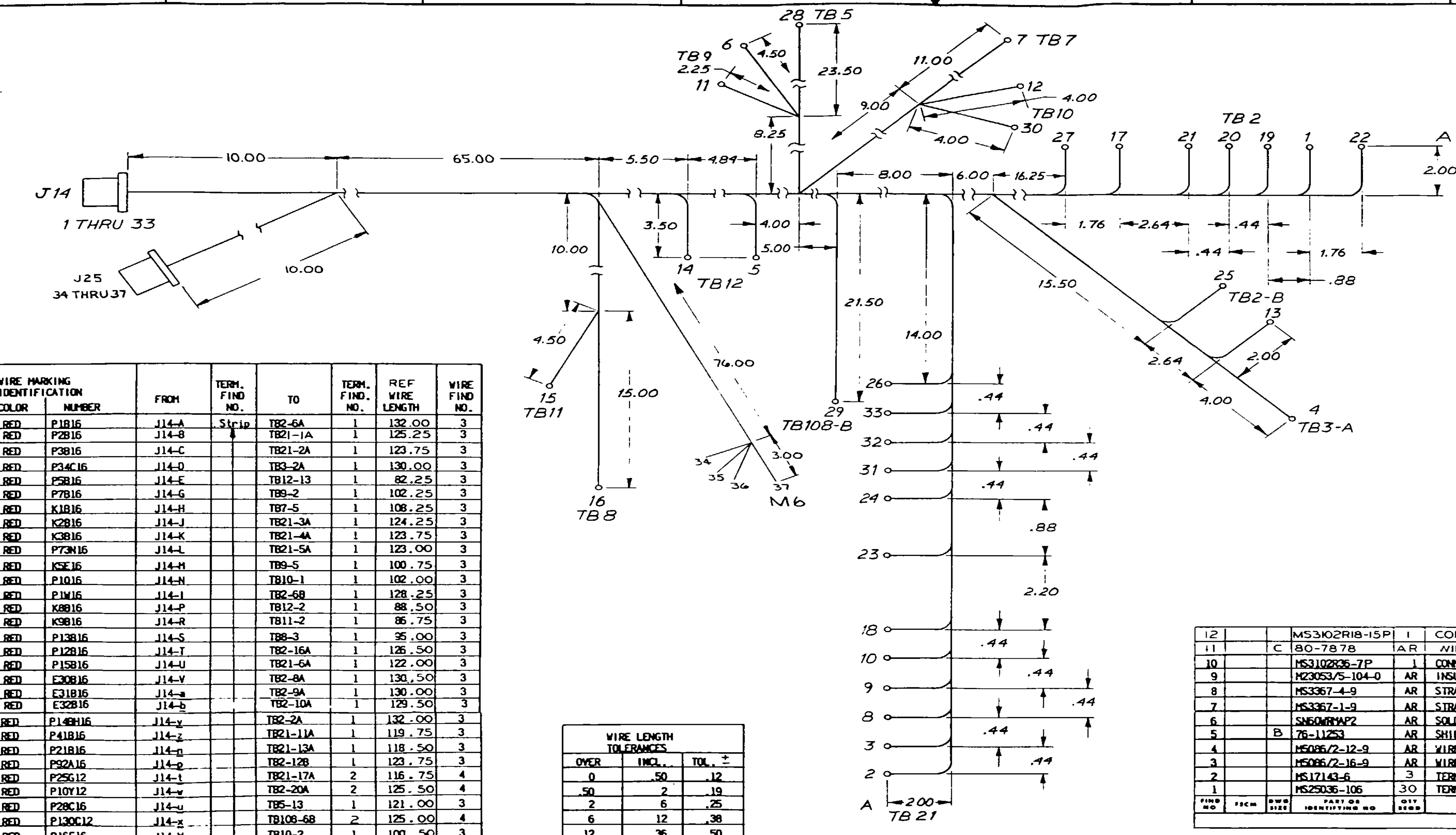
FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
8			MS25036-153	6	TERMINAL LUG		
7			MS25036-112	2	TERMINAL LUG		
6			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
5			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
4			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
3			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
2			MS17143-6	6	TERMINAL LUG		
1			MS25036-106	22	TERMINAL LUG		

PARTS LIST

FO-32. Generator Connection Box Wiring Harness (Sheet 1 of 2)



FO-32. Generator Connection Box Wiring Harness (Sheet 2 of 2)



WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	RED	P1B16	J14-A	Strip	TB2-6A	1	132.00	3
2	RED	P2B16	J14-B		TB21-1A	1	125.25	3
3	RED	P3B16	J14-C		TB21-2A	1	123.75	3
4	RED	P34C16	J14-D		TB3-2A	1	130.00	3
5	RED	P5B16	J14-E		TB12-13	1	82.25	3
6	RED	P7B16	J14-G		TB9-2	1	102.25	3
7	RED	K1B16	J14-H		TB7-5	1	108.25	3
8	RED	K2B16	J14-J		TB21-3A	1	124.25	3
9	RED	K3B16	J14-K		TB21-4A	1	123.75	3
10	RED	P73N16	J14-L		TB21-5A	1	123.00	3
11	RED	K5E16	J14-M		TB9-5	1	100.75	3
12	RED	P10I6	J14-N		TB10-1	1	102.00	3
13	RED	P1W16	J14-I		TB2-6B	1	128.25	3
14	RED	K8B16	J14-P		TB12-2	1	88.50	3
15	RED	K9B16	J14-R		TB11-2	1	86.75	3
16	RED	P13B16	J14-S		TB8-3	1	95.00	3
17	RED	P12B16	J14-T		TB2-16A	1	126.50	3
18	RED	P15B16	J14-U		TB21-6A	1	122.00	3
19	RED	E30B16	J14-V		TB2-8A	1	130.50	3
20	RED	E31B16	J14-a		TB2-9A	1	130.00	3
21	RED	E32B16	J14-b		TB2-10A	1	129.50	3
22	RED	P14BH16	J14-y		TB2-2A	1	132.00	3
23	RED	P41B16	J14-z		TB21-11A	1	119.75	3
24	RED	P21B16	J14-n		TB21-13A	1	118.50	3
25	RED	P92A16	J14-p		TB2-12B	1	123.75	3
26	RED	P25G12	J14-t		TB21-17A	2	116.75	4
27	RED	P10Y12	J14-v		TB2-20A	2	125.50	4
28	RED	P28C16	J14-u		TB5-13	1	121.00	3
29	RED	P130C12	J14-x		TB108-6B	2	125.00	4
30	RED	P16E16	J14-W		TB10-2	1	100.50	3
31	BLK	BLACK 16	J14-G	Strip	TB21-14A	1	118.75	5
32	WHT	WHITE 16	J14-s		TB21-15A	1	117.00	
33	NO	SHIELD 16	J14-m		TB21-16A	1	119.00	
34	NO	WHT	J25-A	STRIP	M6-1(+)	STRIP	154.00	—
35	NO	RED	J25-B		M6-1(−)		154.00	11
36	NO	WHT	J25-C		M6-2(+)		154.00	—
37	NO	RED	J25-D	STRIP	M6-2(−)	STRIP	154.00	11

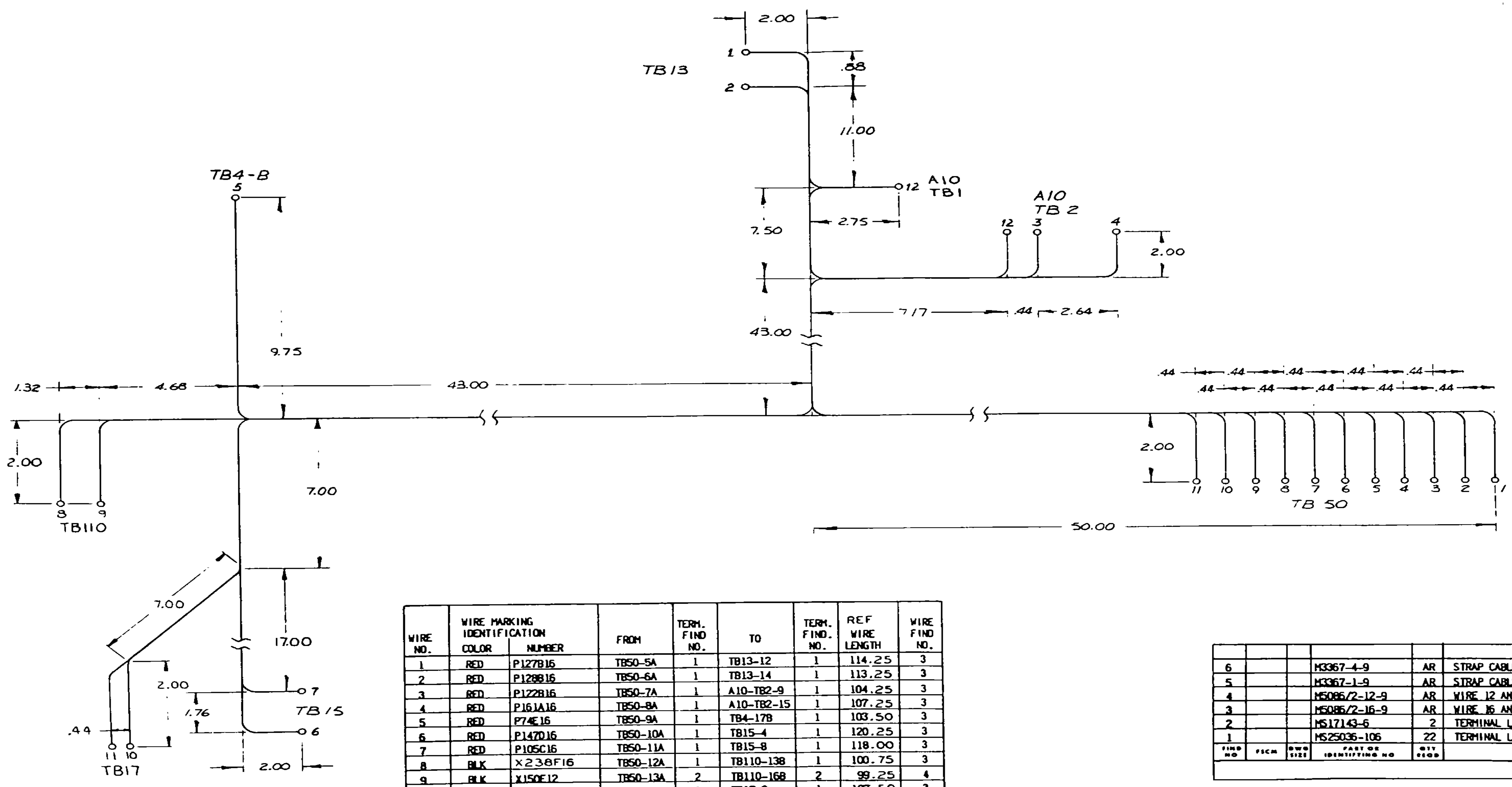
WIRE LENGTH TOLERANCES

OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
12			MS3102R18-15P	1	CONNECTOR J25		
11		C	80-7878	AR	WIRE THERMOCOUPLE		
10			MS3102R36-7P	1	CONNECTOR J14		
9			M23053/5-104-0	AR	INSUL. SLEEVE .125 DIA. BLACK	MIL-I-23053CL1	
8			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
7			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
6			SN60WRMAP2	AR	SOLDER		
5		B	76-11253	AR	SHIELD WIRE		
4			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
3			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
2			MS17143-6	3	TERMINAL LUG		
1			MS25036-106	30	TERMINAL LUG		

PARTS LIST

FO-33. Cabinet C Interconnect Wiring Harness



WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	RED	P127B16	TB50-5A	1	TB13-12	1	114.25	3
2	RED	P128B16	TB50-6A	1	TB13-14	1	113.25	3
3	RED	P122B16	TB50-7A	1	A10-TB2-9	1	104.25	3
4	RED	P161A16	TB50-8A	1	A10-TB2-15	1	107.25	3
5	RED	P74E16	TB50-9A	1	TB4-17B	1	103.50	3
6	RED	P147D16	TB50-10A	1	TB15-4	1	120.25	3
7	RED	P105C16	TB50-11A	1	TB15-8	1	118.00	3
8	BLK	X238F16	TB50-12A	1	TB110-13B	1	100.75	3
9	BLK	X150E12	TB50-13A	2	TB110-16B	2	99.25	4
10	RED	P103B16	TB50-14A	1	TB17-2	1	107.50	3
11	BLK	X240D16	TB50-15A	1	TB17-3	1	106.50	3
12	RED	P73M16	A10-TB1-2	1	A10-TB2-8	1	19.25	3

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
6			M3367-4-9	AR	STRAP CABLE ADJUSTABLE		
5			M3367-1-9	AR	STRAP CABLE ADJUSTABLE		
4			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
3			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
2			MS17143-6	2	TERMINAL LUG		
1			MS25036-106	22	TERMINAL LUG		

PARTS LIST

FO-34. Cabinet B-A Interconnect Wiring Harness

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	WIRE MARKING IDENTIFICATION NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	BLK	X100BA12	T101-X2	1	TB108-17B	2	120.00	4
2		X100AW12	K117-X2	7	TB108-18	2	102.00	4
3		X241E12	T101-X1	1	CB123-1	3	136.50	4
4		X291A12	TB108-19B	2	CB123-3	3	62.50	4
5		X292A12	TB108-18B	2	CB123-4	3	63.50	4
6		X243E12	T101-X3	1	CB123-2	3	130.50	4
7		X302A12	S107-1	8	CB112-2	strip	240.00	4
8		X303A12	S107-2	8	K117-X1	7	119.00	4
9		X304A12	K117-3	7	CB113-A2	strip	292.50	4
10		X305A12	K117-9	7	CB113-B2	strip	293.50	4
11		X306A12	K117-4	7	H105-2	3	54.00	4
12		X306B12	H106-2	3	H105-2	3	98.00	4
13		X306C12	H106-2	3	H107-2	3	62.00	4
14		X307A12	K117-10	7	H105-1	3	55.50	4
15		X307B12	H106-1	3	H105-1	3	99.00	4
16		X307C12	H106-1	3	H107-1	3	69.00	4
17	BLK	X322A12	CB110-2A	¼ strip	K104B-T1	3	228.00	4
18	BLK	X323A12	CB110-2B	¼ strip	K104B-T2	3	228.00	4

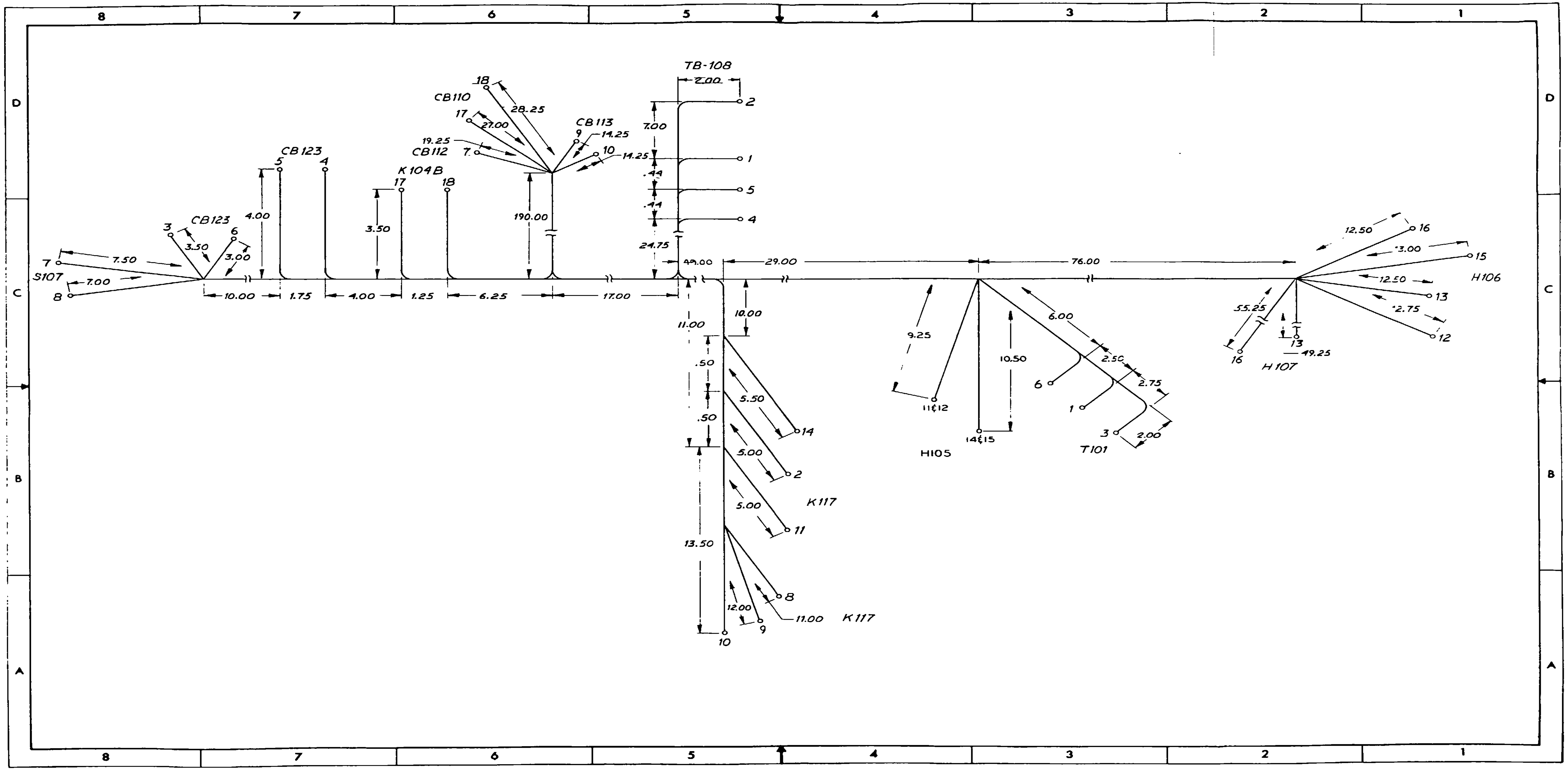
WIRE LENGTH TOLERANCES

OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
8		B	80 7981	2	TERMINAL LUG		
7		B	71-4924	6	TERMINAL LUG		
6			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
5			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
4			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
3			MS25036-112	16	TERMINAL LUG		
2			MS17143-6	4	TERMINAL LUG		
1			MS25036-157	3	TERMINAL LUG		

PARTS LIST

FO-35. Cabinet C Right Hand Upper Wiring Harness (Sheet 1 of 2)



FO-35. Cabinet C Right Hand
Upper Wiring Harness
(Sheet 2 of 2)

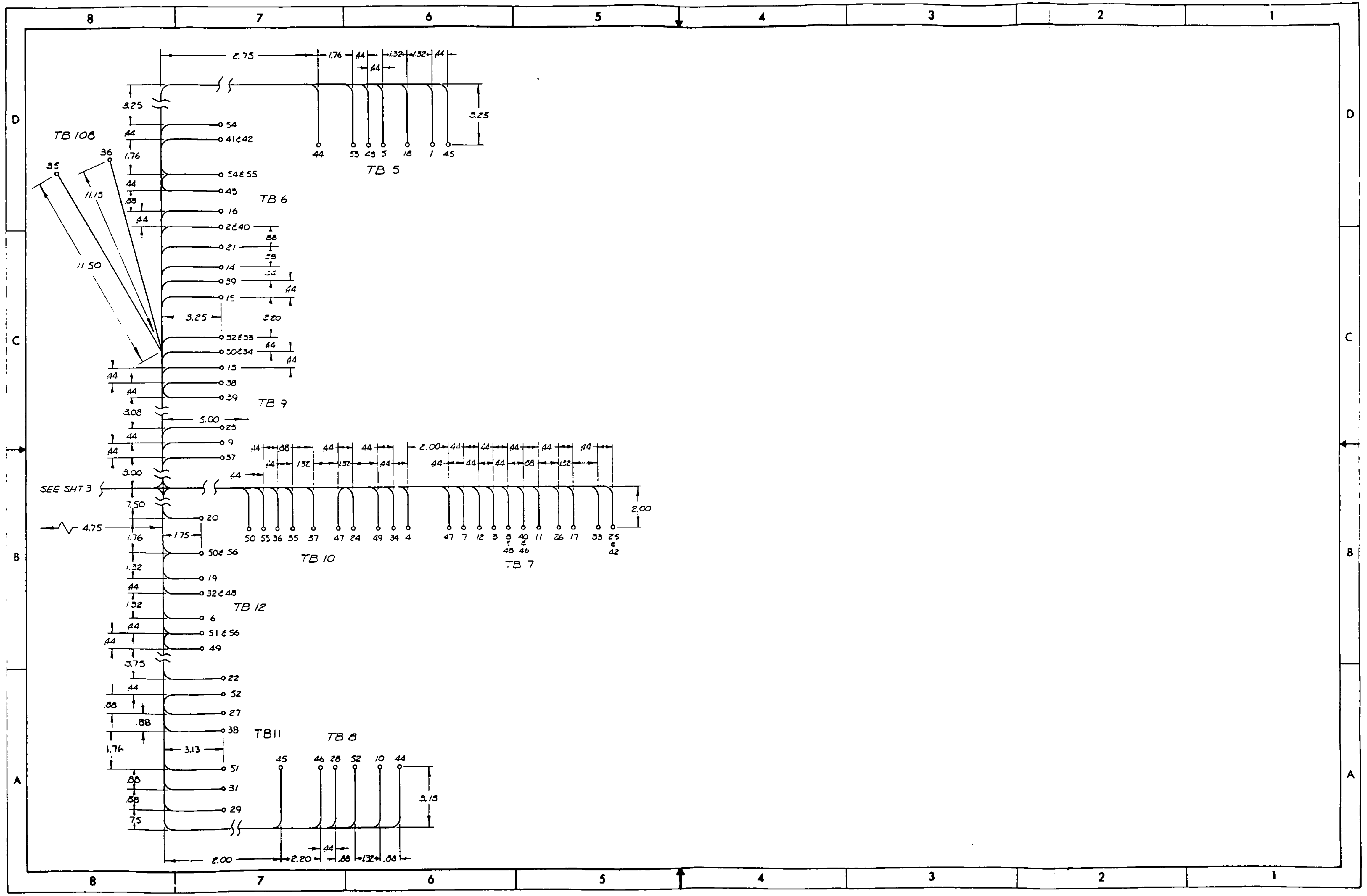
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	WIRE MARKING IDENTIFICATION NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	RED	P154A16	TB5-14	1	VR101-F0	1	100.50	2
2		P32E16	TB2-18A	1	TB6-10	1	57.00	.2
3		P32B16	TB2-18A	1	TB7-12	1	57.00	2
4		P1M16	TB2-7A	1	TB10-1	1	57.50	2
5		P2D16	TB5-8	1	TB21-1B	1	65.00	2
6		P30B16	TB2-5A	1	TB12-14	1	57.50	2
7		P29B16	TB2-4A	1	TB7-14	1	61.00	2
8		P14AB16	TB2-1A	1	TB7-11	1	64.00	2
9		P10Z16	TB2-19B	1	TB9-15	1	42.00	2
10		P22Z16	TB2-13A	1	TB8-4	1	73.00	2
11		P45B16	TB3-16A	1	TB7-9	1	54.50	2
12		P44B16	TB3-15A	1	TB7-13	1	53.00	2
13	RED	K5F16	TB3-11A	1	TB9-5	1	49.50	2
14	BLK	X277B16	TB3-14A	1	TB6-14	1	53.00	2
15	BLK	X276B16	TB3-13A	1	TB6-16	1	52.50	2
16	BLK	X275B16	TB3-12A	1	TB6-9	1	56.00	2
17	RED	P36C16	TB3-4A	1	TB7-6	1	61.00	2
18	RED	P25K16	TB21-17A	1	TB5-11	1	63.00	2
19	RED	P34E16	TB3-2B	1	TB12-10	1	48.00	2
20	RED	P73G16	TB21-5A	1	TB12-3	1	44.00	2
21	BLK	X288B16	TB107-8A	1	TB6-12	1	56.00	2
22	RED	P49B16	TB106-16A	1	TB11-16	1	57.00	2
23	RED	P102A16	TB111-12A	1	TB9-14	1	35.00	2
24	RED	P14AN16	TB111-15A	1	TB10-6	1	37.50	2
25	RED	P1S16	TB7-2	1	K150-X1	1	58.50	2
26	RED	P10G16	TB7-7	1	K150-X2	1	56.00	2
27	RED	P46J16	TB111-18B	1	TB11-13	1	42.00	2
28	BLK	X230C16	TB111-16B	1	TB8-9	1	52.50	2
29	RED	P14AP16	TB111-15B	1	TB11-3	1	48.00	2
30	RED	P16G16	TB111-9B	1	TB9-4	1	35.00	2
31	RED	P16H16	TB111-9B	1	TB11-5	1	49.00	2
32	RED	P14BM16	TB9-3	1	TB12-11	1	23.50	2
33	RED	P14AS16	TB9-3	1	TB7-3	1	31.00	2
34	RED	P16F16	TB10-2	1	TB9-4	1	22.50	2
35	BLK	X138C16	TB108-10B	1	TB10-12	1	27.50	2
36	BLK	X137C16	TB108-11B	1	TB10-13	1	27.00	2
37	RED	P114A16	TB9-16	1	TB10-10	1	15.50	2
38	RED	P14AU16	TB11-11	1	TB9-6	1	36.50	2
39	RED	P10AK16	TB6-15	1	TB9-7	1	11.50	2
40	RED	P32C16	TB6-10	1	TB7-10	1	34.00	2
41	RED	P1V16	TB6-2	1	TB2-7A	1	65.00	2
42	RED	P1P16	TB6-2	1	TB7-2	1	41.00	2
43	RED	P10AJ16	TB6-7	1	TB5-7	1	19.50	2
44	RED	P110B16	TB8-2	1	TB5-2	1	63.00	2
45	RED	P10AN16	TB8-15	1	TB5-15	1	64.00	2
46	RED	P32D16	TB7-10	1	TB8-10	1	48.50	2
47	RED	P10AL16	TB7-15	1	TB10-7	1	8.50	2
48	RED	P14AE16	TB7-11	1	TB12-11	1	29.00	2
49	RED	P131A16	TB10-3	1	TB12-16	1	26.00	2
50	RED	P10AG16	TB10-15	1	TB12-7	1	17.00	2
51	RED	P10AO16	TB11-7	1	TB12-15	1	18.50	2
52	RED	P10AP16	TB11-15	1	TB8-7	1	18.50	2
53	RED	P6A16	TB5-6	1	M7-4	1	63.00	2
54	BLK	X320C16	TB6-6	1	TB6-1	1	10.00	2
55	BLK	X320B16	TB6-6	1	TB10-14	1	27.50	2
56	RED	JUMPER 16	TB12-7	1	TB12-15	1	8.50	2

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

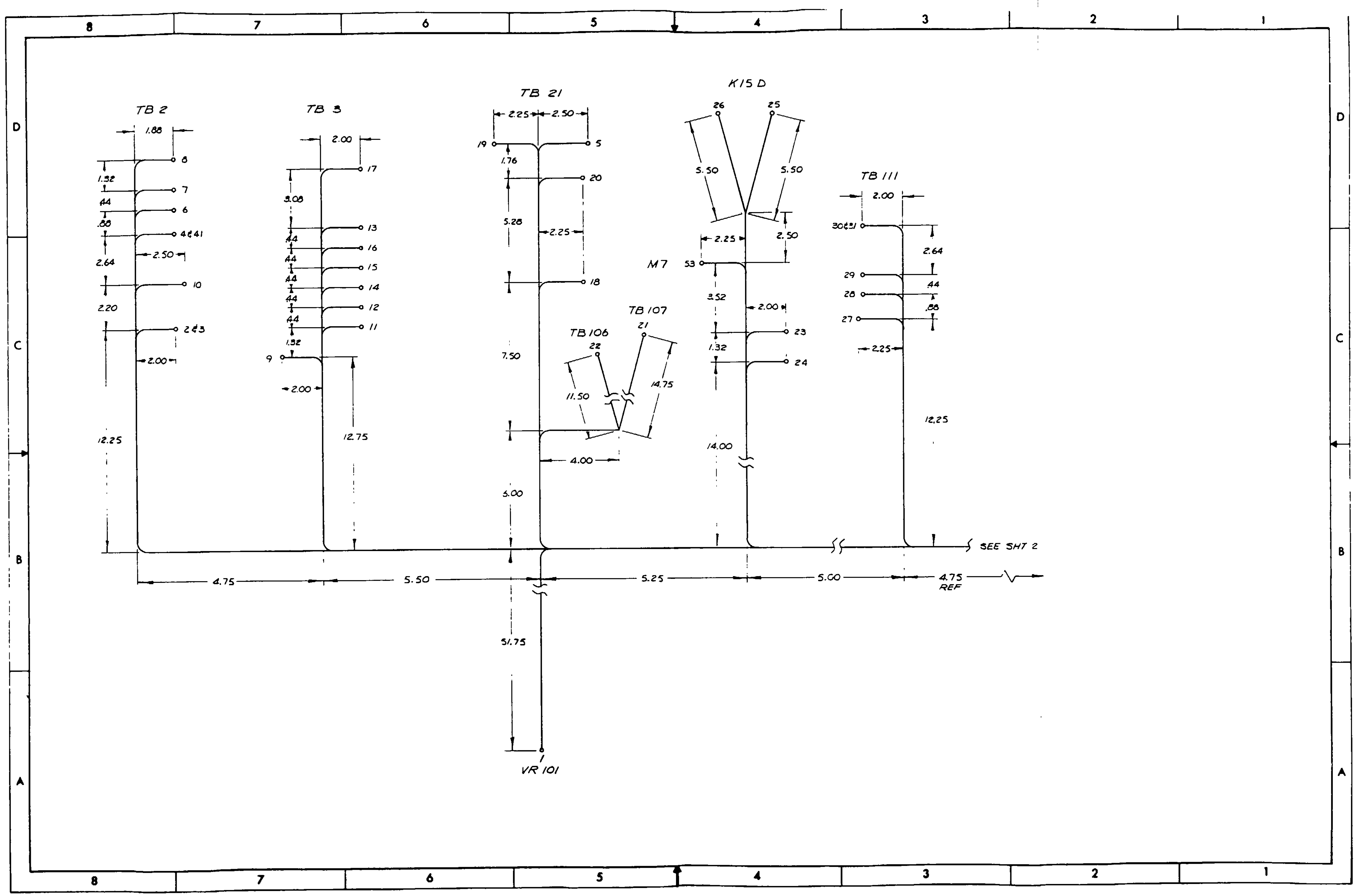
FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
4			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
3			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
2			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
1			MS25036-106	112	TERMINAL LUG		

PARTS LIST

FO-36 Cabinet C Divider
Panel Wiring Harness
(Sheet 1 of 3)



**FO-36 Cabinet C Divider
Panel Wiring Harness
(Sheet 2 of 3)**



FO-36 Cabinet C Divider
Panel Wiring Harness
(Sheet 3 of 3)

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	WIRE MARKING IDENTIFICATION NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1								
2	RED	P144D16	TB3-9B	1	TB111-14B	1	48.00	4
3	RED	P46D16	TB111-17B	1	TB3-17B	1	43.00	4
4	RED	P22T16	K111-4	1	S118-26	1	77.00	4
5	RED	P14M16	TB2-2B	1	TB3-9A	1	8.00	4
6	RED	P10AA16	TB2-19A	1	A104-13	1	67.50	4
7	RED	P10AB16	TB2-19A	1	TB111-19B	1	49.50	4
8	RED	P1J16	TB2-6B	1	A104-12	1	69.50	4
9	RED	P21C16	A10-TB1-12	1	TB21-13B	1	117.50	4
10	RED	P8B16	TB111-10A	1	TB4-15B	1	125.00	4
11	RED	P16A16	A10-TB2-1	1	TB111-9A	1	119.00	4
12	RED	P41C16	TB21-11B	1	A10-TB1-11	1	118.50	4
13	RED	P15C16	TB21-6B	1	A10-TB1-10	1	121.00	4
14	RED	P73F16	TB21-5B	1	A11-TB3-12	1	103.00	4
15	RED	P102B16	TB17-13	1	TB111-12B	1	129.50	4
16	RED	P100A16	TB17-6	1	A105-9	1	114.00	4
17	RED	P99A16	K111-6	1	A10-TB1-6	1	109.00	4
18	RED	P101A16	TB16-10	1	K110-5	1	113.00	4
19	RED	P14X16	K110-4	1	TB20-4	1	109.00	4
20	RED	P96A16	K109-NO	1	A11-TB1-13	1	102.00	4
21	RED	P73E16	K109-NO	1	A11-TB1-2	1	107.00	4
22	RED	P153A16	S118-27	1	K108-3	1	91.50	4
23	RED	P152A16	S118-25	1	K107-3	1	96.00	4
24	RED	P121B16	K107-4	1	A11-TB1-9	1	116.00	4
25	RED	P9C16	TB4-16B	1	TB111-13B	1	130.00	4
26	RED	E33B16	TB4-13B	1	TB2-11A	1	130.00	4
27	BLK	X239A16	A105-8	1	TB21-18A	1	74.00	4
28	BLK	X114B16	K108-5	1	K107-5	1	20.00	4
29	BLK	X259A16	TB17-5	1	A105-6	1	115.00	4
30	BLK	X286B16	A105-13	1	TB2-17A	1	82.00	4
31	BLK	X244D16	TB111-8A	1	TB14-13	1	134.00	4
32	BLK	X237E16	VR101-2	1	TB111-5A	1	82.00	4
33	BLK	X235A16	A105-16	1	TB108-20B	1	86.00	4
34	BLK	X104B16	TB108-16B	1	A101-P	1	96.00	4
35	BLK	X100BL12	VR101-F(-)	2	TB108-15B	2	84.00	5
36	BLK	X234A16	VR101-7	1	TB108-14B	1	86.00	4
37	BLK	X100BM12	VR101-F(-)	2	VR GND STUD	3	22.00	5
38	BLK	X257A16	TB17-1	1	A105-7	1	117.00	4
39	RED	K3C16	TB21-4B	1	A104-16	1	70.00	4
40	RED	K2C16	TB21-3B	1	A104-17	1	71.00	4

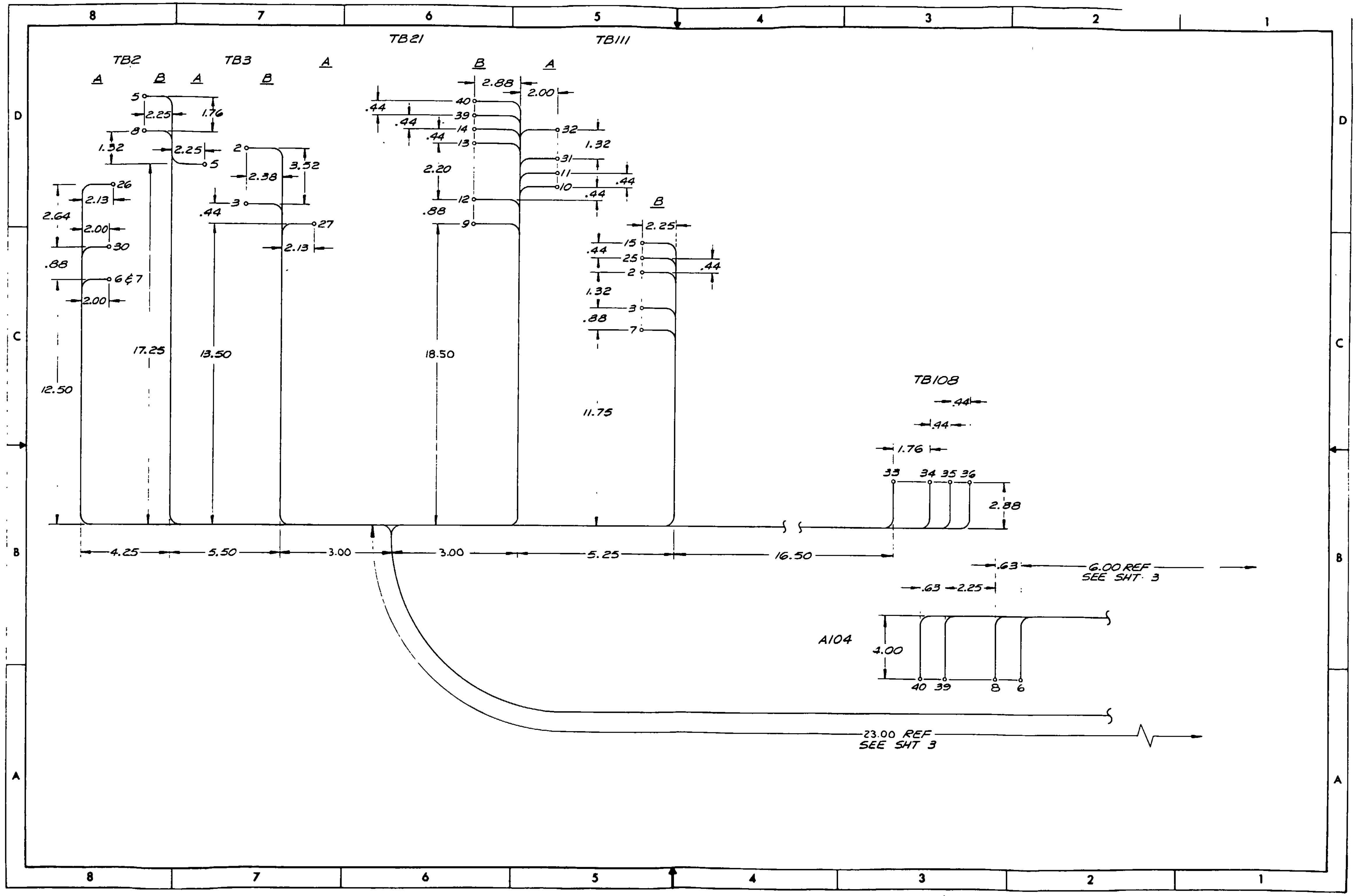
WIRE LENGTH TOLERANCES

OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

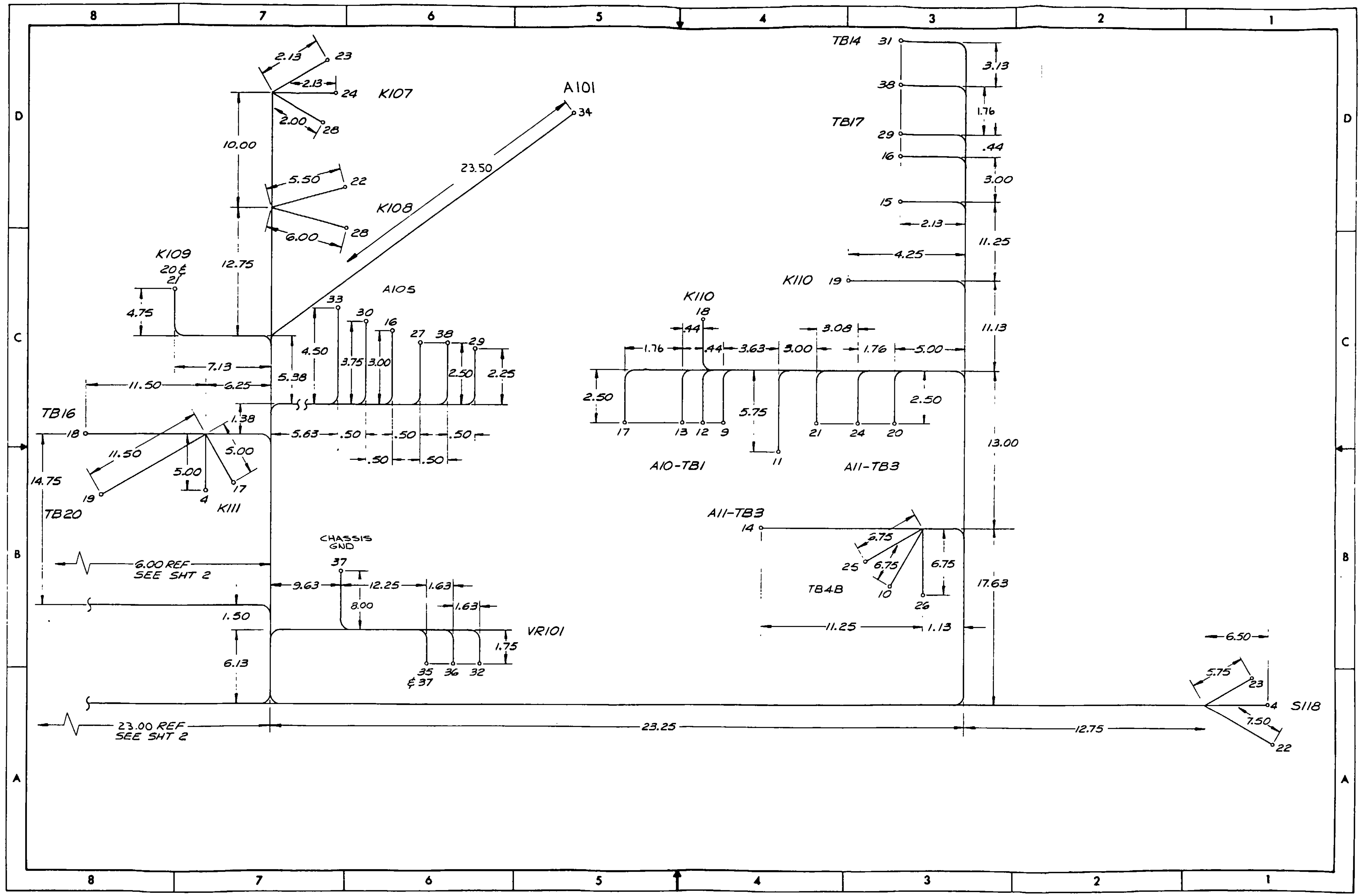
FIND NO.	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
7			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE		
6			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE		
5			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2	
4			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2	
3			MS25036-114	1	TERMINAL LUG		
2			MS17143-6	3	TERMINAL LUG		
1			MS25036-106	74	TERMINAL LUG		

PARTS LIST

FO-37 Cabinet C Interconnect Wiring Harness (Sheet 1 of 3)

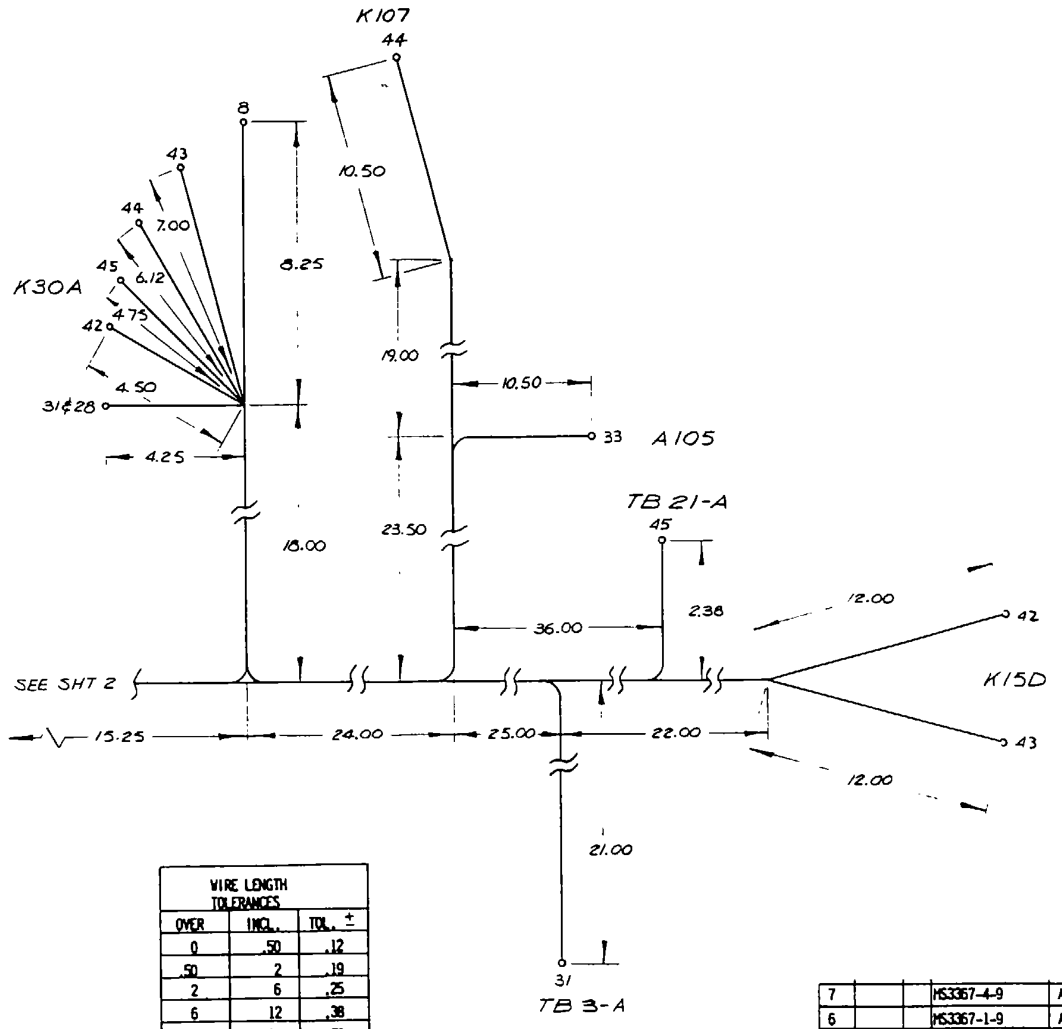


FO-37 Cabinet C Interconnect Wiring Harness (Sheet 2 of 3)



FO-37 Cabinet C Interconnect
Wiring Harness
(Sheet 3 of 3)

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	RED	P10BD16	A10-TB3-14	1	A11-TB3-14	1	17.00	4
2		P10AX16	TB19-15	1	TB16-7	1	19.75	4
3		P10AY16	TB19-7	1	TB20-7	1	26.50	4
4		P10AW16	TB15-7	1	TB16-15	1	53.00	4
5		P10BG16	TB15-7	1	TB13-5	1	70.00	4
6		P10AT16	TB17-7	1	TB14-7	1	12.00	4
7		P10AU16	TB17-15	1	TB18-15	1	9.50	4
8		P10E16	TB18-15	1	K30-X2	1	83.00	4
9		P10AS16	TB13-7	1	TB14-7	1	67.50	4
10		P14CA16	TB19-12	1	TB20-4	1	25.50	4
11		P14AZ16	TB19-4	1	TB18-12	1	40.50	4
12		P14AY16	TB17-11	1	TB20-3	1	19.00	4
13		P14BK16	TB13-15	1	TB18-12	1	55.50	4
14		P14CD16	TB15-15	1	TB13-15	1	62.50	4
15		P14CC16	TB15-15	1	TB14-15	1	26.00	4
16		P14CB16	A10-TB2-17	1	TB14-15	1	56.00	4
17		P14BS16	A11-TB2-11	1	A10-TB2-10	1	35.00	4
18		P14BG16	A10-TB2-6	1	A10-TB1-14	1	14.50	4
19		P73A16	A10-TB3-12	1	A10-TB2-14	1	18.50	4
20		P73B16	TB20-12	1	A10-TB2-14	1	35.00	4
21	RED	P73L16	A11-TB1-3	1	TB19-3	1	9.00	4
22	RED	P73K16	A10-TB3-13	1	TB18-11	1	65.00	4
23	RED	P73J16	TB16-11	1	TB18-11	1	45.00	4
24	RED	P73X16	TB15-3	1	A11-TB3-13	1	64.00	4
25	RED	P73P16	A11-TB3-13	1	A10-TB3-12	1	16.00	4
26	RED	P46K16	TB19-6	1	A11-TB2-5	1	23.00	4
27	RED	P46H16	TB19-6	1	TB18-14	1	39.00	4
28	RED	P46T16	A11-TB2-10	1	K30 -X1	1	50.50	4
29	RED	P46P16	A11-TB2-10	1	A10-TB2-7	1	33.50	4
30	RED	P46L16	A11-TB2-5	1	A10-TB2-7	1	30.00	4
31	RED	P46G16	TB3-17A	1	K30-X1	1	91.50	4
32	RED	P16K16	TB19-14	1	TB20-6	1	24.50	4
33	RED	P66B16	TB13-11	1	A105-5	1	120.00	4
34	RED	P115B16	A11-TB1-10	1	TB20-5	1	23.00	4
35	RED	P117B16	A11-TB1-12	1	TB19-5	1	12.00	4
36	RED	P113B16	TB15-10	1	TB14-10	1	30.00	4
37	RED	P118B16	A10-TB1-5	1	TB18-13	1	47.00	4
38	RED	P120B16	A10-TB1-7	1	TB16-13	1	10.00	4
39	RED	P72C16	TB15-6	1	TB14-3	1	35.00	4
40	RED	P147B16	TB15-4	1	TB13-2	1	72.00	4
41	RED	P93B16	A11-TB3-11	1	A10-TB1-4	1	48.00	4
42	RED	P25A12	K15D-A3	2	K30-A1	2	104.50	5
43	RED	P70A12	K15D-A4	2	K30-A2	2	106.50	5
44	BLK	X114A16	K107-5	3	K30-A4	3	100.50	4
45	BLK	X236A16	TB21-20A	1	K30-A3	3	86.00	4
46	BLK	P116A16	TB20-14	1	A10-TB1-13	1	29.50	4

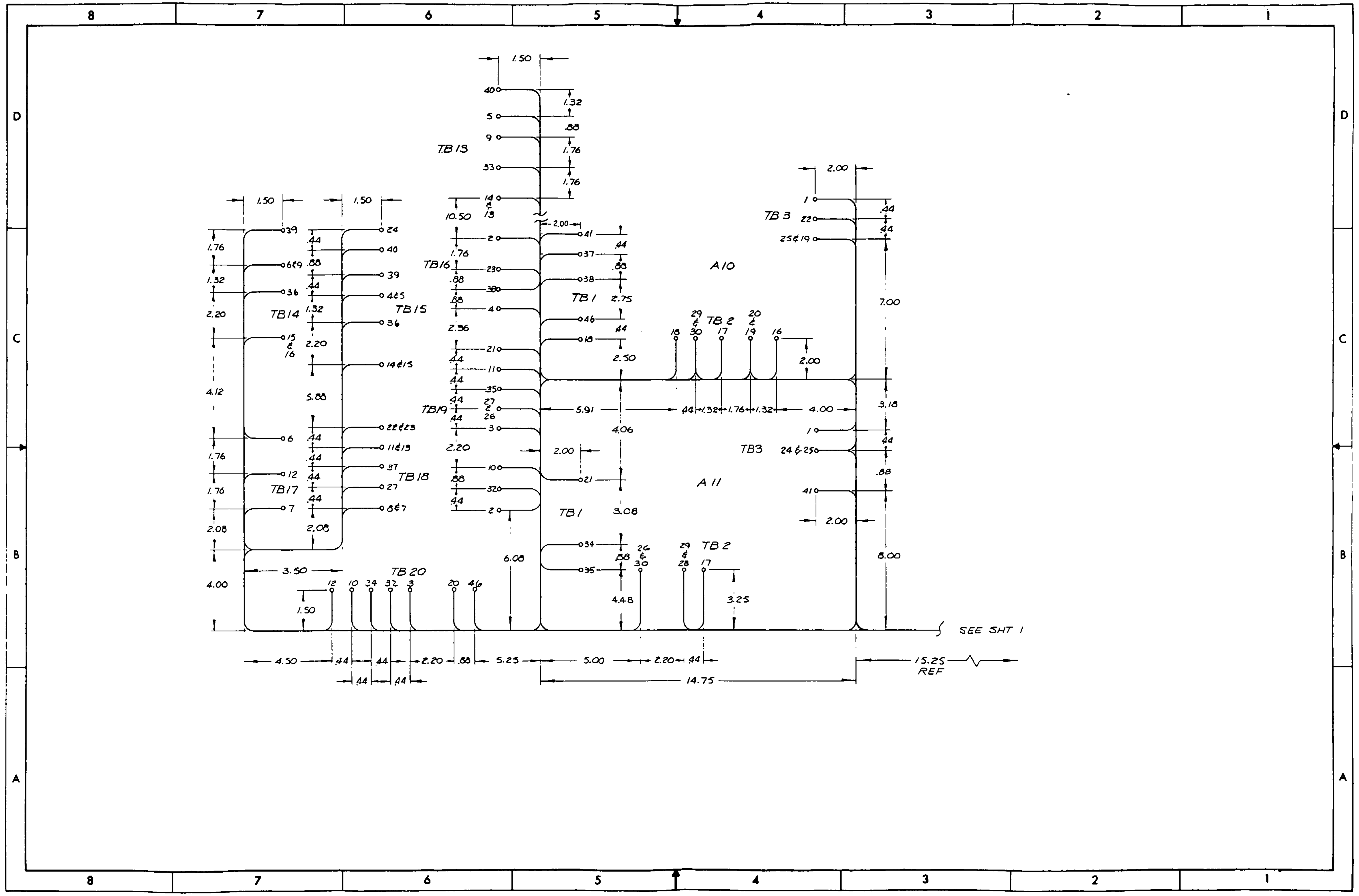


WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
7			MS3367-4-9	AR	STRAP CABLE ADJUSTABLE	
6			MS3367-1-9	AR	STRAP CABLE ADJUSTABLE	
5			M5086/2-12-9	AR	WIRE 12 AN	MIL-W-5086/2
4			M5086/2-16-9	AR	WIRE 16 AN	MIL-W-5086/2
3			MS25036-108	3	TERMINAL LUG	
2			MS25036-112	4	TERMINAL LUG	
1			MS25036-106	85	TERMINAL LUG	

PARTS LIST

FO-38 Cabinet A Divider
Panel Wiring Harness
(Sheet 1 of 2)



FO-38 Cabinet A Divider
Panel Wiring Harness
(Sheet 2 of 2)

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	WIRE MARKING IDENTIFICATION NUMBER	FROM	TERM. FIND NO.	TO	TERM. FIND. NO.	REF WIRE LENGTH	WIRE FIND NO.
1	WHT	X101H00	S120-1	1	TB201-L1	11	77.50	14
2		X102L00	S120-3	1	TB201-L2	11	63.00	14
3		X103J00	S120-5	1	TB201-L3	11	62.00	14
4		J101A00	S120-2	1	CB101-L1	1	98.00	14
5		J102A00	S120-4	1	CB101-L2	1	107.50	14
6		J103A00	S120-6	1	CB101-L3	1	120.00	14
7		X273B00	TB202-2	2	AT	11	100.00	14
8		X273J6	T101-H2	3	TB202-2	4	40.00	15
9		X261B6	C101-A	4	E101-1	4	20.00	15
10		X265B6	C101-B	4	E102-1	4	18.75	15
11		X263B6	C101-C	4	E103-1	4	20.00	15
12		X265C6	E102-1	4	CB101-T2	5	25.00	15
13		X261C6	E101-1	4	CB101-T1	5	38.00	15
14		X263C6	E103-1	4	CB101-T3	5	38.00	15
15		X263D6	F101-2	5	CB101-T3	5	61.00	15
16	WHT	X126A6	F101-1	5	T101-H1	3	92.00	15
17	BLK	X247A2	T103-H2	6	TB103-4	12	69.00	16
18		X248A2	T103-H3	6	TB103-6	12	67.00	16
19		X249B2	T103-X3	7	TB103-3	12	39.00	16
20		X254B2	T103-X1	7	TB103-1	12	43.00	16
21		X255A2	J101-A	Strip	TB103-7	12	62.00	16
22		X251A2	J101-C	Strip	TB103-9	12	62.00	16
23		X100BD2	J101-B	Strip	TB103-8	12	62.00	16
24		X100BB6	T101-X2	8	TB103-8	4 & 22	144.00	17
25		X100BC6	T101-X2	8	T101-GND	4 & 22	32.00	17
26		X100BE2	T103-X2	7	TB103-5	12	44.00	16
27		X308A6	DP2-T1	Strip	S100-A1	13	164.50	17
28		X309A6	DP2-T2	Strip	S100-B1	13	164.50	17
29		X220A6	DP1-T1	Strip	S111-A3	13	120.00	17
30		X227A6	DP1-T2	Strip	S111-A4	13	106.00	17
31		X241A6	S111-A1	9	T101-X1	8	270.00	17
32		X243A6	S111-A2	9	T101-X3	8	270.00	17
33		JMPR-GND	C101-GND	4	CHASSIS-GND	4	17.00	17
34		JMPR-GND	C101-CHASSIS	4	E103-GND	4	10.00	17
35		JMPR-GND	E103-GND	4	E102-GND	4	13.00	17
36		JMPR-GND	E102-GND	4	E101-GND	4	13.00	17
37		X249A6	S111-B4	9	T103-X3	13	190.00	17
38		X227B6	S111-B2	9	S100-B2	9	170.00	17
39		X220B6	S111-B1	9	S100-A2	9	170.00	17
40		X254A6	S111-B3	9	T103-X1	13	190.00	17
41		X100CA6	DP2-GND STUD	STRIP	TB103-8	4	18C.00	17
42		X100CB6	DP2-GND STUD	STRIP	DP1-GND STUD	STRIP	144.00	17
43	BLK	X100CC6	TB201-LO	13	GEN-GND STUD	13	175.00	17
44	WHT	X100CE00	TB201 LO	11 & 20	CHASSIS GND	18 & 20	96.00	14
45	BLK	X100CF6	CHASSIS GND	19	CHASSIS GND	19	306.00	17
46	BLK	X220C6	S111-A3	9	S111-B1	9	9.00	17
47	BLK	X227C6	S111-A4	9	S111-B2	9	12.00	17

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO.	FSCM	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
22			M23053/5-107-0	AR	SLEEVING, HEAT, SHRINKABLE 2 IN LG.	MIL-I-23053/5	
21			M23053/5-109-0	AR	SLEEVING, HEAT, SHRINKABLE 2 IN LG.	MIL-I-23053/5	
20			M23053/5-110-0	AR	SLEEVING, HEAT, SHRINKABLE 2 IN LG	MIL-I-23053/5	
19		B	80-7822	2	TERMINAL LUG		
18		B	80-7819	1	TERMINAL LUG		
17			MS086/2-6-9	AR	WIRE #6 AN	MIL-W-5086/2	
16			MS086/2-2-9	AR	WIRE #2 AN	MIL-W-5086/2	
15		B	80-7979	AR	WIRE, #6 AWG, 5 KV		
14		B	80-7980	AR	WIRE, #00, 5 KV		
13			MS25036-122	4	TERMINAL LUG		
12			MS25036-128	8	TERMINAL LUG		
11			MS20659-120	5	TERMINAL LUG		
10							
9			MS25036-121	10	TERMINAL LUG		
8			MS25036-120	4	TERMINAL LUG		
7			MS25036-127	3	TERMINAL LUG		
6			MS25036-126	2	TERMINAL LUG		
5		C	80-7454-01	6	TWO HOLE LUG		
4			MS20659-143	21	TERMINAL LUG		
3			MS20659-109	1	TERMINAL LUG		
2			MS20659-136	1	TERMINAL LUG		
1		C	80-7454-03	9	TWO HOLE LUG		

PARTS LIST

FO-39 Miscellaneous Wiring

By Order of the Secretaries of the Army and Navy:

Official:

DENNIS J. REIMER
General, United States Army
Chief of Staff

Official:

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army
02407

JACK E. BUFFINGTON
Rear ADMIRAL, CEC, US NAVY
Commander
Navy Facilities Engineering
Command

D.R. Bloomer
Colonel, USMC
Director, Program Support
Marine Corps Systems Command

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To be distributed in accordance with DA Form 12-25-E, block no. 0927, requirements for TM 9-6115-604-34.

These are the instructions for sending an electronic 2028

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however only the following fields are mandatory: 1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, and 27.

From:" Whomever" <whomever@avma27.army.mil>
To: mpmt%avma28@st-louis-emh7.army.mil

Subject: DA Form 2028

1. ***From***: Joe Smith
2. *Unit*. home
3. ***Address*:** 4300 Park
4. ***City*:** Hometown
5. ***St***: MO
6. ***Zip*:** 77777
7. ***Date Sent***: 19-OCT-93
8. ***Pub no***: 55-2840-229-23
9. ***Pub Title*:** TM
10. ***Publication Date***: 04-JUL-85
11. *Change Number*: 7
12. *Submitter Rank*: MSG
13. ***Submitter FName***: Joe
14. *Submitter MName*: T
15. ***Submitter LName***: Smith
16. ***Submitter Phone*:** 123-123-1234
17. ***Problem*: 1**
18. *Page*: 2
19. *Paragraph*: 3
20. *Line: 4*
21. *NSN*: 5
22. *Reference*: 6
23. *Figure*: 7
24. *Table*: 8
25. *Item*: 9
26. *Tota*l: 123
27. ***Text***:

This is the text for the problem below line 27.

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

TEAR ALONG PERFORATED LINE

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 = 0.01 Meters = 0.3937 Inches

1 Meter = 100 Centimeters = 1,000 Millimeters = 39.37 Inches

1 Kilometer = 1,000 Meters = 0.621 Miles

SQUARE MEASURE

1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inches

1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet

1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

CUBIC MEASURE

1 Cu Centimeter = 1,000 Cu Millimeters = 0.06 Cu Inches

1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces

1 Liter = 1,000 Milliliters = 33.82 Fluid Ounces

TEMPERATURE

5/9 (°F -32) = °C

212° Fahrenheit is equivalent to 100° Celsius

90° Fahrenheit is equivalent to 32.2° Celsius

32° Fahrenheit is equivalent to 0° Celsius

9/5 C° +32 = F°

WEIGHTS

1 Gram = 0.001 Kilograms = 1,000 Milligrams = 0.035 Ounces

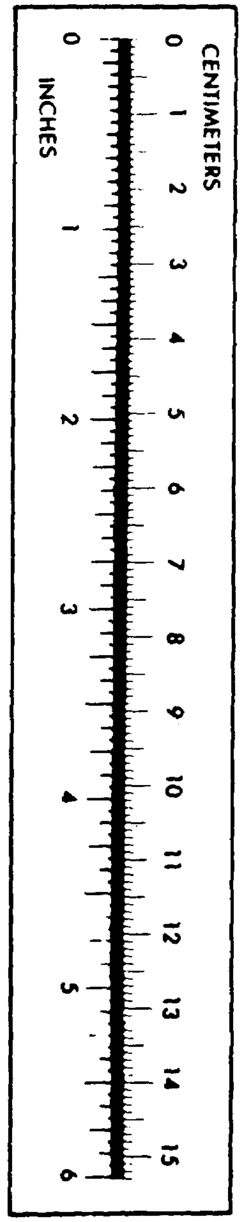
1 Kilogram = 1,000 Grams = 2.2 Lb.

1 Metric Ton = 1,000 Kilograms = 1 Megagram = 1.1 Short Tons

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds Per Square Inch	Kilopascals	6.895
Miles Per Gallon	Kilometers Per Liter	0.425
Miles Per Hour	Kilometers Per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds Per Square Inch	0.145
Kilometers Per Liter	Miles Per Gallon	2.354
Kilometers Per Hour	Miles Per Hour	0.621



PIN: 074896- 000