TM 11-6525-201-14

TECHNICAL MANUAL

OPERATOR ORGANIZATIONAL , DIRECT SUPPORT,

AND GENERAL SUPPORT

MAINTENANCE MANUAL

CONTROL GROUP OK-258/TAQ-2

A N D

GENERATOR GROUP OV-47/TAQ-2

HEADQUARTERS, DEPARTMENT OF THE ARMY

JANUARY 1974

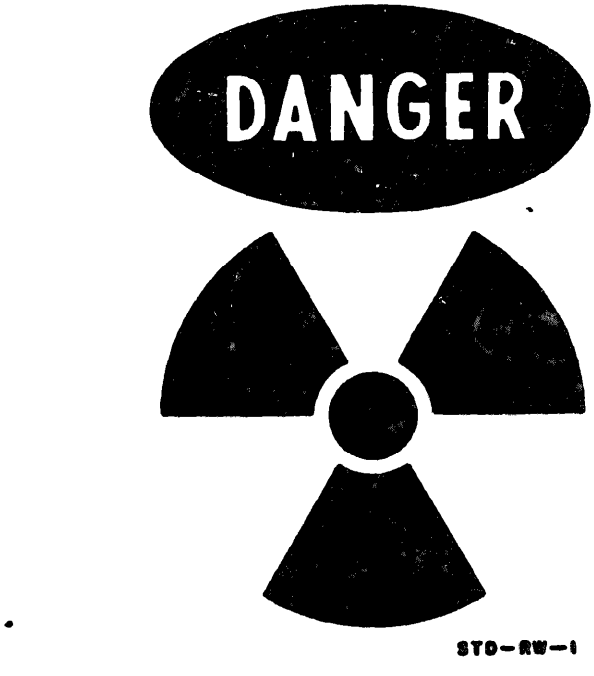
WARNING

Be careful when working on the 115-volt ac line connections. SERIOUS INJURY or DEATH may result from contact with these terminals.

DON'T TAKE CHANCES!

EXTREMELY DANGEROUS VOLTAGES EXIST IN THE FOLLOWING UNITS OF THIS EQUIPMENT:

PULSER UNIT	150,000 VOLTS
HIGH VOLTAGE POWER SUPPLY	20,000 VOLTS



THIS EQUIPMENT GENERATES X-RAYS

X-RADIATION IS EXTREMELY DANGEROUS TO THE HUMAN BODY.

BEFORE OPERATING THIS EQUIPMENT THE OPERATOR MUST READ AND BECOME FAMILIAR WITH SECTIONS IV THROUGH VIII OF CHAPTER 3.

CHANGE
No. 1

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 3 March 1978

Operator's, Organizational, Direct Support, and General Support Maintenance Manual CONTROL GROUP OK-258/TAQ-2 AND GENERATOR GROUP OV-47/TAQ-2 (NSN 6635-00-179-8839)

This change is current as of 23 September 1977.

TM 11-6525-201-14, 25 January 1974, is changed as follows:

1. Title is changed as shown above.
2. Remove old pages and insert pages as indicated below:

Remove pages	Insert Pages
B-1 through B-4	B-1 through B-6

3. File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

Official:

J. C. PENNINGTON
Brigadier General, United States Army
The Adjutant General

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TRADOC (1)
TECOM (1)
LBAD (5)
SAAD (5)
TOAD (5)

ARNG & USAR: None.
For explanation of abbreviations used, see AR 310-50.

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 25 January 1974

OPERATORS, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

CONTROL GROUP OK-258/TAQ-2 AND GENERATOR

LIST OF ILLUSTRATIONS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual describes Control Group OK-258 and Generator Group OV-47 self-contained Apparatus (part of Radiographic. X-ray Industrial System AN/TAQ-21 and provides instructions for operations. organizational maintenance, direct support. and general support maintenance. Instructions are provided for the operator and organizational repairman for installation, operation preventive maintenance, and replacement of parts available at organizational maintenance. Circuit functioning is included for direct and general support categories, together with instructions for troubleshooting, testing, l adjustment, alignment, and replacement of maintenance parts.

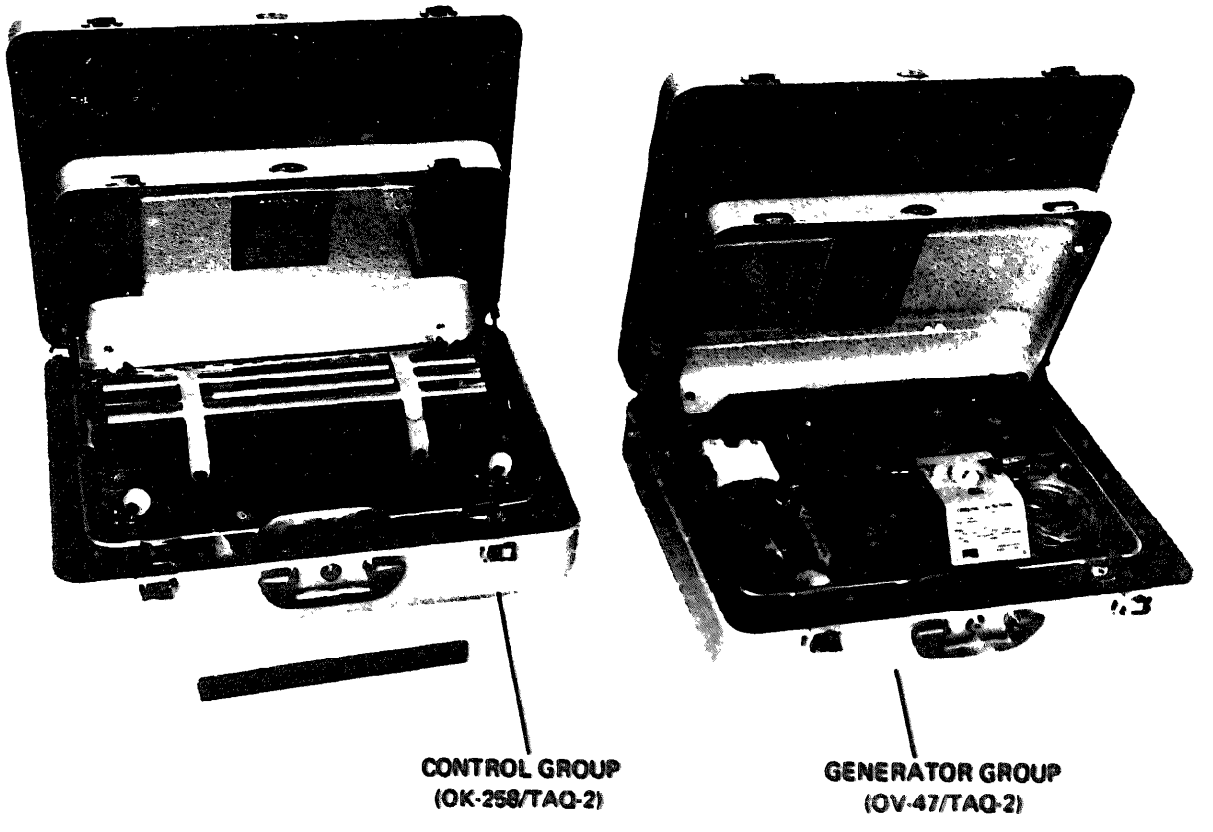

Figure 1-1. Control Group OK-258/TAQ-2 (X-Ray Apparatus)

1-2. Indexes of Publications

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

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

1-3. Forms and Records

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

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Report of Packaging and Handling Deficiencies) as prescribed in AR 700-58 (Army) / NAVSUP Pub 378 (Navy) / AFR 71-4 (Air Force) /and MC0 P4030.29 (Marine Corps).

c. Discrepancy in Shipment Report (DISREP) (SF ***361).*** Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38 (Army) / NAVSUP Pub 459 (Navy) / AFM 75-34 (Air Force) / and MC0 P4610.19 (Marine Corps).

d. Reporting of ***Equipment Manual Improvements.*** The reporting of errors, omissions and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commander, US Army Electronics Command, ATTN : AMSEL-MA-SEW. Fort Monmouth, NJ. ***07703.***

1-4. Destruction of Equipment

Destruction and demolition of equipment should be made under the direction of the commanding officer and in accordance with TM 750-244-2. and the safety instructions of radiation hazards contained in sections IV through VII ***of*** chapter 3.

1-5. Administrative Storage and Disposition Instructions

d. Electronic equipment should be stored in accordance with Administrative Storage of equipment, TM 740-90-l.

b. This equipment will ***not*** be disposed of in accordance with standard procedures. **A** request for disposition of this equipment is required and should be addressed to: Commander US Army Electronics Command ATTN: AMSEL-WL-E. Fort Monmouth NJ 07703.

Section II. DESCRIPTION AND DATA

1-6. Purpose and Use

Control Group OK-258 and Generator Group OV-

Control Group OK-258 and Generator Group OV-47 are a self-contained portable X-ray unit (fig. 1-1). Some of the applications benefiting from its small size, lightweight, portability, and rugged construction are:

a. **Portable medical radiography.**
b. **T. B. survey.**
c. **Remote area dental survey.**
d. **Hospital and clinic.**
e. **Industrial on-site inspection.**
f. **Quality control.**
g. **Research.**

1-7. System Description

a. **X-ray produces a train of high energy, high intensity, X-ray pulses of short duration. A panel-mounted EXPOSURE SELECTOR permits a choice of 1 through 99 pulses in any single pulse train.**

b. **Contrast control is provided by selecting either 100-kilovolt (kv) or 150 kv X-ray tube voltage by means of a toggle switch mounted on the control panel.**

c. **Optimum radiographic exposure is obtained by selecting the proper sequential pulse train length and exposure distance for the chosen X-ray tube voltage.**

d. **A simple, eight-step operating procedure is printed on the control panel to aid in the operation of the system. Do not attempt to operate the equipment without first studying the instructions.**

e. **The cold cathode X-ray tube, with an effective source size of 1.8 mm, provides excellent radiographic resolution. The small tube head (figure 4-11 is light and compact, and provides maximum radiation safety protection.**

where power is available from portable ac generators. The X-ray beam quality, because of circuit design, remains constant with normal input alternating-current (ac) voltage variations.

1-8. Technical Characteristics

Leading particulars and specifications for the X-ray are listed in table 1-1.

Table 1-l. Technical Characteristics

Input line voltage:	Line voltage adjust setting:
85-100 vac	90 vac
100-115	110 vac
115-135 vac	125 vac
135-170 vac	155 vac
170-220 vac	210 vac
220-240 vac	230 vac
240-260 vac	250 vac
	50-60 cycle 11 watts standby
	1,200 watts surge
X-ray tube voltage	150 kv
	100 kv
Effective MAS / pulse	0.06 MAS at 150 kv
	0.03 MAS at 100 kv
MAS / 99 pulse train	6 MAS at 1.50 kv
	3 MAS at 100 kv
Pulse duration	60 nanoseconds (0.00000006 second)
Pulse rate (When line voltage is equal to line voltage. adjust setting)	20 per second at 100 kv: 14 per second at 150 kv
Pulse number selection	1 to **99** pulses
Average X-ray tube life	50,000 pulses at 100 kv,25.000 pulses at 150 kv
Effective X-ray source size	1.8 mm diameter
Inherent filtration	Exceeds 2.5mm aluminum equivalent
Operating temperature range	20° F to 110° F
Maximum operating altitude	8,000 feet
Humidity	to **96%** relative humidity
System temperature for storage / travel	(0^{o} F to 130° F

1-9. Items Comprising and Operable Equipment

The components comprising the X-ray unit are listed in table 1-2. Spare parts and maintenance materials shipped with the unit are listed in table l-3.

Table l-2. Items Comprising an Operable Equipment

Quantity	Item	Dimensions (in.)			Weight (lb)
		Width	Height	Depth	
	Control Group OK-258/TAQ-2 (Control carrying case) (figure 1-3)				
1	Outer carrying case	24	7	18	10
1	Inner carrying case	21	6½	13	49
1	Dolly	18½	1¼	12¼	2
1	High-voltage cable		10 ft long		
1	Control assembly	5	7½	13½	6
1	Remote tubehead and mount assembly	5 dia	10	12	10
1	Mast assembly				
	Mast sections (four)	1½ dia		19 length	12 oz
	Mast extension sections (three)	1 dia		19 length	12 oz
	Generator Group OV-47/TAQ-2 (Pulser carrying case (figure 1-2)				
1	Outer carrying case	24	7	18	10
1	Inner carrying case	21	6½	13	53
1	Resistive load	1 dia		6	1½
1	AC power cable		10 ft long		
1	Exposure switch cable		10 ft long		
1	Control Cable		6 ft long		

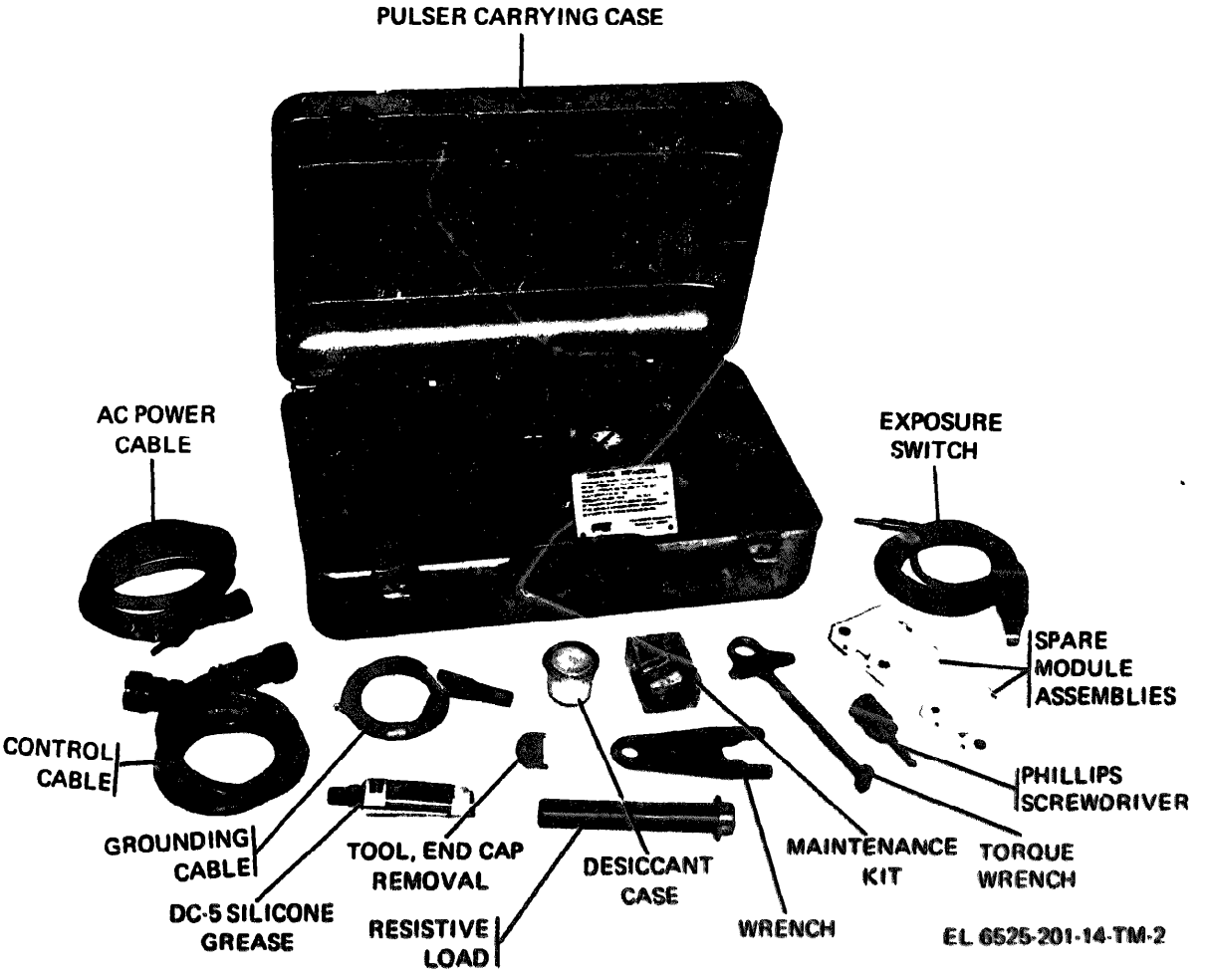

Figure 1-2. Generator Group OV-47/TAQ-2.

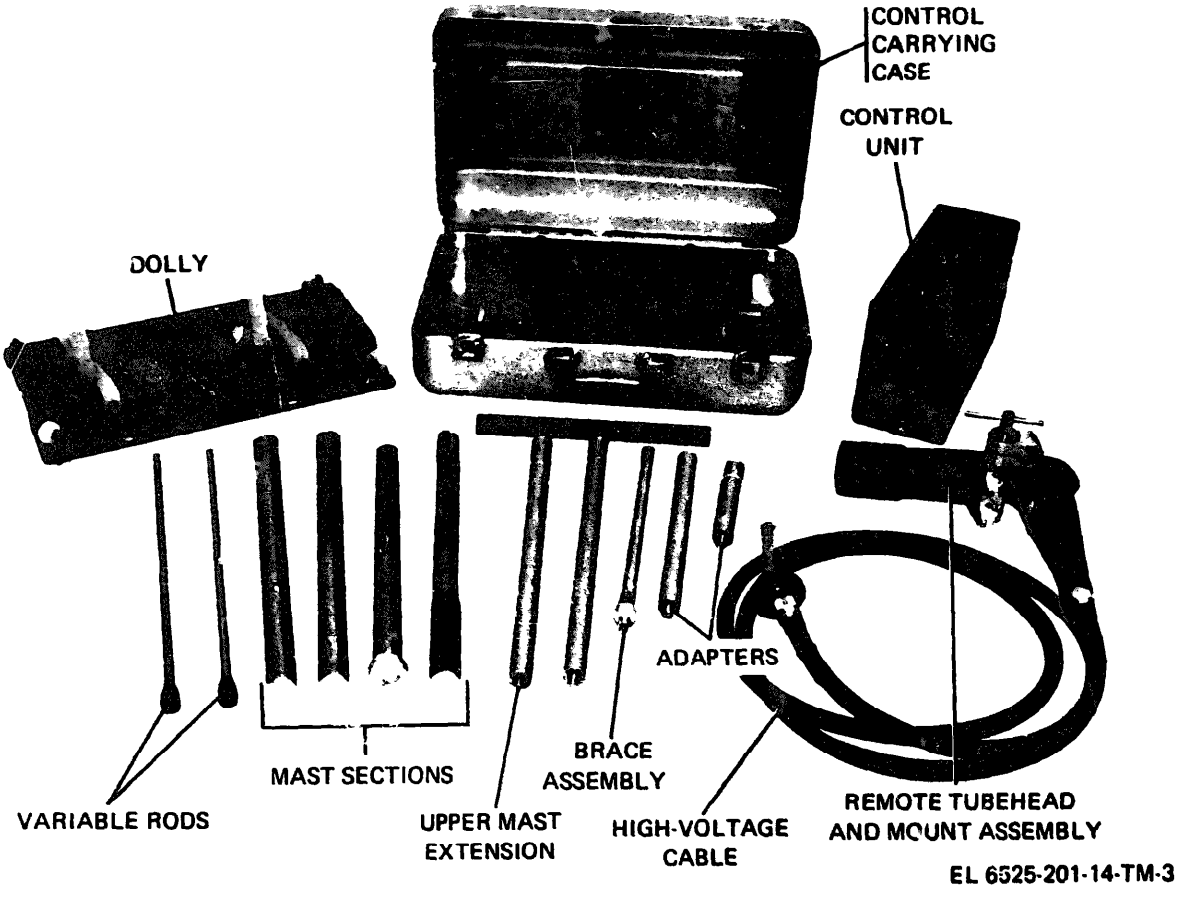

Figure 1-3. Control Group OK-258/TAQ-2.

Table 1-3. Spare Parts and Maintenance Materials

Quantity	Item
	Spare parts consisting of:
2	Module assembly
1	Desiccant case assembly
	Maintenance kit consisting of
5	Fuse, 02 amp
1	Drill bit #43 0.0901
1	Allen wrench. 1/1m
1	Allen wrench. 1/8
1	Allen wrench. 9/16
1	Allen wrench, 8/16
3	O-ring
1	Tool. cap removal
1	Screwdriver, small Phillips
1	Hex bit, [illegible]-in. drive, [illegible]
1 tube	DC-3 silicone grease
1	Torque wrench
1	Wrench

CHAPTER 2

SERVICE UP0N RECEIPT AND INSTALLATION

Section I. UNPACKING AND INSPECTION

2-l. Checking Unpacked Equipment

NOTE

Remove inner carrying case from outer carrying case before attempting to open cover. Lift inner carrying case straight up when removing to avoid damage to foam liner in outer carrying case.

2-2. Inspection of Equipment

a. Inspect the equipment for damage incurred during shipment. Remove X-ray tube from tubehead and inspect for evidence of damage. Check connector at each end of high-voltage cable to ensure that neither has loosened during shipment. If the equipment has been damaged, report the damage on DD Form 6 (paragraph 1-2 b).

b. Check to see that the equipment is complete as listed on the packing slip. If a packing slip is not available, check the equipment against the table of components (table 1-2). Report all discrepancies in accordance with TM 38-750. Shortage of an assembly or part that does not affect proper functioning of the equipment should not prevent use of the equipment.

c. If the equipment has been used or reconditioned, see whether it has been changed by a modification work order (MWO). If the equipment has been modified, the MWO number will appear on the front panel near the nomenclature plate. Check to see whether the MWO number (if any) and appropriate notations concerning the modification have been entered in the equipment manual. (Current MWOs applicable to the equipment are listed in ***DA*** Pam 310-7.)

Section II. INSTALLATION INSTRUCTIONS

2-3. General

Preparation of the X-ray apparatus for installation consists of unpacking the components and connecting the cables. Since the X-ray apparatus can be operated in several different configurations, the procedures for setting up the mast and remote tubehead are covered in paragraphs 2-5 through 2-9. These include procedures for operation with the tubehead less than three feet in height, three-to-ten feet in height, installation of tubehead for horizontal and vertical operation, and use of the variable rods.

2-4 Preparation for Installation of X-Ray Apparatus

a. Remove mast sections from dolly and set aside (figure 2-1). Remove locking screw and dolly from control carrying case. Place dolly on floor, and position pulser carrying case on it (figure 2-2).

NOTE

Locking screw is used in conjunction with tubehead and mount assembly, and will be installed in mount assembly clamp when tubehead is removed from carrying case.

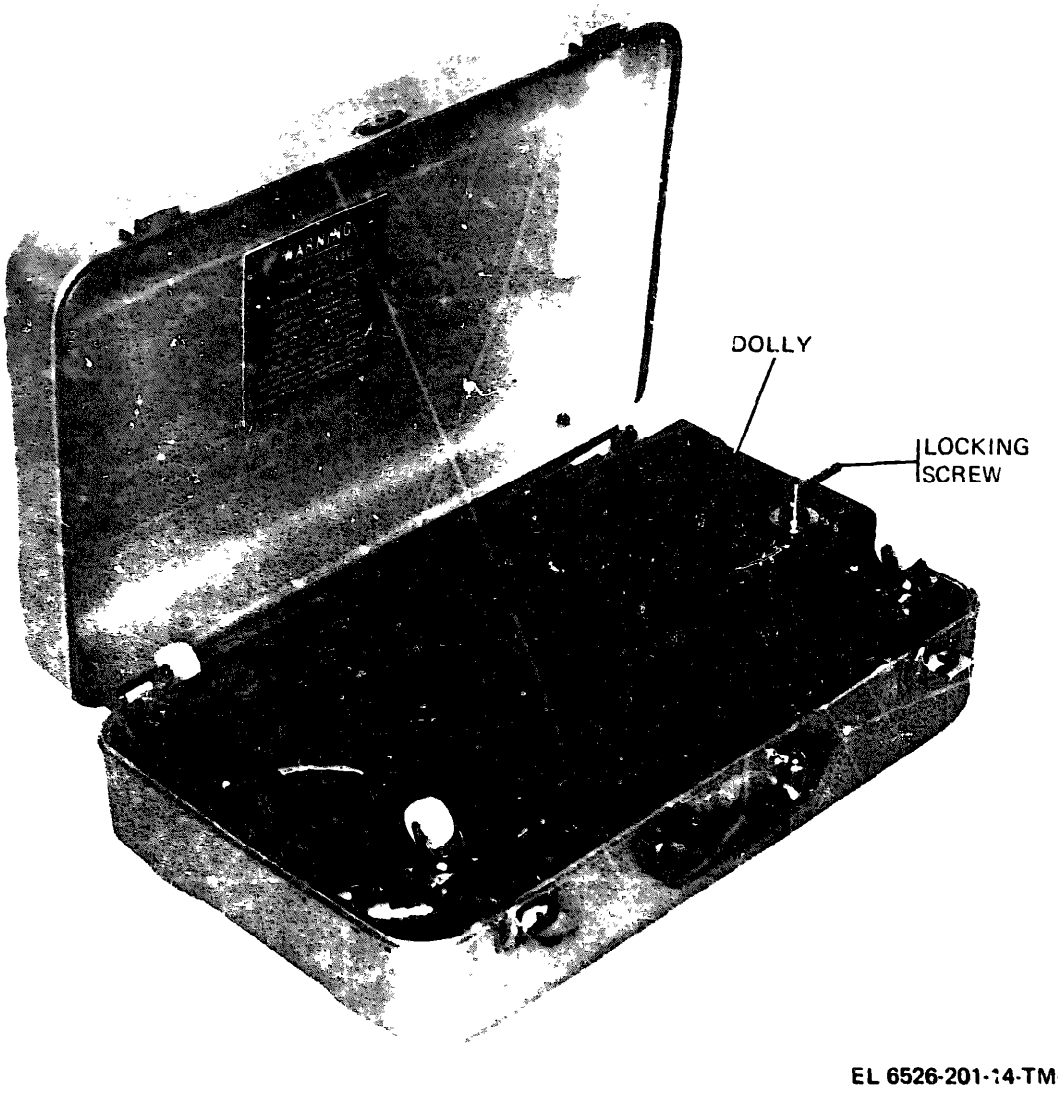

Figure 2-1. Dolly Stowed in Control Carrying Case.

Figure 2-2. Pulser Case Positioned on Dolly

b. Remove control unit from control carrying case (figure 2-3). Be sure that line voltage meter is zeroed and both CIRCUIT BREAKERS are set to the off (down) position. Connect ac power cable to AC INPUT jack. Connect male plug P105 of ac power control cable to the CONTROL OUT jack, and female plug P105 to J105 on the pulser assembly (figure 2-4).

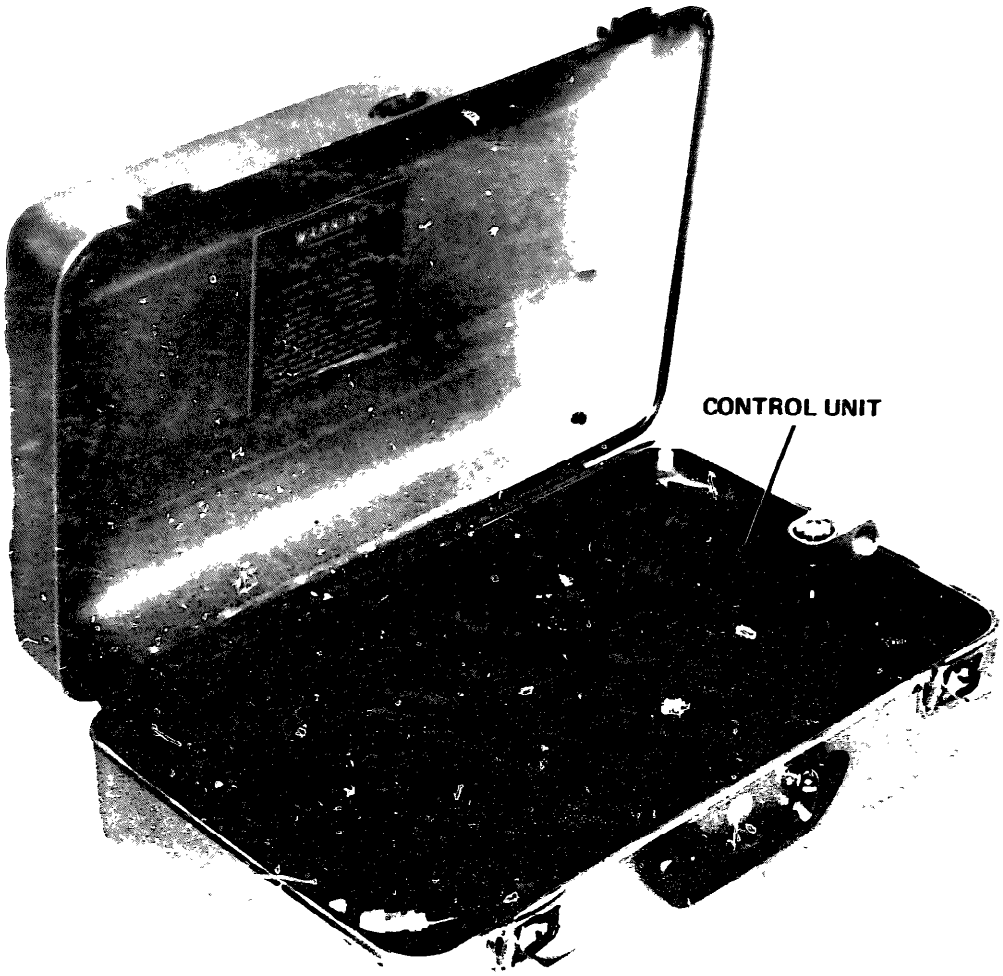

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Figure 2-3. Control Unit Stowed in Control Carrying Case

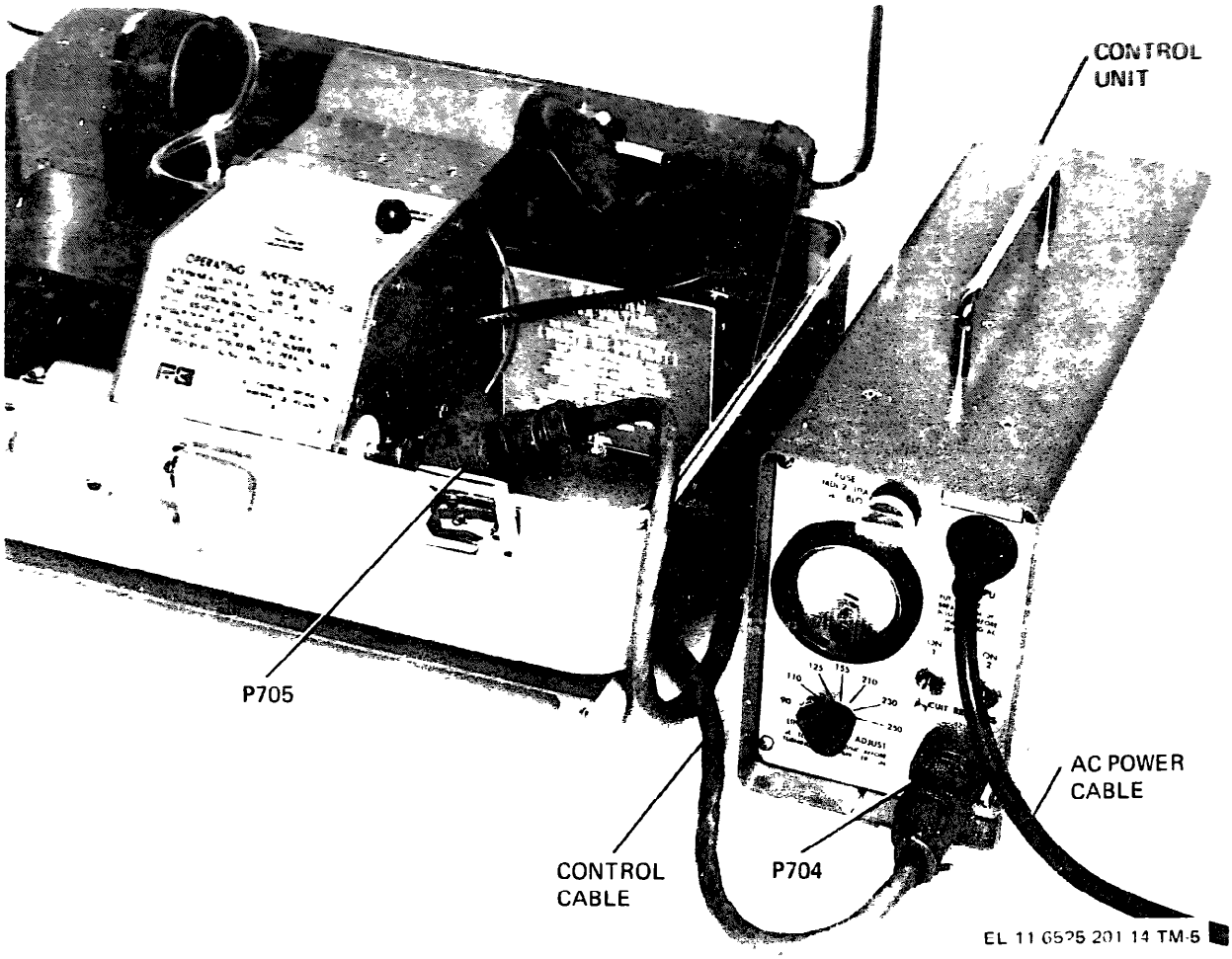

Figure 2-4. Control Unit Cable Connections

c Remove remote tubehead and mount assembly (figure 2-5), variable rods, and mast top section from control carrying case (figure 2-6). Install locking screw in mount assembly clamp.

NOTE

When removing brace assembly from its stored position in lower mast assembly, remove from end opposite internal nut.

d Remove the two variable rods and mast top section from the control carrying case. Remove the red plastic plugs from each end of the mast extensions prior to mounting (figure 2-7). Place all red plastic plugs in control carrying case, and store the control carrying case in outer carrying case until unit is disassembled and replaced.

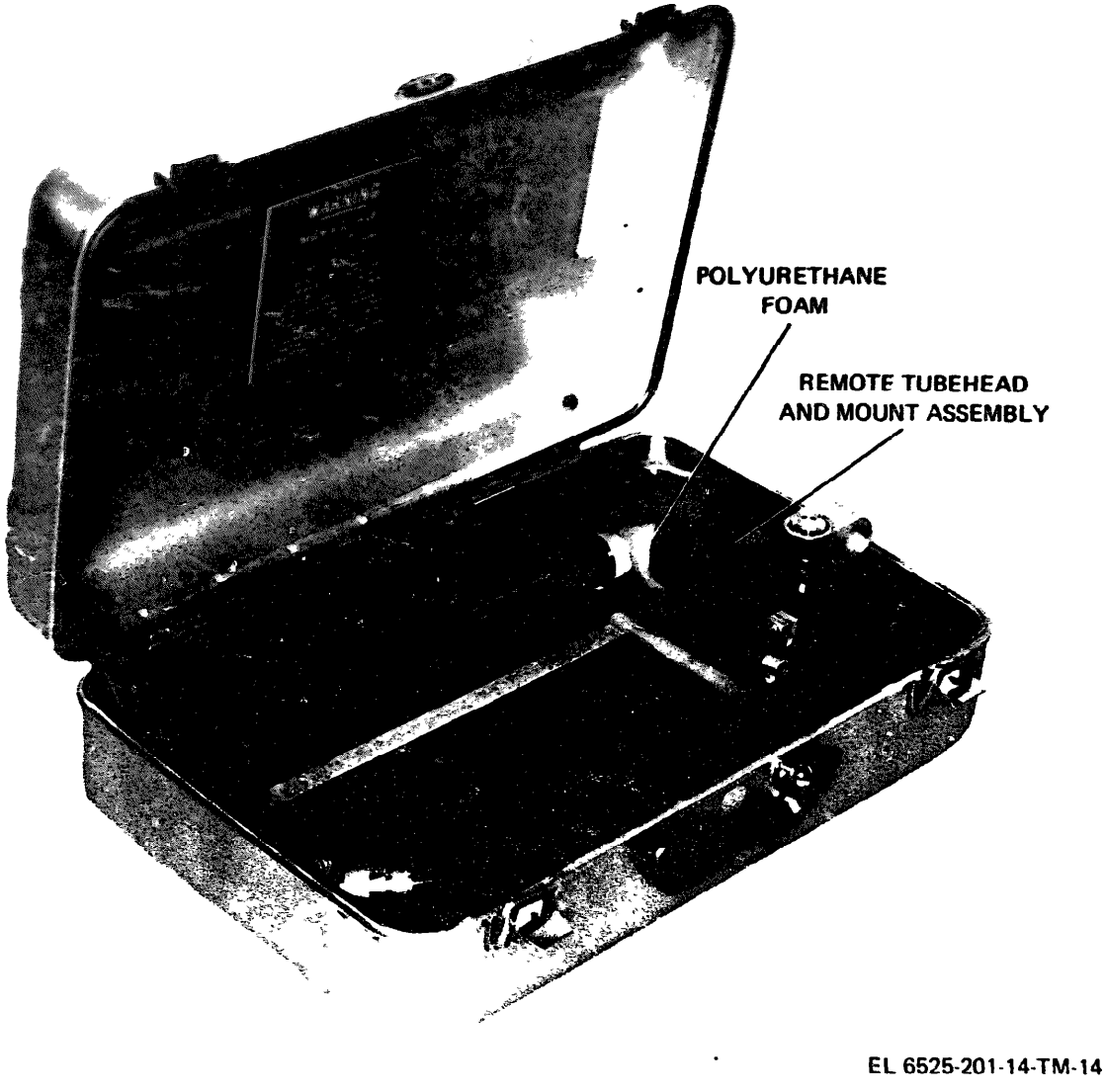

Figure 2-5. Remove Tubehead and Mount Assembly Stowed in Control Carrying Case

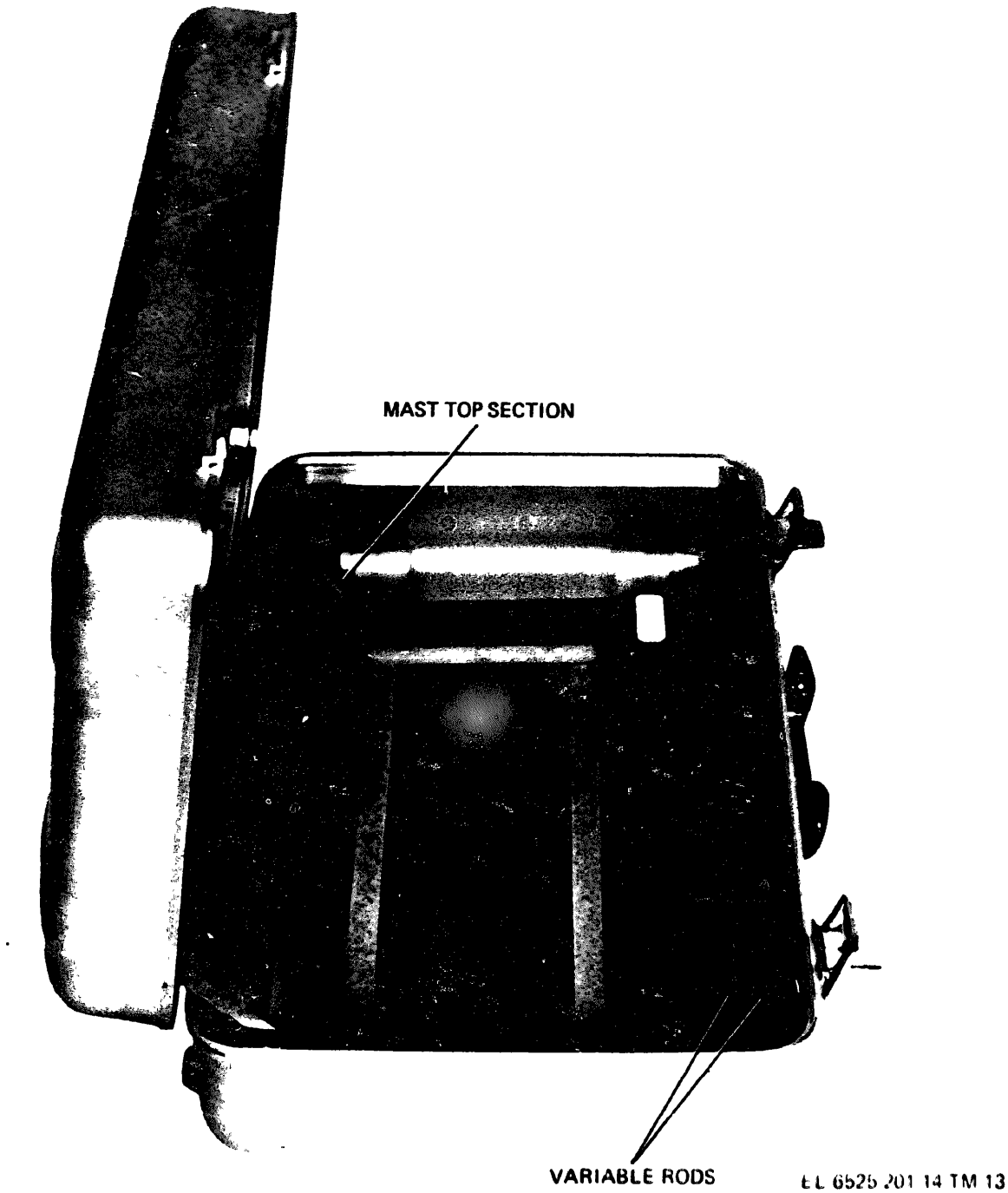

Figure 2-6. Top Mast Section and Variable Rods Stowed in Control Carrying Case.

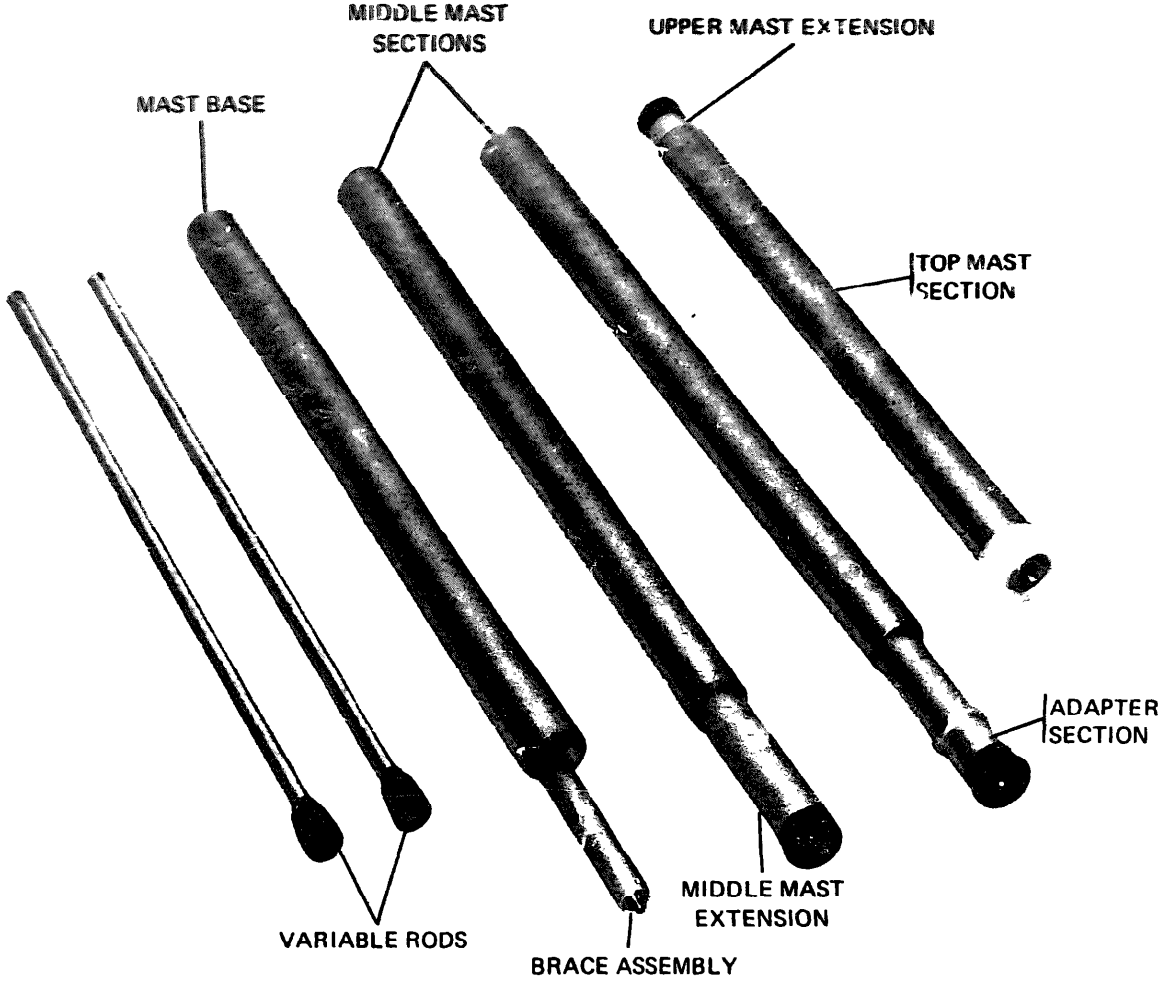

Figure 2-7. Variable rods and Mast Sections

2-5. Installation of Mast Sections for Operation Below a Three-Foot Height

a. Install top mast section (figure 2-7) in pulser case mount (figure 2-8 or 2-9) and hand tighten lock screws.

NOTE

The brace assembly is not used when operating below a three-foot height.

b. Install remote tubehead and mount assembly (paragraph 2-7 for horizontal operation and 2-8 for vertical operation).

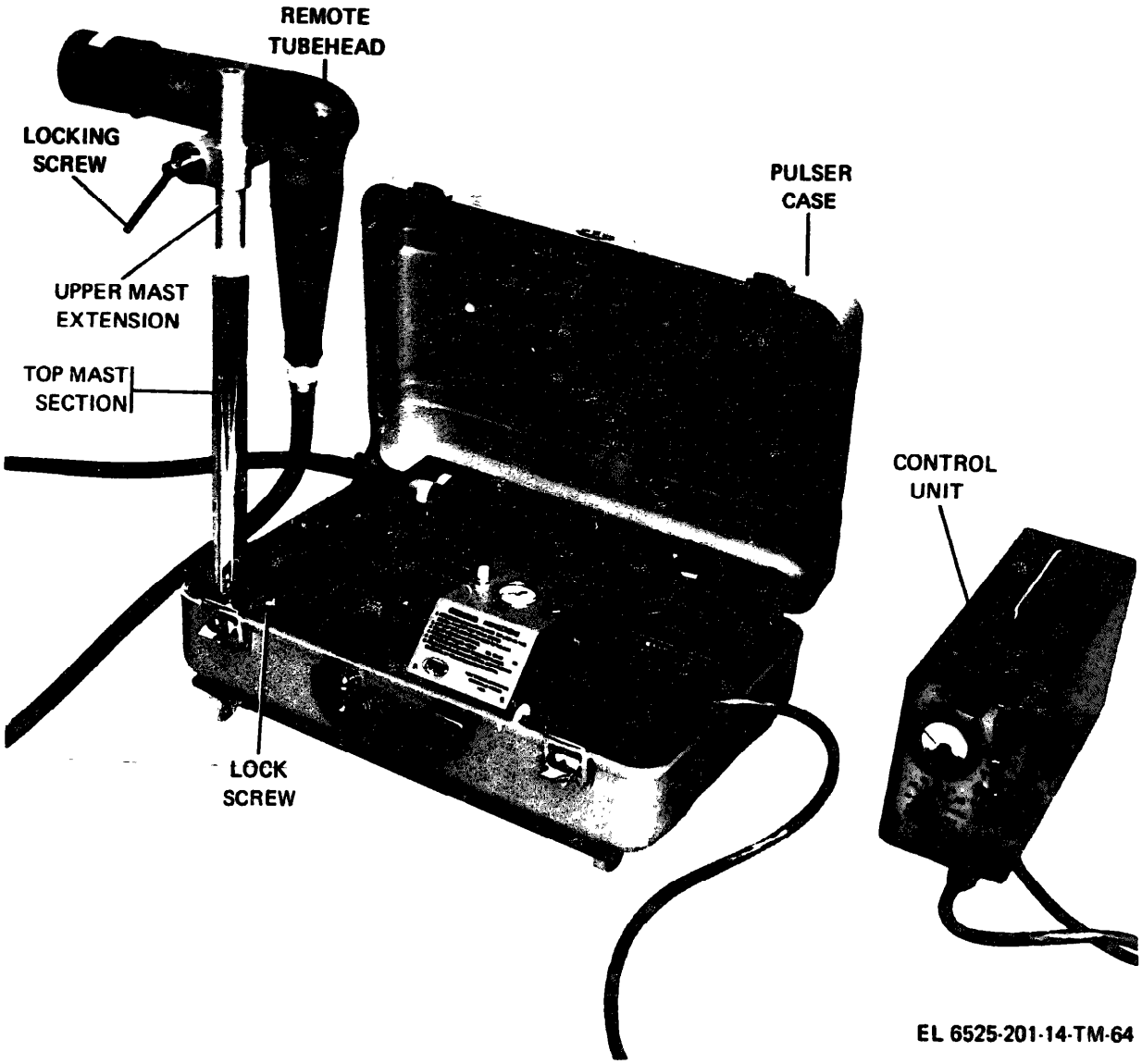

Figure 2-8. Mast and Tubehead Assembly, Three-Foot Height, Horizontal Position.

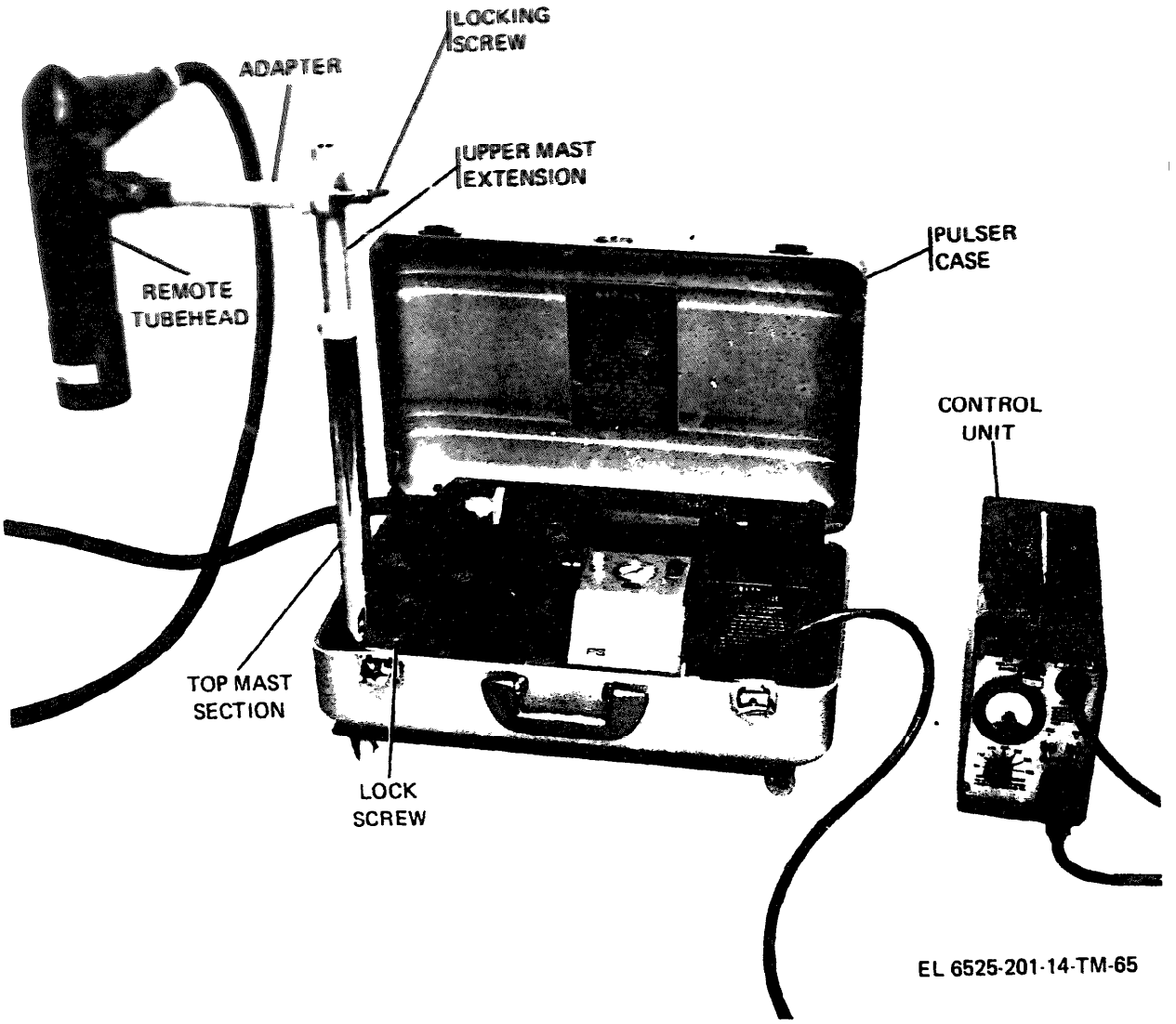

FIgure 2-9. *Mast and Tubehead Assembly. Three-Foot Height. Vertical Position*

2-6. Installation of Mast Sections for Operation Above a Three-Foot Height

d. Install mast base section (figure 2-7 in pulser case mount (figure 2-10) and handtighten lock screws.

b. Loosen locknut on brace assembly (figure 2-10). install large end of brace assembly in right rear of pulser case. extend other end of brace assembly) until it fits in tapped hole on mast base section. then turn both ends of brace assembly until tight. Hand-tighten lock nut.

c. Install one or two middle mast extensions. depending on required height. with tapered end down figure 2-11 or 2-12).

d. Install top mast section.

c.. Install remote tubehead and mount assembly (paragraph 2-7 for horizontal operation and 2-8 for vertical operation).

/. If horizontal operation is to be used and the distance from remote tubehead to the object being X-rayed allows use of the variable rods (figure 2-7). install the variable rods (paragraph 2-9).

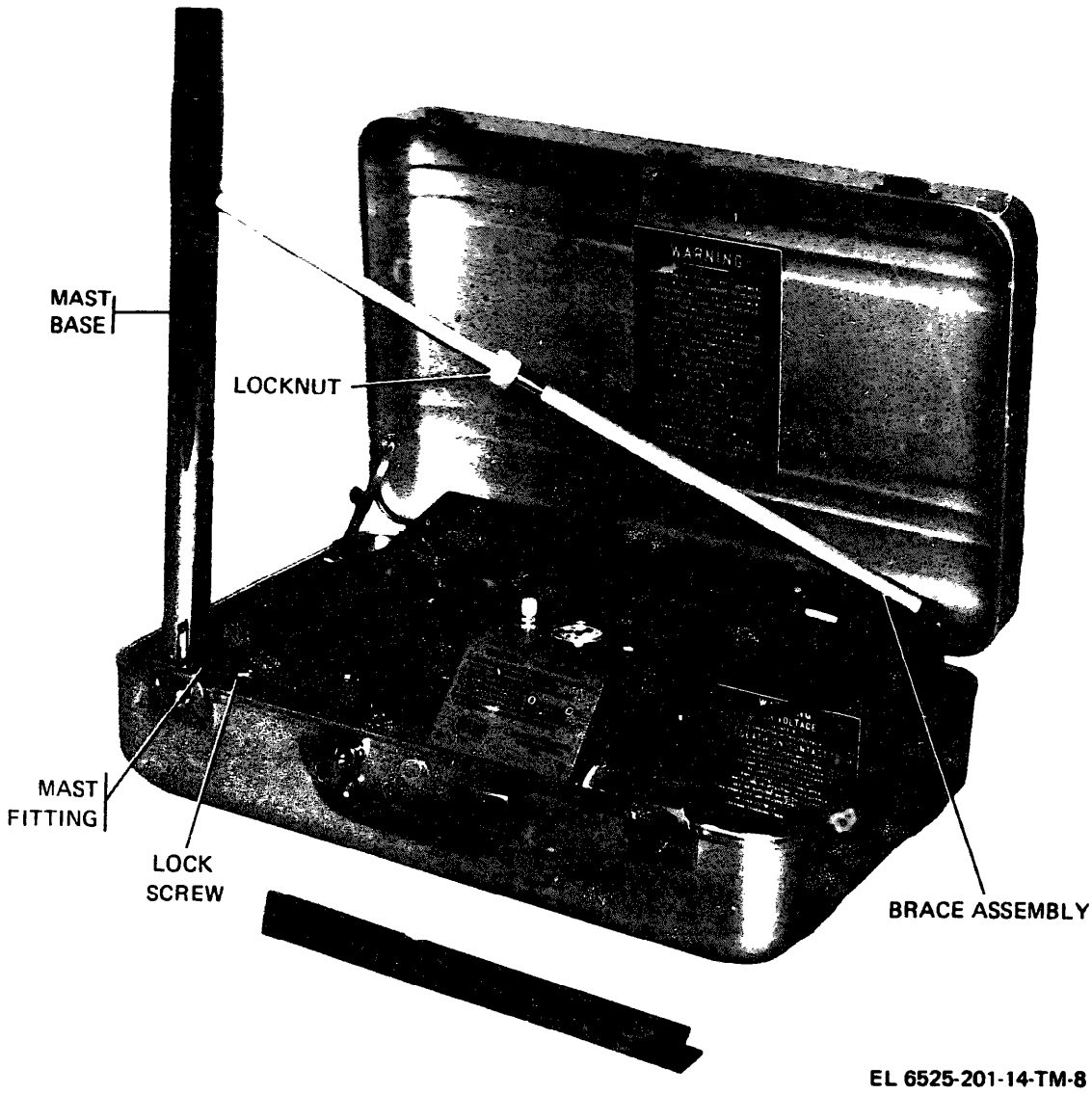

Figure 2-10. Assembly of Mast Base and Brace Assembly.

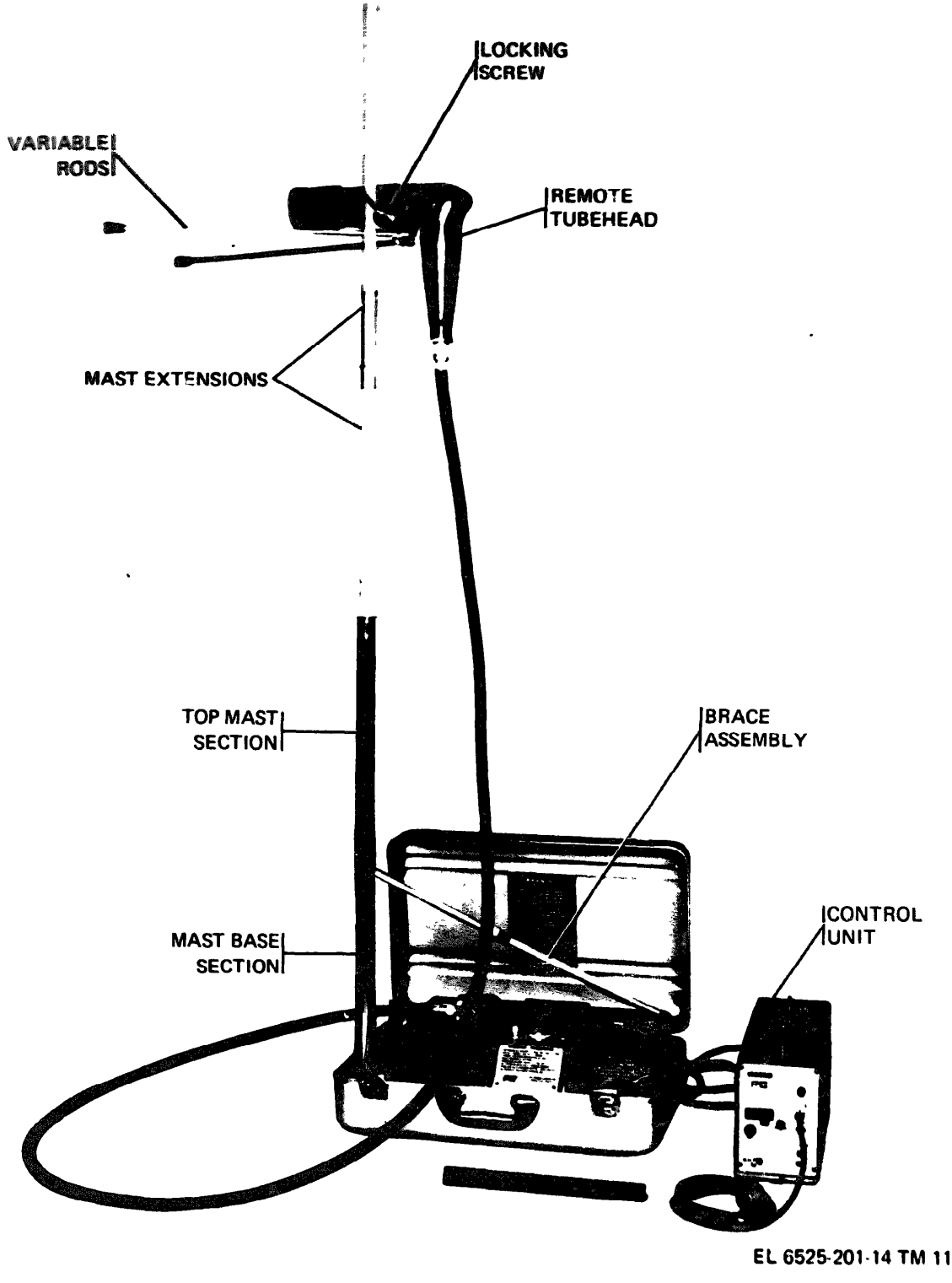

Figure 2-11. Mast and Remote Tubehead Three-to-Ten Foot Height. Horizontal Position.

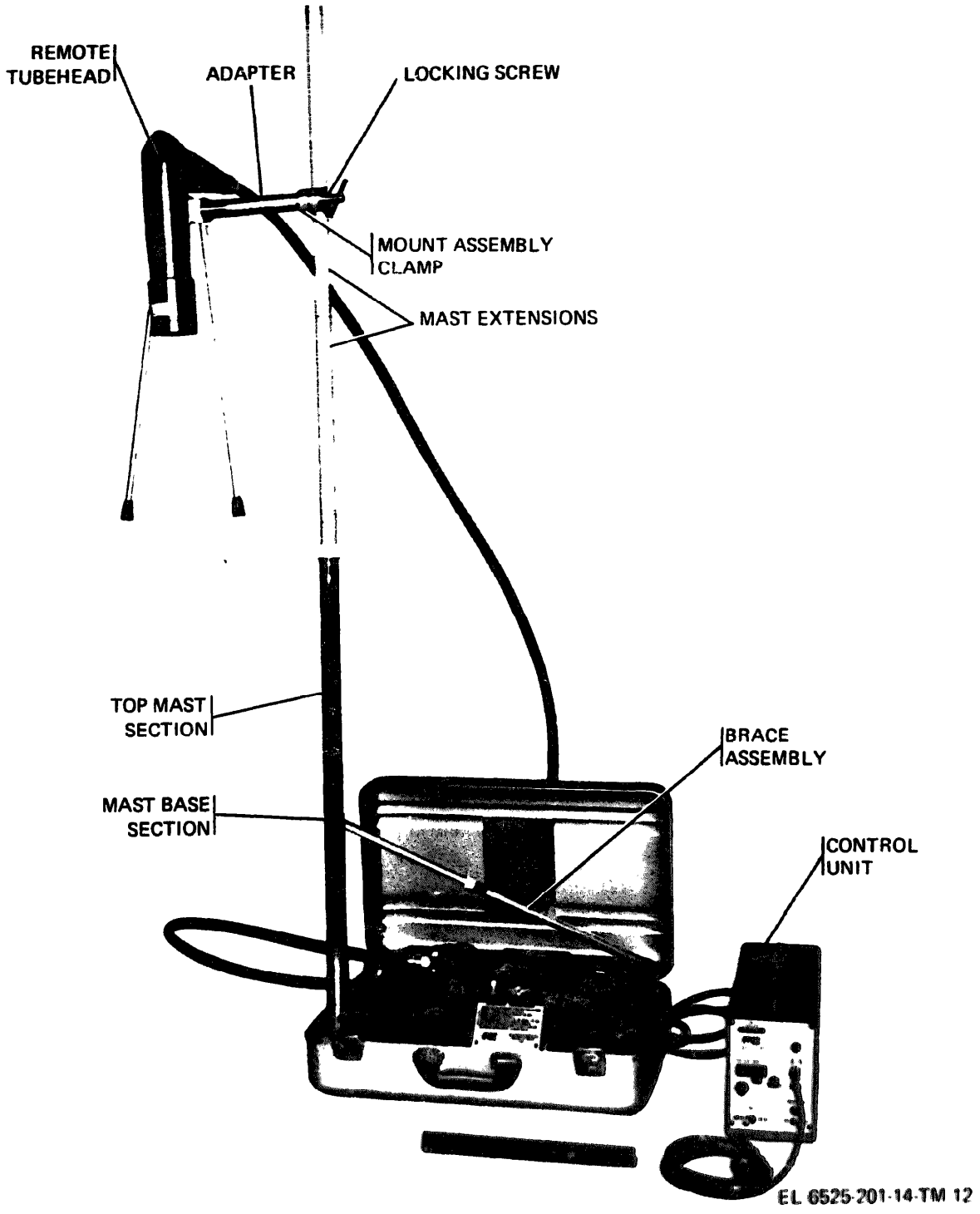

Figure 2-12. Mast and Remote Tubehead, Three-to-Ten Foot Height, Horizontal Position.

2-7. Installation of Remote Tubehead for Horizontal Operation

a. Loosen locknut on top mast section (figure 2-13), extend upper mast extension, and tighten locknut.

b. Slide mount assembly clamp over upper mast extension, secure the remote tubehead to the clamp with the locking screw, then handtighten locking screw. Be sure to align pin (figure 2-14) on tubehead with hole in clamp, then insert pin in hole. This will prevent remote tubehead from moving during operation.

c. Loosen locknut on top mast section, adjust top mast section to desired height, then hand tighten locknut.

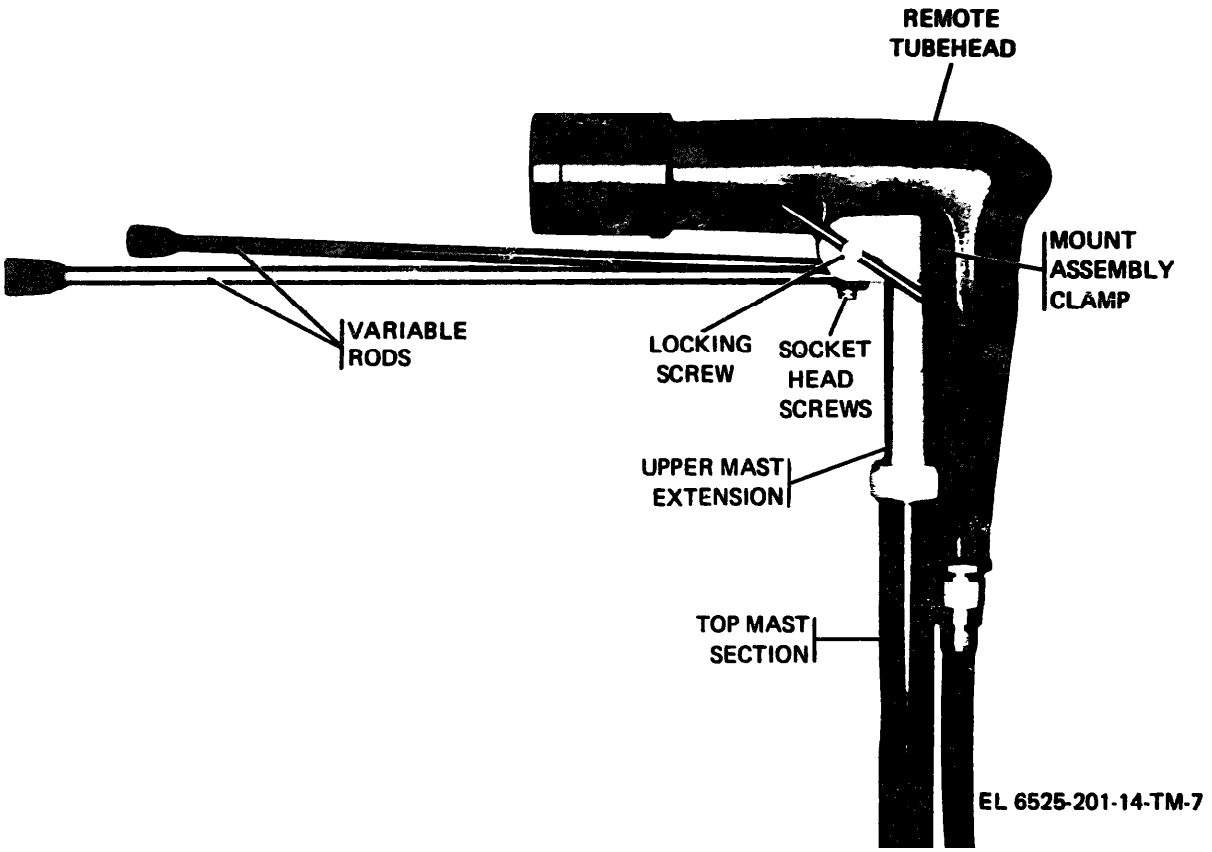

Figure 2-13. Remote Tubehead Installed on Mast.

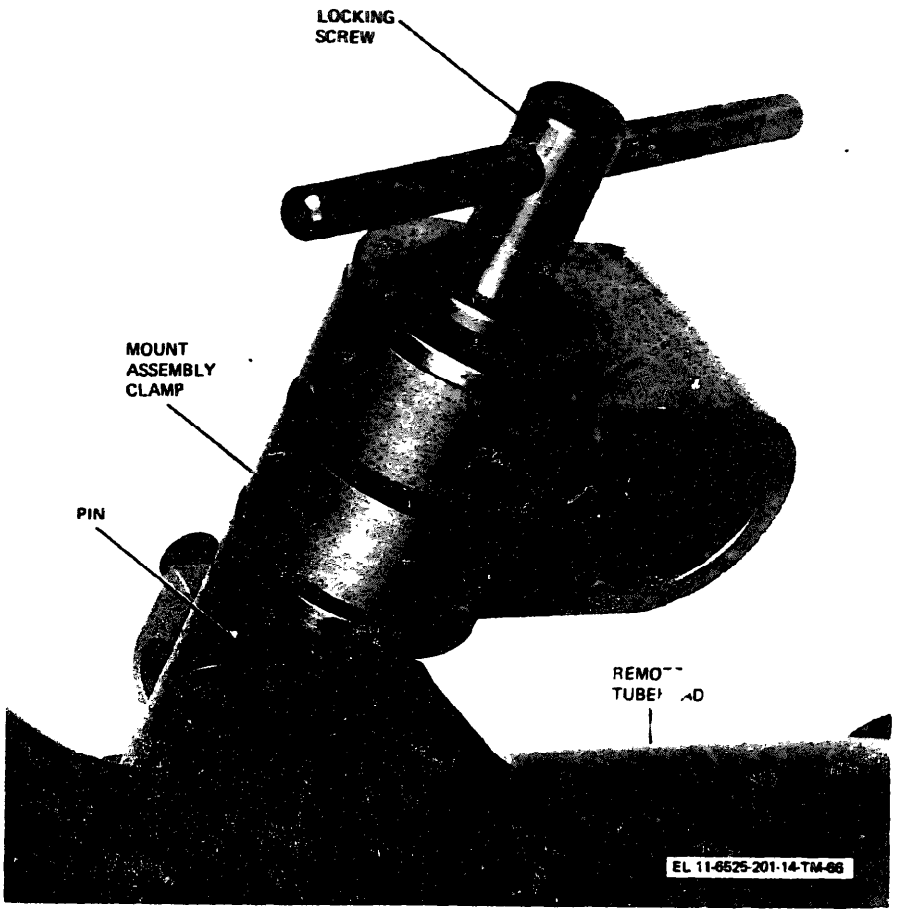

Figure 2-14. Tubehead Locking Pin.

2-8. Installation of Tubehead for Vertical Operation

a. Locate the mast extension that contains the 6-inch screw-type adapter, then remove adapter from the extension arm.

b. Remove locking screw and mount assembly clamp from remote tubehead. This will disconnect the mast sections from the tubehead.

c. Screw the 64-inch adapter arm into the remote tubehead assembly mount (figure 2-12). The flanged end of the adapter section should be on the

d. Reinstall mounting clamp assembly on the 6-inch adapter section, seating clamp assembly firmly against adapter flange, then secure with locking screw.

e. With remote tubehead installed, loosen mounting clamp and position tubehead so the pulser unit will not be in exposure field (figure 2-12), then tighten mounting clamp assembly.

f. The mounting assembly has a pin on the rear mounting plate (figure 2-14). which can be depressed to lock the X-ray tubehead on the adapter. This will prevent the weight of the tuhehead from moving the tubehead assembly out of position during operation.

g. If remote tnbehead is required to be extended for vertical operation. add the 12-inch adapter arm to remote tubehead assembly mount. then add *6-* inch adapter arm. This will increase the **operating** range of the vertical position to 18 inches. Exercise care so pulser case will not be pulled over, especially when remote tubehead is operating at heights over six feet.

2-9. Installation of Variable Rods on Remote Tubehead

a. Loosen socket head screws (figure 2-13) holding clamps on tubehead mounting bracket, using socket head screw key contained in tool kit.

b. Install variable rods in clamps (figure 2-13), adjust to desired length, then tighten socket head screws.

2-10. Installation of High Voltage Cable in Pulser Unit

Before the high voltage cable is installed in the pulser unit the resistive load must be removed.

Remove the resistive load and install high voltage cable as outlined below:

a. Remove resistive load (figure 2-15) from pulser unit high voltage chamber by unscrewing end cap. using end cap removal tool found in the maintenance kit (figure 1-2).

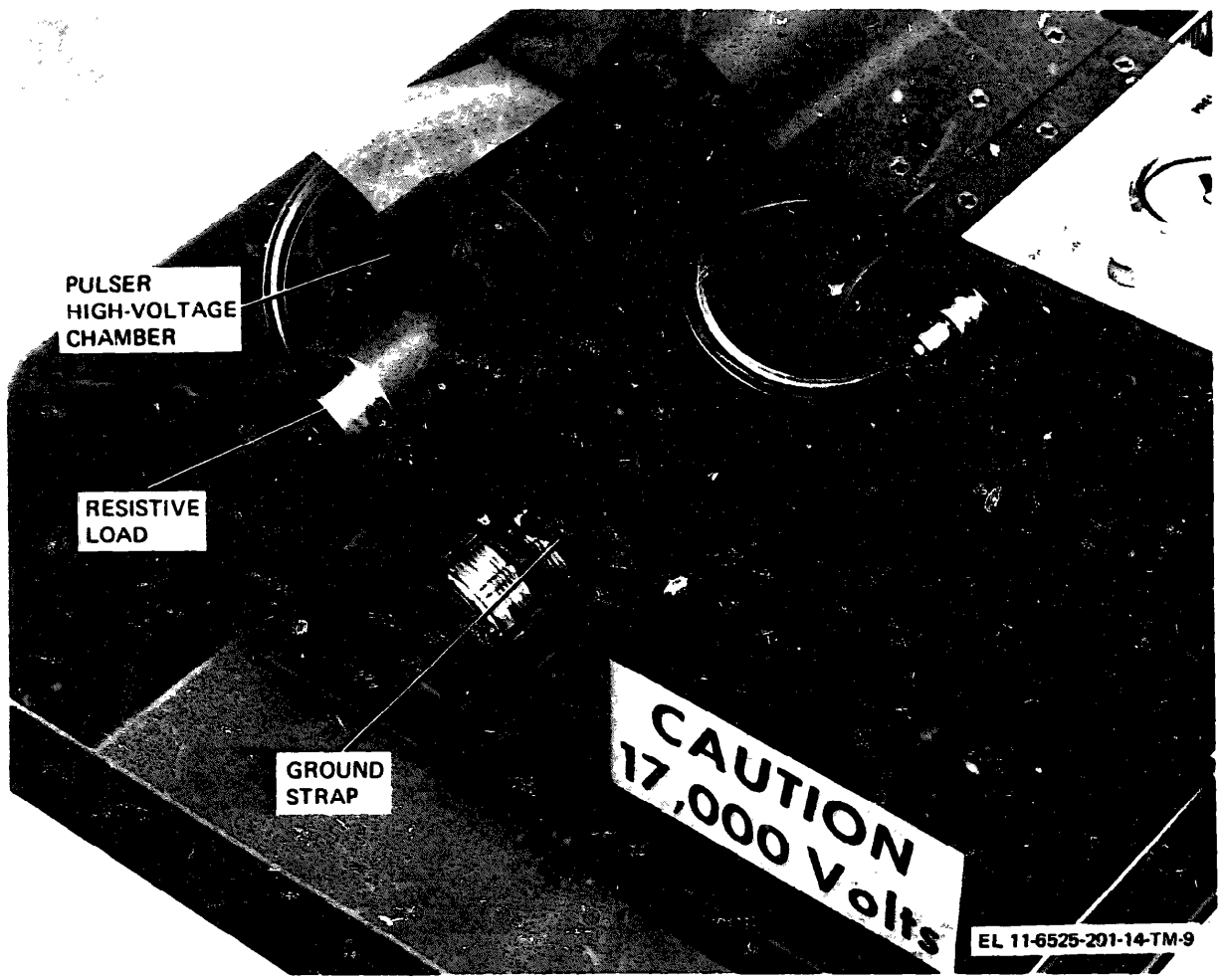

Figure 2-15. Removal of Resistive Load.

b. Place the O-ring (figure 2-16 over the channel of high voltage cable connector. Before inserting high voltage cable into pulser high voltage chamber. loosen the amphenol plug. then seat the cable, Tighten the ring before tightening the amphenol connector. Be sure the O-ring is properly seated. or there will be no pressure buildup.

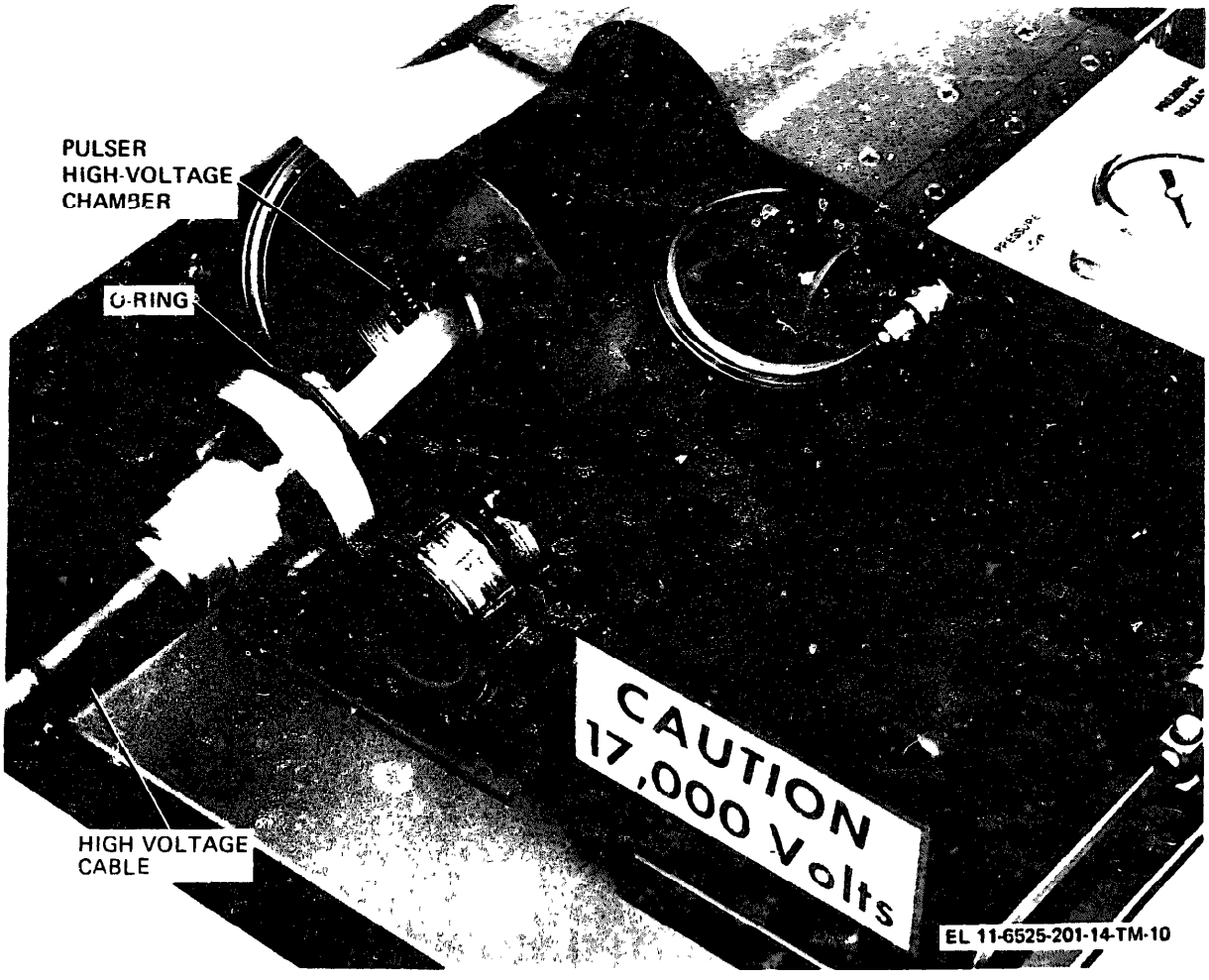

Figure 2-16. Installation of high-voltage Cable.

Section III. DISASSEMBLY AND PREPARATION FOR ST0RAGE OR SHIPMENT

2-11. Assembly of X-Ray Apparatus

a. Set **POWER ON** switch (figure 3-1) and **CIRCUIT BREAKERS** 1 and 2 (figure 3-2) to off (down) position.

b. Remove ac power cord and exposure cable from control unit and pulser assembly. Disconnect ground cable.

c. Release pressure in the system by depressing **PRESSURE RELEASE** on the air system control panel (figure 3-3).

d. Remove high voltage cable from the pulser chamber (figure 2-16) and install resistive load. Replace end cap and secure with cap removal and tool (figure 2-15).

e. Disassemble mast assembly as follows:

(1) Loosen screws on mounting assembly and remove two variable rods from the tubehead.

(2) Loosen locking screw and remove tubehead from mast extension assemblies.

(3) Disassemble mast extension assemblies, loosen extension adapters and store in mast section (figure 2-7). Install red plastic plugs in each section before storing.

(4) Remove mast cross brace, recess extension arm, and secure with nylon locknut.

(5) Remove base mast section by loosening lock screws, slide cross brace assembly inside tube, and secure with red plastic plugs on each end.

2-12. Repacking the Pulser Case

a. Place ac power cord and control unit cable and other cables on the right hand side of pulser case.

b. Coil grounding cable and place it on left hand side of pulser case.

c. Place th maintenance tool kit, which includes spare fuse and spare parts envelope on left hand side of pulser case. Lock pulser case, remove the case from the dolly and place the entire unit in outer carrying case.

2-13. Replacing the Control Carrying Case

a. Replace top mast section in bottom rear of control carrying case (figure 2-6).

b. Place variable rods in bottom front of case.

c. Insert tubehead assembly in right hand side of case. Tilt tubehead until it slides in the right hand corner and then lays flat. Coil high voltage cable in an elongated pattern around inner perimeter of case (figure 2-5).

d. Place control unit in carrying case (figure 2-3). The handle on control unit must face the front of the carrying case; otherwise the dolly will not fit over the retaining studs.

e. P remaining sections of mast on back plate o (figure 2-1) and secure with Velco straps.

f. Place dolly in control carrying case and slide dolly until it is secure in retaining studs.

g. Lock and secure dolly with locking screw (figure 2-1), close case and pack entire unit in outer carrying case.

CHAPTER 3

OPERATING INSTRUCTIONS

Section I. PLANNING THE MISSION

3-1. General Considerations.

The X-ray apparatus is a self-contained unit which can be used in the field. or ideally. in areas specifically designed and shielded for radiography.

3-2. Special Considerations.

When the requirements of the X-ray mission require horizontal exposures, every effort should be made to provide lead shielding behind the film cassette. If lead shielding material of sufficient thickness is not available in the field, locate the X-ray tube target the maximum possible distance from any occupied area. following the instructions and safety procedures outlined in Sections IV through VIII of this chapter.

WARNING

RADIATION CAN BE EXTREMELY DANGEROUS TO THE HUMAN BODY. STUDY THE INSTRUCTIONS CONTAINED IN SECTIONS IV THROUGH VIII BEFORE OPERATING THIS EQUIPMENT.

Section II. OPERATOR'S CONTROLS AND INDICATORS

3-3. General

Improper operation or indiscriminate setting of controls can cause damage to the electrical equipment. It is important to know the function of every control.

3-4. Description of Controls and Indicators

Controls and indicators are listed and described in table 3-1 and are illustrated in figures 3-1, 3-2, and 3-3. System operating procedures are described in paragraphs 3-5 and 3-6.

Table 3-1. ***Table*** of Controls and Indicators

Control or indicator	Function
AC INPUT receptacle	Recessed three-prong connector to which line power is applied .
POWER ON/OFF switch	Toggle switch controlling ac primary power.
EXPOSURE SELECTOR	The exposure selector is a preselection impulse counter. counting back to **zero** from its preset value. One through 99 pulses may be **1** for a pulse train.
Exposure selector reset knob	Locks the ·ter· ·amber of pulses and enables duplicating the selected
EXPOSURE SWITCH	Phone jack for attaching the push-button exposure switch cable.
100 KV-I50 KV voltage level switch	Two-position toggle switch controlling voltage applied to the X-ray tube. Selects 100 kv or 150 kv.
TOTALIZER	Electrically operated counter records cumulative total number of pulses applied to the X-ray tube or resistance load.
AIR PUMP	Hand-operated air pump that supplies pressurized air to the pulser and X-ray tube chamber.
PULSER PRESSURE gauge	Indicates air pressure in pounds per square inch in the pulser and X-ray tube chamber (8 psi for 100-kv operation and 22 psi for 150 operation).
PRESSURE RELEASE valve	***A*** push valve that releaser pressurized air in the system.
PRESSURE LOW lamp	White incandescent lamp which, when lighted. indicates that air pressure is below approximately 6 psi. Under this **rondition. the pressure-activated safety switch will not allow the system to operate.**
POWER ON lamp	**Amber neon lamp which. when lighted. indicates that ac power is available to the system.**

Control or indicator	Function
SET SELECTOR lamp	Green incandescent lamp which, when lighted, indicates that the exposure selector is at zero. When a pulse train selection (1-99 pulses) has been set on the exposure selector and the reset knob released, the lamp turns off.
EXPOSING lamp	Red neon lamp that indicates (by flashing) that the primary circuit of the high-voltage power supply is active and that the trigger relay is operating.
RESET overload	Lighted pushbutton switch (S103) that indicates (red when lighted) that the overload tripout circuit has actuated. The tripout circuit is reset by pushing the RESET button. The light will then go out unless the overload condition continues.
Line voltage meter	Indicates primary power input voltage.
LINE VOLTAGE ADJUST	Adjust selector switch to the input ac power source being used.
CIRCUIT BREAKERS 1 and 2	Permit ac line power to be applied to the components of the X-ray apparatus and protect equipment from an overload.

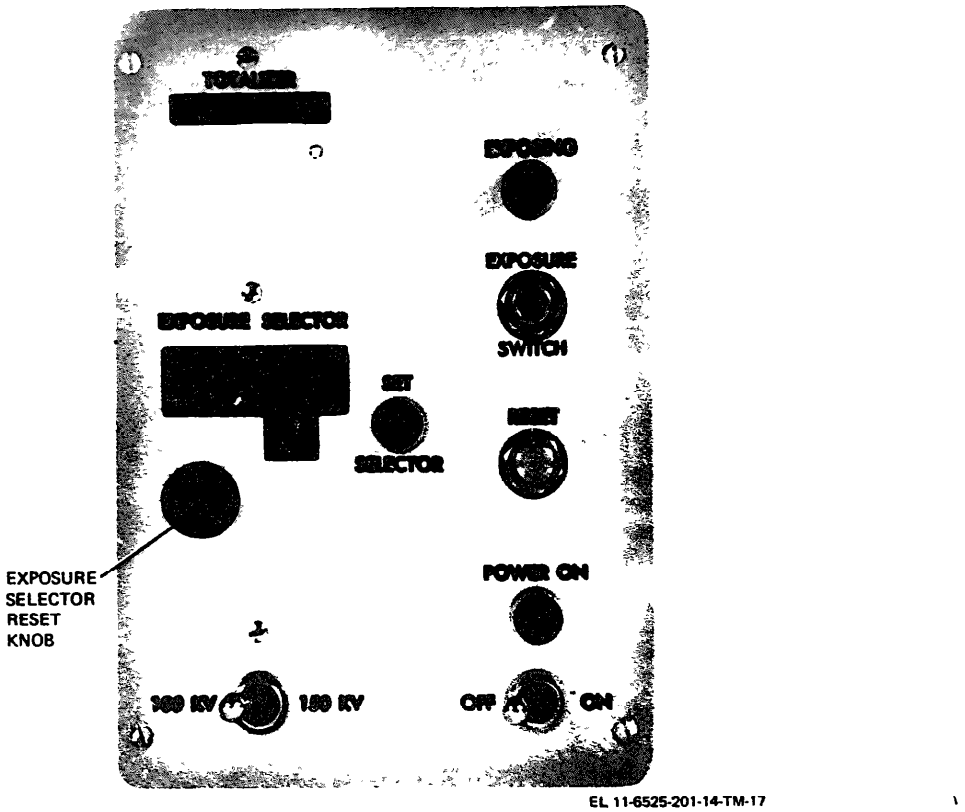

Figure 3-1. Control Unit Controls and Indicators (Control Section).

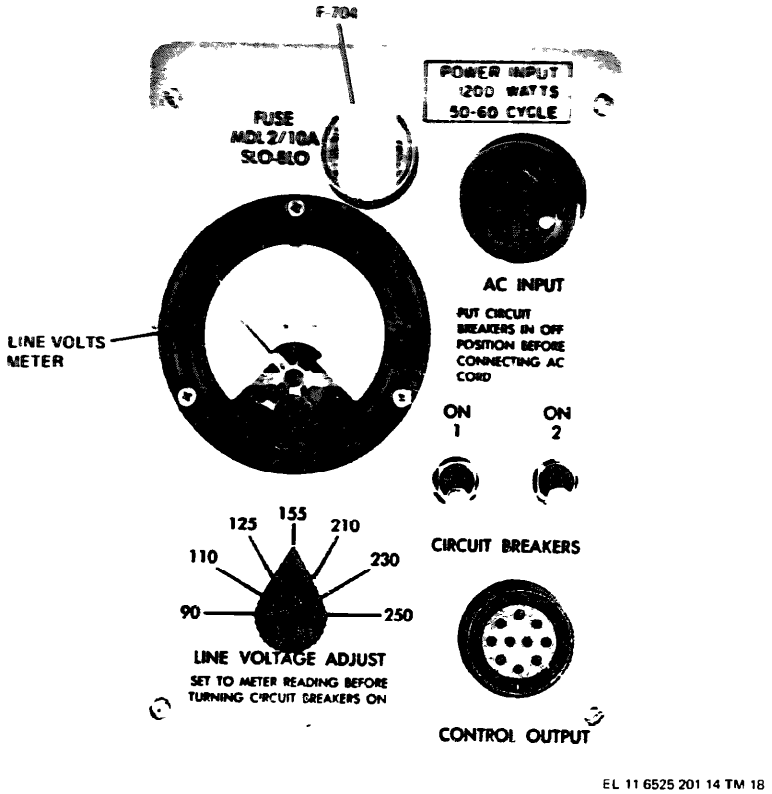

Figure 3-2. Control Unit Controls and Indicators (Transformer Section)

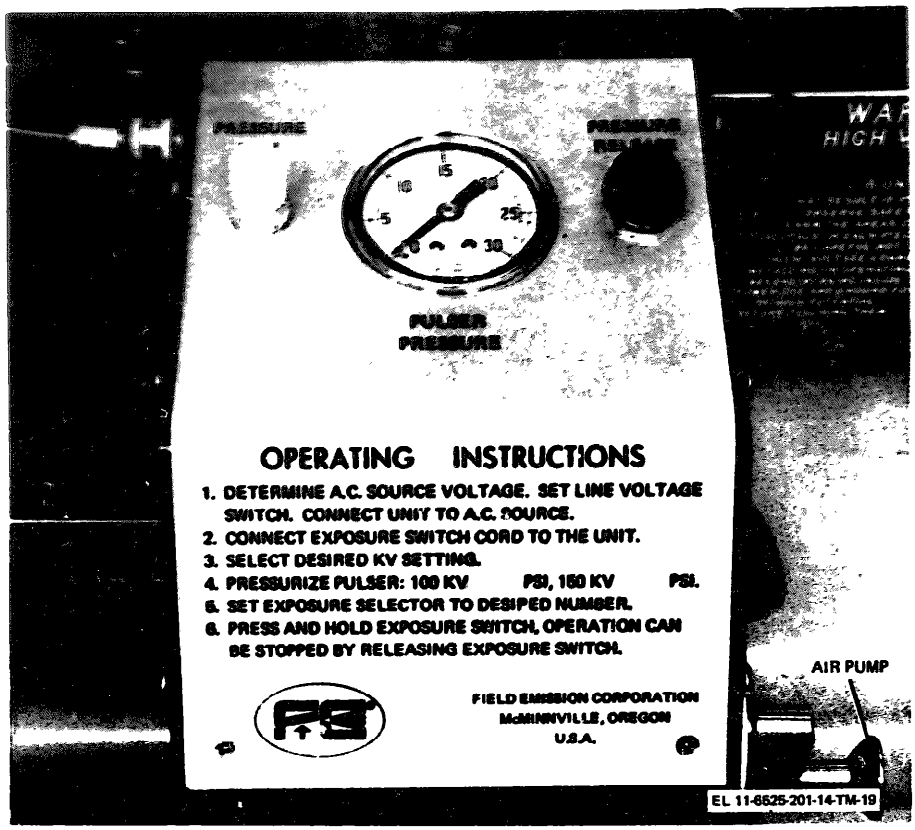

Figure 3-3. Air Pressure Assembly Controls and Indicators.

Section III. OPERATING PROCEDURES

3-5. Preliminary Procedures

A basic operating procedure is printed on the control panel, and is intended to serve as a reference guide for experienced operating personnel. ***DO*** NOT ATTEMPT to operate this equipment unless you are familiar with the safety procedures described in section IV and the protection against X-ray radiation in section V, in addition to the control and recording procedures for occupational exposure to Ionizing Radiation as described in AR40-14. Control unit controls and indicators are illustrated in figures 3-1 and 3-3. and those for the pressure system are shown in figure 3-3.

WARNING

Before operating the equipment. clear the entire room and area exposed to the primary X-ray beam tin front of and behind film cassette) of all personnel except opera tars.

WARNING

Operating personnel must stand as far as possible from the primary beam and X-ray tube during all exposures. DO NOT HOLD THE X-RAY TUBEHEAD IN YOUR HAND DURING EQUIPMENT OPERATION. Never stand in front of the X-ray tubehead. even if the equipment appears to be turned off.

NOTE

Due to the high voltages required in the operation of this equipment (see warning decals on covers and equipment the, the equipment must be grounded to a water pipe before operation, using the Snaptite grounding cable (figure 3-4), using a water pipe. or the best grounding facility available.

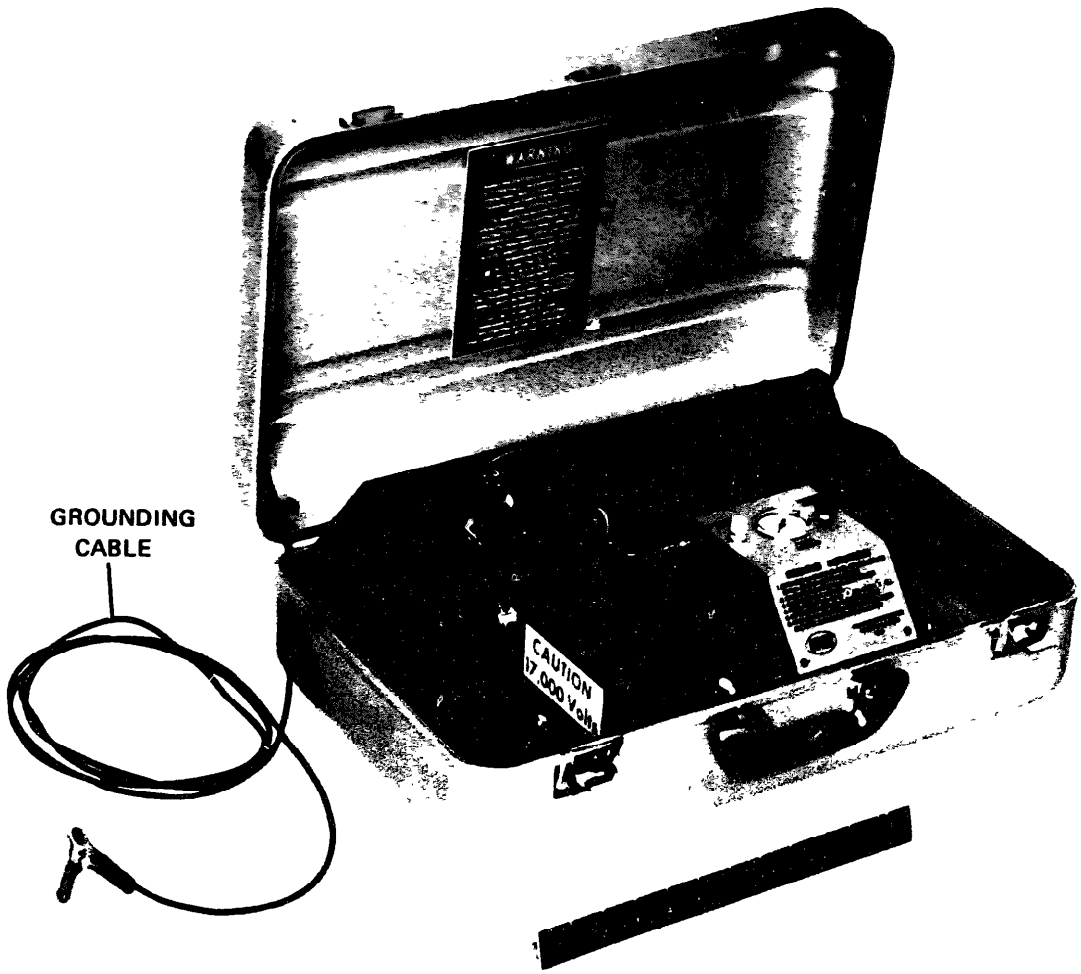

Figure 3-4. Grounding Cable Installed on Pulser.

3-6. Detailed Operating Procedures

a. Place CIRCUIT BREAKERS 1 and 2 in the off (down) position (figure 3-2).

NOTE

Check zero indication of line voltage meter before connecting ac input cord to AC INPUT jack. If necessary, adjust meter zero indication using adjustment screw on faee of meter.

b. Connect the ac input cord to the available power outlet. Place the LINE VOLTAGE ADJUST selector switch at the setting closest to the line voltage meter reading.

c. Insert the exposure switch cable into the EXPOSURE SWITCH jack.

d. Set the 100KV-150KV voltage level switch to the desired setting.

NOTE

A different pressure is required for each voltage level : 8 pounds per square inch (psi for 100KV and 22 psi for 150KV (these pressures are valid at sea level). The pressure level is also dependent upon altitude and temperature. Refer to the conversion (chart presented in figure 3-5 to obtain the correction factor for a specific altitude. and that presented in figure 3-6 for temperature correction factor for 100KV and 150KV outputs respectively.

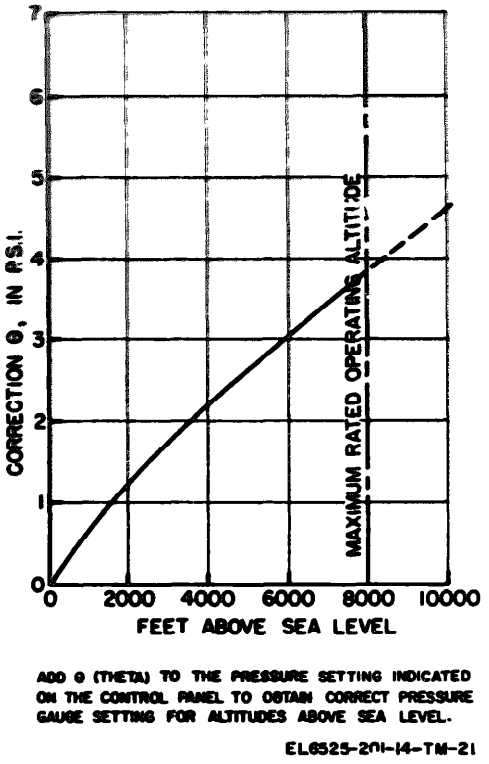

Figure 3-5. Altitude Correction Curve.

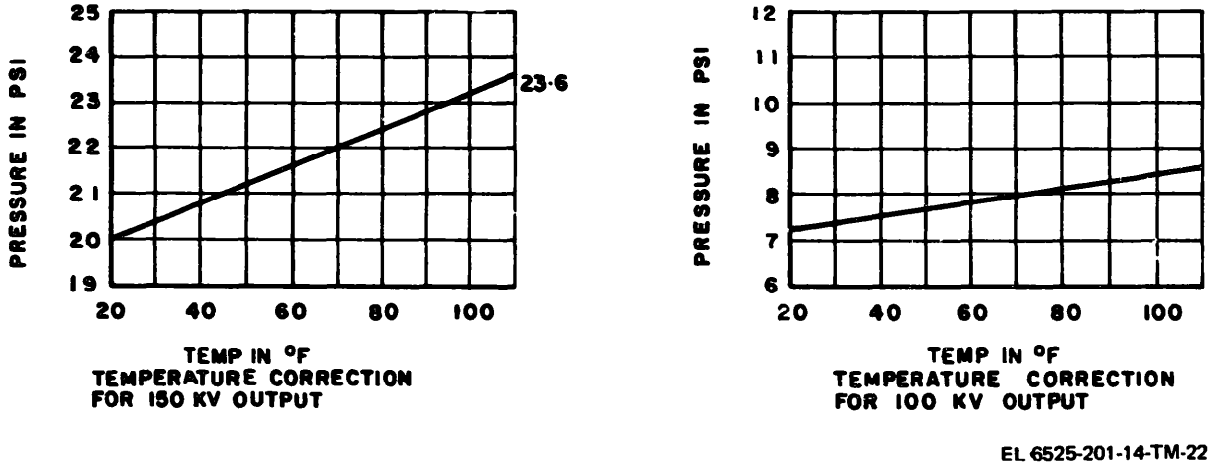

Figure 3-6. Temperature Correction Curves.

e. Pressurize the system with thee the hand-operated air pump to the operating pressure required for the selected voltage level. Pump slowly to allow maximum time for moisture removal.

f. Perform following procedure to select desired number of pulsed on EXPOSURE SELECTOR

(1) Depress the EXPOSURE SELECTOR reset knob and lock with one-quarter turn to left (white line in horizontal position) (figure 3-7).

NOTE

When selecting the number of pulses, keep in mind that the right-hand wheel is used to select pulses 1 through 9 and the left-hand wheel is used for decade selection (10, 20, 30, etc). The combination of the two wheels permits selection of 1 through 99 pulses.

(2) Open cover and set selected number of

pulses by adjusting EXPOSURE SELECTOR wheels. Close cover.

(3) Depress the EXPOSURE SELECTOR reset knob and unlock with one-quarter turn to left (white line in vertical position) (figure 3-8).

NOTE

Insure that EXPOSURE SELECTOR reset knob is depressed completely before attempting to turn to the left. This insures that the EXPOSURE SELECTOR wheels are correctly positioned and locked. If the selector wheels are not properly positioned, they will not engage and lock the electromechanical impulse counter. thus producing a free-running pulse train; that is. one that continues until the EXPOSURE SWITCH is released.

g. Depress, then release, the exposure selector reset knob (do not turn).

h. Set CIRCUIT BREAKERS 1 and 2 and POWER ON/OFF switch to ON.

i. Press and hold the EXPOSURE SWITCH until pulse train is completed.

NOTE

An overload / trip-out circuit is provided to protect the high voltage power supply in the event of a shorted energy storage module in the pulser. It will also interrupt the system operation after consecutive pulser prefires caused by insufficient pressurization of the pulser. The RESET lamp will light red when the trip-out circuit has interrupted system operation.

NOTE

After each exposure, check that EXPOSURE SELECTOR indicates zero and RESET lamp is out. If these conditions are not present, press the RESET switch and continue the exposure until EXPOSURE SELECTOR indicates zero. This will endure proper exposure of film.

j. To duplicate a specific pulse train, depress and release the exposure selector reset knob (do not turn).

Figure 3-7. Exposure Selector Switch in Horizontal Position.

Figure 3-8. Exposure Selector Switch *in* Vertical Position.

Section IV. GENERAL SAFETY INFORMATION

3-7. General Radiation Information

a. **Radiation can be extremely dangerous to the human body. One of the most important considerations in the X-ray work area is the provision and exercise of adequate safeguards for personnel. Protection from Radiological and Electrical hazards is covered in detail in Chapter 4 of TM 8-280; control of occupational exposure to ionization radiation is covered in AR 40-14; and use, application, and processing of film badges is covered in SB 11-206. General principles on the necessary protection precautions are covered in the following chapter.**

b. **Any of the body tissues may be injured by overexposure to X-rays the blood, skin, and some internal organs being particularly sensitive. Unless exposure to X-rays is kept at a minimum, the cumulative effect may cause injury to the body. It is**

essential that workers in the radiographic department be adequately protected against radiation at all times. Furthermore, protective measures should be so arranged that persons in nearby areas are also safe. Precautions should be particularly observed when radiography must be done in the field rather than in a specially protected radiographic room.

c. It should be emphasized that radiography is only as safe as the people working with it want it to be. The basic assumption of anyone working in the field should be that any unnecessary exposure to radiation, no matter how small, is too much.

3-8. Radiation Units of Measurements

a. At the present time there are three generally accepted units that relate to radiation exposure and absorbed dose. They are the roentgen, the rad, and the rem. and are defined as follows:

(1) The roentgen (r) is a measure of radiation exposure based upon the amount of ionization produced in air by a radiation source. When the specific ionization is such that one electrostatic unit of electrical charge is produced per cc of air under standard conditions, then the exposure dose is 1 roentgen at the point at which the measurement is made. The roentgen output can be measured with relative ease by a properly constructed ionization chamber.

(2) The rad is the unit of absorbed dose and, by definition. is the absorption of 100 ergs of energy per gram of irradiator material. The rad dose can be determined from ionization chamber measurements within the test object, by measurement of temperature change of the test object. or by chemical dosimeters.

(3) The rem (rad or roentgen equivalent man) is the absorbed dose in rads multiplied by the relative biological effectiveness (RBE) of the radiation used on the particular biological system irradiated. RBE may be defined as the ratio of closes from two different radiations that produce the same biological change. At the present time. there is no dosimeter than can directly measure the rem.

b. The currently accepted unit of radiation dose to biological systems is the rem. Its usefulness lies in the fact that the biological and physical properties of the test object are taken into account. as well as the ionizing characteristics of the radiation employed. Equal rem doses to the same biological test object delivered by. for example. neutrons and alpha particles. should produce the same biological change. Any of the following may be considered as equivalent to a dose of one rem:

(2) A dose of 1 rad due to X-radiation.

(3) A dose of 0.1 rad due to neutrons or high energy protons.

(4) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye.

3-9. Maximum Permissible Doses of X-Rays

a. The currently accepted maximum permissible doses have been established upon consideration of the estimated exposure of early radiation workers and also upon the radiation that man has always received from such natural sources as radium, cosmic rays, and Carbon 14. Radiation workers who, it is estimated, received 0.1 r per week for periods of many years, have not exhibited any harmful effects which can be directly attributed to radiation.

b. In accordance with AR 40-14 and on recommendation of the U. S. Army Environmental Hygienic Agency, Edgewood, Maryland, the following criteria are established for the control of occupational exposure to ionization radiation. Every effort should be made to maintain radiation dosage below the following radiation protection standards.

(1) The accumulated dose of radiation to the whole body, head and trunk, active blood-forming organs, gonads, or lens of the eye shall not exceed:

(a) 3 rem in any calendar quarter.

(b)5 (N-18) rem total lifetime dose, where N equals the present age in years.

(2) The accumulated dose of radiation to the skin of the whole body or the thyroid shall not exceed :

(a) 10 rem in any calendar quarter.

(b) 30 rem in any calendar year.

(3) The accumulated dose of radiation to the hands: forearms. or feet and ankle shall not exceed :

(a) 25 rem in any calendar quarter.

(b) 75 rem in any calendar year.

c. The maximum permissible accumulated dose (MPD) for the whole body is based on the formula MPD=(AGE-18) X 5 rads per year. A standard of 0.1 rad per week should be used in planning radiation protection facilities. An accumulation of 3 rads over a 13-week period is permissible providing no more than 5 rads are accumulated in one year.

d. Under special circumstances. less restrictive protection standards may be used when approved by The Surgeon General of the military department concerned. Complete justification will be required. including the means for implementing the standard.

Section V. PROTECTION AGAINST X-RAYS

3-10. General

Exposure to X-radiation may come either directly from the X-ray tube target or from some object in the direct path of the X-ray beam. Therefore, while an exposure is being made, the operator and all other personnel must be protected by adequate shielding from the X-ray tube itself, the part being radiographed, and any other item exposed to the X-ray beam. This section contains general information for the protection of personnel working with X-ray equipment.

3-11. Protection Methods

a. Protection can be provided in a number of ways, depending upon the X-ray installation and its use. Whenever possible, protective measures should be built in as permanent features of the installation. Preferably, the X-ray generator should be enclosed in a room or cabinet with the necessary protection incorporated in the walls. The common method is to locate the X-ray tube within a room completely lined with lead of sufficient thickness to provide adequate protection. All the X-ray equipment controls are then located outside the room.

b. When portable or field X-ray units are used, such as the AN / TAQ-2, shielding is important. The lead shield impregnated (0.5 mm lead equivalent) rubber apron (figure 3-9) can be used as a barrier against secondary radiation, but will not fully protect the operator against primary radiation. In some cases where large numbers of relatively small parts are inspected, the protection may consist of a lead-lined hood surrounding the X-ray tube, the specimens, and the cassette until the exposure is completed. Then the hood is opened to allow removal of the radiographed parts and the placement of a new batch. The electrical controls are interlocked so the X-ray cannot be turned on until the hood is fully closed.

Figure 3-9. Lead Shield Impregnated Rubber Apron.

c. When placing equipment and designing protective enclosures. certain principles must be kept in mind. Careful application of these principles adds to the safety of personnel. Safety will be increased if the amount of radiation absorbed in the outside wall of the enclosure is kept to a minimum. TO accomplish this, keep the distance from the X-ray tube target to any occupied space as great as possible. Further, if the nature of the work permits, never point the direct beam toward these occupied areas, and keep the angulation of the tube restricted to a minimum.

d. Ideally, the lead housing around the Y-ray tube should provide protection against all primary radiation except the useful beam, although this is not always feasible in practice. the useful beam itself should be limited in cross-section by the use of cones or diaphragms.

e. If there are parts of the X-ray room that can never be exposed to direct radiation because of the design of the equipment, certain economies in the installation of protective material are possible. Where only scattered radiation can reach a protective wall, less protection is necessary since the itensity of the scattered radiation is much lower than that of the primary. To take advantage of this, exercise care in arranging equipment to prevent the full intensity of the X-ray beam being directed against a wall that provides protection against only scattered radiation.

f. The protective material (usually lead) in the walls of the enclosure, whether it be room or cabinet, should be of sufficient thickness to reduce the exposure in all occupied areas to as low a value as is possible.

g. In some cases, personnel may be exposed to radiation from more than one X-ray equipment. In such cases, the amount of protection must be increased to a point where the total exposure in any occupied area is within the prescribed limits.

h. If the object is too large or heavy to be brought to the X-ray equipment, the radiography must be done in field. Under such conditions special precautions are necessary. These include a completely leadlined booth large enough to accomodate the X-ray equipment controls, the operator, and other X-ray workers. The booth may be completely enclosed, or open on one side. In any event, the exposure within it should be very carefully measured. Lead cones on the X-ray equipment should be used to confine the X-ray beam to a certain direction and to the minimum angle that can be used. Portable screens should be provided to protect nearby workers. Guard rails or ropes and warnings should be used to keep personnel at a safe distance.

i. In field radiography, protection usually is obtained by distance. Care should be taken to see that all personnel are far enough away from the radiation source to ensure safety.

Section VI. MATERIALS AND CONSTRUCTION FOR PROTECTION AGAINST Y-RAYS

3-12. General

Lead is the most common material used to provide protection against X-rays. It combines high protective efficiency with low cost and easy availability. In most cases, recommendations on protective measures are given in terms of lead thickness.

3-13. Shielding Construction

a. When using lead for protection, care must be taken to avoid any leaks in the shielding. This means that adjacent lead sheets should be overlapped, not merely butted, even if the sheets are to be burned together throughout the whole length of the joint. The heads of any nails or screws which pass through the lead should be carefully covered with lead.

b. Extra precautions should be taken at those points where water pipes, electrical conduits, or ventilating ducts pass through the walls of the X-ray room. For small conduits and pipes, it usually is sufficient to provide a lead sheathing around the pipe for some distance on one side of the lead protective barrier in the wall. This sheath should be continuous and very carefully joined, by a burned joint, to the lead in the wall. Better protection is afforded by having a right-angle bend in the pipe either inside or outside the X-ray room. The pipe is then covered with a lead sheath to a point well beyond the right-angle bend. The sheath should be carefully joined to the lead in the wall. In the case of a large opening for ventilation, lead baffles arranged as in figure 3-10 will stop X-rays, while permitting the passage of air. When a large ventilating duct is brought into the X-ray room, two right-angled bends covered with lead will prevent the escape of X-rays

c. To test the protection, it may be necessary to put up X-ray films against the outside of the wall in questionable areas, and to direct the full intensity of the X-ray beam against each of these areas in turn.

d. If the X-ray room is on the lowest floor of a building, the floor of the room need not be completely protected. However, the lead protection in the walls should not stop at the floor level. An apron of lead, continuous with the protection within the wall, should be placed in the floor, extending inward from all four walls (figure 3-10). This apron will prevent X-rays from escaping from the room by penetrating the floor and then scattering upward outside the protective barrier. An alternative is to extend the lead protection in the walls downward for some distance below the floor level. The same considerations apply to the ceiling if the X-ray room is located on the top floor of a building. Of course, if there is occupied space above or below the X-ray room, the ceiling or floor of the X-ray room must have full radiation protection *over* its whole area.

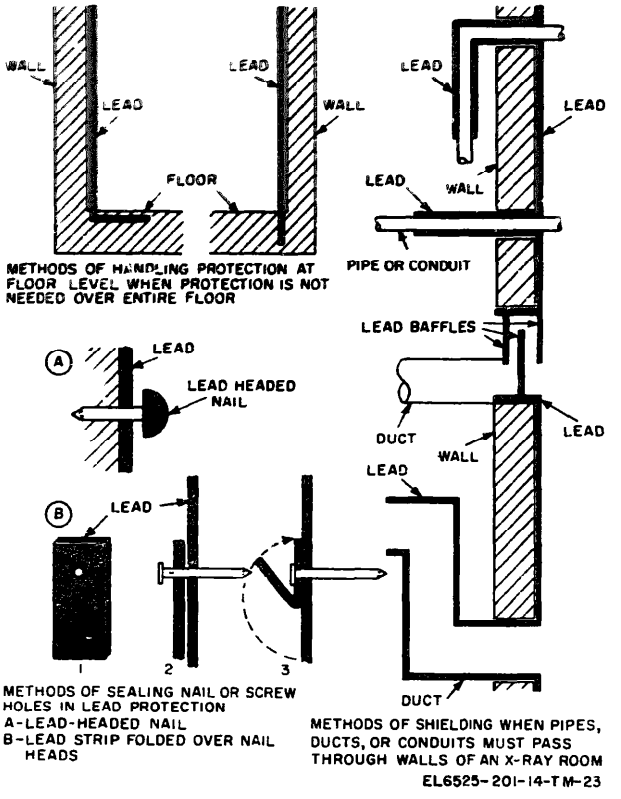

Figure 3-10. Construction for Protection from Radiation.

3-14. Other Shielding Materials

Although lead is the most efficient material for X-ray protection. other materials find some application. In particular. structural walls of concrete brick may afford considerable protection and reduce the thickness of the lead required, and therefore the cost. Concrete is most used as a protective material at voltages above 400 kv. The lead thicknesses required at these potentials are so great that fastening them to the walls becomes a serious problem. and concrete is used for ease of construction.

Section VII. RADIATION DETECTORS

3-15. General

There are four principal types of radiation detectors which have found wide application in the problem of personnel protection. These are the ionization chamber type (Cutie Pie), the pocket dosimeter, and the film badge.

3-16. Ionization Chamber-Type Survey Meter

a. This is a ratemeter device which instantly

records X- and gamma-radiation levels and, if equipped with a suitable window, may be used for beta ray monitoring. Because the most sensitive range of available instruments will indicate dose rates as low as 2 milliroentgens per hour, this device has found wide application to radiation surveys of X-ray installations and radium and radioisotope storage areas. Most available instruments have three sensitivity ranges: 0-25, 0-250, and 0-2500 milliroentgens per hour. If precise results are required, the instrument should be calibrated at the energy range of interest.

b. The advantage of a cutie pie is that radiation levels are measured within a few seconds. It also has relatively high sensitivity and flatness of response to X-ray energy change. The disadvantages are its relatively large size, delicate construction, and warmup drift during the first few minutes of operation. A readily available and easy-to-use reference standard is an extremely important accessory for this type of device.

3-17 Pocket Dosimeter

a. This is an integrating type of ionization chamber whose most sensitive range is usually from 0 to 200 milliroentgens (figure 3-11). Many of these instruments have built-in electrometer circuits so that the accumulated dose may be noted at any time. The only accessory equipment needed is a charging unit.

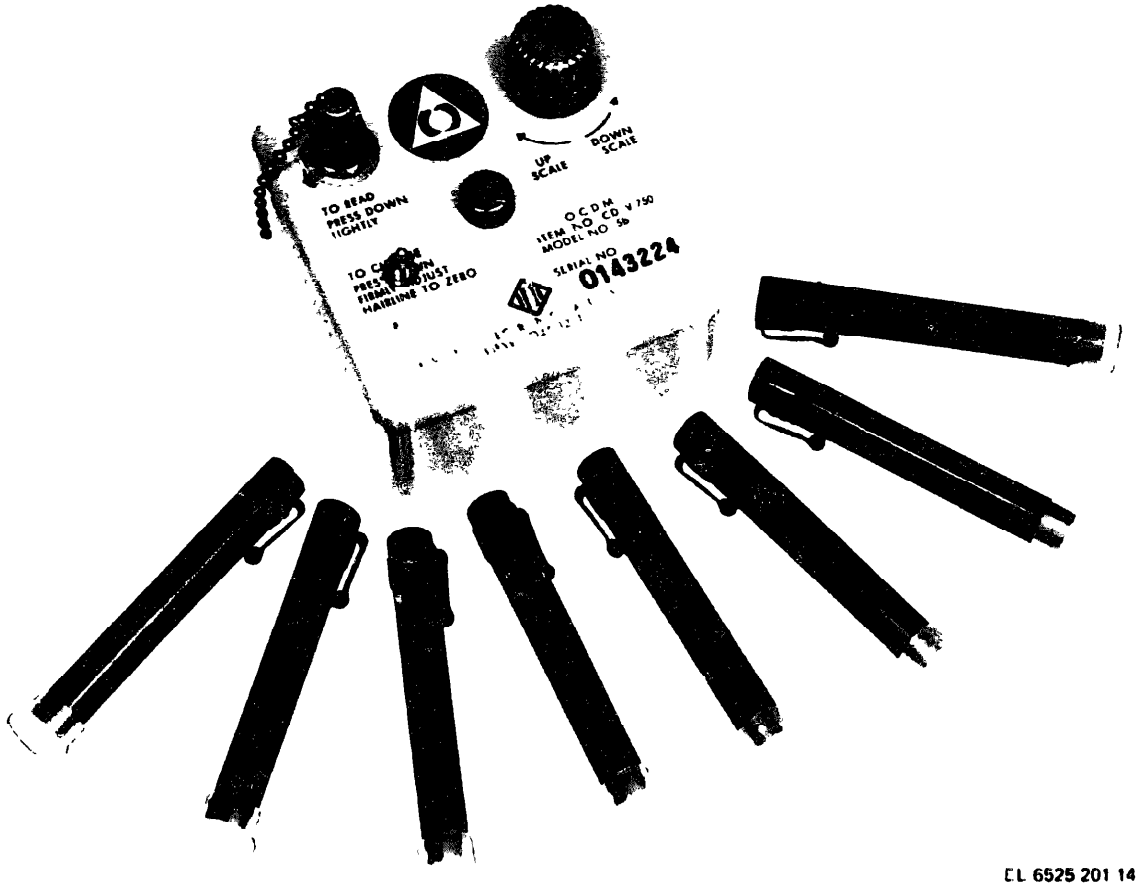

Figure 3-11. Pocket Dosimeter and Charger

b. The main advantages of the pocket dosimeter are its small size. high sensitivity, instantaneous indication of accumulated dose, and relatively flat response to radiations of different energies. The greatest problem in the routine use of this device is the electrical leakage which tends to discharge the

electrometer and give false high indications. For precise work, leakage tests should be performed on each chamber before and after application.

c. Pocket dosimeters have found wide application in monitoring personnel during procedures which last but a few hours and where knowledge of the radiation exposure for that particular procedure is needed.

3-18. Film Badge

a. The most widely used personnel monitor is the film badge (figure 3-12). It is used principally to record the dose accumulated at a low rate over a long period of time. It has the advantage of being extremely rugged, capable of fairly accurate interpretation over the range of X-ray qualities used in radiography, and a very long time period over which a single film may be used. Its disadvantages are that the wearer is never aware of the accumulated dose until the film is developed and, at the time he receives the film badge report, he may not be able to recall any incident responsible for an overexposure.

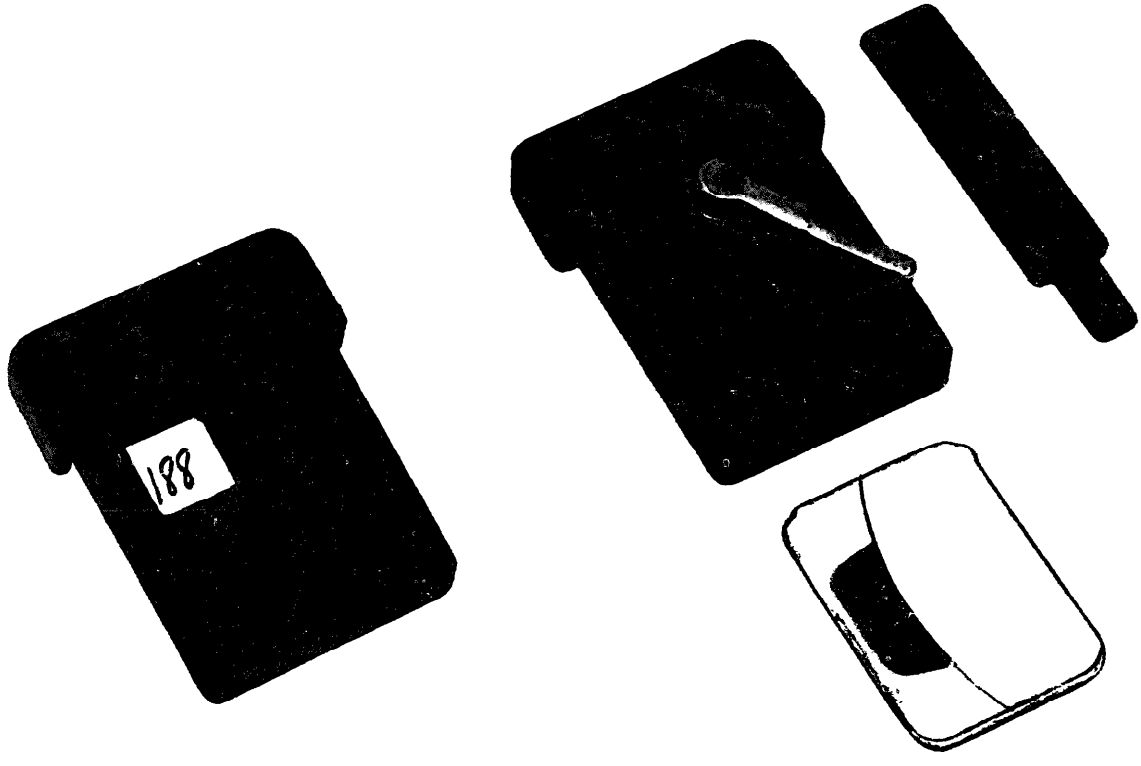

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Figure 3-12. Film Badge

NOTE

All Department of Defense personnel who operate or work near ionizing radiation equipment (e.g., industrial X- and gamma-ray equipment) are governed by the triservice regulation. AR *40-14* BUMEDINST 6150.18B AFR 161-8. Control and Recording Procedures-Occupational Exposure to Ionizing Radiation. This regulation lists the separate requirements of the individual military departments with respect to personnel dosimetry as follows:

(1) Department of the Army. The primary dosimetric device shall be the film packet, except for field radiograph, in combat or simulated combat conditions when the direct reading personnel dosimeter (0-200 mr range) has been designated by the Command Surgeon as the primary device to be worn by personnel occupationally exposed to X-ray. The film packet dosimetry service for Army installation and units is provided for by SB 11-206. Film Badge (Photodosimetry) Supply, and Service for Technical Radiation Exposure Control. This service will be employed solely for film packet dosimetry. except

in unusual circumstances as approved by the Commanding General, U. S. Army Materiel Command.

(2) *Department of the Navy.* Navy and Marine Corps activities shall utilize appropriate dosimetric devices in accordance with U. S. Navy Safety Precautions. OPNAV 34P1. and other applicable directives.

(3) Department of the Air Force. The primary dosimetric device shall be the film badge. The film badge service for Air Force installations is provided by the USAF Radiological Health Laboratory, Wright-Patterson AFB, in accordance with the provisions of AFR 161.11

b. Other regulations in effect include, for Department of the Navy personnel, NAVMED P-50055 Radiation Health Protection Manual; and for Department of Air Force personnel. AFR-160-132 Control of Radiological Health Hazards.

Section VIII. ELECTRICAL SAFEGUARDS

3-19. General Safeguards

Radiographic inspection with X-rays presents a two-fold safety problem to personnel. First. as previously mentioned. X-rays have a very destructive effect on the human body. Second, the extremely high voltages can deliver an electrical shock that may be fatal.

3-20. Electrical Hazards

a. Fortunately, most modern radograpbic equipment is truly shockproof when properly assembled, and most permanent installations offer little danger when personnel are trained in safe practice. Portable equipment, however, can pose serious safety problems if operating and inspection personnel do not employ certain necessary precautions.

b. In X-ray circuits, flexible cables must be used between the power source and the tube so that the X-ray head can be positioned to radiograph objects of all shapes and sizes. Flexible cables are also used between the X-ray tube unit and the control panel. Because extremely high voltages are used, these cables are covered with a heavy layer of rubber or some other insulating material that provides ample protection against shock. However, old or damaged cables or worn insulation constitutes a grave danger of fatal shock. Cables should be moved only when the power is off, or special equipment should be used. such as rubber gloves, high-voltage sticks, and rubber mats.

c. Condensers are another source of danger to those working around X-ray equipment. Condensers are used to store a charge of electricity. to provide instantaneous high voltages, and to prevent arcing. Condenser circuits must be provided with automatic bleeding circuits that are in good working order. A condenser should always be discharged manually before it is serviced.

3-21. Electrical Safety Precautions

The following electrical safety precautions should always be observed wherever X-ray equipment is operated or serviced :

a. Electrical power should be off during the setup procedure.

b. Cables should not be handled when power is on. and insulation should be frequent& checked for wear.

c. Condensers must be discharged completely before a circuit is serviced or checked.

d. Proper safety equipment must be used when energized cables are moved.

e. Persons who operate or work near X-ray equipment should learn artificial respiration and practice it enough to maintain proficiency. Prompt action immediately after an accident may save a life.

CHAPTER 4

OPERATOR'S MAINTENANCE INSTRUCTIONS

Section I. SCOPE, MATERIALS AND EQUIPMENT

4-1. Scope of Operator's Maintenance

The following is a list of maintenance duties normally performed by the operator of the X-ray apparatus. All equipment that comprises an X-ray system is necessary for these procedures. The materials required are listed in paragraph 4-2.

a. Preventive maintenance (paragraph 4-7).
b. Cleaning (paragraph 4-8).
c. Operators' preventive maintenance checks and services (table 4-1).
d. Operational check (paragraph 4-9).

4-2. Materials and Equipment Required for Maintenance

Materials and equipment required by the operator to perform the required maintenance on the X-ray apparatus are listed below:

a. Cloth, lint-free textile.
b. Trichloroethane.
c. Nonmetallic, soft-bristle brush.
d. Radiacmeter (dosimeter) IM-9 / PD.
e. Charger, Radiac Detector PP-1578 / PD.

Section II. LUBRICATION

4-3. Operator's Periodic Lubrication

To insure that the pressure system is functional at all times. periodically remove desiccant assembly O-ring seals and high-voltage end cap O-ring seal. and apply thin coat of Dow Corning No. 5 compound to the seals. After servicing, reinstall O-ring seals.

4-4. Special Instructions

Do not lubricate air pump assembly as it will contaminate the air supply system.

Section III. PREVENTIVE MAINTENANCE

4-5. General

Preventive maintenance is systematic care. servicing. and inspection of equipment to prevent the occurrence of trouble. to reduce downtime. and to insure that the equipment is serviceable.

4-6. Systematic Care

The procedures given in paragraph 4-8 and table 4-I cover routine systematic care and cleaning essential to proper operation of the equipment.

4-7. Preventive Maintenance Checks and Services

The preventive maintenance checks and services chart (table 4-1) outlines tasks to be performed at specific intervals to keep the X-ray apparatus in combat-serviceable condition. If the operator discovers a defect he cannot remedy, a higher level of maintenance or repair is required. Records and reports of the checks and services prescribed in table 4-1 must be made in accordance with the requirements set forth in TM 38-750.

4-8. Cleaning

a. Remove dust and loose dirt from the exterior surface and front panel with a clean cloth dampened with water and mild soap.

Table 4-1. Operator's Preventive Maintenance Checks and Services

Sequence No.	Item to be inspected	Procedure	Reference
1	Exterior surface	Clean panels, cables, and meter glass.	Paragraph 4-8
2	Mounting	Tighten loose nuts or bolts. Replace missing hardware as required.	
3	Intercabling, connectors and ground strap	Check all interconnecting cables and connectors for cracks and breaks. Replace cables that have cracks or broken connectors.	
4	Knobs, dials, and switches	When performing operational checks, check that the mechanical action of each knob, dial, and switch is smooth and does not bind.	Paragraph 4-9
5	Fuses	Check fuseholders. Ensure that each contains a good fuse of the correct rating.	
6	Air pressure assembly	Check to see that desiccant crystals have not changed from blue to pink.	Paragraph 4-10 a
7	X-ray tube	Check X-ray tube for internal arcing and proper output.	Paragraphs 4-11 and 4-12
8	Tubing, O-rings, and gaskets	Check for cracks or breaks.	

WARNING

The fumes of trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable, but exposure of the fumes to an open flame converts the fumes to highly toxic, dangerous gases.

b. Remove grease, fungus, and ground-in dirt with a cloth dampened (not wet) with trichloroethane.

c. Remove dust and other dirt from plugs and sockets with a non-metallic, soft-bristle brush.

4-9. Operational Check

Prepare the X-ray apparatus for operation as directed in paragraphs 2-3 and 3-5. Perform the steps outlined in the procedure column of table 4-2. If an indication is normal as specified in the table, go on to the next procedure. If an abnormal indication results, refer to a higher level of maintenance unless otherwise directed in the corrective measures column.

NOTE

If operational check is to be performed in an area that is not specifically intended for radiography, substitute the resistive load for the X-ray tube before performing check. This will eliminate the radiation hazard to personnel in the area.

Table 4-2. *Operational Check*

Sequence No	Procedure	Normal indication	Corrective measures
1	Set the 100KV / 150KV level switch to 100KV. Plug in ac input power cable and set CIRCUIT BREAKERS 1 and 2 to ON.	1. Line voltmeter indicates input voltage.	1. Check ac input power cable.
2	Pressurize the system with the AIR PUMP to 8 psi.	2*a*. PRESSURE LOW lamp goes out.	2*a*. Set CIRCUIT BREAKERS to OFF and check seal of O-rings at desiccant case and high-voltage chamber.
		b. PULSER PRESSURE gauge indicates proper value.	*b*. Check hose connections for possible leakage.
3	Set EXPOSURE SELECTOR for 25 pulses.	3. Proper number appears in EXPOSURE SELECTOR window.	
4	Set POWER ON switch to ON.	4. POWER ON lamp lights.	
5	Press and hold EXPOSURE SWITCH.	5*a*. EXPOSING lamp will flash.	5. Check EXPOSURE SWITCH cable.
		b. TOTALIZER will record number of pulses.	
		c. SET SELECTOR lamp will light.	

Sequence No.	Procedure	Normal indication	Corrective measures
6	Press the exposure selector reset knob.	6. SET SELECTOR lamp goes out.	
7	Press the PRESSURE RELEASE button.	7. PRESSURE LOW lamp lights.	

Section IV. OPERATOR MAINTENANCE

4-10. Air Pressure Assembly Check

To minimize corrosion of pulser spark gaps and connectors, change the air in the system after prolonged operation and release the pressure at the end of each operating day. When pumping air into the system, operate the pump slowly to allow maximum time for moisture removal.

4-11. Desiccant Inspection and Service

The following procedures are related to desiccant **assembly inspec**tion and service.

a. Visually inspect the desiccant assembly (fig. 2-6) before each equipment use. If the crystals have changd from blue to pink, reconditioning is necessary.

b. To remove the desiccant assembly, unscrew the outer retaining cap from the pulser and pump air into the system. Air pressure will force the desiccant capsule out to a point where it can be removed by hand.

c. Recondition the desiccant crystals by heating them in an oven to a temperature of 130° F (not to exceed 150° F) for a period of 2 to 3 hours.

4-12. Measurement of X-ray Tube Output

Check the X-ray tube periodically to insure proper film exposure. The following procedure enables the operator to determine the power output of the X-ray tube and the operational readiness of the equipment.

NOTE

Do not use radiation detection devices *of* the portable survey meter type. These instruments are not designed for response to pulse radiation. Integration of these pulses gives erroneous indications on the calibrated scale of milliroentgens per hour (mr / hr).

a. Prepare the X-ray apparatus ***for*** operation as outlined in paragraphs 2-3 and 3-4.

b. Observe the following X-ray tube output using the dosimeter : 150 KV level, 55 mr at 24 inches and 25 pulses; 100 KV level, 65 mr at 12 inches and 25 pulses.

NOTE

After an extended period of inactivity (one month or longer), two pulse trains of ten pulses each should be run before an output measurement is attempted.

4-13. Removal and Inspection of X-ray Tube

Figure 4-1 illustrates the components to be removed in the inspection procedure. An example of a defective X-ray tube is illustrated in figure 4-2. When a tube is replaced, note the number of pulses indicated on the control panel TOTALIZER counter.

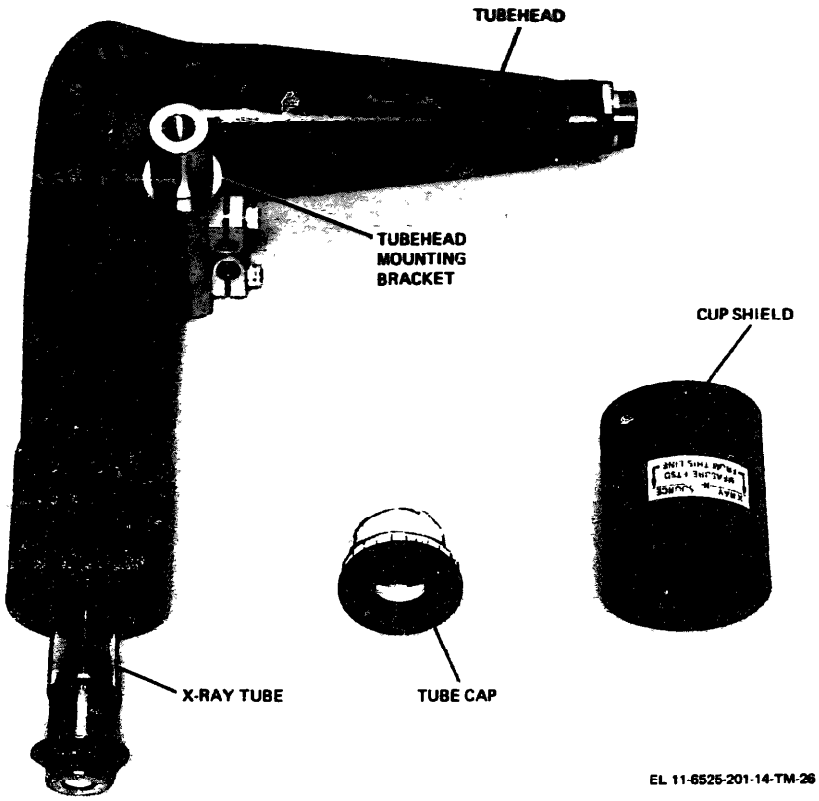


Figure 4-1. Remote Tubehead and Mount Assembly Components.

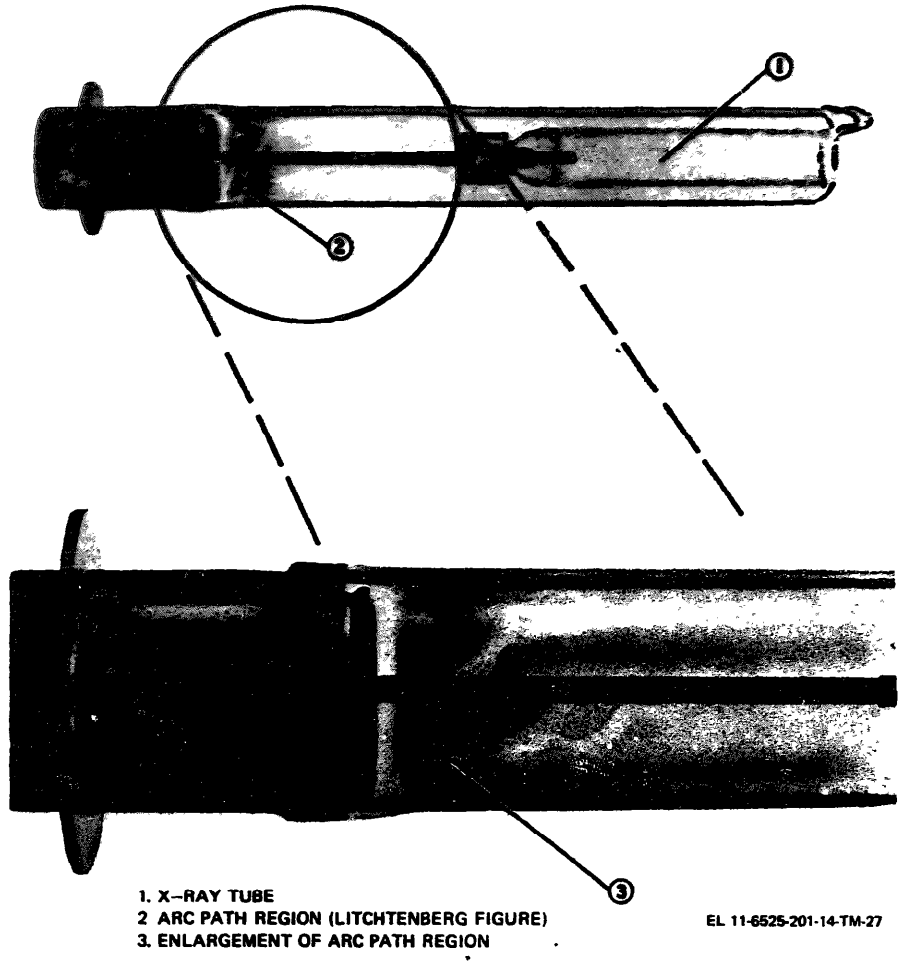


Figure 4-2. Example. Internal Arc Pattern.

WARNING

Disconnect equipment from power source, and high-voltage cable from high-voltage chamber (figure 2-16).

a. Remove pan head screw and remove cup shield from tubehead.

CAUTION

Exercise extreme care when removing X-ray **tube** from tubehead. Every effort must be made to insure that X-ray tube is not damaged during removal and inspection.

b. Rotate **tube** cap counter clockwise and remove from tubehead. X-ray tube can now be removed.

c. Check the X-ray tube for internal arcing (figure 4-2). If evidence of arcing is noted. replace the tube (paragraph 4-14).

d. If no evidence of arcing or deterioration is noted. install X-ray tube in tubehead and secure with tube cap.

e. Install cup shield on tubehead and secure using pan head screw.

NOTE

Tighten pan head screw attaching cup shield to tubehead very carefully to avoid damage to threads in tubehead.

4-14. Replacement **of** X-ray Tube

If visual inspection (paragraph 4-13) or output measurement (paragraph 4-12) indicates that replacement of the X-ray tube is necessary. perform the procedure outlined below.

a. Remove X-ray tube according to paragraph 4-13. steps a and b.

NOTE

Check the envelope of the replacement X-

ray tube. If there is foreign material (fingerprints. dirt. etc.) on the surface of the tube. clean the **X-ray** tube with neutral soap and water and allow to dry thoroughly.

b. Carefully insert replacement X-ray tube into tubehead and press into tube socket until it stops.

c. Insure that X-ray tube base is properly seated and has not been damaged, then install and secure tube cap and cup shield.

4-15. Indicator Lamp Removal and Replacement

If PRESSURE LOW (figure 3-3) or SET SELECTOR (figure 3-1) indicator lamps burn out during operation, remove and replace as follows:

a. Unscrew the lens of the indicator assembly and remove the defective lamp.

b. Replace defective lamp with type 327 incandescent lamp and secure with lens.

4-16. Fuse Removal and Replacement

If fuse (figure 3-2) on control unit blows, unscrew lens. replace fuse with MDL 2 / 10A Slo-Blo fuse. and secure with lens.

4-17. Ground Strap Removal and Replacement

To replace ground strap (figure 2-15), remove two screws and one nut. If a replacement ground strap is not available, make one using insulated wire and two terminal lugs.

CHAPTER 5

ORGANIZATIONAL MAINTENANCE

Section I. GENERAL

5-1. Scope of Maintenance

a. **This chapter includes** the instructions for **organizational** maintenance of the X-ray apparatus.

b. **Organizational** maintenance includes:

(1) **Painting** and finishing (section II).

(2) Lubrication (section III).

(3) **Preventive maintenance** (section IV).

(4) Troubleshooting (section V).

(5) Maintenance (section VI).

5-2. Tools and Test Equipment **Required**

Test equipment available to the organizational maintenance personnel is limited to a multimeter TS-352B / U. Radiacmeter IM-9/ PD (Dosimeter). and a Charger. Radiac Detector PP-1578 / PD (Charger).

Section II. REPAINTING AND REFINISHING

5-3. Preparation and Repainting Procedures

When the finish on the components of the main assembly or subassemblies sustains damage, prepare and refinish the affected areas as follows:

a. Use No. 000 sandpaper to clean the surface down to the bare aluminum; obtain a bright, smooth finish. If necessary, use cleaning compound to soften surface.

b. Sand the area back to solid paint and feather the paint edge around the exposed metal.

c. Wipe the area clean and apply one coat of zinc chromate metal primer and two finish coats of paint to metal surfaces.

5-4. Minor Repairs

a. If only touchup is necessary, proceed as follows: Remove rust by cleaning corroded metal with sandpaper.

b. Apply paint with a small brush.

Section III. LUBRICATION

5-5. General

Refer to paragraph 4-3 for general lubrication instructions. Visually check charging cable connections to charging resistor and charging resistor re-entrant cavity. Service with Dow Corning DC-5 silicone grease.

5-6. Special Lubrication Instructions

Do not lubricate the air pump assembly as it will contaminate the air supply system.

Section IV. PREVENTIVE MAINTENANCE

5-7. General

a. Preventive maintenance is the systematic care. servicing. and inspection of the equipment to maintain it in a serviceable condition. prevent breakdowns. and assure maximum operational capability. Preventive maintenance of equipment includes the testing and repair or replacement of parts. assemblies. or units that inspection or test indicate will probably fail before the next scheduled servicing.

b. Preventive maintenance checks are made weekly. monthly. and quarterly unless otherwise directed by the commanding officer.

c. For equipment maintenance purposes. weekly is defined as approximately 7 calendar days of **hours-per-day** operation. If the equipment is

operated 16 hours a day, monthly maintenance intervals must be made to compensate for any unusual operating conditions. Equipment in limited storage (requires servicing before operation) does not require monthly maintenance. The organizational maintenance checks and services are contained in table 5-1.

5-8. Organizational Preventive Maintenance Checks

a. Maintenance will be scheduled in accordance with the requirements of TM 38-750. All deficiencies or shortcomings will be recorded and those not corrected during inspection will be reported to higher levels of maintenance in accordance with the procedures listed in TM 38-750. Perform all maintenance and inspection in the sequence listed. Whenever a normal condition is not observed, make corrective action in accordance with the paragraphs listed under references.

b. With the equipment and the test equipment available to the organizational level perform the output check and visual inspection of the X-ray tube per instructions in paragraphs 4-12 and 4-13. If the X-ray tube is faulty, replace per paragraph 4-14.

c. Perform the sequential preventive maintenance checks as listed in table 5-1.

d. To determine the operational readiness of the pulser assembly. perform the following pulser assembly continuity tests. Remove and disassemble pulser assembly in accordance with instructions presented in paragraph 5-15, steps a and b. If modules or pulser assembly components fail to comply with requirements of following tests, replace defective component in accordance with appropriate instructions of paragraph 5-15.

NOTE

The following test will disclose a complete module failure, but will not necessarily indicate individual capacitor breakdown under high-voltage application.

Table 5-1. Organizational Preventive Maintenance Checks and Services Chart

Sequence No	Item to be inspected	Procedure	Reference
1	Exterior surface	Clean panels, cables, and meter glass. Refinish painted surfaces as necessary.	Paragraph 5-3.
2	Intercabling and connectors	Check all interconnecting cables and connectors for cracks or other physical damage. Check continuity of cable wiring and replace wires or connectors as necessary.	
3	Control unit	Disassemble control unit and visually inspect chassis and electronic components for evidence of deterioration. Replace missing hardware items as necessary.	Paragraphs 5-13 through 5-18.
4	High voltage power supply and pulser assembly	Visually inspect input to charging resistor and pulser assembly reentrant cavity for evidence of moisture or deterioration. Clean and apply silicone grease if required.	Paragraph 5-14.

(1) Set multimeter OHMS selector to highest multiplier value. Connect one probe to module high-voltage connector and the other to module ground connector on same side of module. Multimeter should indicate infinite resistance.

NOTE

The following continuity tests can be performed on all modules except No. 18, the output module (figure 5-1).

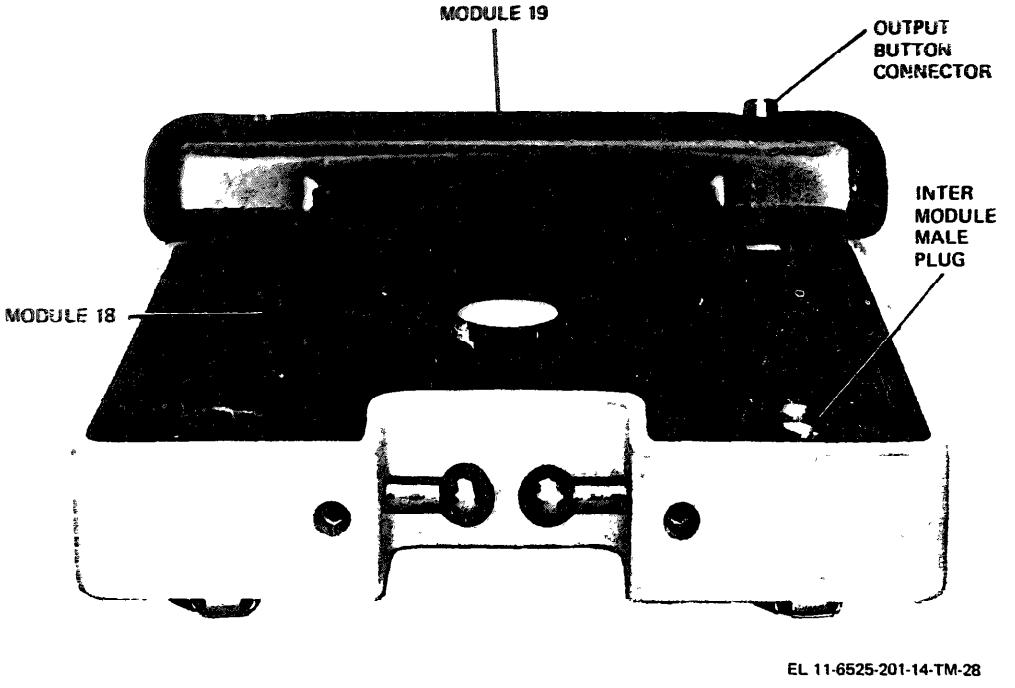


Figure 5-1. Electrostatic Shield Module (Module 19) and Output Module (Module 18)

(2) Set multimeter OHMS selector to lowest multiplier value. Check continuity between high-voltage input and output connectors (figure 5-2). between high-voltage input connector and adjacent spark ball (high-voltage side), and between spark ball and high-voltage output connector. Multimeter should indicate 1 ohm or less for each of the three tests.

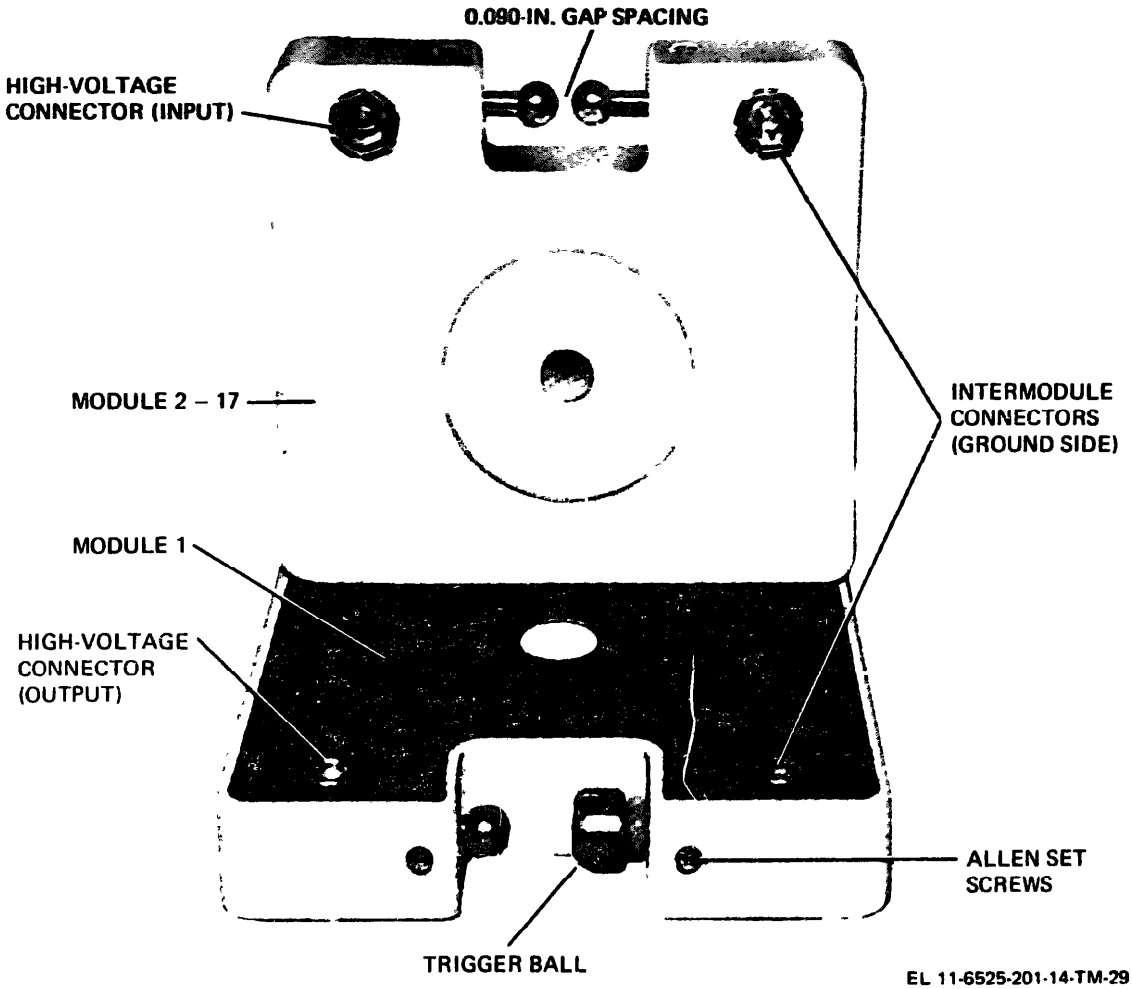


Figure 5-2. Trigger Module and Typical Standard Module.

(3) Repeat tests of step (2). substituting ground side of module for high-voltage side. Indications should be the same.

(4) Check continuity between anode connector in X-ray tube chamber and high-voltage output connector on inside rear wall of pulser case. Multimeter should indicate I ohm or less.

(5) Measure resistance between trigger input isolation resistor and spring-loaded trigger button (middle connector) on inside face of pulser end plate (figure 5-3). Multimeter should indicate approximately 20 kilohms.

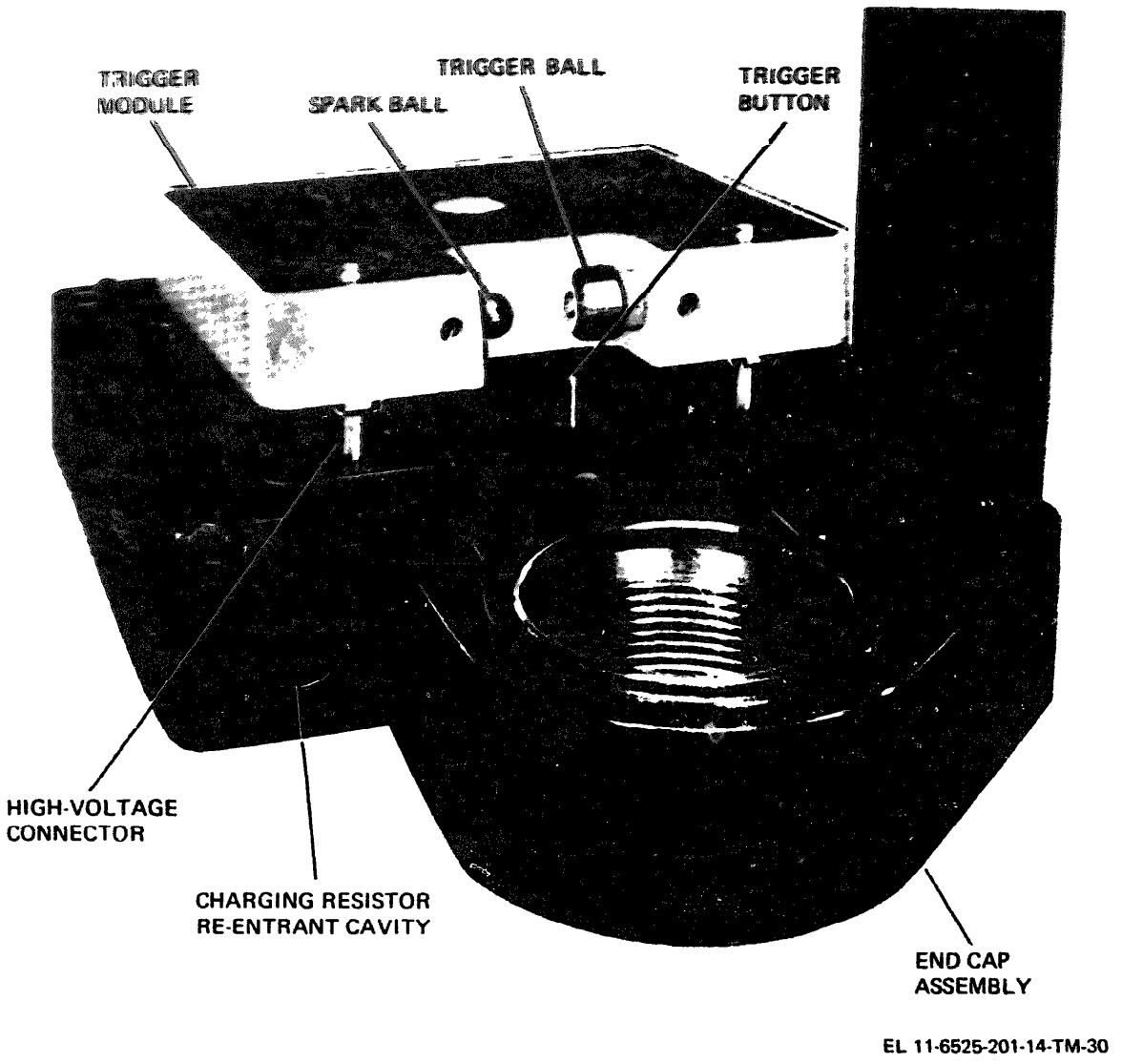


Figure 5-3. Detailed View of Trigger Module and End Cap Assembly.

(6) Measure resistance between input cavity and the banana plug of the high-voltage isolation resistor assembly. Multimeter should indicate approximately 70 kilohms.

(7) Check continuity between high-voltage input entrant cavity and spring-loaded high-voltage connector on inside face of pulser end plate. The multimeter should indicate I ohm or less.

(8) Check continuity between X-ray tube cavity in pulser end plate and spring-loaded high-voltage connector on inside face of end plate. The multimeter should indicate 1 ohm or less.

Section V. TROUBLESHOOTING

5-9. General

This section provides a general description of the X-ray apparatus component functions and their relationship to the entire system. Organizational maintenance personnel can use this information to isolate trouble to a general area within the system

5-10. Block Diagram Description

The X-ray apparatus is divided into functional

components. The function of each component and the relationship of the components to each other are shown in the system functional block diagram (figure 6-1).

5-11. Troubleshooting Procedures

a. Fault analysis of the X-ray apparatus at the organizational level is limited to operational checks for trouble indications to removal and replacement of major assemblies and some detailed parts as covered in the maintenance allocation chart. Table 5-2 lists step-by-step instructions for troubleshooting at the organizational level.

b. The malfunctions listed in table 5-2 are correlated with the operating procedures in paragraph 3-6. If a malfunction is observed while performing the operational checks. locate the test sequence and the appropriate corrective action to he taken to correct the deficiency.

5-12. Fault Analysis

Repair of the X-ray apparatus at the Organizational Maintenance level is limited to removal and replacement of major assemblies and some detail parts (for example. pulser assembly replacement. printed circuit board replacement. pulser module replacement. etc.). The following troubleshooting table presents step-by-step instructions consistent with the maintenance responsibilities delegated to this level.

a. Analysis of Malfunctions Observed During Operational Check.

The malfunctions listed in table 5-2 are correlated with the operational check presented in table 4-2. Perform the operational check and observe indications listed. If a malfunction is observed while performing operational check, note the occurrence of the malfunction in the test sequence, and locate the appropriate corrective action in table 5-2 (malfunctions listed in troubleshooting table are organized in the came sequence as operationa check).

b. Overload Trip-out Circuit Board Function. After operational checks have been corn pleted. perform an additional test to check the operation of the overload trip-out circuit board. A systematic isolation and repair procedure for the overload trip-out circuit is presented at the end o the troubleshooting table.

(1) Insure that resistive load is installed in pulser assembly.

(2) Pressurize the system to 6 to 8 psi a indicated by PULSER PRESSURE gauge.

(3) Connect control unit to pulser with the control cable.

(4) Set LINE VOLTAGE ADJUST to the input voltage, and connect exposure switch cable to the jack on control panel.

Table 5-2. Organizational Maintenance Troubleshooting

Ma'n nction	Probable Cause	Corrective Action
1. Line voltmeter fails to indicate input voltage	1*a*. Ac input power cable defective	1*a* Check continuity of power cable.
	b. Line voltmeter defective.	*b*. Check for appropriate ac voltage across meter input terminals.
2. PRESSURE LOW indicator fails to go off	2*a*. Loose hose connections or O-ring seals.	2*a*. Check hose connections and O-ring seals and tighten if necessary.
	b. Pressure switch defective.	*b*. Refer to a higher level of *maintenance*
	c. Indicator lamp defective.	*c*. Replace defective lamp.
3 Pressure gauge fails to indicate system pressure.	3*a*. Same as 2*a* above.	3*a*. Check hose connections and O-ring seals and tighten if necessary.
	b. Pressure release valve defective.	*b*. Refer to a higher level of maintenance
	c. Air pump defective.	*c*. Refer to a higher level of maintenance
4. EXPOSURE SE! ECTOR fails to indicate correct number of exposures.	4. EXPOSURE SELECTOR (CT102) defective.	4.Refer to a higher level of maintenance.
5. POWER ON indicator fails to come on.	5*a*. Indicator lamp defective.	5*a* Replace defective lamp
	b. Power transformer T703 defective.	*b* Refer to a higher level of maintenance

Malfunction	Probable Cause	Corrective Action
6. EXPOSING indicator fails to flash.	6a. Exposure switch or cable defective.	6a. Refer to a higher level of maintenance.
	b. Control circuit board (PC522) defective.	b. Replace defective circuit board (paragraph 5-15).
	c. Indicator lamp defective.	c. Replace indicator lamp.
7. TOTALIZER fails to record.	7a. Control circuit board (PC522) defective.	7a. Replace defective circuit board.
	b. Totalizer (CT101) defective.	b. Refer to a higher level of maintenance.
8. SET SELECTOR indicator fails to come on.	8a. Indicator lamp defective.	8a. Replace indicator lamp.
	b. Observe PRESSURE LOW indicator light. If it is on, check pressure switch (S701).	b. Refer to a higher level of maintenance.
	c. Control circuit board (PC522) defective.	c. Replace defective circuit board (paragraph 5-15).
9. PRESSURE LOW indicator fails to light when PRESSURE RELEASE button is pressed.	9. Check PULSER PRESSURE gauge. If pressure value is indicated, check pressure system exhaust line and pressure release valve.	9. Refer to a higher level of maintenance.
10. Overload trip-out relay (K103) trips continually, causing RESET indicator light to come on.	10a. Leakage of air in pressure system.	10a. Check air pressure system and repair as necessary.
	b. Shorted pulser module.	b. Remove high-voltage lead at high-voltage power supply. If operation of trip-out circuit returns to normal, check for shorted pulser module or wet or dirty module stack assembly. Replace module or clean as necessary. If module stack assembly is dirty or wet, recondition desiccant assembly.
	c. Defective high-voltage power supply.	c. Refer to a higher level of maintenance.
	d. Defective charging resistor.	d. Replace charging resistor.
11. Overload trip-out relay (K103) fails to energize (refer to paragraph 5-12b).	11. Overload trip-out circuit board (PC521) defective.	11. Replace defective circuit board (paragraph 5-15).

(5) Set EXPOSURE SELECTOR to 99 and 100KV / 150KV switch to 150KV.

(6) Set CIRCUIT BREAKERS 1 and 2 to ON and POWER ON switch to ON.

NOTE

Selection of 150KV output voltage in conjunction with low pulser pressure will result in a prefire condition to activate the overload trip-out circuit.

(7) Press exposure switch. Overload trip-out relay (K103) should energize. causing RESET indicator to light. If the overload trip-out circuit does not operate. refer to a higher level of maintenance for repair.

Section VI. ADJUSTMENTS AND REPLACEMENTS

5-13. Organizational Adjustments and Replacement of Components

Components within the X-ray apparatus are adjusted and replaced when they are determined to be faulty during preventive maintenance checks or troubleshooting procedures. Refer to the replacement procedures in this section before removing or replacing major components or assemblies.

5-14. Pulser Assembly Removal and Replacement

a. Refer to figures 5-4 through 5-7 for illustrations of pulser assembly chassis and attaching hardware. An exploded view *of* pulser assembly is shown in figure 5-6.

(1) Remove three flat head screws (figure 5-4) and pulser holddown clamp.

(2) Remove charging resistor from re-entrant cavity (figure 5-5). Loosen nylon setscrew and remote red lead from trigger resistor.

(3) Remove pulser assembly by lifting upward.

(4) Remove the resistance load.

(5) Unscrew desiccant cover and remove desiccant case.

(6) Unscrew and remove pulser ground clamp (14, figure 5-6).

(7) Stand the pulser on end, unscrew attaching bolts and remove end plate.

CAUTION

When removing Allen screws, use care to maintain even pressure until the last bolt is removed to prevent cracking the springloaded end plate.

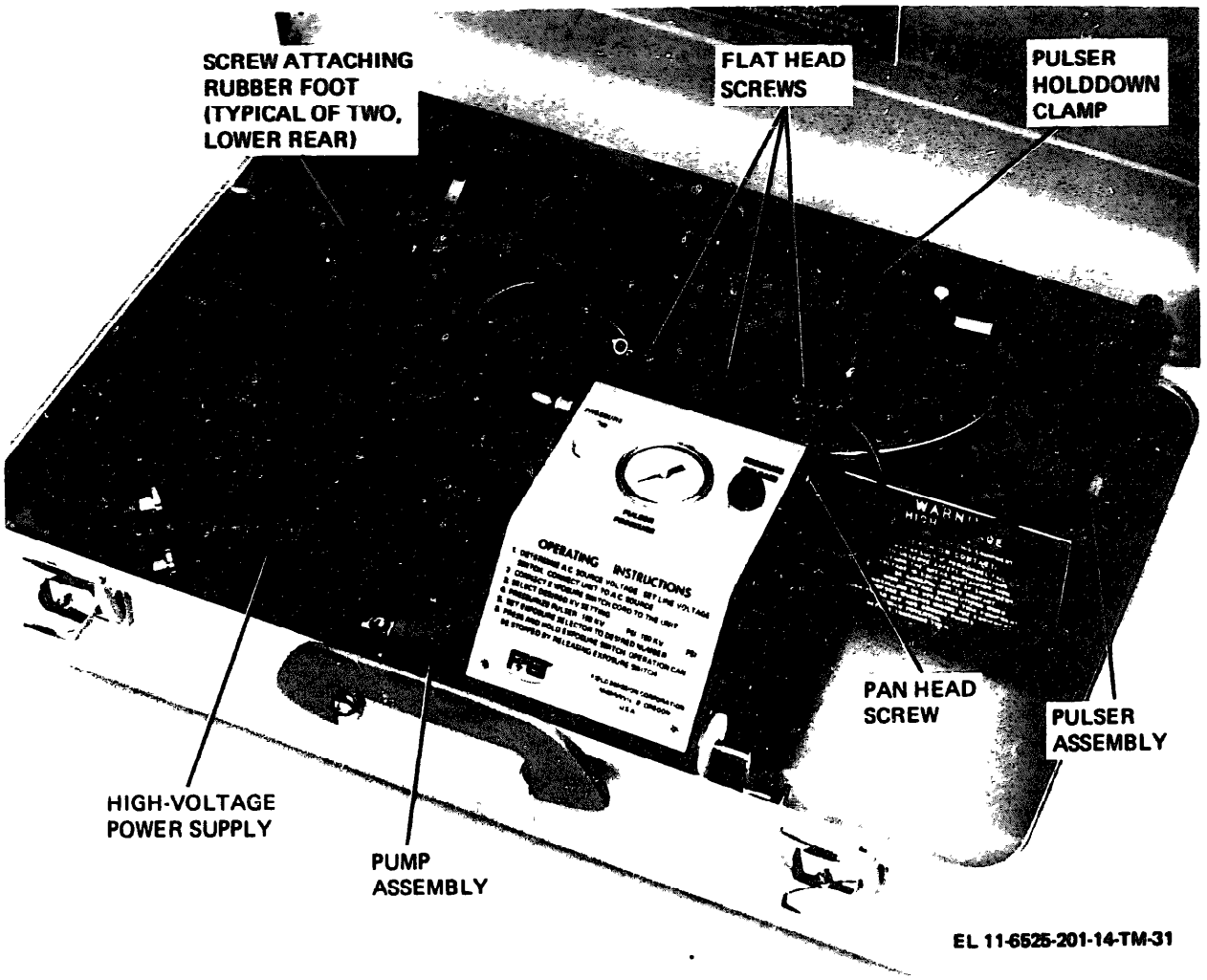


Figure 5-4. *Pulser Chasm Mounted* in *Inner Carrying Case.*

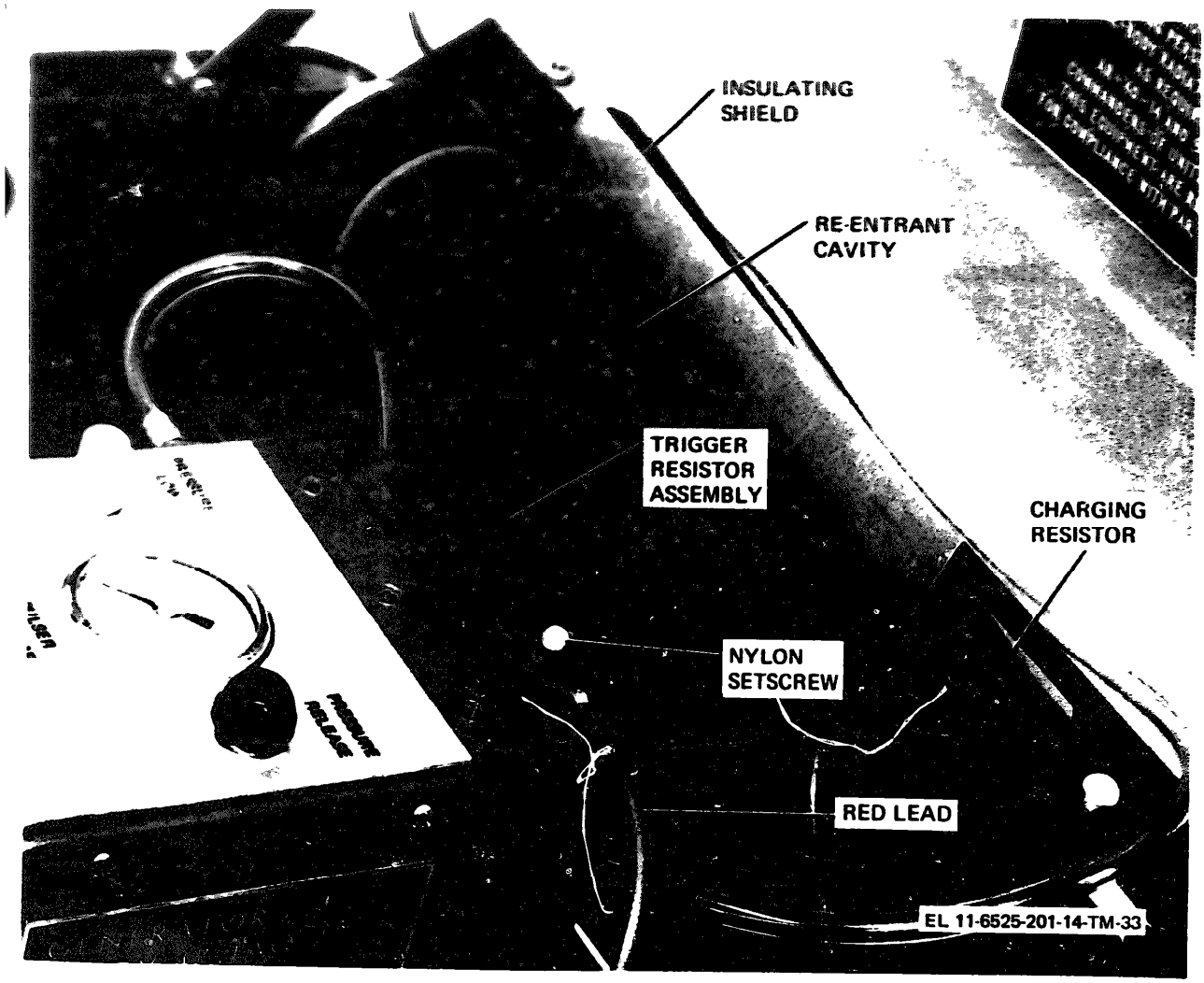
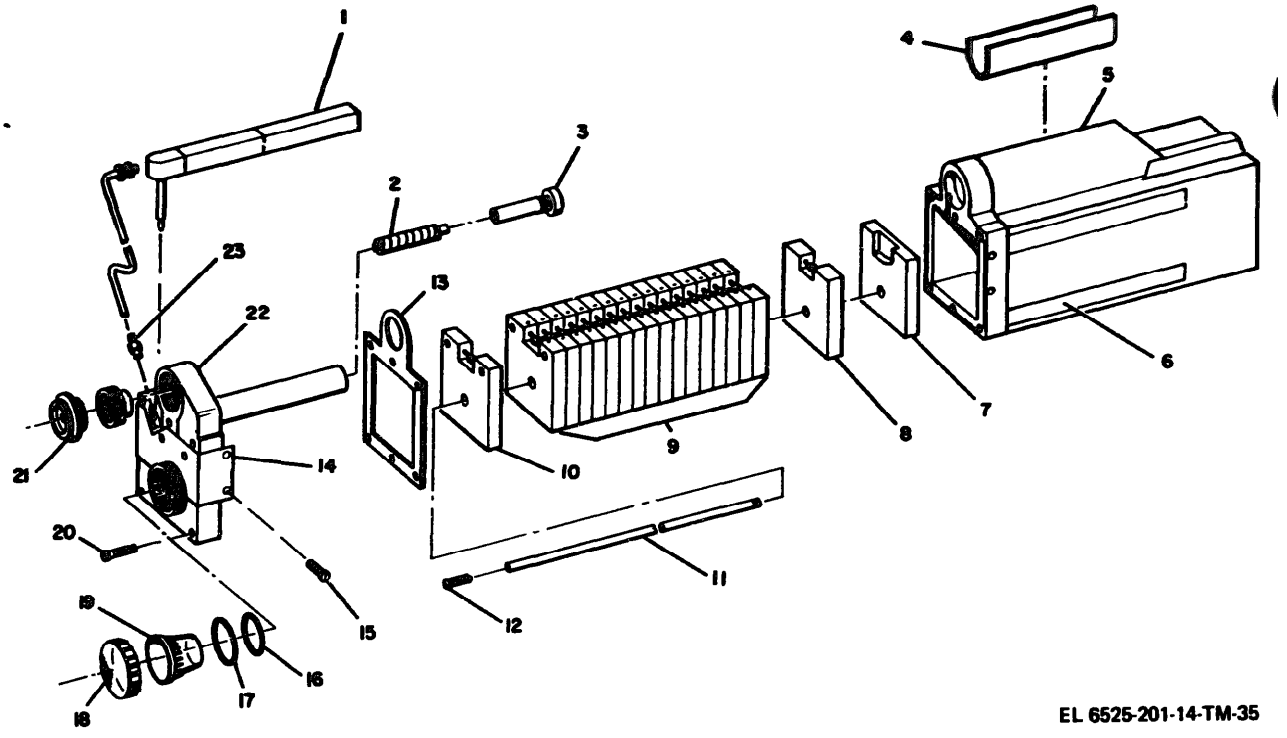


Figure 5-5. View of Charging Resistor and Re-entrant Cavity.



1. Charging Resistor
2. Trigger Resistor
3. Trigger Resistor Holder
4. Insulating Shield
5. Pulser Case
6. Foam Tape
7. Corona Module
8. Top Module
9. Module Assy
10. Trigger Module
11. Lucking Rod
12. Flathead Screw
13. Gasket
14. Ground Clamp
15. Machine Screw
16. Q-Ring
17. O-Ring
18. Desiccant cap
19. Desiccant Case
20. Allen Screws
21. Contact Ring
22. End Cap Assy
23. Hose Fitting

Figure 5-6. Exploded View **of** *Pulser Assembly.*

b. Remove the stack assembly and visually inspect the stack assembly to determine if cleaning or maintenance, as described in paragraph 5-14c, is required.

(1) Remove the module stack assembly by placing one hand over upright open end of pulser. Rotate the pulser so the open end is resting on a workbench and carefully lift pulser case off module stack assembly.

WARNING

Short circuit module stack to discharge capacitors.

(2) Install module stack assembly in the replacement pulser assembly.

CAUTION

Be careful not to apply too much torque to Allen bolts in step (7), or rubber gasket may be damaged.

(3) Install pulser end plate over module stack assembly. Insure that rubber gasket is properly positioned and secure using Allen bolts. Use torque wrench supplied in maintenance kit to tighten Allen bolts: apply 20 pound-inches of torque.

(4) Replace pulser end cap ground clamp and **secure with pan head screws.**

(5) Before installing replacement pulser assembly in pulser chassis, pack a liberal amount of Dow Corning No. 5 compound into the high-voltage entrant cavity of the end plate and the high-voltage charging resistor re-entrant cavity.

(6) Slide pulser assembly into position on pulser chassis.

CAUTION

The nylon setscrew that holds trigger resistor lead in place must be tightened just enough to hold lead. Overtightening of the

setscrew might pinch the lead, resulting in a short circuit.

(7) Insure that insulating shield (refer to figure 3-6) is in position on pulser assembly and install charging resistor probe in re-entrant cavity.

(8) Install pulser holddown clamp and secure with three screws.

(9) Connect pressure hose fitting to pressure assembly.

c. Module Stack Assembly Cleaning and Repair. The module stack assembly is shown in figure 5-7.

(1) After removing the module stack assembly from pulser assembly, paragraph 5-14b, clean and repair if necessary as outlined below.

CAUTION

When short circuiting spark gaps, be extremely careful not to scratch the surface of the spark gap with screwdriver.

(2) After removing module stack assembly from pulser assembly. carefully turn it to horizontal position on work surface. Short circuit spark gaps with a screwdriver.

(3) Clean modules, inside of pulser case, and X-ray tube cavity with soap and water. Be certain all parts are thoroughly dry before reassembling.

(4) Check condition of trigger electrode ball. intermodule connectors, and output connector located at inside rear of pulser case.

(5) Check condition of teflon shielding strip on upper interior face of pulser case. Wipe clean with dry cloth.

(6) Polish spark gap balls with polishing compound.

NOTE

Routine cleaning and inspection of module stack assembly can be accomplished without disassembling stack assembly. Perform steps (7) through (12) only if it is necessary to repair, replace or adjust a specific module.

(7) Unscrew threaded dowel and carefully remove from module stack. maintaining original column (module) continuity.

(8) If it is necessary to adjust spark gap. loose two Allen setscrews at top of module so that spark gap balls can be repositioned.

(9) Using the shank of the No. 43 drill (supplied in maintenance kit) as a feeler gauge. adjust the spark gap balls on modules 1 through 18 for a gap of 0.090 inch.

(10) Secure spark gap balls on module by tightening Allen setscrews.

(11) Position modules in proper sequence with Corona module on top and trigger module (face down) on bottom.

(12) Carefully align modules (figures 5-6 and 5-7) and assemble using locking rod and flathead screw.

(13) Install module stack assembly and polyethylene spaces in pulser spacer case and secure in accordance with steps (10) and (11) of paragraph a.

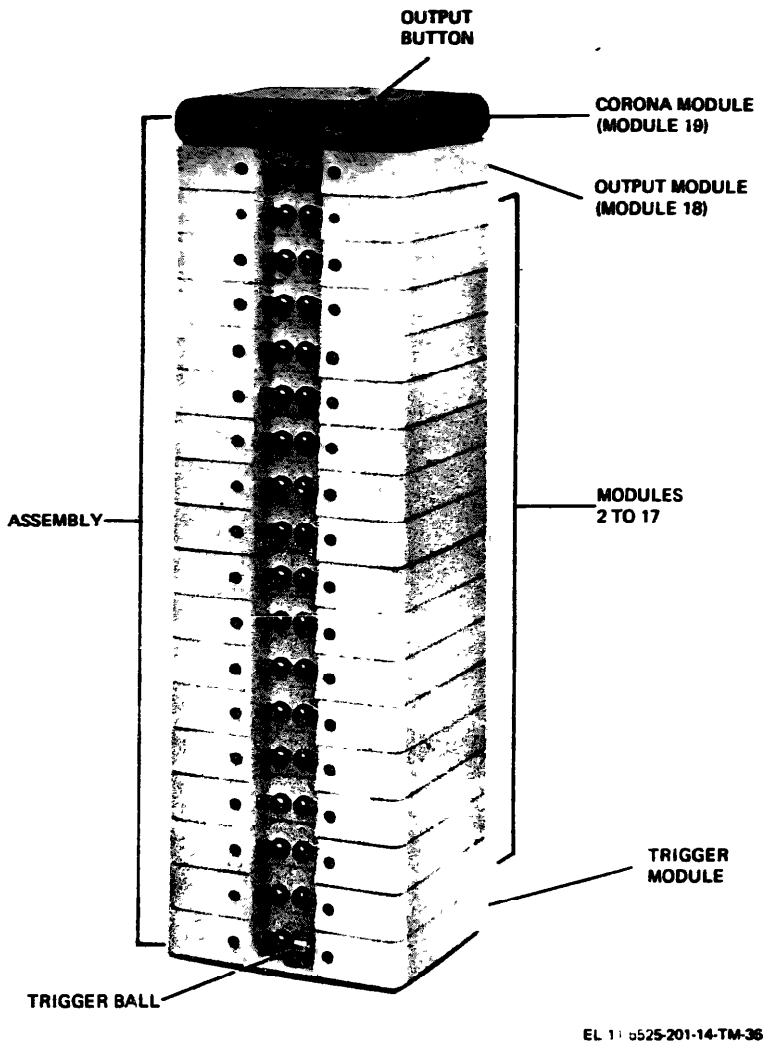


Figure 5-7. Module Stack Assembly Removed from Pulser Case.

5-15. Disassembly and Replacement of Control Unit

The control unit is disassembled and the circuit boards replaced as follows:

a. Remove six bottom screws, three top screws, and four screws from front and rear control panels.

b. Slide control section out from front of case and transformer section out from rear.

c. Removal and Replacement of Control Circuit Board (PC522) (figure 5-8).

(1) Remove one screw and carefully remove *circuit board from connector.*

(2) Install replacement circuit board in connector and secure with screw.

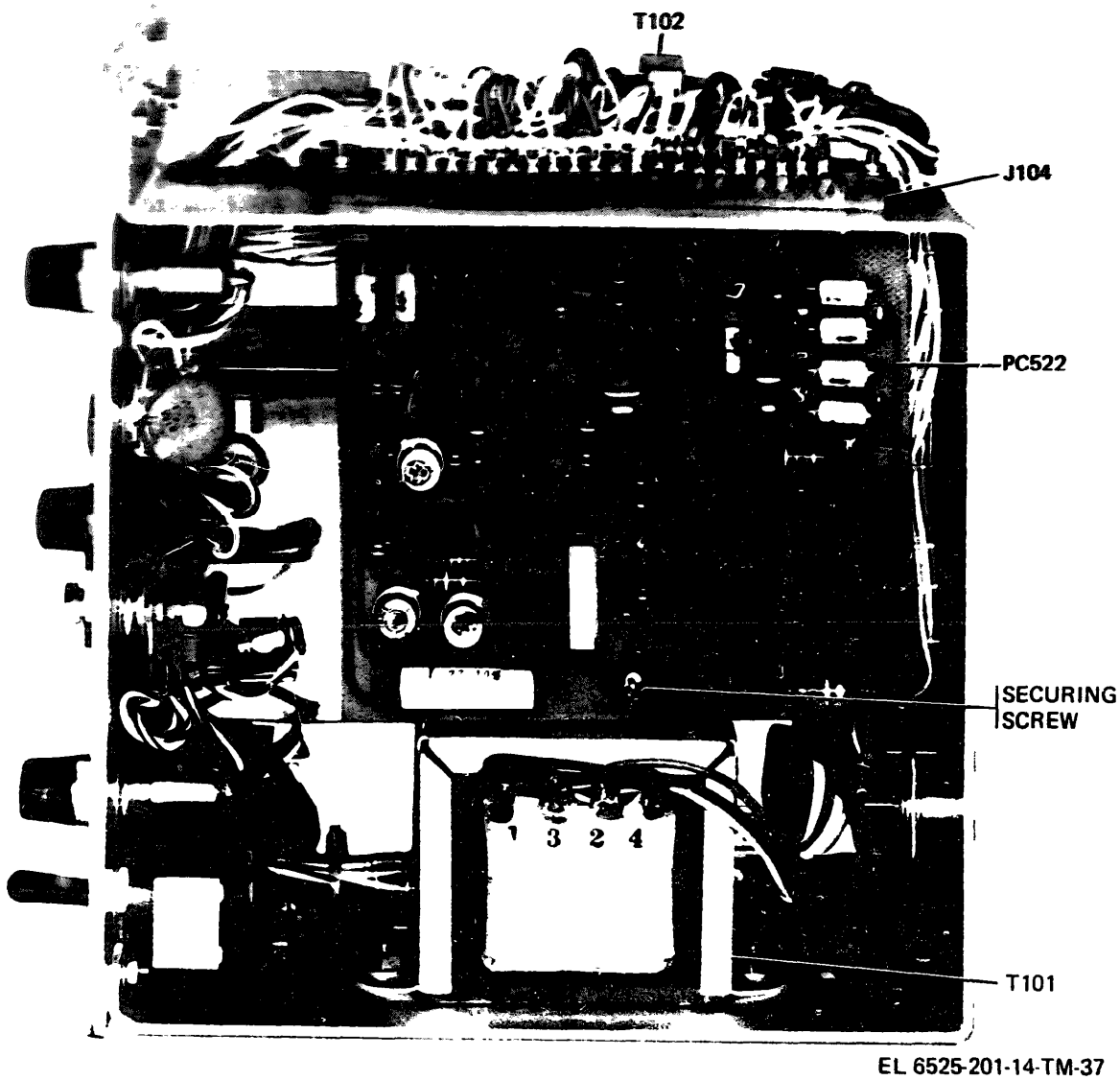


Figure 5-8. Control Section *Right* Side *(PC 522 Installed).*

d. Removal and Replacement* of *Overload Trip-Out Circuit Board (PC 521) (figure 5-9).

(1) Remove trip-out circuit board. Remove one screw and carefully remove circuit board from connector.

(2) Install replacement circuit board in connector and secure with screw.

e. Slide transformer chassis into the end of control unit case that has two holes for attaching screws. and slide control chassis into position through opposite end.

f. Install three top screws. four bottom screws, and four screws in each control panel.

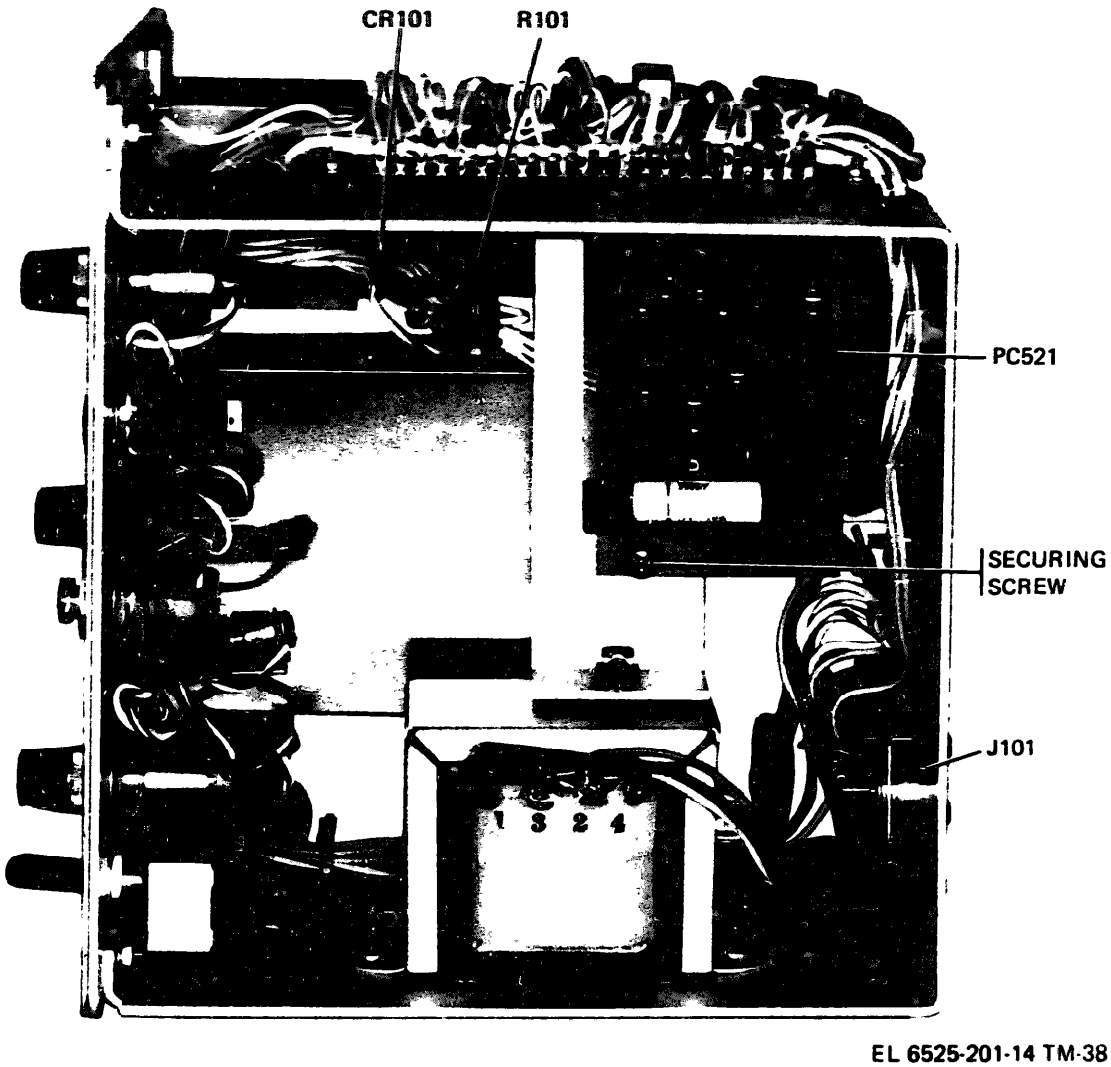


Figure 5-9. Control Section Right Side (PC 522 Removed).

5-16. Removal and Replacement of LINE VOLTAGE ADJUST Selector Switch (S702) (figure 5-10).

Before unsoldering and removing wires from selector switch. mark and tag all leads to facilitate accurate reassembly.

a. **Loosen setscrew and remove selector switch knob.**

b. Remove locknut from panel side and remove selector switch from back of panel.

c. Unsolder and remove electrical wiring from *witch.

d. Solder ***wires*** to terminals of replacement selector switch.

e. **Position selector switch on panel and secure with locknuts.**

f. **Install knob on shaft of selector switch and secure with setscrew.**

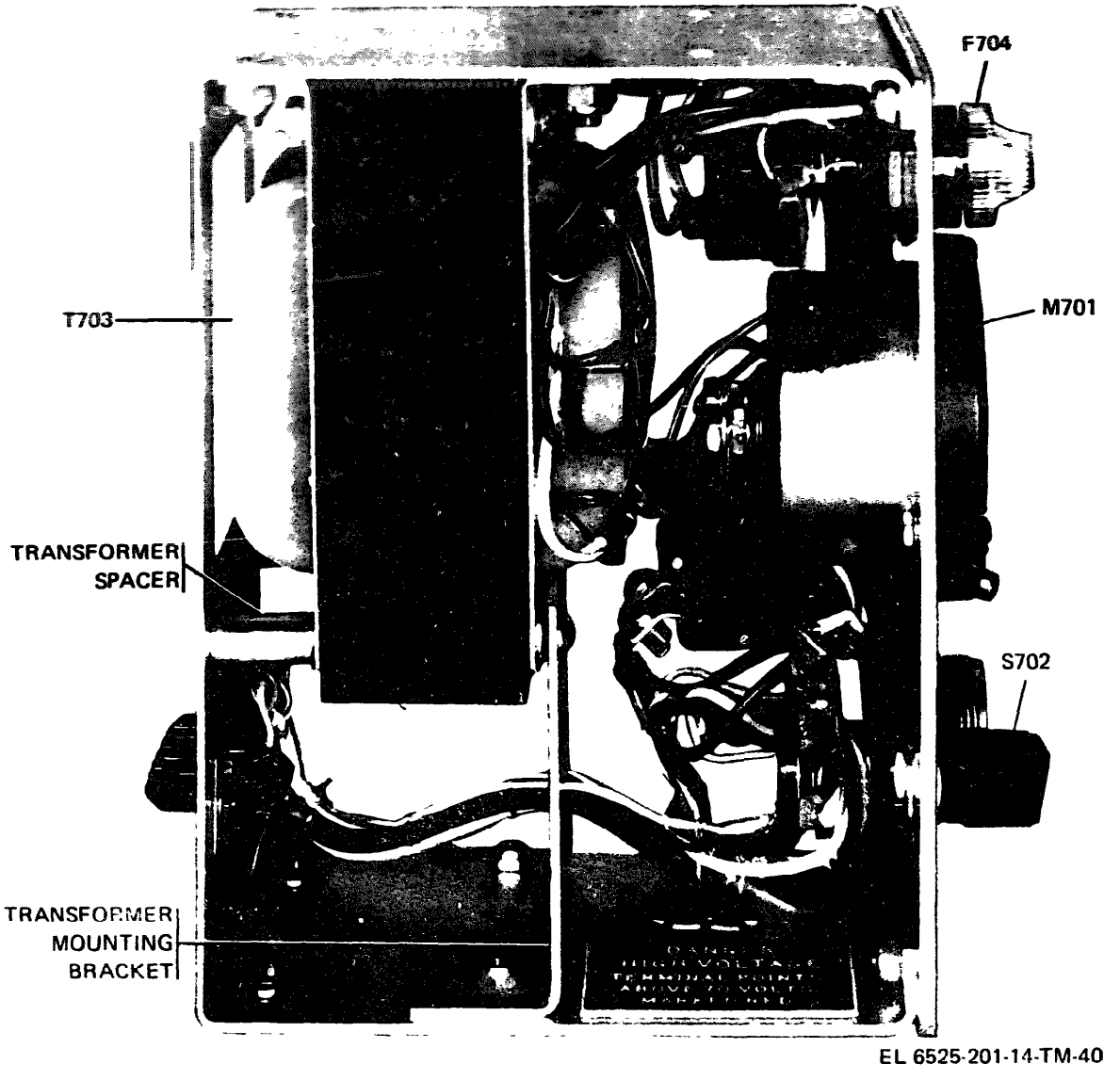


Figure 5-10. Transformer Section. Left Side.

5-17. Removal and Replacement of Switches, Fuseholder, and Meter

Before unsoldering and removing wires, identify wire locations to insure accurate reassembly.

a. Disconnect all wires, being careful not to damage insulation.

b. Remove attaching hardware and components.

5-18. Removal and Replacement of Indicator Light Assembly

The indicator light assembly is soldered into the electrical circuit. Mark and tag all leads before removing and replacing the unit as follows:

a. Unsolder and remove two wires from the bottom of the indicator light assembly.

b. Unscrew and remove the lens from the indicator light assembly.

c. Remove the locking nuts securing the indicator assembly to the air pressure assembly panel and remove the indicator light assembly.

d. Install the replacement indicator light assembly on the air pressure panel and secure with the locking nuts.

e. Install the lens on the indicator light and solder the wires to the terminals on the bottom of the indicator.

Section VII. TESTING

5-19. General

To insure that X-ray apparatus is capable of optimum performance after maintenance and repair procedures have been completed, perform the operational test appearing in table 4-2. In addition to operational check, perform the test in paragraph 5-20.

5-20. X-ray Apparatus Functional Test

a. Set CIRCUIT BREAKERS 1 and 2 to down (off) position.

b. Set 100KV / 150KV level switch to 150KV.

c. Pressurize system to 20 psi and set CIRCUIT BREAKERS 1 and 2 to ON.

d. With EXPOSURE SELECTOR set for 25 pulses. set POWER ON switch to ON.

e. Press and hold EXPOSURE SWITCH.

f. TOTALIZER should indicate number of pulses as they occur. Carefully observe pulser operation to insure that it is firing evenly and smoothly.

NOTE

Erratic operation of pulser assembly can result from improper alignment of spark gaps or pressure system malfunction, which is especially critical at the higher voltage level.

CHAPTER 6

CIRCUIT FUNCTIONING

Section I. GENERAL DESCRIPTION OF OPERATION

6-1. General

This chapter contains block diagram description (paragraph 6-2) and detailed circuit functioning (paragraph 6-3 through 6-14) of the X-ray apparatus. The block diagram is illustrated in figure 6-1: complete circuit diagram is illustrated in figure 7-1.

6-2. Block Diagram Description

a. The low-voltage power supply converts ac power (90 to 250 vac, 50 to 60 Hertz) to high-voltage. direct-current dc power (approximately 20 kv dc). This electrical energy flows from the high-voltage power supply, through an isolation resistor assembly. into the pulser. which serves as an electrical energy storage and pulse forming unit. The pulser begins to charge toward a voltage level, Vo (figure 6-2). A trigger circuit monitors the stored electrical energy. and at a pre-selected voltage (VI) delivers a trigger pulse to the pulser. This results in a discharge of the stored energy through the X-ray tube, producing a burst of X-rays approximately 0.06 microsecond in duration. This process is repeated until the number of pulses preset on the exposure selector has been attained. A totalizing counter records and displays the accumulated total number *of* pulses supplied to the X-ray tube or dummy load.

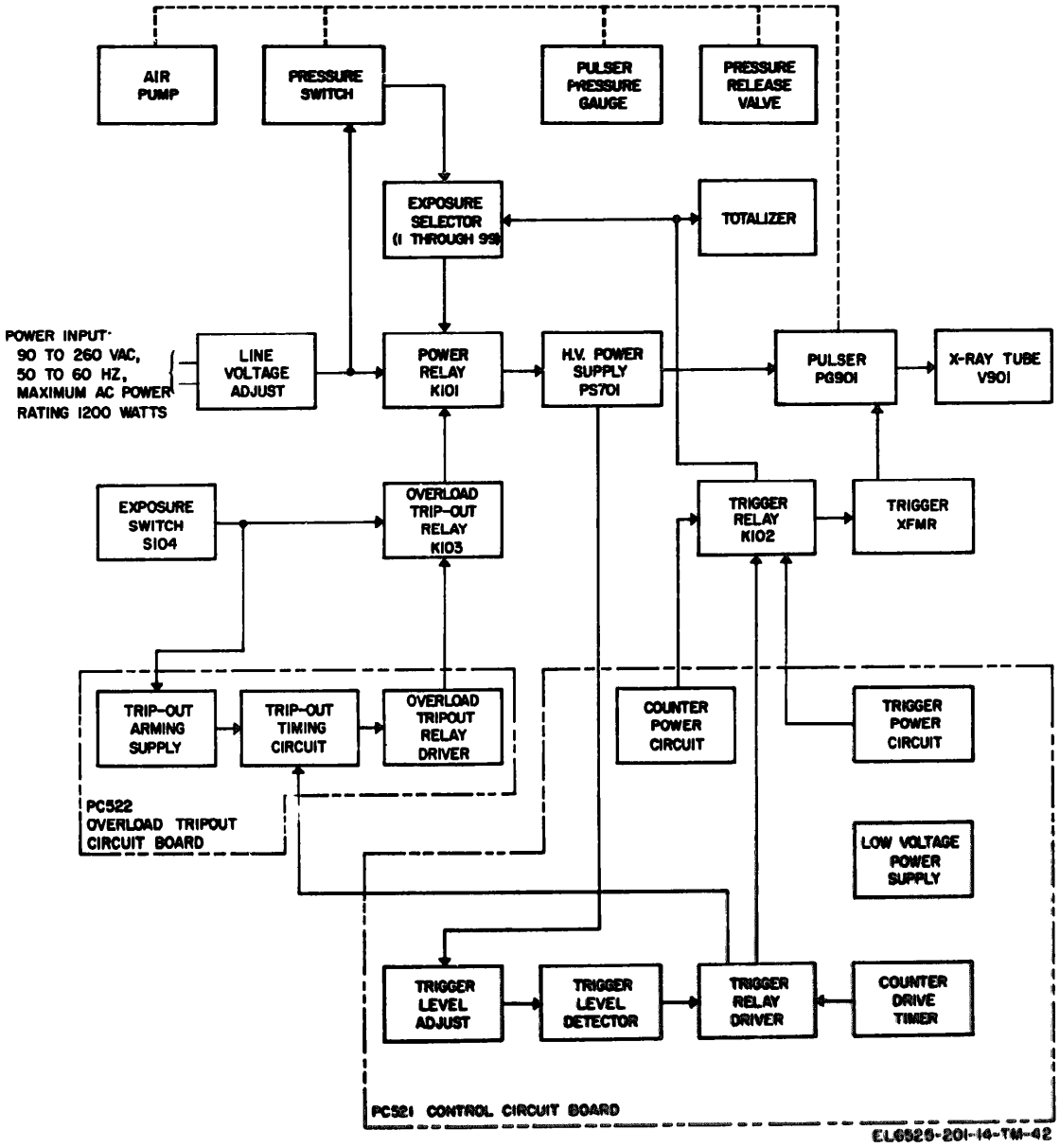


Figure 6-1. X-Ray Apparatus Block Diagram.

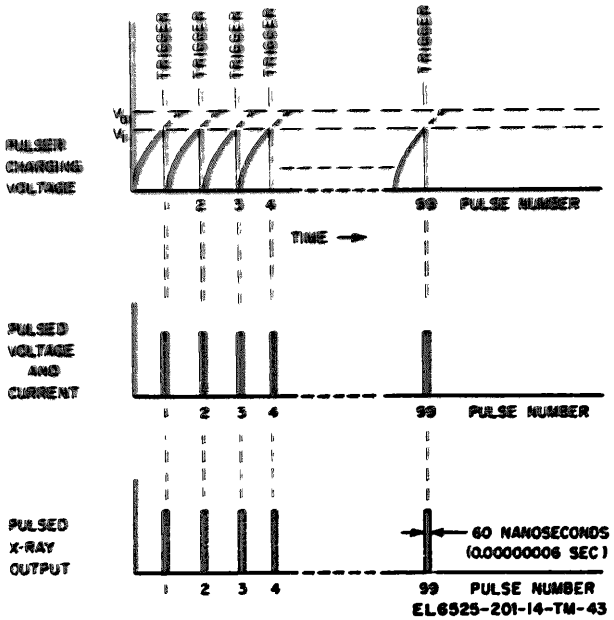


Figure 6-2. Pulser Charging Wave Shape.

b. **A two-position panel switch allows selection of either 100 kv or 150 kv X-ray tube voltage. The lower voltage provides better contrast with thin body sections and the higher voltage gives increased penetration capability where required, as well as reducing the patient dose.**

c. **A hand pump supplies air at a positive pressure, permitting operation at the two voltage levels without requiring mechanical adjustment of the spark gap switches. In addition, it provides effective isolation of the spark gap switches from environmental effects such as humidity, dust, and** altitude.

d. An overload trip-out circuit provides protection for the hv power supply in the event of a shorted energy storage module in the hv pulse generator. It will also interrupt the system operation after several consecutive hv pulse generator prefires caused by insufficient pressurization.

Section II. DETAILED DESCRIPTION OF OPERATION

6-3. Primary Power Circuit (figure 7-1).

Main power is applied through the power input jack. J701, CB701, T703, CB702, and to POWER ON switch through pins I and 3 of P701 and J101. Voltmeter M701 is connected across the input line for checking the input voltage. When power relay K 101 is energized. its contacts transfer power to hv power supply PS701 through 100 KV/ 150KV rangeswitch S102. When S102 is at 100 KV, R102 is inserted in series with the primary circuit of *PS701.* Resistor R 102 fixes the maximum 100-kv pulse repetition rate by limiting the current in the primary circuit of PS701.

6-4. Power Relay Coil Circuit

a. The circuit is energized by one of the 30-vac secondary windings of low-voltage power supply transformer T 101. Circuit current must flow through the equipment interlock circuit on printed circuit boards PC522 and PC521 so that. if either board is removed from its socket or not properly installed. the circuit is inoperative. When the interlocks are closed. current flows through pressure switch S701, which is actuated by a minimum air pressure of approximately 4 psi. When the air pressure is low. *S701* remains in its normally closed position (opening the circuit to K 101) and current is supplied to PRESSURE LOW indicator I701 to indicate low pressure. When the pulser pressure system has been pumped up to its normal operating pressure. S701 is switched to its normally open position. deenergizing I701 and allowing current flow to the switches in EXPOSURE SELECTOR CT102. This condition indicates minimum air pressure.

b. The positions of the switches in CT102 are shown with the numeral wheels at zero and the exposure selector reset knob released. In this condition. current flows through the turnoff switch to terminal 5 and through SET SELECTOR indicator I104. which is then energized When the numeral wheels are at a number other than zero. current is transferred to the armature of the interlock switch. If the exposure selector reset knob is depressed. the interlock switch will transfer current to terminal 5. and I104 is again energized. With the exposure selector reset knob released, and the numeral wheels at a number other than zero. the interlock switch transfers the current to terminal i and to pin 7 of relay K 101.

c. When pushbutton EXPOSURE SWITCH S104 is depressed. energizing current flows through the coil of K 101. through normally cloned contacts 2-4 of K 103. and through S104 to chassis ground. With the circuit complete to energize K 101.

contacts 5-6 are made with 3-4 to complete the circuit to energize the high voltage; K101 can then be deenergized by releasing S104 or by the operation of the overload trip-out circuit, which will actuate K103 and open contacts 2 and 4 of K103.

d. During normal system operation, K101 is deenergized when EXPOSURE SELECTOR CT102 counts back to zero and its turnoff switch actuates. transferring current to terminal 5 and SET SELECTOR I104. Capacitor C604 and resistor R608. located on PC-521, are across the coil of K 101 to form a transient suppression network to suppress the inductive voltage spike produced by the coil when it is deenergized.

e. The voltage drop across R103, due to normal coil circuit current. is applied to the primary of T102. the trip-out arming supply transformer. Whenever power relay K 101 is energized, voltage is supplied by T102 to the trip-out arming supply in the overload trip-out circuit.

6-5. Trigger Circuits

a. Low-Voltage Power Supply. The 30-volt windings of T101, diodes CR501 and CR502, and electrolytic capacitor C501 form a full-wave, center-tapped power supply with capacitor-input filtering. Zener diode CR503 is a shunt-type regulator providing regulated + 15 volts to Q501. Zener diode shunt regulator CR101 provides regulated + 27 volts to the remainder of the trigger circuit.

b. Trigger Level Adjust. A precision 100-megohm metering resistor, located in hv power supply PS701, furnishes current, which is proportional to the hv pulse generator charging voltage, to the trigger level adjust input. The current is split through R503 and the series combination of R502 and R504. Potentiometers R-502 and R503 serve as adjustable voltage dividers that set sensitivity to the trigger level detector. The 100 KV / 150 KV range switch (S102-B) selects the appropriate potentiometer output.

c. Trigger Level Detector.

(1) Unijunction transistor Q501 is used as a trigger level detector. The base-two voltage of Q501 is furnished by the regulated + 15 volts from Zener diode CR503, thus producing a highly stable emitter peak-point voltage of about 8.5 volts.

(2) As the hv pulse generator charges, the current to the trigger level adjust circuit and the voltage output through S102-B to the emitter of Q501 increase. thus charging capacitor C502. When the emitter peak-point voltage is reached. Q501 rapidly switches to its conducting state and *C502* is discharged across base-one resistor R505. thus producing a positive pulse. When C502 is nearly discharged, the emitter ceases to conduct and Q501 switches back to its nonconducting state.

d. Trigger Relay Driver.

(1) Trigger relay driver Q502 is a silicon controlled rectifier (SCR). In the quiescent state, its anode and the bottom of trigger relay K102 coil are set at approximately +27 volts. When a positive pulse from trigger level detector Q501 is applied through coupling capacitor C503 to the gate of Q502, it rapidly switches to its conducting state. *Q502* anode falls to approximately 1 volt above ground and the trigger relay coil is thus energized.

(2) Resistor R512 furnishes holding current to the anode of Q502 during switching, when current has not yet built up through the trigger relay coil. Diode CR505 and resistor R513 absorb the inductive voltage transient produced by the relay coil upon turnoff and thus protect Q502 from anode breakover.

e. Counter Drive Timer.

(1) The counter drive timer circuit determines the length of time trigger relay driver Q502 remains on, and also provides a turnoff signal to Q502. In the quiescent state, when Q502 is off, the junction of C505 and R507 is at approximately + 27 volts and turn-on bias current is furnished to the base of Q503 through R507. The anode of CR504 is clamped essentially to ground by transistor Q503. Transistor collector current is furnished through R510 and R511. Timing capacitor C505 is charged to about 27 volts, with R507 end positive. Q504 is in its nonconducting state with interbase current being furnished through R509 from the +27-volt supply.

(2) When Q503 switches on, the junction of C505 and R507 is rapidly clamped to approximately 1 volt above ground. The base of Q503 is then zero-biased and turned off. Since the charge in C505 cannot change rapidly, the anode of CR504 is driven to approximately 26 volts below ground, cutting off CR504, which disconnects the collector of Q503. Capacitor C505 then reverse-charges slowly through resistors R510 and R511, and the anode of CR504 rises toward +27 volts. When the anode of CR504 reaches about + 15 volts. Q504 rapidly switches to its conducting state. clamping its emitter and the anode of CR504 to a few volts above ground. Again the charge in C505 cannot change rapidly. and the junction of C505 and R507 and the anode of Q502 are driven about 9 volts below ground. Capacitor C505 furnishes reverse anode current to Q502 until it has had time to turn off and regain its forward blocking characteristics The potential at junction of C505

and R507 rapidly rises to approximately +27 volts, and the circuit returns to its quiescent state, with the anode of CR504 clamped to ground and C505 charged to about 27 volts. The timing cycle is adjusted for a duration of 19 milliseconds by means of potentiometer R510. This duration, plus the 1-millisecond release time of trigger relay K102, provides the required 20-millisecond drive time for the electromechanical counters, exposure selector CT102, and totalizer CT101.

6-6. Overload Trip-Out Circuit

a. Trip-Out Arming Supply. When power relay K101 is energized by EXPOSURE SWITCH S104, the relay coil current produces an ac voltage drop of approximately 1 volt across current-sampling resistor R103. The voltage is applied to the primary of T102, and a center-tapped 36 volts is produced across its secondary. The secondary winding, diodes CR604 and CR605, and electrolytic capacitor C601 form a full-wave, center-tapped power supply with capacitor input filtering. Approximately 25 volts dc is developed across resistor R604, and diode CR603 is back-biased above emitter peak-point voltage *of* Q601.

b. Trip-Out Timing Circuit.

(1) In the quiescent state, before EXPOSURE SW ITCH S104 is actuated, energizing K 101 and the trip-out arming supply, a small amount of current flows through R609. R602. CR603. and R604. Diode CR602 is back-biased. Capacitor C602 and the emitter of Q601 are at approximately + 2 volts due to the voltage divider action of the network.

(2) When S104 is actuated, and K101 and the trip-out arming supply are energized, CR603 is back-biased and capacitor C602 starts to charge toward the voltage at the anode of Q502. Normally. when the hv pulse generator has been adequately charged. the trigger circuit is actuated and the anode of Q502 fails to approximately 1 volt above ground. When this action occurs. C602 is rapidly discharged through R609 and diode CR602. which is now forward-biased, thus shunting R602. In this manner, C602 is reset each time the trigger circuit operates. When Q502 turns off, C602 starts to charge again. repeating the cycle.

(3) If the trigger circuit fails to operate for any of the following reasons. C602 will charge to the emitter peak-point voltage of Q601: hv power supply PS701 output becomes grounded by a shorted pulser module; several consecutive pulser prefires occur due to insufficient pulser pressure; an internal short develops in the hv power supply; or certain malfunctions occur in the trigger circuit. When the voltage across C602 reaches the emitter peak-point voltage of Q601 (approximately +15 volts) the transistor switches to its conducting state and C602 is suddenly discharged through R606 and R607, developing a positive pulse across the resistors. After C602 has discharged to approximately 2 volts, the emitter ceases to conduct and Q601 switches back to its nonconducting state. Interbase current far Q601 is furnished from the +27-volt supply through R605, a temperature-compensating resistor.

c. Overload Trip-Out Relay Driver. During quiescent conditions, Q602. the overload trip-out relay driver, is in its forward blocking state and its anode sits at + 27-volts. When the trip-out timing circuit completes operation, a portion of the positive pulse developed across voltage divider R606 and R607 is applied to the gate of Q602. causing it to switch to its forward conducting state. Q602 anode pulls down to approximately + 1 volt and overload trip-out relay K 103 is energized. Contacts 2 and 4 on K 103 then interrupt the coil current through power relay K101 and the system reverts to an overload standby condition. Contacts 1 and 6 on K 103 operate red RESET indicator I103, an integral part of RESET pushbutton switch S103. The overload trip-out circuit is reset by pressing S103, which interrupts the anode current of Q602, allowing it to return to its forward blocking state. Resistor R603 furnishes holding current to the anode of Q602 during switching. Diode CR601 and resistor R601 suppress the inductive voltage transient produced by the relay coil upon turnoff. If an overload condition still exists after resetting. the overload trip-out circuit will again operate when system operation is attempted.

6-7. Trigger Power Circuit

The 290-volt winding of low-voltage power supply transformer, diode CR506. and electrolytic capacitor C507 form a half-wave power supply with capacitor input filtering. A nominal + 400 volts dc with respect to ground is developed across resistor R517. The power supply furnishes charging current to trigger capacitor C506 through current-limiting resistor R516 and normally closed contacts 2 and 4 on K 102. When K 102 is actuated by the trigger circuit. charged trigger capacitor C506 is rapidly discharged through the primary of trigger transformer T701. The high step-up turns ratio of T701 produces d high-voltage pulse of about 20 kilovolts across its secondary as C506 discharges. The high-voltage trigger pulse is fed through trigger isolating resistor R902 to the trigger electrode in the hv pulse generator.

6-8. Counter Power Circuit

The secondary of T101 supplies 115 vac to the input of a full-wave bridge composed of diodes CR502 through CR510; 170 volts dc is produced across electrolytic filter capacitor C509 and bleeder resistor R521 with polarity as shown. Resistor R520 serves to limit rectifier surge current when the system power is turned on. When K102 is actuated by the trigger circuit, the counter power supply delivers current to exposure selector CT102 and totalizer CT101 electromechanical counters through normally open contacts 1 and 6 of K102. Drive current is applied to the counters for 20 milliseconds as determined by the trigger circuit. Each time the drive current is applied to the counters, they count one digit until CT102 has counted to ***zero*** and the system returns ***to*** its standby condition. Each time K102 switches power to the counters. red EXPOSING indicator lamp 1102 flashes. Capacitor C508 and resistor R518, **across the relay contacts, suppress contact arcing due to inductive voltage transients produced by the counter coils upon deenergization. Resistor R519 serves to limit drive current to CT101.**

6-9. High-Voltage DC Power Supply

Hv dc power supply (PS701) is comprised of a full-wave doubler circuit that is encapsulated in epoxy for maximum ruggedness (figure 6-3) At nominal input voltage, the power supply has a no-load output voltage of 21.7 kv dc, and is designed to furnish sufficient energy to allow hv pulse generator PG901 to operate with a repetition rate of 14 pulses per second at 150 kv and 20 pulses per second at 100 kv. The dependence of pulse repetition rate on input ac line voltage variations is shown in figure 6-4. Power supply PS701 will operate with either 50-cycle or 60-cycle ac input power. Average power consumption during pulse train operation is 1,200 watts at 150-kv and l00-kv output from hv pulse generator PG901.

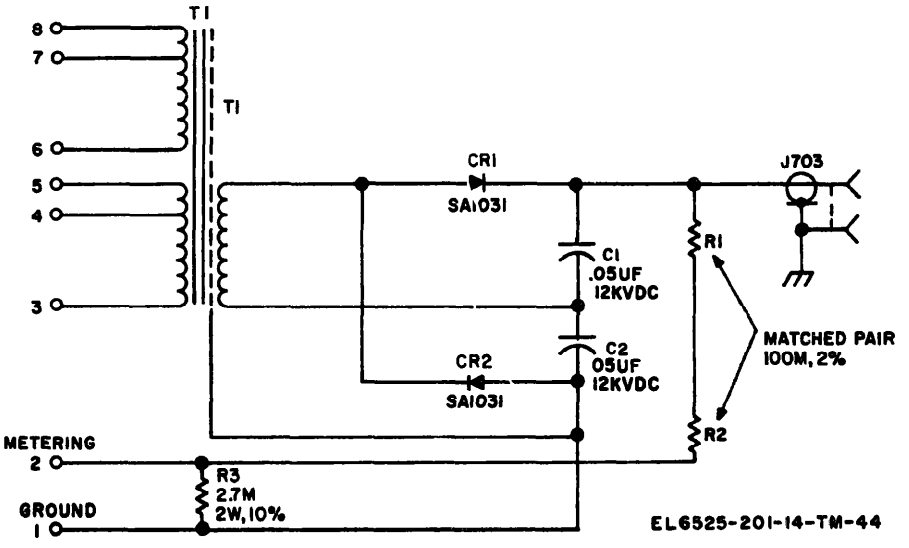


Figure 6-3. High-Voltage Power Supply PS701

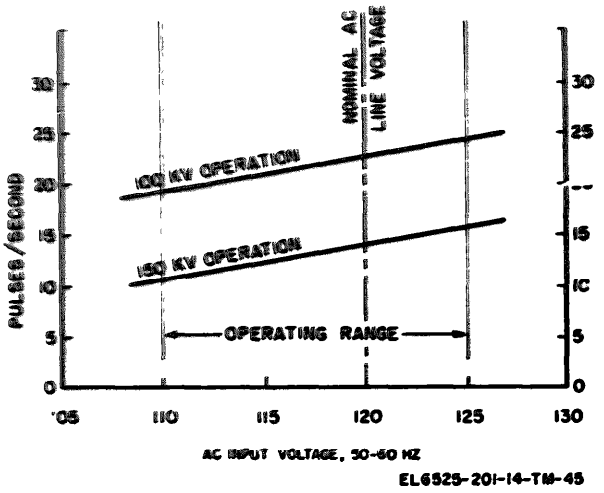


Figure 6-4. Pulse Repetition Rate Versus Input Line Voltage.

NOTE

The quality of the X-ray beam does not change with input line variations.

6-10. High-Voltage Pulse Generator

a. Hv pulse generator PG901 is a modified **Marx Surge circuit. As shown schematically in figure 6-5, energy storage elements (modules) are parallel-connected during the charging phase of operation. During the discharge phase, these modules are series-connected by the spark gap switches and deliver a high-voltage pulse to the X-ray tube (figure 6-6). Each of the modules is constructed so that the stored electrical energy is delivered to the X-ray tube (or resistive load) in a square-wave pulse of approximately 60 nanoseconds (0.00000006 second) duration. The electrical impedance of each** module is approximately **5 ohms, resulting in a total series (discharge mode) generator** impedance **of ap-**proximately 90 ohms. The Model 533 X-ray tube is designed to match the output impedance of **the** pulse generator. At 150 kv, the peak current supplied by the X-ray tube cathode is:

$$I\ (\text{amperes}) = \frac{V\ (\text{volts})}{R\ (\text{ohms})} = \frac{150{,}00}{90} = 1{,}700 \text{ amperes}$$

$$= 1{,}700{,}000 \text{ milliamperes}$$

At 100 kv, the current is approximately 1,100 amperes.

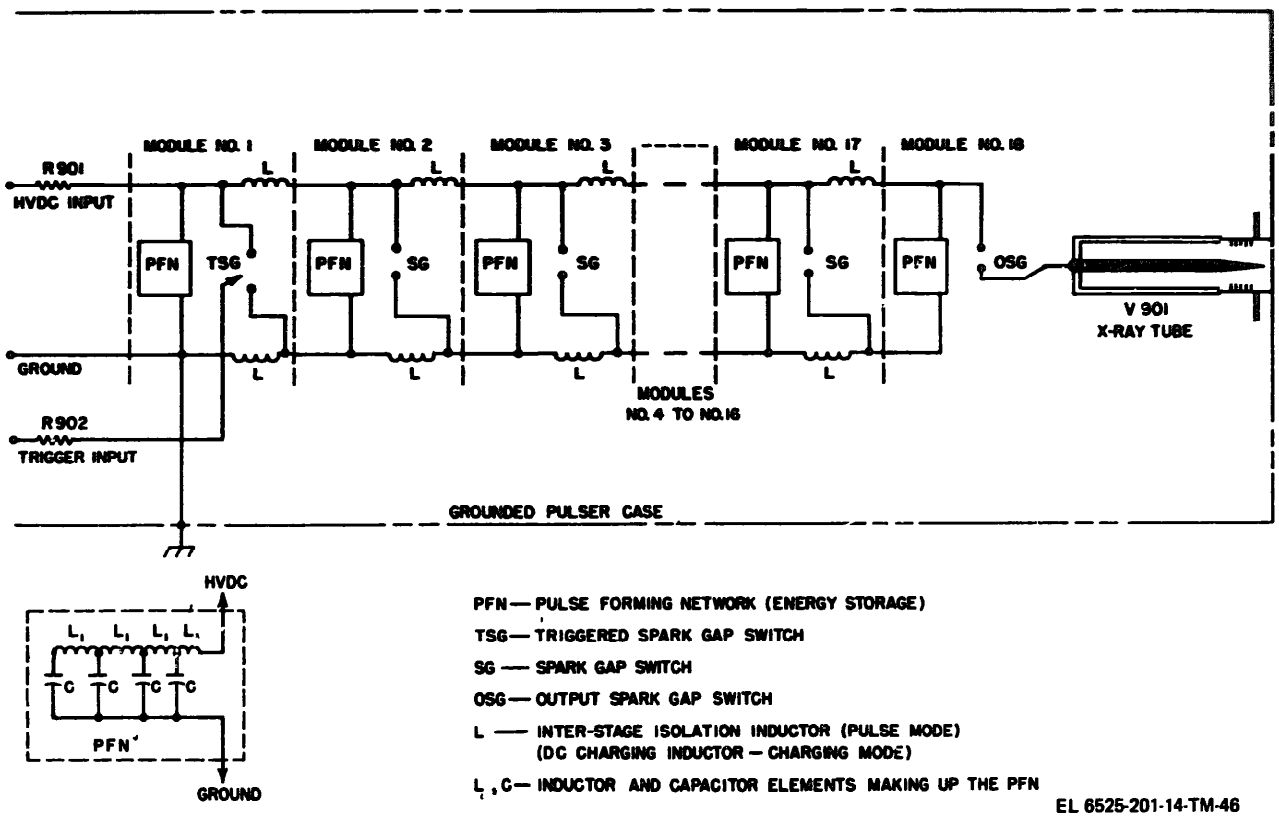


Figure 6-5. High-Voltage Pulse Generator in Charging Mode.

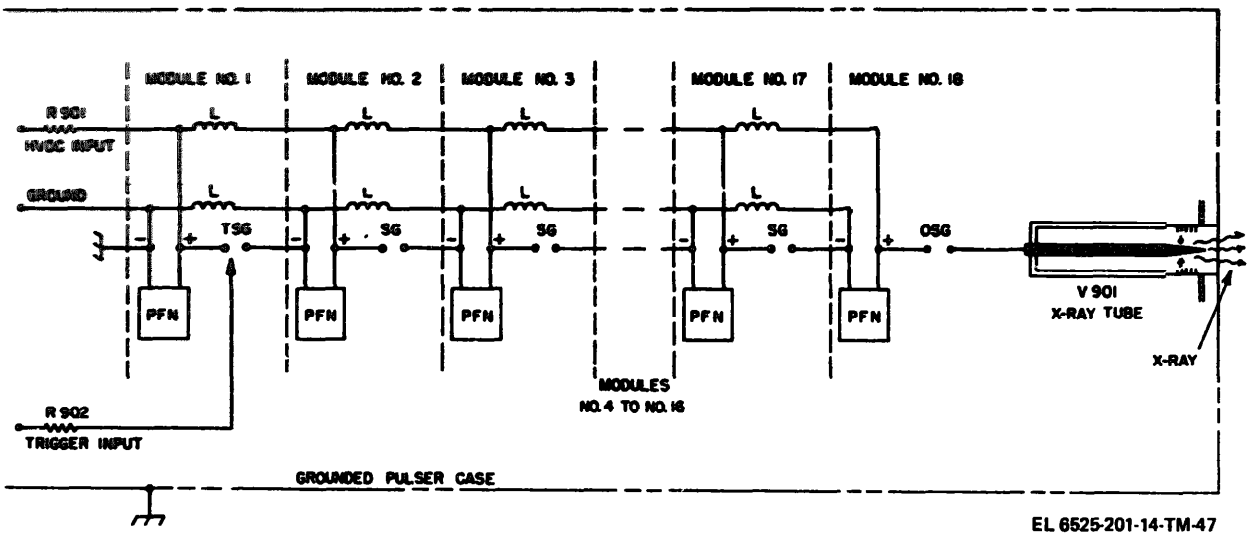


Figure 6-6. High-Voltage Pulse Generator in Discharge Mode.

b. The modules are numbered in sequence, beginning with the module nearest the base (figure 6-7). The first module incorporates the trigger electrode used to initiate the discharge mode. Modules 2 through 17 are identical. The output module (18) differs from the others in that it contains no isolating inductors (figures 6-5 and 6-6). Module 18 is fitted with only one electrical contact button on the top. An electrostatic shield module is used in position 19 to properly define the electric field line distribution at the hv output end of the pulse generator.

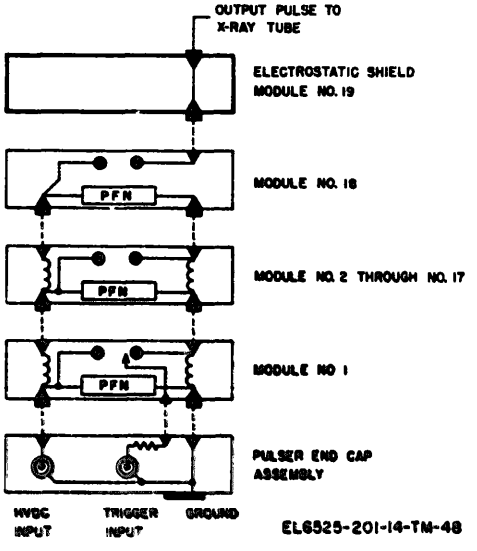


Figure 6-7. Module Interconnection Schematic.

c. The outside of the hv pulse generator case is covered with an electroplated layer of copper that is connected to the system ground, thus containing all high voltage in a grounded metal shield for maximum operator safety.

d. In order to minimize size and provide maximum system reliability. a lead-shielded (3-mm lead). high-voltage chamber is provided as an integral part of the hv pulse generator. Figure 6-8. presents cutaway of the high-voltage chamber The chamber is pressurized with air simultaneously with the hv pulse generator. In addition to isolating viromental effects. the use of pressurized operation at 1.50 kv and 100 kv without mechanical adjustment of the spark gaps; this is accomplished simply by varying the pressure value-

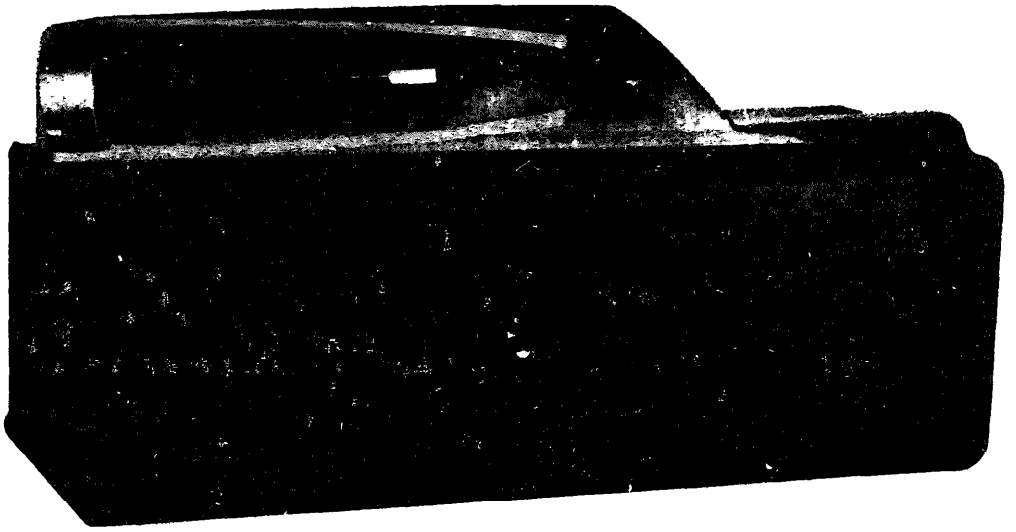


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Figure 6-8. Pulser *Unit Showing Cutaway View of High-Voltage Chamber.*

6-11. Air Supply Assembly

a. The air supply assembly provides hv pulse generator and X-ray tube pressurization. Air passes from the hand pump, through a desiccant chamber, into the pulse generator interior. Refer to figure 6-9 for the air flow diagram. ***A*** minimum pressure level interlock switch is incorporated in the air system. ***A*** pressure release valve is provided to facilitate rapid and ***safe*** release of air from the system.

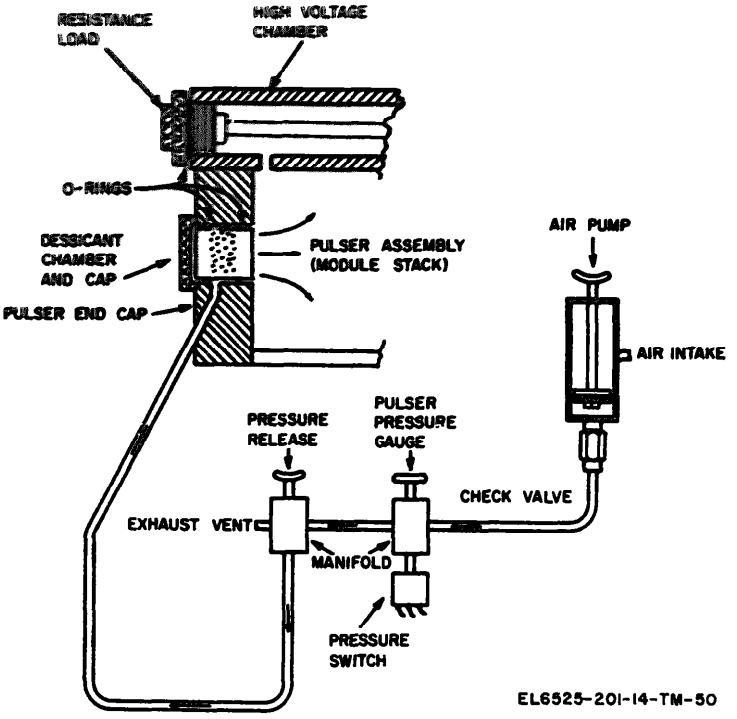


Figure 6-9. Air Flow Diagram in Air Pressure System.

b. The desiccant (housed in the hv pulse generator end cap) serves to remove dust and moisture from the air to insure maximum spark gap life and stability.

6-12. X-Ray Tube

a. The X-ray tube (V9011) (figure 6-l0) is a cold-cathode tube designed specifically for use with the X-rav apparatus. A schematic representation is shown in figure 6-11. Several comb-shaped electron sources are arranged around a conical tungsten anode. The conical anode provides a large surface area for heat dissipation, but also a small X-ray source when viewed end on. Another advantage of the conical anode is that maximum resolution occurs at the center of the X-ray field **and** degrades only slightly toward the edges of the field.

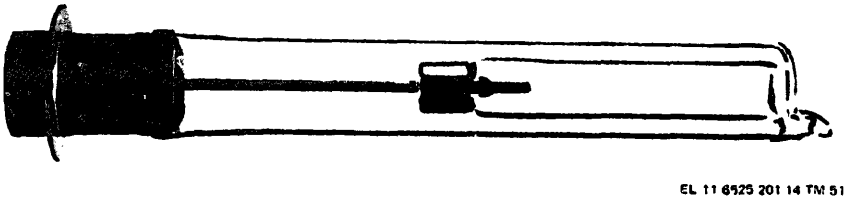


Figure 6-10. X-Ray Tube

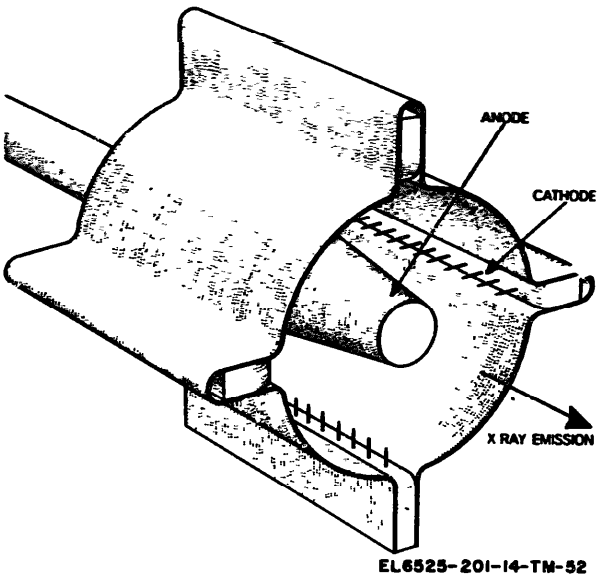


Figure 6-11. Internal Construction of X-Ray Tube.

b. **A 100-kv or 150-kv square-wave pulse is applied between anode and cathode, creating an extremely high electric field at the cathode. An electron current of 1,100 to 1,700 amperes is** emitted from the cold comb-shaped cathodes. The electrons are accelerated across the cathode-anode gap and strike the anode, resulting in the generation of X-rays. With appropriate lead-shielding, the useful X-ray beam is limited to a cone approximately 30 degrees. Inherent filtration is in excess of 2.5 mm aluminum equivalent. The effective X-ray source size is 1.8 mm or less.

6-13. Resistive Load

The resistive load shown in figure 6-12 is a 90-ohm, wire-wound resistor for use with X-ray apparatus remote tubehead. The resistive load may be substituted for the X-ray tube during operational checkout procedures and maintenance procedures, eliminating unnecessary radiation hazards.

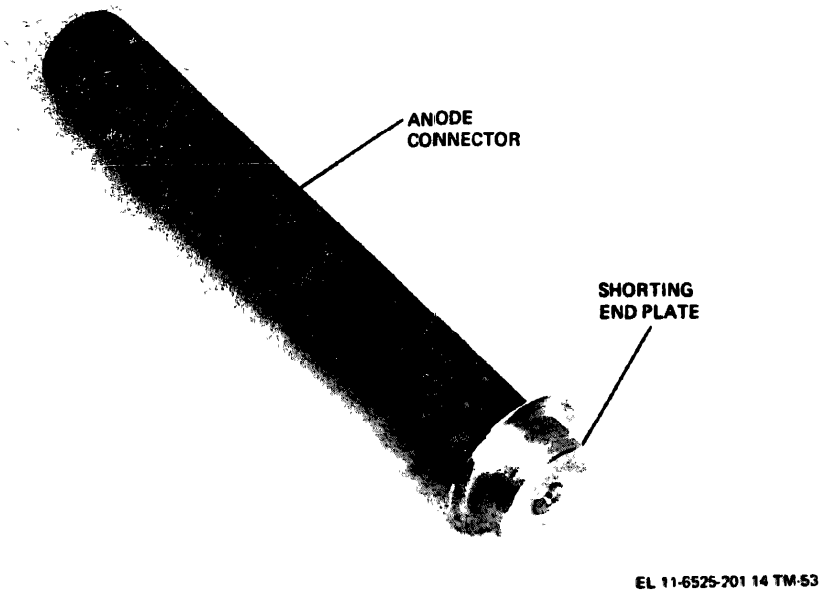


Figure 6-12. Resistive Load.

6-14. Remote X-Ray Tubehead

The impedance of the hv pulse generator is approximately 90 ohms. The X-ray tube (or resistive load) may be separated from the pulse generator provided the interconnecting cable has the same characteristic impedance; so there is an impedance-matched system. A special 90-ohm, high-voltage coaxial cable has been developed to satisfy this requirement. The tubehead contains the same lead shielding as the tube chamber in the pulse generator.

CHAPTER 7

DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

7-1. Scope of Maintenance

a. This chapter contains **instructions covering** direct support maintenance for **the X-ray ap-**partus. It includes instructions Text for replacement of maintenance parts. instructions for troubleshooting, and repair procedures to be ac-**complished by** direct maintenance personnel.

b. Direct support maintenance includes:

(1) Tools. Materials. and Test Equipment (Section I).

(2) Troubleshooting (Section II).

(3) Adjustments. Alignment, Replacements, Repair. and Final Testing (Section III).

7-2. Tools, Materials, and Test Equipment

a. Tools at Direct Support level are contained in Tool Kit TK-101/G (FSN 5180-064-5178).

b. Materials.

(1) Clean. lint-free cloths.

(2) Lubricating oil.

c. Test Equipment.

(1) Multimeter TS-352B/U (FSN 6625-553-0142).

(2) Oscilloscope AN/USM-281 (FSN 6625-053-3112).

(3) Radiac Meter IM-9/PM (FSN 6625-243-8199).

(4) Charger, Radiac Detector PP-1578-PD (FSN 6625-542-1177).

Section II. TROUBLESHOOTING

7-3. General

Preliminary procedures necessary to prepare the control unit for troubleshooting, as well as the appropriate test points required for voltage and waveform measurements, are presented in the following paragraphs. The test procedures presented in these paragraphs are augmented by simplified circuit diagrams showing test point locations and typical waveform illustrations. Items of test equipment required to perform tests are listed in paragraph 7-2

7-4. Voltage and Waveform Measurements

Voltage measurements are included on the schematic diagram. figure 7-1. Waveforms are referenced to their location.

7-5. Fault Analysis

a. The troubleshooting information in table 7-1, Direct Support Troubleshooting, will assist a technician in analysis of malfunctions observed during performance of control unit test procedure and operational check. A detailed schematic diagram of the X-ray apparatus is shown in figure 7-1.

b. Conduct the operational check (paragraph 4-9) first to determine overall performance of the X-ray apparatus; refer to organizational maintenance troubleshooting, table 5-2, for initial fault isolation procedures. Perform control unit test (paragraph 7-15) to verify operational readiness of overload trip-out circuit board and further isolate possible malfunctions observed during analysis of the overload trip-out function (paragraph 5-12 b.). Information obtained while conducting the control unit test. along with that provided in the troubleshooting chart, enables the maintenance technician to isolate overload trip-out circuit board malfunctions to detailed electronic components.

CAUTION

When conducting voltage measurements, use tape or sleeving to insulate the entire test probe except for the extreme t i p . A momentary short circuit can ruin a transistor. **Take** care when measuring resistance values in transistorized circuits Use the times-10 scale on multimeter for measuring resistance in circuits containing low-signal-type transistors; other scale & **may contain battery voltages that can cause excessive current flow through the transistor.**

Figure 7-1. X-Ray Apparatus Schematic Diagram

(Located in back of manual.)

Table 7-1. *Direct Support Maintenance Troubleshooting*

	Probable Cause	Corrective Action
I. X-ray apparatus operates with 150K. output but not with 100 kv.	1. Rate resistor (Rl02) defective.	1. Replace defective resistor.
2. Erratic pulse train operation.	2a. Loose high-voltage cable from power supply to charging resistor. *b.* Charging resistor not properly seated in high-voltage end cap assembly.	2a. Check security of high-voltage cable and tighten if **necessary.** b. Check charging resistor. Service with Dow Corning No. 5 compound and reseat if necessary (refer to paragraph 5-l4a. step (12)).
3. Overload trip-out circuit sawtooth waveform out of tolerance.	3a. Timing capacitor C602 out *of* tolerance. *b.* Resistance value of resistor R606 or R607 out of tolerance.	3a. Check capacitor value and replace if required. b. Check resistance value and replace defective resistor.
4. Oscilloscope indicates absence of sawtooth waveform	4a. Transistor Q601 or associated components defective. *b.* 'riming capacitor C602 open. c. Timing resistor R606 or R607 open.	4a. Troubleshoot circuit and replace defective component. b. Replace capacitor. c. Replace resistor.
5. X-ray tube output drops to low value (refer to output test. paragraph 4-13).	5a. Defective high-voltage cable b. Short circuit in remote tubehead assembly.	5a. Replace high-voltage cable. b. Using ohmmeter. check for short in tubehead assembly. Replace tubehead assembly if neceesary Note. Ohmmeter will indicate short circuit only if continuous *arc* path has formed.
6. Dc voltage at pin D of JIO4 out of tolerance.	6a. Capacitor C501 defective. b. Resistor R50l open. c. Diode CR501 or CR502 defective	6a. Replace defective capacitor b. Replace defective resistor. c. Replace defective diode.
7. Dc voltage at pin L **of** JIO4 out of tolerance.	7 a. Resistor R101 open. b. Zener diode CR101 defective.	7a. Replace defective resistor. b. Replace defective diode
8. Voltage at zener diode CR503 incorrect.	8a. Resistor R501 open. b. Zener diode CR503 defective.	*8a.* Replace defective resistor. b. Replace defective diode.
9. Voltage level between JIO4 pins U and Z incorrect.	9a. Resistor R520 open. b. Diode CR507, CR508, CR509, or CR510 defective.	9a. Replace resistor. b. Troubleshoot circuit and replace defective diode.
10. Dc voltage at pin R of JI04 incorrect.	IO a. Resistor R510 open. b. Diode CR506 defective.	IO *a.* Replace resistor. b. Replace diode
11. Waveform at pin 5 of trigger relay K102 incorrect.	11a. a. Trigger **transformer T701** defective. b. Relay K102 defective. c. Trigger relay driver transistor Q502 or associated components defective.	11a. Replace transformer. b. Replace relay. c. Troubleshoot relay driver circuit and replace defective component.
12. Waveform observed at pin E of J1O4 during 100KV operation incorrect.	12a. I 100KV trigger level msadjusted.	**12a. Calibrate 100KV circuit in accordance with General Support Maintenance.**
	b. Resistor R504 or potentiometer R502 defective.	**b. Troubleshoot and replace defective component**
	c. Diode CR101 or associated components defective.	**c. Troubleshoot circuit and replace defective component**
13. Waveform observed at pin E of J104 during 150KV operation incorrect.	**13a. 150KV trigger level misadjusted.**	**13a. Calibrate 150kV circuit in accordance with General Support Maintenance.**
	b. Potentiometer R503 defective.	**b Replace potentiometer**
	c. Diode CR101 or associated components defective.	**13c. Troubleshoot circuit and replace defective component**
14. Waveform observed at pin M of J104 incorrect.	**14a. Timing circuit misadjusted.**	**14a Calibrate timing circuit in accordance with General Support Maintenance**
	b. Resistor R511 or potentiometer R510 defective.	**b. Troubleshoot and replace defective component.**
	c. Capacitor C505 defective.	**c Replace capacitor**

Section III. ADJUSTMENTS, ALIGNMENT, REPLACEMENTS, REPAIR, AND FINAL TESTING

7-6. Direct Support Maintenance of X-ray Apparatus

Direct support maintenance of X-ray apparatus consists of removal and replacement of defective components on overload trip-out circuit board, and checkout and repair of control cables. and removal of tubehead assembly. The thee test and troubleshooting instructions presented in preceding paragraphs. along with schematic diagram shown in figure 7-l will aid in isolating defective components. Excessive soldering and unsoldering of electronic components may result in damage to the printed circuit board. Therefore, determine the component responsible for a particular malfunction before removing any item from the circuit board.

7-7. Repair of Overload Trip-out Circuit Board

When the most probable cause of an overload trip-out circuit malfunction has been determined, remove circuit board from control unit according to instructions presented in paragraph 5-15, and locate defective component on circuit board. Review the following soldering and repair techniques, and observe all cautions before attempting to remove and replace components from printed circuitry.

d. Apply heat to the component lead on the component side of the board. Remove the component with a straight outward pull. Use a toothpick or a suitable wooden splinter to clean the hole where the component lead is removed. Solder the replacement component from the conductor side of the board.

b. Before replacing a part, note the orientation of the part. as well as its lead length and dress. Insure that the replacement part is oriented in the same manner, and that its lead length and dress are the same.

CAUTION

Use a pencil-type soldering iron with a ***5O***-watt maximum rating. If an ac iron must be used, use an isolation transformer between the iron and the ac line. Do not use a soldering gun; damaging voltages can be induced in the transistors.

CAUTION

When soldering transistor leads, use a well tinned iron, and solder quickly. Whenever lead length permits, use a heatsink (such as long-nosed pliers) between the soldering joint and the body of the transistor.

7-8. Repair of Control Circuit Board

Remove control circuit board in accordance with instructions presented in paragraph 5-15. Review the following soldering and repair techniques, and observe cautions before attempting to remove and replace components from printed circuitry.

a. Apply heat to the component lead on the component side of the board. Remove the component with a straight outward pull. Use a toothpick or a suitable wooden splinter to clean the hole where the component lead is removed. Solder the replacement component from the conductor side of the board.

b. Before replacing a part. note the orientation of the part. as well as its lead length and dress. Insure that the replacement part is oriented in the same manner. and that its lead length and dress are the same.

CAUTION

Use a pencil-type soldering iron with a SO-watt maximum rating. If an ac iron must be used, use an isolation transformer between the iron and the ac line. Do not use a soldering gun; damaging voltages can be induced in the transistors. When soldering transistor lead length permits, use a heatsink (such as longnosed pliers) between the soldering joint and the body of the transistor.

7-9. Low-Voltage Power Supply Transformer (TlOl) Removal and Replacement (figure 5-8)

NOTE

Before unsoldering and removing wires from transform , identify wire locations to facilitate accurate reassembly.

a. Remove two screws and two nuts and remove transformer from chassis.

b. Unsolder and remove electrical wiring from transformer.

c. Solder wires to terminals of replacement transformer.

d. Position transformer on chassis and secure with two screws and two nuts.

7-10. Line Voltage Transformer (T703) Removal and Replacement (figures 5-10 and 7-2)

NOTE

Before unsoldering and removing wires from transformer, identify wire locations to facilitate accurate reassembly.

a. Remove four screws and four nuts from top of chassis, two screws and two nuts from bottom of chassis, and two screws from rear of chassis (above plug).

b. Slide transformer out of transformer chassis.

c. Remove two screws securing bracket and standoffs to transformer.

d. Unsolder and remove electrical wiring from transformer.

e. Solder wires to terminals of replacement transformer.

f. Position bracket and standoffs on replacement transformer and secure using two screws.

g. Slide replacement transformer into position on transformer chassis and secure with two screws and two nuts on chassis, and two screws through rear of chassis.

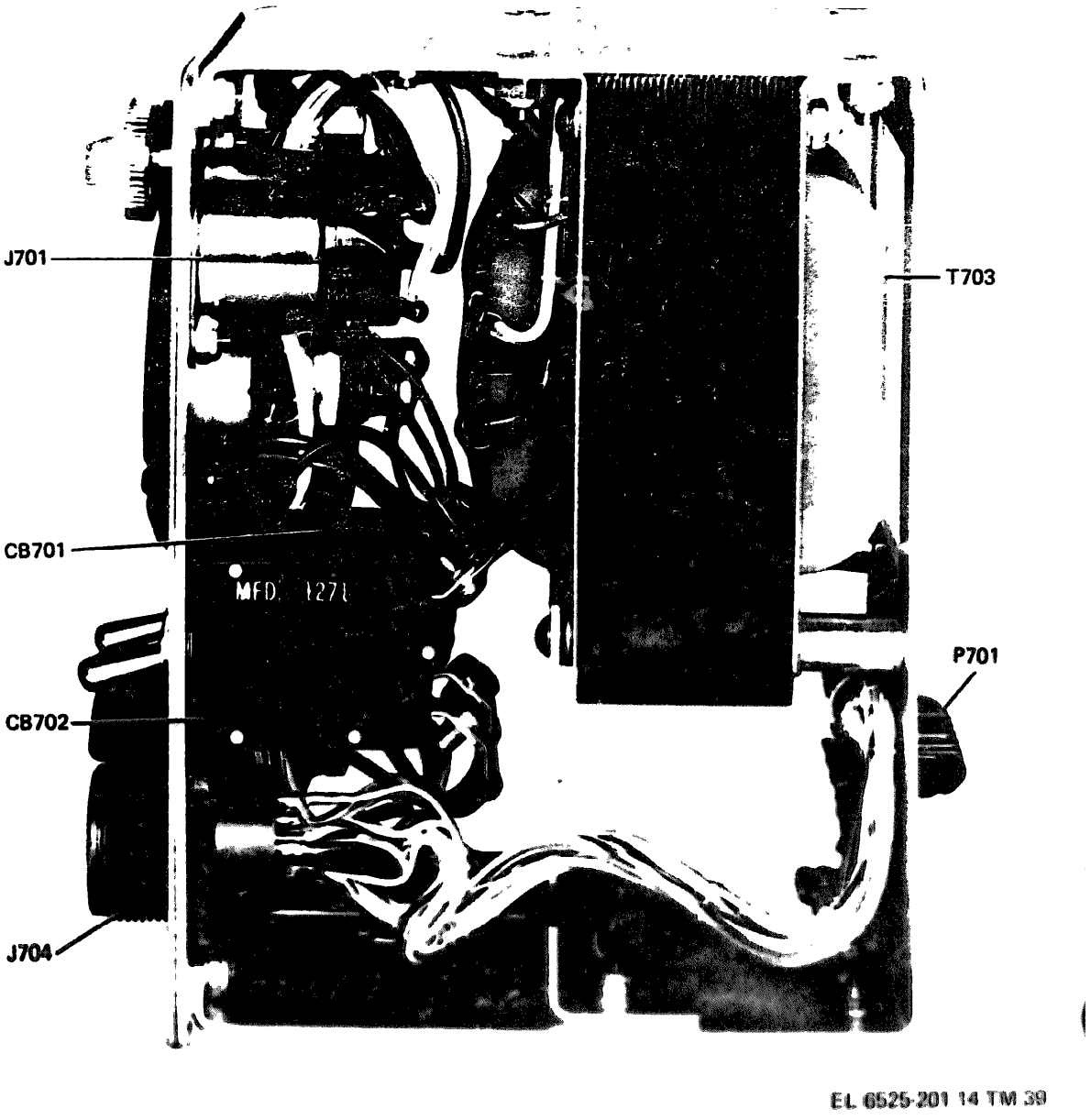


Figure 7-2. Transformer Section, Right Side.

7-11. TOTALIZER (CT 101) Removal and Replacement

a. Remove upper and lower counter clamps (lower counter clamp is also used to secure EXPOSURE SELECTION counter).

b. Remove counter from subpanel and slide counter out of chassis.

c. Remove electrical wiring from counter by pulling slip-on wire lugs off counter terminals.

d. Press wire lugs on terminals of replacement counter.

e. Position replacement counter in chassis and secure with upper and lower counter clamps.

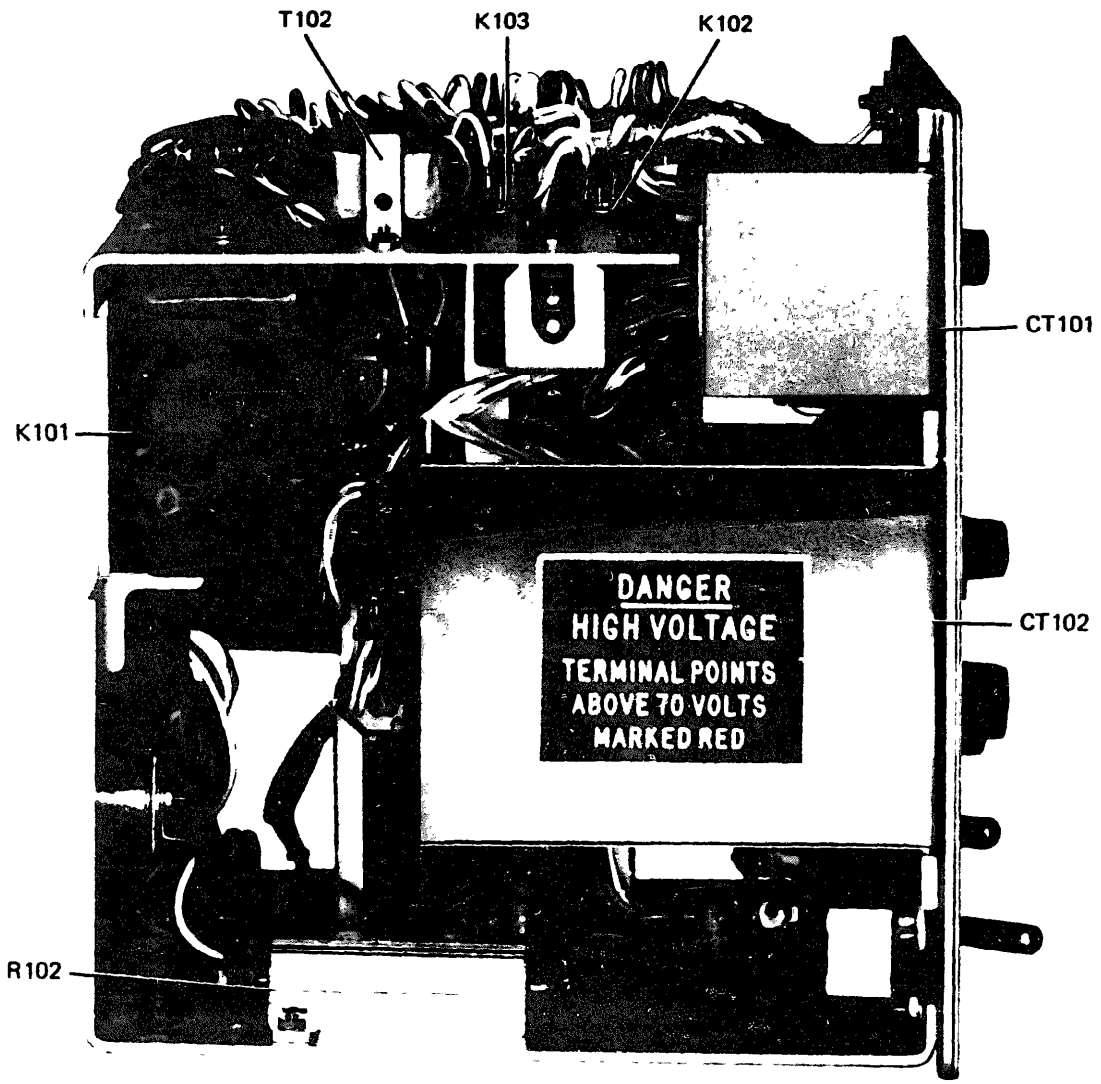


Figure 7-3. Control Section. Left Side

7-12. Exposure Selector (CT 102) Removal **and** Replaccment

[figure 7-3).

NOTE

Before unsoldering and removing wires from counter. identify wire locations to facilitate accurate reassembly.

d. Remove upper and lower counter clamps tupper counter clamp is also used to secure TOTALIZER counter).

b. Remove counter from subpanel and slide counter out of chassis.

c. Remove electrical wiring from counter by pulling slip-on wire lugs off of two upper counter terminals.

d. Unsolder and remove wiring from remaining three counter terminals.

e. Solder wires to lower three terminals **of** replacement counter and press wire lugs on upper two terminals.

/. Position replacement counter in chassis and secure with upper and lower counter clamps.

7-13. Repair of Control Cable

Repair of control cable consists of removal and replacement of connectors or 12-conductor electrical cable. If connectors are damaged, replace as follows :

d. Remove two screws and unscrew cable clamp from connector.

b. Unsolder wires from damaged connector.

NOTE

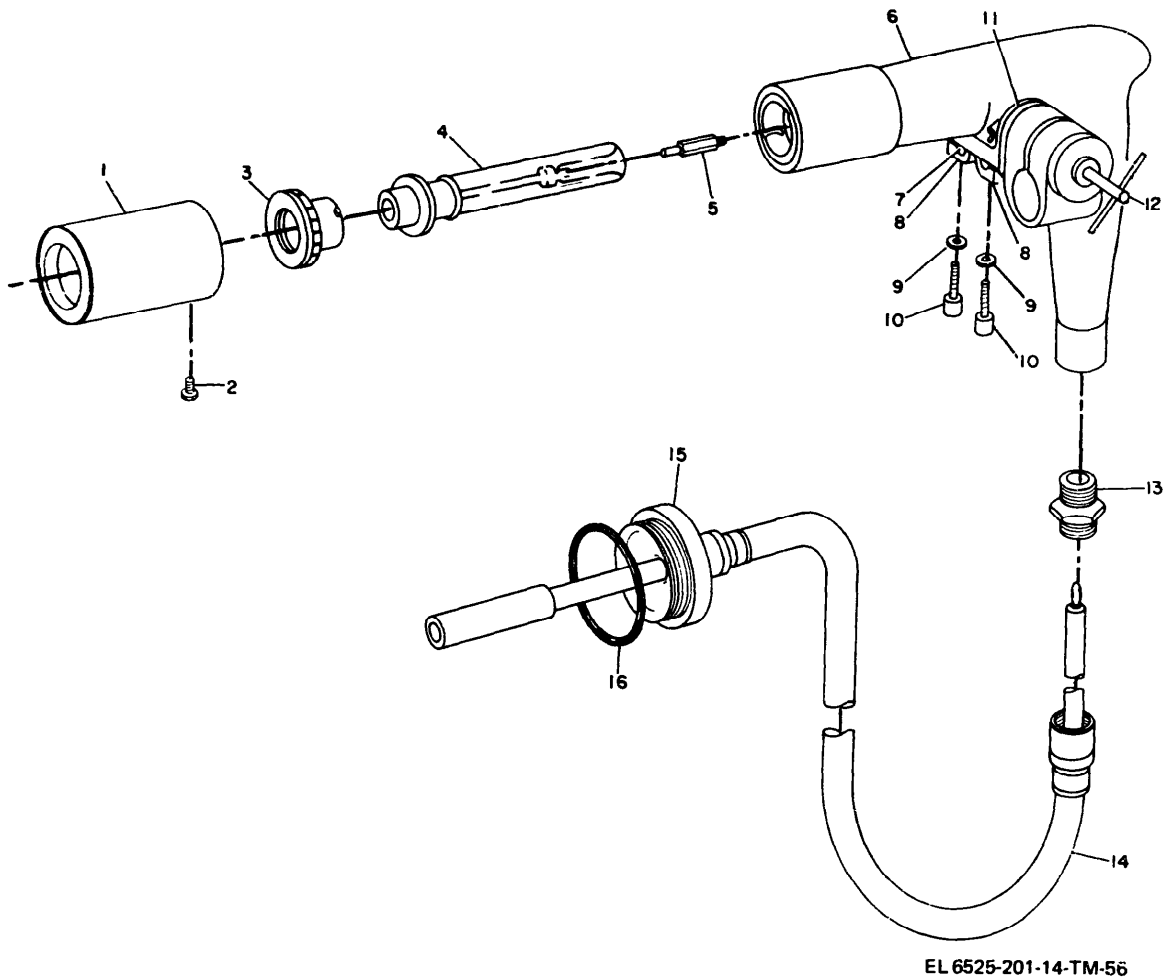
Make certain that wire ends are in good condition and are properly tinned before soldering to pins of replacement connector. If any of the wiring is damaged, remove damaged portion, strip insulation back to expose **new** wire, and tin before soldering.

c. Slide cable clamp over cable. Solder wires to replacement connector.

d. Secure cable clamp to replacement connector and tighten two screws.

7-14. Repair of Remote Tubehead Assembly

An exploded view of the remote tubehead assembly is shown in figure 7-4. Repair consists of replacing damaged or defective high-voltage cable, or damaged components of the remote tubehead housing. No special disassembly or repair instructions are necessary; refer to explored view and remove and replace defective components as required.



1. **Cup Shield Assembly**
2. **Pan Head Machine Screw**
3. **Tube Cap Assembly**
4. **X-ray Tube**
5. **Anode Connector**
6. **Modified Right-Angle Tubehead**
7. **Tubehead Mounting Bracket**
8. **Spacer Rod Clamp**
9. **Flat Washer**
10. **Socket Head Capscrew**
11. **Tubehead Clamp**
12. **Locking Screw**
13. **Cable Connector**
14. **Cable Assembly**
15. **Cable Adaptor**
16. **O-Ring**

Figure 7-4. Remote Tubehead Assembly Exploded Vleu

WARNING

If tests are to be performed with X-ray tube installed. insure that equipment is operated in a facility specifically designed for X-ray radiography , and observe all safety, precautions associated with the operation of S-ray equipment.

7-15. Overload Trip-out Circuit Test

a. Disassemble control unit and remove PC521 circuit board in accordance with paragraph 5-15, steps a through d.

b. Refer to figure 7-5 for location of overload trip-out circuit test point.

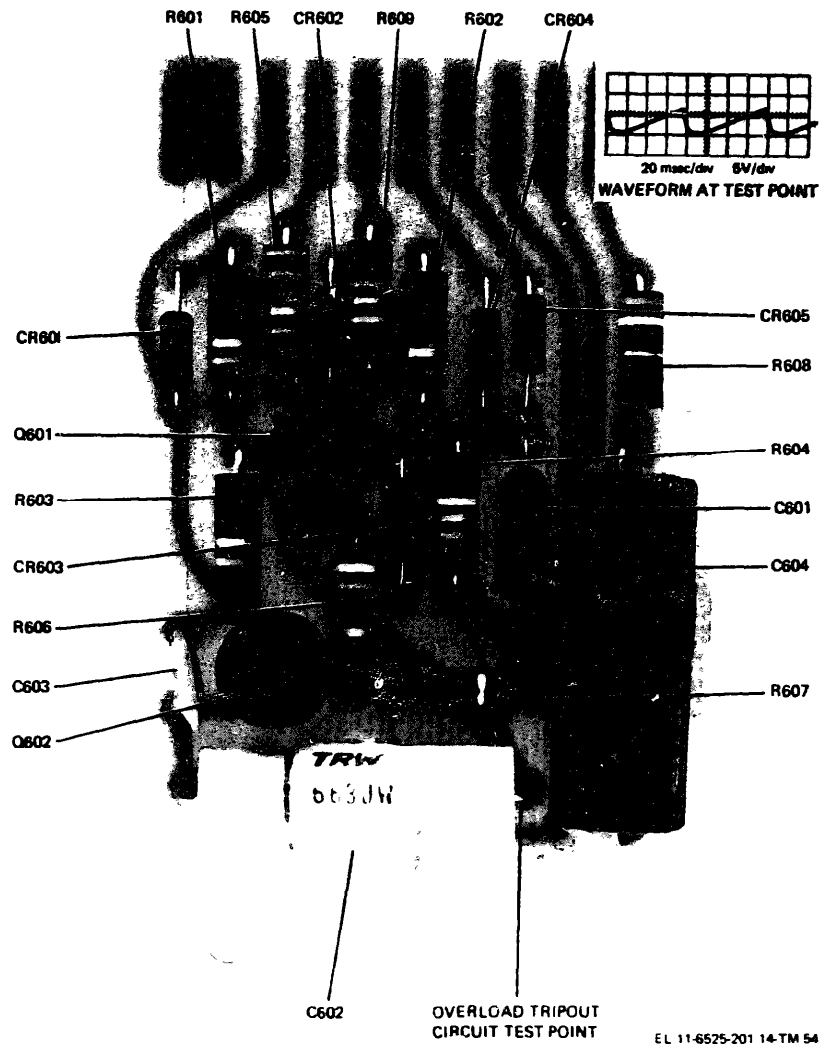


Figure 7-5. Overload Trip-Out Circuit Board (PC521)

CAUTION

Use a pencil-type soldering iron with a 50-watt maximum rating to prevent damage to printed circuitry. If an ac soldering iron must be used, use an isolation transformer between the iron and the ac line. Insure that soldering iron is properly tinned to permit maximum heat transfer, thus reducing contact time between iron and circuit board.

c. Solder a 6-inch piece of insulated wire to test point (solder wire to land pattern side of circuit board).

d. Reinstall PC521 and PC522 circuit boards and connect control and transformer chassis.

CAUTION

Insure that control unit chassis are isolated from possible electrical damage before applying power to unit.

e. Install resistive load in pulser assembly.

f. Pressurize the system to 6 to 8 psi as indicated by PULSER PRESSURE gauge.

g. Interconnect control unit and pulser using control cable.

h. Set LINE VOLTAGE ADJUST to valve

corresponding to input voltage. Connect exposure switch cable to jack on control unit panel.

i. Set EXPOSURE SELECTOR to 99 and 100KV/15OKV switch to 150KV.

j. Set oscilloscope VERTICAL INPUT selector switch to DC COUPLING position. Connect times-*IO* probe to oscilloscope input and connect it to 6-inch wire soldered to overload trip-out circuit board.

k. Set CIRCUIT BREAKERS 1 and 2 to ON and POWER ON switch to ON.

NOTE

Selection of l50KV output voltage in conjunction with low pulser pressure will result in a prefire condition, thus activating the overload trip-out circuit.

l. Press exposure switch and observe waveform on oscilloscope. (Refer to figure 7-5 for typical waveform.) Duration of sawtooth waveform should be 175= 20 milliseconds.

m. Upon completion of test, disconnect power source from system and remove overload trip-out circuit board from control unit. Unsolder 6-inch wire from circuit board.

n. Reassemble control unit in accordance with paragraph 5-15, steps e and f.

7-16. Low-Voltage Power Supply Test

a. Disassemble control unit to gain access to test points in accordance with paragraph 5-15, steps a and ***b.***

b. Refer to figures 7-6 and 7-7 for location of low-voltage power supply test points.

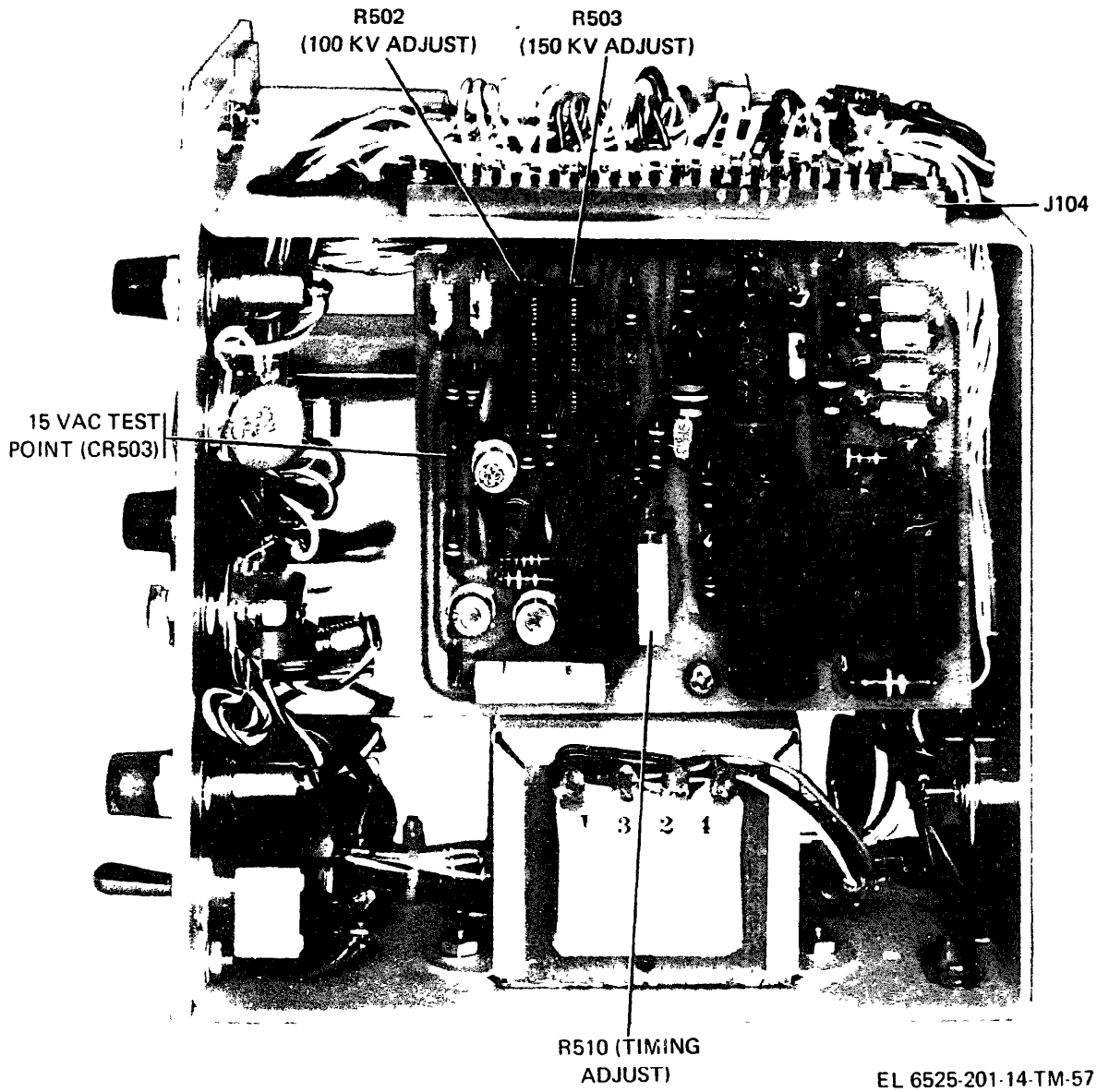


Figure 7-6. Control Circuit Board Test Point and Adjustment Locations

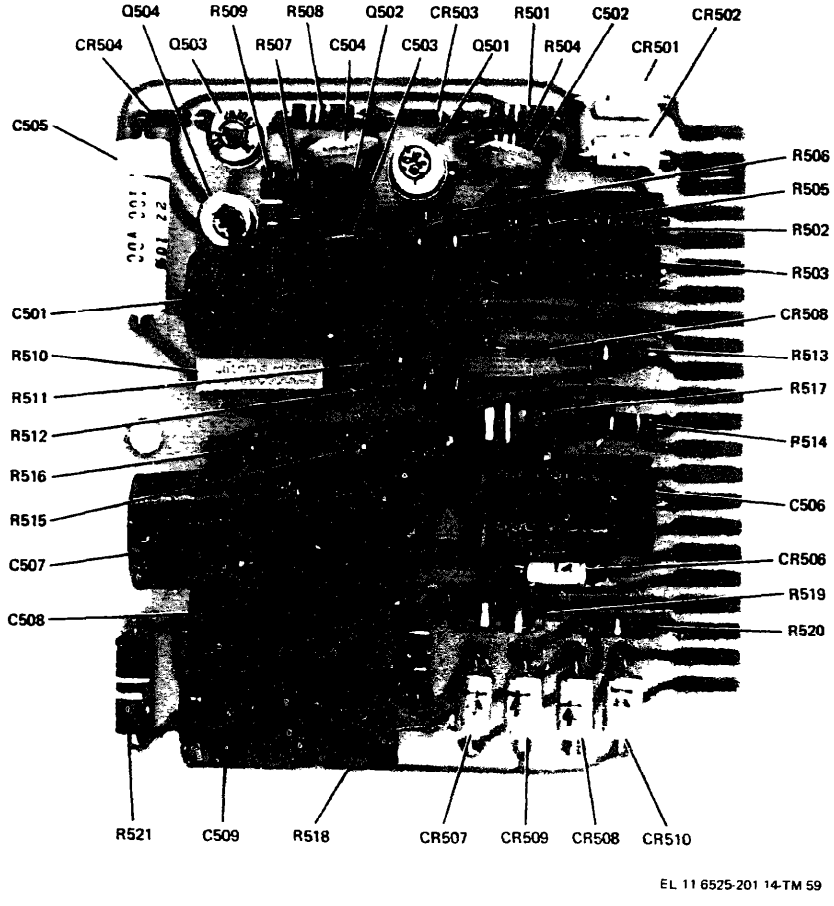


Figure 7-7. Control Circuit Board (PC 522) Component Identlfication.

CAUTION

Insure that control unit chassis are isolated from possible electrical damage before applying power to unit.

NOTE

It is not necessary to connect pulser to control unit to perform the following test.

c. Interconnect control unit sections by installing transformer section plug in control section connector.

d. Set LINE VOLTAGE ADJUST to value corresponding to input voltage.

e. Set CIRCUIT BREAKERS 1 and 2 to ON and POWER ON switch to ON

f. Adjust vtvm for ac voltage measurements Connect vtvm to pin A of J104 Vtvm should indicate 30.0 ±1.5 vac.

g. Connect(vtvm m to pin B of J104 Vtvm should indicate 300±1.5 vac

h. Adjust vtvm for dc voltage measurements Connect vtvm to pin D of J104. Vtvm should indicate 38.0 ±7.5 vdc.

i. Connect vtvm to pin L of J104. Vtvm should indicate 27.0 ± 1.5 vdc.

j. Connect vtvm to cathode (top) of diode CR503. Vtvm should indicate 15.0± 0.75 vdc.

7-17. Counter Power Supply Test

d. Disassemble control unit to gain access to test points in accordance with paragraph 5-15, steps a and b.

CAUTION

Insure that control unit chassis are isolated from possible electrical damage before applying power to unit

NOTE

It is not necessary to connect pulser to (control unit to perform the following test.

b. Interconnect control unit sections by installing transformer section plug in control section connector

c. Set LINE VOLTAGE ADJUST to value corresponding to input voltage.

d. Set CIRCUIT BREAKERS 1 and 2 to ON and POWER ON switch to ON.

e. Adjust vtvm for ac voltage measurements. Connect vtvm to pin X of J104. Vtvm should indicate 120±5 vac.

f. Adjust vtvm for dc voltage measurements. Connect positive lead of vtvm to pin U of J104 and negative lead to pin Z of J104. Vtvm should indicate 170± vdc.

7-18. Trigger Power Circuit Test

a. Disassemble control unit to gain access to test points in accordance with paragraph 5-15, steps a and b.

b. Refer to figures 7-3 and 7-6 for location of trigger power circuit test points.

CAUTION

Insure that control unit chassis are isolated from possible electrical damage before applying power to unit.

c. Install resistive load in pulser assembly.

d. Pressurize the system to 8 psi for 100 KV operation .

e. Interconnect control unit sections by installing transformer section plug in control section connector. Connect control unit to pulser using control cable.

f. Set LINE VOLTAGE ADJUST to value corresponding to input voltage. Connect exposure switch cable to jack on control unit panel.

g. Set EXPOSURE SELECTOR to 99 and 100KV/I5OKV switch to 100KV.

h. Set CIRCUIT BREAKERS 1 and 2 to ON and POWER ON switch to ON.

i. Adjust vtvm for ac voltage measurements. Connect vtvm to pin T of J104. Vtvm should indicate 290 ±15 vac.

j. Adjust vtvm for dc voltage measurements. Connect vtvm to pin R of J104. Vtvm should indicate 400 to 450 vdc.

k. Connect times-10 probe to oscilloscope input and connect it to pin 5 of trigger relay (K 102). Press exposure switch and observe waveform shown in figure *7-8.*

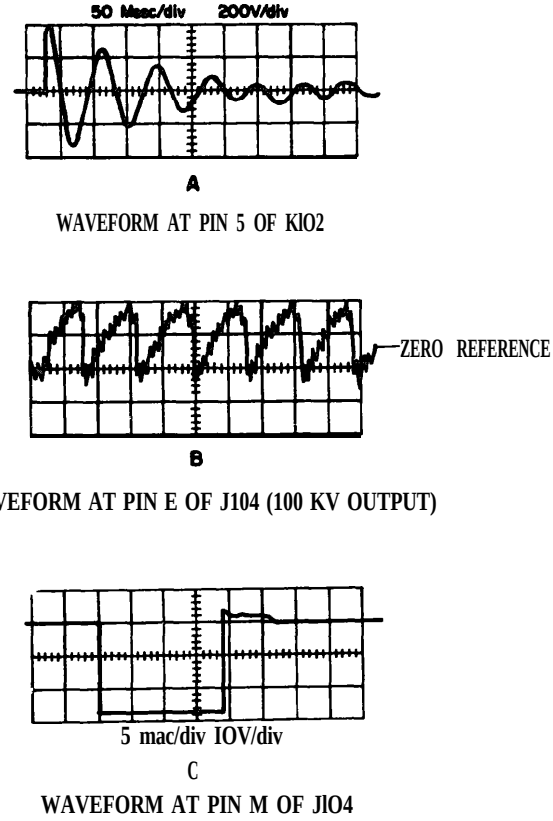


Figure 7-8. Control Circuit Board Waveforms.

7-19. Trigger Level Circuit Test

a. Disassemble control unit to gain access to test points in accordance with paragraph 5-15, steps a and b.

6. Refer to figure 7-6 for location of trigger level circuit test points.

CAUTION

insure that control unit chassis are isolated from possible electrical damage before applying power to unit.

c. install resistive load in pulser assembly.

d. Pressurize the system to 8 psi for 100KV operatlon.

e. Interconnect control unit sections by installing transformer section plug in control section connector. Connect control unit to pulser using control cable.

f. Set LINE VOLTAGE ADJUST to value corresponding to input voltage. Connect exposure switch cable to jack on control unit panel.

g. Set EXPOSURE SELECTOR to 99 and 100KV/150KV switch to 100KV.

h. Set CIRCUIT BREAKERS 1 and 2 to ON and POWER ON switch to ON.

i. Set oscilloscope VERTICAL INPUT selector switch to DC COUPLING position. Connect times-10 probe to oscilloscope input and connect it to pin E of J104. Press exposure switch and observe waveform on oscilloscope (figure 7-8). Waveform observed on oscilloscope should have a peak amplitude of 11.4 volts above zero reference. If voltage is out of tolerance, refer to General Support Maintenance for adjustment procedure.

j. Pressurize the system to 22 psi for 150KV operation.

h. Set lOOKV/150KV switch to 150KV and EXPOSURE SELECTOR to 99.

l. Press exposure switch and observe waveform on oscilloscope. Waveform observed on oscilloscope should have a peak-to-peak amplitude of 16.4 volts. If voltage is out of tolerance, refer to General Support Maintenance for adjustment procedure.

7-20. Timing Circuit Test

d. Disassemble control unit to gain access to test points in accordance with paragraph 5-15, steps a and b.

b. Refer to figure 7-6 for location of trigger level circuit test point.

CAUTION

Insure that control unit chassis are isolated from possible electrical damage before applying power to unit.

c. Install resistive load in pulser assembly.

d. Pressurize the system to 8 psi for 100KV operation.

e. Interconnect control unit sections by installing transformer section plug in control section connector. Connect control unit to pulser using control cable.

j. Set LINE VOLTAGE ADJUST to value corresponding to input voltage. Connect exposure switch cable to jack on control unit panel.

g. Set EXPOSURE SELECTOR to 99 and 1OOKV/150KV switch to 100KV.

h. Set CIRCUIT BREAKERS 1 and 2 to ON and POWER ON switch to ON.

i. Set oscilloscope VERTICAL INPUT selector switch to DC COUPLING position and adjust horizontal and vertical sweep controls for 5 msec/div and 10 V/div respectively.

j. Connect times-10 probe to oscilloscope input and connect it to pin M of J104. Press exposure switch and observe waveform on oscilloscope (figure 7-8C). Waveform observed on oscilloscope should have a pulse width of 19 milliseconds. If pulse width is out of tolerance, refer to General Support Maintenance for adjustment procedure.

7-21. Final Testing

To verify operation of the X-ray apparatus after direct support maintenance has been performed, reassemble control unit and perform X-ray apparatus functional test appearing in paragraph 5-20.

CHAPTER 8

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

8-1. Scope of Maintenance

d. This chapter contains instructions covering general support maintenance for the X-ray apparatus. It includes instructions for replacement of maintenance parts, instructions for troubleshooting, and repair procedures to be accomplished by general maintenance personnel.

b. General maintenance includes:

(1) Tools, Materials, and Test Equipment (Section I).

(2) Troubleshooting (Section II).

(3) Adjustments, Alignment, Replacements, Repair, and Final Testing (Section Ill).

8-2. Tools, Materials, and Test Equipment

Table 8-1 lists the test equipment required to perform general support maintenance. The technical manual related to each item of test equipment is referenced in the second column. The common name used to identify each item throughout this chapter appears in the third column.

Table 8-l. Test Equipment Requlred for General Support Maintenance

Equlpment	Technical manual	Common name
Multimeter ME-26A/U	**TM 11-6625-200-12**	**Vtvm**
Oscilloscope AN/USM-140A	**TM 11-6625-535-15**	**Oscilloscope**
Test Set. Transistor TS-1836/U	**TM 11-6625-539-15**	**Transistor tester**
Test Set. AN/TAQ-2		**Test set**

Section II. TROUBLESHOOTING

8-3. General

Troubleshooting at the General Maintenance level consists of fault analysis and testing of the high-voltage power supply to determine if it is defective.

8-4. Fault Analysis

The high-voltage power supply is a non-repairable maintenance **item.** If the indication at step 1 of paragraph 8-5 is incorrect, replace the power supply (paragraph 8-7). Refer to **figure 6-3 for** power supply schematic diagram and to figure 7-l for detailed schematic diagram of X-ray apparatus. **The operational check appearing in table 4-2. as well as organizational and direct support maintenance troubleshooting informatlon. will aid in isolating malfunctions.**

8-5. High-Voltage Power Supply, Test

a. Disassemble control unit **to gain access to test points in accordance with paragraph 5-15. steps a and b**

CAUTION

Insure that control unit chassis are isolated from possible electrical damage before applying power to unit.

b. Install **resistive load in pulser assembly.**

c. Pressurize the system to 8 psi for 1OOKV **operation.**

d. Interconnect **control unit sections by installing** transformer section plug in control section con**nector. Connect control unit to pulser using control cable.**

WARNING

Remove cable connecting high-voltage power supply to pulser assembly, (charging **(able) at power supply, not at pulser assembly The cable passes approximately 20,000 volts to pulser assembly: therefore. if cable is removed from pulser assembly rather than high-voltage power** l **supply. 20,000 volts will be present at exposed end**

c. Remove charging cable from high-voltage power supply

f Unsolder pink wire connected to pin E of J104 Connect dc microammeter between pink wire and ground

g Set LINE VOLTAGE ADJUST to value corresponding to input voltage Connect exposure switch cable to jack on control unit panel.

h. **Set** EXPOSURE SELECTOR to 99 and 1OOKV/15OKV switch to 100KV.

i. Set CIRCUIT BREAKERS 1 and 2 to ON and POWER ON switch to ON.

j. Press exposure switch and observe microammeter indication. Indication should be not less than 170 microamperes.

Section Ill. ADJUSTMENTS, ALIGNMENT, REPLACEMENTS, REPAIR, AND FINAL TESTING

8-6. General Support Maintenance of X-Ray Apparatus

General support maintenance of X-ray apparatus consists of removal and replacement of the high-voltage power supply and air pressure assembly components determined to be defective during testing and troubleshooting. Detailed instructions for removal and replacement of the high-voltage power supply, and the air pressure assembly as well as appropriate cautions and notes pertaining to repair techniques, are provided in the following paragraphs.

8-7. High-Voltage Power Supply Removal and Replacement

The high-voltage power supply is shown mounted in the pulser assembly in figure 5-4.

a. Remove five pan head screws and separate pump mounting plate and pump assembly from mounting plate assembly (figure 5-4 and 8-l) a sufficient amount to permit access to Allen screw.

b. Remove Allen screw that attaches carrying case handle to pulser chassis (figure 8-l).

c. Remove two screws attaching rubber feet at lower rear of carrying case (figure 5-4).

d. Lift pulser chassis out of carrying case.

e. Remove pressure hose fitting at pressure assembly (figure 8-1).

/. Remove five screws and remove mounting plate assembly and air pressure assembly (figure 5-5 and 8-l).

g. Remove charging resistor cable from high-voltage power supply.

h. Remove four screws (figure 8-2) and high-voltage power supply from pulser chassis.

i. Install replacement high-voltage power supply in pulser chassis and secure with four ***screws.***

j. Attach charging resistor cable to connector on power supply.

k. Install mounting plate assembly and air pressure assembly and secure with five screws.

l. Connect pressure hose fitting to pressure assembly.

m. Install pulser chassis in carrying case. Install rubber feet and secure pulser chassis with two screws at lower rear of carrying case and one screw at left front.

n. Attach carrying case handle using Allen screw.

o. Slide pump mounting plate into position on mounting plate assembly and ***secure*** with five pan head screws.

p. Inspect pressure lines and fittings and replace as necessary.

q Position air pump mounting plate on air pressure assembly and secure with three screws.

r. Install air pressure assembly in pulser chassis and secure with three screws.

s. Secure bottom of air pump mounting plate to pulser chassis with two screws.

t Attach pressure line to air pressure assembly fitting above high-voltage power supply.

u. Install pulser chassis in accordance with paragraph 8-7. steps ***m*** through o.

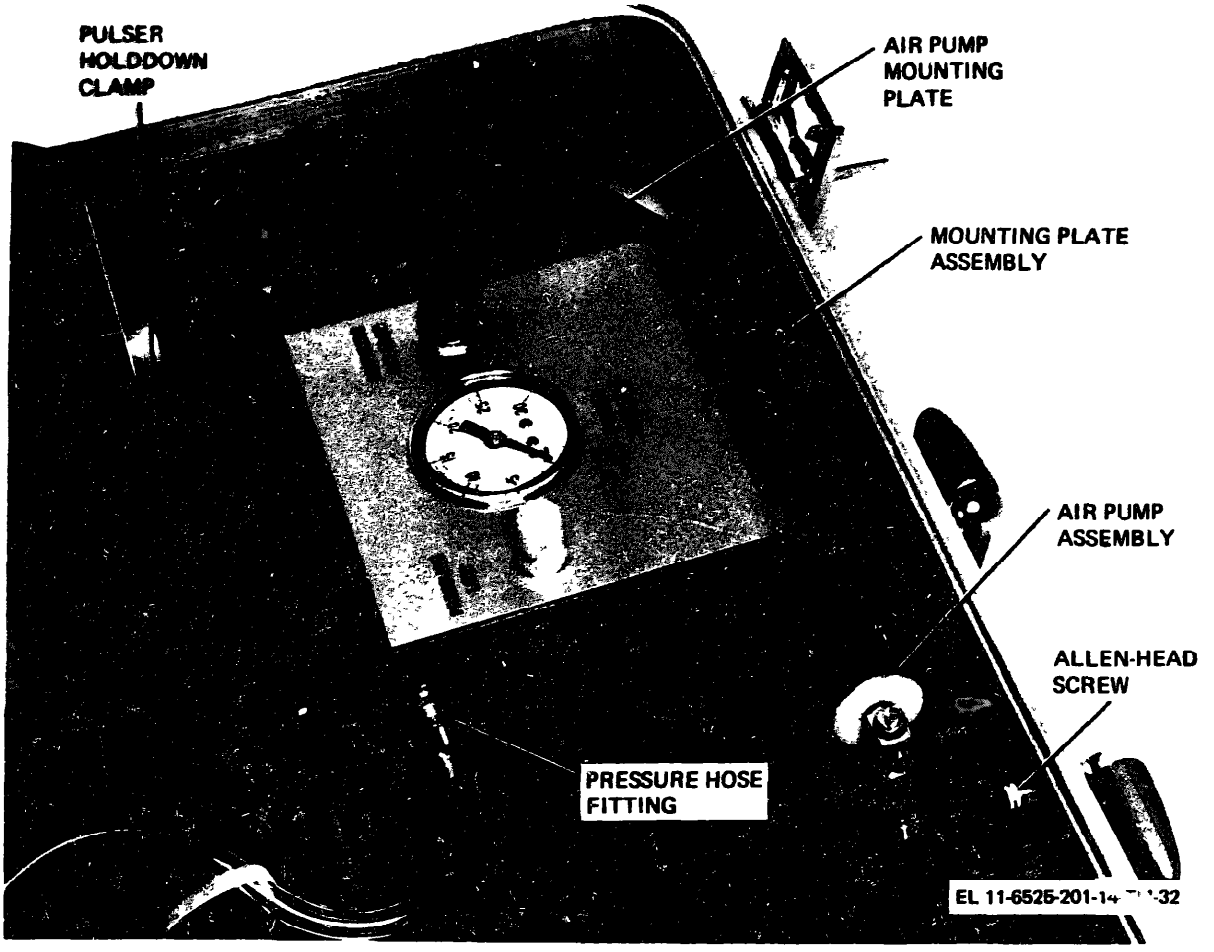


Figure 8-1. Air Pressure Assembly.

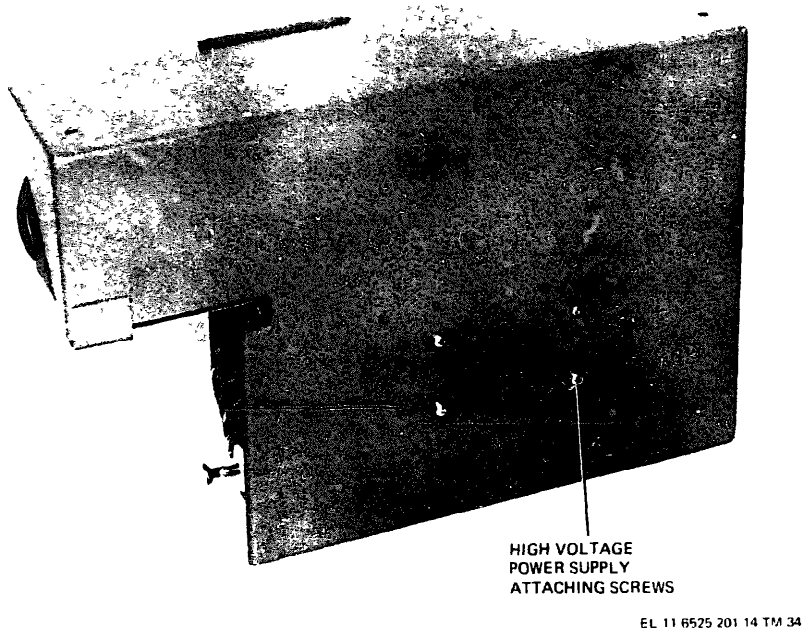


Figure 8-2. Pulser Chassis Bottom View

8-8. Air Pressure Assembly Removal and Repair

Repair of the air pressure assembly consists of removal and replacement of air pump, pressure gauge, pressure switch indicator light assembly, and pressure hose and connectors as required to restore normal operation of the system. The following procedure enable a technician to disassemble the assembly (figure 8-3) to the extent necessary for removal and replacement of components

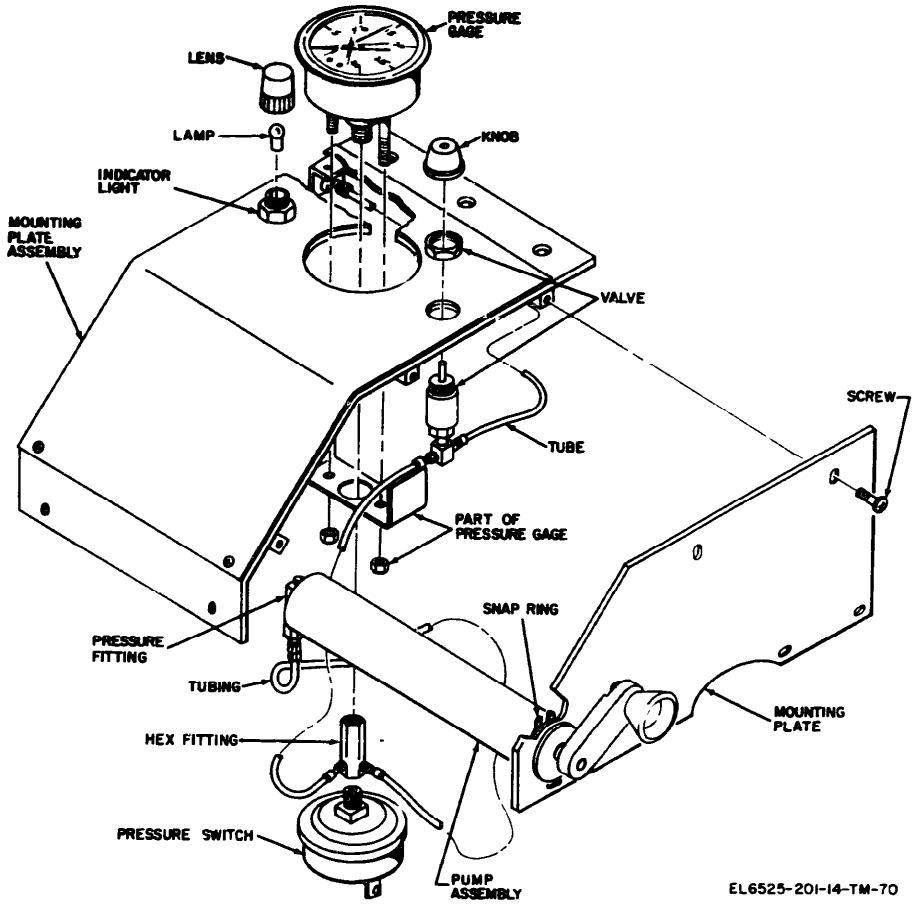


Figure 8-3. Air Pump Assembly Exploded View.

a. Remove pulser chassis from pulser carrying case in accordance with procedure of paragraph 8-**7.** steps a through ***d.***

b. Remove pressure hose fitting at pressure assembly .

c. Remove three screws from top rear oi air pressure assembly and two screws that secure front of assembly to pulse: chassis. Air pressure assembly can now be removed from pulser chassis.

8-9. Air Pump Removal and Replacement

a. **Remove** pressure fitting and hose from end of air pump.

b. Using snap-ring spreader, remove snap ring securing air pump to mounting plate.

c. Remove wave washer and slide air pump out of mounting plate.

d. Slide replacement air pump into position on mounting plate.

e. Slide wave washer over end of air pump and position against back of mounting plate.

f. Spread snap-ring and slide into position Denma wave wasner. directly over slot in air pump housing. Release snap-ring and make certain that it locks in slot.

g. Install pressure fitting in end of air pump.

h. Position air pump mounting plate on air pressure assembly and secure using three screws.

8-10. Pressure Gauge Removal and Replacement

a. Unscrew lens retaining ring from pressure gauge

CAUTION

Hold hex fitting securely before attempting to remove pressure gauge to avoid damage to pressure switch wiring. pressure switch. or pressure hose

b. Unscrew and remove pressure gauge from hex fitting.

c. Attach replacement pressure gauge to hex fitting.

d. Position pressure gauge on panel of air pressure assembly and secure with lens retaining ring.

8-11. Pressure Switch Removal and Replacement

NOTE

Before attempting to remove pressure switch, identify wire locations to facilitate accurate reassembly.

a. Remove three wires from bottom of pressure switch

NOTE

Hold hex fitting securely before attempting to remove pressure switch.

b. Unscrew pressure switch and remove from hex fitting.

c. Attach replacement pressure switch to hex fitting.

d. Attach electrical wiring to pressure switch.

8-12. Indicator Light Assembly Removal and Replacement

NOTE

The indicator light assembly is hard-wired (soldered) into the electrical circuit. Observe standard soldering techniques when removing and replacing the indicator light assembly.

a. Unsolder and remove two wires from bottom of indicator light assembly.

b. Unscrew and remove lens from indicator light assembly.

c. Remove locking nuts securing indicator light assembly to panel of air pressure assembly and remove indicator light assemoly.

d. Install replacement indicator light assembly on panel and secure with locking nuts.

e. Install lens on indicator light assembly and solder wires to light assembly terminals.

8-13. Testing After General Support Maintenance

To verify operation of the X-ray apparatus after general support maintenance has been performed, conduct control unit (Direct Support Maintenance) and high-voltage power supply tests presented in paragraph 8-5. Reassemble control unit and perform X-ray apparatus alignment procedure (paragraph 8-13) and functional test (paragraph 5-20).

WARNING

If tests are to be performed with X-ray tube installed, insure that equipment is operated in a facility specifically designed for X-ray radiography and observe all safety precautions associated with the operation of X-ray equipment.

8-14. Alignment Procedure

Under normal operating conditions, the X-ray apparatus will maintain the factory alignment over a long period of time; consequently, any other cause of trouble should be eliminated before realignment is undertaken. However, if it becomes apparent that realignment is necessary, perform the following procedures, keeping in mind that only a small angular adjustment should be required.

8-15. Test Equipment Requirements

The test equipment required to perform final adjustment procedures is listed in table 8-1. The AN/TAQ-2 Test Set is a special piece of test equipment used only during performance of final adjustment.

8-16. Trigger Level Adjustment

A separate adjustment is provided for each of the X-ray apparatus operating voltages: 100KV and 150KV. Both adjustment potentiometers are located on the control circuit board. Disassemble control unit to gain access to control circuit board in accordance with paragraph 5-15, steps *a* and *b*.

a. Install resistive load in pulser assembly.

b. Pressurize the system to 8 psi for 100KV operation.

c. Interconnect control unit sections by installing transformer section plug in control section connector. Connect control unit to pulser using control cable.

CAUTION

Insure that control unit chassis are isolated from possible electrical damage before applying power to unit.

d. Refer to figure 8-4 for test setup. Connect 28V lead of test set to pin L of J104. OUTPUT lead to pin E of J104, and GRD lead to one of the screws attaching J104 to chassis.

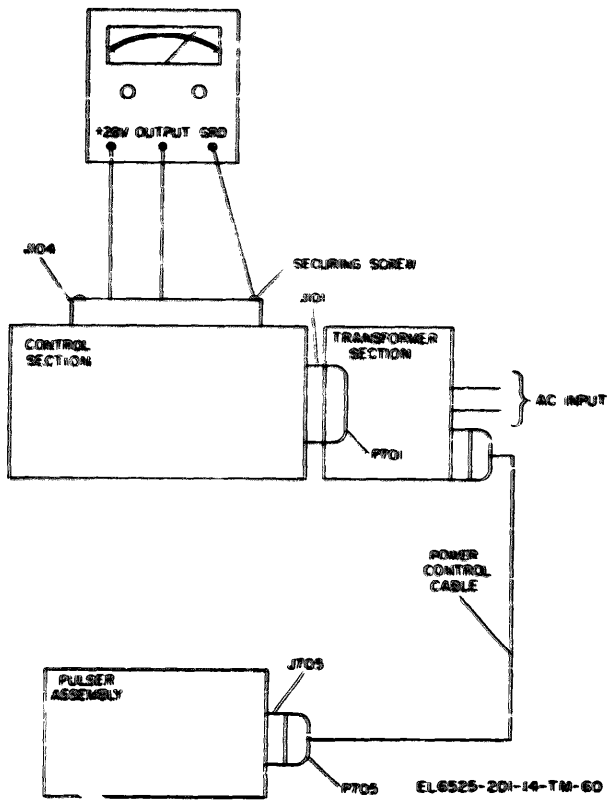


Figure 8-4. Test Setup.

e. Set **LINE VOLTAGE ADJUST** to value corresponding to input voltage. Connect exposure switch cable to jack on control unit panel.

f. Set **EXPOSURE SELECTOR** to a number other than zero.

g. Set test set **CAL** switch to **CAL** position and adjust **TRIGGER** control fully counterclockwise.

h. Set **CIRCUIT BREAKERS** 1 and 2 to **ON** and **POWER ON** switch to **ON**.

i. Adjust **TRIGGER** control clockwise until indicating needle on test set meter approaches 100KV reference point. Continue to adjust **TRIGGER** control very slowly until trigger relay (K102) begins to chatter; this should occur when indicating needle crosses 100KV reference point. If indication is correct, proceed to step *j*. If indication is incorrect, adjust **TRIGGER** control until indicating needle coincides with 100KV reference point. Adjust potentiometer R502 (refer to figure 7-2 for location) until trigger relay begins to chatter. Repeat step *i* to verify adjustment.

j. Set **POWER ON** switch to **OFF**.

k. Pressurize the system to 22 psi for 150KV operation.

l Set 100KV 150KV switch to 150KV and **POWER ON** switch to **ON**.

m. Adjust **TRIGGER** control until indicating needle on test meter approaches 150KV reference point. Continue to adjust **TRIGGER** control very slowly until trigger relay (K102) begins to chatter; this should occur when indicating needle crosses 150KV reference point. If indication is correct, proceed to step *n*. If indication is incorrect, adjust **TRIGGER** control until indicating needle coincides with .50KV reference point. Adjust potentiometer R503 (refer to figure 7-2 for location) until trigger relay begins to chatter. Repeat step *m* to verify adjustment.

n. Set **POWER ON** switch to **OFF** and **CIRCUIT BREAKERS** 1 and 2 to **OFF**. Disconnect test set from control unit.

NOTE

When trigger level adjustments have been completed, seal screwdriver adjustments on potentiometer with a drop of glyptol (paint can be used as a substitute).

8-17. Timing Adjustment

The timing adjustment (potentiometer R510) controls the operating time of the mechanical counters (CT101 and CT102) by influencing the operating conditions of the trigger relay driver (Q502). Disassemble the control unit to the extent necessary to gain access to R510 in accordance with paragraph 5-9*c*, steps (1) and (2).

a. Refer to figure 7-2 for location of trigger level circuit adjustment potentiometer.

b. Install resistive load in pulser assembly.

c. Pressurize the system to 8 psi for 100KV operation.

d. Interconnect control unit sections by installing transformer section plug in control section connector. Connect control unit to pulser using control cable.

CAUTION

Insure that control unit chassis are isolated from possible electrical damage before applying power to unit.

e. Set **LINE VOLTAGE ADJUST** to value corresponding to input voltage. Connect exposure switch cable to jack on control unit panel.

f. Set **EXPOSURE SELECTOR** to 99 and 100KV / 150KV switch to 100KV.

g. Set **CIRCUIT BREAKERS** 1 and 2 to **ON** and **POWER ON** switch to **ON**.

h. Set oscilloscope **VERTICAL INPUT** selector switch to **DC COUPLING** position and adjust horizontal and vertical sweep controls for 5 msec div and 10 V div respectively.

i. Connect times-10 probe to oscilloscope input and connect it to pin M of J104. Press exposure switch and observe waveform on oscilloscope

Adjust potentiometer R510 for a waveform pulse width of 19 milliseconds.

j. Set POWER ON switch to OFF and CIRCUIT BREAKERS 1 and 2 to OFF. Disconnect oscilloscope from control unit and reassemble unit.

8-18. Final Test

Upon completion of adjustment procedures, perform X-ray apparatus functional test outlined in paragraph 5-20.

WARNING

If tests are to be performed with X-ray tube installed, insure that equipment is operated in a facility specifically designed for X-ray radiography, and observe all safety precautions associated with the operation of X-ray equipment.

APPENDIX A

REFERENCES

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	U. S. Army Equipment Index of Modification Work Orders
TB SIG 255	Radioactive Electronic Tube Handling
TM 8-280	Radiological and Electrical Hazards
TM 38-750	The Army Maintenance Management System (TAMMS)
TM 740-90-1	Administrative Storage of Equipment
TM 750-244-2	Destruction and Demolition of Equipment

APPENDIX B

MAINTENANCE ALLOCATION

Section I. INTRODUCTION

B-1. General

This appendix provides a summary of the maintenance operations for Control Group OK-258/TAQ-2 and Generator Group OV-47/TAQ-2. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

B-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. Replace. The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipments/components.

B-3. Column Entries

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a "worktime" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "worktime" figures will be shown for each category. The number of task-hours specified by the "worktime" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable

condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C — Operator/Crew
O — Organizational
F — Direct Support
H — General Support
D — Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks. Column 6 contains an alphabetic code which leads to the remark in section IV, Remarks, which is pertinent to the item opposite the particular codes.

B-4. Tool and Test Equipment Requirements (sec III)

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

B-5. Remarks (sec IV)

a. Reference Code. This code refers to the appropriate item in section II, column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing in section II.

SECTION II MAINTENANCE ALLOCATION CHART
FOR

[illegible]

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQPT	(6) REMARKS
00	[illegible] CONTROL GROUP OS-2[illegible] TAQ-2 AN[illegible] GENERATOR GROUP OV-[illegible] TAQ-2	Inspect	0.2						
		Test	0.4						
		Service	0.6						
		Install	0.4						4
		Repair			2.0			5,6	
		Overhaul				20		[illegible] thru 8	
0[illegible]	[illegible] CONTROL GROUP OS-2[illegible] TAQ-2	Inspect	0.1						
		Test	0.1						
		Service	0.2						
		Replace			0.5			5	
		Repair				1.0		5,6	
0[illegible]	[illegible] CONTROL BOX	Inspect	[illegible]						
		Test	[illegible]						
		Service	[illegible]						
		Replace			[illegible]			5	
		Repair				[illegible]		[illegible] thru [illegible]	
		Repair		[illegible]				[illegible]	[illegible]
[illegible]	POWER SUPPLY [illegible] VOLTMETER	Inspect	[illegible]						
		Test			[illegible]			[illegible]	
		Replace			0.5			5	
		Repair				0.5		[illegible] thru [illegible]	
		Repair		0.5				[illegible]	[illegible]
[illegible]	[illegible] RESISTOR [illegible]	Inspect	[illegible]						
		Test			[illegible]			[illegible]	
		Service				0.1			
		Replace			[illegible]			[illegible]	
[illegible]	[illegible] THERMISTOR [illegible]	Inspect	[illegible]						
		Test			0.2			[illegible]	
		Service				0.1			
		Adjust				[illegible]		[illegible]	
		Replace			[illegible]			[illegible]	
[illegible]	[illegible] CIRCUIT BOARD ASS[illegible]	Inspect				[illegible]			
		Test				[illegible]		[illegible]	
		Adjust				[illegible]		[illegible]	
		Replace		[illegible]				[illegible]	
		Repair			0.5			[illegible] thru 5	
[illegible]	[illegible] BOARD ASS[illegible]	Inspect				[illegible]			
		Test				[illegible]		[illegible]	
		Adjust				[illegible]		[illegible] thru 5	
		Replace		[illegible]				[illegible]	
		Repair			[illegible]			[illegible] thru 5	
[illegible]	[illegible] TUBE	Inspect	0.1						
		Service	0.2						
		Replace	0.2						4
22	GENERATOR GROUP [illegible]	Inspect	0.1						
		Test	[illegible]						
		Service	[illegible]						
		Replace			0.5			5	
		Repair				1.0		[illegible]	
								6	
		Repair		[illegible]				[illegible]	
[illegible]	[illegible] [illegible]	Inspect	[illegible]						
		Test	[illegible]						
		Service	[illegible]						
		Replace			0.5			5,6	
		Repair				1.0		[illegible]	

SECTION II MAINTENANCE ALLOCATION CHART
FOR
OK-258/TAQ-2 AND OV-47/TAQ-2

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQPT.	(6) REMARKS
	[illegible] POWER SUPPLY	Inspect	0..						
		Test	0 2						
		Replace				0.5		5	
	[illegible]	Inspect	0.1						
		Test	0.2						
		Service	0 3						
		Replace			0.7			5	
		Repair				1 0		5,6	
		Repair		0.5				7	
	[illegible] TABLES	Inspect	0 1						
		Repair				1.0		1,2,3	
		Replace			0.1			5	

SECTION III TOOL AND TEST REQUIREMENTS FOR

OK-258/TAQ-2 AND OV-47/TAQ-2

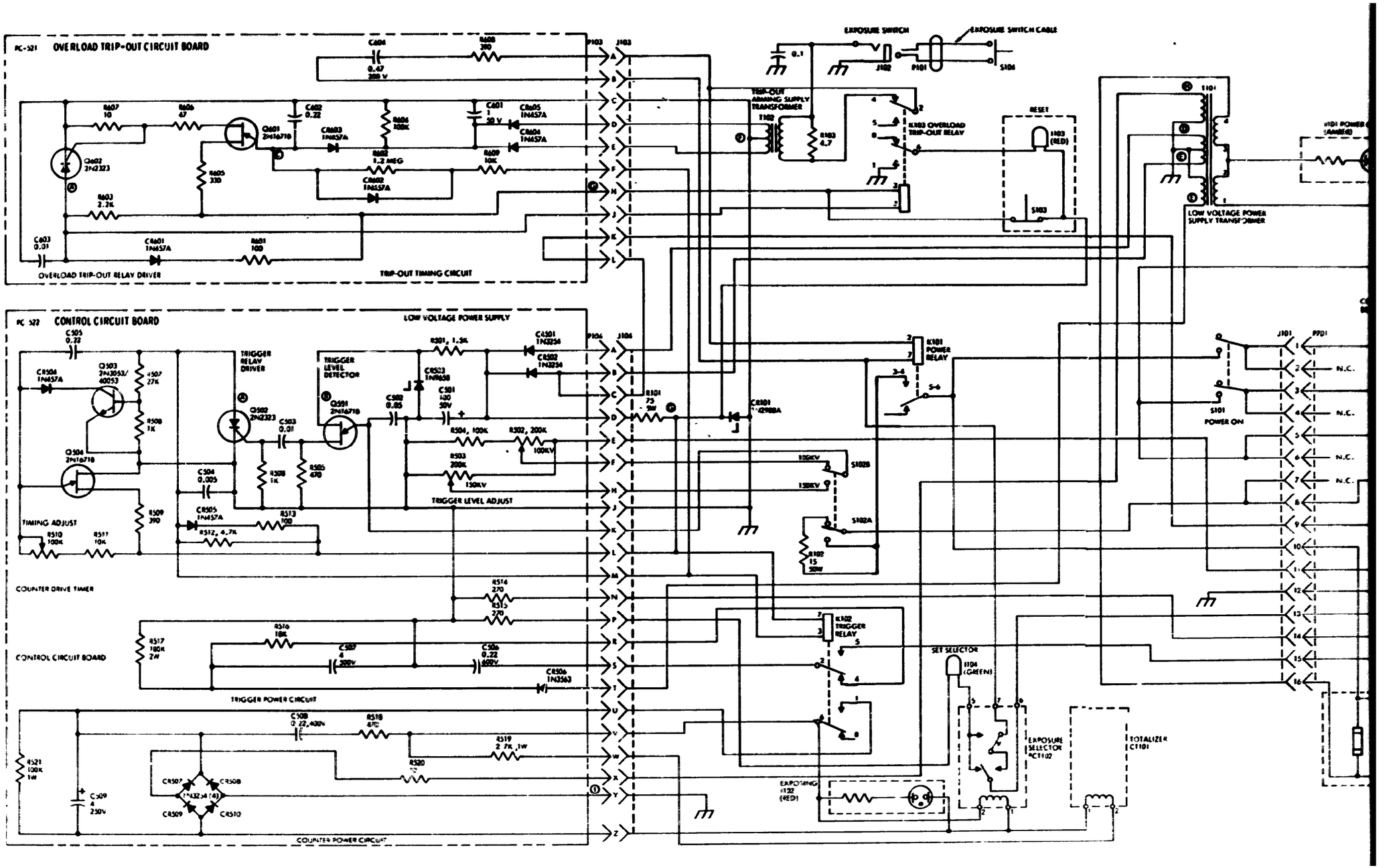
TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL NATO STOCK NUMBER	TOOL NUMBER
1	F,H,D	MULTIMETER AN USM-[illegible]	[illegible]	
2	F,H,D	MULTIMETER ME-26A U	[illegible]	
3	F,H,D	OSCILLOSCOPE AN USM-117	[illegible]	
4	F,H,D	TESTER TRANSISTOR TS-[illegible]	[illegible]	
5	F,H,D	[illegible] FLIGHT CONTROL EQUIPMENT TK-[illegible]	[illegible]	
6	[illegible]	[illegible] TORQUE 5-[illegible] IN LBS	[illegible]	
7	[illegible]	[illegible] ELECTRONIC EQUIPMENT TK-[illegible]	[illegible]	

SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A	A TOOL KIT IS INCLUDED IN GROUP 02.
B	BY REPLACEMENT OF LAMPS, KNOBS, FUSES.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1979-765-066/650

INDEX


PC-521 OVERLOAD TRIP-OUT CIRCUIT BOARD
OVERLOAD TRIP-OUT RELAY DRIVER
TRIP-OUT TIMING CIRCUIT
PC 522 CONTROL CIRCUIT BOARD
LOW VOLTAGE POWER SUPPLY
TRIGGER RELAY DRIVER
TRIGGER LEVEL DETECTOR
TRIGGER LEVEL ADJUST
TIMING ADJUST
COUNTER DRIVE TIMER
CONTROL CIRCUIT BOARD
TRIGGER POWER CIRCUIT
COUNTER POWER CIRCUIT
EXPOSURE SWITCH
EXPOSURE SWITCH CABLE
TRIP-OUT ARMING SUPPLY TRANSFORMER T102
K103 OVERLOAD TRIP-OUT RELAY
RESET
LOW VOLTAGE POWER SUPPLY TRANSFORMER
K101 POWER RELAY
POWER ON
K102 TRIGGER RELAY
SET SELECTOR
EXPOSURE SELECTOR CT102
TOTALIZER CT101
EXPOSING
N.C.

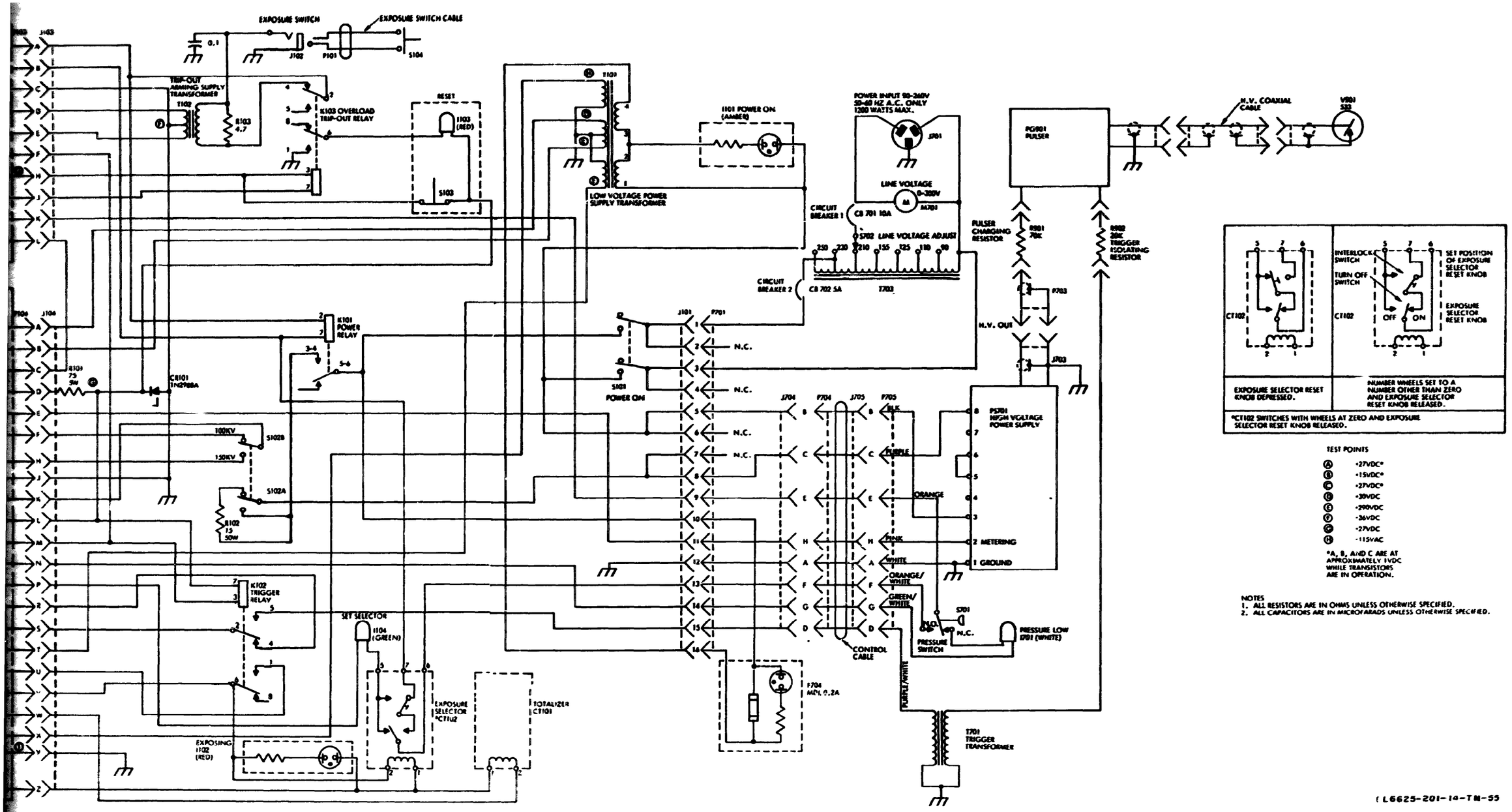


Figure 7-1. X-Ray Apparatus.

By Order of the Secretary of the Army:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

Official:
VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution:
Active Army:
CNGB (1)
TSG (1)
WRAMC (1)
MFSS (5)
AMC (1)
TRADOC (1)
TECOM (1)
LBAD (5)
SAAD (5)
TOAD (5)
LOGCOMD (2)

ARNG & USAR: None.
For explanation of abbreviations used, see AR 310-50.

U S GOVERNMENT PRINTING OFFICE 1971—768-270 322

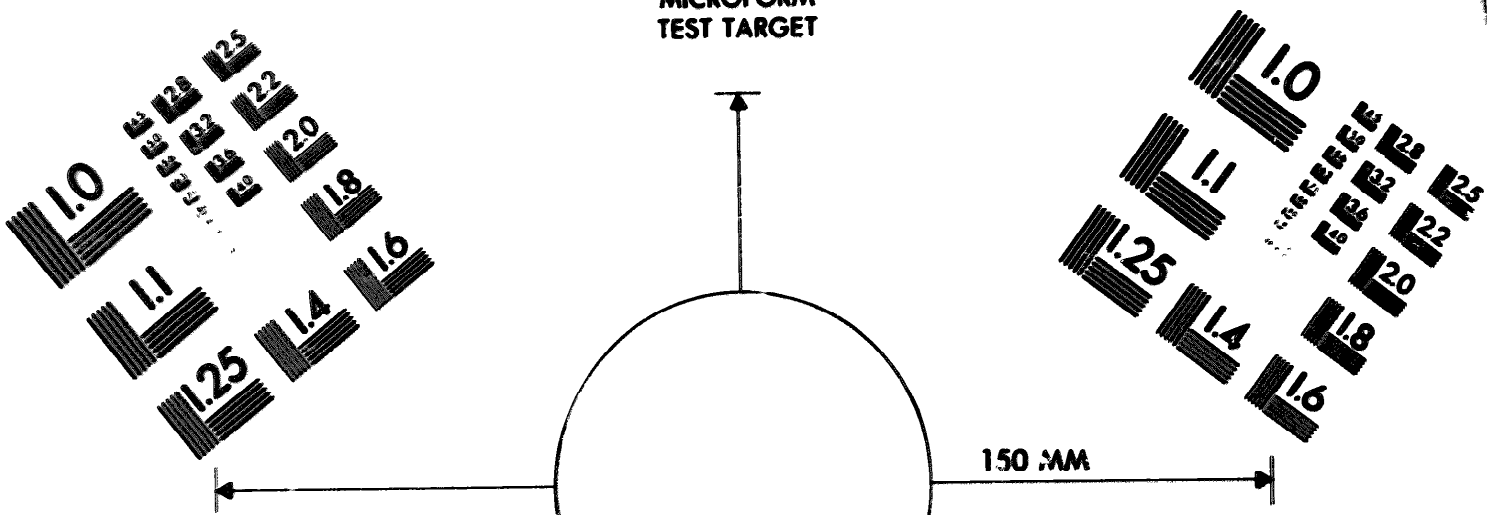
END

12-25-82

DATE

DEPARTMENT OF THE ARMY

MICROFORM
TEST TARGET



1.5 mm (e= 1.09 mm)

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2.0 mm (e= 1.37 mm)

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
12345678905¢£/%#½¼¾—=+×&@*

2.5 mm (e= 1.77 mm)

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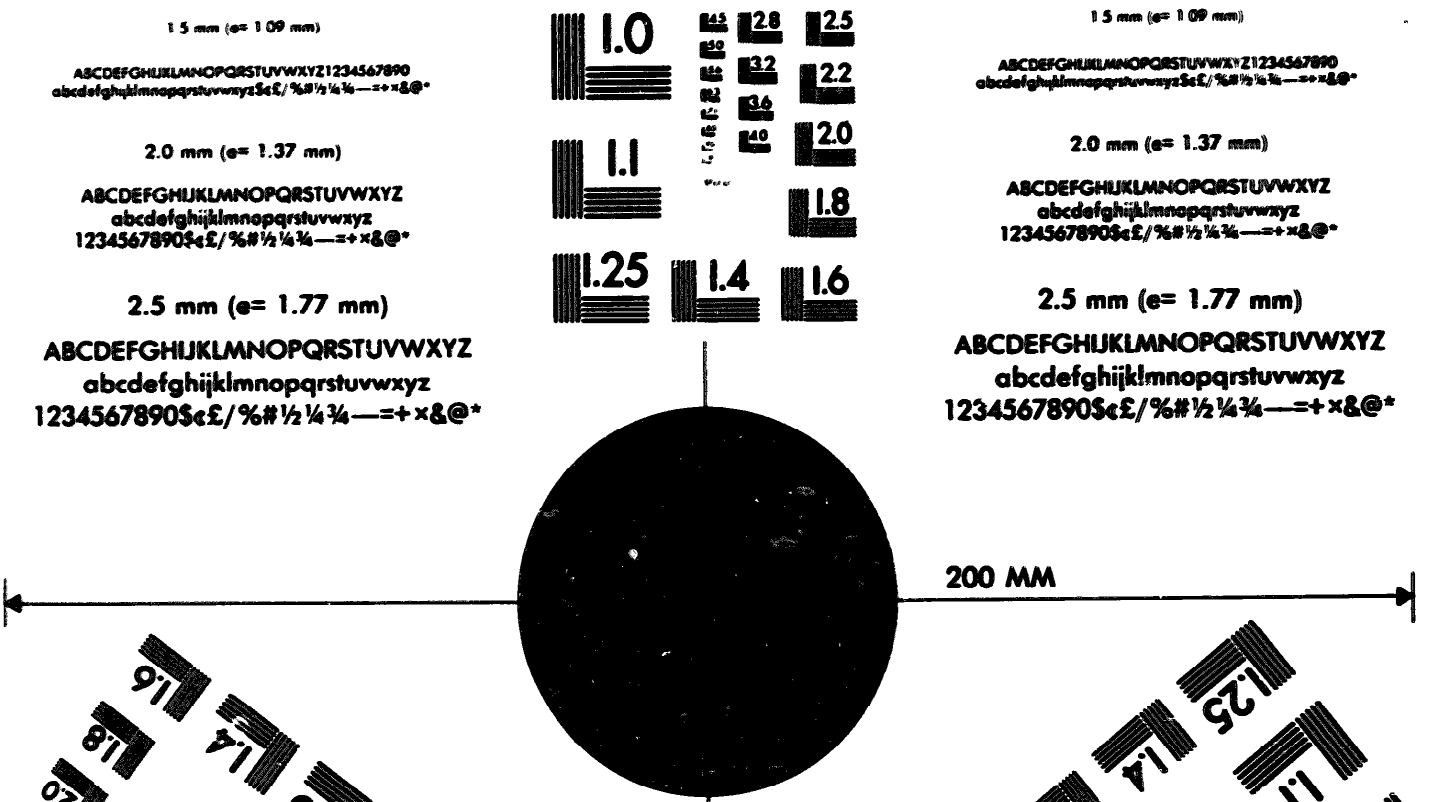

END

12-25-82

DATE

DEPARTMENT OF THE ARMY

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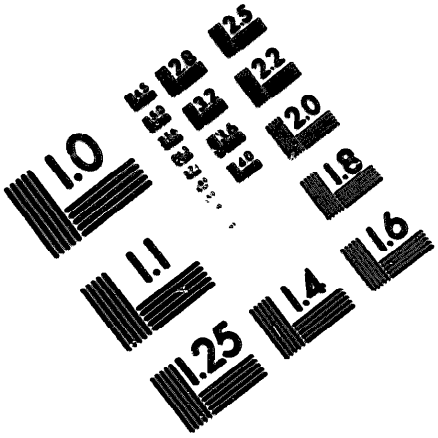

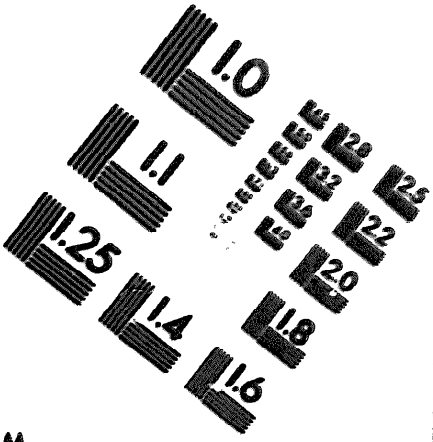

150 MM

.5 mm (e= 1.09 mm)

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2.0 mm (e= 1.37 mm)

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890$¢£/%#½¼¾—=+×&@*

2.5 mm (e= 1.77 mm)

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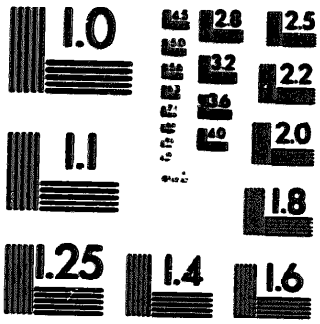


1.5 mm (e= 1.09 mm)

ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890
abcdefghijklmnopqrstuvwxyz$¢£/%#½¼¾—=+×&@*

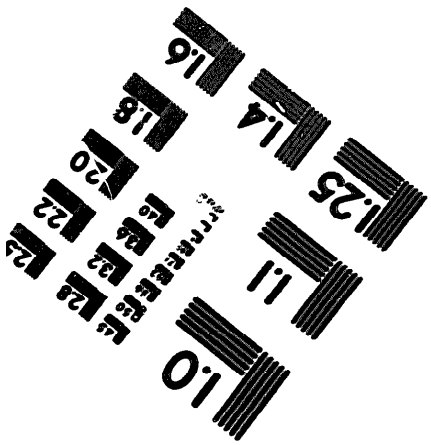
2.0 mm (e= 1.37 mm)

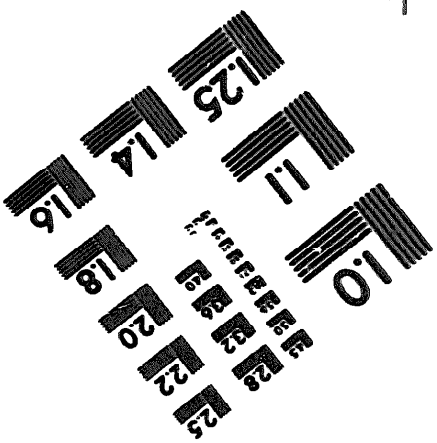
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890$¢£/%#½¼¾—=+×&@*

2.5 mm (e= 1.77 mm)

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890$¢£/%#½¼¾—=+×&@*

200 MM





250 MM