

TOSHIBA

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INSTALLATION MANUAL FOR CAPACITOR DISCHARGE TYPE MOBILE X-RAY APPARATUS MODEL KCD-10M-7A

TOSHIBA CORPORATION

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1. SCOPE CONTENTS - cont'd

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9. FINISHING 15 or near the installation site.

(2) The floor level must be flat and smooth.

(3) The installation site must be in a restricted zone for operation of radiation equipment.

3. OPERATING REQUIREMENTS

(1) Voltage : 100/110/115/120/127/220/240VAC \pm 10%

(2) Number of phases : Single phase

(3) Frequency : 50/60Hz

(4) Impedance : 0.5 ohms or less (100/110/115/120/127VAC)
: 2.0 ohms or less (220/240VAC)

(5) Power capacity : 1.5kVA

(6) Grounding : 100 ohms or less

(7) Atmospheric pressure : 700 ~ 1060mbar

(8) Temperature : 5 ~ 35°C

(9) Relative humidity : 45 ~ 85% (No condensation should occur.)

4. UNPACKING

(1) Weight

Approximately 490kg (1080 lb)

(2) Unloading

The X-ray unit must be unloaded by lifting only through the use of the pallet placed beneath it. During the unloading, the unit must be kept in a horizontal position to ensure that no disturbance in its normal balance occurs. The floor onto which the unit is to be set must have a flat, smooth level.

1. SCOPE

This manual describes the procedures for installation of capacitor discharge type mobile X-ray apparatus, Model KCD-10M-7A. Although the balance weight is control lever being attached to it. This manual should be closely read before carrying out any procedural steps for installation.

2. INSTALLATION REQUIREMENTS

- (1) No potentially inflammable materials and gases must exist at or near the installation site.
- (2) The floor level must be flat and smooth.
- (3) The installation site must be in a restricted zone for operation of radiation equipment.

3. OPERATING REQUIREMENTS

- | | | |
|--------------------------|---|--|
| (1) Voltage | : | 100/110/115/120/127/220/240VAC±10% |
| (2) Number of phases | : | Single phase |
| (3) Frequency | : | 50/60Hz |
| (4) Impedance | : | 0.5 ohms or less (100/110/115/120/127VAC)
2.0 ohms or less (220/240VAC) |
| (5) Power capacity | : | 1.5kVA |
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4. UNPACKING

(1) Weight

Approximately 490kg (1080 lb)

(2) Unloading

The X-ray unit must be unloaded by lifting only through the use of the pallet placed beneath it. During the unloading, the unit must be kept in a horizontal position to ensure that no disturbance in its normal balance occurs. The floor onto which the unit is to be set must have a flat, smooth level.

5. (3) The packed unit

As illustrated below, the unit is packed without the X-ray tube, the beam limiting device, the lifter control knob, and the support column control lever being attached to it. Although the balance weight is packed in an unbalanced state, it is secured within the support column by two screws.

(2) Monkey wrench, medium-size _____ 1

(4) Allen wrench _____ 1 set

5.2 Measuring Instruments Required

The following instruments are needed for the testing of this unit:

Measuring Instrument	Remarks
AC voltmeter	Measuring range up to 150 or 300V
Oscilloscope	Or its equivalent (10MHz DC, 2-channel, storage-CRT type)
Digital voltmeter	Or their equivalent
Meters for high voltage applications	
kV meter	KV-201 Or its equivalent (accuracy: less than 2% of the setting in error terms)
map meter	MAP-600 Or its equivalent (accuracy: less than 3.5% of the setting in error terms)
mas meter	MAS-301 Or its equivalent (accuracy: less than 3.5% of the setting in error terms)

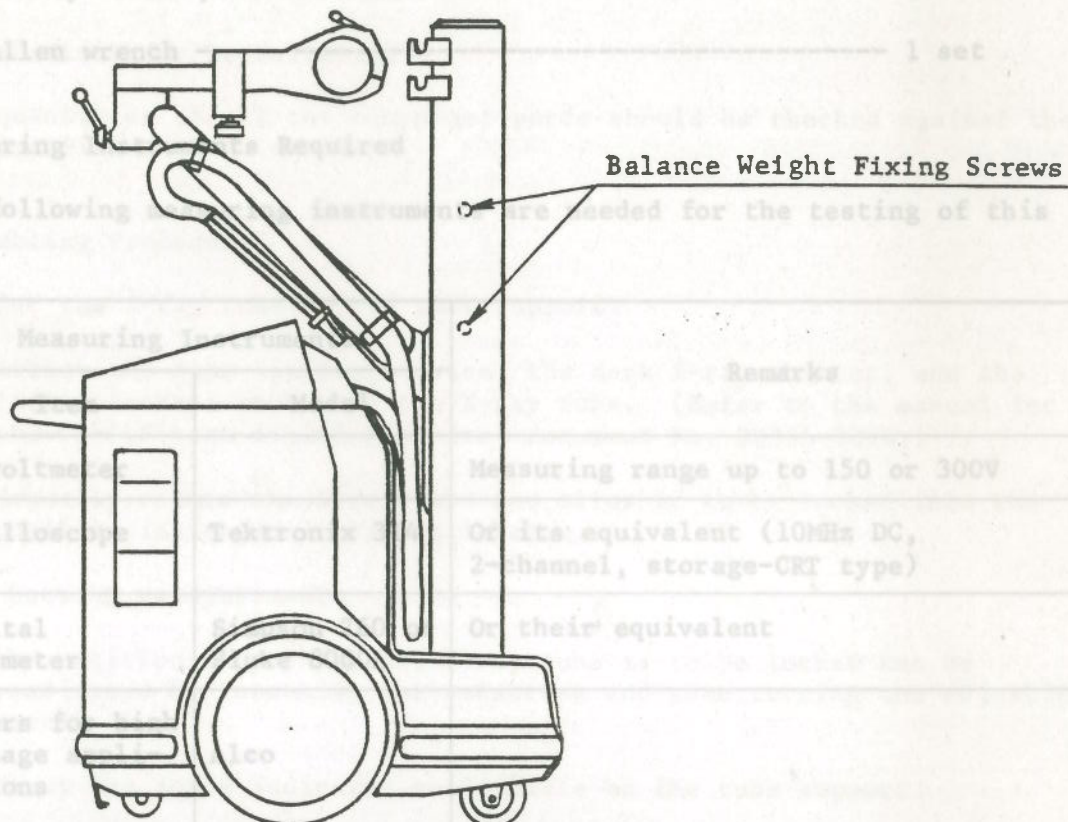
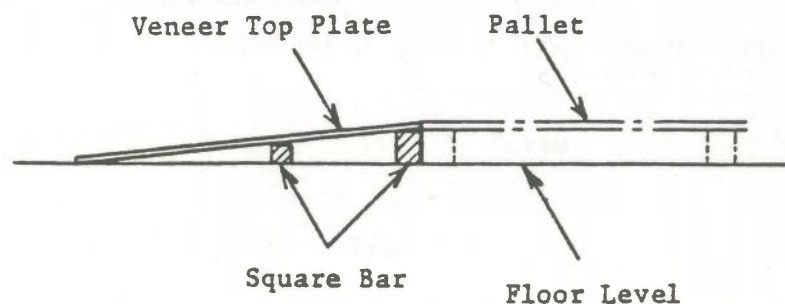


Fig. 4.1

(4) Unpacking procedure

The unit should be unpacked from the top downwards. After unpacking, the top plates (veneer plates) and the square bars that were used for crating the unit should be arranged on the floor as shown in the illustration below so that these can be used as ramp boards for unloading the unit smoothly onto the floor.



5. PREPARATIONS FOR INSTALLATION

5.1 Tools Required

- (1) Phillips type screwdrivers, medium- and small-size ----- 1 each
- (2) Bladed screwdrivers, large-, medium-, and small-size --- 1 each
- (3) Monkey wrench, medium-size ----- 1
- (4) Allen wrench ----- 1 set

5.2 Measuring Instruments Required

The following measuring instruments are needed for the testing of this unit:

Measuring Instruments		Remarks
Item	Model	
AC voltmeter		Measuring range up to 150 or 300V
Oscilloscope	Tektronix 314	Or its equivalent (10MHz DC, 2-channel, storage-CRT type)
Digital voltmeter	Simpson 260 or Fluke 8000A	Or their equivalent
Meters for high voltage applications	Alco	
kV meter	KV-201	Or its equivalent (accuracy: less than 2% of the setting in error terms)
mAp meter	MAP-600	Or its equivalent (accuracy: less than 3.5% of the setting in error terms)
mAs meter	MAS-301	Or its equivalent (accuracy: less than 2% of the setting in error terms)

Fig. 6.1

6. INSTALLATION, ASSEMBLY, AND CABLE CONNECTION

6.1 Unit Composition

This X-ray unit consists of an X-ray tube, a beam limiting device (provided with a dark X-ray shutter), a mobile carriage, an X-ray high potential generator, etc. Of these, only the X-ray tube and the beam limiting device are packed in their non-assembled states.

6.2 Preparations for Installation

The quantities of all the component parts should be checked against the packing list. FOR SERVICING HIGH POTENTIAL CIRCUIT (Section 5) and HIGH POTENTIAL CABLE CONNECTION (Section 6) of the attached Preventive Maintenance Manual (2Y300-015E).

6.3 Assembling Procedure

- (1) Set the X-ray tube on the tube support.
- (2) Attach the beam limiting device, the dark X-ray shutter, and the lifter control knob onto the X-ray tube. (Refer to the manual for the TF-TLF beam limiting device, document No. 2D356-006E.)
- (3) Manually rotate the X-ray tube and allow it to be locked into the position indicated in Fig. 6.1 below.

(8) Locking readjustment

The position into which the X-ray tube is to be locked can be readjusted by loosening the setscrews and then turning the adjusting screw.

- (4) Mount the angle indicator scale plate on the tube support.

See Figs. 6.2 and 6.3 for further details.

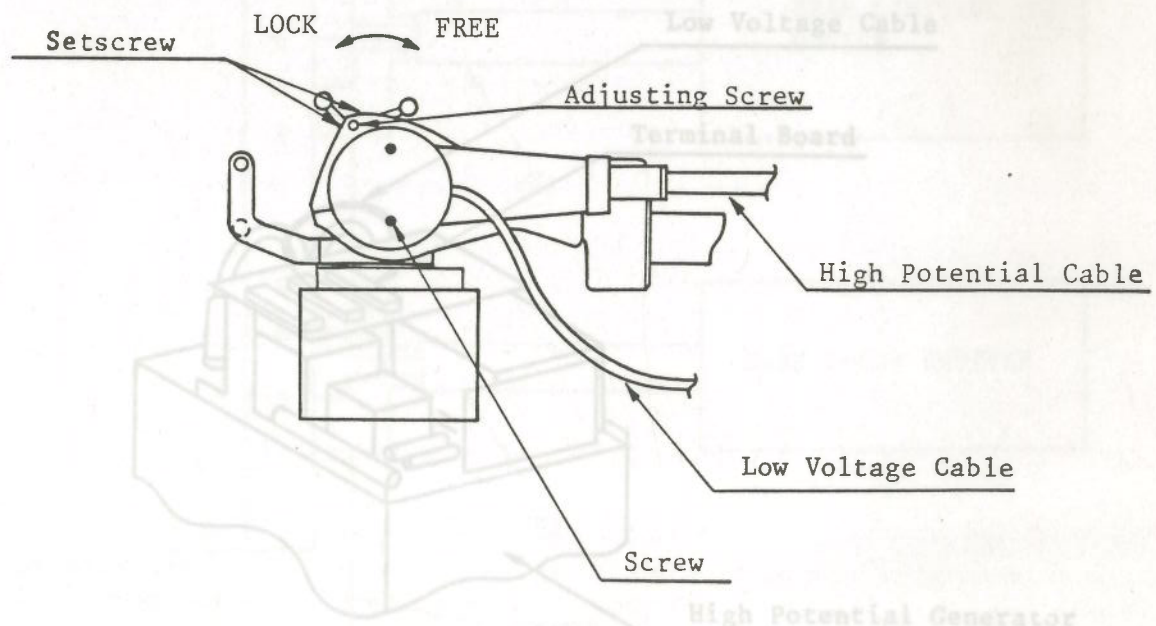


Fig. 6.1

Fig. 6.2

- (5) Tighten the lock used for vertical movement of the lifter and remove the lifter balance weight fixing screws (2 places) from the support column. After removing the screws, cover the holes with the nylon caps supplied with this X-ray unit.
- (6) Remove the resin cover (top cover) from the main unit.
- (7) High potential cable connection

Connect the high potential cables of the high potential generator to the X-ray tube.

For details of the cable connections, refer to Fig. 6.3 and SAFETY PROCEDURE FOR SERVICING HIGH POTENTIAL CIRCUIT (Section 5) and HIGH POTENTIAL CABLE CONNECTION (Section 6) of the attached Preventive Maintenance Manual (2Y300-015E).

(CAUTION)

- Take extreme care not to damage the cable-heads while handling the high potential cables.
- Do not bend the cables excessively.
- Take care to correctly identify the polarities of the X-ray tube and the high potential generator.

- (8) Low voltage cable connection

Connect the low voltage cables of the beam limiting device and of the dark X-ray shutter to the terminal board of the X-ray control. Then connect the low voltage cable used for anode rotation to the terminal board of the X-ray tube.

See Figs. 6.2 and 6.3 for further details.

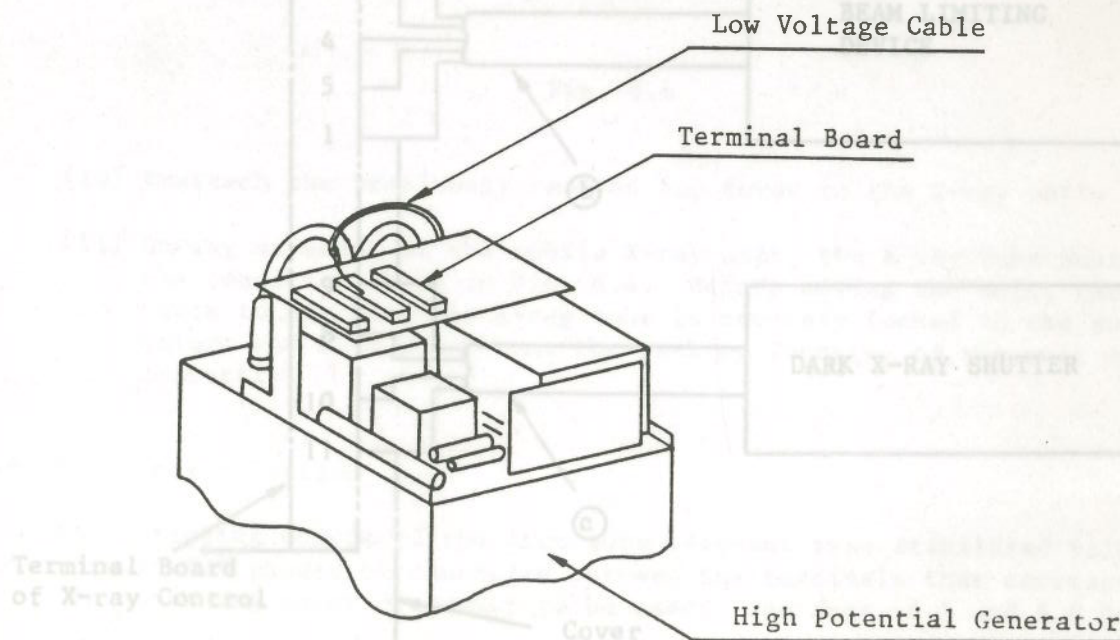


Fig. 6.2 connection

(9) Cable routing

High Potential
Cables

Route the low voltage cables of the beam limiting device and of the dark X-ray shutter along the high potential cables, taking into account the possible movement of the beam limiting device and the X-ray tube shown in Fig. 6.4. After routing this operation, tie the high potential and low voltage cables together using the cable bands. Cover up the cables using the cable hose and secure it to the support arm.

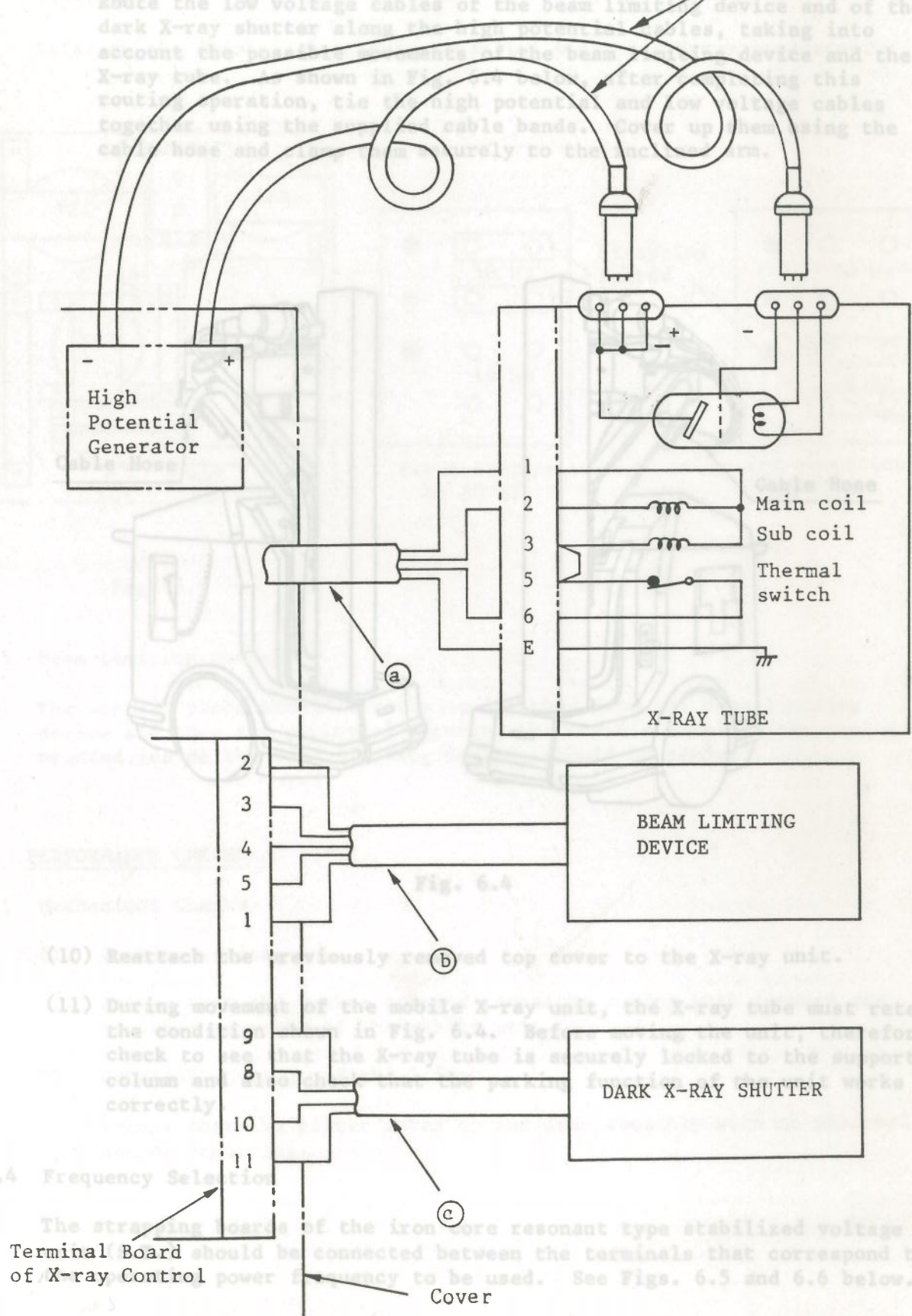


Fig. 6.3 Cable connection

- (9) Cable routing. Check the wire connection to the input terminals of the transformers, Tr1 and Tr2 to be correct referring to the line voltage supplied. Route the low voltage cables of the beam limiting device and of the dark X-ray shutter along the high potential cables, taking into account the possible movements of the beam limiting device and the X-ray tube. As shown in Fig. 6.4 below, after completing this routing operation, tie the high potential and low voltage cables together using the supplied cable bands. Cover up them using the cable hose and clamp them securely to the inclined arm.

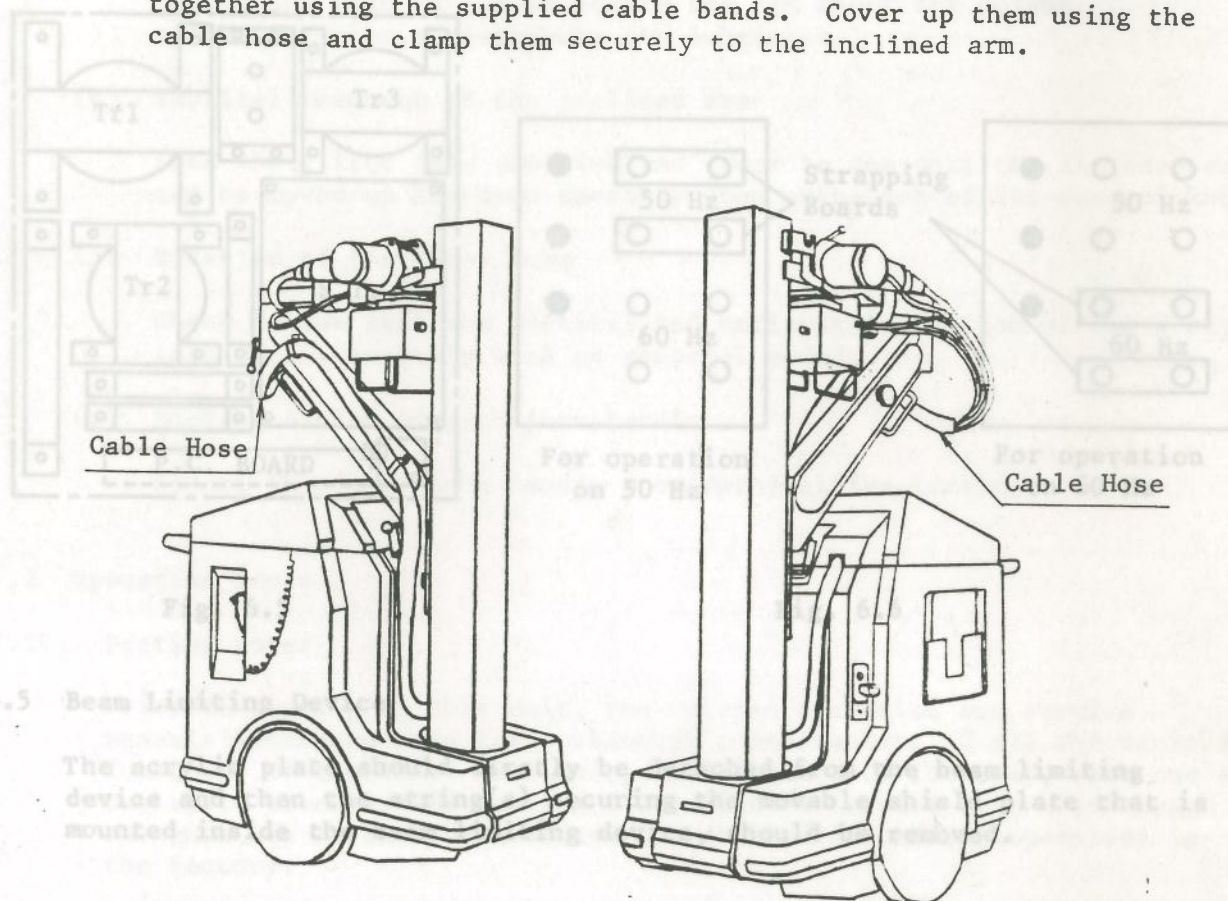


Fig. 6.4

7. PERFORMANCE CHECKS

7.1 Mechanical Checks

- (10) Reattach the previously removed top cover to the X-ray unit.
- (11) During movement of the mobile X-ray unit, the X-ray tube must retain the condition shown in Fig. 6.4. Before moving the unit, therefore, check to see that the X-ray tube is securely locked to the support column and also check that the parking function of the unit works correctly.

Ensure that the lifter moves up and down smoothly with no abnormal sounds occurring.

6.4 Frequency Selection

The strapping boards of the iron core resonant type stabilized voltage unit (S.T.) should be connected between the terminals that correspond to the operating power frequency to be used. See Figs. 6.5 and 6.6 below.

At the same time check the wire connection to the input terminals of the transformers, Tr1 and Tr2 to be correct referring to the line voltage supplied.

Refer to the electrical diagrams supplied with this X-ray apparatus.

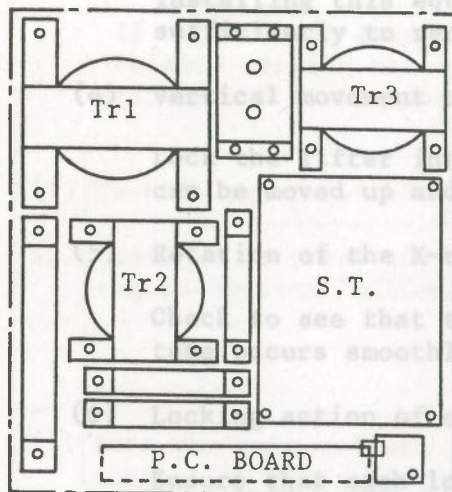


Fig. 6.5

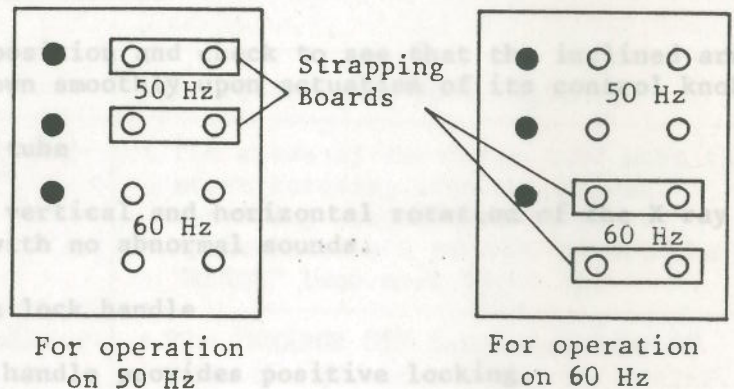


Fig. 6.6

7.2 Operation Tests

7.2.1 Testing notes

6.5 Beam Limiting Device

The acrylic plate should firstly be detached from the beam limiting device and then the string(s) securing the movable shield plate that is mounted inside the beam limiting device, should be removed.

7.2 PERFORMANCE CHECKS

7.1 Mechanical Checks

(1) Braking actions

Ensure that the brakes operate correctly during both forward and backward movement of the mobile unit.

(2) Vertical movement of the lifter

Ensure that the lifter moves up and down smoothly with no abnormal sounds occurring.

(4) Check to see that all the PWB (printed Wiring Board) units of the X-ray control are mounted correctly and also that they are attached properly to their respective connectors.

(3) Rotation of the support column

Ensure that the support column can rotate smoothly without jerking (that is, with adequate contact friction) upon operation of its control lever. Several weeks after manufacture or shipping, the lubricant of the column may become unevenly distributed and thus lead to increased friction upon rotation of arm. Therefore, after installing this equipment rotate the arm about the column sufficiently to redistribute the lubricant.

(4) Vertical movement of the inclined arm

Lock the lifter into position and check to see that the inclined arm can be moved up and down smoothly upon actuation of its control knob.

(5) Rotation of the X-ray tube

Check to see that the vertical and horizontal rotation of the X-ray tube occurs smoothly with no abnormal sounds.

(6) Locking action of each lock handle

Ensure that each lock handle provides positive locking.

7.2 Operation Tests

7.2.1 Testing notes

- (5) Prior to testing of this unit, the related operation and service manuals should be read for a thorough understanding of all the various functions of the unit. Following installation of the unit, each one of the tests described in section 7.2.3 must be carried out, even though the unit has already been tested and checked for normal operation in the factory.

7.2.2 Preliminary visual checks

The following preliminary visual checks should be made on the interior of the X-ray control:

- (1) Check all the component parts and terminals for any loose connections and for the possibility of short-circuiting.
- (2) Check to see that all the relays are secured into their respective sockets.
- (3) Check all the screws, bolts, and terminals to see that they are tightened and connected correctly.
- (4) Check to see that all the PWB (printed Wiring Board) units of the X-ray control are mounted correctly and also that they are attached properly to their respective connectors.

- (5) Check to see that the high potential cable connections between the X-ray tube and the high potential generator are not loose.
- (6) Wipe off any dirt from the surfaces of the various sections.

7.2.3 Operational testing of the various sections

If an abnormal condition is detected during the following tests, the related service manual should be referred to for details of possible causes and countermeasures.

(1)	Turn ON power switch.	The "POWER" lamp must light up.
(2)	Continue to press the discharging pushbutton "DISCHARGE".	<ul style="list-style-type: none"> The anode of the X-ray tube must then start rotating with no abnormal operating sounds occurring. Approximately 2 seconds later, the "READY" lamp must light up.
(3)	Turn the tube voltage regulator control to 40kV and press the charging pushbutton "CHARGE".	<ul style="list-style-type: none"> The "CHARGE UP" lamp must come ON when the kV meter indicates 40 ± 2 kV.
(4)	Continue to press the "DISCHARGE" pushbutton.	<ul style="list-style-type: none"> The indication of 40 ± 2 kV on the kV meter must then drop to zero and consequently cause the "CHARGE UP" lamp to go OFF.
(5)	Repeat steps (3) and (4) above five times for each of the tube voltages: 40, 50, 60, 70, 80, 90, and 100kV. Allow 30 seconds or more between each of these checks.	
(6)	Turn the tube voltage regulator control to 80kV and press the "CHARGE" button.	<ul style="list-style-type: none"> The "CHARGE UP" lamp must light up when the kV meter indicates 80 ± 2 kV. The kV meter indication must then gradually decrease and after it has decreased by approximately 2kV, automatic recharging should begin.
(7)	With the kV meter indicating 80 ± 2 kV, turn the tube voltage regulator control to 60kV.	<ul style="list-style-type: none"> The kV meter indication must then decrease from 80 ± 2 kV to 60 ± 2 kV. Automatic recharging will not begin at 60 ± 2 kV unless the "CHARGE" button is subsequently pressed.
(8)	Perform charging at an exposure rate of 2mAs and a tube voltage of 100kV. After the "CHARGE UP" lamp has come ON, press and hold the pushbutton of the hand switch to its first stage.	<ul style="list-style-type: none"> The anode of the X-ray tube must then start rotating with no abnormal operating sounds occurring. Two seconds later, the "READY" lamp should come ON.

(9)	Next, press and hold the push-button of the hand switch to its second stage.	<ul style="list-style-type: none"> • Upon pressing this switch, the dark X-ray shutter should start operating with no abnormal sounds occurring and the "X-RAY" lamp should light up. At the completion of X-ray exposure, the buzzer should start sounding (sounding of this buzzer should continue until the pushbutton is released). • The kV meter indication should decrease by approximately 2kV.
(10)	Perform charging at 100kV and then perform X-ray exposure at 4mAs.	<ul style="list-style-type: none"> • The kV meter indication should decrease by approximately 4kV.
(11)	Perform charging at 100kV and then perform X-ray exposure at 10%.	<ul style="list-style-type: none"> • The kV meter indication should decrease by approximately 10kV.
(12)	Perform charging at 100kV and then perform X-ray exposure at 20%.	<ul style="list-style-type: none"> • The kV meter indication should decrease by approximately 20kV.
(13)	Perform charging at 100kV and then perform X-ray exposure at 35%.	<ul style="list-style-type: none"> • The kV meter indication should decrease by approximately 35kV.
(14)	Perform charging at 50kV and then perform X-ray exposure at 2mAs.	<ul style="list-style-type: none"> • The kV meter indication should decrease by approximately 2kV.
(15)	Perform charging at 50kV and then perform X-ray exposure at 4mAs.	<ul style="list-style-type: none"> • The kV meter indication should decrease by approximately 4kV.
(16)	Perform charging at 50kV and then perform X-ray exposure at 10%.	<ul style="list-style-type: none"> • The kV meter indication should decrease by approximately 5kV.
(17)	Perform charging at 50kV and then perform X-ray exposure at 20%.	<ul style="list-style-type: none"> • The kV meter indication should decrease by approximately 10kV.
(18)	Perform charging at 50kV and then perform X-ray exposure at 35%.	<ul style="list-style-type: none"> • The kV meter indication should decrease by approximately 15kV.

Notes concerning decreases in the kV meter indications the control panel exceeds 35kV with the tube voltage set at 50kV, turn off the X-ray unit. Decreases in the kV meter indications observed after carrying out X-ray exposures must be equivalent of the mAs settings. Percentage representations denote the required rates of decrease in the meter indications relative to the set charging voltages. The X-ray unit is designed to terminate X-ray exposure once the tube voltage has decreased to 35kV or less. The conversion chart "EXPOSURE RATE" must be affixed on the control panel should be used for quick conversion of a specific % setting into mAs terms.

7.2.4 Beam limiting device

The front acrylic plate should be reattached to the beam limiting device and the projector lamp should be lit by pressing the switch of the lamp on the beam limiting device. Following this, the acrylic plate should be positioned correctly so that the cross mark in the middle of the acrylic plate and the center of the light field come into perfect alignment with one another.

8. FINAL TESTS

After all of the preliminary tests have been successfully completed, the final test phase should be performed.

Note: Take care during this procedure to avoid electric shock or inadvertent X-ray irradiation.

8.1 Tube Voltage Test

Before performing the tests and inspections described below, completely close the variable aperture of the beam limiting device.

- (1) Mount the standard kV meter as directed in subsections 3.5.1 of the Preventive Maintenance Manual.
- (2) Referring to subsection 3.5.1 of the Preventive Maintenance Manual, jump between terminals No. V1 and No. E in the X-ray control.
- (3) Set the "POWER" switch to ON.
- (4) Select 50kV with the kV regulator.
- (5) Press the "CHARGE" button.
- (6) Check to see that the "CHARGE UP" lamp lights up after charging.
- (7) Check to see that the indication on the standard kV meter is 51kV and the indication on the kV meter of the control panel is 50 ± 2 kV.
- (8) Check to see that the map meter indicates 300map as listed in the table below.

- (8) If during charging the indication on the kV meter of the control panel exceeds 53kV with the tube voltage set at 50kV, turn off the "POWER" switch immediately. And when the kV meter indication does not exceed 53kV, turn off the "POWER" switch and see the preventive maintenance and check items listed in the service manual.
- (9) Select 100kV and repeat steps (5) and (6) above. The indications on the kV meter of the control panel and on the standard kV meter must be as listed in the table below:

kV regulator (kV)	kV meter on the control panel	kV meter on the control panel	Standard kV meter
50kV	50±2kV	50kV	51kV±1%
100kV	100±2kV	100kV	101kV±1%

Note: The differences between the indications on the standard kV meter and the indications on the kV meter of the control panel (kV regulator) correspond to the compensations for voltage drops across the two safety resistors (2kΩ) in the high potential generator.

- (10) Automatic recharging will be performed when the set tube voltage of 100kV drops to about 2kV because of natural discharge.
- (11) If the meter indications described above are incorrect, make the necessary adjustments referring to subsection 3.5.2 of the Preventive Maintenance Manual.

8.2 Tube Current Test

- (1) Disconnect the standard kV meter as instructed in SAFETY PROCEDURE FOR HIGH VOLTAGE CIRCUIT (section 5) of the Preventive Maintenance Manual.
- (2) Mount the mAp meter as instructed in subsection 3.6.1 of the Preventive Maintenance Manual.
- (3) Select 4mAs with the mAs selector switch.
- (4) Select 50kV with the kV regulator and press the "CHARGE" button.
- (5) Press the pushbutton of the hand switch to its first stage.
- (6) About 2 seconds later, check to see that the "READY" indicator lamp on the control panel lights up.
- (7) Start X-ray exposure by pressing the pushbutton of the hand switch one stage further.
- (8) Check to see that the mAp meter indicates 300mAp as listed in the table below.

- 8.4 (9) The "X-RAY" indicator lamp must remain lit during X-ray exposure. Check to see that the buzzer sounds upon the completion of exposure and continues to sound until the "X-RAY" button is released.

- (10) Check that the mAp meter indications with respect to tube voltage settings between 50 and 100kV are as listed below.

kV regulator (kV)	50	100
mAp (X-ray tube used: DRX-66D)	300	150

Each measured value must be within $\pm 10\%$ of the values listed above.

- (11) If a measured tube current value is outside the range specified above, readjust it in accordance with the instructions given in subsection 3.6.3 of the Preventive Maintenance Manual.

8.3 mAs Value Test

- (1) Mount the mAs meter as instructed in subsection 3.7.1 of the Preventive Maintenance Manual.

- (2) Set the kV regulator control to 50kV and press the "CHARGE" button.

- (3) Perform X-ray exposure at each mAs setting.

- (4) Check to see that the mAs values obtained at 50 and 100kV are as listed below:

mAs selector	kV setting	
	50kV	100kV
2mAs	2mAs	2mAs
4mAs	4mAs	4mAs
10%	5mAs	10mAs
20%	10mAs	20mAs
35%	15mAs	35mAs

The measured mAs values must be within $\pm 20\%$ of the values listed above.

- (5) If a measured mAs value is outside the range specified above, readjust it in accordance with the instructions given in subsection 3.7.2 of the Preventive Maintenance Manual.

8.4 Reproducibility Test

After completing the mAs value tests, conduct reproducibility tests using the following procedure:

- (1) Set the kV regulator control to 100kV and the mAs selector control to 20%, and then perform X-ray exposure. During this exposure, read the indication on the mAs meter.
- (2) Repeat this test 10 times. Check to see that the differences between the maximum and minimum indications on the mAs meter are 0.4mAs or less.

8.5 Alignment of Light Field and X-Ray Field

This alignment should be made using the same procedure as that for maintenance. For details, refer to section 4.8 of the Preventive Maintenance Manual.

8.6 Illumination Test of Light Field

This test should be conducted using the same procedure as that for maintenance. For details, refer to section 4.7 of the Preventive Maintenance Manual.

8.7 Beam Quality

Beam quality tests should be conducted using the same procedure as that for maintenance. For details, refer to section 4.6 of the Preventive Maintenance Manual.

9. FINISHING

After the installation, assembling, testing, and adjusting operations described above have all been completed, the following finishing operations should be performed:

- (1) Arrange the cables.
- (2) Reattach the top cover.
- (3) Lubrication

Apply new coats of wire rope oil No. NR-40 to any sections that have become dry.

- (4) Recheck that all the screws are tightened.
- (5) Finally, remove any stains from the various sections of the X-ray unit using soft swabs.