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CD38S

MOBILE X-RAY GENERATOR

INSTALLATION & SERVICE INSTRUCTION No 2316

NOTE.... This issue contains Inst 2317 previously issued as a separate instruction.

IMPORTANT

Always refer to the Supplement Section at the rear of this manual before commencing either installation or service work.

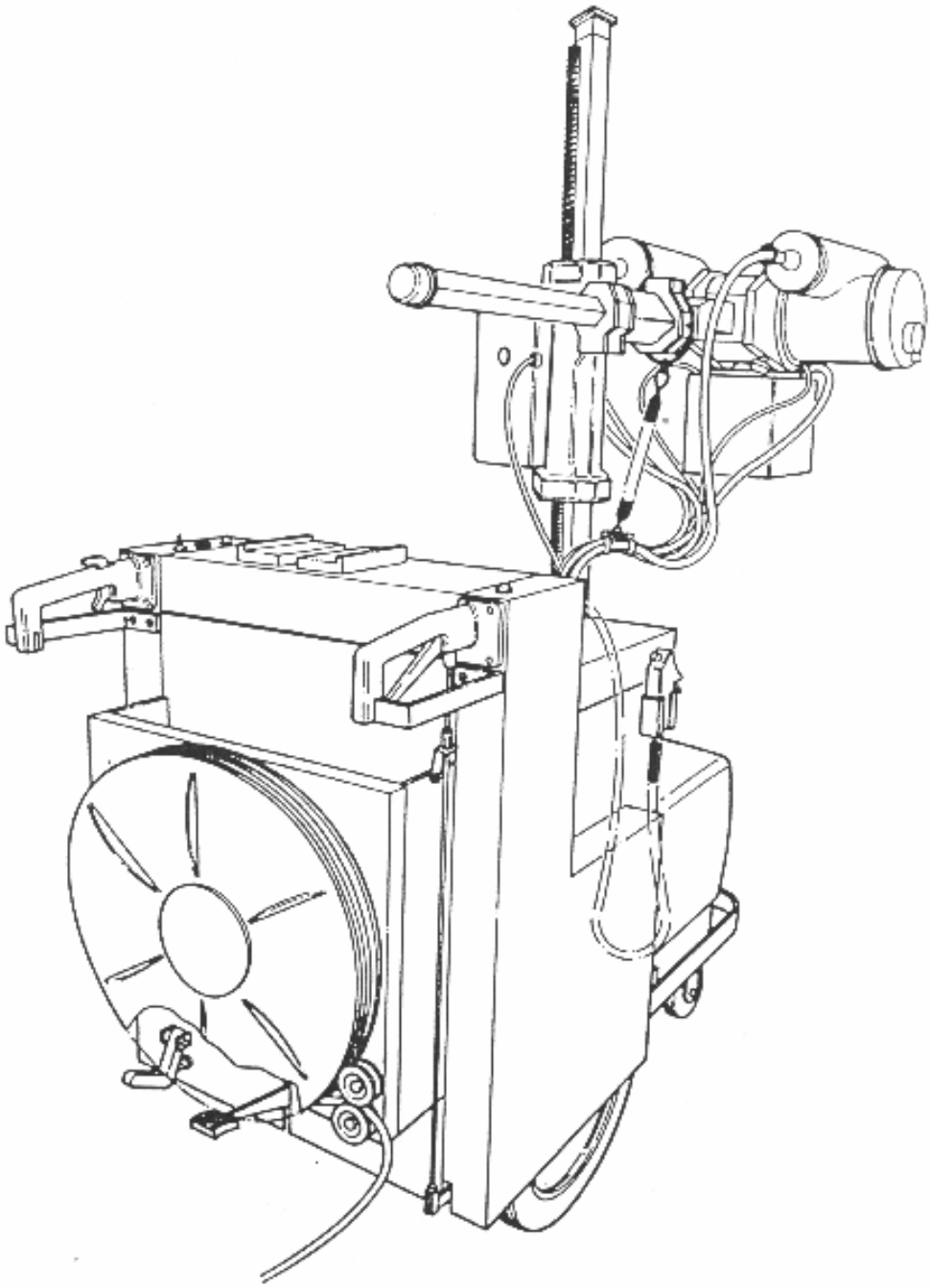


Fig 1 CD38S MOBILE X-RAY GENERATOR

CONTENTS

Supplements to this manual will be accompanied by a new yellow contents sheet. Please replace existing yellow sheet with the new one and amend supplement section to conform to the new contents list.

RADIATION HAZARDS & SAFETY PRECAUTIONS

It is dangerous for any person to operate this equipment without having received appropriate training which will have included instruction in the means for using X-radiation without hazard to patient, user and surroundings.

The purpose of these instructions is to inform the user about the technical functioning of the equipment for its intended purpose(s); they do not cover any aspects of radiation protection or other aspects of safety relating to the application of the equipment.

The user must be aware of all regulations and requirements that may be applicable governing the installation and use of equipment producing ionising radiation for medical purposes.

ELECTRIC SHOCK HAZARD

Do not remove any high voltage cable connection to an X-ray tube. Note also that such a cable may retain an electric charge or be connected to other components retaining a charge after the equipment has been switched off.

Do not remove any covers or panels giving access to live parts. Any cover requiring the use of a tool for its removal can be assumed to be in this category.

EXPLOSION HAZARD

This equipment is not classified as anaesthetic-proof and may ignite flammable anaesthetics. Flammable agents used for skin cleaning or disinfection may also produce an explosion hazard.

HEALTH & SAFETY AT WORK ACT 1974 (UK installations only)

All equipment manufactured and supplied by this Company has been tested and examined to ensure as far as is reasonably practicable, that it is safe and without undue risk to health when properly used.

The conditions under which our equipment will operate safely and without undue risk to health are specified in our Operating Instructions and users should ensure that they fully understand the technical conditions regarding safe operating of the equipment and are conversant with and observe Regulations and Codes of Practice which relate to X-ray Equipment.

It is also the duty of the employer to ensure that his employees fully understand the Regulations and Operating Instructions.

It is highly recommended that this manual is read before commencing installation or service work. The tasks details should only be carried out by a competant X-ray engineer.

Introduction

The CD38S mobile X-ray generator utilises the well proven principles of a capacitor discharging through an X-ray tube in order to generate X-rays. The generator is mounted on a mobile carriage which is driven by rechargeable batteries mounted on the carriage. The CD38S is completely self contained and only requires a source of mains power to make radiographic exposures.

The maximum capacitor charge time is approximately 20 seconds and kV can be changed as desired after initial charging. The equipment is so arranged that it can be safely left unattended, whilst the batteries are being recharged, with no fear of unauthorised use. It can only be driven and X-rays generated when the key is in the keyswitch.

The multi-leaf collimator gives a field of view of 450mm x 450mm at an FFD of 1000mm. When the push button on the front of the demarcator is pressed a black cross is projected for 30 seconds to indicate the field centre whilst the illuminated area shows the area to be radiated. A bar of light is also projected to indicate the centre line of the tube on a cassette holder.

The capacitor discharge system allows high tube currents and short times to be used in order to achieve the selected mAs. This ensures high quality radiographs even with a restless patient.

The kV can be easily set in the range of 30-125kV with the actual kV being shown on a digital indicator. The mAs is set by a 15 position switch and covers the range 2-60mAs. The actual exposure time is determined by the electronic circuitry dependant upon the setting of the mAs and the kV.

The drive controls are all conveniently located at the operators position and are simple to operate. Should the drive batteries become discharged the equipment has the facility whereby the drive can be easily disconnected and then be manually pushed to a power source to enable the batteries to be recharged.

CAUTION

MAINS PLUGS FOR CAPACITOR DISCHARGE MOBILE EQUIPMENT

Please note that RED 13A plugs must NOT be fitted to CD Mobile units.

These units MUST be fitted with a standard 13A fused plug

INSTALLATION

The CD38S is normally supplied as a completely assembled equipment and would only require a charge applied to the drive batteries. However, there can be occasions when the major assemblies only will be supplied and the engineer will be required to assemble them on site.

Fitting the tube column

The tube column may be supplied with the crossarm fitted to the carriage. Before the tube column can be fitted the crossarm must be removed in the following manner.

1. Place the tube column on a strong bench or table.
2. Remove the crossarm lock screw, cup, spring and plunger.
3. Remove the crossarm end plate and cover.
4. Remove large rubber stop pad.
5. Remove crossarm retaining plate.
6. Support the crossarm and carefully slide it out of the carriage.

Replacing the crossarm is the reverse of the above. The tube column can now be fitted. Lift the tube column to the vertical position and carefully lower it into its seat.

Fitting the X-ray tube and demarcator

1. Fit the din plate to the end of the crossarm extension using the 2 set screws.
2. Place the demarcator on a bench or a table and ensure the table is suitably protected by a thick blanket or similar material.

> CAUTION....The two lead leaves in the demarcator entry port must not be damaged.

3. Position the tilt indicator bracket over the demarcator entry port with the tilt indicator above the entry port and facing in the same direction as the demarcator.
4. Carefully position the X-ray tube over the demarcator entry port so that the HT cable sockets are at the rear of the demarcator. The X-ray tube is secured by 4 counter sunk Allen screws and the two on either side of the tilt indicator bracket secure two bushes which act as rotational stops. Access to the 4 Allen screws can be obtained by rotating tube on the demarcator.

> CAUTION.... When rotating tube ensure that tube/demarcator alignment is maintained so as to prevent damage to the lead leaves.

Multicore cables

The demarcator, tube and column drive motor cables have to be connected to the generator. The demarcator and the tube multicore cables are connected to the 4-way terminal strip at the top of the generator control. Access to this terminal strip is obtained by removing the cable exit covers (two) above the HT tank. Before removing these covers operate the safety discharge plunger with a suitable insulated rod, that is located on top of the HT tank and between the HT cables. The column drive motor cable is terminated by an Amplock connector and is mated to the same coloured connector that is tucked away on the left of the 4-way terminal strip (as viewed from the operators position.

Demarcator cable connections

4-way terminal strip	Demarcator cable
L100	2
3	3
L0	5
8	8
9	9
11	11
12	12
E	E

X-ray tube cable connections.

4-way terminal strip	Tube cable
L0	1
L100	2
X	X
L0	Y
Z	Z
L100	TH8
TH2	TH9
E	E

Setting main supply voltage

The wander lead idented LF2 must be connected to the lower terminal strip and an appropriate fuse fitted.

Ascertain the nominal supply voltage and connect LF2 to the appropriate terminals.

Supply Volts	Terminal	Fuse rating
250V ±25V	250	10A
235V ±23.5V	235	10A
220V ±22V	220	10A
205V ±20.5V	205	10A
190V ±19V	190	10A
120V ±12V	120	20A
110V ±11V	110	20A
100V ±10V	100	20A

The fuse and fuse holder is located inside the cabinet on the right hand side wall.

Mains Plug (See Supplement No 2373 in rear of this manual)

Fit an appropriately fused mains plug. Note that the green/yellow lead must be connected to the earth pin, brown lead to live and the blue lead to neutral.

H.T. tank oil level

Measure the oil level in the H.T. tank. It should be measured from the lower edge of the tank top - correct levels are given in the table below.

Room temperature	Level
0°C	1.3cm
20°C	1 cm
40°C	0.7cm

Batteries

The batteries must be filled and installed in accordance with the instructions contained on page 11.

IMPORTANT NOTICE

PLEASE READ THESE INSTRUCTIONS CAREFULLY BEFORE FILLING AND FITTING YOUR BATTERY

GENERAL

The sulphuric acid contained in the special plastic bottles is a caustic liquid and can be dangerous. KEEP WELL AWAY FROM CHILDREN.

Keep your battery in a dry place and do not fill until it is required for use.

PUTTING INTO SERVICE

1. Choose a convenient place outside the building. Remove the battery and acid bottles and inspect carefully for any damage received in transit. (DO NOT ATTEMPT TO FILL A DAMAGED BATTERY).

2. Remove the plastic vent plugs or vent covers from the battery, and carefully break the black seal (if present) of each cell using a short blunt piece of wood. The seal is quite brittle and very little pressure is required to break it. Avoid using sharp metal instruments, which if inserted too far into the cell will damage the tops of the plates or separators. The broken pieces will fall into the bottom chamber and do no harm. Some seals may be already broken which is the result of factory quality control checks.

3. With the acid bottle in an upright position, cut off the tip of the spout with a pair of scissors or sharp knife, approximately $\frac{1}{4}$" from the top, fill each cell to $\frac{1}{4}$" above the plastic shield visible within the cell.

4. Allow the battery to stand for TWO HOURS and then top up if necessary to the level as before.

ONCE THE FILLING OPERATION IS COMPLETED ONLY DISTILLED WATER MUST BE USED FOR FUTURE TOPPING UP.

5. Wipe the top of the battery clean using if available a rag soaked in a little household ammonia which will neutralize the acid, and replace the plastic vent plugs or covers.

6. The new battery can now be fitted, making sure the terminal connectors and hold down bolts are firmly secured but NOT over-tightened. ENSURE CORRECT TERMINALS ARE CONNECTED.

7. Once the battery has been filled with acid, electrolytic action commences and it MUST be fitted to the unit WITHIN 2 HOURS and given a charge overnight.

8. The empty acid bottles should be thoroughly washed out with water and placed in a dustbin together with the funnel and any cleaning rags. THESE BOTTLES MUST NOT BE USED FOR ANY OTHER PURPOSE.

FIRST AID . . . . . In the event of acid getting on any part of the body, immediately rinse off with plenty of cold water. If in the eye, rinse with cold water, preferably using an eye bath, repeating the process many times. After taking this action it is advisable to consult your doctor. Acid spilt on clothes or household items should be rinsed with cold water and neutralized with common washing soda. These actions will immediately destroy any effects of the acid.

BATTERY MAINTENANCE AND CARE

By following these simple instructions you will obtain the maximum efficiency from your battery and ensure long and trouble-free life.

(a) Check your battery once a week and top up with distilled water if required. (NEVER USE ACID).

(b) Do not allow the battery to stand for more than 4 weeks without charge.

(c) Keep leads, terminals and connectors free from dirt and corrosion-clean regularly and smear with vaseline.

(d) Keep vent plugs clean and secure and top of the battery clean and dry.

SERVICE

Brief Description

When the equipment is connected to a power source, power is applied to the battery charger via the circuit breaker and two fuses.

If the key switch is now turned to ON power is available at the main contactor, which is energised when the CONTROL ON push button is pressed, and passes power to the main transformer. The main transformer then provides 100V to the power transformer, via the FUSE UNIT pcb and the CONTROL pcb.

The main transformer also provides a 100V supply to the CONTROL pcb that is used by the HT transformer.

Circuit Description

When the CHARGE push button is pressed the capacitors in the HT tank charge up to the kV selected on the kV regulator, under the control of the analogue circuitry on zones A and C of the pcb. During the charging sequence the CHARGE lamp, on the control panel, and the charge LED on the indicator pcb illuminates. There are two LED's built into these areas of the pcb. D9-01 identified SH, illuminates whenever the charge exceeds approximately 80kV and D9-02 identified DCH illuminates to show a discharge sequence is in operation eg when kV regulator is turned to the OFF position (fully anti clockwise) or when it is decided to reduce kV after a charging sequence.

Zone B of the control pcb contains the circuitry that regulates the pcb power supplies ie + 5V, +15V and -11Vd.c.

Zones D, E and F contain the radiographic exposure circuits the radiographic exposure timer, tube filament pre heat circuits, the discharge circuits and the tube filament current control circuits. There are no on board indications on these zones of the pcb.

If the PREPARE grip switch on the handswitch is now operated, relays K-RE1 and K-RE2 are energised, the tube rotor energised, the demarcator shutter is moved out of the X-ray path, the tube filament current will be boosted and further charging inhibited. After a delay of approximately 1.6 secs relay K-ST is energised, the READY lamp illuminates and the equipment is ready to carry out an exposure.

When the EXPOSE push button is operated relay K-XR is energised. The X-RAY warning light illuminates, the negative grid bias in the tube is removed, and an X-ray exposure is made. The exposure counter will also advance by one count and the warning buzzer will operate.

The method of construction of the CONTROL pcb is such that replacement of components is difficult. Therefore only repairs of a minor nature should be attempted. Repairs to the other smaller pcb's can be attempted.

A more detailed and comprehensive circuit description of the generator control is contained in Instruction No 2317, reprinted after page 30 of this instruction.

Mobile base and tube column

The mobility carriage and tube column used on this equipment is the same as that used on the D38. In this unit, the column carriage winding handle is not fitted. In an emergency, the carriage may be moved up or down the column by removing the rubber bung and inserting a screwdriver.

Main Drive

Depress Drive Wheel Release pedal and check Forward Drive including:-

(i) Function of Slow/Fast switch
(ii) Reverse Drive
(iii) Motor stops when brake lever operated

Column Drive

(i) Check drive from both control and tubehead controls. If both up and down buttons are depressed check that motor stops.

(ii) Check both limit switches.

(iii) Check control lid limit switch.

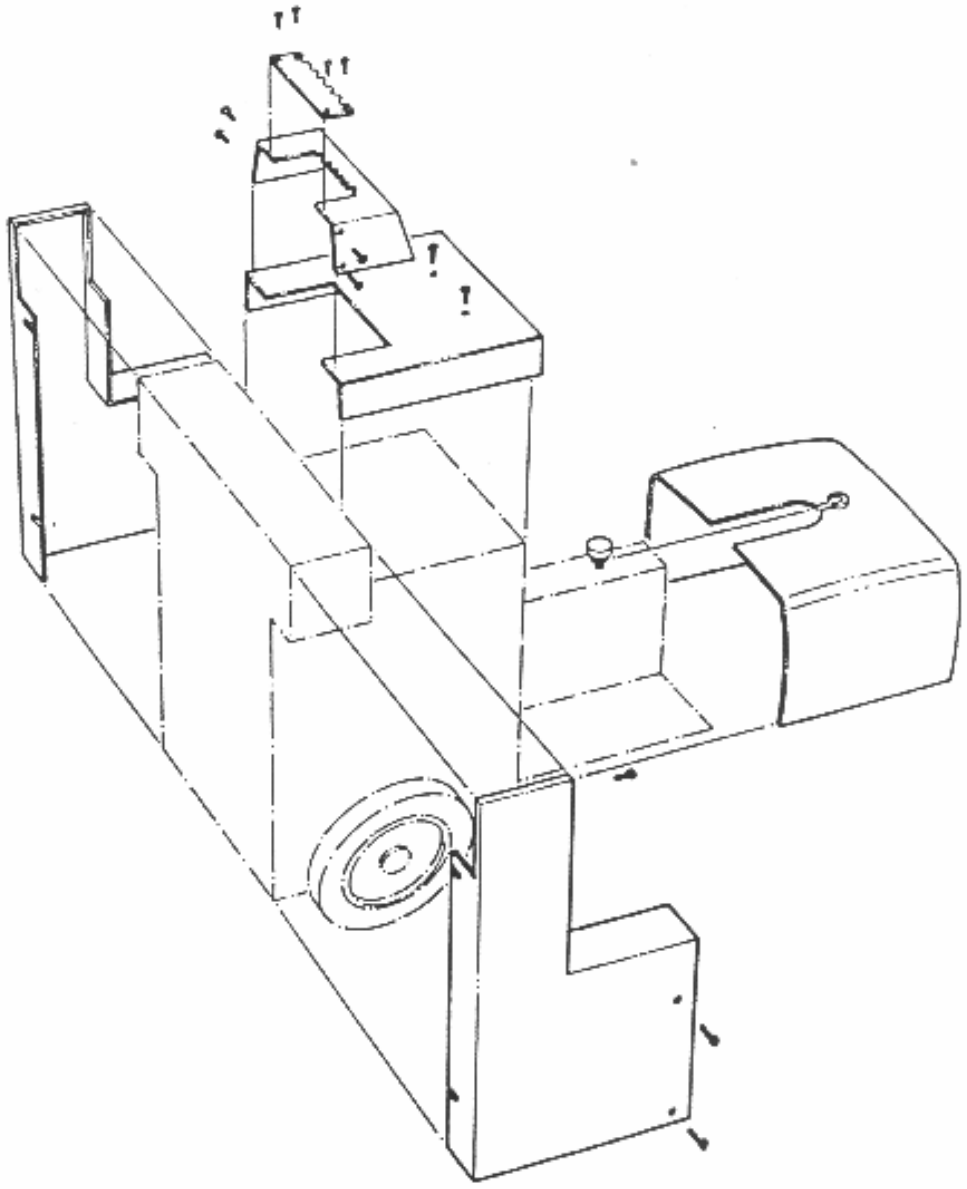


Fig 3 Removal of covers

Fig 3 above shows how all the covers are secured to the main assembly.

Component location (Refer to Figs 4 & 5)

MC Main contactor - under left hand side panel
CB Miniature circuit breaker - inside cabinet left hand side
F1 and F2 Fuses - inside cabinet left hand side
Mains on neon - top panel
Mains on switch - control panel
Mains OFF switch - control panel
MR101 rectifier - under left hand side cover
S102 carriage down push button - tilt indicator bracket
S103 carriage down push button - control panel
S104 carriage up push button - tilt indicator bracket
S105 carriage up push button - control panel
UD up drive relay)
DD down drive relay) - under left hand side cover
S101 resistor)
S111 down safety switch - under control panel
S101 keyswitch - top panel
kV meter - control panel
kV regulator - control panel
Board indicator 20 - upper centre of cabinet
Board mAs selector 20 - under control panel
CHARGE push button - control panel
Exposure counter - right hand side of cabinet
Transistor board unit 10 - upper centre of cabinet
Power transformer - on cabinet door
RF1 & RF2 resistors - on cabinet door
Autotransformer)
K-DS relay) - right hand side of cabinet
Board fuse unit 20)
Charge indicator - control panel
Ready indicator - control panel
T1010 transformer)
D1011 diode bridge) - low voltage supply for handswitch) under right side cover
RL1055 relay)
RL1056 relay)
Fuse between leads
LF1 and LF2 - right hand side of cabinet

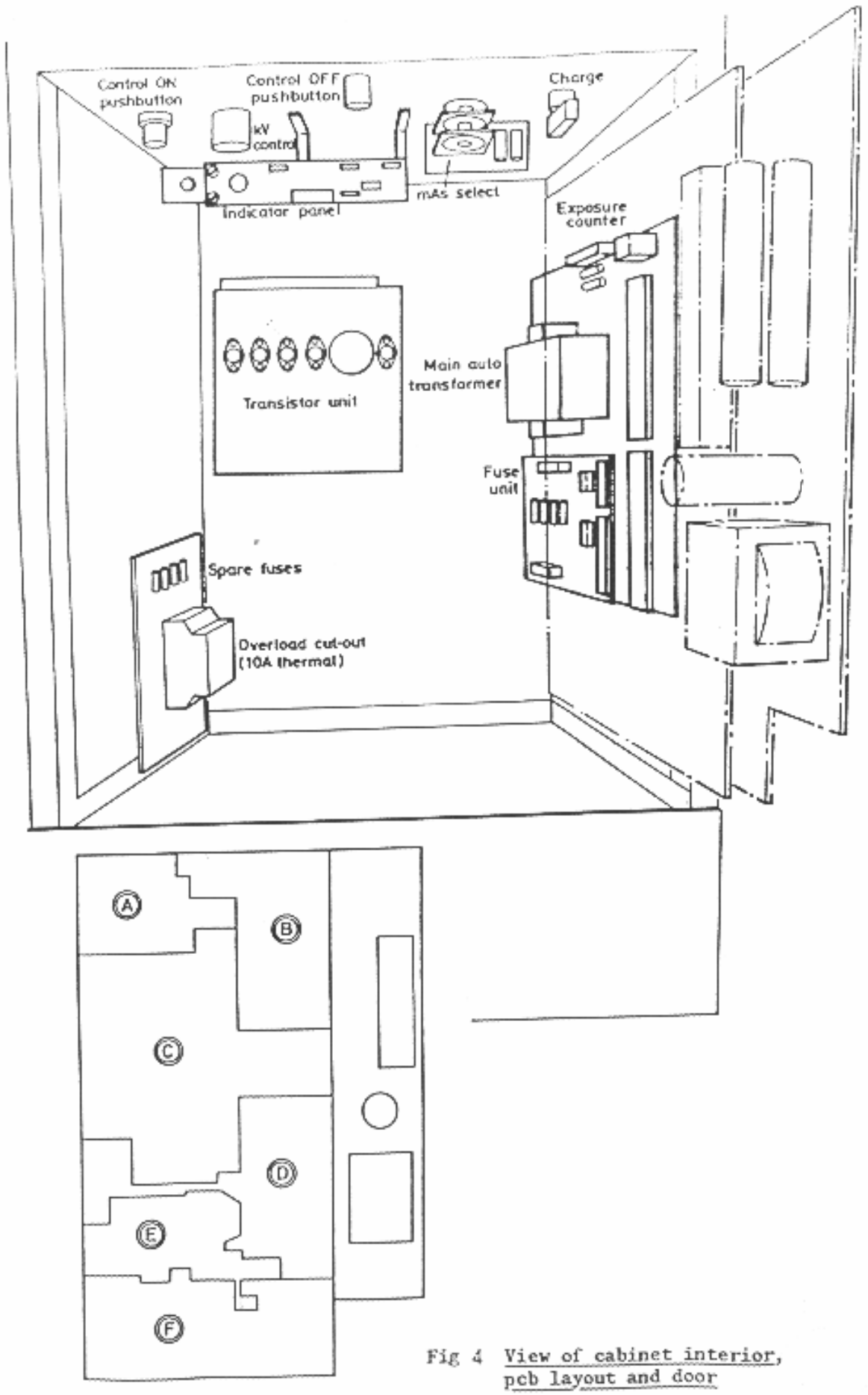


Fig 4 View of cabinet interior, pcb layout and door

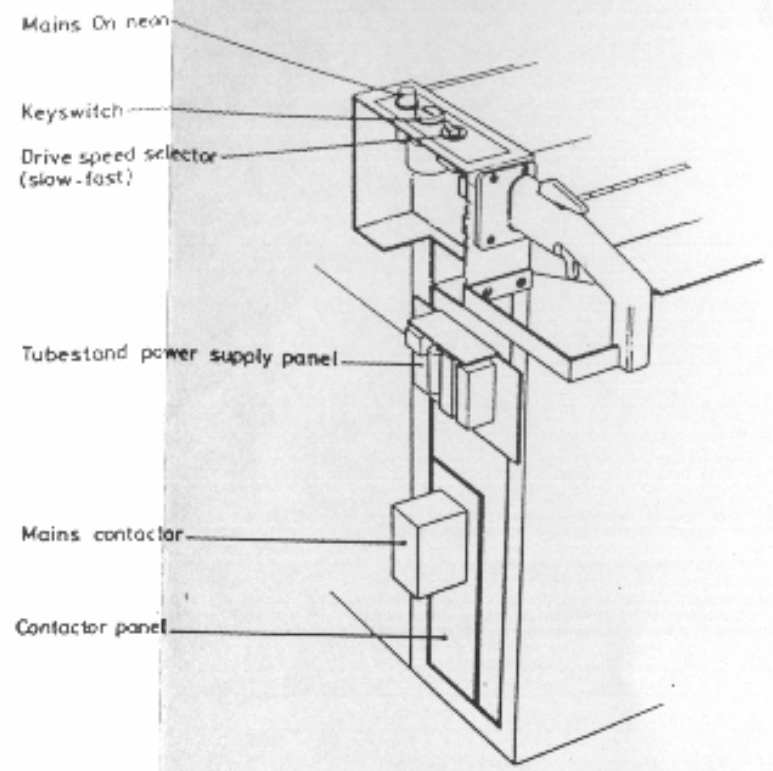


Fig 5 Left-hand side panel

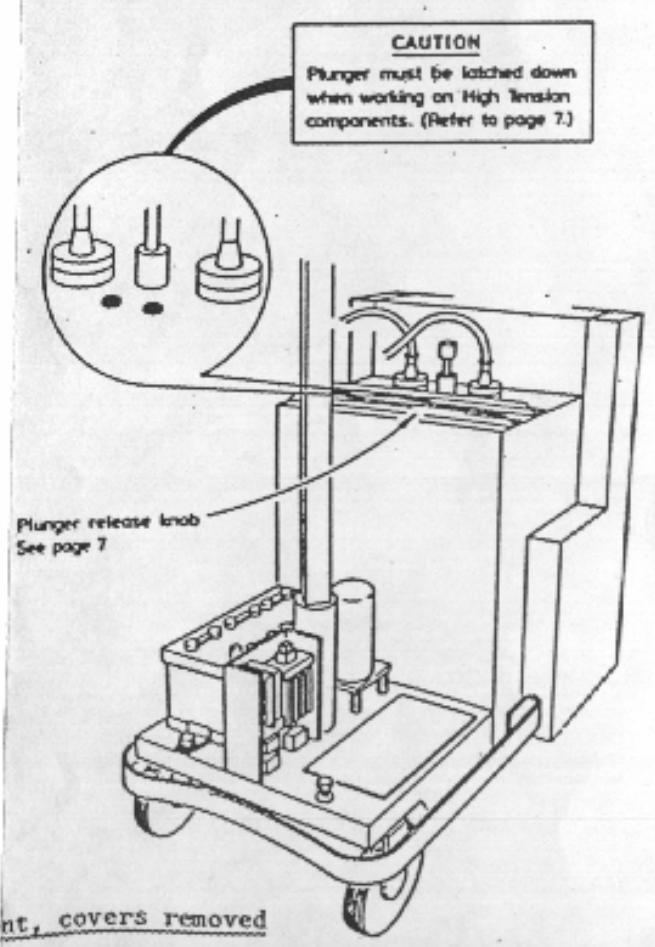


Fig 6 View from front, covers removed

Relay functions

K-T1 – energised on operation of Charge push button

1. C/O – completes HT primary circuit, disables K-BU1.
2. N/O – completes HT primary circuit

K-T2 – energised on operation of Charge push button

1. N/O – hold on contact for K-T1
2. N/O – hold on contact for K-T2
3. N/O – completes supply rail to charge switching circuit
4. C/O – disconnects and discharges C7-03 (delay capacitor across K-T2).

K-RE1 – energised on prepare

1. C/O – switches OFF Q2-01 and Q2-02 inhibiting charging operation.
2. C/O – changed J/P to M3-10 from stand by filament to boosted filament.
3. N/C – opens in DISCHARGE line, inhibiting discharge operation
4. N/O – closes in supply line to hand switch

K-RE2 – energised on prepare

1. N/O –) both close in tube filament supply rail,
2. N/O –) shorting out RF1.

K-ST – energises at end of prepare delay

1. N/O)
2. N/O) closes in supply rail to hand switch and
3. N/O) illuminates Ready lamp
4. N/C puts 100V on plug 28C-DT during prepare delay period

K-XR – expose relay

1. N/O – initiates expose circuit
2. N/C – discharges mAs timing capacitor at end of expose
3. C/O –)
4. C/O –) not used

K-BU1 – energises under fault conditions e.g. when triac D1-01 goes short circuit

1. N/C)
2. N/C) Removes supply from relays K-T1 and K-T2

K-BU2 – energises under fault conditions in filament control circuit

1. N/C – Removes supply to tube filament transformer
2. N/C – Removes supply to hand switch circuit

Summary of Preset Potentiometer functions

VR5 - sets prepare delay of 1.6 secs.

VR2-01 - KVM	Set for 85kV on kV meter with 60V ac applied to HT primary	
VR3-01 - KVL	Sets kV meter/kV control tracking at 30kV	
VR1-01 - KVH	Sets kV meter/kV control tracking at 110kV	
VR4-02 mAF	Sets discharge current of 3mA	)
VR4-01 LVmA	0.5, 1, 6-50mAs adjust for 400mAp at 60kV	) Refer to
VR1-02 MVmA	0.5, 1, 6-50mAs adjust for 290mAp at 60kV	) page 27
VR4-03 HVmA	0.5, 1, 6-50mAs adjust for 116mAp at 60kV	)
VR2-04 SHmA	2-5mAs adjust for 490mAp at 60kV	)
VR3-02 HSHmA	2-5mAs adjust for 160mAp at 125kV	)
VR2-03 mAs	adjust for 20kV drop on kV meter at 100kV, 20mAs	

Setting up procedure

The procedures described below would normally only be carried out after a repair involving the replacement of an assembly or a component. However, aging of components can also cause circuit degradations indicating the need to carry out the setting up procedure.

Adjusting 'PREPARE' delay time

1. Disconnect connector 28C from the control pcb. This will isolate the exposure counter.

2. Press the prepare contact on the hand switch and using a suitable timing device (stopwatch) measure the PREP/DELAY time.

3. If the time (1.6 sec $\pm$ 0.1 sec) is incorrect then it can be corrected by adjusting VR5, located on the control pcb. Clockwise adjustment will cause the count to increase.

4. Once the correct time has been achieved, replace connector 28C.

kV meter circuit adjustment

Whenever the kV meter requires setting up, normally after a repair involving component replacement or when kV indication appears to be incorrect, it should be carried out in the following manner.

1. Switch OFF the equipment. Disconnect connectors 1C and 2C from the control pcb (zone A). Connect terminals 190 and 250 of the terminals strip to terminals T1 and T2 respectively, on top of the HT tank. Use cables with a conductor csa greater than 1.25mm.

2. Connect an accurate, recently calibrated AC voltmeter (AVO) that is capable of measuring 100V between terminals 190 and 250.

3. Set the kV control, on the control panel, fully counter clockwise.

4. Switch ON the mains supply by operating the key switch.

5. Switch ON the equipment by pressing the CONTROL ON push button.

6. Select a value of kV by operating the kV control and press the CHARGE push button.

7. When the charging operation has been completed, indicated by a steady reading on the kV meter and the CHARGE lamp extinguishing, read the value of kV on the kV meter and the primary voltage on the voltmeter connected across terminals 190 and 250.

continued overleaf

8. The graph at Fig 7 defines the relationship between kV applied to the X-ray tube and the primary voltage during an actual radiographic exposure (drawn in solid line). The dotted line shows the charge voltage applied to the HT capacitors, the difference between the two graphs being the volts dropped across any resistance in series with the X-ray tube.

9. In this particular case the primary voltage will be 60 ± 6V and the kV will be between 95 and 77kV. Refer to the graph at Fig 7 for the exact value of kV that is generated by the measured primary voltage.

10. Adjust the potentiometer kVM on the control pcb (zone C) so that the kV reading on the kV meter is correct for the primary voltage as defined on the graph Fig 7 .

11. Remove the wires connecting terminals 190 and 250 to terminals T1 and T2. Reconnect connectors 1C and 2C to the control pcb

N.B. This adjustment has only ensured that the kV indication is correct for a given primary voltage and has not affected the charging circuit.

Adjustment of Automatic Charging Circuit

If after carrying out the adjustment described in paras 1 to 11 there is a difference between the kV selected by the kV control and the kV meter reading, then carry out the following procedure.

NOTE.... Ensure adjustments described in paras 1 to 11 are correctly carried out before setting up the Automatic Charging Circuit.

1. Set the kV control to 30kV.

2. Press the CHARGE push button and when the charge sequence is complete, indicated by the CHARGE lamp extinguishing, read the kV meter.

3. If a difference exists between the kV reading and the kV setting then potentiometer kVL on the control pcb (zone C) will require adjusting until they are equal.

4. Set the kV control to its fully counter clockwise position and allow the capacitors to fully discharge.

5. Reset the kV control to 30kV and ensure that, after charging is completed, the kV meter reads 30kV.

6. Set the kV control to 110kV and repeat the procedures listed above but in this case use potentiometer kVH on the control pcb (zone C).

7. Occasionally there can be some inter action between kVL and kVH, in such a case it may be necessary to repeat the above procedures (1-6).

Adjustment of X-ray tube filament pre heat current

1. Set the kV control to 90kV and press the CHARGE push button.

2. After the charging operation is complete reset the kV control to less than 60kV.

3. Measure the time taken for the charge on the capacitors to drop from 90kV to 60kV. The time should be 10 seconds.

4. If this is incorrect adjust potentiometer mAF on the control pcb (zone E) for a 10 second period.

5. An alternative method is as follows.

6. Ensure that the capacitors are fully discharged by turning the kV control fully anticlockwise and allowing time for the charge to decay.

7. Remove the short circuits links between terminals CN1 and E, and CN2 and mAs1 of connector 7C on the control pcb.

8. Connect a d.c. milliammeter (AVO) between terminals CN2 and CN1 with CN2 positive.

9. Set the kV control to 90kV and press the CHARGE push button.

10. After the charging operation is complete reset the kV to less than 60kV.

11. During the discharge period the ammeter should read 3mA. Adjust potentiometer mAF on the control pcb (zone E) so that a discharge current of 3mA is achieved.

12. Discharge the capacitors by setting the kV control fully anticlockwise and allow time for charge to decay.

13. Disconnect the milliameter and replace the shorting links between terminals CN1 and E, and CN2 and mAS1 of connector 7C.

X-ray tube current

If the X-ray tube is replaced it is important that the X-ray tube current is adjusted in the following manner.

X-ray tube current is automatically determined by the setting of the kV control. The graph at fig 8 page 26 describe the short time rating of the X-ray tube used with this equipment (CIRCLEX 1.2μG). If the X-ray tube is replaced, or the tube current appears to be incorrect, it is important that the X-ray tube current is adjusted in the following manner.

1. The tube current should be adjusted at the following four points.

0.5, 1, 6-50mAs	60kV
0.5, 1, 6-50mAs	80kV
0.5, 1, 6-60mAs	125kV
2-5mAs	60kV
2-5mAs	125kV

2. To measure mAp connect a recently calibrated oscilloscope across R18 (300Ω). Circuit reference (D) .

3. Set the mAs selector to 6mAs.

4. Set the kV control to 60kV and press the CHARGE pushbutton.

5. Once the charge sequence is complete carry out a radiographic exposure and read the current on the oscilloscope.

6. Adjust potentiometer LV mA on the control pcb (zone E) so that the reading agrees with that given in the table 1 overleaf.

7. Set the kV control to 80kV and repeat the tests in paras 4-5 above. Adjust potentiometer MVmA on the control pcb (zone E) to achieve the tube current specified in table 1 overleaf.

8. Set the kV control to 110kV and repeat the tests in paras 4-5 above and adjust potentiometer HVmA for the tube current specified in table 1 overleaf.

9. Set the mAs selector to 4mAs and the kV control to 60kV and repeat the tests in para 4-5 above. Adjust potentiometer SHmA to achieve the tube current specified in table 1 overleaf.

10. Set the kV control to 125kV and repeat the tests in para 4-5 above. Adjust potentiometer H SH mA to achieve the tube current specified in table 1 overleaf.

11. The five potentiometers must be adjusted in the order given, LVmA, MVmA, HVmA, SHmA and HSHmA.

    NOTE....Turning the potentiometer clockwise increases the tube current except HSHmA and SHmA which are the reverse.

12. Make further measurements at intermediate points and ensure that tube current is approximately 90% of that given on the graph in fig 8.

13. When adjustments are complete turn the kV control fully anticlockwise and switch OFF the control. Ensure that the capacitors are fully discharged by operating the safety discharge device. Disconnect the oscilloscope from across R18.

Adjustment of mAs timer

When a radiographic exposure is made with settings of 20mAs and 100kV, then the kV drop is numerically equal to the mAs ie mAs = 20 kV - 100 after 1 exposure kV will fall to 80kV.

If the kV does not fall by 20 then the mAs timer is incorrect and must be adjusted in the following manner.

1. Set the mAs selector to 20mAs.
2. Set the kV control to 100kV and press CHARGE push button.
3. After the charging operation is complete carry out a radiographic exposure and read the kV drop on the kV indicator.
4. Adjust potentiometer mAs on the control pcb (zone D) so that the kV drops to 80kV after the radiographic exposure.

Adjusting order	Variable resistor	mAs selector	Tube voltage	Tube current mAp 60Hz	50Hz	
1	LVmA	6mAs	60kV	450	400	120V
2	MVmA	6mAs	80kV	330	290	87V
3	HVmA	6mAs	125kV	180	160	48V
4	SHmA	4mAs	60kV	540	490	147V
5	HSHmA	4mAs	125kV	180	160	48V

Table 1

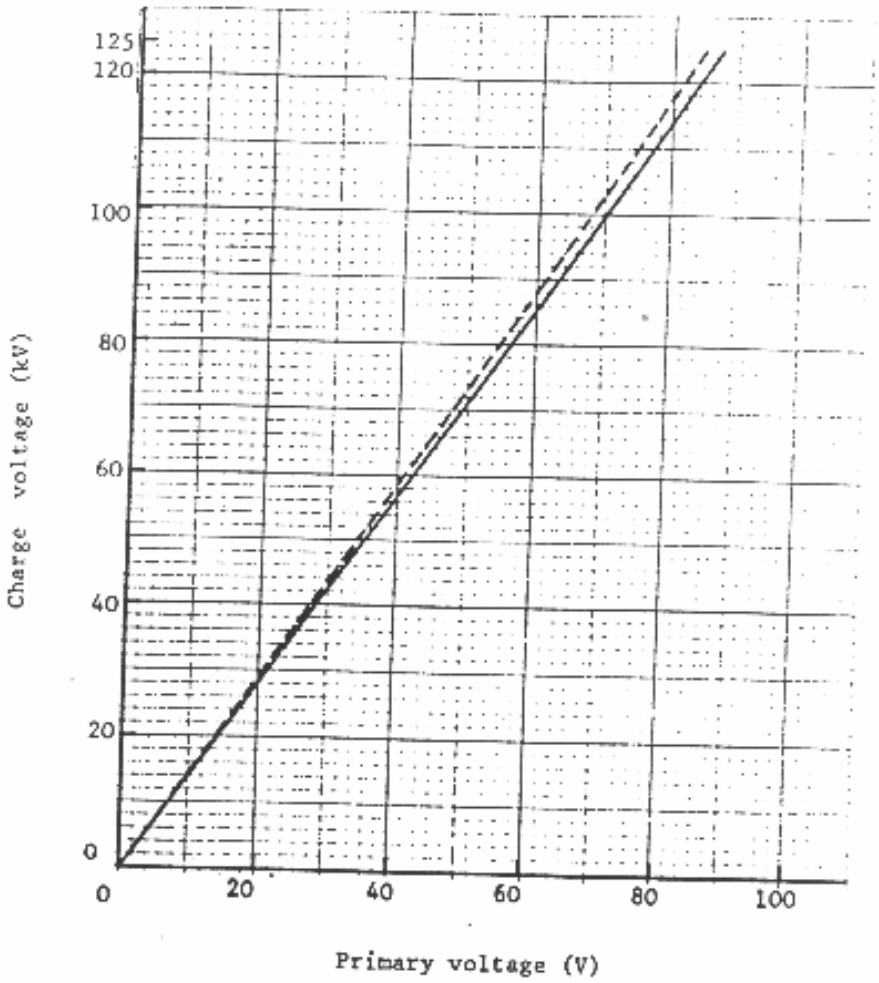
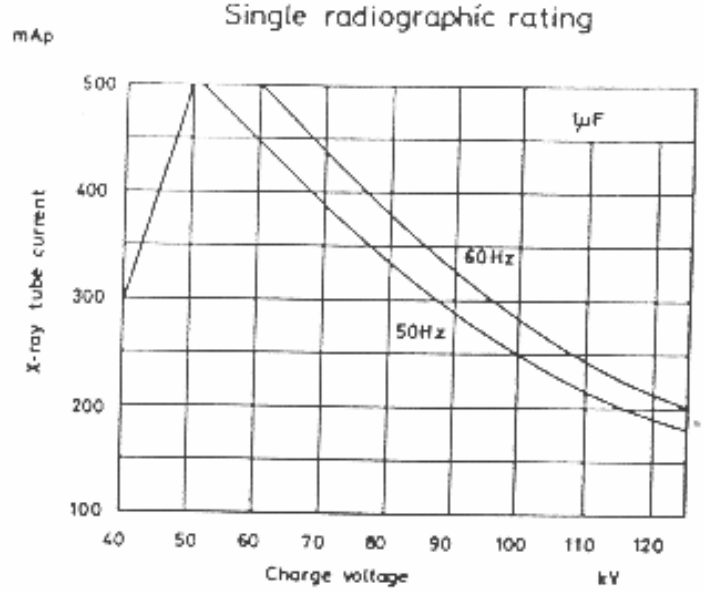

125
120
100
80
60
40
20
0
0
20
40
60
80
100
Charge voltage (kV)
Primary voltage (V)

Figure 7



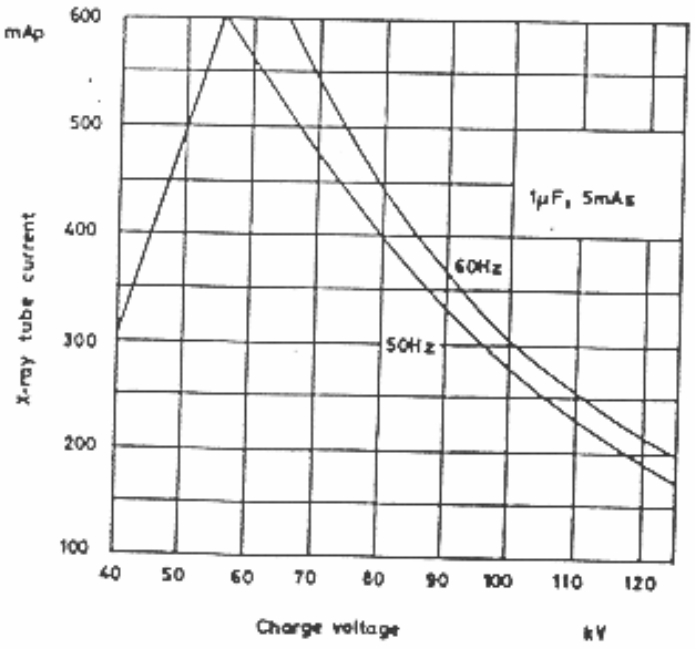
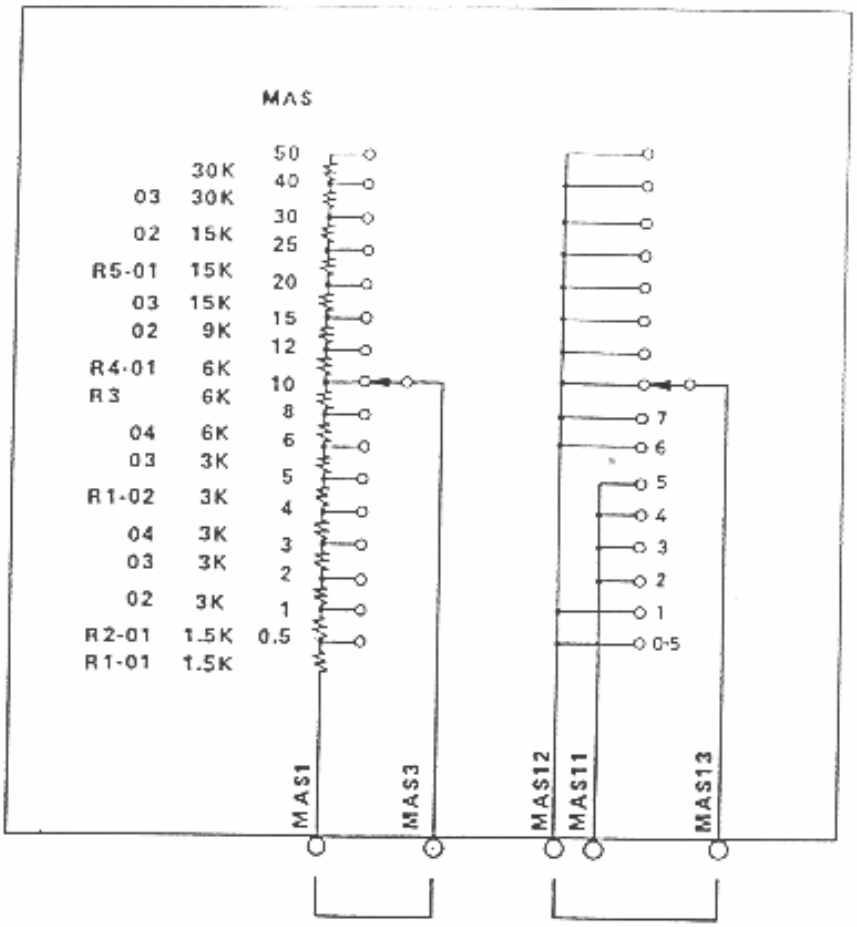


Fig 8

(2316/1/280)



At 0.5mAs or 1mAs position, the tube current is set to the same value with the current value of more than 6mAs.

Note: For earlier units refer to page 27.

Figure 8A: mAs SELECTOR – Latest Units
Modification Number 1690

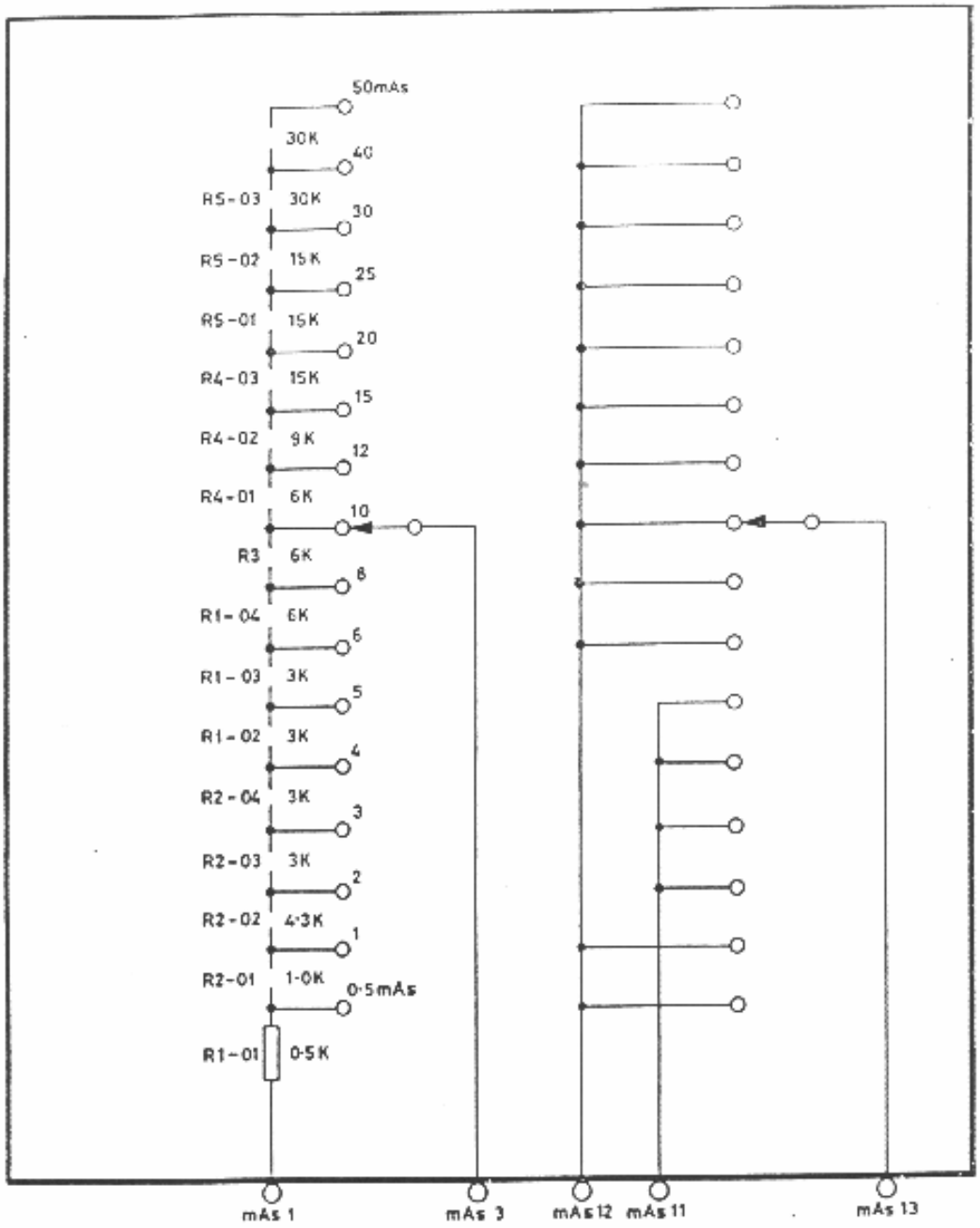


Fig 9. mAs SELECTOR -20

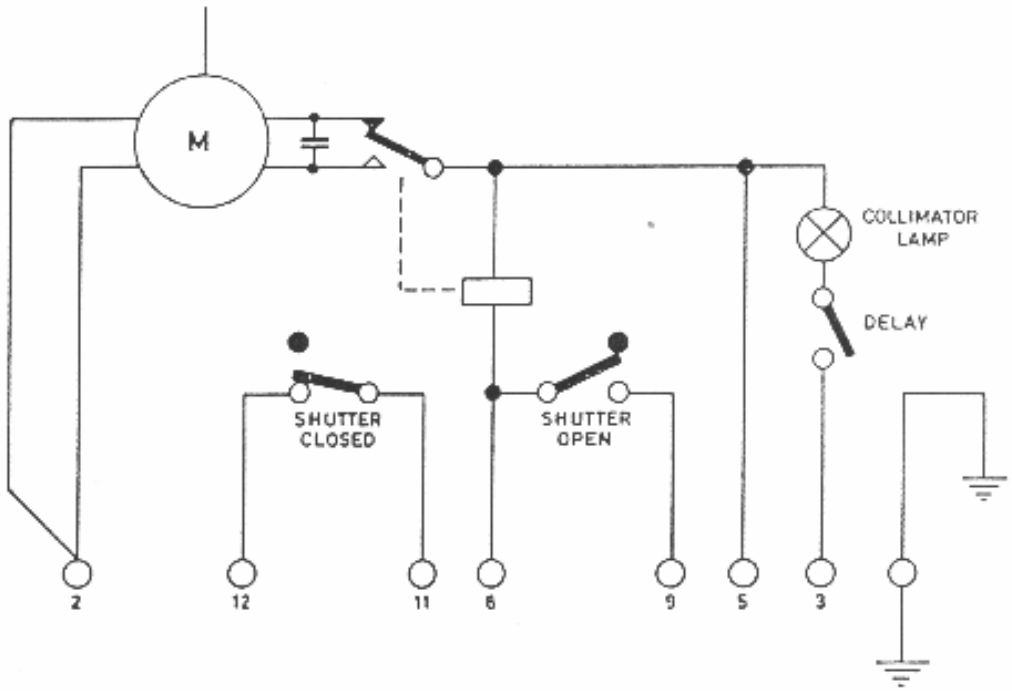
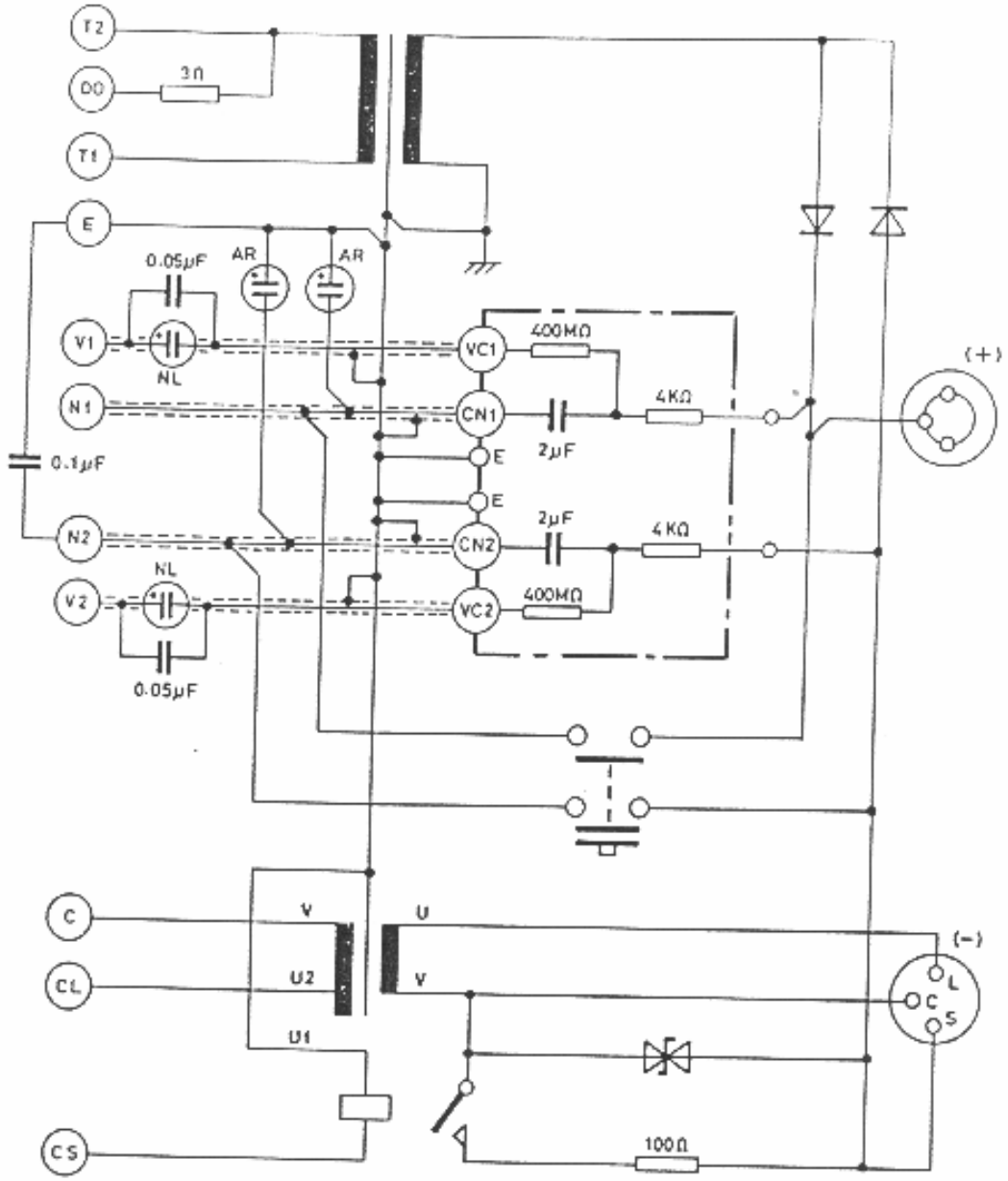


Fig 11. COLLIMATOR CIRCUIT



AR = ARRESTER
NL = NEON LAMP

Fig 12. H.T GENERATOR (MC125L-30)

(2316/1/280)(From

5 Ensure that the tube/homocentor is in a stable and safe condition. Position the mobile base so that the crossarm is at the same level as the X-ray tube and the din plate is located between the HT cable entry horns.

6 Locate the lower trunnion rings to the tube then align the din plate to the trunnion rings by manoeuvering the mobile base and crossarm.

7 Secure the lower trunnion rings to the din plate with the socket-headed screws.

8 Position and secure the upper trunnion rings to the lower trunnion rings with the socket-headed screws.

9 Ensure that the X-ray tube is firmly secured to the crossarm din plate.

Fitting the HT cables to the tube

1 Examine HT cables and ensure they are not damaged.

2 Locate the +ve anode terminal of the tube. They are identified on the underside of the HT cable horns. Ensure that HT cable makes good contact with the +ve terminal and liberally coat the end of the cable with special HT grease, but not the actual contact area.

3 Insert the HT cable into the +ve terminal and work it down until it makes contact. Secure the cable by fixing the retaining plate with three Allen screws to the cable horn.

4 Carry out the same procedure with the -ve cathode cable.

IMPORTANT ..... Ensure both HT connectors are tight and locked into position with the adjacent grubscrews.

Fitting HT cables to the HT tank

CAUTION Before removing the covers operate the safety discharge plunger with a suitable insulated rod. The plunger is located on top of the HT tank and between the HT cables. The plunger latches on when depressed and is released by the plunger release knob. (See page 16.)

1 Remove the top plate that secures the cables to the top cover and then remove the top cover.

2 When the covers are removed, and the top of the HT tank is exposed, two small glass windows will be seen; these are the neons that glow whenever there is a charge on the capacitors.

3 Identify the +ve cable and the +ve terminals of the HT tank.

4 Connect the cable using transformer oil, not grease, to fill the space between the connector and its socket.

5 Repeat the above procedure for the -ve cable.

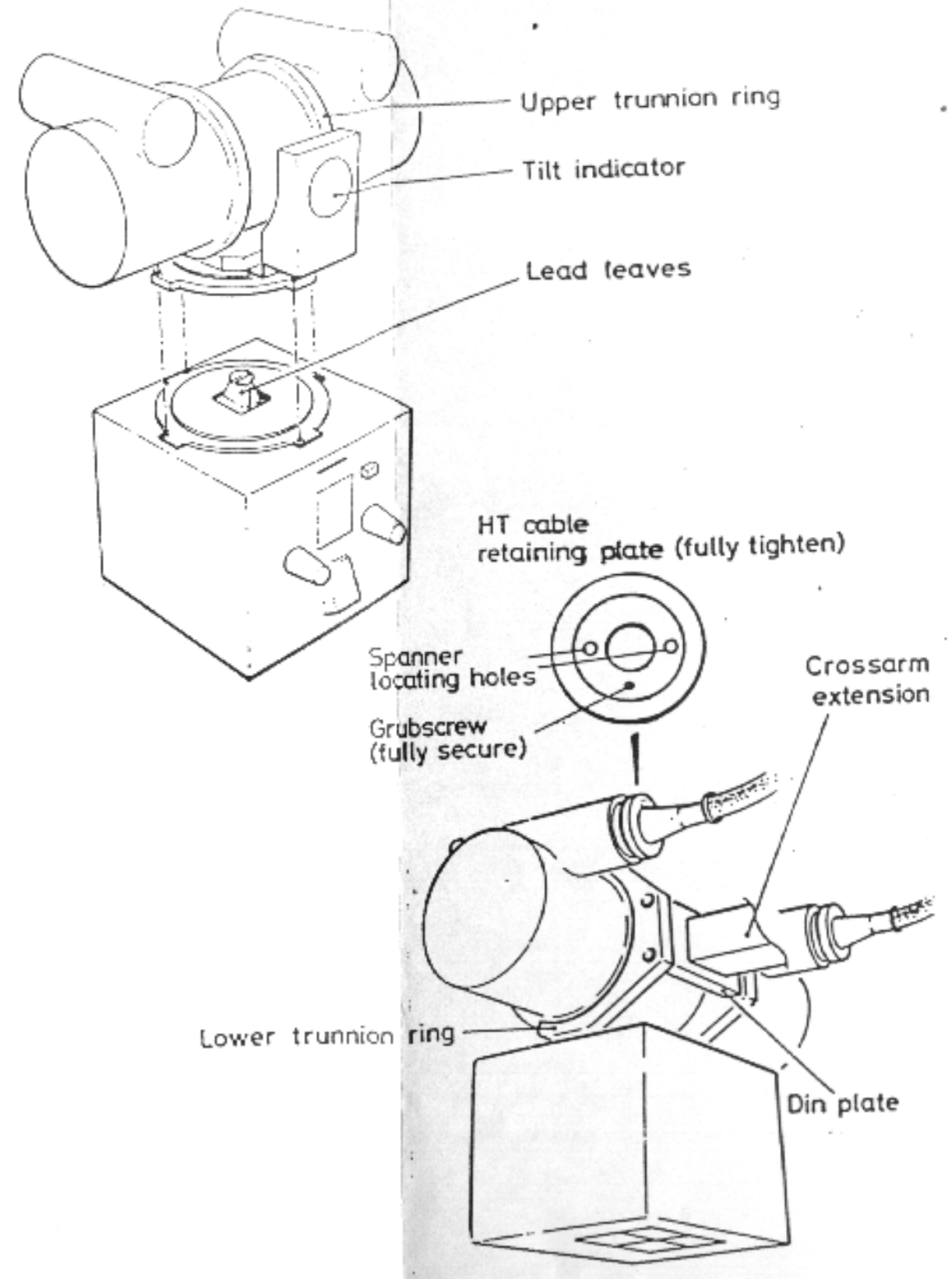
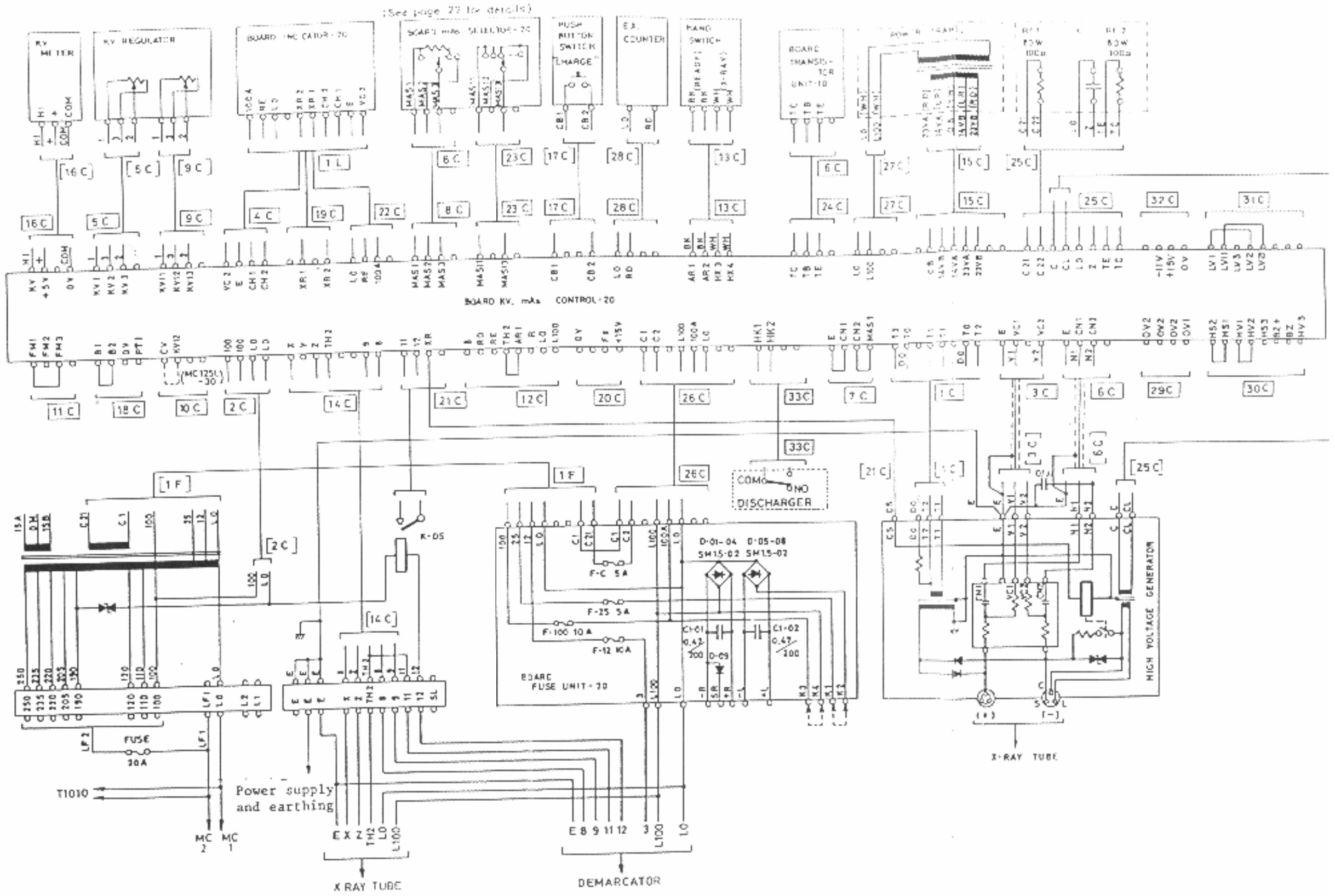
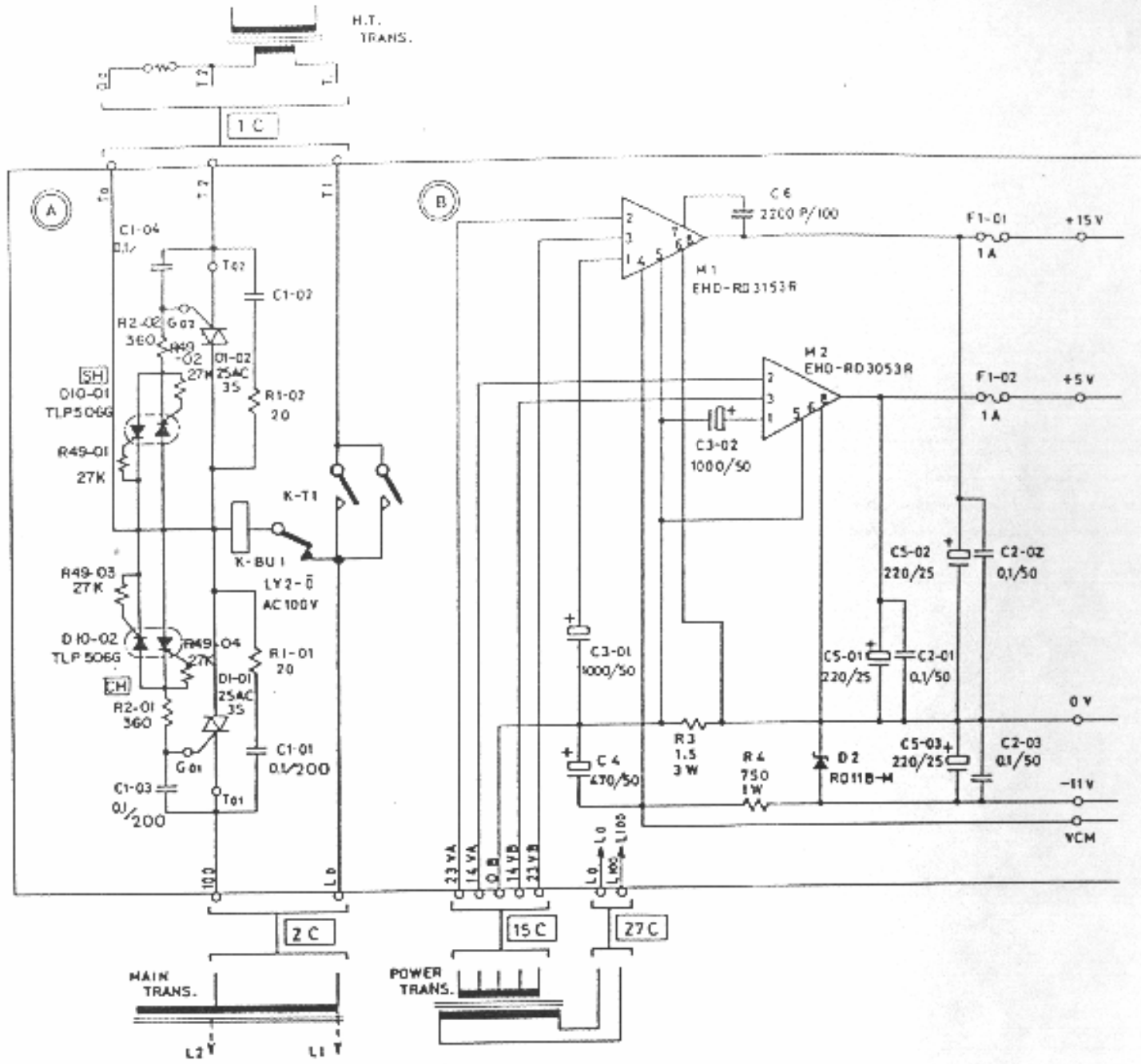


Figure 2
Collimator and X-ray tube



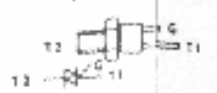
(2316/2/880)(From 501-06892D)

Fig 13. INTERCONNECTION DIAGRAM



(2316/1/280)(From 501-07015 1/5 D)

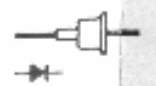
TRIAC 25A 35
VDRM 300 V
IT 25 A



IC POWER REG.
EHG-RD3153R
VOUT 15±0.2 VDC
VIN 17.5-28 VAC
IMAX 3 A

IC POWER REG.
EHG-RD3053R
VOUT 5±0.2 VDC
VIN 9.5-18 VAC
IMAX 1 A

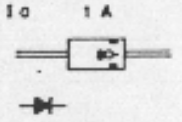
ZENER DIODE
RD11B-M
Vz 10.6-11.7 V
P 1 W



ZENER DIODE
RD13A-M
Vz 12.1 - 13.3 V
P 200 mW

OP AMP 741CE
Supply V ±18 V
Offset V 2 mV
Input R 1 MΩ
Gain 10^5

DIODE SM1-02
VRM 200 V
Io 1 A



TRANSISTOR
2SC372-Y
VCEO 30 V
IC 100 mA
hFE 120-240

TRANSISTOR
2SC504-Y
VCEO 30 V
IC 600 mA
hFE 50-150

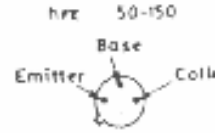
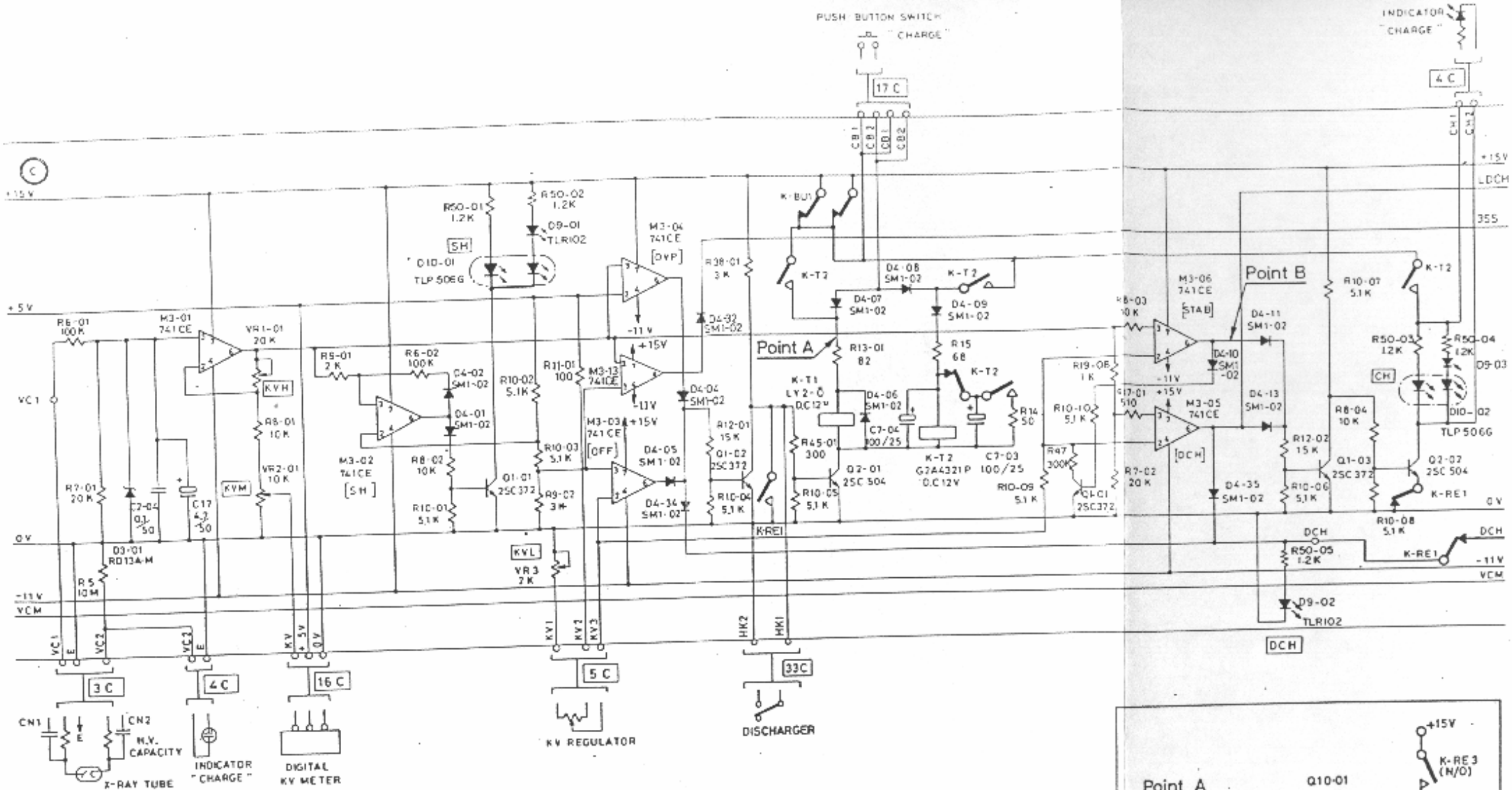
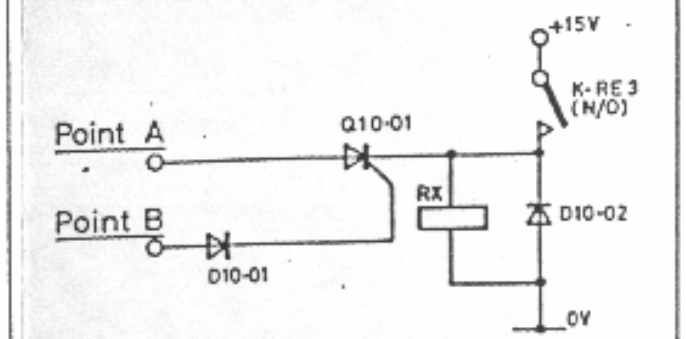


Fig 14. kV mAs CONTROL - 20



D9 LED
TLRI02
I_F 25mA
V_R 4V
P_D 75mW
Anode
Cathode

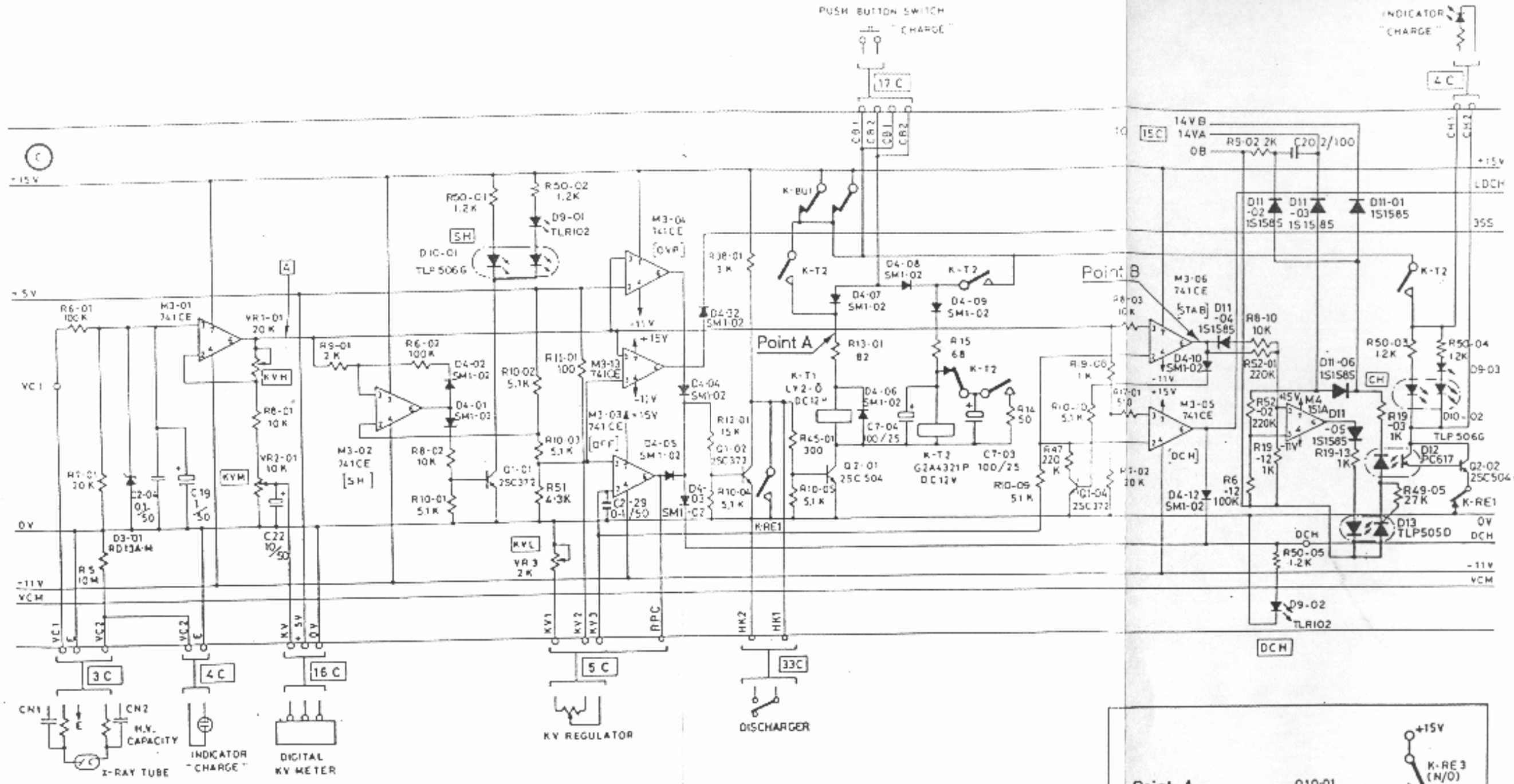
D10 TLP 506G
I_F 60mA
V_R 5V
P_D 75mW
V_{DRM} 400V



Modification to prevent multiple exposures.
Refer to Supplement No 2503.

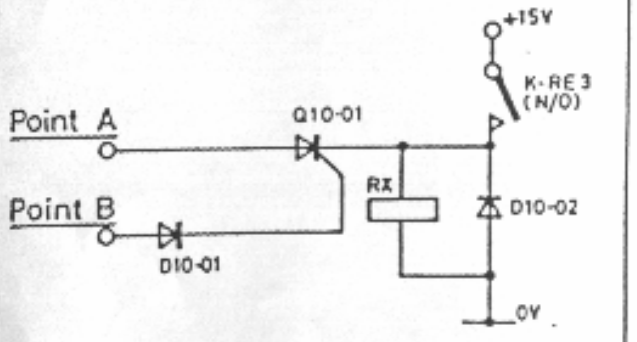
Fig 15. kV mAs CONTROL-20

(2316/3/184)(From 501-07015 2/5F.)



D9 LED
TLR102
I_F 25mA
V_R 4V
P_D 75mW
Anode
Cathode

D10 TLP506G
I_F 50mA
V_R 5V
P_D 75mW
V_{CEO} 400V

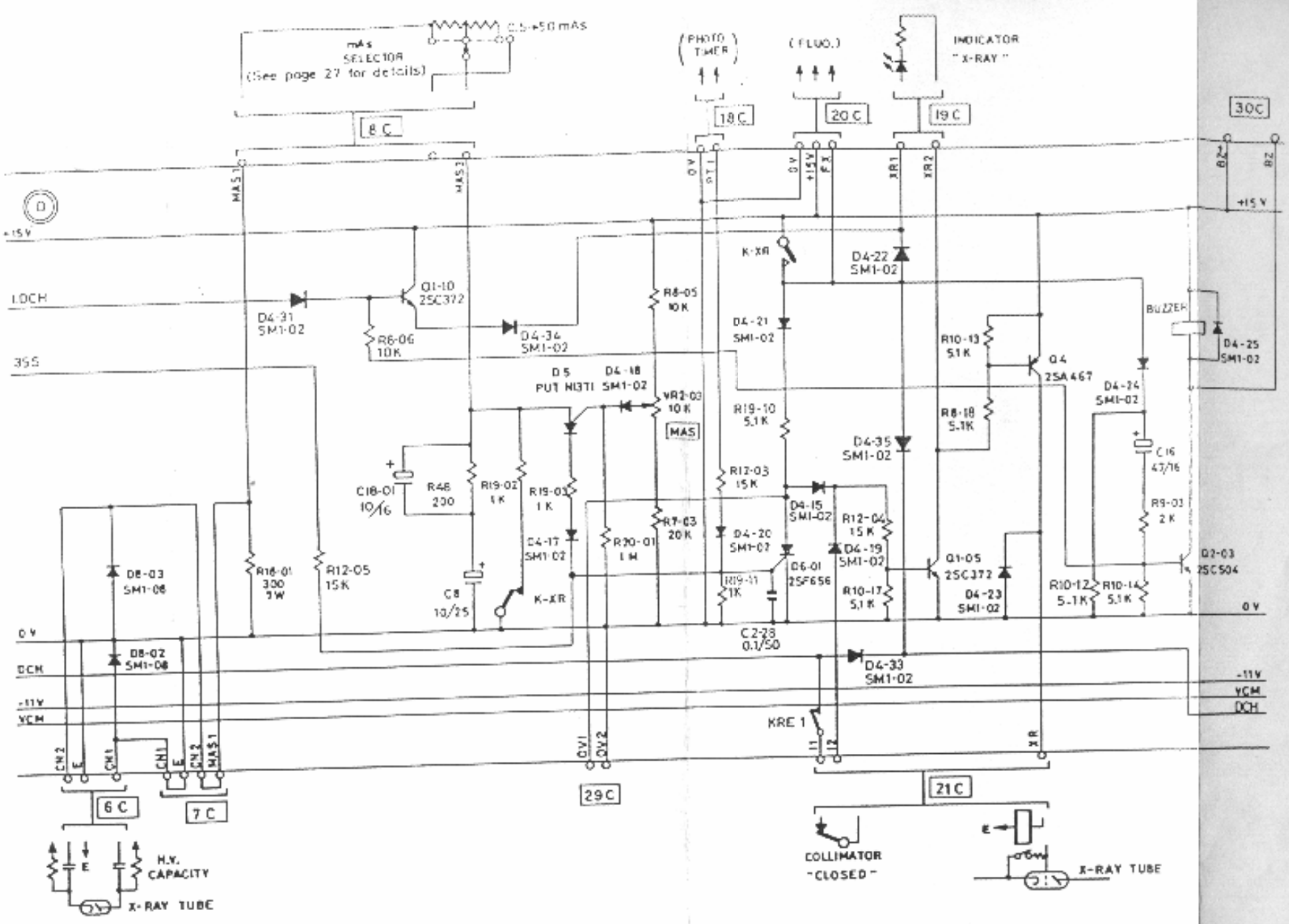


Modification to prevent multiple exposures.
Refer to Supplement No 2503.

Figure 15A

kV mAs CONTROL-20

Latest (March 1984) Units
Serial No EE500 onwards



DIODE SM1-08
V_{RM} 800 V
I_O 1 A

THYRISTOR 2SF656
V_{DRM} 50 V
$I_{T(AV)}$ 200 mA
Gate, Anode, Cathode

TRANSISTOR 2SC372-Y
V_{CEO} 30 V
I_C 100 mA
h_{FE} 120–240
Emitter, Base, Collector

TRANSISTOR 2SC504-Y
V_{CEO} 30 V
I_C 600 mA
h_{FE} 50–150
Emitter, Base, Collector

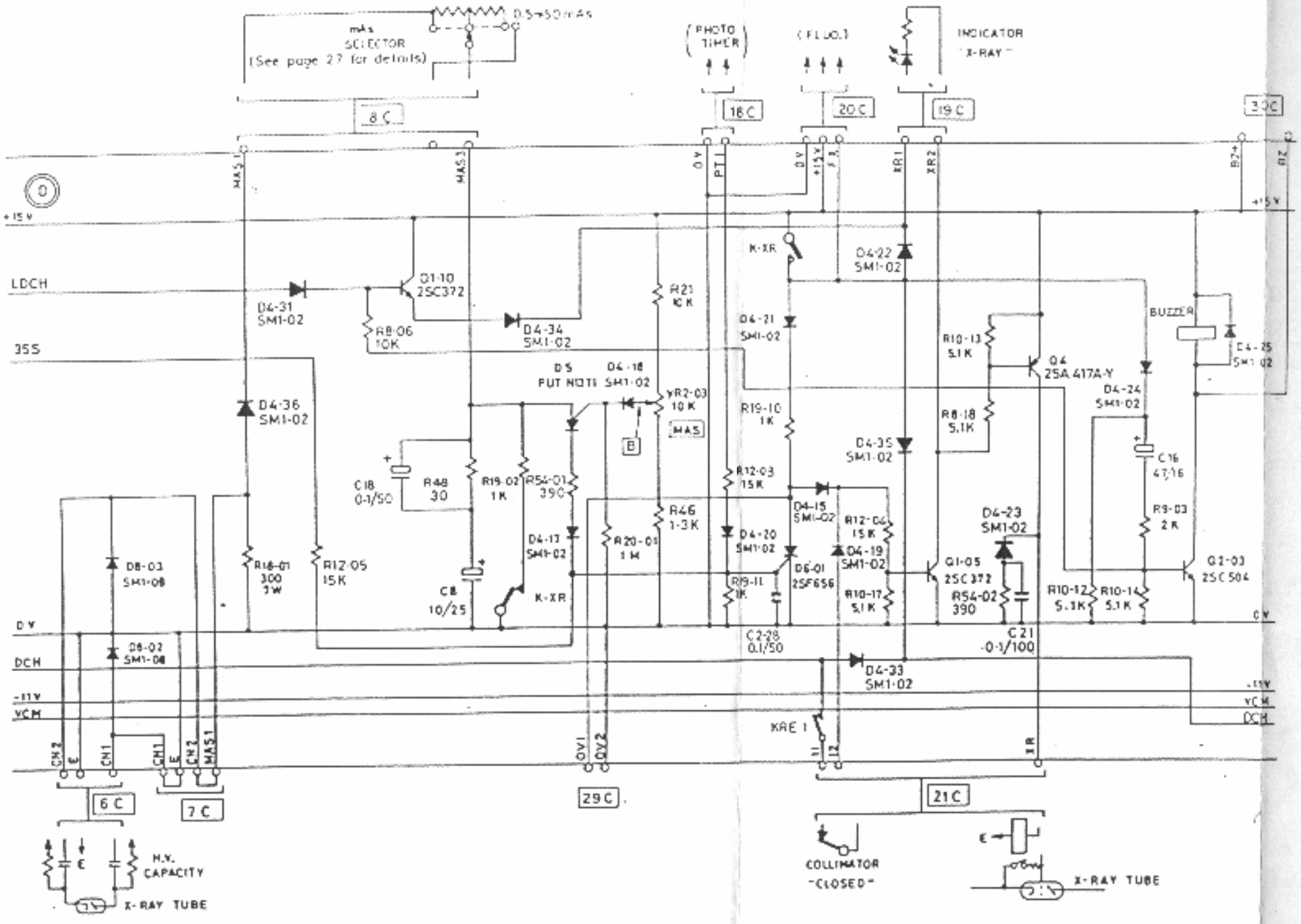
TRANSISTOR 2SA495-Y
V_{CEO} −30 V
I_C −100 mA
h_{FE} 120–240
Emitter, Base, Collector

TRANSISTOR 2SA467G-Y
V_{CEO} −30 V
I_C −400 mA
h_{FE} 120–140
Emitter, Base, Collector

PUT N13T-1
V_{AK} 40 V
I_T 150 mA
V_T 0,2–1,6 V
Anode, Gate, Cathode

DIODE SM1-02
V_{RM} 200 V
I_O 1 A

Fig 16. kV mAs CONTROL-20



DIODE SM1-08
VRM 800 V
Io 1 A

THYRISTOR 2SF 656
VDRM 50 V
IT(AV) 200 mA
Gate Anode Cathode

TRANSISTOR 2SC372-Y
VCEO 30 V
Ic 100 mA
hFE 120-240
Emitter Base Collector

TRANSISTOR 2SC504-Y
VCEO 30 V
Ic 600 mA
hFE 50-150
Emitter Base Collector

TRANSISTOR 2SA495-Y
VCEO -30 V
Ic -100 mA
hFE 120-240
Emitter Base Collector

TRANSISTOR 2SA467G-Y
VCEO -30 V
Ic -400 mA
hFE 120-140
Emitter Base Collector

PUT N13T-1
VAK 40 V
IT 150 mA
VT 0.2-1.6 V
Anode Gate Cathode

DIODE SM1-02
VRM 200 V
Io 1 A

Figure 16A:

kV mAs CONTROL-20

Latest (March 1984) Units
Serial No EE500 onwards

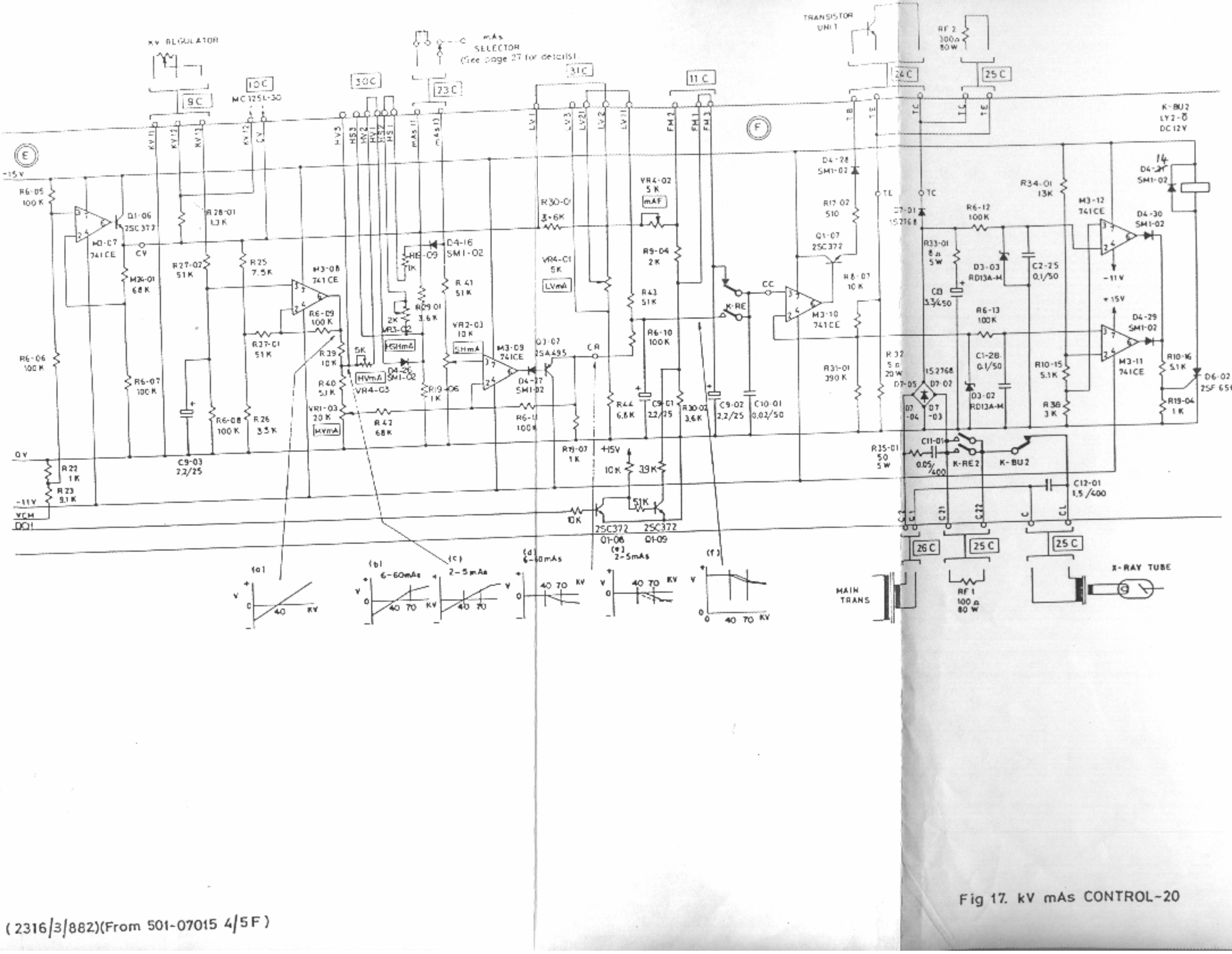
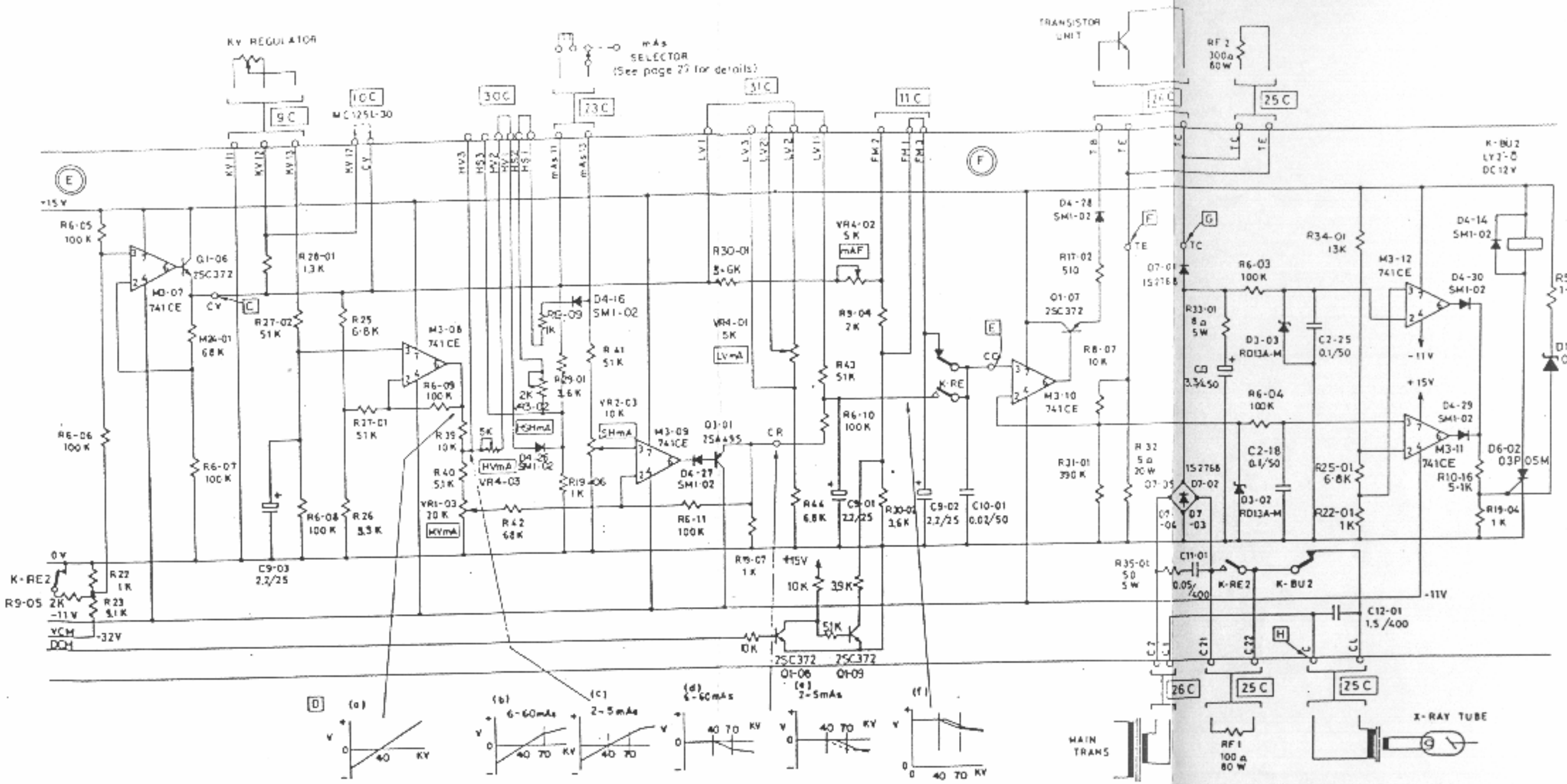


Fig 17. kV mAs CONTROL-20

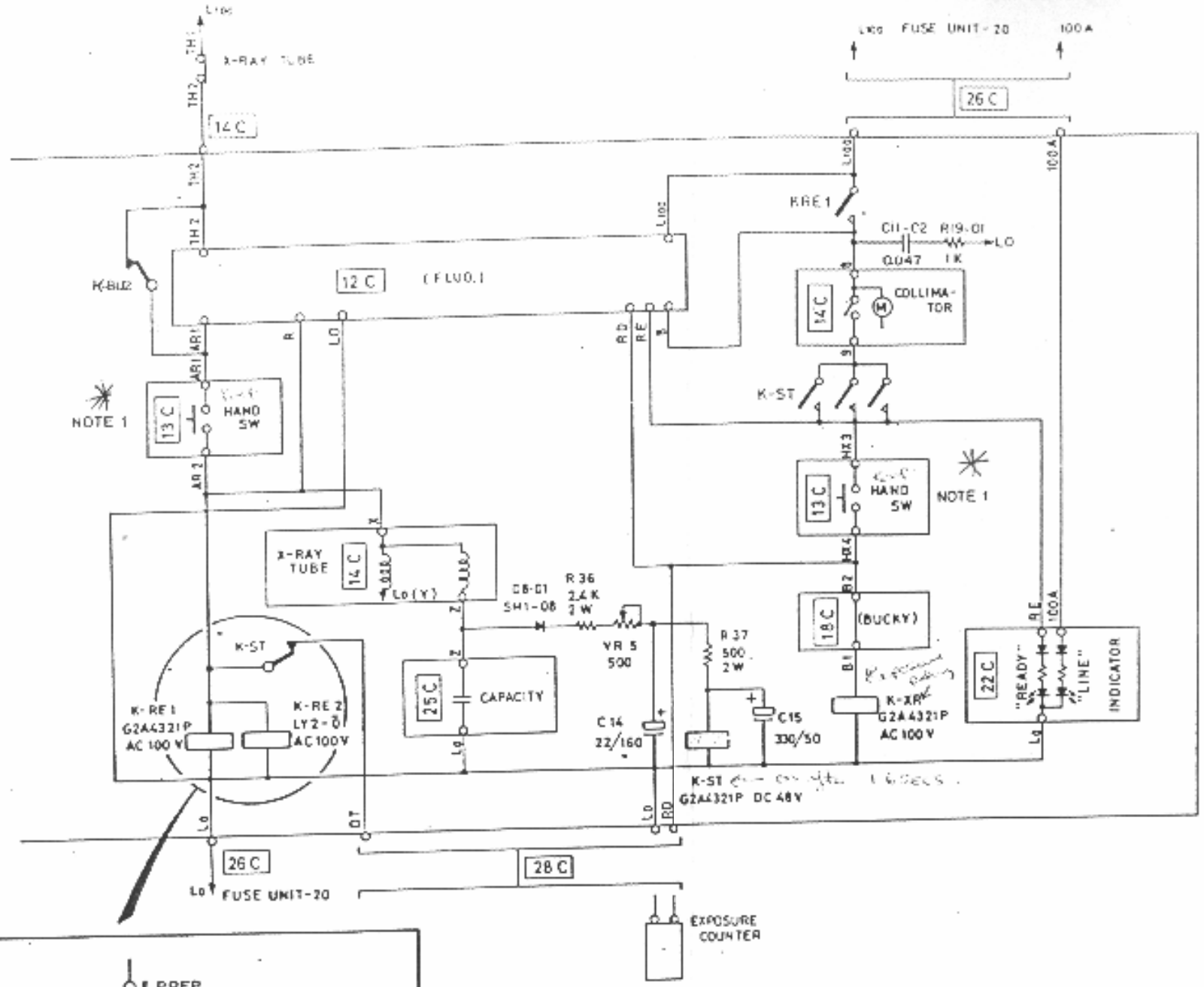


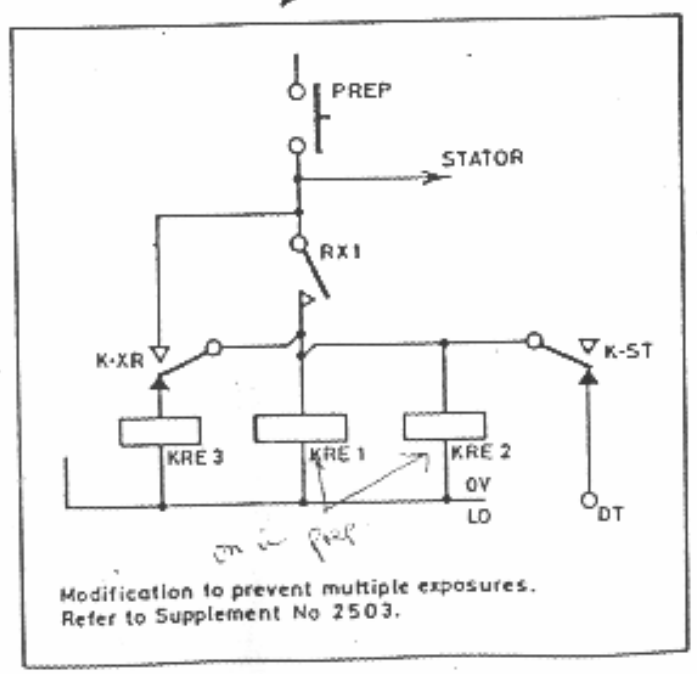
(2316/4/484) (From 501-07015 4/5M)

Figure 17A

kV mAs CONTROL-20

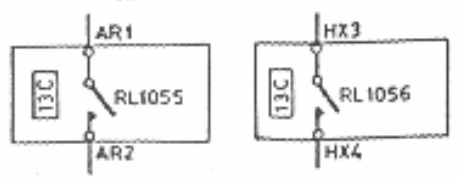
Latest (March 1984) Units
Serial No EE500 onwards



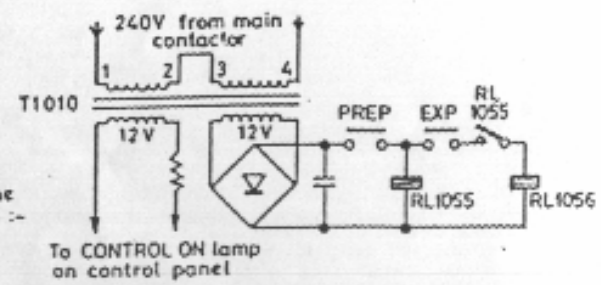


Modification to prevent multiple exposures.
Refer to Supplement No 2503.

NOTE 1 With low voltage handswitch fitted circuit is thus :—



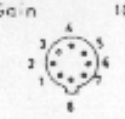
NOTE 2 Additional circuitry to energise the relays is mounted on a pcb and located under the right hand side cover and is shown thus :-



(2316/3/184)(From 501-07015 5/5F)

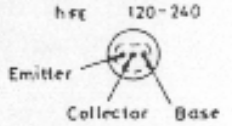
Fig 18. kV mAs CONTROL-20

OP AMP 741CE
Supply V ±18V
Offset V 2mV
Input R 1MΩ
Gain 10^5

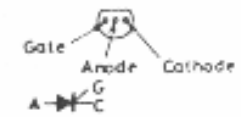


ZENER DIODE
RD13A-M
Vz 12.1-13.3 V
P 200 mW

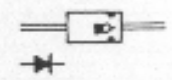
TRANSISTOR
2SC372-Y
VCEO 30 V
Ic 100 mA
hFE 120-240



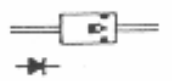
THYRISTOR
2SF656
VDRM 50 V
IT(AV) 200 mA



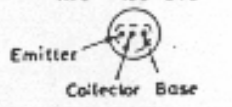
DIODE SM1-02
VRM 200 V
Io 1 A



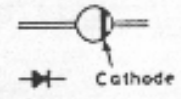
DIODE SM1-08
VRM 800 V
Io 1 A

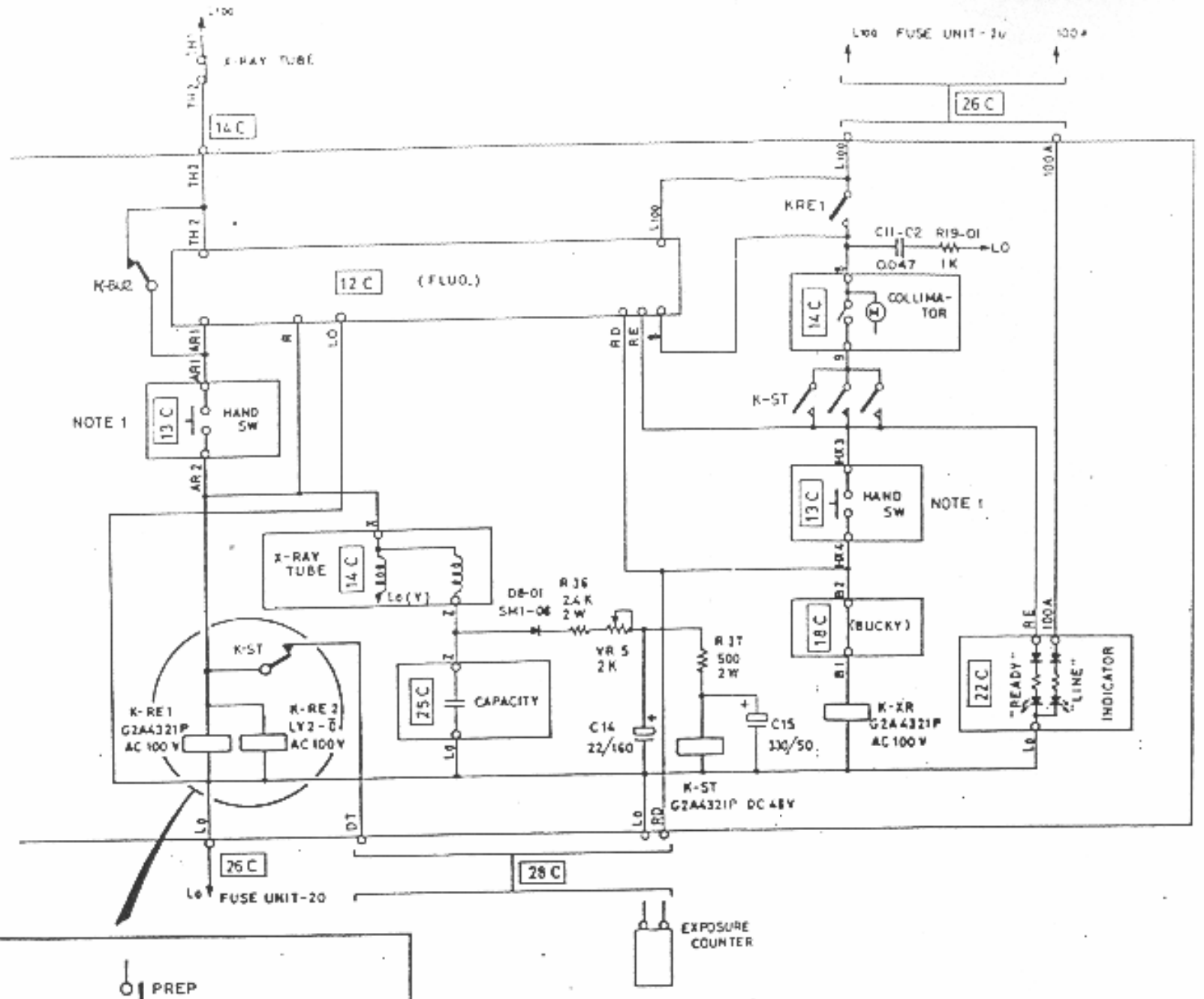


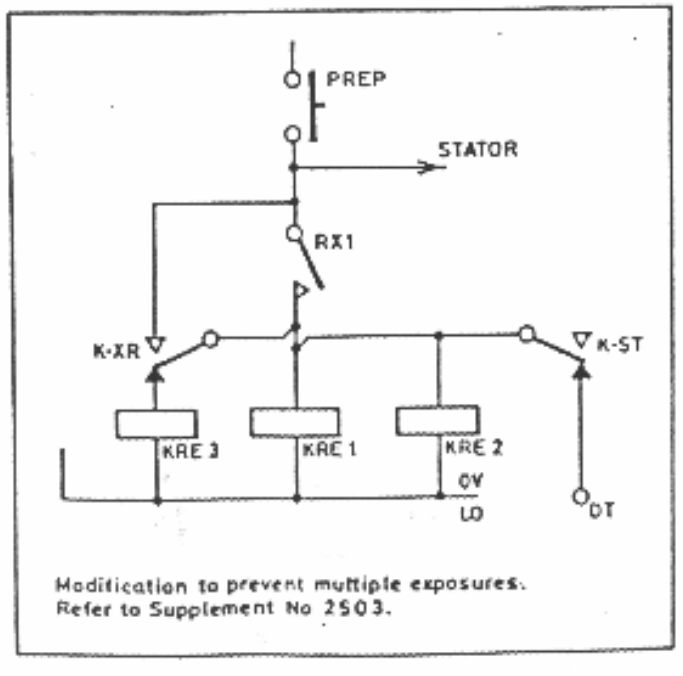
TRANSISTOR
2SA495-Y
VCEO -30 V
Ic -100 mA
hFE 120-240



DIODE 1S2768
VR 800 V
Io 3 A



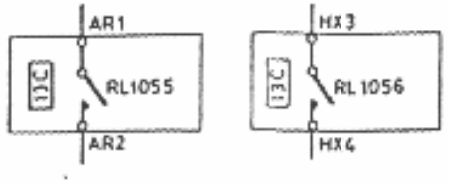




Modification to prevent multiple exposures.
Refer to Supplement No 2503.

(2316/3/484) (From 501-07015 S/SM)

NOTE 1 With low voltage handswitch fitted circuit is thus :-



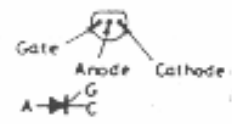
NOTE 2 Additional circuitry to energise the relays is mounted on a pcb and located under the right hand side cover and is shown thus :-

DIP AMP 741CF
Supply V ±18 V
Offset V 2 mV
Input R 1 MΩ
Gain 10^5

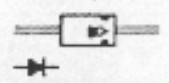
ZENER DIODE
RD13A-M
Vz 12.1-13.3 V
P 200 mW

TRANSISTOR
2SC372-Y
Vceo 30 V
Ic 100 mA
hFE 120-240

THYRISTOR
2SF656
VDRM 50 V
IT(AV) 200 mA

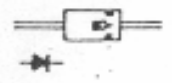


DIODE SM1-02
VRM 200 V
Io 1 A

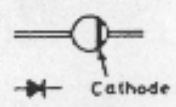


TRANSISTOR
2SA495-Y
Vceo -30 V
Ic -100 mA
hFE 120-240

DIODE SM1-08
VRM 800 V
Io 1 A



DIODE 1S2768
VR 600 V
Io 3 A



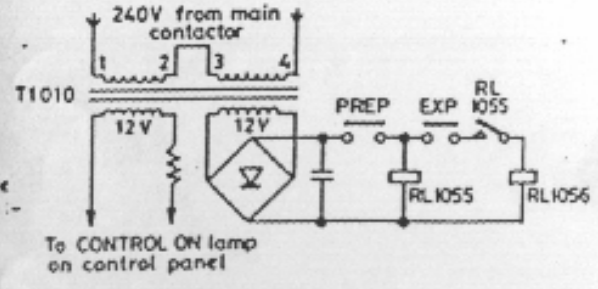
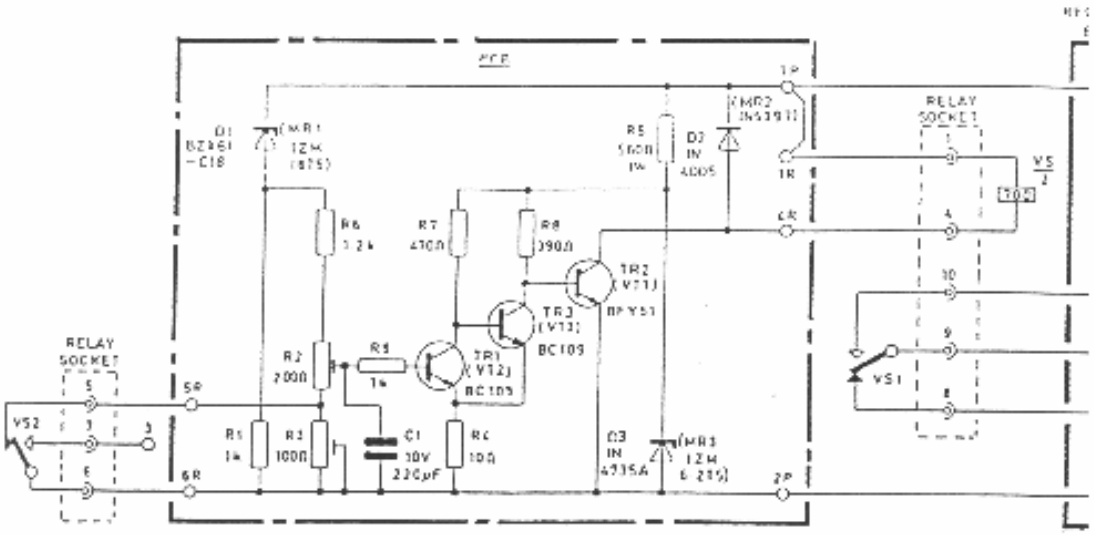


Figure 18A

kV mAs CONTROL-20

Latest (March 1984) Units
Serial No EE500 onwards



NOTE

LEGENDS IN BRACKETS ARE FOR EARLY UNITS

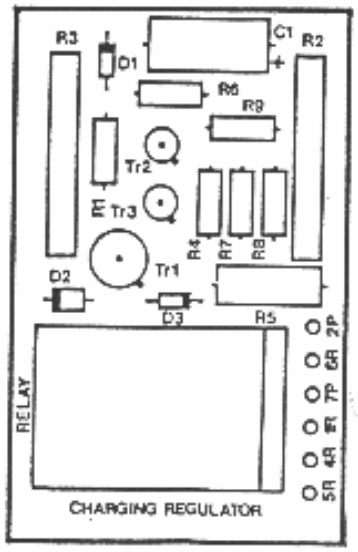
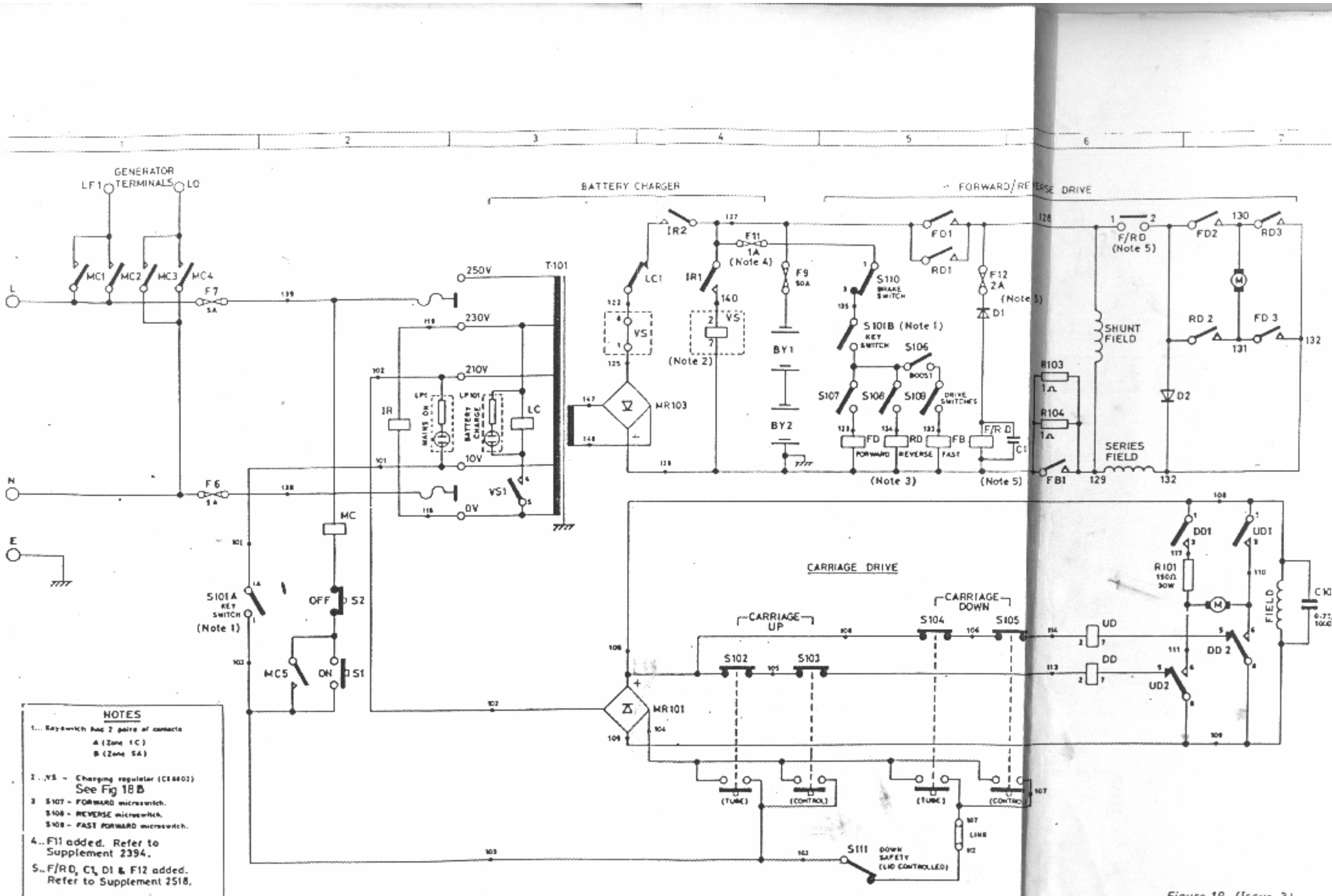


FIG. 18B CHARGING REGULATOR (LATEST UNITS)

(See Fig. 19 for main circuit)

(2316/2/584)



NOTES

1. Keyswitch has 2 pairs of contacts
   A (Zone 1C)
   B (Zone 5A)
2. VS - Charging regulator (CB6802) See Fig 18B
3. S107 - FORWARD microswitch.
   S108 - REVERSE microswitch.
   S109 - FAST FORWARD microswitch.
4. F11 added. Refer to Supplement 2394.
5. F/RD, C1, D1 & F12 added. Refer to Supplement 2518.

Figure 19 (Issue 3)

CD38 S

Mobile Base and Carriage Drive Circuit

(2316/3/284)

CD38S MOBILE

RECOMMENDED ROUTINE INSPECTION PROCEDURE

With reference to Service Manual No 2316, check good operation of:

1. Controls
2. Switches
3. Indicators
4. Meters

Check the following:

5. Charging and discharging
6. Operation of discharge plunger and latch
7. Prep delay (1.6 sec)
8. Timer operation
9. Handswitch and cable
10. Charge, ready and X-ray lights
11. Auxiliary lights
12. Mains plug terminations
13. All internal connections and plugs to main pcb.
14. Tightness of HT cables
15. Stator connections
16. Shutter connections and interlock
17. Earth continuity
18. Insulation resistance
19. Tubestand vertical movements (remove cover around tubestand - check correct gear meshing and security) check extension in vertical
20. Crossarm movement and extension
21. Column rotation
22. Tube angulation
23. Brakes - adjust if necessary
24. Cut-out switches on vertical drive
25. Rack for tightness
26. Alignment of collimator - adjust if necessary
27. Light switch - adjust if necessary
28. Security of collimator
29. Battery: top up with distilled water if necessary, clean top and terminals, re-grease if necessary
30. Operation of battery charger
31. Drive relays
32. Wheels and castors

(2316/1/984) (6364A - TSG - AB)

Table of Contents

1. Preface

This is the Technical instructions of the electric circuits of Condenser Type Mobil X-ray Apparatus MC125L-30.

Introducing semiconductors and printed circuit boards in all the circuits (control circuits, main circuit switching, and high tension rectifier), this apparatus has a number of improved performances in its manufacture and service.

2. Construction

2-1. Construction of apparatus

This apparatus consists of the following parts.

(1) Mobile unit
(2) Control unit
(3) Motor control section
(4) High tension generator
(5) Collimator
(6) X-ray tube unit

Of the parts listed above, the explanations in this book mainly refer to (2), (3) and (4).

2-2. Composition of electric circuitry

The electric circuitry in this apparatus consists of the following.

(1) X-ray control circuitry

(a) Main charging circuit

(b) DC power source circuit

(c) Charge voltage control circuit

(d) mAs control circuits

(e) X-ray tube current control circuits

(f) Relay circuit

(2) Motor control circuitry

(a) Motor control circuit

(b) Battery charging circuit

3. Description of X-ray control circuitry

3-1. Main charging circuit

This circuit, being switched by triac, is intended to control the charging to the high tension condenser.

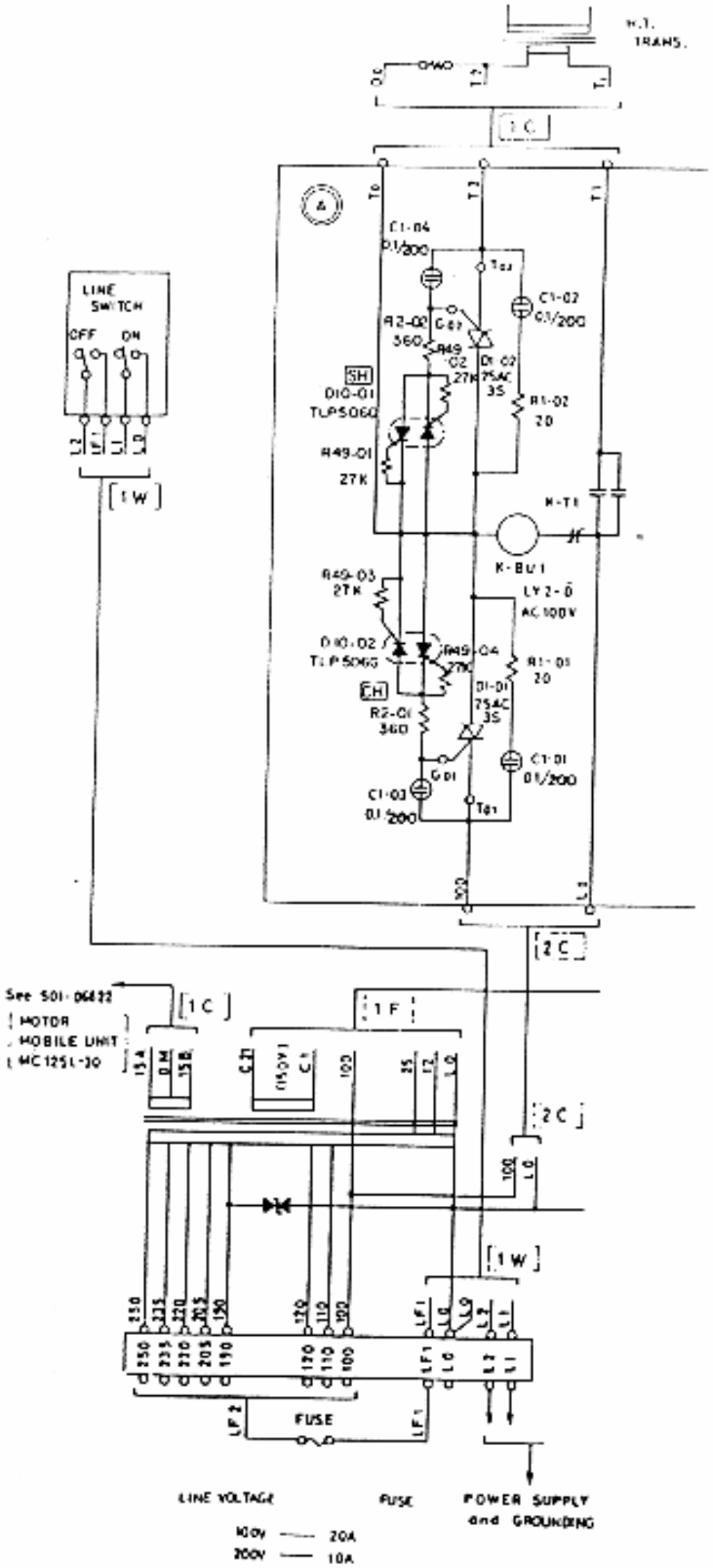

H.T. TRANS.
LINE SWITCH
OFF
ON
L2
L1
L0
1W
1C
T0
T2
T1
C1-04
0.1/200
C1-02
0.1/200
R2-02
360
G02
R49-02
27K
D1-02
75AC 3S
SH
D10-01
TLP5060
R1-02
20
R49-01
27K
K-T1
K-BU1
LY2-0
AC100V
R49-03
27K
D10-02
TLP5060
R49-04
27K
R1-03
20
EH
R2-01
360
D1-01
75AC 3S
G01
C1-01
0.1/200
C1-03
0.1/200
T01
300
L3
2C
See SDI-06822
MOTOR
MOBILE UNIT
MC125L-30
1C
1F
154
0M
155
C21
(HOT)
C1
100
35
L2
L0
2C
100
L0
1W
250
235
220
205
190
120
110
100
LF1
L0
L2
L1
LF2
FUSE
LF1
LINE VOLTAGE
FUSE
POWER SUPPLY and GROUNDING
100V —— 20A
200V —— 10A

Fig. 3-1-1

(1) Figure 3-1-1 is the connection diagram of the low tension side of this circuit.
In the diagram, line voltage is supplied into terminal L_1 and L_2 of terminal board. And, this voltage passes through the line switch to be applied to terminals LF_1 and L_0. Terminal LF_1 is connected to either one of terminals 100, 110, 120, 190, 205, 220, 235 and 250, by way of a fuse. Figures 100 through 250 represent the voltage. The terminal is connected to a necessary position according to the value of line voltage. (The rating of fuse should be 20A at line voltage of about 100 volts, or 10 A at about 200 V.)
The line voltage may have fluctuations of up to $\pm$10% of the terminal board indication. And this voltage is supplied into the autotransformer.

(2) From the autotransformer, a voltage of 100 $\pm$ 10 V is supplied to the circuit in the printed circuit board (kV-mA CONTROL-20) by way of terminals L_0 and 100 of connector [2C].
A charging operation causes relay $K\text{-}T_1$ to be turned on and then a photocoupler [CH] is also turned on a little later. (As for the relay actions, refer to par. 3-3-1.) In consequence, triac D1-01 is switched on and a voltage of

100 ± 10 V is impressed between terminals T_1 and T_0 of connector [1C]. And this voltage is applied to the primary side of high tension transformer after passing through the charge restriction resistor, so that the high tension condenser is charged with this voltage.
However, when charging, this voltage may drop about 20% at maximum due to influences of charging current.

(3) When the charge voltage reaches about 80 kV, photocoupler [SH] (see par. 3-3-3) operates and triac D1-02 is switched on.
Then the charge restriction resistor mentioned in item (2) is short-circuited, and the charging speed is accelerated.

(4) Relay K-BU1 is turned on when the triac is made to conduct (that is, broken) while charging operation is not done (relays K-T_1 and [CH] not operating).
After this, relay K-T_1 won't work even by charging operation (see par. 3-3), and the high tension condenser is not charged.

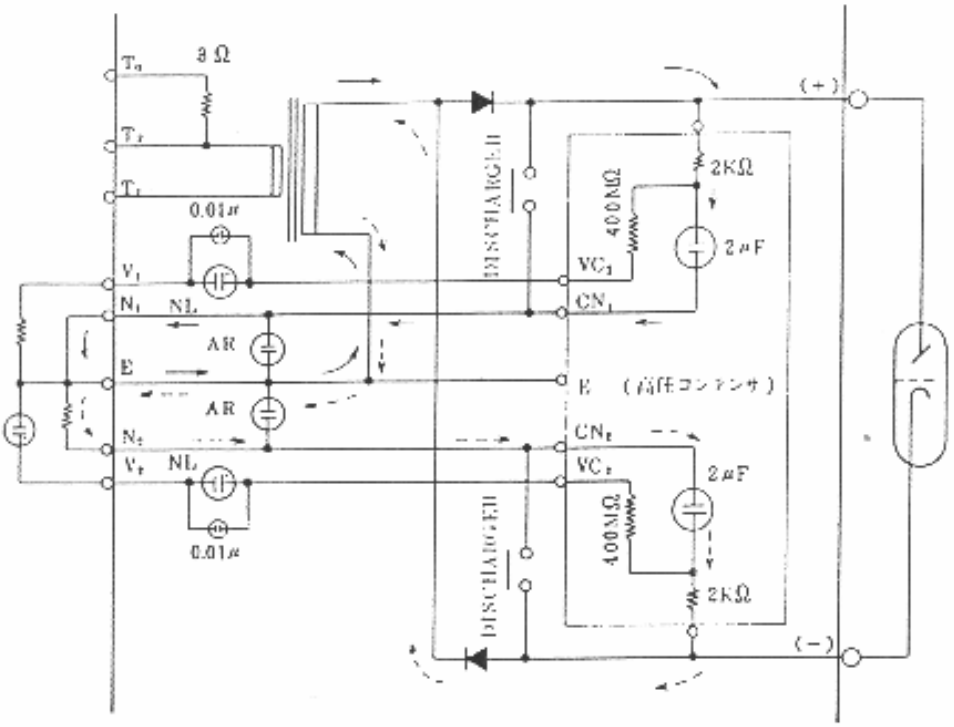


Fig. 3-1-2

(5) Figure 3-1-2 is the connection diagram of the high tension side of this circuit.
The high tension condenser has 2 μF connected to the plus side and 2 μF connected to the minus side, with respect to the grounding point. (The compound capacity is 1 μF.)
When a voltage is impressed between terminals T_1 and T_0 or T_1 and T_2 of high tension generator,

(2317/2/880)

a voltage is generated at the secondary side of high tension transformer to charge the high tension condenser. When the grounding point of secondary winding of high tension transformer is at negative potential, a current flows along the solid line in the diagram to charge the plus side high tension condenser; when its grounding point is at positive potential, a current flows along the dotted line to charge the minus side high tension condenser.

(6) The resistor connected between terminals N_2 and E is intended to detect X-ray tube current when taking radiograph so as to control the mAs timer. While in radiography, the tube current flows in the following circuit: plus side high tension condenser → X-ray tube → minus side high tension condenser → terminal CN_2 → terminal N_2 → terminal N_1 → terminal CN_1 → plus side high tension condenser.

Arrester AR connected between terminals N_1 and E and between N_2 and E is designed to prevent generation of high voltage at terminal N_1 or N_2 in case N_1-E and N_2-E connections are disconnected at outside by mistake.

(7) The resistor connected between terminals V_1 and E is to detect the charge voltage. From the plus side of high tension condenser, a current corresponding to the charge voltage flows into this resistor by way of 400-Mohm (MC125L-30) resistor. The neon lamp fitted between terminals V_2 and E is for "CHARGE" lamp on the control panel. Presence of charge in the high tension condenser is indicated by the illumination of this neon lamp. Neon lamp NL fitted between terminals V_1 and VC_1 and between V_2 and VC_2 also tells the high tension condenser has a charge. It is provided on the top of high tension generator.

3-2. DC power source voltage

This circuit is entitled to provide the various control circuits with stabilized d-c voltage and the X-ray tube current control circuit with unstabilized d-c voltage.

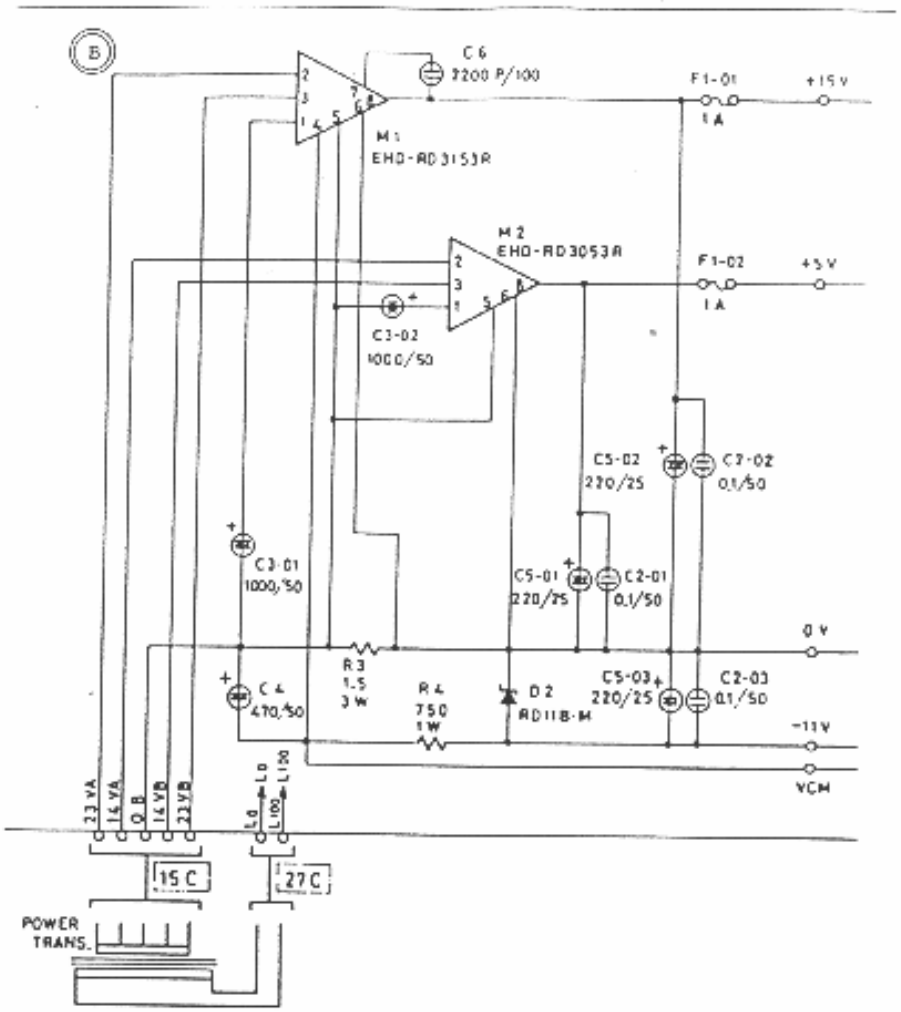

B
C6
3200 P/100
F1-01
+15 V
1 A
M1
EHD-RD3153R
M2
EHD-RD3053R
F1-02
+5 V
1 A
C3-02
1000/50
C5-02
220/25
C7-02
0.1/50
C3-01
1000/50
C5-01
220/25
C2-01
0.1/50
0 V
R3
1.5
3 W
C4
470/50
R4
750
1 W
D2
RD11B-M
C5-03
220/25
C2-03
0.1/50
-11 V
VCM
23 VA
14 VA
0 B
14 VB
23 VB
Lo
L100
15 C
27 C
POWER
TRANS.

Fig. 3-2-1

(1) Figure 3-2-1 is the connection diagram of this circuit.

In the diagram, M1 and M2 are IC'd power source regulators.

The output voltage of M1 is +15 V; that of M2 is +5 V.

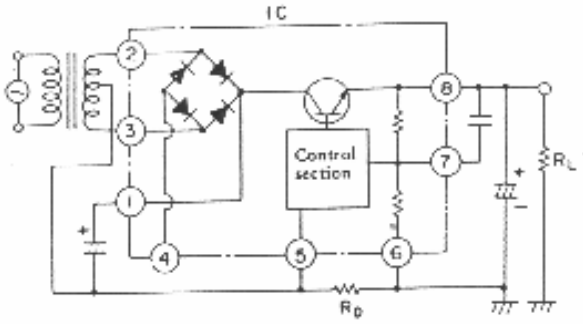


Fig. 3-2-2

The chain-lined area of Fig. 3-2-2 is a rough sketch of internal circuit of M1 and M2.

When voltage of 23 volts is respectively applied to input terminals 2 and 3 of M1 (14 volts to M2), with respect to the middle tap of power transformer, a stabilized +15 V voltage will be obtained between output terminals 8 and 6 of M1. Similarly, stabilized +5 V will be produced between output terminals 8 and 6 of M2.

(2) Resistor R3 in Fig. 3-2-1 (resistor R_D in Fig. 3-2-2) is provided to detect the load current.

If the detected value exceeds 1 ampere, the output voltage becomes zero volt automatically to protect the IC from overload. Fuses F1-01 and F1-02 are to protect the IC if IC's load current more than 1 ampere without passing through resistor R3 (for instance, between terminals +15 V and +5 V, or +15 V and -11 V).

(3) At terminal 4 of M1 is delivered an unstabilized negative d-c voltage. This output voltage is smoothed by condenser C4, and an unstabilized negative d-c voltage appears at check terminal VCM. This voltage is used in the X-ray tube current control circuit of par. 3-5.

(4) A voltage of -11 V stabilized by resistor R4 and zener diode D2 is obtained at check terminal -11 V.

3-3. Charge voltage control circuits

3-3-1. Relay circuit for charging

This circuit controls the actions of a relay ($K\text{-}T_1$) and a photocoupler [CH] for the charging circuit mentioned in par. 3-1 and relay $K\text{-}T_2$ as well.

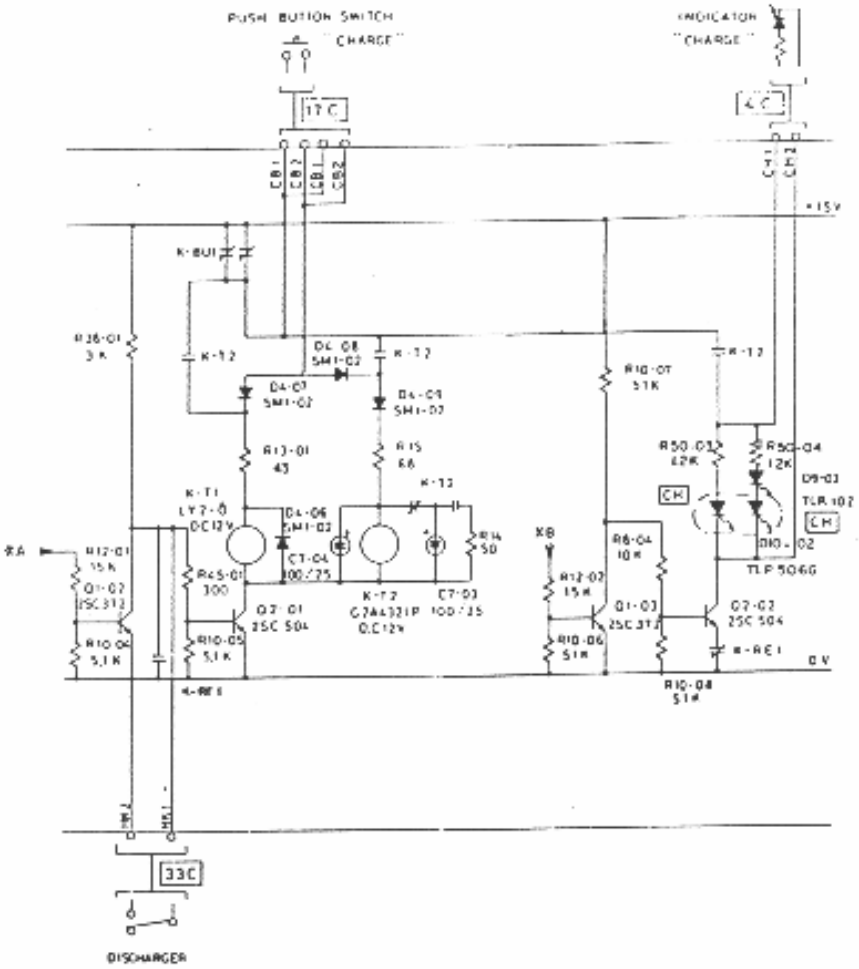


Fig. 3-3-1

(1) Figure 3-3-1 is the connection diagram of this circuit.

When "CHARGE" button is pressed, a voltage is impressed in the following circuit to actuate

relay K-T_1:
contact of relay K-BU_1 → terminal CB_1 of connector [17C] → "CHARGE" button → terminal CB_2 of connector [17C] → diode D4-07 → resistor R13-01 → coil of relay K-T_1 → transistor Q2-01.

Relay K-BU1 is designed to function when the triac is broken down as explained in item (4) of par. 3-1. This contact is normally closed.

Transistor Q2-01 is normally on, and is cut off when a signal voltage (see par. 3-3-2) is applied to *A point. (It is because the base current of Q2-01 does not flow when Q1-02 is switched on.) Besides, transistor Q2-01 is likewise cut off also when HK1 - HK2 interval of connector [33C] is short-circuited. (See item (6) of par. 3-3-1.)

(2) Somewhat later than the action of K-T_1, relay K-T_2 operates in the following circuit:
terminal CB2 of connector [17C] → diode D4-08 → diode D4-09 → resistor R15 → coil of relay K-T_2 → transistor Q2-01.

Since "CHARGE" button and diode D4-08 are short-circuited by the contact of K-T_2, K-T_2 keeps

operating ever after releasing "CHARGE" button.

(3) Similarly, since the "CHARGE" button and diode D4-07 are short-circuited by the contact of K-T_2, relay K-T_1 keeps operating even after releasing "CHARGE" button.

(4) When relay K-T_2 operates, photocoupler [CH] works in the following circuit:
contact of relay K-T_2 → resistor R50-03 (resistor R50-04 + luminous diode [CH]) → LED of photocoupler [CH] → transistor Q2-02.

When photocoupler [CH] is in action, red luminous diode [CH] lights up. Transistor Q2-02 is normally ON, and is cut OFF when signal voltage (see par. 3-3-2) is impressed to *B position. (It is because to base current of Q2-02 does not flow when Q1-03 is switched on.)

(5) When a current flows into the LED of photocoupler [CH], the LED at the left side of "CHARGE" indicator connected in parallel with it lights up. (For the illumination of right-side lamp, see item (7) of par. 3-1.)

This indicator is an LED assembled in the printed circuit board "INDICATOR-20". Illumination of LEDs in "INDICATOR-20" can be all confirmed on the control panel.

(6) To connector [33C], confirmative contacts (HK1 and HK2) of discharger (see Fig. 3-2-2) which is equipped to the high tension generator are connected. When the discharger is in the state of short-circuiting the high tension condenser by way of a 2 kΩ resistor, HK1 and HK2 are short-circuited. Accordingly, since base current of transistor Q2-01 does not flow at that time, transistor Q2-01 is switched off, and relays K-T1 and K-T2 do not function.

3-3-2. Charge hold and discharge circuit

This circuit functions as follows.

a) When charged up to the preset tube voltage, charging is stopped automatically. (Automatic charging)

b) When the charged voltage drops somewhat due to effects of resistors connected in parallel with high tension condenser, charging starts again automatically up to the preset value. (Charge hold)

c) After complete charging, if the tube voltage regulator is set to a lower value, discharging proceeds automatically to the new setting value through X-ray tube with the protective shutter closed. (Automatic discharging)

(1) Figure 3-3-2 is the connection diagram of this circuit.

In the diagram, OP AMP M3-06 [STAB] is responsible for "automatic charging" and "charge hold".

A control voltage corresponding to the tube voltage set by the tube voltage regulator is applied to the inverted input terminal 2 of M3-06 from terminal KV_3 of connector [5C] through resistor R10-09.

This voltage becomes as follows:

a) When set at 125 kV on MC125L-30;

Approx. 4.9 V

(2) A current corresponding to the charge voltage of high tension condenser flows between terminals VC_1 and E of connector [3C], and the voltage drop at resistor R7-01, that is, the voltage impressed to non-inverted input terminal 3 of OP AMP M3-01 becomes as follows:

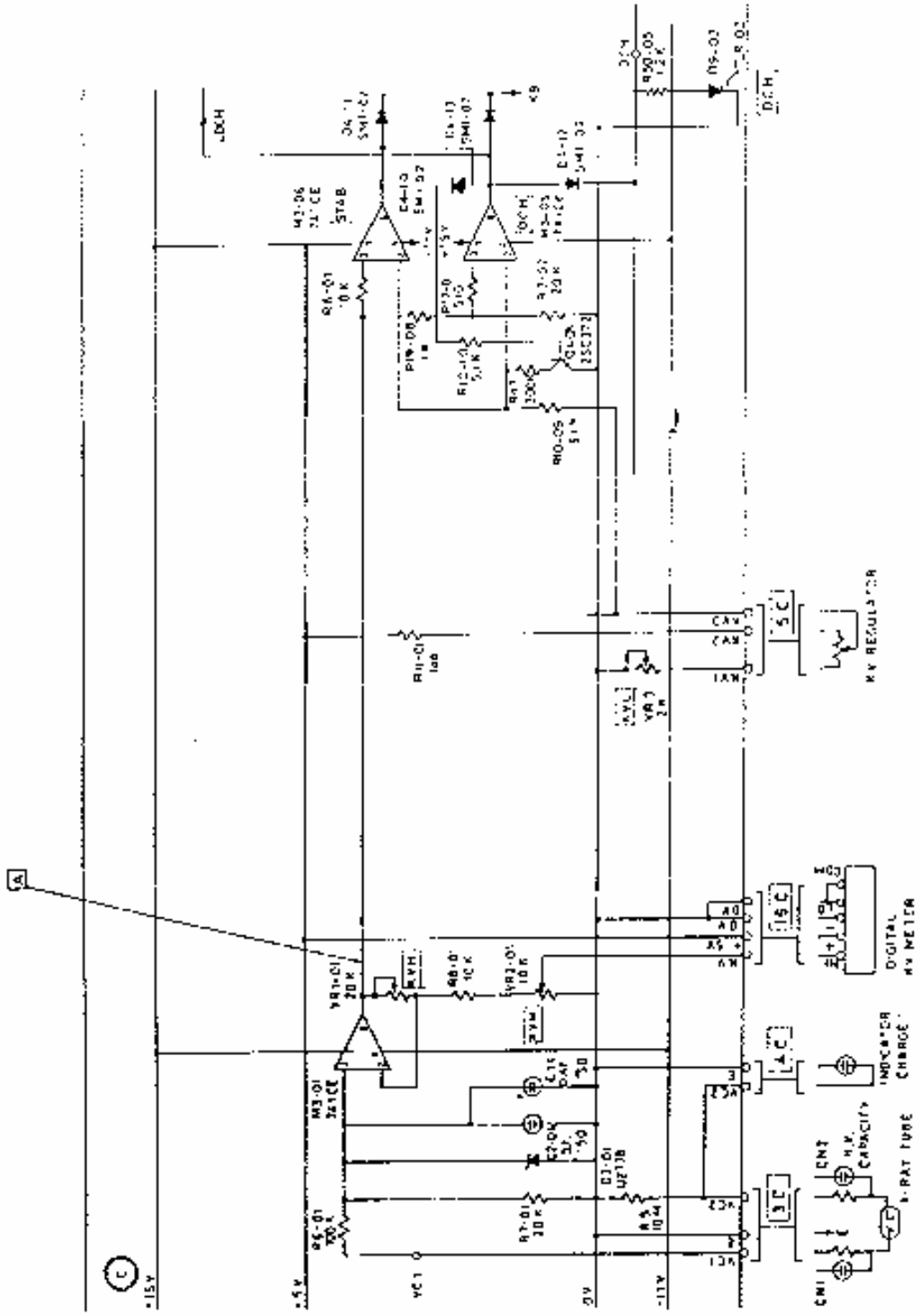

+15V
-15V
+5V
-5V
0V
DCH
KV REGULATOR
DIGITAL
KV METER
INDICATOR
CHARGE
H.V. TUBE
CAPACITY

Fig. 3-3-2

a) 125 kV charge on MC125L-30;

$$\frac{62.5 \times 10^{3}[V]}{(400 \times 10^{6}) + (100 \times 10^{3}) + (20 \times 10^{3})[\Omega]} \times (20 \times 10^{3}(\Omega)) = 3.1[V]$$

Accordingly, the output voltage of M3-01 becomes equal to the value given in item (1) after adjustment by variable resistor [kVH].

(3) The output voltage of M3-01 is added to the non-inverted input terminal 3 of M3-06. If the voltage charged in the high tension condenser is lower than the voltage set by the tube voltage regulator (when the voltage of M3-06 input terminal 3 is lower than that of terminal 2), the output voltage of M3-06 becomes about -14 V, and no output appears at *B position.

(4) By charging the high tension condenser, when the voltage exceeds the preset value, the output voltage of M3-06 becomes +14 V, which is applied to *B position by way of diode D4-11. (This circuit is connected to *B position in Fig. 3-3-1.) And, when transistor Q1-03 in Fig. 3-3-1 is switched on, transistor Q2-02

is cut off, making photocoupler [CH] inactive. This stops charging.

(5) When the voltage charged in high tension condenser is discharged by resistors connected in parallel with it, the voltage at input terminal 3 of M3-06 also goes down gradually. And, when its voltage becomes lower than the input terminal 2 voltage, the output voltage of M3-06 becomes -14 V and the voltage at *B disappears. Thereby, Q1-03 and Q2-02 in Fig. 3-3-1 are cut off and switched on respectively, so that photocoupler [CH] is turned on. This starts charging again.
When charged up to the preset value, charging is stopped again by the function explained in item (4).
In this way, the charge voltage is always maintained at a fixed value.

(6) In Fig. 3-3-2, OP AMP M3-05 [DCH] is responsible for "automatic discharging".
During charging or right after complete charging, the voltage at non-inverted input terminal 3 of M3-05 remains lower than that at

inverted input terminal 2, so that the output voltage is -14 V. After charging, if the tube voltage regulator is set to a lower value, the terminal 2 voltage becomes lower than the terminal 3 voltage, so that the output voltage builds up to +14 V, applying voltage to *B through diode D4-13. (For the subsequent actions, refer to item (4) above.) Simultaneously, a voltage is applied to LDCH, too. (For the subsequent action, refer to par. 3-4-1.)

In addition, a +14 V voltage is applied to check terminal DCH by way of diode D4-12. This signal voltage is sent into the lead relay control circuit to turn on the lead relay in high tension generator, thereby causing X-ray to be radiated. (For details, see par. 3-4-1.)

As a +14 V voltage is applied to the check terminal, red LED DCH lights up.

(7) When X-rays are radiated, the voltage charged in the high tension condenser drops, and the voltage at input terminal 3 of M3-05 also descends. Subsequently, when its voltage

becomes lower than the input terminal 7 voltage, the output voltage of M3-05 becomes -14 V, so that the voltage at *B disappears. And as the signal voltage impressed to check terminal DCH also disappears, X-ray radiation is stopped.

(8) Variable resistors in Fig. 3-3-2 give following functions respectively.

a) Variable resistor [KVM] is intended to send signal voltage corresponding to charge voltage into the digital kV meter. The size of signal voltage is "1 V/100 kV".

b) Variable resistors [KVH] and [KVL] are designed to adjust the set value of kV regulator to the indication of kV meter. The former is responsible for adjustment at high tension (125); the latter is for low tension (40 kV).

3-3-3. Miscellaneous circuit

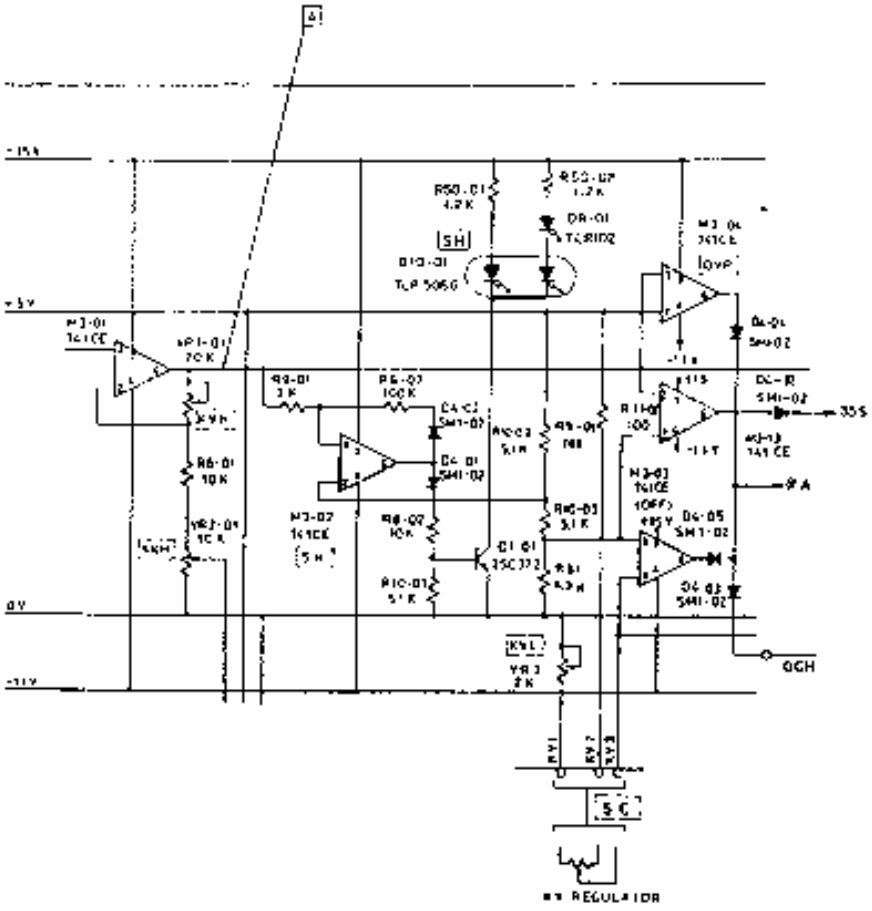


Fig. 3-3-3

This circuit provides the following functions.

a) When the charge voltage exceeds about 80 kV, photocoupler SH is turned on and the charge restriction resistor is short-circuited to accelerate the charging speed.

b) If the charge voltage exceeds 125 kV due to disorder in the automatic charging circuit, the protective circuit functions to stop charging.

c) If the tube voltage regulator is set near zero volt, charging is stopped and the collected charge is discharged until 0 kV.

d) When tube voltage drops below 35 kV in radiographing, X-ray radiation is shut off.

(1) Figure 3-3-3 is the connection diagram of this circuit.

At output terminal 6 of OP AMP M3-01 appears a control voltage proportional to the charge voltage. (See item (2) of par. 3-3-2.) And this voltage passes through resistor R9-01 and is applied to non-inverted input terminal 3 of AMP M3-02. On the other hand, inverted input terminal 2 of M3-02 is impressed with a control voltage corresponding to 80 kV (on

MC125L-30). When the voltage at input terminal 3 becomes higher than that at terminal 2, voltage of +14 V appears at output terminal 6 of M3-02 and a current starts to flow into the base of transistor Q1-02 by way of diode D4-01 and resistor R8-02.

Then Q1-01 is switched on and photocoupler [SH] is turned on. (For subsequent operations, refer to item (3) of par. 3-1.)

(2) The output voltage of M3-01 is applied to non-inverted input terminal 3 of OP AMP M3-04 [OVP]. To inverted input terminal 2 is applied a control voltage corresponding to 127 kV (on MC125L-30).

When the voltage at input terminal 3 of M3-04 exceeds that at terminal 2, a +14 V voltage appears at output terminal 6. Consequently, this voltage is applied to *A position through diode D4-04. (This circuit is joined to *A in Fig. 3-3-1.) As transistor Q1-02 in Fig. 3-3-1 is switched on, transistor Q2-01 is cut off, making relay K-T_1 inactive. This stops charging.

(3) A voltage corresponding to control voltage of about 35 kV is applied to non-inverted input terminal 3 of OP AMP M3-03 [OFF]. The control voltage corresponding to the tube voltage which is set by the tube voltage regulator is applied from terminal kV_3 of connector [5C] into inverted input terminal 2 of M3-03.
When the input terminal 2 voltage goes lower than the terminal 3 voltage, a +14 V voltage appears at output terminal 6. And this voltage is added to *A position by way of diode D4-05. (For the subsequent operations, see item (2) above.) This stops charging.
Furthermore, +14 V is applied to check terminal DCH by way of diode D4-34. This signal voltage is sent into the lead relay control circuit to cause the lead relay into the high tension generator to be turned on, thereby permitting X-rays to be radiated. (For details see par. 3-4-1.) This causes the charge collected in the high tension condenser to be discharged gradually through the X-ray tube.

(4) A control voltage corresponding to the charge voltage of about 35 kV is applied to non-inverted input terminal 3 of OP AMP M3-I3. Output voltage of OP AMP M3-01, that is, a control voltage proportional to the charge voltage, is applied to inverted input terminal 2. Besides, the output voltage is impressed on 35S by way of diode D4-32.

When the charge voltage drops below about 35 kV during X-ray radiation, +14 V voltage appears at output terminal 6 to shut off X-ray radiation. (Refer to par. 3-4-2.)

3-4. mAs control circuits

3-4-1. Lead relay control circuit

This apparatus is designed to control the grid bias of triode X-ray tube by means of lead relay. This circuit is to control this lead relay.

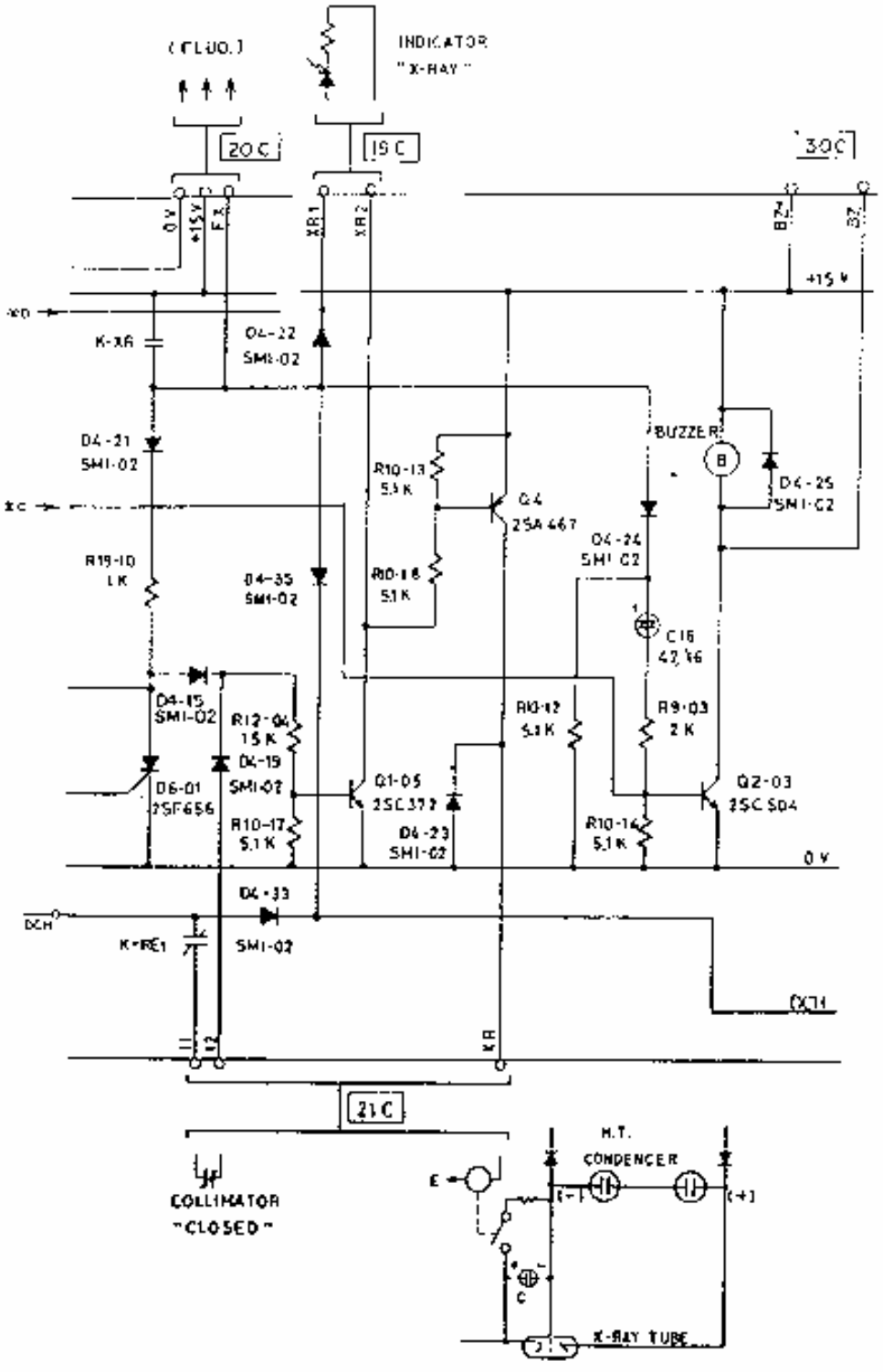

(CLUD.)
INDICATOR
"X-RAY"
20 C
19 C
30 C
0 V
+15 V
F.X.
XR1
XR2
BZ
+15 V
K-XR
D4-22
SM1-02
D4-21
SM1-02
BUZZER
D4-25
SM1-02
R10-13
5.1 K
Q4
2SA 467
D4-24
SM1-02
R19-10
1 K
D4-35
SM1-02
R10-16
5.1 K
C16
42 V6
D4-15
SM1-02
R12-04
1.5 K
D4-19
SM1-02
R10-12
5.1 K
R9-03
2 K
D6-01
2SF656
Q1-05
2SC372
Q2-03
2SC 504
R10-17
5.1 K
D4-23
SM1-02
R10-14
5.1 K
0 V
D4-33
K-RE1
SM1-02
KR
21 C
COLLIMATOR
"CLOSED"
H.T.
CONDENCER
X-RAY TUBE

Fig. 3-4-1

(1) Figure 3-4-1 is the connection diagram of this circuit.
By "X-RAY" operation with the hand switch, relay K-XR starts to function. (For the functional explanation, see par. 3-6.)
When relay K-XR operates, the lead relay in the high tension generator functions in the following circuits:

a. +15 V power → contact of relay K-XR → diode D4-21 → resistor R19-10 → diode D4-15 → resistor R12-04 → base of transistor Q1-05 → OV power (Q1-05 switched on).

b. +15 V power → resistor R10-13 → resistor R10-18 → Q1-05 → OV power (Q4 switched on).

c. +15 V power → transistor Q4 → terminal XR of connector [21C] → coil of lead relay in high tension generator → terminal E of connector [6C] → OV power.

(2) When transistor Q1-05 is switched on, the "X-RAY" LED lights up in the following circuit:
+15 V power → contact of relay K-XR → diode D4-22 → terminal XR_1 of connector [19C] → "X-RAY" lamp → terminal XR_2 of connector [19C] → transistor Q1-05 → OV power.

(3) When radiography end signal from mAs timer circuit is applied to the gate of thyristor D6-01 (see par. 3-4-3), D6-01 is switched on and transistors Q1-05 and Q4 are cut off. Then the lead relay in the high tension generator is turned off, so that "X-RAY" lamp LED goes out.

(4) The lower right corner of Fig. 3-4-1 is a rough sketch of X-ray tube grid control circuit. In this diagram, C is the electrostatic capacity between core wires of high tension cable. When charged into the high tension condenser, the electrostatic capacity C is charged in the polarity shown in the diagram. By this voltage, a negative bias is applied to the grid of X-ray tube, so that X rays are not radiated. Next, when the lead relay is turned on by "X-RAY" operation, capacity C is short-circuited through a small resistance. And the grid bias of X-ray tube disappears, and x rays are radiated.

(5) When x rays are radiated, the buzzer sounds in the following circuit:

a. +15 V power → contact of relay K-XR → diode D4-24 → condenser C16 → resistor R9-03 → base of transistor Q2-03 → 0V power (Q2-03 switched on).

b. +15 V power → buzzer → transistor Q2-03 → 0V power.

When charging into condenser C16 comes to an end, the buzzer stops automatically.

(6) After complete charging, if the tube voltage regulator is set to a lower value, the lead relay in the high tension generator is turned on and x rays are radiated in the following circuit. In this case, discharge proceeds slowly because heating current of X-ray tube filament is small. Check terminal DCH (for previous operations, see item (7) of par. 3-3-2 and item (3) of par. 3-3-3) → contact of relay $K\text{-}RE_1$ → terminal 11 of connector [21C] → collimator "close" acknowledgement contact → terminal 12 of connector [21C] → diode D4-19 → resistor R12-04 → base of transistor Q1-05 (Q1-05 switched on).

(For the subsequent operations, see par. (1)

above.)

Relay K-RE_1 functions by "READY" operation with the hand switch. (For details see par. 3-6.)

(7) After complete charging, if the tube voltage regulator is set to a low value, +14 V output voltage of OP AMP M3-05 [DCH] switches on transistor Q1-10 by way of diode D4-31 from LDCH.

Then the "X-RAY" lamp LED lights up in the following circuit:

+15 V power → transistor Q1-10 → diode D4-34 → terminal XR1 of connector [19C] → "X-RAY" lamp → terminal XR2 of connector [19C] → transistor Q1-05 → OV power.

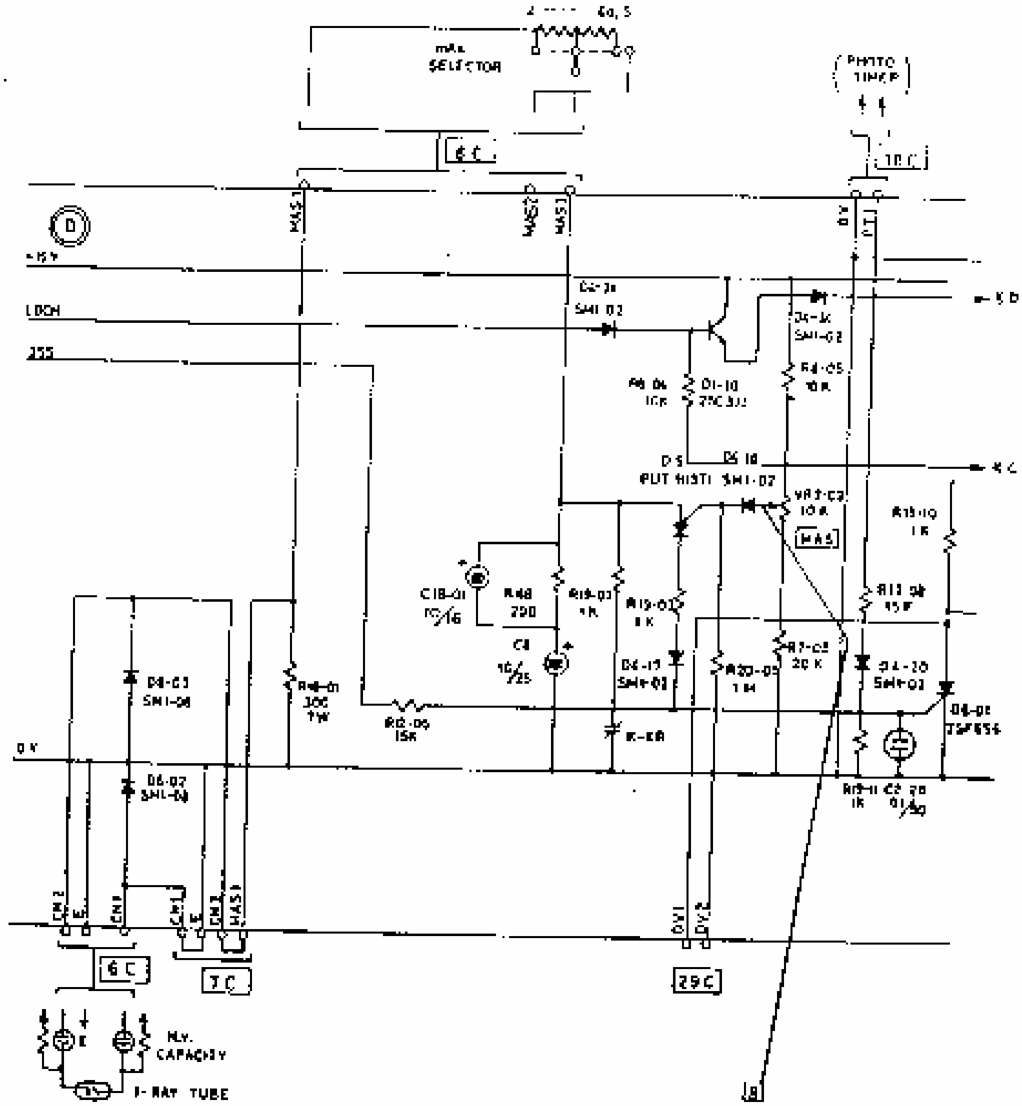
At the same time, the buzzer sounds in the following circuit:

LDCH → diode D4-31 → resistor R8-06 → base of transistor Q2-03 → OV power (Q2-03 switched on).

Consequently, while a +14 V output is given to LDCH, the "X-RAY" lamp lights up, and the buzzer sounds.

3-4-2. mAs timer circuit

This circuit is intended to control the discharge amount (mAs value) of high tension condenser at the time of radiography.



SELECTOR
PHOTO TIMER
10C
6C
7C
29C
LOCH
0V
DV1
DV2
MAS
8
H.V. CAPACITY
X-RAY TUBE

Fig. 3-4-2

(1) Figure 3-4-2 is the connection diagram of this circuit.
When x rays are radiated, a current flows in the following circuit to develop voltage across resistor R18-01:
negative side high tension condenser → terminal CN_2 of connector [6C] → terminal CN_2 of connector [7C] → terminal MAS1 of connector [7C] → resistor R18-01 → terminal E of connector [7C] → terminal CN_1 of connector [6C] → positive side high tension condenser → X-ray tube → negative side high tension condenser.

(2) The voltage developed across resistor R18-01 is as follows (when tube current is 500 mA):
$E = 300 \times I = 300 \times 0.5 = 150$ [V]
And condenser C8 is charged in the following circuit:
terminal MAS1 of connector [8C] → mAs selector → terminal MAS3 of connector [8C] → resistor R48 → condenser C8.

(3) The sum of the voltage charged in condenser C8 and the voltage across resistor R48 is applied to the anode of PUT D5. And, when the voltage goes beyond the gate voltage of D5 (the

voltage adjusted by variable resistor [MAS]), D5 is turned on.

Consequently, a current flows into the gate of thyristor D6-01 by way of resistor R19-03 and diode D4-17 to turn on D6-01. (For subsequent operations, see par. 3-4-1.)

(4) Since the final charge voltage of C8 is sufficiently small as compared with the voltage across resistor R18-01, the charge voltage of C8 rises in linear function in terms of the lapse of time. Therefore, the value of mAs when the charge voltage of C8 reaches the gate voltage of D5 will be in proportion to the resistance of mAs selector.

(5) As the charge voltage drops below about 35 kV, a +14 V appears at 35S (see item (4) of par. 3-3-3), and this voltage switches on thyristor D6-01. Consequently, if the charge voltage drops below 35 kV during X-ray radiation, X-ray radiation is shut off.
(Refer to par. 3-4-1.)

3-5. X-ray tube current control circuits

The control circuit of X-ray tube current conventionally

depends on the constant voltage transformer and enamelized resistor with band for stabilization of filament voltage and adjustment.

Of late, however, the semiconductor circuit composition becomes possible due to advancement of various semiconductor parts.

This circuit controls the filament current of X-ray tube by means of operational amplifier (OP AMP) and power transistor and adjusts by means of a variable resistor.

3-5-1. Circuit outline

Figure 3-5-1 show the basic contrution of this circuit.

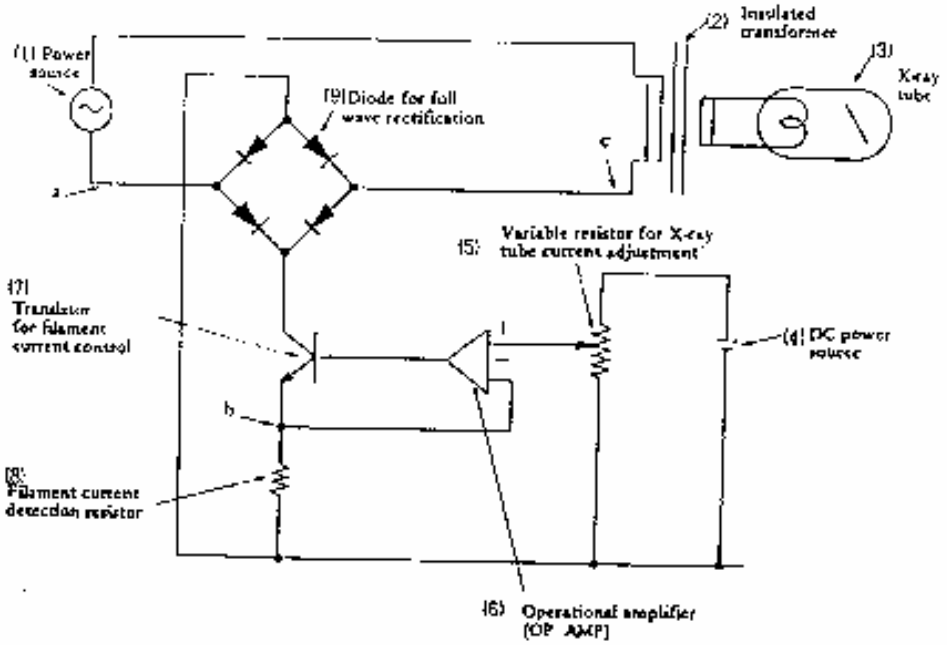


Fig. 3-5-1

(1) Figure 3-5-2 shows the voltage waveform of each part given in Fig. 3-5-1; waveforms (a), (b) and (c) represent the voltage waveforms at the corresponding circuits in Fig. 3-5-1. In Fig. 3-5-1, the voltage supplied from DC power source (4) is applied to the variable resistor (5), and the DC voltage adjusted by (5) is added to the non-inverted input terminal of OP AMP (6). And the output of (6) is applied to the base of transistor (7) for filament current control. And the filament current detection resistor (8) is connected to the emitter of (7) and to the inverted input terminal of OP AMP (6).

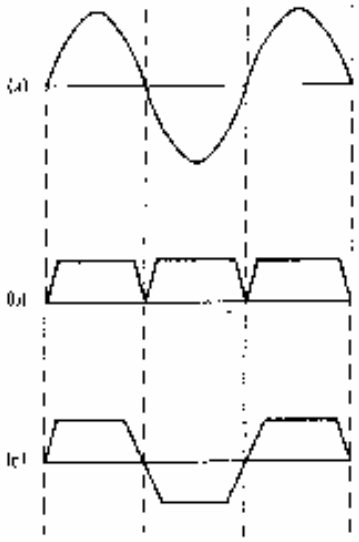


Fig. 3-5-2

The collector of transistor (7) is impressed with AC voltage of power source (1) full wave rectified by the diode (9) for full wave rectification.

In this circuit formation, a voltage as waveform (b) in Fig. 3-5-2 is applied across the filament current detection resistor (8). Since the amplification factor of OP AMP (6) is very large, the output voltage of variable resistor (5) becomes equal to the peak of voltage impressed to the resistor (8).

Further, by designing the amplification factor of transistor (7) sufficiently large and ignoring the base current, the collector current becomes equal to the current flowing in the resistor (8).

(2) Figure 3-5-3 is the voltage waveform at point (b) in Fig. 3-5-1 when the line voltage fluctuates.

Fig. 3-5-3

A higher line voltage will produce the dotted-line waveform, whereas a lower voltage will cause the solid-line waveform.

In other words, the voltage of DC power source (4) in Fig. 3-5-1 descends when the line voltage is high and ascends when the line voltage is low. Thereby, the voltage of (b) in Fig. 3-5-1, that is, the effective value of X-ray tube filament current remains constant even if the line voltage fluctuates.

(3) By the relatively simple circuit as mentioned above, the filament current can be kept stable in spite of line voltage fluctuations. In addition, the filament current can be controlled by changing the amplitude of filament current with the aid of variable resistor (5) in Fig. 3-5-1.

3-5-2. Control power source circuit

This circuit is intended to obtain DC power source (4) in Fig. 3-5-1.

(1) Figure 3-5-4 is the connection diagram of this circuit.

In the diagram, the voltage impressed to non-inverted input terminal 3 of OP AMP M3-07 becomes as follows:

$$\frac{100K}{100K + 100K} \times (15 + \frac{1K}{1K + 9.1K} \times VCM) \quad [V]$$

The voltage VCM is an unstabilized negative DC voltage as explained in par. 3-2. Its value is within about -29 V to -35 V in the allowable range of line voltage.

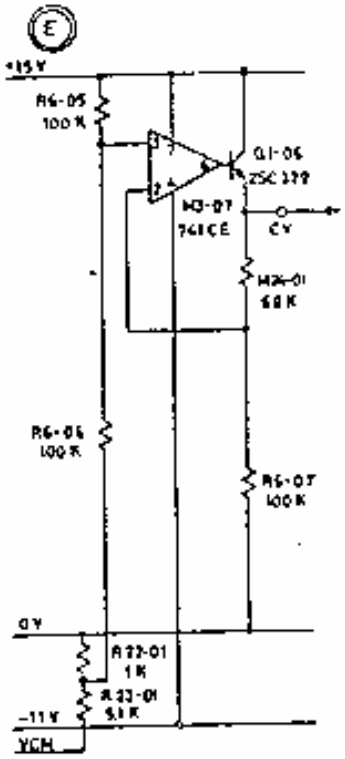


Fig. 3-5-4

(2) After current and voltage amplification at OP AMP M3-07 and transistor Q1-06, the following voltage will be obtained at output terminal CV:

$$\frac{1}{2} \times (15 + \frac{VCM}{10.1}) \times \frac{168}{100} \quad [V].$$

When VCM is -29 V, it follows that;

$$\frac{1}{2} \times (15 \times \frac{-29}{10.1}) \times \frac{168}{100} = 10.2 \quad [V].$$

When VCM is -35 V, it follows that;

$$\frac{1}{2} \times \left(15 \times \frac{-35}{10.1}\right) \times \frac{165}{100} = 9.7 \text{ [V]}$$

3-5-3. Outline of adjustment circuit

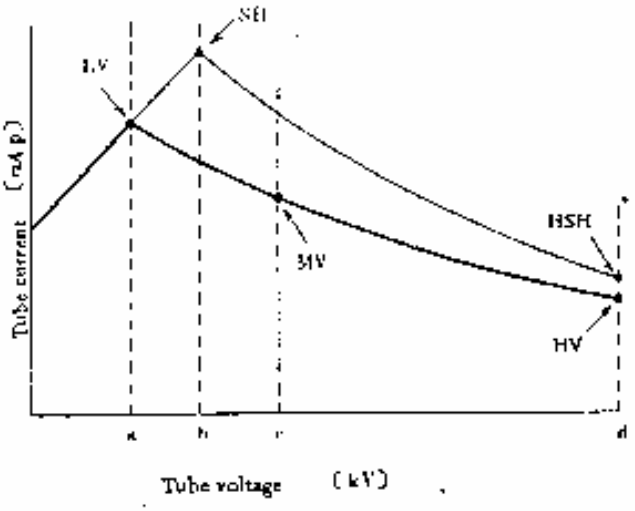


Fig. 3-5-5

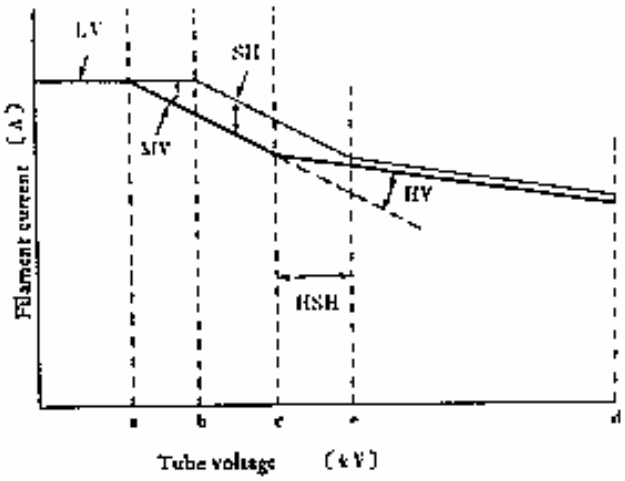


Fig. 3-5-6

This circuit is designed to set the tube current automatically to an allowable maximum value depending upon the setting position of tube voltage regulator.

(1) Figure 3-5-5 represents the radiographic rating chart of X-ray tube.

Tube voltages a, b, c and d are respectively the following values (the exact values are quoted in the Installation Manual): a - 50 kV, b - 60 kV, c - 80 kV, and d - 125 (100) kV.

The thick-line curve refers to the case where the mAs selector is set beyond 6 mAs; the thin-line curve is the radiographic rating when set below 5 mAs.

Symbols LV, MV, HV, SH, and HSH stand for variable resistors for tube current adjustment at each point.

That is, at these five points, the tube current of this circuit is adjusted. Accordingly, also at other tube voltages, the tube current roughly corresponding to this rating chart can be obtained.

(2) Figure 3-5-6 is the curve to illustrate the relation between the tube voltage and the X-ray

tube filament current adjusted in this circuit. The meaning of various symbols is the same as in (1) above.

The thick-line curve and thin-line curve show the relation between X-ray tube filament current and tube voltage when the mAs selector is set beyond 6 mAs and below 5 mAs, respectively.

(3) The filament current and tube voltage relation when the mAs selector is set beyond 6 mAs becomes as described below. (See Fig. 3-5-6.)

a. While the tube voltage is lower than point a, the filament current remains constant. However, as the tube voltage goes lower, the emission of X-ray tube is worsened and the tube current decreases as shown in Fig. 3-5-5. This value can be adjusted by variable resistor "LV".

b. While the tube voltage stays between point a and point c, the filament current decreases in linear function along with the rise of tube voltage.
This decreasing rate can be adjusted by variable resistor "MV".

c. While the tube voltage stays between point c and point d, the decreasing rate of filament current is slower than in the case of staying between point a and point c.
This decreasing rate can be adjusted by variable resistor "HV".

(4) The filament current and tube voltage relation when the mAs selector is set below 5 mAs is as explained hereunder. (See Fig. 3-5-6.)

a. While the tube voltage is lower than point b, the filament current remains constant.
However, as the tube voltage goes lower, the tube current decreases.
This point b can be adjusted by variable resistor "SH".

b. While the tube voltage stays between point b and point e, the filament current decreases in linear function along with the rise of tube voltage.
This decreasing rate is the same as the case where the tube voltage is between point a and point c at above 6 mAs.

c. While the tube voltage stays between point c and point d, the decreasing rate of filament current is slower than in the case of staying between point b and point e.
This decreasing rate is the same as in the case where the tube voltage is between point c and point d at above 6 mAs.
This point c can be adjusted by variable resistor "HSH".

3-5-4. Adjustment circuit

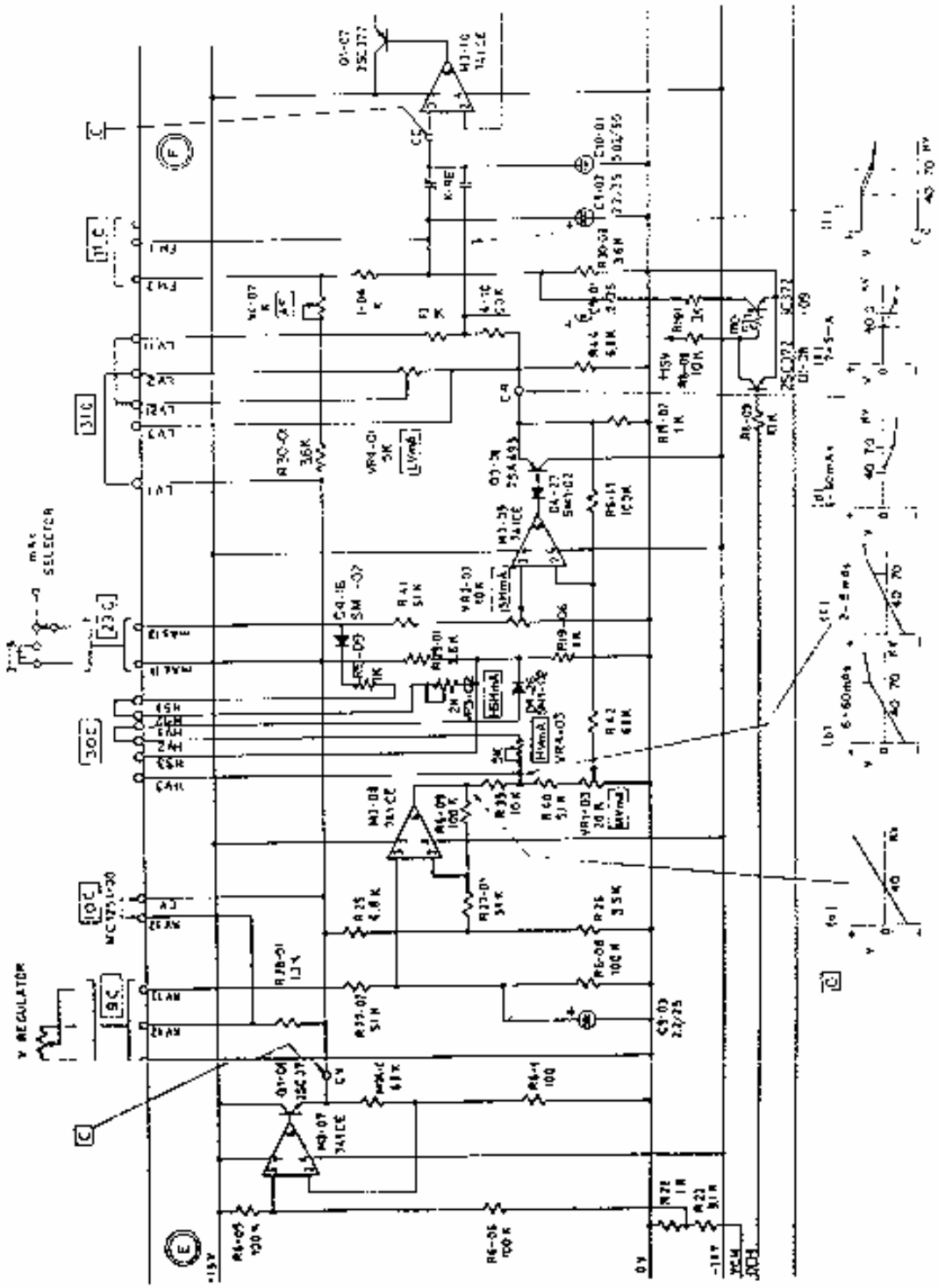


Fig. 3-5-7

(1) Figure 3-5-7 is the connection diagram of this circuit.
In the diagram, the output voltage of the above-mentioned control power source circuit (see par. 3-5-2) is applied to check terminal CV.
A control voltage corresponding to the tube voltage set by tube voltage regulator is applied to terminal KV13 of connector [9C], and is divided by resistors R27-02 and R6-08 to be added to non-inverted input terminal 3 of OP AMP M3-08.
Besides, a control voltage corresponding to about 50 kV is applied to inverted input terminal 2 of M3-08 by way of resistor R27-01.
In this circuit formation, the output voltage of M3-08 will be like curve (a) shown in the diagram.

(2) By the function of resistor R39, variable resistor [HVmA] and diode D4-26 which are connected to the output side of M3-08, the voltage at connection points of resistors R39 and R40 changes its slope angle at about 80 kV point to be as curve (b) shown in the diagram. (In the case of above 6 mAs)

Variable resistor [HVmA] is used to adjust the slope in the diagram when the tube voltage is higher than above 80 kV.

(3) When the mAs selector is set below 5 mAs, since terminals mAs 13 and mAs 11 of connector 23C are connected together, the voltage at connection points of R39 and R40 becomes as curve (c) in the diagram. This slope changing point can be adjusted by variable resistor [HSHmA].

(4) The voltage of curve (b) or (c) is applied to variable resistor [MVmA] by way of resistor R40. The output voltage of [MVmA] is applied to inverted input terminal of OP AMP M3-09 via resistor R42.

(5) When the mAs selector is set above 6 mAs, since terminals mAs 13 and mAs 11 of connector [23C] are not connected, the voltage impressed to non-inverted input terminal 3 of M3-09 becomes zero volt. Again, since diode D4-27 is inserted to the output side of M3-09, the voltage applied to check terminal CR becomes as curve (d). Meanwhile, transistor Q3-02 is responsible for current amplification.

(6) When the mAs selector is set below 5 mAs, the non-inverted input terminal 3 of M3-09 is impressed with the voltage adjusted by variable resistor [5mA].
Accordingly, the voltage applied to check terminal CR at the output side of M3-09 becomes as the solid line of curve (e) shown in the diagram.

(7) The voltage impressed to check terminal CR and the voltage adjusted by variable resistor [LVmA] are compounded together through resistors R43 and R6-10, and then applied to non-inverted input terminal 3 of OP AMP M3-10 by way of the contact of relay K-RE1 and check terminal CC.
This voltage becomes as curve (f) in the diagram.
The lower curve refers to the case above 6 mAs and the upper curve shows the case below 5 mAs.
The contact of relay K-RE1 is closed by "READY" operation.

(8) Since relay K-RE1 remains inactive except while in "READY" operation, the voltage applied to non-inverted input terminal 3 of M3-10 is not supplied in the circuit mentioned above, but

supplied in the following circuit.

The voltage adjusted by variable resistor mAF is applied to non-inverted input terminal 3 of M3-10 by way of contact of relay K-RE1.

Variable resistor mAF is to adjust the discharge current value in the event of operation to discharge through X-ray tube.

(9) Under the condition of the foregoing item (8), the voltage applied to non-inverted input terminal 3 of M3-10 refers to a voltage existing under the condition that resistors R30-02 and R16-01 are put in parallel (normally transistor Q1-09 is put on).

As a +14 V voltage is impressed on DCH, transistor Q1-08 is switched on while transistor Q1-09 is switched off. Consequently, resistor R16-01 is cut off from the circuit, and the input voltage of input terminal 3 of M3-10 rises. In this way, when the charge voltage is maintained (when a +14 V voltage is appearing at DCH), the filament heating voltage is kept low.

3-5-5. Main transistor control circuit

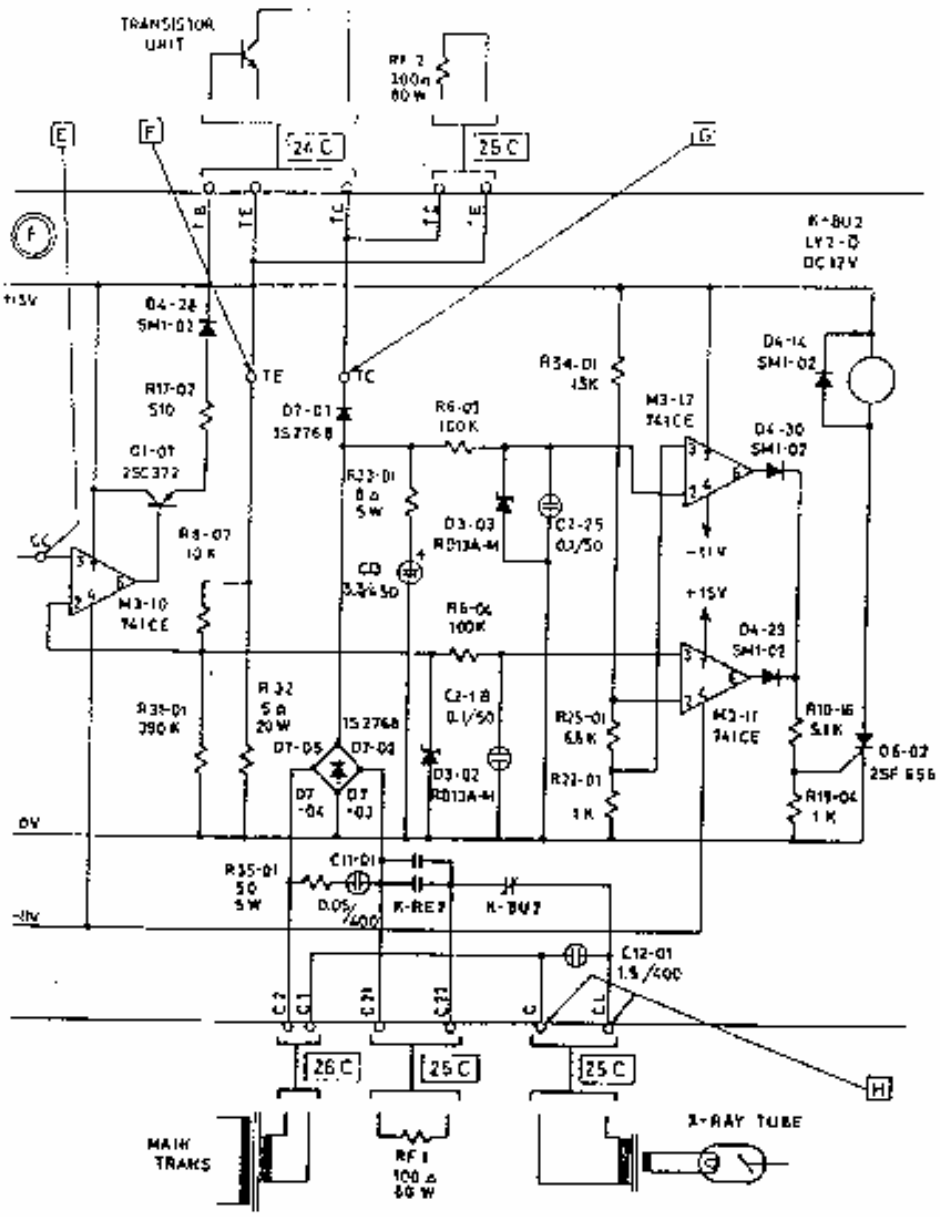


Fig. 3-5-8

(1) Figure 3-5-8 is the connection diagram of this circuit.
The DC voltage adjusted by the above-mentioned adjustment circuit is applied to the non-inverted input terminal 3 of OP AMP through check terminal CC. The output voltage is M3-10 is subject to current amplification at transistor Q1-07 and is applied to the base of main transistor of "TRANSISTOR UNIT-10" by way of resistor, diode and terminal TB of connector [24C].

(2) The collectors of this main transistor are connected to the plus side terminals of diodes D7-02 through D7-05 for full wave rectification in the filament current circuit by way of terminal TC of connector [24C] and diode.
The emitters of this main transistor, on the other hand, are connected to the minus side terminals of those diodes D7-02 through D7-05 and the terminal OV of DC power source by way of terminal TE of connector [24C] and resistor R32 for filament current detection.

(3) Therefore, when a voltage is applied to the base of main transistor, the filament current starts to flow.

Then a voltage proportional to the filament current appears across resistor R32 for filament current detection. (As for the waveform, see curve (b) in Fig. 3-5-2.)

This voltage is then fed back to the inverted input terminal 2 of the above-mentioned OP AMP M3-10 by way of dividing resistor. Hence, the voltage which appears across R32 has the peak proportional to the input voltage of M3-10.

This causes the X-ray tube filament current to be controlled by the input voltage of M3-10.

(4) At the alternating current side of diodes D7-02 through D7-05 are joined the contacts of relays K-RE_2 and K-BU_2.

Relay K-RE_2 functions by "READY" operation. When the contact of K-RE_2 is closed, resistor 100-ohm, 80-watt connected between terminals C21 and C22 of connector [25C] is short-circuited.

This resistor is intended to reduce power consumption of main transistor in preheating time (while "READY" operation is not done), that is, when the filament current is small.

Relay K-BU_2 is responsible for cutting of filament current when the protective circuit (see par. 3-5-6) operates.

(5) In Fig. 3-5-8, the inside of "TRANSISTOR UNIT-10" is written as one transistor but, in effect, it is composed of several transistors as seen from the connection diagram of "TRANSISTOR UNIT-10" (Dwg. No. 501-06663). That is, in order to increase the amplification factor, the Darlington connection is adopted, and in order to enlarge the allowable power loss, the second side has four transistors connected in parallel.

(6) Resistor 300-ohm, 80- watt connected between terminals TC and TE of connector [25C] is intended to reduce power consumption of main transistor. The dotted-line curve in Fig. 3-5-9 shows the waveform of current flowing in this resistor; the solid-line curve refers to the waveform of current flowing in filament current detection resistor R32. Hence the differential current of these two flows into the main transistor.

Fig. 3-5-9

3-5-6. Protective circuit

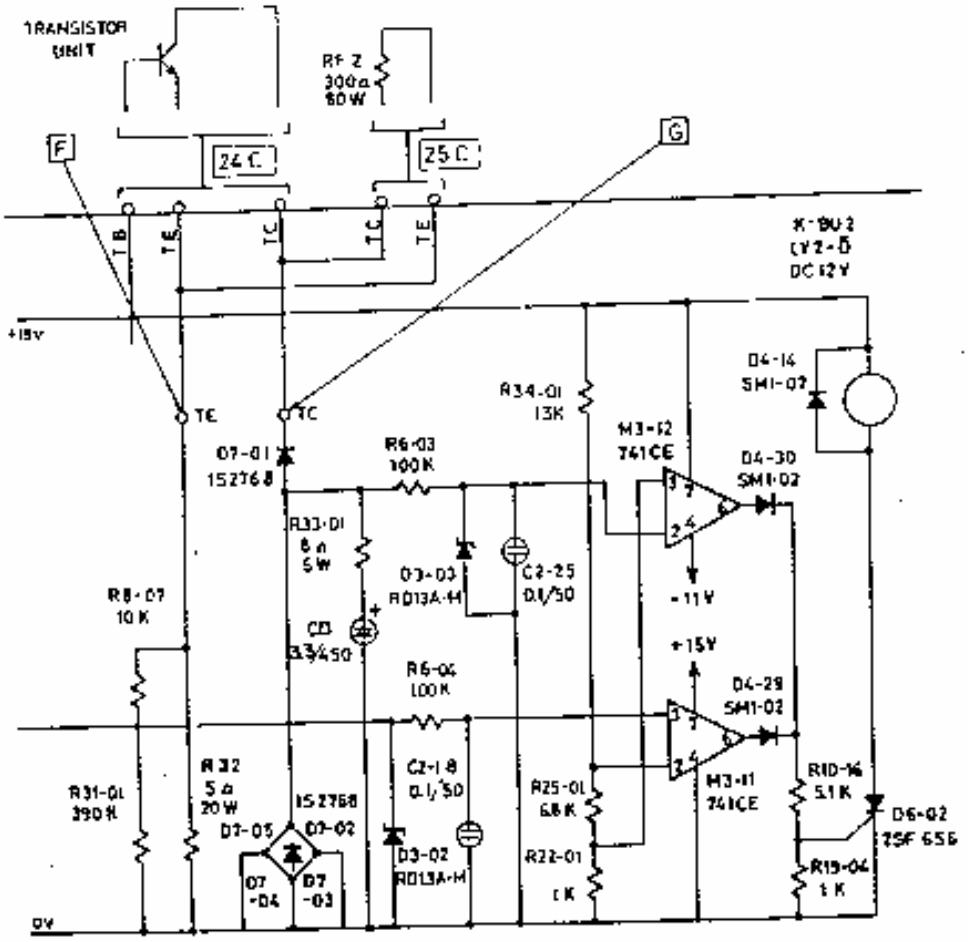


Fig. 3-5-10

(1) Semiconductor parts will be easily broken down when the method of use is mistaken.
In this apparatus, if the main transistor or any one of the diodes D7-02 through D7-05 should be broken, the line voltage would be directly impressed to the X-ray filament and the filament would be broken to make the X-ray tube unusable.
This circuit is intended, in case the said transistor or diode should be broken, to prevent filament breakage and protect the X-ray tube.

(2) Figure 3-5-10 is the connection diagram of this circuit.
OP AMP M3-11 is to detect breakage of main transistor. A DC 5.6 V voltage is applied to inverted input terminal 2 of M3-11. The voltage impressed to non-inverted input terminal 3 is lower than 5.6 V as far as the main transistor is functioning normally. However, if the main transistor should break down, an excessively large current will flow into the filament current detection resistor R32, thereby causing the voltage at terminal 3 of M3-11 to exceed 5.6 V.

Consequently, a positive voltage appears at output terminal 6 and a current starts to flow into the gate of thyristor D6-02. This operates the relay K-BU_2. (See par. 3-5-5.)

(3) OP AMP M3-12 is provided to detect breakage of diodes D7-02 through D7-05. A DC 0.7 V voltage is impressed to the non-inverted input terminal 3 of M3-12. And the voltage applied to inverted input terminal 2 is higher than 0.7 V as far as the diodes are functioning normally. However, the voltage drops to zero when any one of the diodes is broken. Consequently, a positive voltage appears at output terminal 6 and a current starts to flow into the gate of thyristor D6-02. This operates the relay K-BU_2.

(4) As relay K-BU_2 functions, its contact breaks the circuit of filament current. (Refer to para. 3-5-5.) Besides, since the "READY" operation circuit is also broken at the same time, "READY" operation becomes impossible to do. (Refer to par. 3-6.)

3-6. Relay circuit

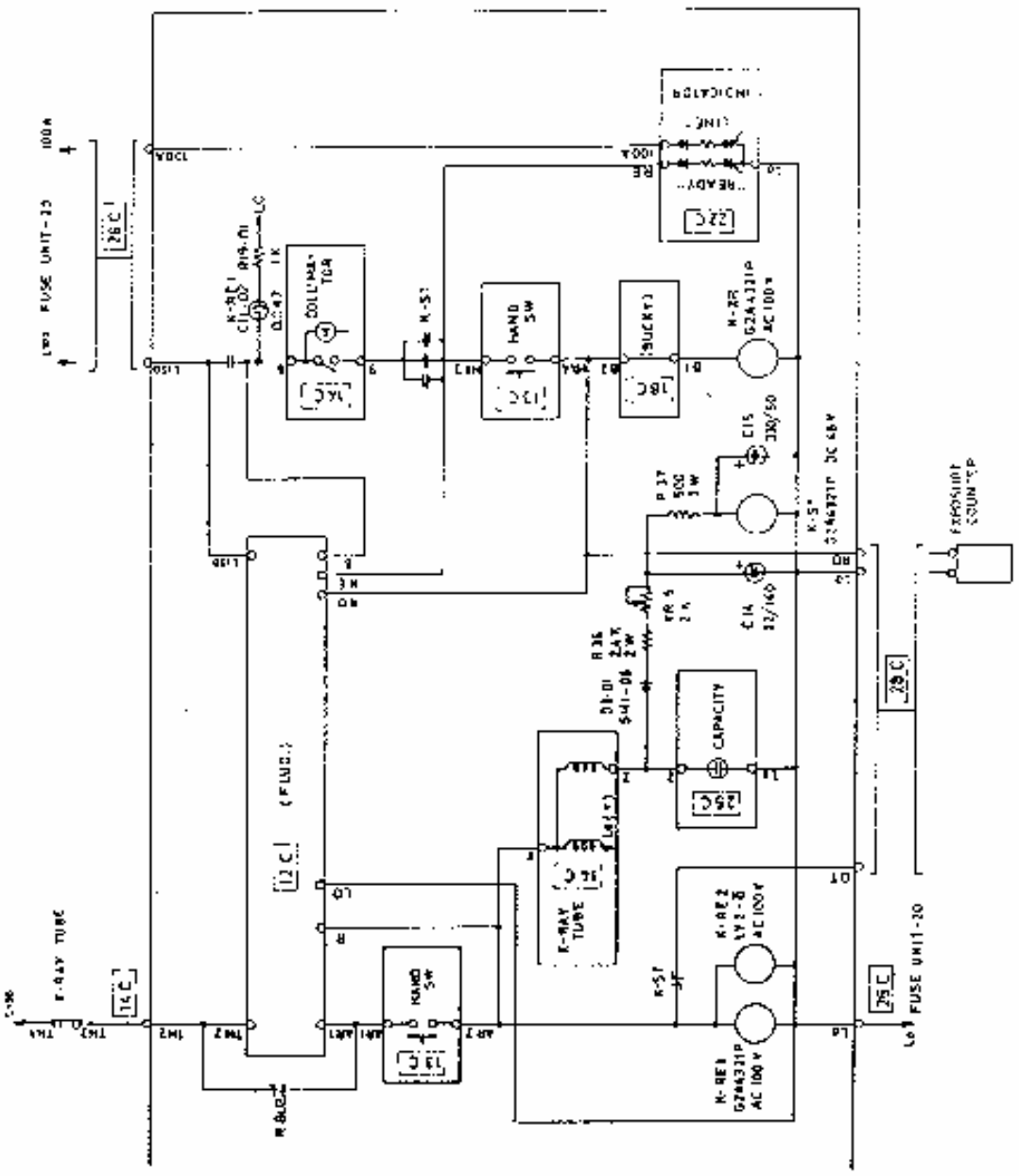


Fig. 3-6-1

(1) Figure 3-6-1 is the connection diagram of this circuit.

In the diagram, the voltage passing from L_{100} of power source through thermal switch of X-ray tube (which is turned off when the temperature of X-ray tube housing exceeds about 80°C on the average) is applied to terminal TH_2 of connector [14C]. And it is added to terminal AR_1 of connector [13C] by way of closed contact of relay $K\text{-}BU_2$. (Refer to par. 3-5-6.)

By "READY" operation with the hand switch, the terminals AR_1 and AR_2 of connector [13C] are short-circuited to turn on relays $K\text{-}RE_1$ and $K\text{-}RE_2$.

(2) Simultaneously, the L_{100} voltage will be applied from terminal AR_2 into terminal X of X-ray tube stator. The one end Y of main coil is connected to terminal L_0 of power source. The one end Z of auxiliary coil is connected to terminal L_0 of power source through the phase advancing condenser.

In this circuit connection, a current flows into the stator to cause the X-ray tube anode to start rotating.

Above 1.5 second afterwards, relay K-ST is turned on.

(3) When relay K-RE_1 functions, a voltage is impressed to terminal 8 of connector [14C] and the shutter of collimator opens. When the shutter opens, terminals 8 and 9 of connector [14C] will be short-circuited. Next, action of relay K-ST will cause the L_{100} voltage to be impressed to terminal HX3 of connector [13C]. And an impression of L_{100} voltage into terminal RE of connector [22C] will illuminate LED of "READY" lamp.

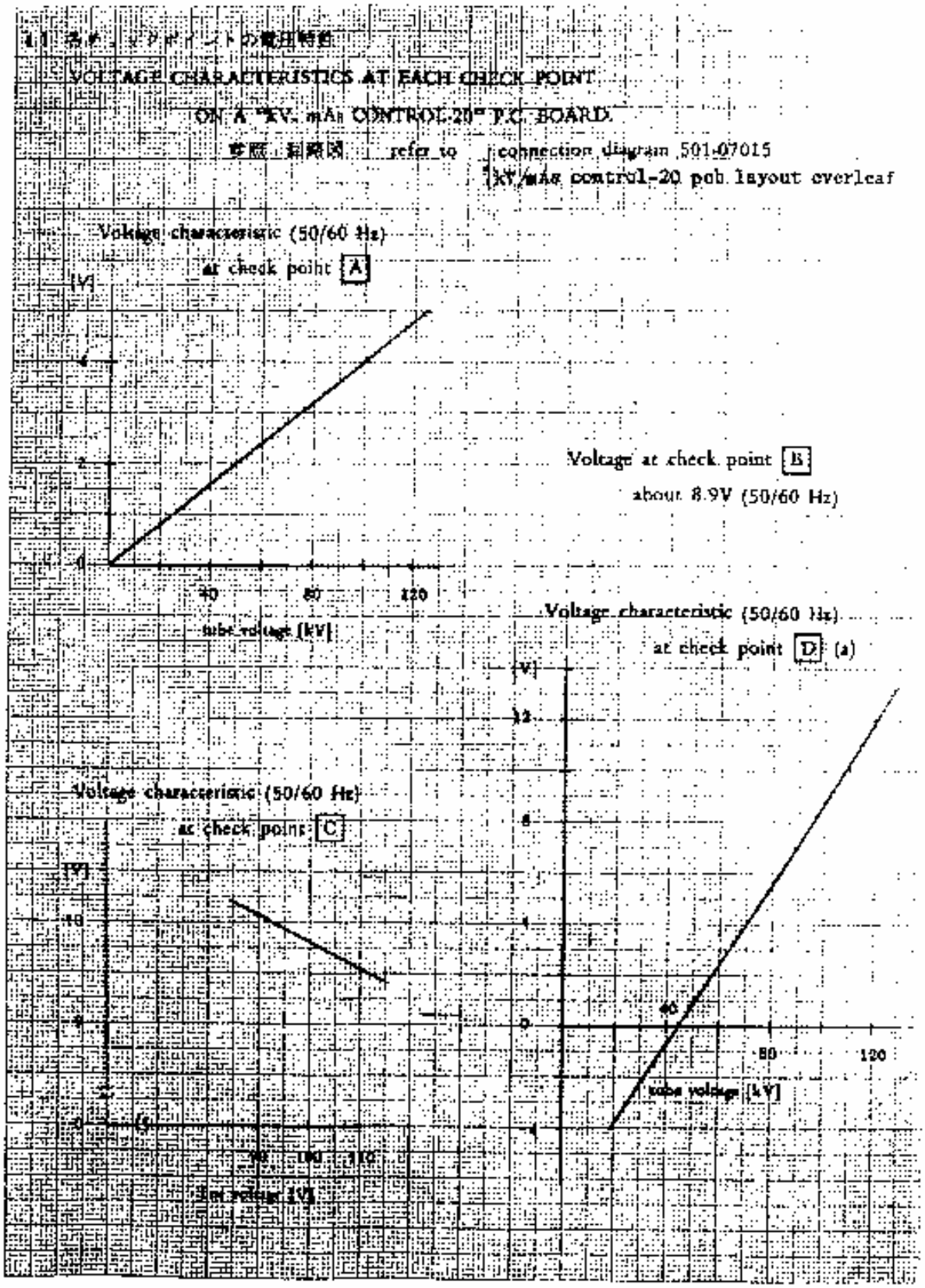
(4) By "READY" operation with the hand switch, a voltage passes through terminals B2 and B1 of connector [18C] to reach relay K-XR, which is then put into action.

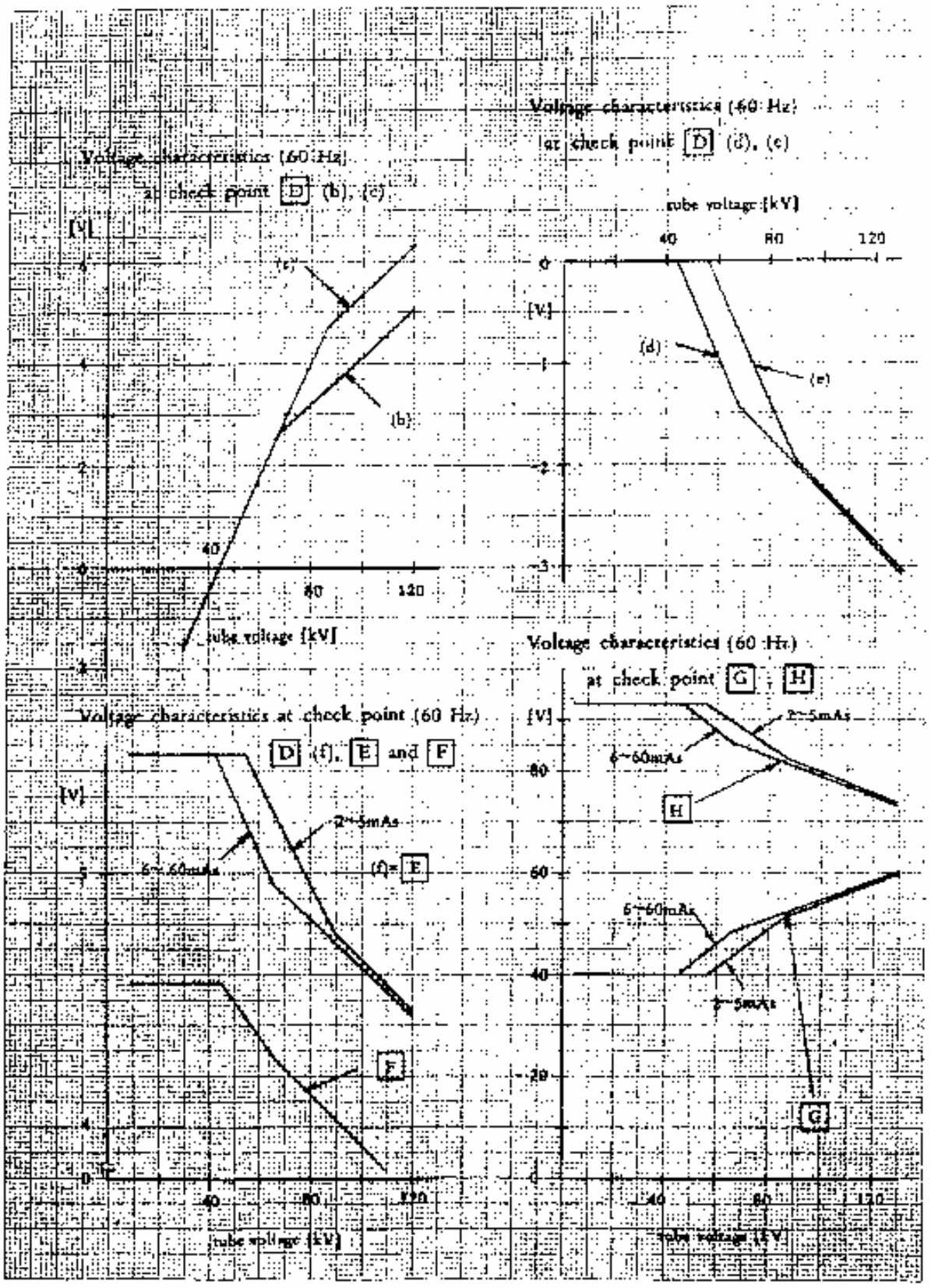
各チェックポイントの電圧特性

VOLTAGE CHARACTERISTICS AT EACH CHECK POINT

ON A "kV, mAs CONTROL 20" P.C. BOARD

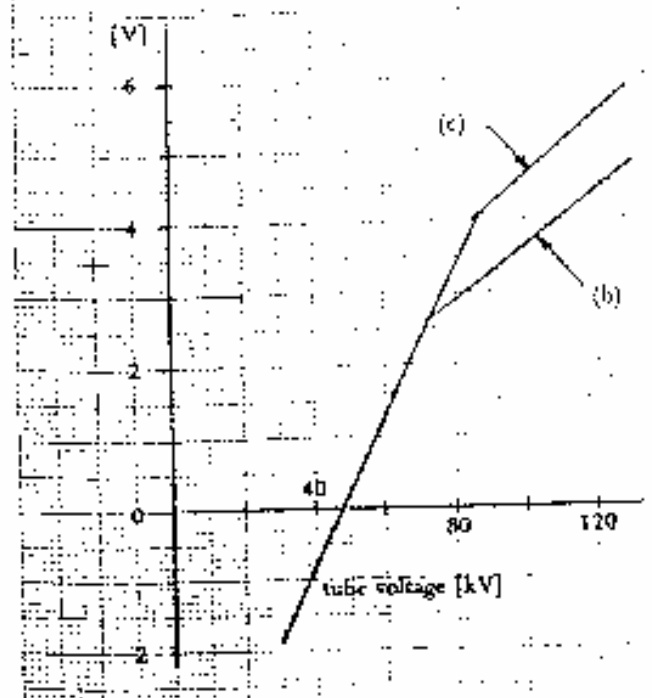
参照 refer to connection diagram 501-07015
kV/mAs control-20 pcb layout overleaf



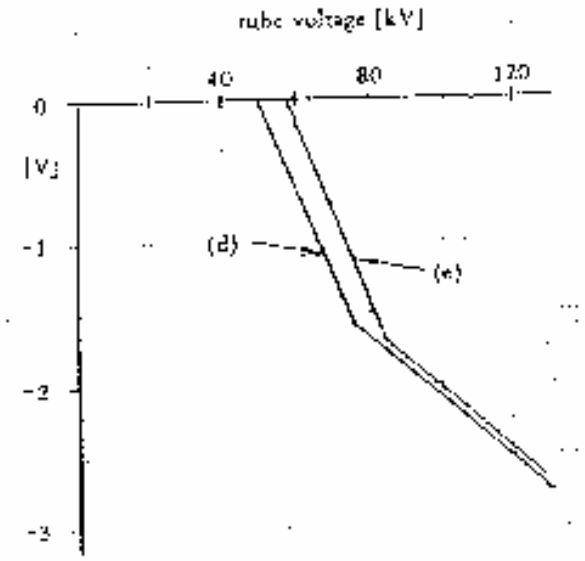

Voltage characteristics (60 Hz)
at check point D (b), (c)
[V]
(c)
(b)
40
80
120
tube voltage [kV]
Voltage characteristics (60 Hz)
at check point D (d), (e)
tube voltage [kV]
40
80
120
[V]
(d)
(e)
Voltage characteristics at check point (60 Hz)
D (f), E and F
[V]
2~5mAs
6~60mAs
(f)= E
F
tube voltage [kV]
Voltage characteristics (60 Hz)
at check point G , H
[V]
2~5mAs
6~60mAs
H
6~60mAs
2~5mAs
G
tube voltage [kV]

(2317/1/85c)

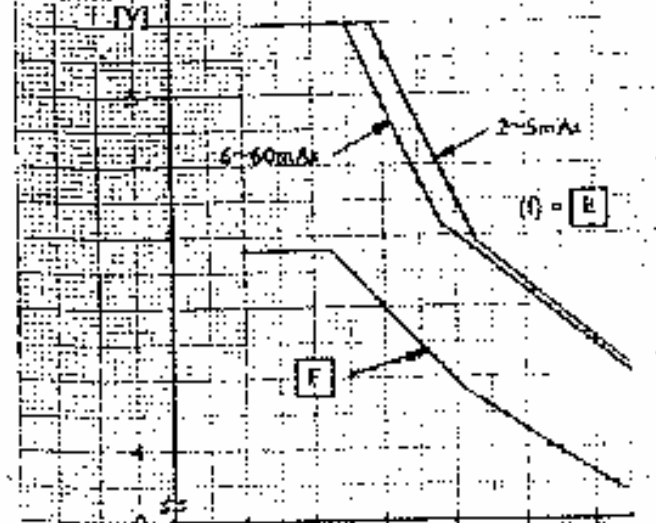
Voltage characteristics (50 Hz)
at check point D (b), (c)



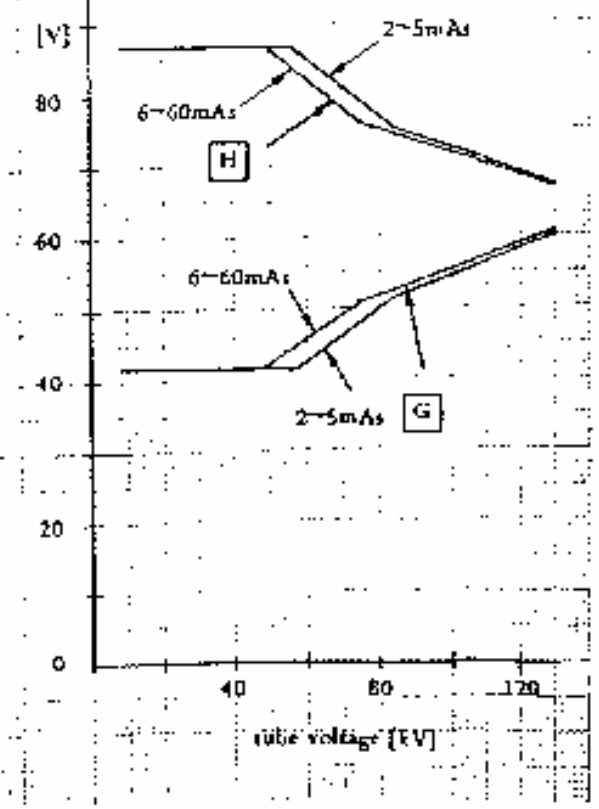
Voltage characteristics (50 Hz)
at check point D (d), (e)

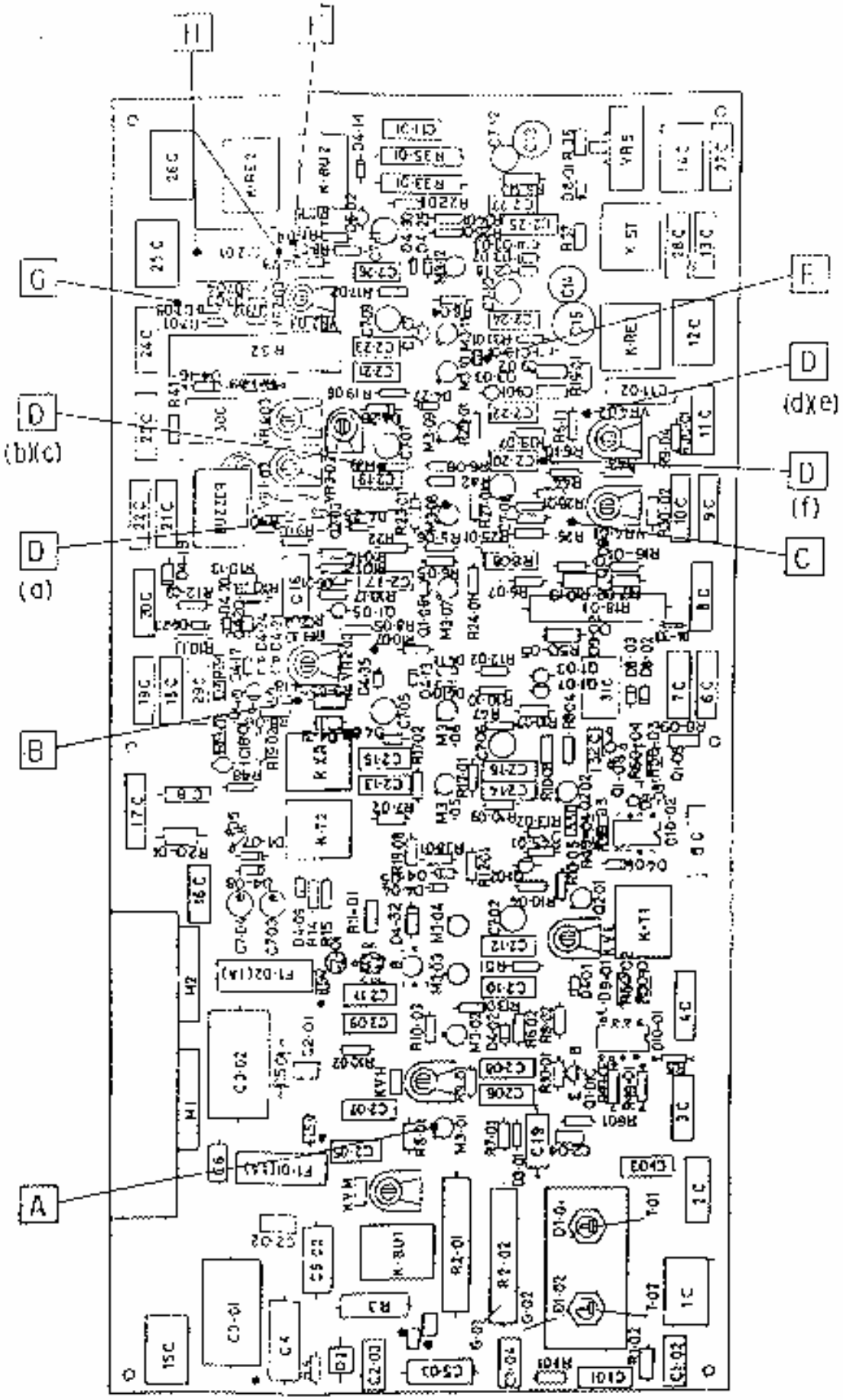


Voltage characteristics (50 Hz)
at check point D (f), E and F



Voltage characteristics (50 Hz)
at check point G , H





kV, mAs control - 20
(501 - 64360)

(2317/2/880)

Installation and Service

CD38S

MOBILE UNIT

SUPPLEMENT SECTION

KEEPING YOUR MANUAL UP TO DATE

At the time of printing, this manual gives accurate details of the equipment it describes. However, changes in components, materials, or other variations in the equipment may introduce minor discrepancies in the content.

In order to keep your book up to date, supplement sheets will be issued containing additional information obtained since the original printing.

This yellow sheet is the index sheet for such supplements and a replacement will always accompany new supplements. Please discard this sheet and insert the new one when adding supplements to the manual.

Such action will ensure your manual is kept up to date.

CONTENTS OF SUPPLEMENT SECTION

PICKER INTERNATIONAL LIMITED

P.O. Box No. 2, East Lane, Wembley,
Middlesex, England HA9 7PR

BULLETIN 1009W
January 1980

D38 MOBILES

GEAR MESHING

In April 1977 a Yellow Notice (No 1001W) was issued on the D38 mobile unit which required engineers to check and, if necessary, adjust the gear meshing on every field unit.

It would now seem that it is necessary to make regular inspections of this gear meshing as fair wear and tear on the bearings may bring the gear out of mesh with the pinion so allowing the carriage to fall.

1. The primary check is simple. Just try to rotate the carriage about the column. No slack is acceptable. The carriage MUST BE TIGHT on the column.

   If no slack is apparent, also examine meshing of gearbox pinion and rack:

   (a) by looking from left side of gearbox. Mesh should appear as shown in diagram overleaf.

   (b) by lifting carriage (90lbs!) and checking clearance. There should be not more than 1/32" vertical movement.

2. If meshing of pinion and rack requires adjustment, the crossarm must be removed before the gearbox screws are loosened.

3. Note that the pinion is slightly wider than the rack. If the apparent overlap is more or less than 1/32", the pinion has moved on its spindle. Reset it by slackening the two grub screws and then retighten screws.

   Provided the above points 1, 2 and 3 are all correct the unit may be considered safe.

4. If any slack is apparent, adjust diabolo bearings as follows:

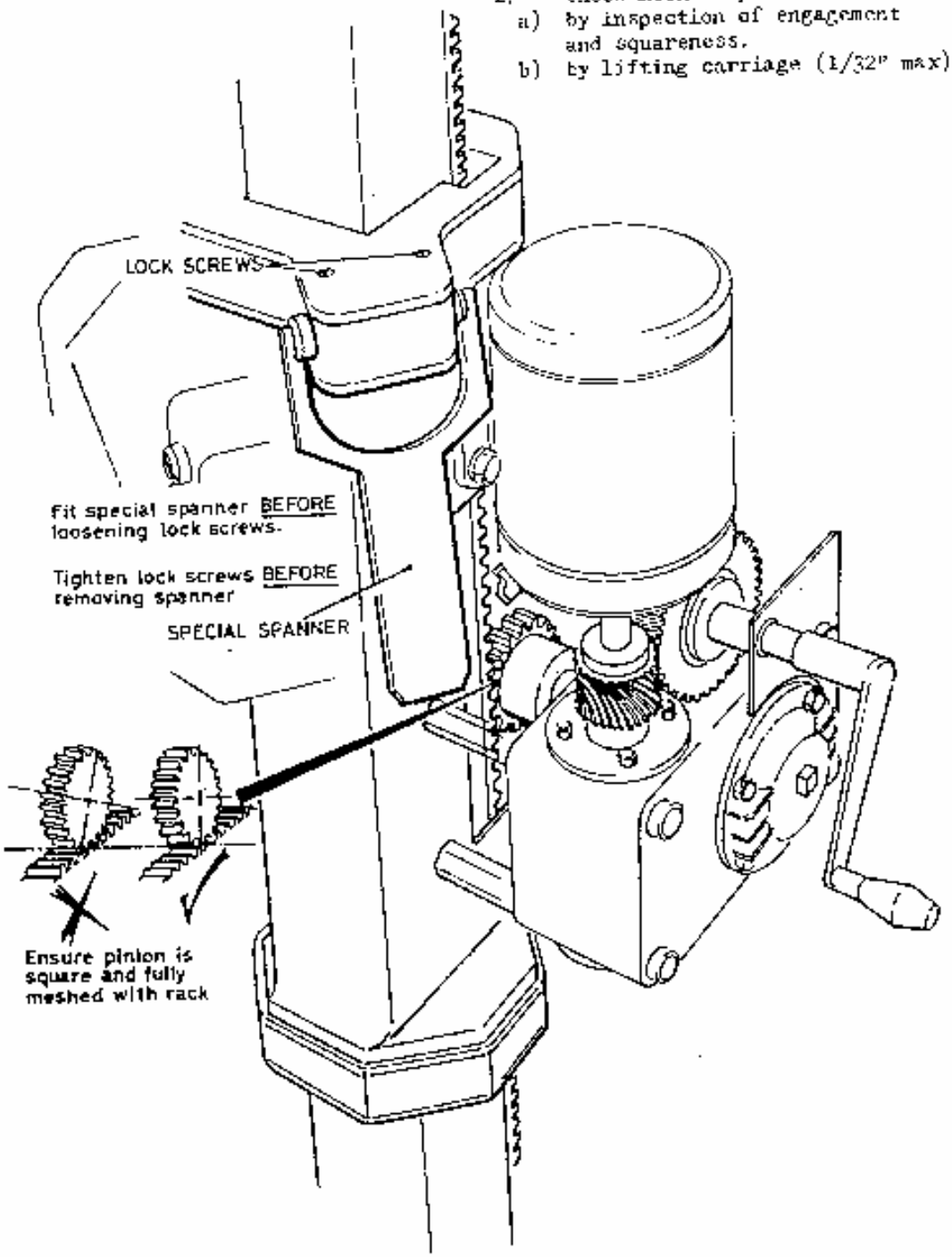
   1. Remove cross arm and tube.
   2. Slacken locking grub screws of top diabolo shaft. (See illustration overleaf).
   3. With special key adjust eccentrics until firm contact is felt between diabolos and column; back off eccentrics slightly to prevent binding. Note that eccentric bushes should project equally out of carriage casting. Tighten grub screws.
   4. Repeat on lower bearing.
   5. Recheck for rotational slackness which should have disappeared. If it cannot be adjusted out, then diabolos should be replaced.

5. Re-examine meshing of gearbox as 1(a) and above.

see overleaf .....

1. Check that carriage casting does not rotate about column. Adjust bearings as shown after removing crossarm.

2. Check mesh of pinion and rack:
   a) by inspection of engagement and squareness.
   b) by lifting carriage (1/32" max)



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Supplement No 2338
(June 1980)

This supplement applies to the following Service manuals:-

D38 Mobile ..... Inst 1682
CD38 Mobile ..... Inst 2154
CD38S Mobile ..... Inst 2346

GEAR MESHING INSPECTION HOLE MODIFICATION

In January of this year a Yellow Notice (Bulletin 1009W) was issued on the D38 Mobile unit which required engineers to make regular checks and, if necessary, adjust the gear meshing on every field unit.

On current D38 (from Serial No GM1132 onwards) and CD38S (from Serial No BE211 onwards) units, an inspection hole has been drilled in the crossarm casting to enable easier inspection of the gear meshing.

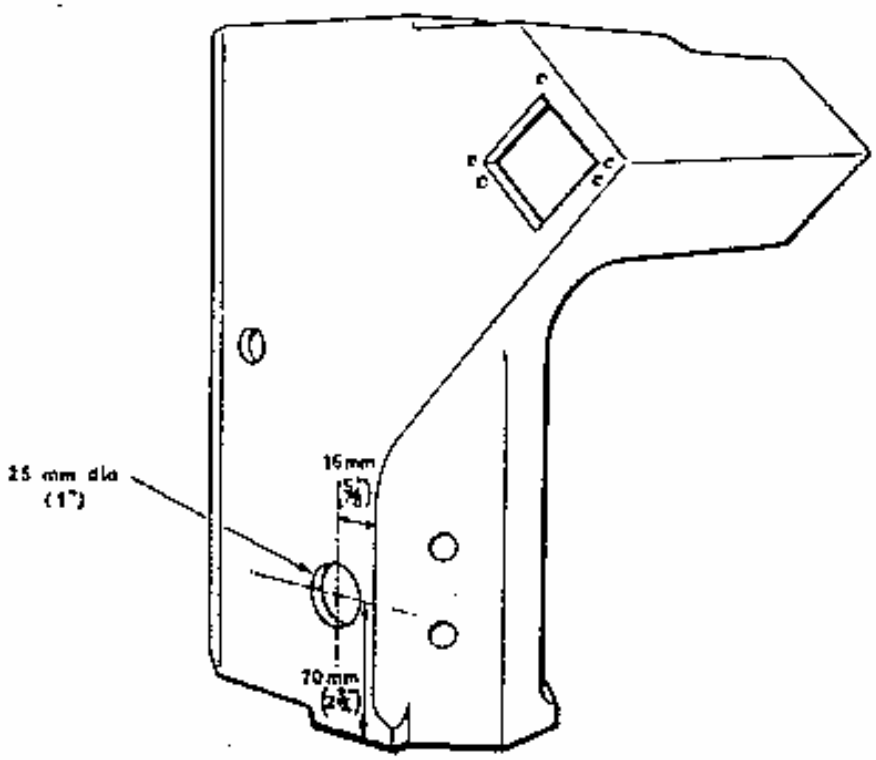
Local arrangements may be made to incorporate this modification into existing D38, CD38 and CD38S units. The location of the hole is shown below.

If the modification is done in the field, the following should be noted:

a) Remove any drilling swarf from inside the casting.

b) Prevent the pilot drill of the cutter from damaging parts within the casting.

c) Obtain a tight-fitting plastic bung from a motor accessory shop.



Insert this supplement in the Supplement Section of the relevant Service manual and refer to it in the Supplement Contents list.

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Supplement No 2356
(November 1980)
to Inst No 2316

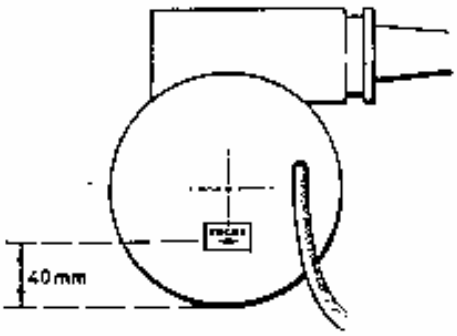
CD38S MOBILE

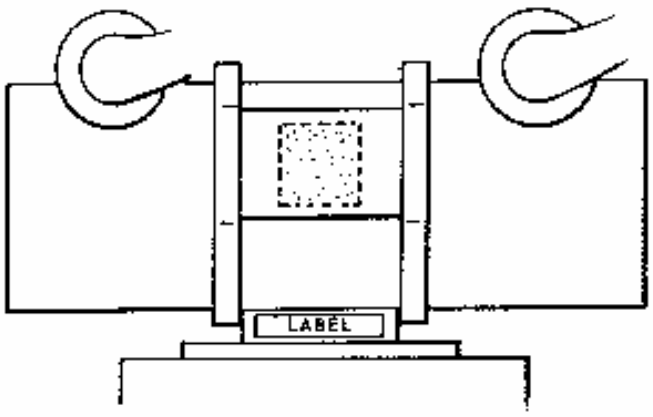
Units prior to Serial Number EE230

Please note that a number of these units were sent out of the factory with the X-ray tube labels obscured.

On the next convenient occasion the label on the output port flange should be moved to the opposite side of the flange and the focal spot label should be moved to an end cap; the locations are shown below.

In future this will be carried out in the factory.





Insert this supplement in the Supplement Section of Instruction No 2316 and refer to it in the Supplement Contents List.

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Supplement No 2358
(November 1980)
to Inst No 2316

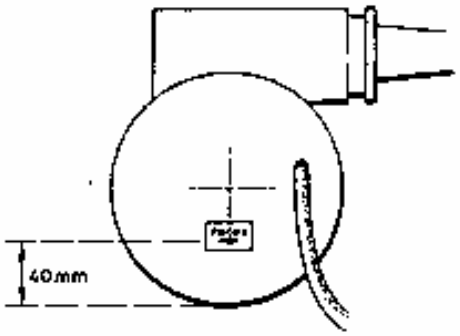
CD38S MOBILE

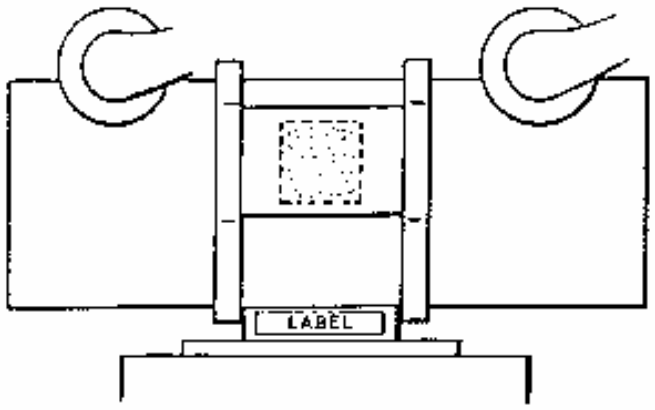
Units prior to Serial Number EE230

Please note that a number of these units were sent out of the factory with the X-ray tube labels obscured.

On the next convenient occasion the label on the output port flange should be moved to the opposite side of the flange and the focal spot label should be moved to an end cap; the locations are shown below.

In future this will be carried out in the factory.





Insert this supplement in the Supplement Section of Instruction No 2316 and refer to it in the Supplement Contents List.

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Supplement No 2373
(June 1981)

This supplement applies to the following Service manuals:-

CD38 (Hitachi)	No 2154
CD38S (Shimadzu)	No 2316
Hitachi Mobile	No 1931

MAINS PLUGS FOR CAPACITOR DISCHARGE MOBILE EQUIPMENT

Please note that RED 13A PLUGS must NOT be fitted to CD Mobile units.

It must be stressed that these units MUST be fitted with a standard 13A fused plug.

Some Hitachi Auto-Condix Mobiles were fitted with a thick mains cable which will not accept a standard 13A fused plug. In these cases the cable should be changed to 1.5mm cable purchased locally.

Insert this supplement in the Supplement Section of the relevant Service Manual and refer to it in the Contents list.

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Tel: 01-904 1288. Telex: 923177. Cables: Pickram, Wembley.

Supplement No 2394
(January 1983)
to Instruction No 2316

CD38S MOBILE

(Units up to Serial Number EE316)

Addition of Fuse to Battery Charger and Motor Drive Circuit.

Background.

On current production units, from Serial Number EE317 onwards, a 1A fuse has been added to that part of the Battery Charger and Motor Drive circuit that is supplied from the batteries; the main motor circuit is still protected by the existing 50A fuse.

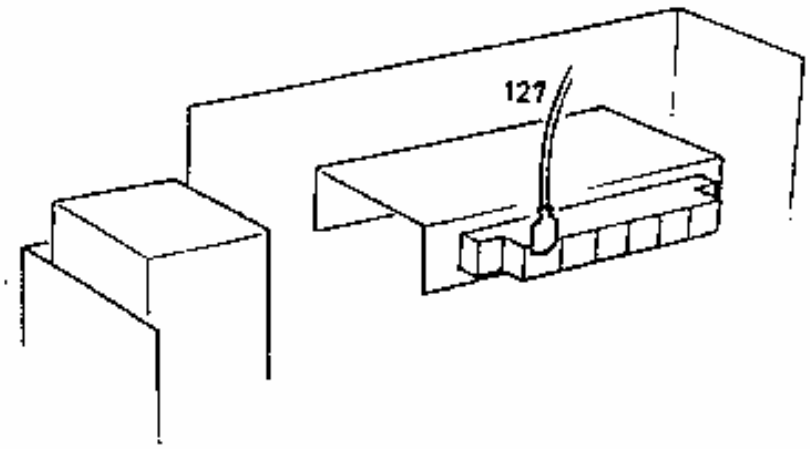
Action.

On the next routine maintenance or service visit, a 1A fuse may be fitted as detailed below.

Procedure.

With reference to CD38S Service manual No 2316, gain access to the faston terminal block on the Battery Charger assembly.

1. Detach wire Ref No 127 (16/0.2, violet) from the battery feed side, via the 50A fuse, Line from brake microswitch to faston terminal block.
2. Cut off faston tag, leaving sufficient wire on tag to re-use on fuseholder.
3. Insert 'In-Line' fuseholder (Stock No 5843-101, Bulgin type F180) in line 127.
4. Fit 1A fuse link, $1\frac{1}{4}$ x $\frac{1}{4}$ dia (Stock No 5841-227).
   Unit draws approximately 125mA on boost.
5. Mark connecting leads to and from the fuseholder with idents '1 AMP'.
6. In Service manual No 2316, discard existing Fig 19 and insert revised circuit (Issue 2) attached.



7. Insert this supplement in the Supplement Section of Instruction No 2316.

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Supplement No 2405
(August 1983)

D37/38, CD38 & CD38S MOBILES

Fitting Tube Column Rotation Stop

This supplement applies to the following Service Manuals:-

D37/38	Instruction No 1682
CD38	Instruction No 2154
CD38S	Instruction No 2316

Background

Current production units have a tube column rotation stop fitted to prevent accidental entanglement of the cables.

Action

Units in the field can be modified using Kit of Parts No 1286-034(6) comprising:-

1	Column clamp	(MB 20285)	1 off
2	Stop	(MB 20287)	1 off
3	Lock screw	(MA 20288)	1 off
4	Circlip	(7457-081)	1 off
5	M6 x 20 screw	(7111-486)	2 off
6	M6 washer	(7325-006)	2 off
7	M5 x 20 screw	(7111-467)	4 off
8	M5 washer	(7325-005)	4 off

Procedure

Refer to illustration overleaf.

1 Remove front cover, discard existing circlip and lock screw.

2 Place stop (item 2) on cover ring, and align with new lock screw (item 3).

3 Spot through; remove stop and drill four holes 5.3 dia in cover ring.

Note ... Prevent swarf from falling on battery, etc.

4 Place stop on ring and secure with four screws and washers (items 7 & 8).

5 Fit circlip (item 4) on new lock screw to retain.

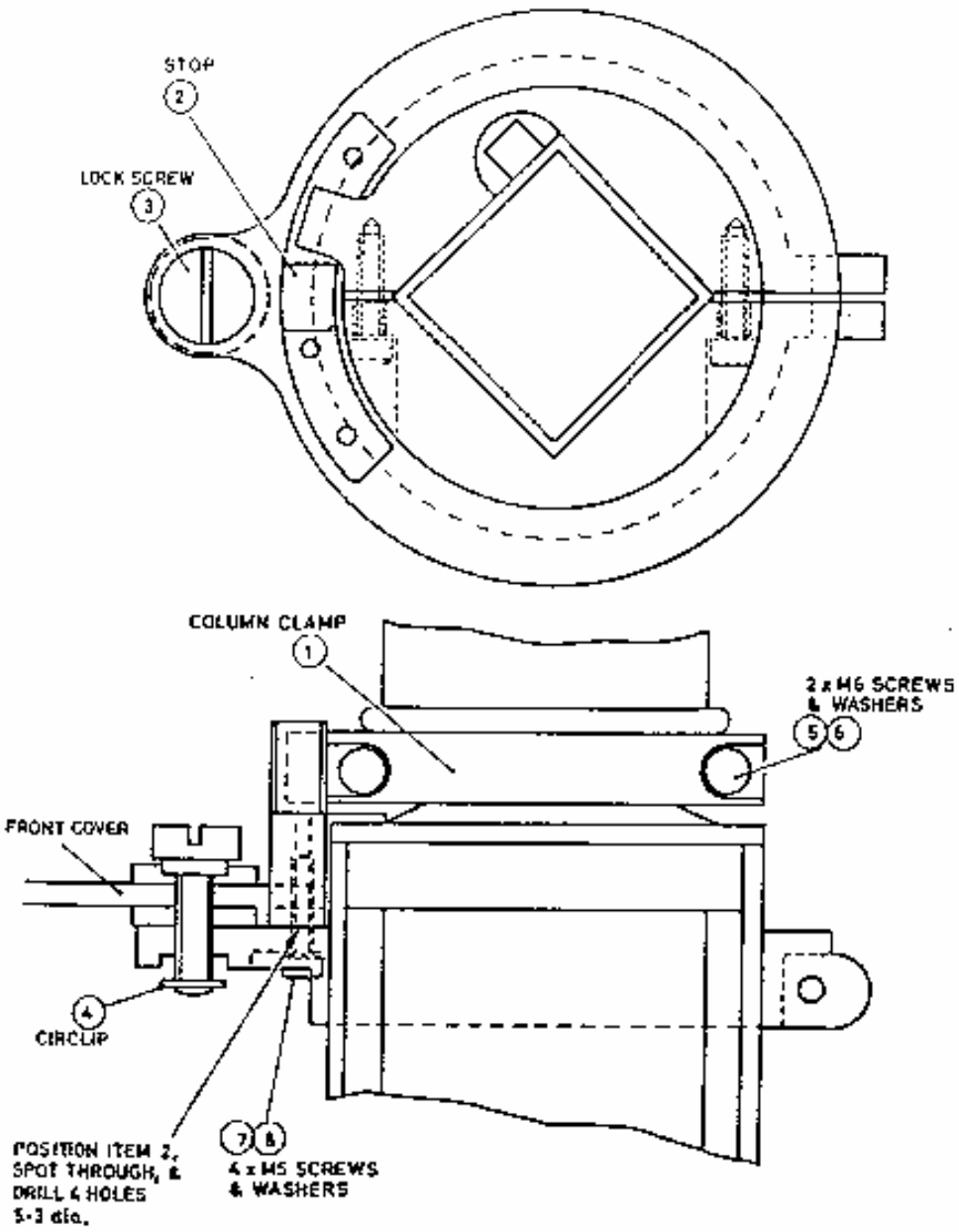
6 Offer up front cover and cut to clear stop. Refit cover.

7 Split column clamp (item 1), place around column and secure in position with two screws and washers (items 5 & 6).

8 Check unit for column movement.

9 Insert this supplement in the Supplement Section of the relevant Service Manual and amend the contents list.

[4615A]


STOP
2
LOCK SCREW
3
COLUMN CLAMP
1
2 x M6 SCREWS
& WASHERS
5 6
FRONT COVER
4
CIRCLIP
7 8
4 x M5 SCREWS
& WASHERS
POSITION ITEM 2,
SPOT THROUGH, &
DRILL 4 HOLES
5·3 dia.

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Tel: 01 [illegible] Telex 923177. Cables: Pickerdom, Wembley.

Supplement No 2446
(February 1983)
to Instruction No 2316

CD38S MOBILE UNITS

Chafing of mains cable

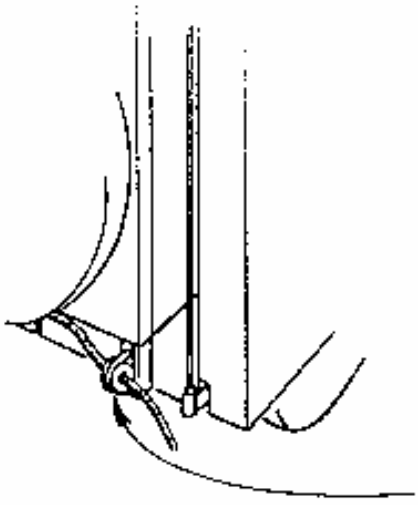
Background

A repeated problem is occurring in the field where the mains cable is being damaged by the fibre fairlead. This affects approximately seventy units (not early units fitted with a pulley type cable guide).

Action

On the next service visit discard the fibre fairlead and replace it with a PTFE fairlead (Stock No 1935-004) using the existing fixings.

Examine the outer insulation of the mains cable for chafing and replace it if necessary.



Discard existing and fit new part

Notify Quality Assurance Department, Wembley of unit serial number, hospital and date modified.

Insert this supplement in the Supplement Section of CD38S Service manual No 2316.

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Supplement No 2478
(September 1983)

CD38S, CD38(H) and D37/38 MOBILE UNITS

Securing Column Gearbox Pinion

This supplement refers to the following service manuals:-

D37/38	Instruction No 1682
CD38(H)	Instruction No 2154
CD38S	Instruction No 2316

Background

Further to previously issued Service Bulletins No 1001W (1977) and No 1009W (1980), it is found that a modification is necessary to secure the column gearbox pinion on the units listed below.

Applicability

This applies to all CD38S units from Serial Number EE313 onwards and any CD38(H) or D37/D38 units which have been factory or field fitted with the grey (self-colour) metric M28 style gearbox and gearbox modification kit (No 1286-677).

Note: For CD38S and CD38(H) units; and D37/38 units fitted with these gearboxes this supplement is to be implemented as soon as possible.

For D37/38 with old style gearboxes, the unit is to be inspected at the next and <u>each</u> service visit, and this supplement actioned if necessary.

Action

Modify units as detailed below using Kit of Parts No 1287-511 comprising:-

M5 x 8 full dog point grub screw	(7117-063)	2 off
4.2mm dia drill bit	(7511-100)	1 off
3.8mm dia drill bit	(7511-095)	1 off
Loctite 221 (phial)	(8743-011)	1 off
Modification record label	(8881-351)	1 off
QA record card		1 off

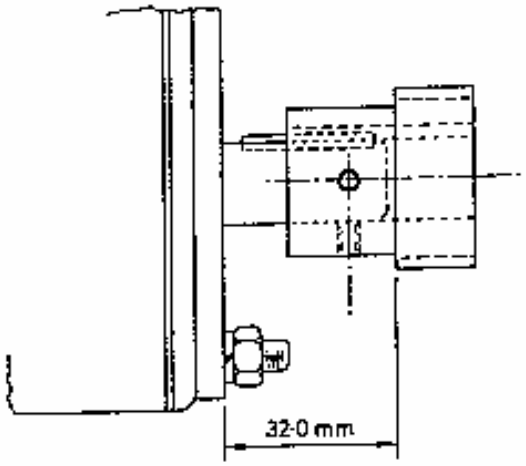
Continued .....

Procedure

1 Examine rack and pinion for correct alignment and meshing.

2 Remove cross-arm from casting assembly. Remove casting assembly from column. Remove gearbox assembly from casting.

3 Ensure pinion is correctly positioned on output shaft.



4 Remove one existing grub screw from pinion, spot shaft using 4.2mm drill supplied. Replace and tighten first grub screw, remove second existing grub screw and repeat process.

5 Remove pinion from shaft and drill two holes 3.8mm x 3mm deep (parallel portion) with drill supplied.

6 Replace pinion on shaft and secure with two new screws and loctite supplied.

7 Refit gearbox ensuring correct alignment with motor via coupling. Check torque setting on gearbox retaining bolts (5-7 lbf/ft).

8 Refit casting assembly on column and ensure engagement of pinion and play is as described in previously issued Service Bulletins 1001W (1977) and 1009W (1980).

9 Fit modification label on base, adjacent to Rating Plate, and strike through No 1.

10 Branches must notify the QA Department at Wembley by completing the QA record card supplied, with the hospital, serial number of unit(s) and date modified.

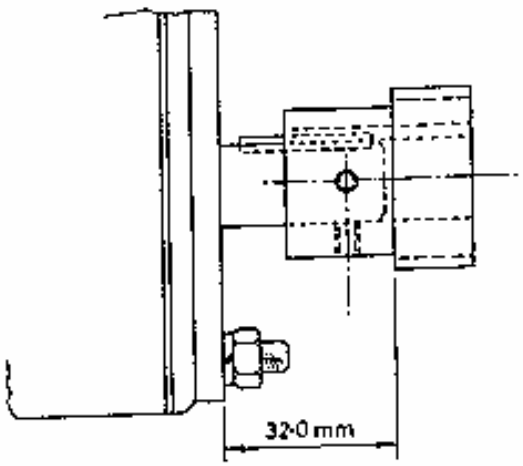
11 Insert this supplement in the Supplement Section of the relevant D37/D38, CD38(H) and CD38S service manual.

Procedure

1 Examine rack and pinion for correct alignment and meshing.

2 Remove cross-arm from casting assembly. Remove casting assembly from column. Remove gearbox assembly from casting.

3 Ensure pinion is correctly positioned on output shaft.



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5 Remove pinion from shaft and drill two holes 3.8mm x 3mm deep (parallel portion) with drill supplied.

6 Replace pinion on shaft and secure with two new screws and loctite supplied.

7 Refit gearbox ensuring correct alignment with motor via coupling. Check torque setting on gearbox retaining bolts (5-7 lbf/ft).

8 Refit casting assembly on column and ensure engagement of pinion and play is as described in previously issued Service Bulletins 1001W (1977) and 1009W (1980).

9 Fit modification label on base, adjacent to Rating Plate, and strike through No 1.

10 Branches must notify the QA Department at Wembley by completing the QA record card supplied, with the hospital, serial number of unit(s) and date modified.

11 Insert this supplement in the Supplement Section of the relevant D37/D38, CD38(H) and CD38S service manual.

(2478/1/983)

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Supplement No 2502
(November 1983)
to Instruction No 2316

CD38 'S' MOBILE - LATEST UNITS

Background

On current production units (Serial numbers EE466 to 488) the mains cable connections to the Cable Drum could be wired incorrectly resulting in an intermittent loss of power.

Also, the HT leads to the tubehead may not be sufficiently tightened.

Action

On the next routine maintenance or service visit, the mains input cable to the cable drum should be inspected as detailed in figure 1.

Procedure

1 Unplug mains lead from supply.

Remove the four screws attaching the Cable Drum assembly to the mobile.

Ensure the mains lead line and neutral are connected as per sketch, and that they have not been wired to the spring securing screws.

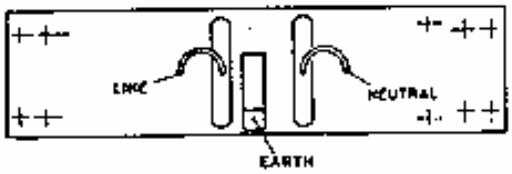

FIGURE 1

If the line and neutral connections are fitted to the spring securing screws, examine the springs to ensure they have tension and are not collapsed. Replace them if necessary (Part No for spring, AX 12969). Rewire line and neutral connections as shown above.

2 Ensure that both HT connectors are tight and locked into position with the adjacent grubscrew, as shown in Figure 2.

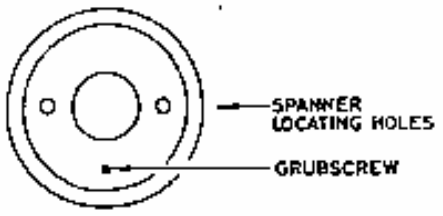

FIGURE 2

3 Insert this supplement in the Supplement Section of Instruction No 2316.

[4998A]

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Supplement No 2505
(January 1984)
to Instruction No 2316

CD38S & CD35S MOBILES

Modification to prevent multiple exposures

Background

A modification is available to ensure that the unit is recharged to the selected kV before prepare is initiated, thus preventing the possibility of an exposure being made at an incorrect kV.

Action

At the customer's request carry out the following modification using Kit of Parts No 1286-680 comprising:

Item	Description	Stock No	No off
1	Ribbon cable	(MC 25202)	1
2	Insulator	(MA 25203)	1
3	RX Relay pcb	(1714-161B)	1
4	M3 x 8 pozi pan head screw	(7121-025)	4
5	M3 washer	(7322-003)	12

Procedure

With reference to Service Manual No 2316:-

Switch off the mains supply and remove plug.

Latch down the discharge plunger.

1 Open the control door and swing out the main pcb panel.

Detach all connectors and remove the kV-mAs Control board.

Note configuration of connectors (see page 62 of Instruction No 2316).

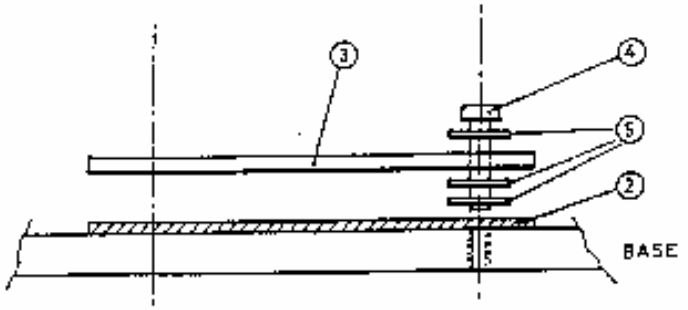
2 Connect ribbon cable (item 1) to the kV-mAs Control pcb as shown.

Replace pcb and connectors.

(5280A) (ECR 1801-393)

3 On the base of the control position the insulator (item 2) as shown, spot holes, drill and tap M3 through the base.

Mount insulator (item 2) and RX Relay pcb (item 3) as shown using fixings supplied (items 4 and 5).



Connect ribbon cable to new pcb.

Complete the reassembly of the unit.

4 Switch on the mains supply.

Release the discharge plunger.

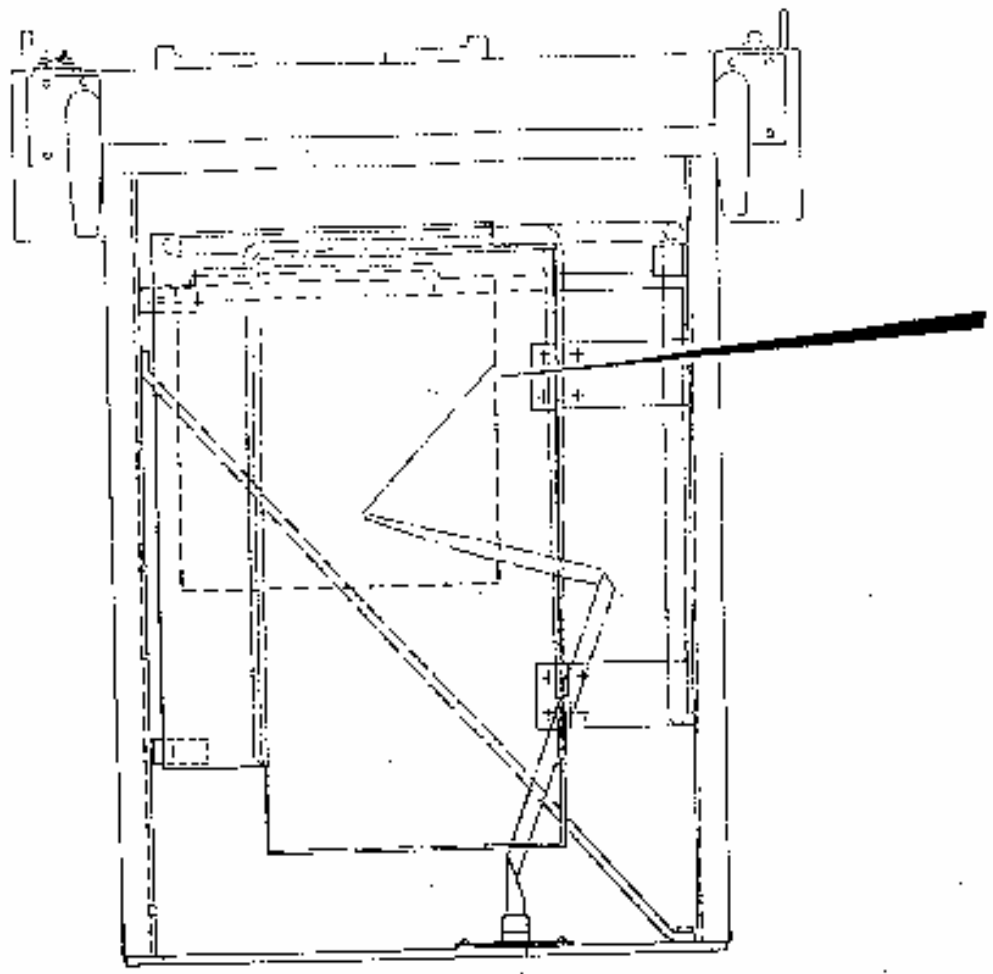
Check that prepare is not possible until the unit is charged to the selected kV and that repeat exposures cannot be made without recharging.

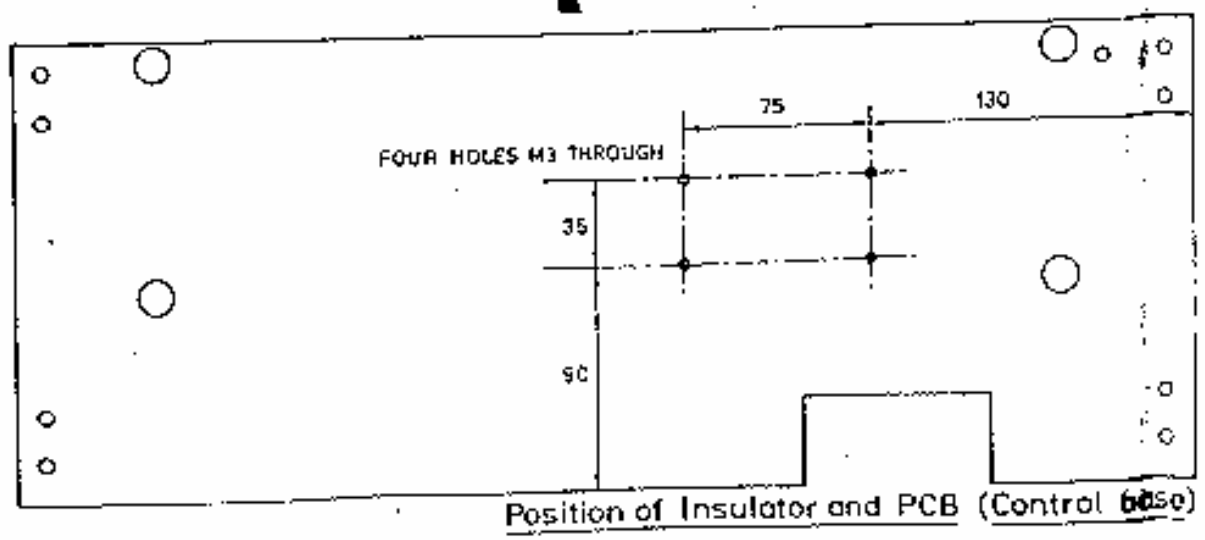
NOTE This applies even if a subsequent exposure is at a lower kV than the remaining charge level.

5 In the CD38S Service manual No 2316 (which is also used for CD35S), carry out the following update:

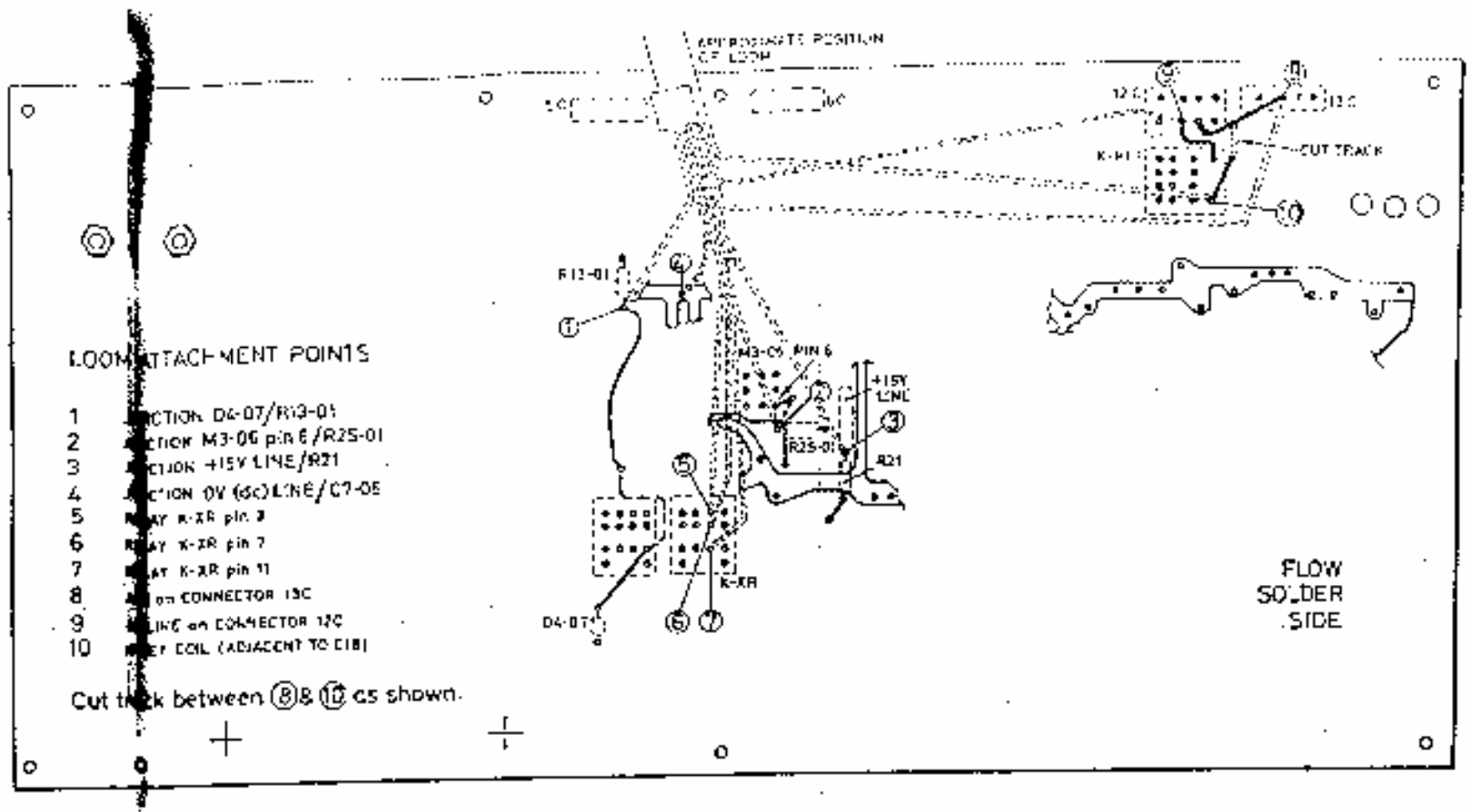
Replace existing figures 15 and 18 with the new circuits attached.

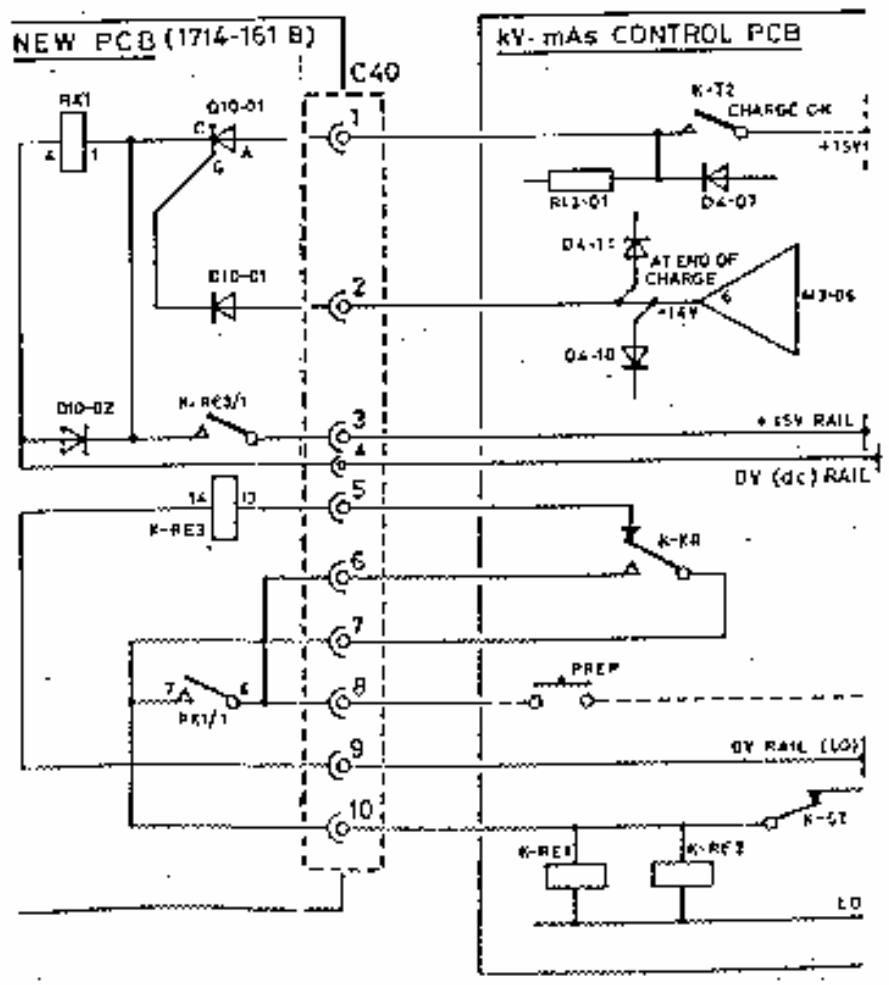
Insert this supplement in the Supplement Section of the manual.





Position of Insulator and PCB (Control base)





(2503/1/184)

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Supplement No 3518
(March 1984)

D38, CD38(H) and CD38S Mobiles

Fitting Additional Relay to Drive Circuit

This Supplement applies to the following service manuals:

D38	1682
CD38H	2154
CD38S	2316

Background

The keyswitch relays fitted to the drive circuits of these units are prone for their contacts to weld together causing the drive switch to become inoperative.

A modification is now available to improve the reliability of the drive circuit.

Action

Fit on failure or demand.

These units can be modified using Kit of Parts No 1286-691 as detailed below.

Procedure

With reference to relevant Service Manual:-

Switch off the mains supply and remove plug.

Latch down the discharge plunger.

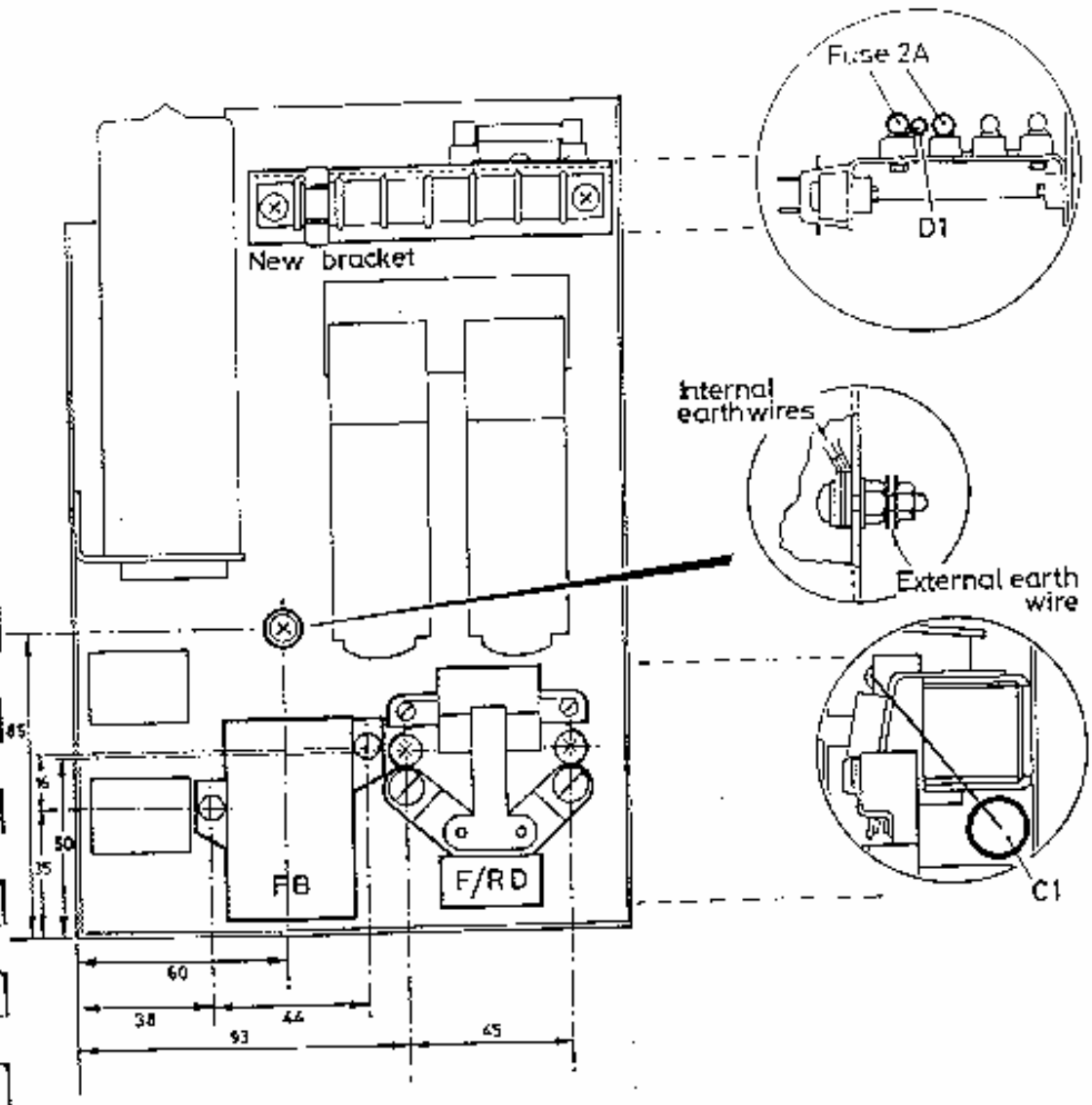
1 Remove battery cover. Remove 50 Amp fuse on battery lead. Disconnect and remove left-hand battery.

WARNING: Disconnect positive earth lead from other battery.

2 Lift black plastic cover to gain access to drive and battery charger assembly. Remove assembly.

Refer to illustration.

3 Remove existing bracket, FB relay and earth stud from assembly.



4 Drill holes 4.5 dia in new positions for FB and F/RD relays and earth stud. (NOTE: Relay FB, previously 4-hole fixing, is now two-hole fixing.)

5 Fit FB and F/RD relays as shown, fit new bracket (MS 25170). Replace two-way fuse holders with four-way and attach earth stud in new position.

6 Reconnect FB relay fuses etc.

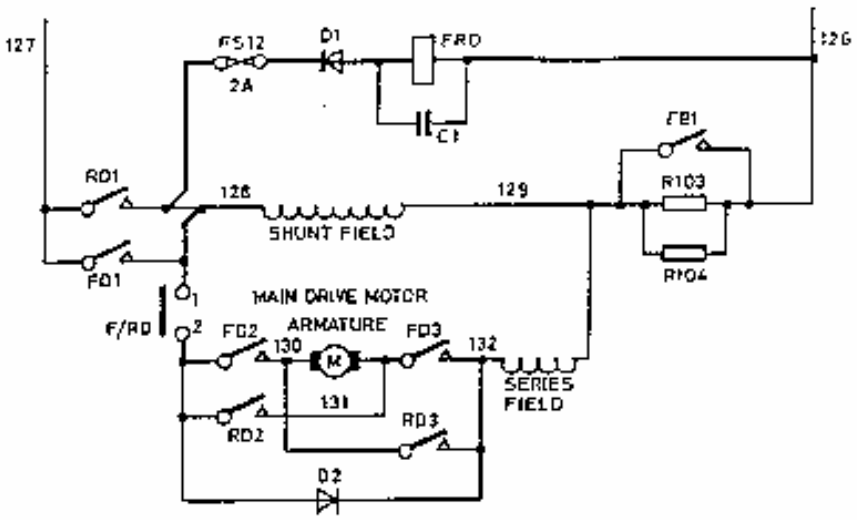
Connect F/RD relay, C1 and D1 as per new circuit.

7 Reassemble.

Release the discharge plunger.

Switch on and test the unit.

8 In the D38 manual No 1682, mark up circuit diagram DX 2962 thus:-



9 In CD36S manual No 2316, replace existing Figure 19 with the new circuit attached.

10 In CD38(H) manual No 2154, add a note to existing Mobile Base and Carriage Drive Circuit Diagram page 28 as follows: "Modification to Drive Circuit - refer to Supplement No 2518".

Insert this supplement in the Supplement Section of the relevant service manual.

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Supplement No 2521
(March 1984)

CD38S : CD38H : D38

Incorrect Assembly of Friction Device

This Supplement applies to the following service manuals:

D38	1682
CD38H	2154
CD38S	2316

Background

An incident occurred recently in which the tubehead became insecure because the three screws securing the dished washers of the friction device had sheared, leaving the tubehead free to rotate and free to be pulled off the crossarm. This was because the three dished washers were assembled in the wrong order.

A number of service visits had been made to the unit and in attempts to achieve correct friction, the screws had been overtightened. This led ultimately to the failure of the three screws.

Answers to the questionnaire circulated to all branches revealed that several units suffer the problem of insufficient friction to hold the tube in the required position.

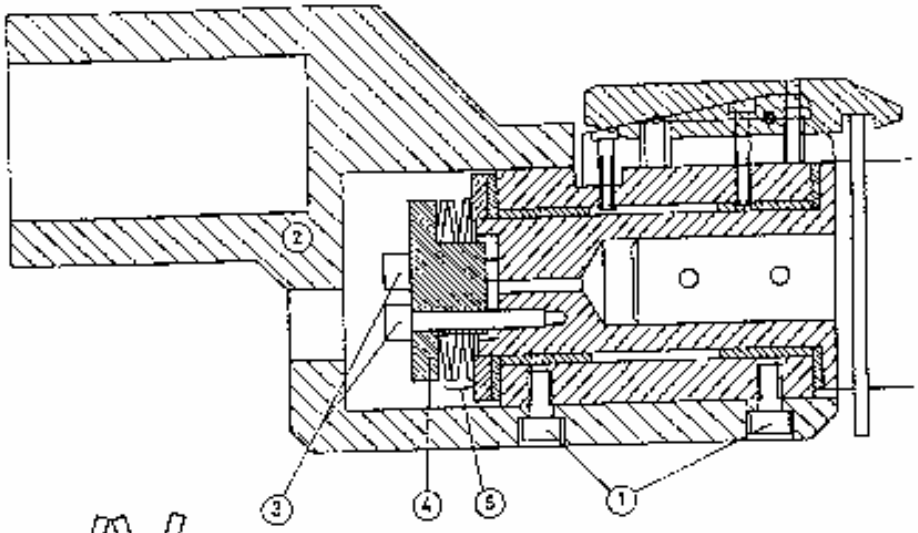
Action

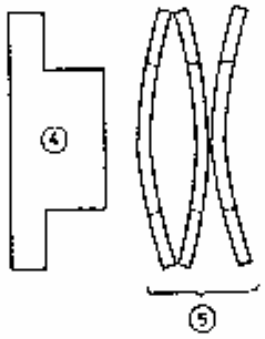
ALL UNITS WHICH HAVE AT ANY TIME REQUIRED TIGHTENING OF THE THREE FRICTION SCREWS MUST BE CHECKED AS FOLLOWS:-

Continued overleaf ...

Safety Check

Remove the six screws marked (1) on the drawing and remove tubehead complete with clutch housing marked (2). This will reveal, on the end of the crossarm, three socket head screws (3) securing the tensioning block (4). Behind the tensioning block will be seen three dished washers (5).





Check that these dished washers are assembled in the order shown. If they are at variance with the drawing, they must be removed by undoing the three socket head screws, then re-assembled in the correct order. If the dished washers do have to be altered then the three socket head screws MUST be replaced, as they will have been over-stressed previously. Replace with Socket Head Cap Screws M4 x 30 Steel (Picker part No 7111-450).

When this assembly is correct, the three socket screws should be adjusted to give 1.04 Kg/m (90 lbf/in) torque, which will hold the tubehead in any position in which it is placed.

On completion, please fill in the details on the attached form and return it to QA Dept, Wembley.

(2521/J/384)

CD38S CD38H D38

Equipment CD38S CD38H D38 *

Hospital .....

Serial No .....

Were Friction Discs correct on arrival? YES/NO *

Engineer ..... Date .....

* Delete as applicable

CD38S CD38H D38

Equipment CD38S CD38H D38 *

Hospital .....

Serial No .....

Were Friction Discs correct on arrival? YES/NO *

Engineer ..... Date .....

* Delete as applicable

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Supplement No 2522
(March 1984)
to Instruction No 2316

CD38S MOBILE

Serial Nos 50466 - 500

Modification to improve operation of column rotation stop and gearbox mounting

Background

Some of the above listed units were fitted with an internal steel column rotation stop. However, field reports suggest that this causes excessive shock at the limit of rotation, and may result in temporary disengagement of the gearbox rack mechanism.

Action

Fit on failure.

After routine inspection, units affected should be modified using Kit of Parts No 1286-692 as detailed below:

Procedure

With reference to Service Manual No 2316:-

Switch off mains supply and remove plug. Latch down the discharge plunger.

1 Disconnect HT cables and remove X-ray tube from crossarm.

2 Disconnect and remove batteries.

3 Gain access to column base.

4 Remove hex head bolt securing column to base, remove column.

5 Remove internal 'fixed' stop from column mounting socket.

6 Replace with new rubber stop (MA 25281) and spacers (MA 25282) using existing screws.

7 Remove cover from column casting assembly, remove bolt at unsupported corner of gearbox. Discard the nut, but retain the spring washer.

Use the bolt to fit new spacing block (MA 25280) to gearbox.

8 Position block as shown overleaf and spot through using 6mm drill.

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Supplement No 2526
(April 1984)
to Instruction No 2316

CD38S Mobile

Tube End HT Cable Security

Background

Previously issued supplement No 2502 dated November 1983 briefly advises ensuring that the HT Cable connectors are tight on CD38S units No EE466 to EE488. However, recent field checks of about a dozen units outside the serial numbers cited revealed that the anode and cathode HT Cable securing rings had not been screwed down to their fullest extent before being locked in position with the grub screw. In all instances with the screw slackened, the locking rings could be further tightened - anything up to two complete turns. In other instances the grub screw itself was found to be loose.

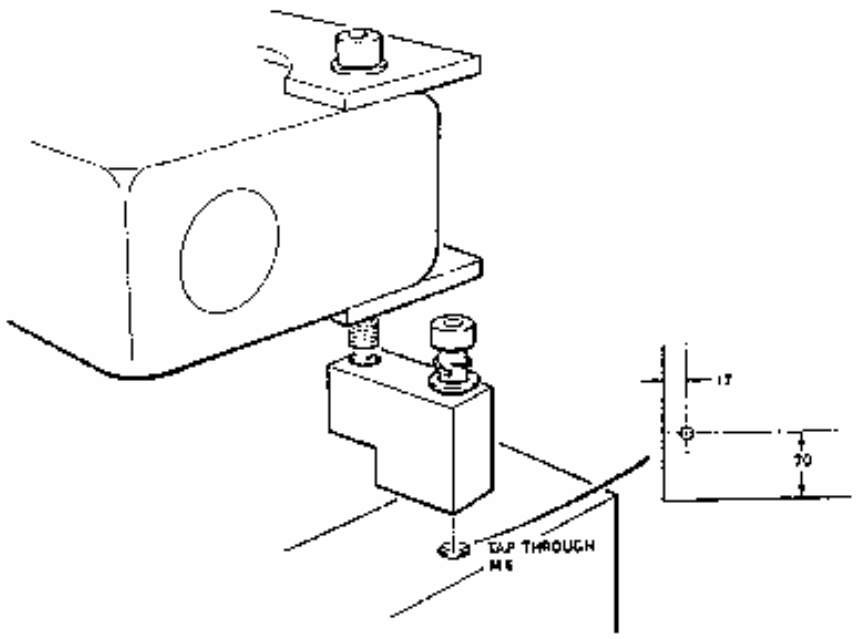
Action

Revised factory procedures for fitting the HT Cables should eliminate the problem for the future. Nonetheless, in view of the recent findings we re-emphasise the vital importance of checking initially that with the grub screw loosened the HT Cable termination retaining rings are fully tightened, and that they are locked in position by means of the grub screw.

This applies to ALL CD38S units, and must be carried out at every inspection visit.

A copy of Supplement 2377, instructions for installing HT Cables, is attached for reference.

Insert this supplement in the Supplement Section of Instruction No 2316.



9 Remove gearbox, drill and tap M6. Be careful of swarf.

10 Secure spacing block with M6 x 30 skt cap head screw (7111-488) with spring washer (removed in paragraph 6).

11 Complete reassembly. Test to ensure smooth operation.

Insert this supplement in the supplement section of CD38S manual No 2316.

(2522/1/384)

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[illegible]

Supplement No 2377
(June 1981)

INSTRUCTIONS FOR INSTALLING HT CABLES

(Reproduced from Specification No M302)

ALWAYS DISCHARGE AN HT CABLE BEFORE HANDLING IT

The object of this procedure is to exclude air from the space between the HT Cable end and its socket, particularly in the region of the current carrying pins. If any air is left, a corona discharge will occur, and this will eventually cause insulation failure.

This instruction calls for the space to be filled with transformer oil at the HT Transformer end and with grease at the X-ray tube end. Because many tubes get quite warm in service, there is a problem in retaining the grease and in keeping it in good condition; this is the reason for fitting the sealing gasket, which should also be fitted at the HT Transformer end to prevent evaporation of the oil.

HT Transformer Cable End

1. Inspect the current carrying pins and the locking threads for damage and correct engagement. If necessary, open the gap in the pins with a thin bladed penknife.

2. Thoroughly clean the cable end and socket with lint-free cloth or paper. Ensure that a sealing gasket is fitted to the insulator (see fig). Do not touch with hands after cleaning.

3. Fill the cable sockets with clean transformer oil to a depth of 12mm. This can be done with a disposable syringe - just over 10ml of oil is required for a 75kV cable.

4. Note the positions of the key and keyway.
Fit the cable end into the socket slowly. Push it in as far as possible and screw down the retaining nut by hand - do not use a tool.

5. Mop up any surplus oil that has overflowed onto the transformer top.

6. After 10/15 minutes, recheck the tightness of the cable retaining nut.

7. Old bitumen filled cables must not be immersed in oil. If the HT transformer cables are greased, check before filling the sockets with oil. If the cable ends are bitumen filled, use grease as for the X-ray tube end.

X-ray Tube End

1.)
2.) as 1 and 2 above

3. Apply a thin coat of special grease (see parts list) over the whole area of the insulator. Then build up a cone of grease about 15mm high at the pin end of the insulator. Apply a small amount of grease to the thread of the retaining nut (see fig).

   Do not apply grease with your finger. Use a clean, dry spatula or the end of the plastic tube.

   Do not use medical vaseline or other types of grease. Use only the specified grease.

Note the positions of the key and keyway.

Fit the cable end into the socket slowly to permit excess grease to ooze out. Screw down the retaining nut firmly by hand – do not use a tool.

If there is difficulty in pushing the cable end sufficiently far into the socket to engage the thread of the nut, it may be found helpful to slide back the cable support so that the nut pushes on the earth flare of the cable end. Once the cable end has been pushed into the socket, the nut must be removed and the cable support repositioned before finally tightening the nut.

5. Wipe away any surplus grease outside the connector.

6. After 10/15 minutes, recheck the tightness of the cable retaining nut.

NOTES ON HT CABLE CONNECTIONS

1. Cable nuts should be tightened by hand at quarterly inspections before the mA is checked.

2. In installations where X-ray tubes are known to run hot (ie are heavily loaded) HT cable connections should be remade four times per year.

3. Depending on usage, all HT cable connections should be remade every six months maximum at the tube end. The HT transformer end should be inspected and topped up every year.

4. Always recheck mA setting after remaking HT cable connections.

5. Some Hitachi cable ends have been oil filled at the X-ray tube end. When these joints are re-made, HT grease should be used instead of oil, as instructed above.

6. After disconnecting a cable end (eg for kV measurements), the end must be regreased in accordance with the above procedure.

PARTS LIST

Part No	Description	
8768-901	HT Cable Grease, 50ml tube.	
MA 9877	Gasket, 75kV insulator	(Machlett P7158)
6247-960	Gasket, 55kV insulator	(Machlett A2946)

75kV CABLE END