GEC Medical Equipment Limited
P O Box 2 East Lane Wembley
Middlesex HA9 7PR England

Instruction No 2277
(Issue 2)
September 1980

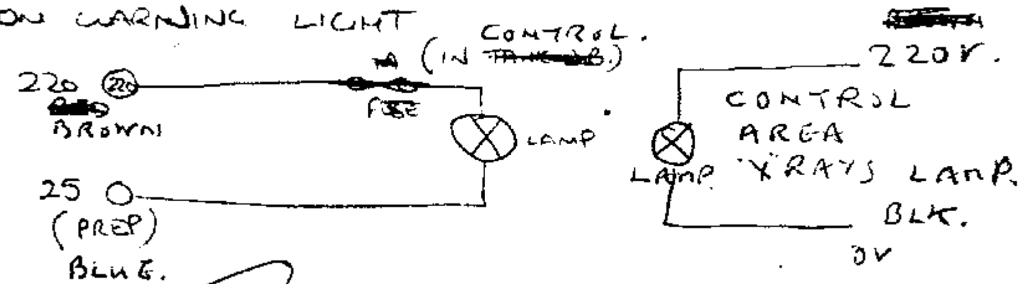
POSTION. 4 USED ONLY

TO SCREEN LINK 24 TO 34 VIA PUSH BUTTON AND
LINK 147 TO 149

26 AND 30 LINKED TO GIVE EXPOSURE (NO BUCKY)

STATOR 9, 7B AND 8B.

ROOM WARNING LIGHT



ROENTGEN 500

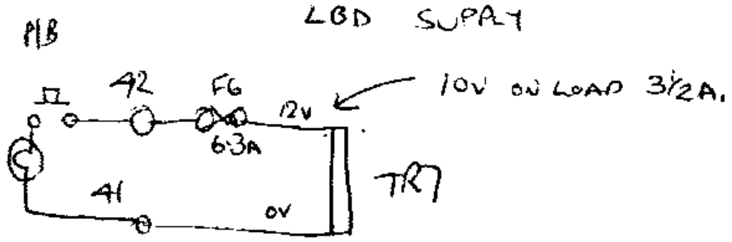
INSTALLATION INSTRUCTIONS

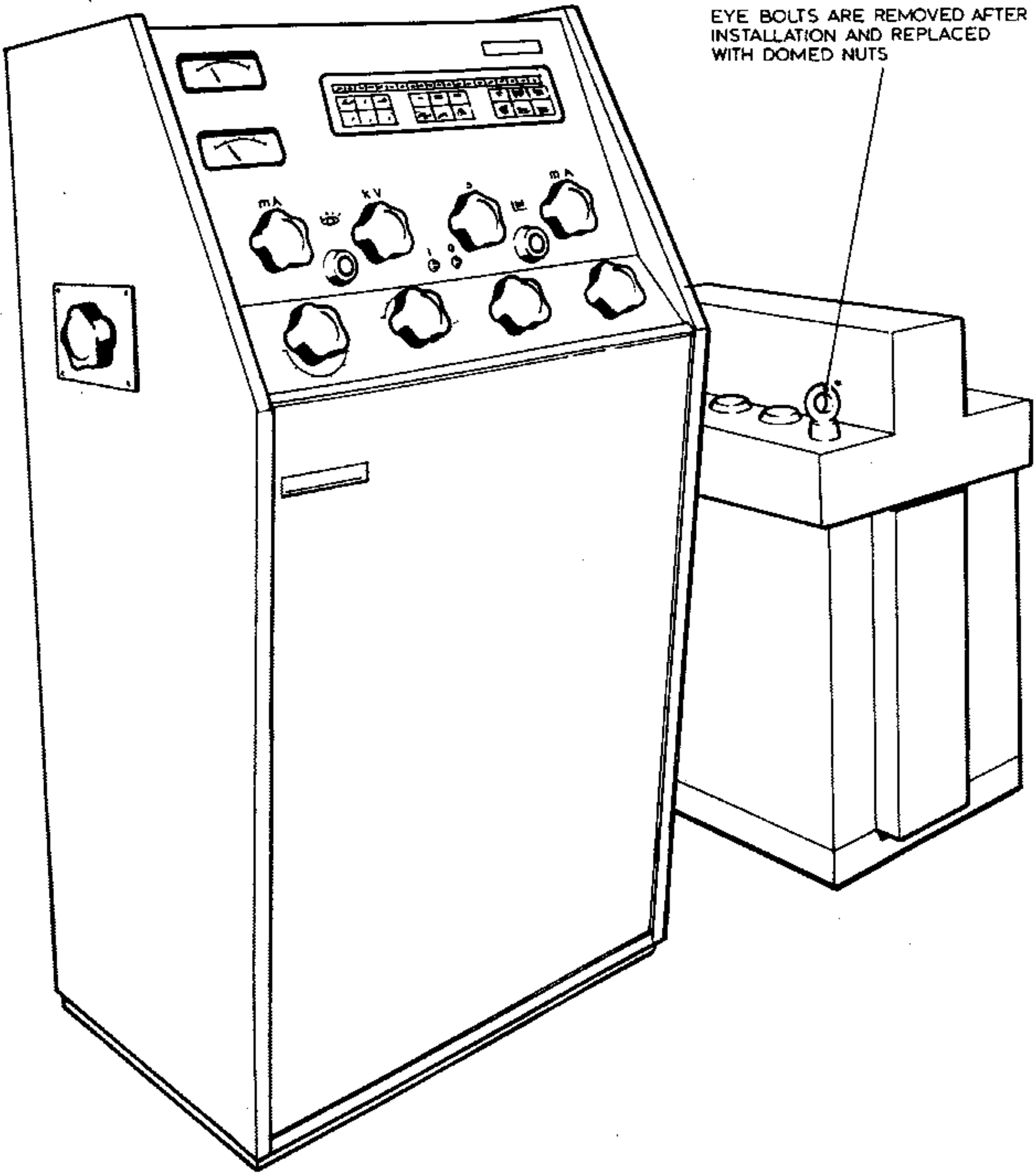
AND SERVICE NOTES

Instruction No 2277

17 - 37 THERMAL O'LOAD TRIP.

LBD SUPPLY





R500 Control Console and HT Transformer

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 the 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.

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CONTENTS (Continued)

Supplement Section

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.

ILLUSTRATIONS

ILLUSTRATIONS (Continued)

GENERAL REQUIREMENTS

PRE-INSTALLATION INSTRUCTIONS

The following instructions are to be read in conjunction with the layout drawing prepared by GEC Medical Equipment Ltd.

GENERAL ELECTRICAL REQUIREMENTS

All electrical wiring, interconnection etc. must be strictly in accordance with the recommendations contained in 'The regulations for the Electrical Equipment of Buildings' published by the Institute of Electrical Engineers or other appropriate National Wiring Regulations. Special care must be taken to ensure that all conduits are properly bonded and connected to earth.

All metal parts of tables, tubestands, tracks, etc., must be securely earthed at the points indicated in the Pre-installation Schedules and layout drawings, then returned to the Main Earth Point at the Mainswitch in the X-ray room. A stranded conductor of suitable cross sectional area may be used or alternatively a copper strip of not less than 16mm x 2.5mm. A tail of 0.5 metres should be left for connection by the Installation Engineer. The resistance between any earthed metal part and the Main Earth Point must not exceed 0.1ohm as specified by paragraph 7 of DHSS General Technical Clauses 1973. All leads must be enclosed in steel conduit or trunking.

Normally all connections to terminals will be made by GEC Medical Equipment Engineers.

CSA mm	Metric Sizes		Imperial Sizes		Amp Rating
	Stranded	Flexible	Stranded	Flexible	
1.0 1.25 1.5	3/.74 nominal	32/0.20 30/0.25	 3/.029 	40/.0076 	10 10 15
2.0 3.0			3/.036 7/.029	70/.0076 110/.0076	15 20
2.5 4.0	 7/0.85	50/0.25 56/0.30			20 25
4.5 5.3			7/036 	162/.0076 105/.010	25 30
6.0 6.8	7/1.04 		 7/.044		30 36
10.0 15.0	7/1.35 7/1.70		7/052 7/.064		42 53
20.0 25.0 35.0	 7/2.14 19/1.53		19/.044 19/.052 		62 73 90
40.0 50.0	 19/1.78		19/.064 		97 145
65.0 70.0	 19/2.14		19/.083 		160 185

The metric sizes quoted are nominal, some variations are made by Suppliers.

NOTE: Solid conductors are **NOT** suitable. Stranded or Flexible cables **MUST** be used.

GENERAL STRUCTURAL REQUIREMENTS

Each installation must be investigated by an Architect or Surveyor to determine the size of girders and other bearers required to support the weight of equipments installed.

PREPARATION OF CEILING

Ceiling tracks can be fixed directly to the ceiling but, normally, a board is required which must be of hardwood not less than 40mm thick. For width, length and positions, refer to layout drawing. Ceiling boards must be level and capable of supporting the moving load stated in the relative pre-installation instruction and must be firmly bolted to the ceiling or other fixings. Access to the upper side of the board should be possible for the Installation Engineer to bolt the tracks in position.

CEILING MOUNTED TUBE SUPPORTS

The lateral movement of ceiling tracks must not be greater than 3mm; if necessary fit cross-members between girders or use some other method to prevent excessive lateral movement.

FLOOR TO CEILING MOUNTED TUBE SUPPORTS - MOBILE

The ceiling board and floor track must be plumb level to within a tolerance of 3mm in the position shown on the layout drawing.

FLOOR TO CEILING/WALL MOUNTED TUBE SUPPORTS & BUCKY STANDS

Provide and fit a hardwood fixing board to the ceiling or wall. The board should be a minimum size of 230mm x 230mm x 40mm. Fixings for the board must not coincide with the fixings on the extension tube plate or ceiling tracks. For the maximum loading on the extension tube plate fixings, refer to the pre-installation instructions.

CEILING SUPPORT FOR HT CABLES

A ceiling board 50mm wide is normally required to support the Capitol Track and fittings. together with the HT cables. For length and position refer to the layout drawing.

PREPARATION OF FLOOR

A level floor surface must be provided for all equipments. No part of the floor area concerned may be more than 3mm from the nominal floor level. The areas over which the equipments are to be fixed must be checked with the aid of a Straight Edge, and any high spots removed until the areas are within tolerance. If the floor cannot be improved or is too weak, bearers of the type as shown in the pre-installation Instruction should be let into the floor. The upper surface of the bearers must be level in all directions and the bearing surface must not be lower than the highest point of the adjacent floor.

In rooms where a new concrete or composition floor is being laid, built in bearers may be considered.

FLOOR TRACKS

When a flush floor track is to be used a suitable channel must be made in the floor, or a channelled bearer provided. (See pre-installation schedules.)

1 SPECIFICATION

1.1 Output

33kW (IEC Rating)	2 peak waveform
Max.mA — 500mA at 90kV	with silicon
Max.kV — 300mA at 125kV	rectifiers.

1.2 Power Supply

Nominal 415, 380 and 220 volt, single phase, 50Hz.
Units for 60Hz supplies available to special order.

Line to line resistance not to exceed 0.3ohm at 380 volts (0.33ohm at 415V, 0.15ohm at 220 volts. Note reduced output performance with 220V power supplies).

1.3 Mains Voltage Compensation

Manual adjustment as follows:

Nominal 220V	(180 — 268)
Nominal 380V	(340 — 428)
Nominal 415V	(375 — 463)

1.4 kV Range

Radiography: Fine and Coarse kilovoltage controls with adjustment between 25—125kV increments of approximately 1.8kV steps.

Fluoroscopy: 60—110kV continuously adjustable.

1.5 mA Range

Broad Focus:	300, 400, 500mA
Fine Focus:	50, 100, 200mA
Fluoroscopy:	0.5 — 5mA continuously adjustable.

1.6 Timer Range

Radiography:	0.01 — 5 seconds. 24 position rotary switch selector.
Fluoroscopy:	0 — 10 minutes with buzzer and exposure termination at zero.

1.7 Repetition Rate

Up to 2 exposures per second.

1.8 X-ray Tubes

Provision to connect 4 double-focus X-ray tubes. Automatic overload protection for a total of 4 different foci.

1.9 Displays

Kilovoltmeter for direct indication of kV selected for radiography and fluoroscopy.

mA meter, with dual scale 0 —10, 0 —1000mA (and correct line-compensator setting).

Illuminated display panel indicating the following factors:

Preset radiographic exposure time
Preselected radiographic mA
X-rays ON
Overload condition
Tube and focal-spot chosen

1.10 Interfacing

Facilities are provided for direct connection to the following GEC Equipments.

A X-ray tables and Chest Bucky Stands (modification required for standard sectograph)

B Apollo Ceiling Mounted Tube Stand

C K9 series of Image Intensification and TV Systems

D GECOMAT 2.

E HS150 Frequency Converter

Installation of associated equipment and accessories not listed above should not be attempted without prior consultation with GEC Medical Equipment Ltd. Wembley.

2 PRELIMINARY INSTALLATION WORK

2.1 Checking Pre-Installation Work

Ensure that the required pre-installation work has been completed in accordance with the pre-installations schedules and layout drawings provided.

3 INVENTORY

Two versions of the equipment can be supplied as listed in 3.1 and 3.2 below.

3.1 Kit A

For multi-interface installations.

BOX 1 Containing R500 Control Console.

BOX 2 Containing R500 H.T. Transformer

BOX 3 Containing the following items:-

1 off Wall Junction Box prewired to 2 flexible wiring conduits for connection to the Control Console

1 off Wall Junction Box identical to the above for connection to the HT Transformer

1 off flexible wiring conduit to connect the Wall Junction Box to the HT Transformer

3.2 Kit B

For economy installations requiring minimum interface.

BOX 1 Containing R500 Control Console

BOX 2 Containing R500 HT Transformer

BOX 3 Containing 10 metres of Multi-core cable for interconnecting the Control Console and HT Transformer.

3.3 Kit Supplied with DHSS Orders

DHSS installations will be supplied with an additional kit Stock No.M12116 containing the following items:

4 off	Exposure Counters	X610—905
25 off	Terminals Crimp Spade 4 BA	G233—201
6 off	Potentiometers Multi-turn 100K (for use on kW/time Overload Board if required)	X210—973
1 off	Wall Box containing: Tube selected lights and Auxiliaries Panel Room lights transformer	MC 12125

4 INSTALLATION

4.1 Preliminaries

Ensure that the required pre-installation work has been completed in accordance with the pre-installations schedules and layout drawings provided.

4.2 HT Transformer – Oil Level

Undo two screws at each end to remove the top cover of the HT Transformer. Remove the oil-filler cover from the HT Transformer. (Complete the following as soon as possible to prevent contamination of the oil.) Check that the oil level is between 25mm (1 in) and 38mm (1½ in) from the cover of the HT generator. Use a clean implement such as a screwdriver as a dipstick; allow for expansion of the oil. The levels given are for normal ambient temperatures. If the oil level is low, proceed as described below for export units.

Export units may have 5 gallons (nearly 23 litres) of the oil despatched separately in a can. Transfer this oil to the HT Transformer as follows:

Use a funnel with a fine gauze filter. Add the oil slowly, directing it so that the minimum number of air bubbles are formed.

Re-fit the cover. DO NOT use the HT Transformer for at least 12 hours to allow air bubbles to escape from the oil.

DIALA grade B Shell or equivalent oil must be used.

NOTE: The Vent screw in oil filler is in position during transit, but should be removed when in use. See Fig 1, page 8.

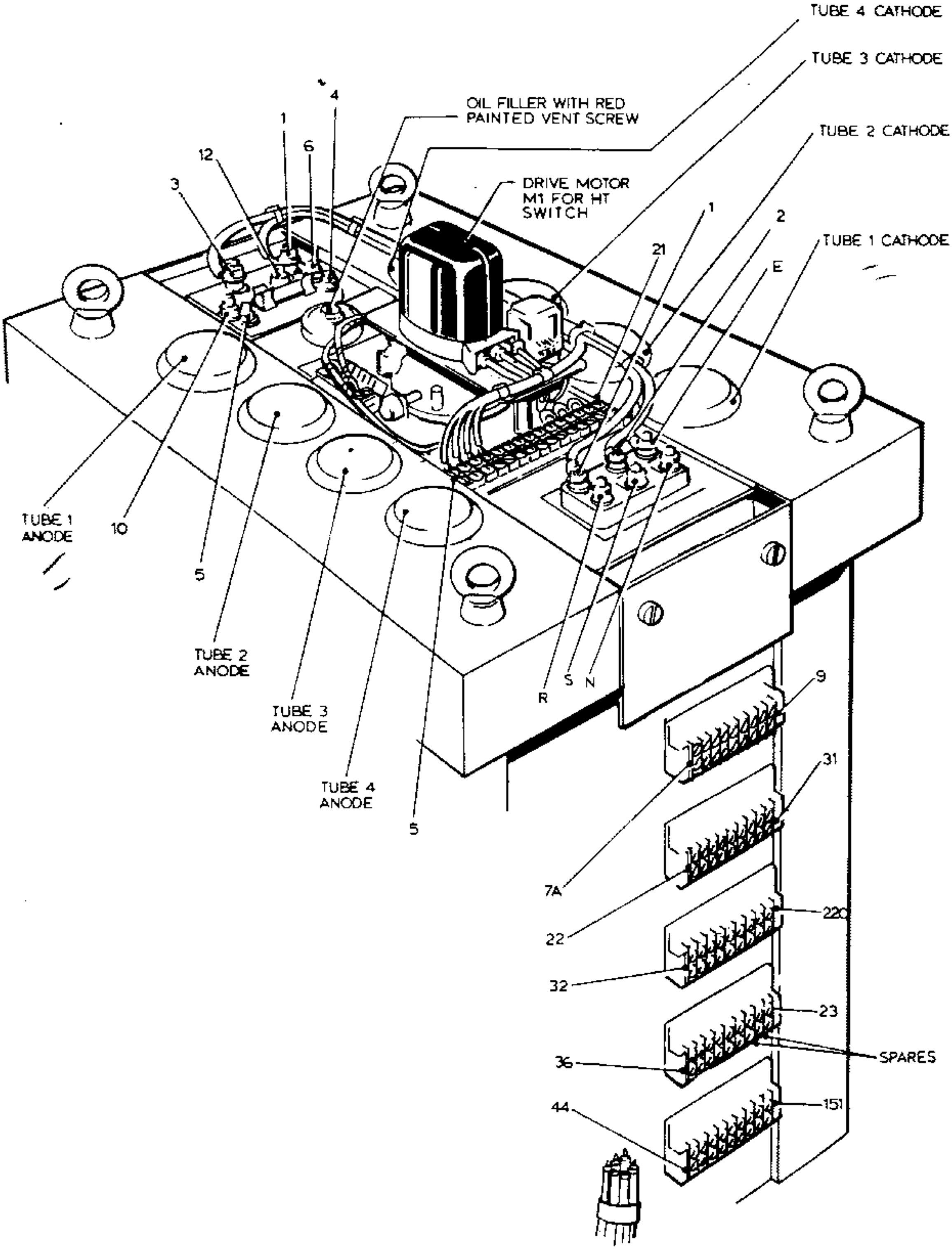


Fig.1 HT Transformer Tap and Connecting Strips

4.3 Removing and Replacing Control Unit Covers

To gain access to the interior of the Control Unit it is necessary to remove the Front, Rear, Top and Side Covers. The details for removing these covers are illustrated in Fig 2 below. The reverse procedure is used to replace covers.

WARNING: IT IS IMPERATIVE THAT THE EARTH LEADS CONNECTED TO THE COVERS AND FRAME ARE SECURED WHEN THE COVERS ARE REFITTED.

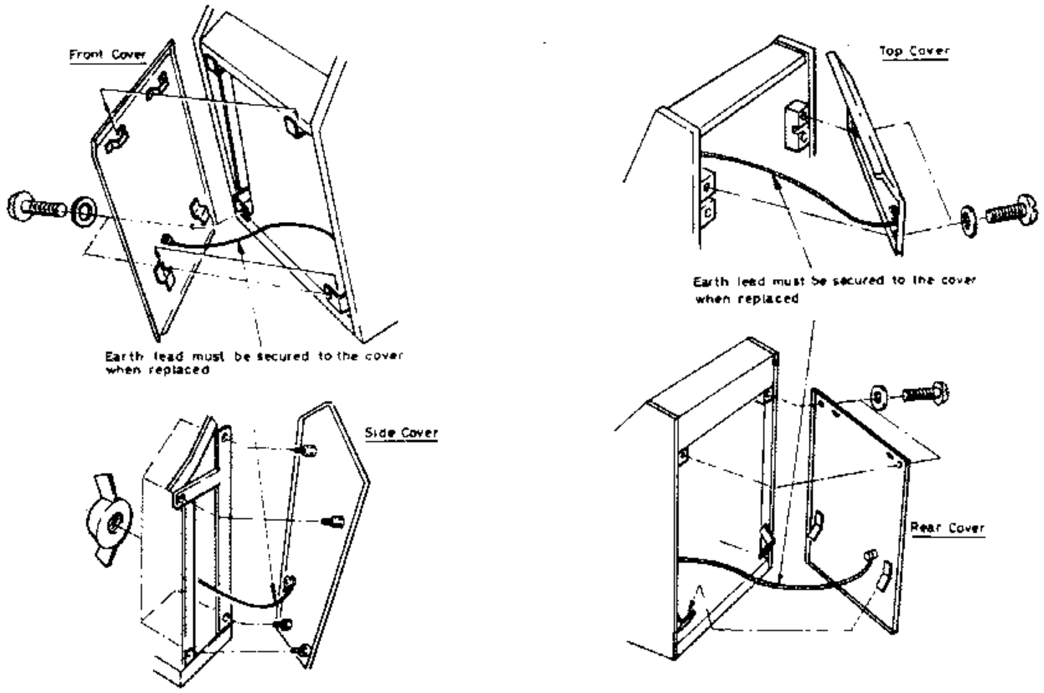


Fig.2 Removing and replacing Control Unit Covers

4.4 Connecting the Control Console

4.4.1 Kit A

A The two flexible conduits from the prewired wall box can enter the Control Console either from the right side or the left side. Two holes are provided on each side of the Console base and the choice of left or right-hand entry is dependent on the installation layout.

B The two conduits contain 60 light conductors plus 20 spare light conductors and 8 heavy conductors. They are formed into 7 branches and terminated with 7 multi-way terminal strips and 1 flying lead idented MAS.

C The first and last wire on each terminal strip is idented with numbers corresponding to the fixed terminal strips on which they have to be mounted.

D There are 7 fixed terminal strips of which only 6 are used.

Four 15-way on the front left side of the Console and three 15-way on the front lower left of the Console. See Figs 3 and 4, page 10.

E Connect the flexible conduit wiring strips to the fixed terminal strips and check that the flexible conduit terminal strip idents correspond with the numbers on the fixed terminal strips.

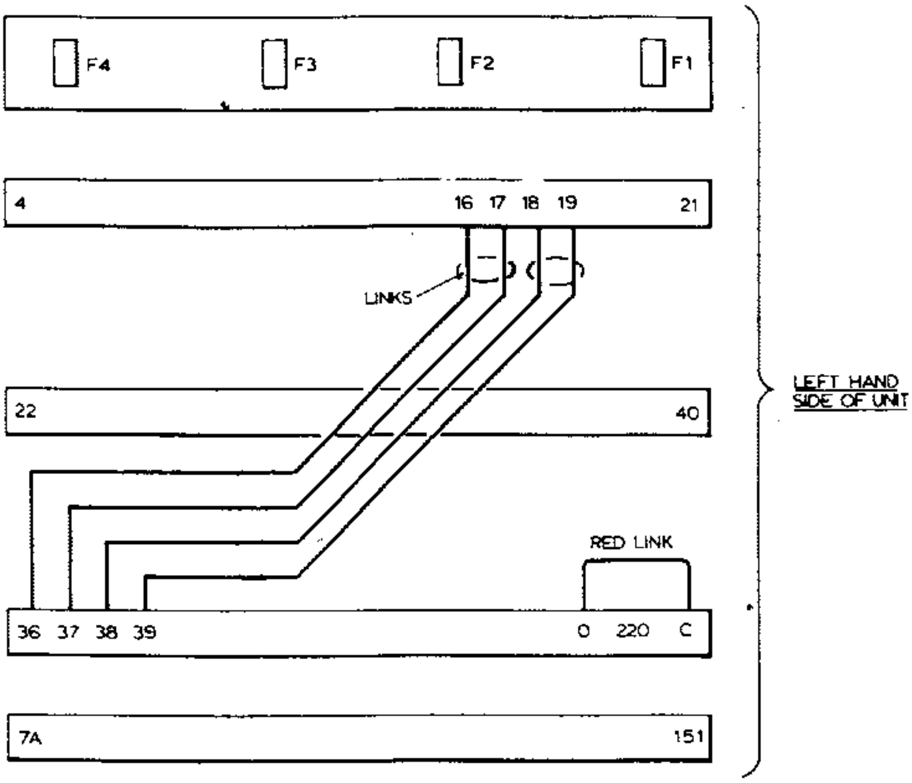


Fig.3 Control Console connecting strips, LH side of unit

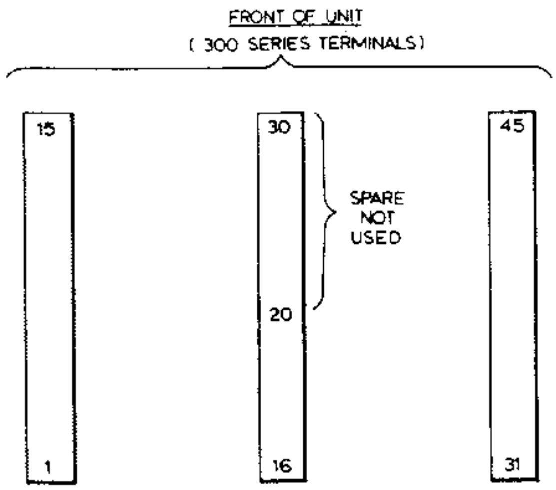


Fig.4 Control Console terminal strips, front LH side of unit

F The flying lead idented MAS should be secured to the vacant terminal on the external mAs meter link. This is visible from the rear of the Console to the right of the middle shelf.

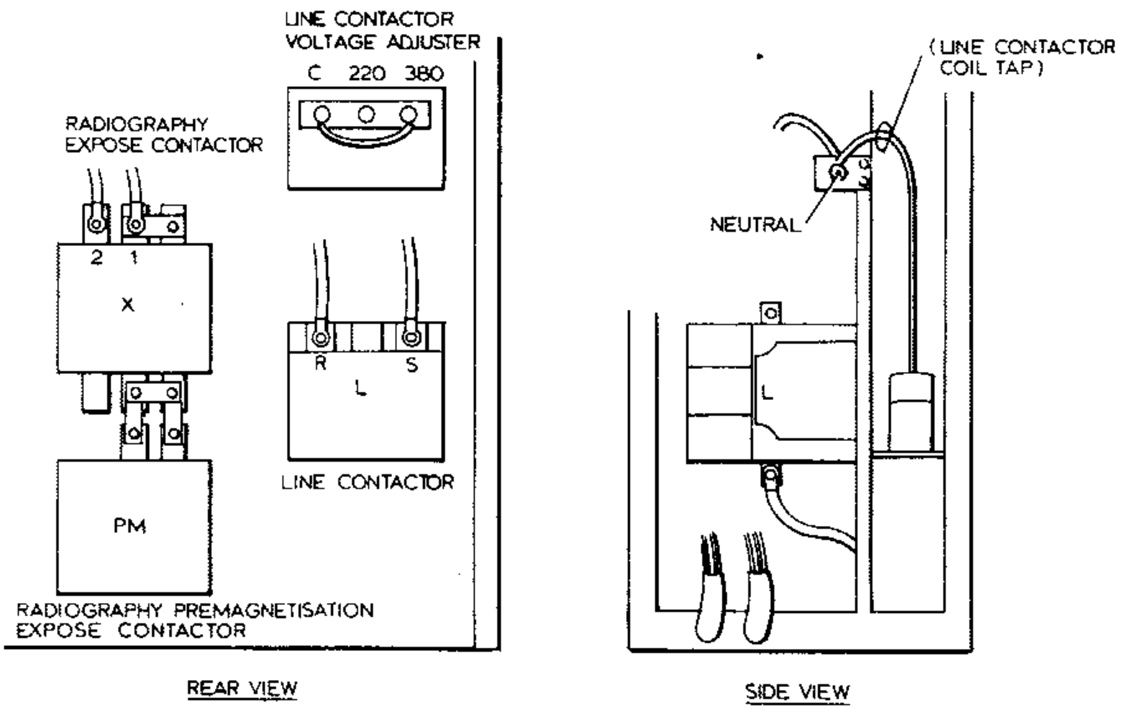
G Secure the heavy conductors idented R and S to terminals R and S on Contactor L. (This is L1 and L2 from the mains supply.)

H Secure the heavy conductors idented 1 and 2 to terminals 1 and 2 on Contactor X. (This is the primary supply to the HT transformer.)

J Secure the Main Neutral Conductor to the terminal illustrated below. Fig 5

K Secure the Main Earth Conductor to the terminal on the Console Chassis rear left support stanchion.

L The conductors idented T and 3 are not required for a single phase generator and should be insulated and tucked out of sight.



CAUTION: THERE MAY BE A LINK CONNECTING THE NEUTRAL AND EARTH, THIS MUST BE DISCONNECTED FOR USE IN U.K.

Fig.5 Cable connections rear and side of Control Console

4.4.2 Kit B

A A multi-core cable is provisioned to interconnect the Control Console to the HT Transformer.

B At the Control Console end this has 60 light conductors and 7 heavy conductors formed into 4 branches terminating at four 15-way terminal strips and one flying lead idented MAS.

C The heavy conductors are idented as follows:-

i Mains Supply R
S
N **NOTE:** On earlier equipments the neutral may be idented as T.
E

ii HT Transformer Supply 1
2
3 (Not used)

D Feed the cable into one of the Console entry holes as in paragraph 4.4.1.A and connect the four terminal strips to the four 15-way fixed terminal strips running down the left-hand side of the Console in a similar fashion to paragraphs 4.4.1.C to F.

NOTE: On this installation, wall boxes are not included so there is no requirement to provide 20 spare interfacing conductors for connection to the spare fixed 300 series terminal strips on the front left of the Console.

E Connect the heavy conductors as per paragraph 4.4.1.G to L and note that earlier production models may have the neutral conductor idented T.

The conductor 3 is not required and should be insulated and tucked out of sight.

4.5 Connecting the HT Transformer

4.5.1 Kit A

A The flexible conduit for connecting the HT Transformer to JB4A contains 15 light conductors and 4 heavy conductors.

The light conductors are terminated at either end to 15-way terminal strips.

B Connection to JB4A is made via the terminal strip which has the first and last wires idented 4 and 21 respectively.

These numbers should be aligned with the corresponding numbers on the top JB4A fixed terminal strip and finally screwed home.

The heavy conductors idented 1, 2 and E should be connected to the corresponding heavy terminals and the remaining conductor idented 3 which is not required, should be insulated and tucked out of sight.

An illustration of JB4 terminal board is contained on page 13, Fig 6.

C Connection to the HT transformer is made via the terminal strip which has the first and last wires idented 5 and 21 respectively.

The conduit enters the tank as illustrated on page 8 and all the terminations are made on the top of the tank. The five fixed terminal strips on the side of the tank are for KIT B installations only.

Connection of the conductors idented 1, 2 and E should be made to the similarly marked heavy terminals adjacent to the 15-way terminal strip and the remaining conductor idented 3 should be insulated and tucked out of sight.

4.5.2 Kit B

A The other end of the multi-core cable already connected to the Console in paragraph 4.4.2 is taken direct to the HT Transformer. The point of entry is the same as illustrated for the KIT A vacuflex.

B The longest conductors from this cable containing 7 heavy and 15 light conductors terminated with a 15-way terminal strip should be routed to the HT tank top and secured as per paragraph 4.5.1.C.

In addition to the conductors listed in paragraph 4.5.1 C the heavy conductors idented R, S and N should be connected to the R, S and N terminals on the terminal block adjacent to the 15-way terminal strip.

NOTE: On early production models, terminal N may be designated with the letter T.

C The remaining 45 light conductors terminated with five 9-way terminal strips are to be connected to the five 9-way terminal strips on the side of the HT transformer.

The terminals numbers to which they are to be connected must be an extension of the numbers already connected within the console.

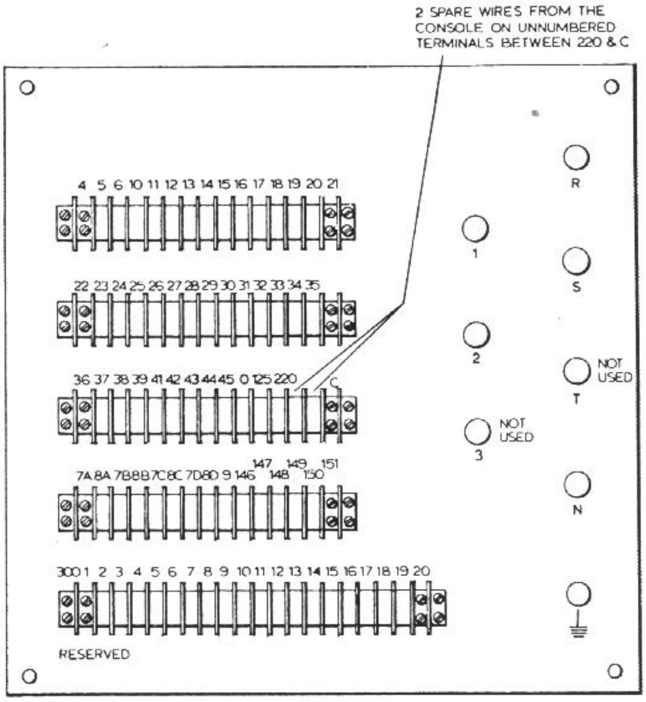


Fig. 6 Terminal Board for R500 Junction Box

4.5.3 HT Cables

The HT transformer is arranged to supply up to four double-focus x-ray tubes. The positions of the HT cable receptacles are illustrated in Fig.1.

4.6 Preliminary connections and links to be made

4.6.1 Mains Supply Voltage Tap

On the terminal strip designated Mains Voltage Tapping Panel in Fig 26 page 56, there will be a single heavy wire connected to one of the terminals 415, 380 or 220.

Reconnect this wire to the terminal number which is nearest to the voltage of the prevailing mains supply (e.g in UK this will normally be 415).

4.6.2 Line Contactor Voltage Adjustment

On the terminal strip designated LINE CONTACTOR VOLTAGE ADJUSTER, on the page 11 Figure 5 connect the wander lead from terminal C to the terminal number nearest to the prevailing mains supply voltage (e.g. for a 415V supply terminal 380 should be employed).

4.6.3 X-Ray Tube Over Pressure Thermal Cut-Out Terminals

On delivery these will be linked on the X-ray Console Main Terminal Strips as follows:

A	TUBE 1	36 to 16
B	TUBE 2	37 to 17
C	TUBE 3	38 to 18
D	TUBE 4	39 to 19

If Over-Pressure Thermal Cut-outs or X-ray table interlocks have to be fitted, the associated links must be removed. (Table wiring details are given on page 18, Fig 7).

For KIT A Installations, terminals are available on the Main Wall JBs to accommodate the wires from the tube thermal cut-outs.

For KIT B Installations, the tube thermal cut-out wires must be taken direct to the HT Transformer terminal strips.

4.6.4 X-ray Tube Change Focus TERMINAL STRIP CF

This is mounted on the kW/time Overload Board illustrated on page 40, Fig 22.

Normal Company Policy is to operate X-ray tubes on fine focus from 50mA to 200mA and on broad focus from 300mA to 500mA.

Terminal C on the above strip should be linked to terminals 1, 2, 3 and 4 to operate all tubes — on fine focus up to 200mA.

If there is a requirement for any other tube focus/mA arrangement, it is possible to change the combination but advice from Picker International, Wembley should be obtained.

4.6.5 X-ray Tube STATOR CONNECTIONS

Stator wires for KIT A Installations should be connected to the Main Wall JB.

Stator wires for KIT B Installations should be connected to the terminals on the side of the HT Transformer.

The terminal numbers are as follows:

TUBE NO	TERMINAL NUMBER	STATOR WIRE COLOUR
1	9	BROWN (COMMON)
	7A	BLACK (MAIN)
	8A	BLUE (CAPACITIVE)
	E	GREEN/YELLOW
2	9	BROWN (COMMON)
	7B	BLACK (MAIN)
	8B	BLUE (CAPACITIVE)
	E	GREEN/YELLOW

TUBE NO	TERMINAL NUMBER	STATOR WIRE COLOUR
3	9	BROWN (COMMON)
	7C	BLACK (MAIN)
	8C	BLUE (CAPACITIVE)
	E	GREEN/YELLOW
4	9	BROWN (COMMON)
	7D	BLACK (MAIN)
	8D	BLUE (CAPACITIVE)
	E	GREEN/YELLOW

4.6.6 Bucky Connections

The standard bucky connections are as follows:

27 — Tube 1 Bucky start technique 1
28 — Tube 1 Bucky start technique 2
29 — Tube 2 Bucky start technique 3
30 — Tube 2 Bucky start technique 4
31 — Tube 3 Bucky start technique 5
32 — Tube 4 Bucky start technique 6
33 — Bucky return for all above terminals
26 — Exposure start from all above terminals less 33

For techniques that do not require buckies, link the associated bucky start terminals to terminal 26. This can be effected on the Console main terminal strips.

The bucky wiring should be connected to the Main Wall JB for KIT A installations and for KIT B installations there is a choice of the main console terminal strips or the terminal strips on the side of the HT Transformer.

A typical table of interconnections is listed below.

Technique	Tube	Bucky	R500 terminals	Bucky terminals
1	Undertable	Not used	Link 26 to 27	Not used
2	Undertable	Not used	Link 26 to 28	Not used
3	Overtable	Table	29 26 33	124 125 129
4	Overtable	Versatilt	30 26 33	126 125 129
5	3	Other	31 26 33	Bucky start Exp start Bucky return
6	4	Other	32 26 33	Bucky start Exp start Bucky return

NOTE: There is no provision to switch a bucky in or out once a particular technique has been selected.

4.6.7 TV and SCT Relay Wander Leads

On the Console main terminal strips, check that the wires labelled TV and SCT are connected to terminals 146 and 147 respectively.

Connection of these relays is only required when a serial changer is included in the installation.

4.6.8 Tube Exposure Counters

A Screw the 4 Counter Assemblies to the Tube Counter Mounting Panel illustrated on page 56, Fig 26.

B Connect each counter to its associated pair of terminals on the upper side of the panel. The terminal strips reading from left to right are pre-wired for tubes 1 to 4 respectively.

4.7 Designation of Terminal Numbers

4.7.1 Main Terminals

4)
5) mA meter AC input
6 Filament transformer broad and fine common
10 Broad filament transformer supply
11 Fine filament transformer supply
12 Supply for Tube 1 HT change over circuit
13 Supply for Tube 2 HT change over circuit
14 Supply for Tube 3 HT change over circuit
15 Supply for Tube 4 HT change over circuit
16 To Tube 1 thermal interlock switch
17 To Tube 2 thermal interlock switch
18 To Tube 3 thermal interlock switch
19 To Tube 4 thermal interlock switch
20)
21) Main 24 Volt DC supply for HT change over circuit
23 Radiography exposure initiation
24 Fluoro start
25 Radiography preparation start
26 Radiography expose command from buckies
27 Radiography expose ready to bucky 1 common
28 Radiography expose ready to bucky 2 common
29 Radiography expose ready to bucky 3 common
30 Radiography expose ready to bucky 4 common
31 Radiography expose ready to bucky 5 common
32 Radiography expose ready to bucky 6 common
33 Return line for all bucky start coils
34 Supply to remote prep/expose/fluoro switches (Tube 1 only)
135 Exposure blocking interlock connection for use with Tube Selected Lights failure circuit
36 To Tube 1 thermal interlock switch
37 To Tube 2 thermal interlock switch
38 To Tube 3 thermal interlock switch
39 To Tube 4 thermal interlock switch
40 For K9/5 mA meter (Normally linked to terminal 4)
41 0 Volt Common return for demarcator lamp
42 12 Volt AC Supply for demarcator lamp
43 24 Volt AC Supply for demarcator lamp

44)
45) Normally closed contact of fluoro contactor for room lights

0)
125) 0 VOLT RETURN line for accessories NOTE. 125 does NOT indicate 125 volts.

220 220 Volt AC Supply outlet for accessories

7A Tube 1 main stator winding supply
8A Tube 1 capacitive stator winding supply
7B Tube 2 main stator winding supply
8B Tube 2 capacitive stator winding supply
7C Tube 3 main stator winding supply
8C Tube 3 capacitive stator winding supply
7D Tube 4 main stator winding supply
8D Tube 4 capacitive stator winding supply
9 Common return for stator windings

146 220V ac accessory supply outlet which is live with tube 1 selected on technique 1 only
147 220V ac accessory supply outlet which is live with tube 1 selected on either technique 1 or technique 2
148 220V ac accessory supply outlet which is live with tube 2 selected on technique 3 only
149 220V ac accessory supply outlet which is live with tube 2 selected on technique 4 only
150 220V ac accessory supply outlet which is live with tube 3 selected on technique 5 only
151 220V ac accessory supply outlet which is live with tube 4 selected on technique 6 only

SPARE WIRES Two unnumbered wires are taken from two terminals between terminals 220 and C in the Control Console to the wall box (KIT A) or the HT Transformer (KIT B).

On the wall box the spare terminals are situated between terminals 220 and C.

On the HT Transformer the spare terminals are situated between terminals 42 and 23.

4.7.2 300 Series Interfacing Terminals

Situated on the front left of the Control Console they are as follows:

1 SECTO SELECT MOD
2 SECTO SELECT MOD
3 SPARE (used only on R703)
4 SECTO EXPOSE MOD
5 SECTO EXPOSE MOD
6 PREP INDICATION FOR SIEMENS PUCK MOD
7 PREP/EXPOSE FOR AOT/PUCK MOD
8 TO K9/5 V7
9 TO K9/5 V9
10 TO K9/5 V10
11 TO K9/5 V12
12 TO K9/5 W1/W3 or K9 MK2 TERM 3 (230V a.c. TV SUPPLY)
13 TO K9/5 W6
14 TO K9/5 W12
15 TO K9/5 X6
16 TUBE 1 TABLE AND THERMAL INTERLOCKS
17 TO K9/5 Y4
18 TO K9/5 Z3
19 STATOR INTERLOCK FOR HIGH SPEED MCU MOD
20 STATOR INTERLOCK FOR HIGH SPEED MCU MOD

4.8 Common Interface Connections

4.8.1 X-ray Tables

A Interfacing Connections

R500 MAIN JB TERMINALS		CONGRESS TABLE TERMINALS	
Link 26, 27 and 28			
Connect Terminal	34	TO	133
Connect Terminal	23	TO	131
Connect Terminal	24	TO	130
Connect Terminal	25	TO	132
Connect Terminal	16	TO	153
Connect 300 series Terminal	16	TO	154
Connect Terminal	26	TO	125
Connect Terminal	29	TO	124
Connect Terminal	33	TO	129

B Tube Thermal Cut Out and Table Interlocks

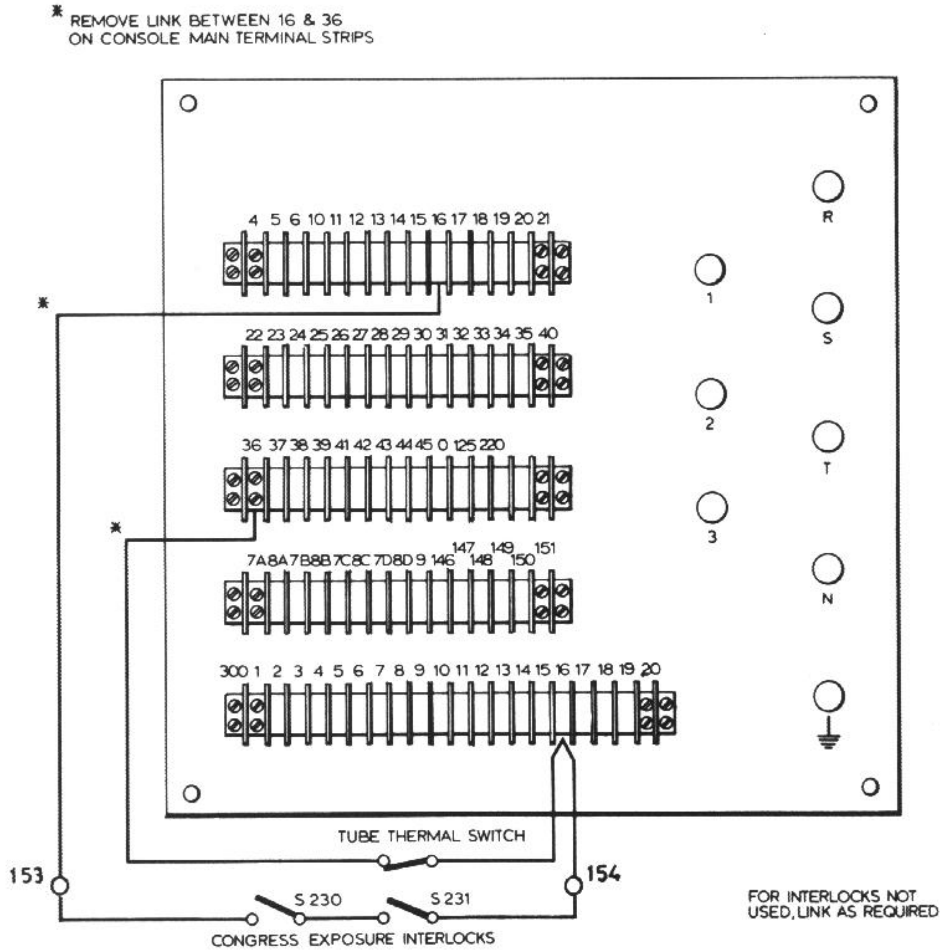


Fig.7 R500 JB Exposure Interlock and Tube Thermal Switch conversion for X-ray tables

C Diagrammatic Representation

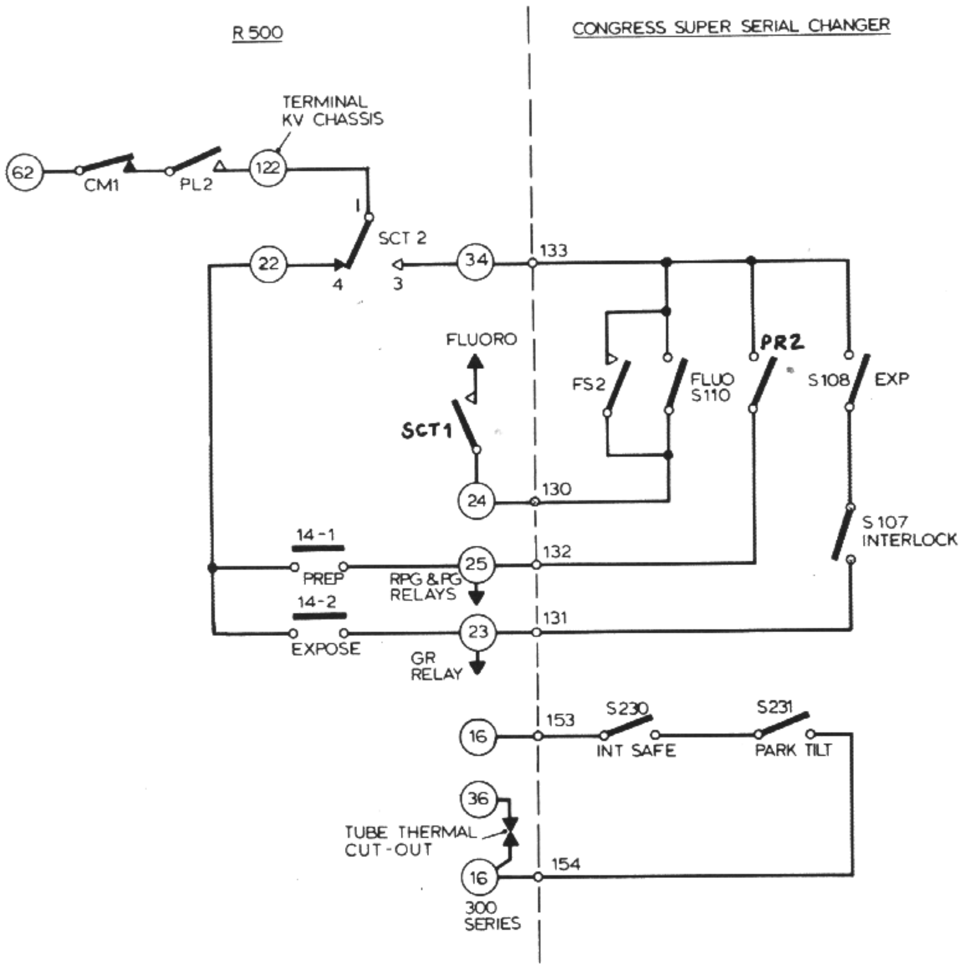


Fig.8 R500 Congress Super Serial Changer Interface connections

To set up the undertable tube mAs output from the Control Console, temporarily link terminals 22 to 34 on JB4.

To screen from the Control Console temporarily link terminals 24 to 34 on JB4 and use the fluoro timer on facia panel to 'screen in' the tube.

4.8.2 Standard Sectograph Attachment

A Materials required

Relay 590 type, Stock No RS 1730

Fasteners for above

Wire 24/0.2mm

B The Standard Sectograph attachment can be incorporated with technique 3 (table bucky) by means of an additional Secto Select Relay which will insert the secto exposure contact in series with the table bucky expose circuit when the Secto Control Box is switched on. When the Secto control is off, the secto contact will be short circuited allowing normal overtable exposures to be made.

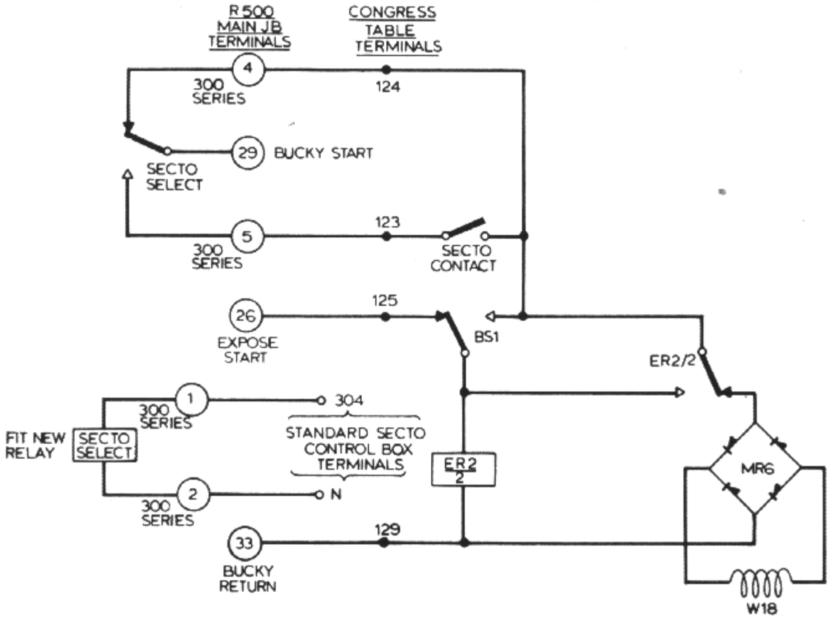


Fig.9 Standard Sectograph Interface connections

C Fitting and Connection details

i On the underside of the main JB paxolin board behind the terminal 36 end of the middle terminal strip, mount the relay and make sure that there is sufficient electrical clearance between the relay contacts and the JB metal base plate

ii Wire the coil of the relay to terminals 1 and 2 of the 300 series terminal strips

iii Wire the pole of the relay contact to terminal 29

iv Wire the normally closed contact to terminal 4 of the 300 series terminal strip

v Wire the normally open contact to terminal 5 of the 300 series terminal strip

vi Transfer table connection 124, located on terminal 29 to terminal 4 on the 300 series terminal strip

vii Connect terminal 123 on the table to terminal 5 on the 300 series terminal strip

viii From the Secto Control Box, wire terminals 304 and N to terminals 1 and 2 on the 300 series terminal strips.

D Wire the remainder of the Secto Box terminals to the table as per page 10 of Inst 1528.

4.8.3 Apollo Sectograph Attachment

A There is no requirement for an additional Secto Select Relay.

B Wire the spare set of contacts on CO Relay mounted in the Apollo Secto Control Wall Box — as shown below.

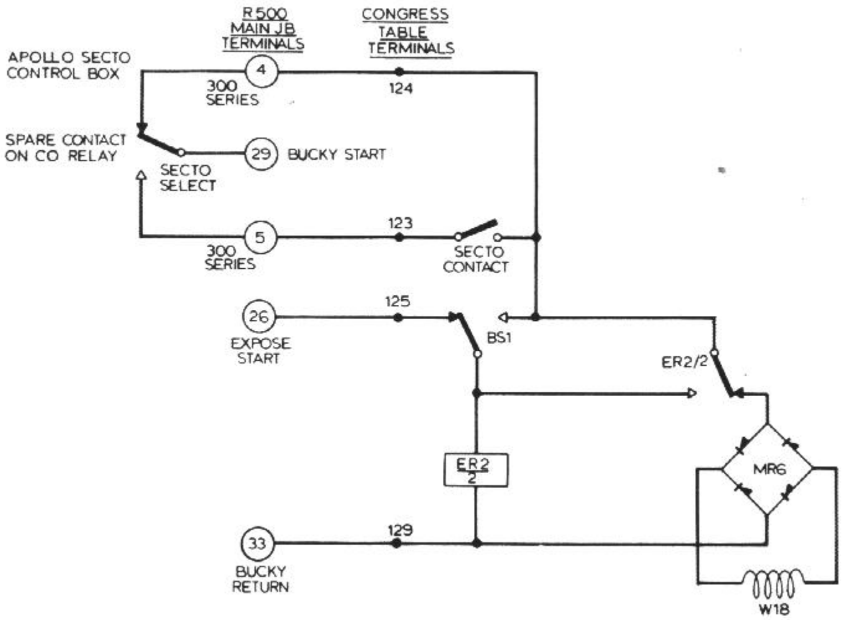


Fig.10 Apollo Sectograph Interface connection

4.8.4 Kompact 9 Mk2

A Connect terminal 3 from the K9 Mk2 wall box to terminal 12 on the R500 main junction box Series 300 terminal strips

B Connect terminal 2 from the K9 Mk2 wall box to terminal 125 on the R500 main junction box

C Complete the remainder of the installation as per Inst 2096 (K9 Mk2)

D TV blanking details are contained on page 25paragraph 4.8.6C.

4.8.5 Kompact 9/5

Introduction

If the K9/5 system is set up in accordance with Chapter 3, paragraph 8g of Inst.2014, it is possible for the mA meter on the R500 to indicate a higher mA than that displayed on the K9/5 mA meter.

To eliminate this discrepancy between the two meters, zener diode D5 in Chapter 8 Figure 6 of Inst.2014 must be permanently removed. An alternative method of protecting the meter during radiography exposures is provided by relay contact RPG3 which bypasses the K9/5 meter during the radiography prepare and expose modes of control.

Connecting Details

A In the Control Console, permanently remove the links between the following 300 series terminals located on the lower front left of the unit:

8 — 9
10 — 11
13 — 14

B On the Control Console, permanently remove the link between terminal 4 and terminal 40 on the main terminal strips running along the left-hand side of the unit.

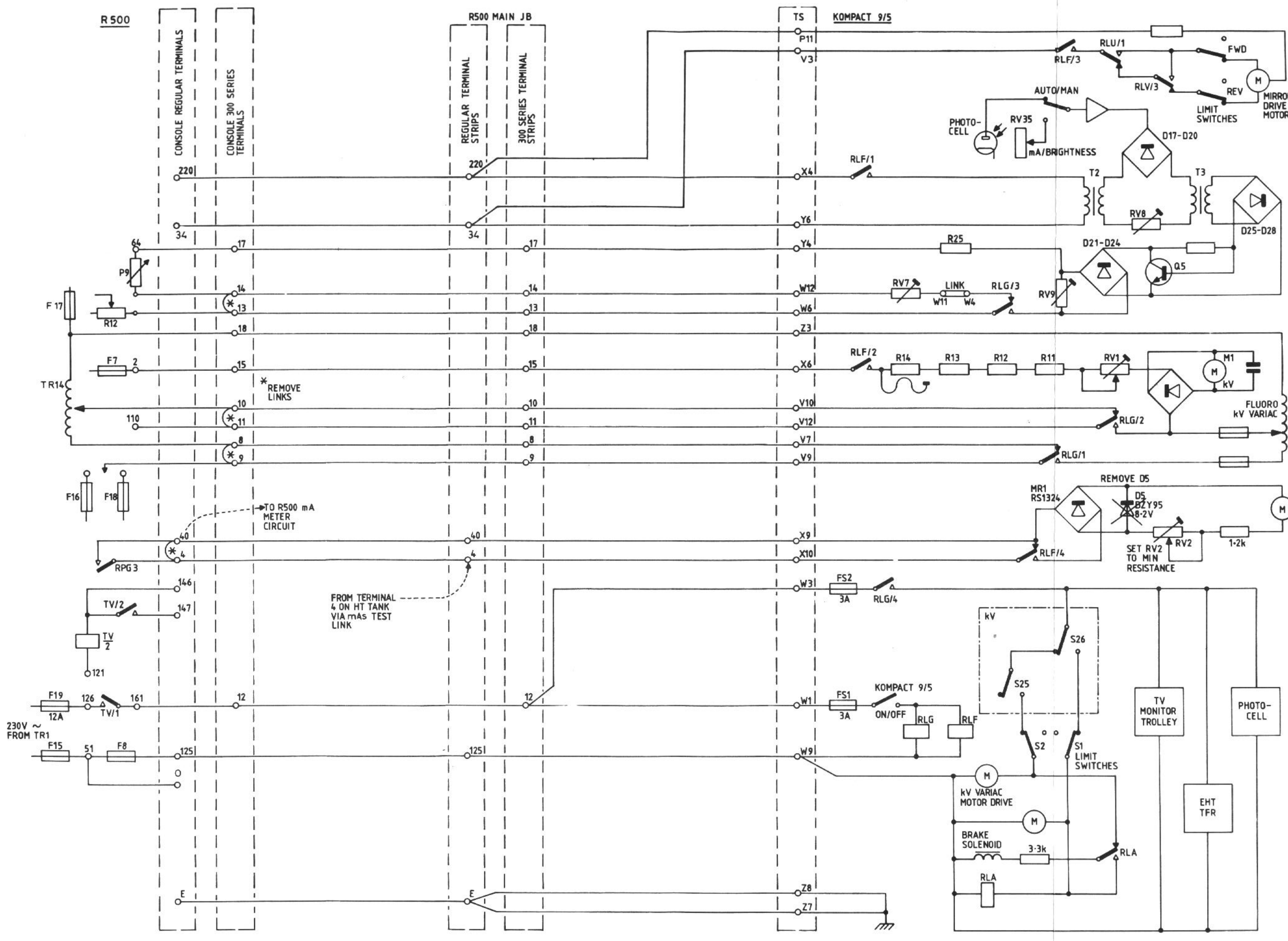
C On the main junction box (JB4 or JB4A) connect the K9/5 system as detailed in the interface diagram on page 23, Fig 11.

D Before setting up the system, as per Inst 2014, ensure that RV2 in the K9/5 Interconnection Unit is set for **minimum** resistance and that Zener diode D5 shown in Chapter 8 Figure 6 of Inst.2014 and on the main interface diagram is permanently removed.

E During the K9/5 setting up procedure, ignore Chapter 3 paragraph 8g of Inst.2014.

F To increase the X-ray tube filament drive with the K9/5 switched ON, adjust tap 1 on R12 in the R500 console.

G When the K9/5 is switched off, RV7 in the K9/5 Interconnection Unit must be adjusted to restrict the tube emission to 5mA max. when the R500 fluoro mA control is turned fully clockwise.



(2277/1/380) R 500/KOMPACT 9/5 INTERFACE -23- Fig 11

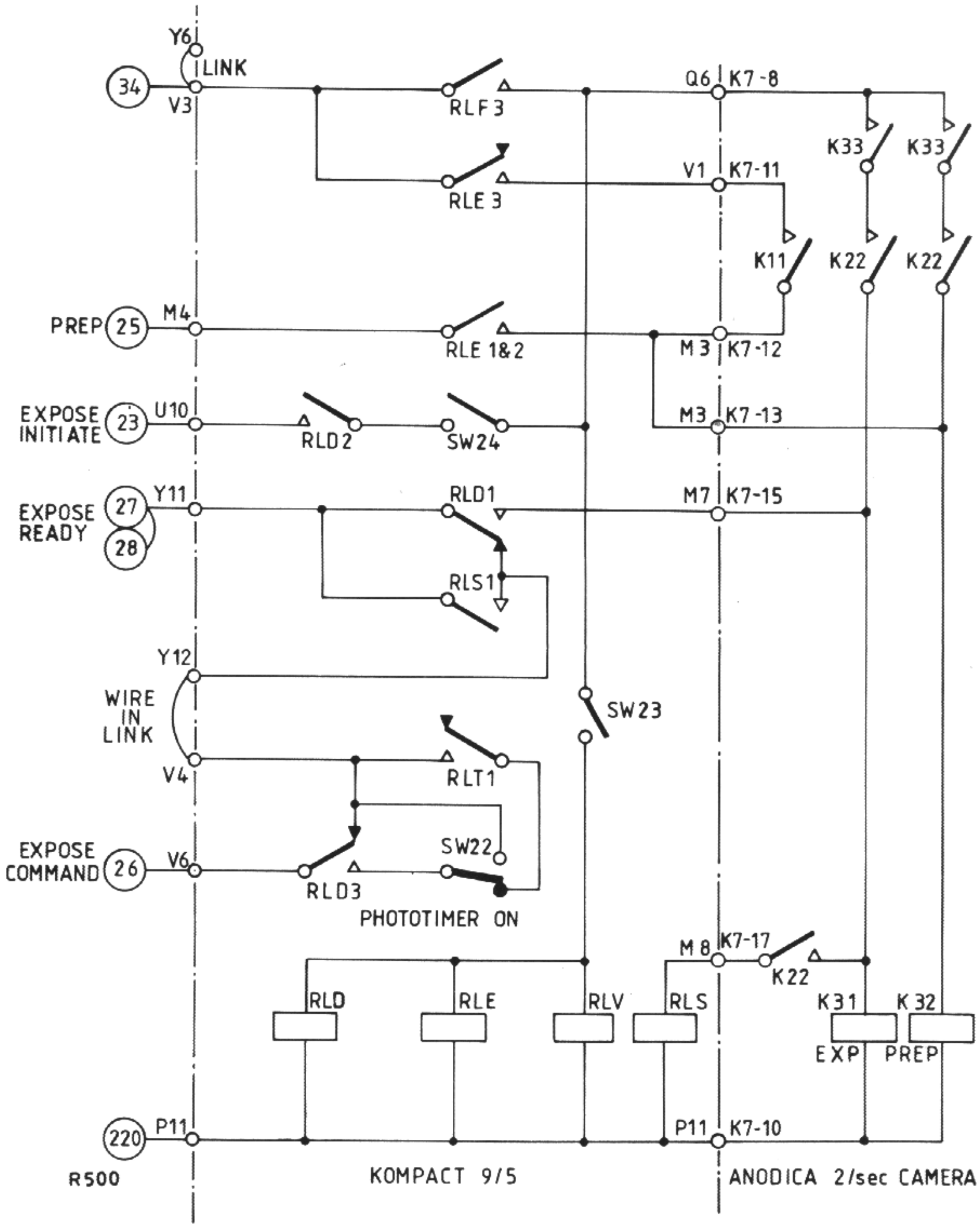


Fig.12 Kompact 9/5 Anodica Camera Interface

4.8.6 X-ray Room Hazard Warning Light Incorporating TV Blanking Facility

A For rooms with no screening facilities, connect the 240V lamp to terminals 25 and 220 on JB4 or JB4A. The lamp will light when the R500 is switched to the prepare and expose modes of control.

B For rooms which will have both screening and radiography facilities, it will be necessary to modify the apparatus as follows:

Materials required

2 off Relay 590 type 240V AC STOCK NO RS1730
3 metres Wire 24/0.2mm
1 off Choc block terminal strip 4-way

Modification

Secure the relays and chock block to the paxolin terminal board of JB4 or JB4A and wire as shown below, Fig 13.

C If TV facilities are to be included in the installation, an additional contact on each of the above relays can be wired to unblank the TV system as shown on the same diagram.

The TV black level will be suppressed during the following modes of control:

i FLUOROSCOPY EXPOSURE
ii RADIOGRAPHY PREPARATION
iii RADIOGRAPHY EXPOSURE

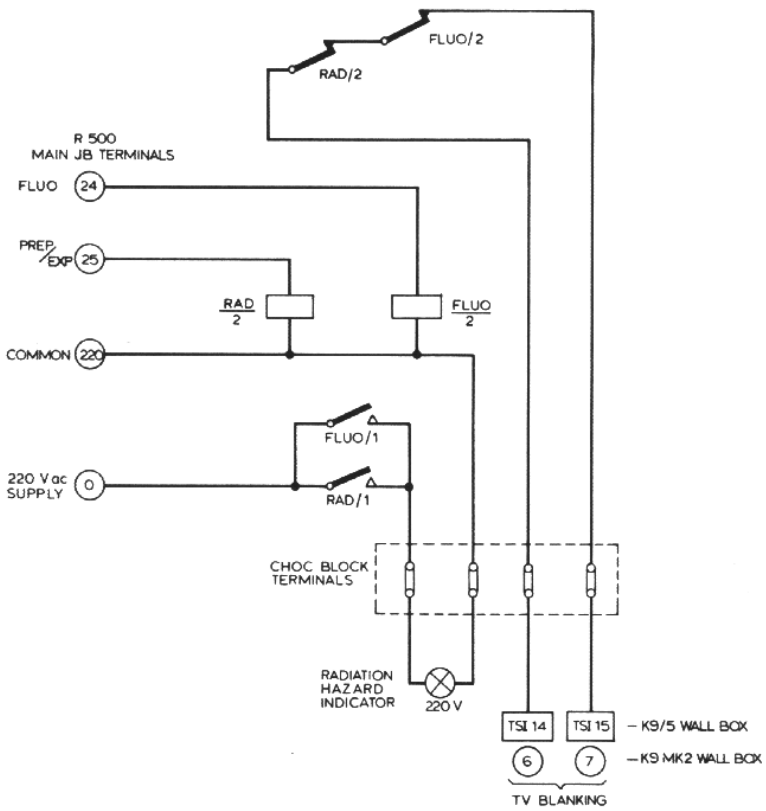


Fig.13 Radiation Hazard Indicator and TV Blanking Facility Modification

4.8.7 X-ray Tube Selected Lights and Auxiliaries Panel

A This panel is supplied with DHSS KIT STOCK No M12116 and is mounted together with the room lights isolating transformer in a standard Stylos PSU Wall Box.

B Four 220V a.c. accessory outlets are provided to supply apparatus which must be switched in with a particular tube as opposed to a particular technique (e.g. High Speed Stator MCU).

Connection details are tabulated below:

TUBE 1	ACCESSORY SUPPLY	TERMINALS T1 and 220
TUBE 2	ACCESSORY SUPPLY	TERMINALS T2 and 220
TUBE 3	ACCESSORY SUPPLY	TERMINALS T3 and 220
TUBE 4	ACCESSORY SUPPLY	TERMINALS T4 and 220

C Apart from a simple modification to be effected within the X-ray Console, the only other wiring which has to be done is to connect the subject Wall Box direct to the Generator Main JB4 or JB4A. (THIS IS EMBODIED FROM SERIAL No Y029 ONWARDS)

Connection Details

D Connect the 12V d.c. TS1 terminals 21, 36, 37, 38 and 39 on the panel to the same terminal numbers on JB4 or JB4A.

E Connect the 220V a.c. TS1 terminals 0, 135 and 220 on the panel to the same terminal numbers on JB4 or JB4A. (From Serial No Y029, unlink terminals 0 and 135 in Console.)

F Connect the X-ray tube indicator lights to the panel terminal strip TS2.

Terminal C is common.

Terminals TB1 to TB4 are Tubes 1 to 4 respectively.

NOTE: If tube 1 (normally the undertable tube) has to be redeployed for overtable technique, an indication lamp assembly can be connected to TS2 terminals TBI and TBC but RL2026/1 contact must be disconnected to allow the lamps failure device to take over control.

4BA spade crimp terminals are provided with the DHSS kit to ease the task of connecting this terminal strip.

Modification to R500 Exposure Interlocks NOT REQUIRED FROM SERIAL NO Y029 ONWARDS

G In the X-ray Console, locate terminal 135 on the main terminal strips running down the front of the left-hand side.

NOTE: On early production models this terminal may be designated 35. If this is encountered, unsolder and insulate all wires terminated on this terminal except the main Console/JB4 interconnection and redesignate the number to 135 with a permanent marker.

H Connect a 1 metre length of 24/0.2mm wire to terminal 135 and run the free length to the 20-second delay synchronous timer on nearby chassis TI.

J Remove the microswitch cover on the 20-second delay timer, unsolder and insulate the wire on microswitch I14 which comes from terminal 51 on TI chassis. See illustration below, Fig 14.

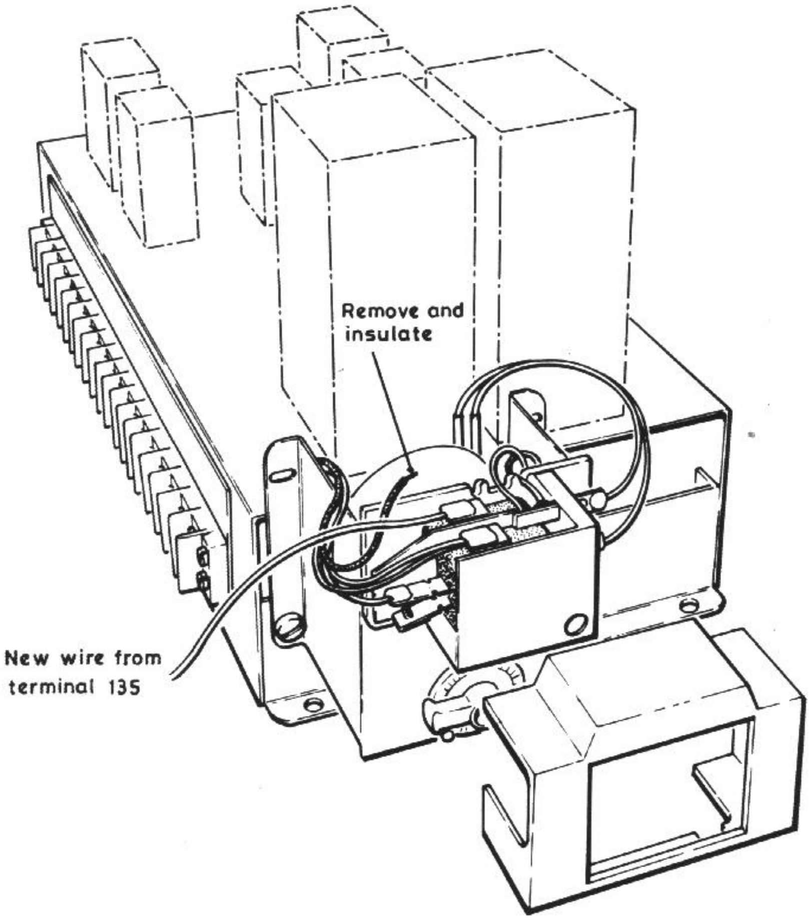


Fig.14 T1 Chassis

K Solder the free end of new wire from terminal 135 to the vacated tag on microswitch I14 in paragraph J above and replace microswitch cover.

4.8.8 Room Lights Isolating Transformer

A The transformer is mounted in the Wall Box itemised in paragraph 4.8.7.

B On the Tube Selected Lights Control Panel, run a pair of wires from TS1 terminals 0 and 220 to the room light transformer and terminate at the terminal block on top of the transformer.

C Connect the dead side of the insulated fuse holder on top of the transformer to terminal 44 in either Generator JB4 or JB4A.

D Connect the earth terminal for the transformer secondary to the main earth terminal of the Subject Box.

E Wire the room lights to local requirements. A circuit diagram is reproduced below for guidance and it should be noted that a switch is not provided on the X-ray Console.

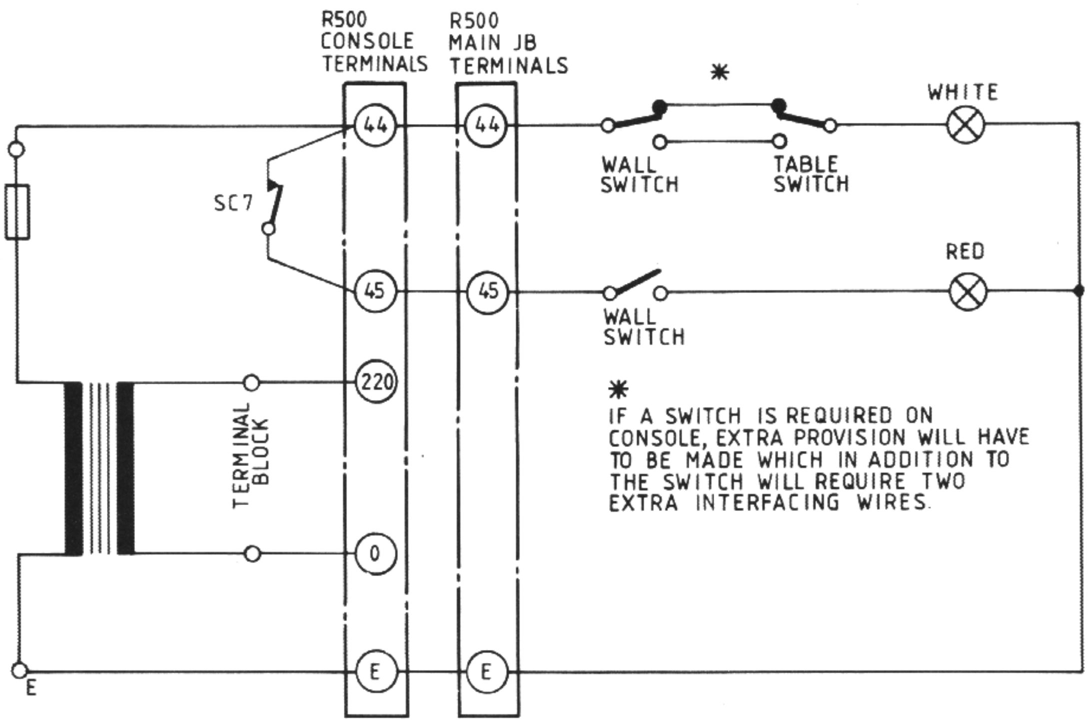


Fig.15 Room Lights Circuit

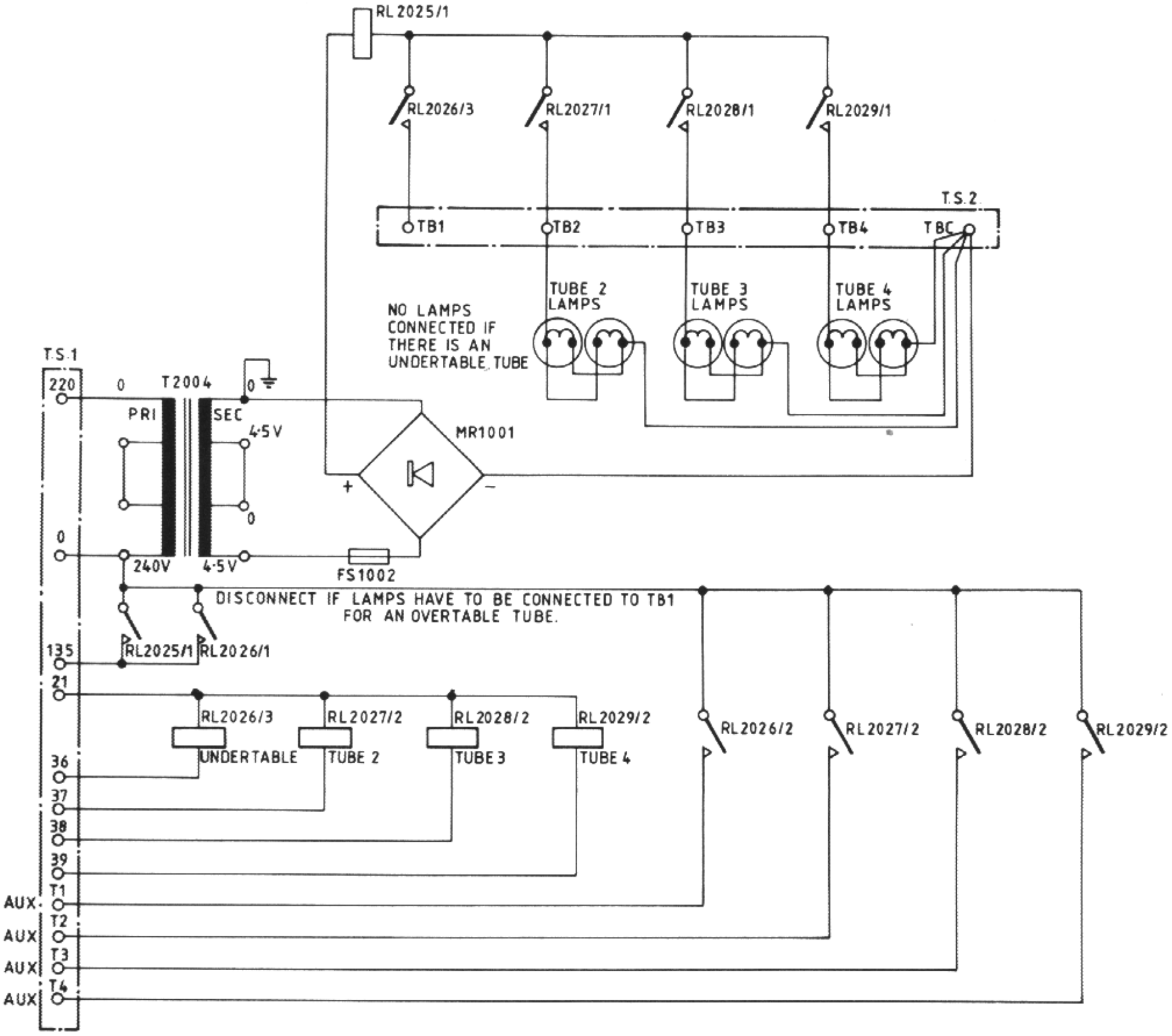
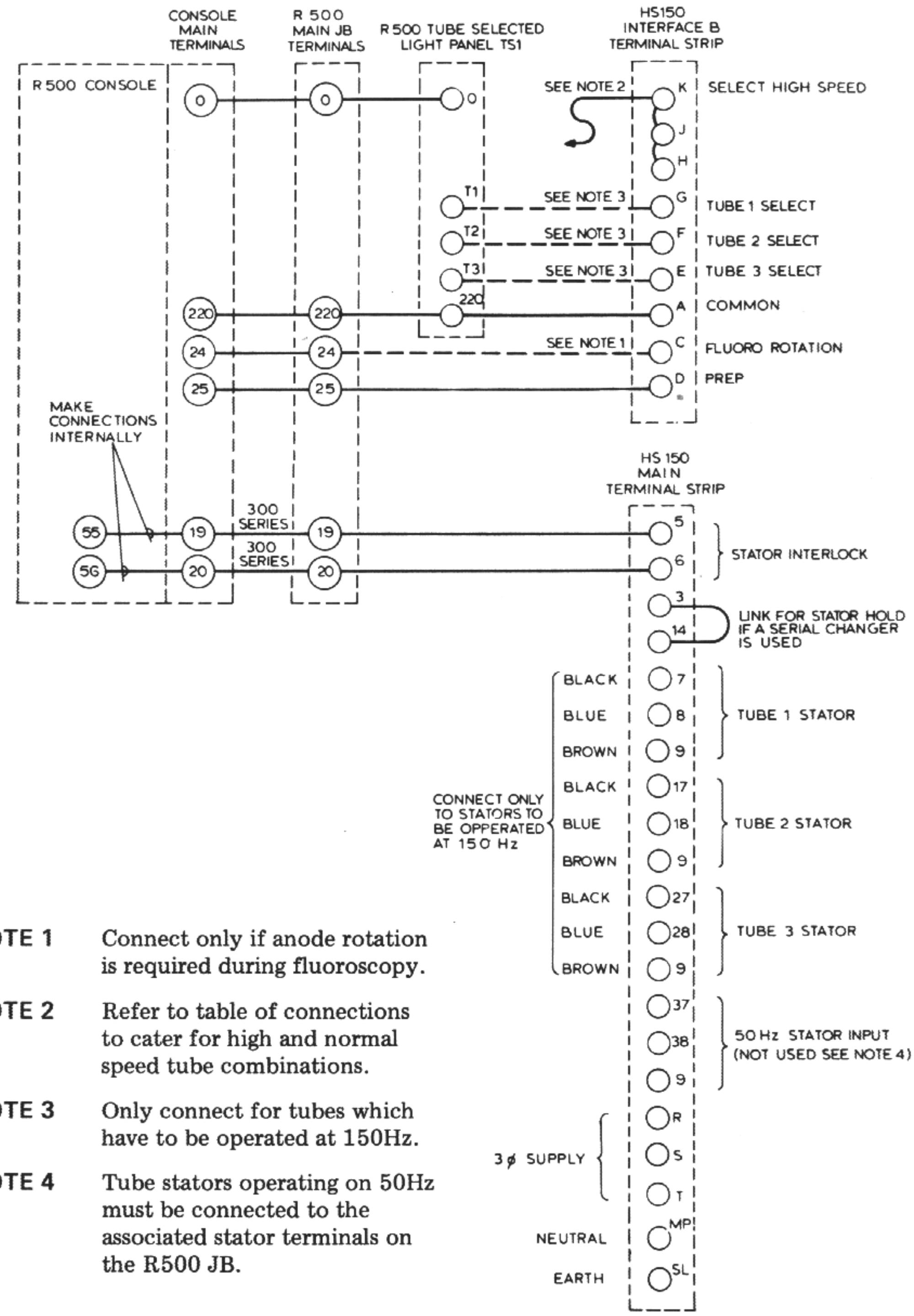


Fig.16 Table Selected Lights and Relay Panel wiring

4.8.9 HS 150 MCU

Connect as per the details illustrated below and the tube combinations itemised in page 31.



NOTE 1 Connect only if anode rotation is required during fluoroscopy.

NOTE 2 Refer to table of connections to cater for high and normal speed tube combinations.

NOTE 3 Only connect for tubes which have to be operated at 150Hz.

NOTE 4 Tube stators operating on 50Hz must be connected to the associated stator terminals on the R500 JB.

Fig.17 Interface R500 to HS 150 Frequency Converter

All Tubes High Speed

Connect terminal H--J--K on HS 150 Interface Panel to Terminal 0 on Tube Select Lights and Auxs Panel.

1 High Speed Tube and 1 Normal Speed Tube

Tube 1 normal speed Tube 2 high speed	Link terminals H—J--K on HS 150 Interface Panel to F
Tube 1 high speed Tube 2 normal speed	Link terminals H—J--K on HS 150 Interface Panel to G

1 High Speed Tube and 2 Normal Speed Tubes

Tube 1 normal speed Tube 2 normal speed Tube 3 high speed	Link terminals H—J--K on HS 150 Interface Panel to E
Tube 1 normal speed Tube 2 high speed Tube 3 normal speed	Link terminals H--J—K on HS 150 Interface Panel to F
Tube 1 high speed Tube 2 low speed Tube 3 low speed	Link terminals H—J--K on HS 150 Interface Panel to G.

2 High Speed Tubes and 1 Normal Speed Tube

Tube 1 high speed Tube 2 high speed Tube 3 normal speed	Connect terminals H—J—K on HS 150 Interface Panel to the normally closed contact of RL2028/2 in Tube Selected Lights and Aux Panel
Tube 1 high speed Tube 2 normal speed Tube 3 high speed	Connect terminals H—J—K on HS 150 Interface Panel to the normally closed contact of RL2027/2 in Tube Selected Lights and Aux Panel
Tube 1 normal speed Tube 2 high speed Tube 3 high speed	Connect terminals H—J—K on HS 150 Interface Panel to the normally closed contact of RL2026/2 in Tube Selected Lights and Aux Panel

2 High Speed Tubes Only

Connect terminals H—J--K on HS 150 Interface Panel to terminal 0 in Tube Selected Lights and Aux Panel

4.8.10 Gecomat 2

A R500 Control Console

Refer to the diagrams on pages 34 to 36, Figs 18 to 21.
Further information is contained in Inst.2249. (Gecomat 2)

i Inscribe and drill holes for GECOMAT CONTROL UNIT.

ii If a Bucky is to be used, the link between terminal 26 and the relevant terminals 27-32 in the R500 must be removed.

iii The link from terminal 26, on the R500 Console main terminal strips must be reconnected from terminal 3 on the timer chassis to terminal 4. (Terminal 3 has 2 green wires; one wire links terminals 3, 8 and 10 on the timer chassis, the other wire connects to terminal 26.)

iv Connections between Gecomat 2 and the R500 via Cable C are as follows:

R500 terminals	Wire colour	Gecomat 2 control unit terminals
3) on timer	brown	11
4)	blue	10
9) on timer	black	2s
1)	yellow	1s
E (2 wires)	green & yellow/green (2 wires)	E

This cable contains a blue 6-way Amplok connector.

B Gecomat 2 Power Unit

WARNING: DISCONNECT LEADS FROM CONTACTOR SUB-CHASSIS TO TERMINALS 4, 4A AND 5 IN THE POWER UNIT BEFORE CONNECTING UP TO R500 GENERATOR AND JUNCTION BOX 4. DAMAGE MAY RESULT IF THIS IS NOT DONE.

C Junction Box 4 (Refer to page 36 for interconnections.)

Fit the new identification panel into junction box 4 as shown below. Use the existing nuts and studs and wire

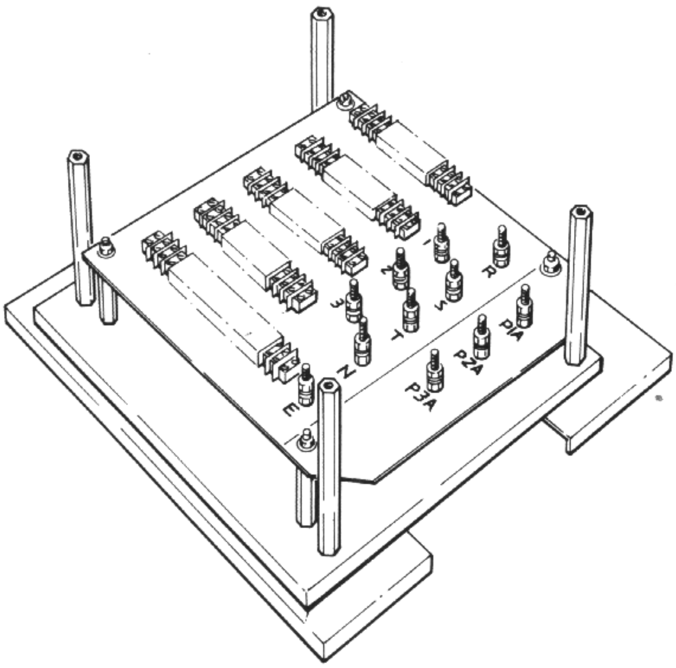


Fig.18 Junction Box 4 modified for Gecomat 2

Note: Terminals 3 and P3A NOT used.

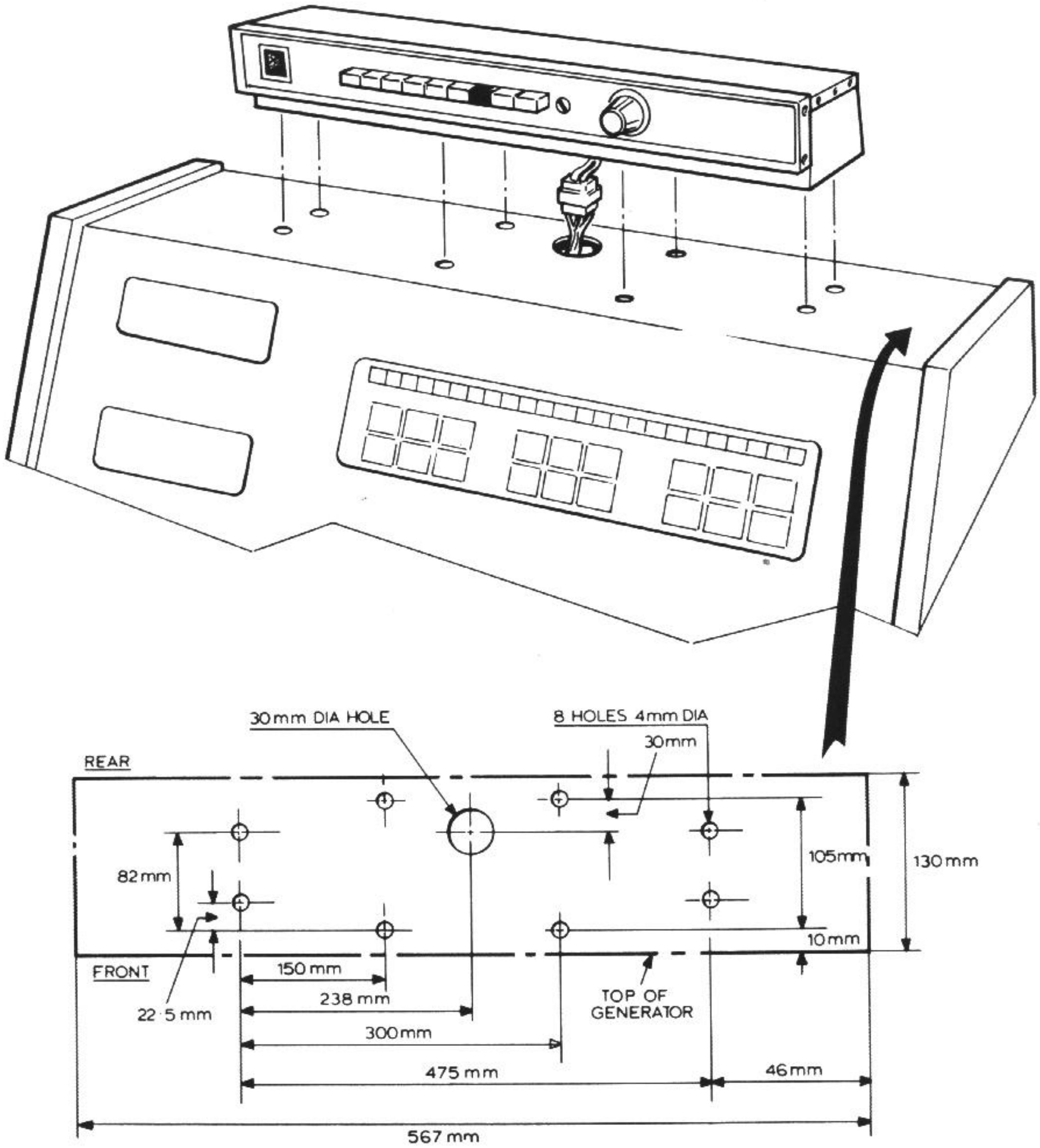


Fig.19 Drilling required on R500 Control Console for Gecomat 2

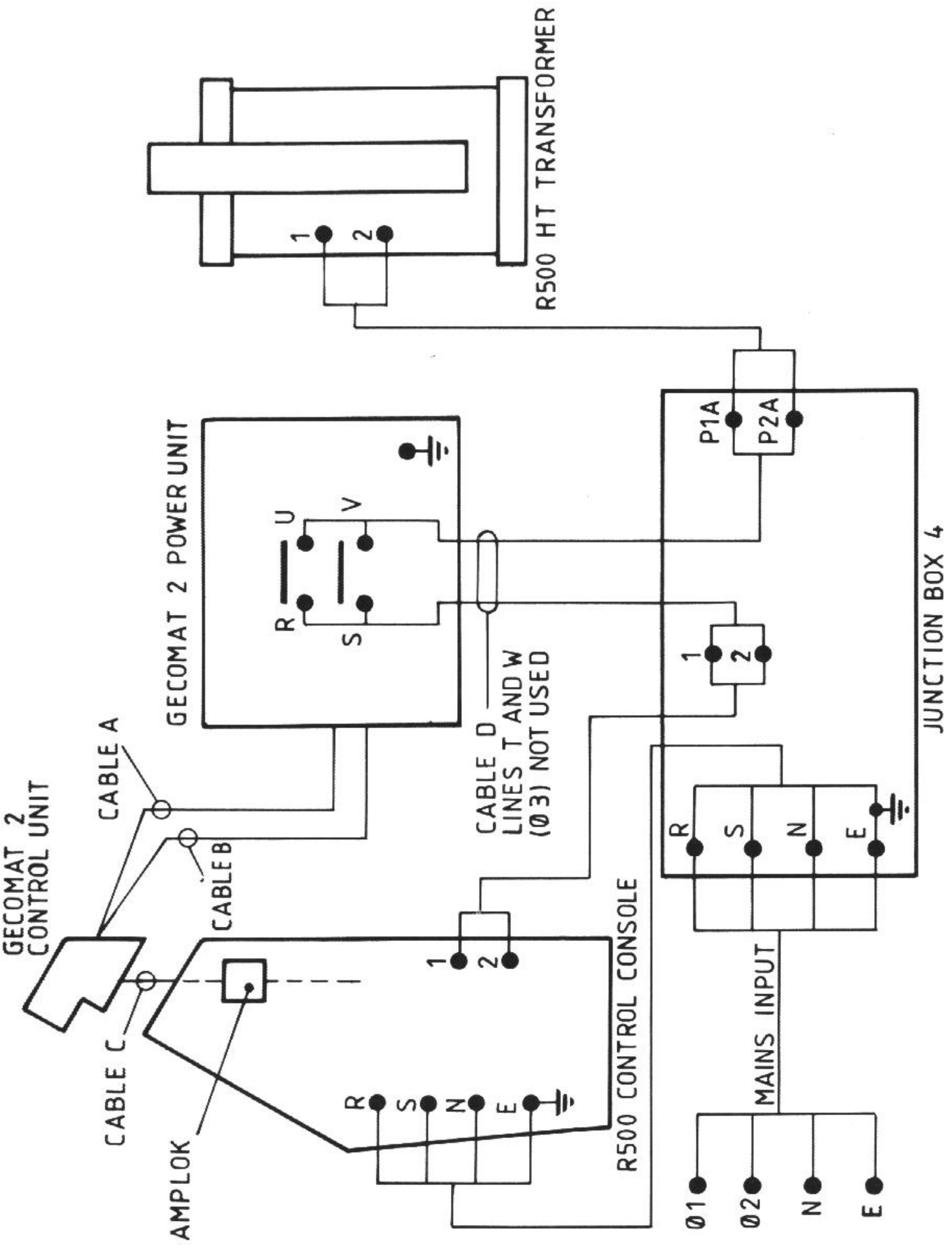
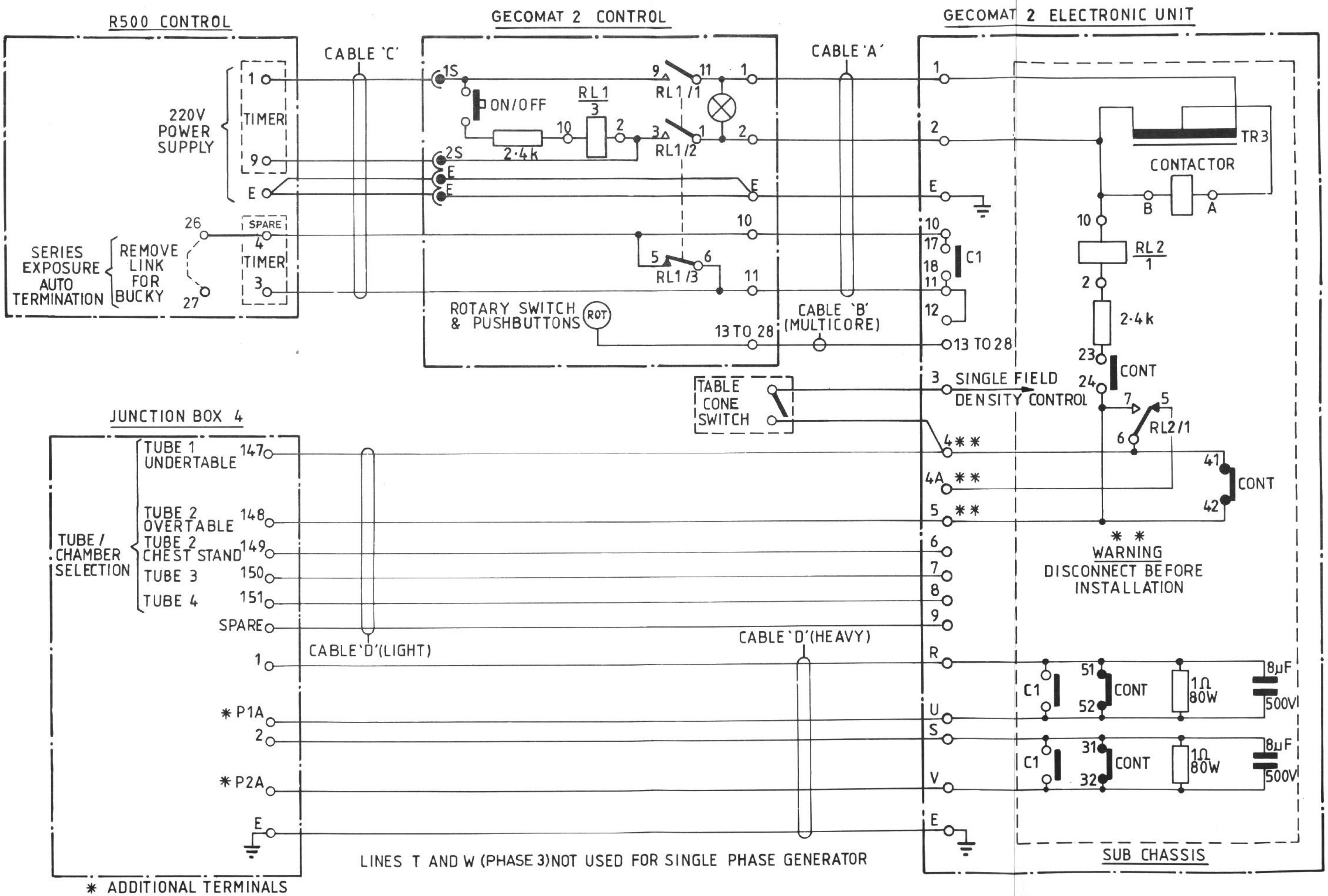


Fig 20 Mains and HT Primary Cable runs and connections from Gecomat 2 to R500



(2277/1/380)

R500 - GECOMAT 2 INTERCONNECTIONS

Fig 21

HARPERBURY

5 COMMISSIONING

5.1 Preliminaries

A Disconnect and insulate the heavy wires from JB4A (KIT A) or the Control Console (KIT B) at terminals 1 and 2 on the HT Transformer.

B Double check that the HT Cables from the X-ray tubes are connected to the correct receptacles on the HT Transformer.

REMINDER: THE UNDERTABLE TUBE ON THIS EQUIPMENT IS TUBE 1.

C Check that the WHITE, RED, YELLOW and GREEN sliding cursors on the filament drive adjusting rheostats illustrated on page 57 are all at the bottom end of travel on each rheostat. (Maximum series resistance)

D Read Operator Instruction INST 2276 for the positions and functions of all controls.

5.2 Electrical Safety Checks

5.2.1 Earth Continuity Resistance Tests

Check with Earth Bond Tester (25A for 5 secs) that the resistance between the Main Earth Terminal (mains input) and all other earth terminals and all accessible metal parts is less than 0.1 ohm. All earthed parts must have a permanent and reliable path to the Main Earth Terminal and identified with earth symbol washers MA 10419 or MA 10420.

5.2.2 Earth Insulation Resistance Tests

A Refer to Fig. 5, page 11 for terminal locations.

B With a 500 volt Megger, measure the insulation resistance at each of the following points with respect to the Main Earth Terminal.

i Dead side of line R (L1) on Line Contactor L.

ii Dead side of line S (L2) on Line Contactor L.

iii Main Neutral Terminal on the Control Console.

iv Terminal 1 on the HT Transformer.

v Terminal 2 on the HT Transformer.

The measurements recorded for each of the tests in sub-paragraph 5.2.2 B should not be less than 20 M Ohms.

5.3 Line Compensation Voltmeter Check

A Connect a 300 Volt FSD a.c. Voltmeter to terminals 0 and 220 on the Console Main Terminal Strips.

B Switch ON the R500.

C By means of the LINE COMPENSATOR SWITCH obtain a reading of 220 Volts on the test voltmeter.

D Verify that the pointer of the mA meter is coincident with the red datum line. (During the stand-by mode of control, the mA meter is converted to indicate Volts.)

E If the mA meter pointer does not line up with the red datum line adjust P16 on Chassis T6 (bottom rear left of Control Console) to bring the meter pointer into coincidence.

F Switch off the R500.

G Disconnect the test voltmeter.

5.4 Setting up the kW/Time Overload Board

WARNING: THE APPEARANCE OF THE OVERLOAD BOARD IS SIMILAR TO THAT ON THE R703 BUT THE OPERATING VOLTAGES ARE IN THE REGION OF 110 VOLTS AC.

DO NOT TOUCH TERMINALS ON THIS BOARD WHEN THE MACHINE IS SWITCHED ON.

5.4.1 Tube Type Programming - see page 40, Fig 22.

A Two types of X-ray tube can be deployed to make up the total complement of 4 tubes.

B On the kW/time Overload Board the two types of tube are referred to as Group A and Group B

C The tube selector switch must be programmed for the tube combination deployed. This is achieved by re-arranging the links on each of 3 terminal strips designated kV MAX.

The individual terminal numbers on each of these terminal strips are as follows:

A 1 2 3 4 B

When the programming procedure is completed the links on each terminal strip must correspond with one another.

D The following examples should clarify the programming procedure:

TUBE TYPE COMBINATION	kV MAX TERMINAL STRIP LINKS
ALL TUBES GP A (e.g. ALL D 50/69)	A 1 2 3 4 B
TUBE 1 GP A (e.g. HD 40) TUBES 2, 3 & 4 GP B (e.g. D 50/69)	A 1 2 3 4 B
TUBES 1, 2 & 4 GP A TUBE 3 GP B	A 1 2 3 4 B
TUBES 1 & 2 GP A TUBES 3 & 4 NOT USED	DO NOT CONNECT A 1 2 3 4 B
TUBE 1 GP A TUBE 2 GP B TUBES 3 & 4 NOT USED	A 1 2 3 4 B DO NOT CONNECT

5.4.2 Maximum kV Adjustments Refer to illustration page 40, Fig 22.

A The following procedure applies to a tube to be set up on the Group A links.

i Ascertain from a tube rating chart the mA values at which the X-ray tube can be operated unrestricted up to 125 kV at 5 seconds.

For a Dynamax Super 50/69 this will usually occur on the 0.6mm focal spot at 50mA and 100mA.

ii The top left-hand Group A Terminal Strip designated mA Voltage has 6 terminals. Each is associated with a selected mA value as follows:

Terminal C	50 mA
Terminal D	100 mA
Terminal E	200 mA
Terminal F	300 mA
Terminal G	400 mA
Terminal H	500 mA.

Link the terminals apertaining to each mA chosen in sub-paragraph 5.4.2 A i to the left-hand tap (terminal 1) on the mA voltage resistance decade.

For the Dynamax Super 50/69 example, terminals C and D would be linked to terminal 1 on the mA Voltage resistance decade.

iii The bottom left-hand Group A Terminal Strip designated mA seconds, also has 6 terminals associated with selected mA as follows:

Terminal C	50 mA
Terminal D	100 mA
Terminal E	200 mA
Terminal F	300 mA
Terminal G	400 mA
Terminal H	500 mA

Link the terminals apertaining to each mA chosen in sub-paragraph 5.4.2 A i to the left-hand terminal (0.01 secs) on the lower Time Voltage resistance decade.

For the Dynamax Super 50/69 example, terminals C and D would be linked to the 0.01 sec tap on the Time Voltage resistance decade.

iv Switch on the R500.

v Set the line compensator switch to bring the mA meter pointer into coincidence with the red datum line.

vi Select 126 kV.

vii Select 50 mA.

viii Select 0.01 seconds.

ix Turn potentiometer A on the Overload Board until the overload lamp just switches ON.

x Select the other mA values which were linked on the GP A mA Voltage and mA Time Terminal Strips and check that the overload light switches ON at 126 kV.

xii Repeat sub-paragraphs 5.4.2 A **v** to x above and check that the operation of the overload lamp is not influenced by movement of the time switch from 0.01 secs to 5 secs.

xiii Switch OFF the R500.

B For a tube to be set up on the Group B links, follow the procedure outlined in sub-paragraph 5.4.2.A substituting the Group B mA Voltage and mA Time Terminal Strips and adjust for maximum kV on potentiometer B on the Overload Board.

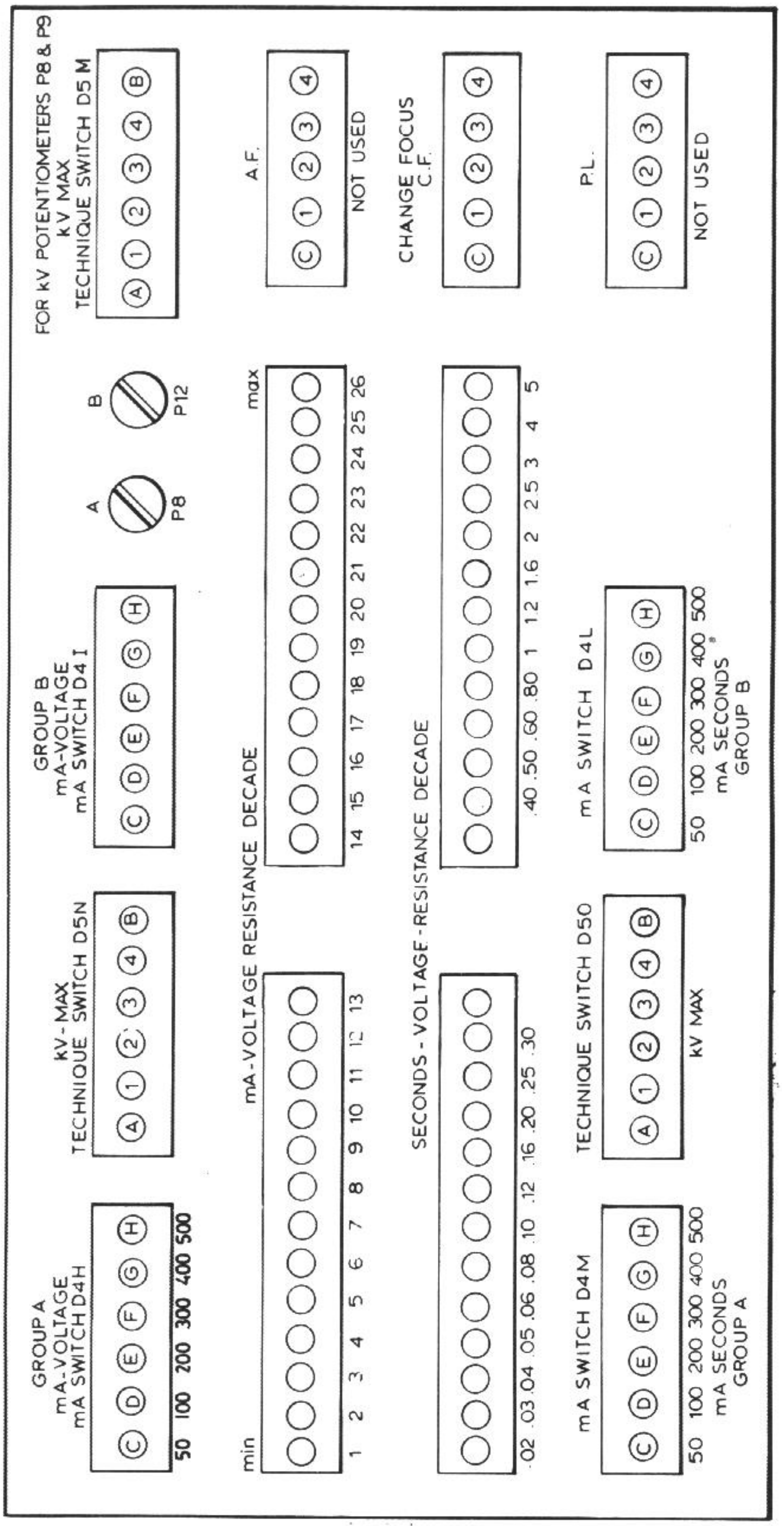


Fig 22 R500 kW/Time Overload Board

R500 Overload Time Resistance Starting Points

Dynamax Super 50/69 0.6mm 50Hz Single Phase

mA	Limits	Resistance Value	Time Tap number (seconds)	mA Tap number
50	No restrictions. Connect time tap C thus		0.01	1
100	Tube can be operated at 125kV and above. 125kV overload occurs at 5 sec. Connect time tap D thus		4	5
200	Tube cannot be operated at 100kV. 90kV tube overload occurs at 0.5 secs. Connect time tap E thus	73kΩ	Between 0.16 and 0.5	11

Dynamax Super 50/69 1.3mm 50Hz Single Phase

300	Tube can be operated at 125kV and above. 125kV tube overload occurs at 1.6 secs. Connect time tap F thus		1.2	13
400	Tube can be operated at 125kV and above BUT R500 is restricted to 110kV. 110kV tube overload ovvurs at 0.8 secs. Connect time tap G thus	12kΩ	0.8	16
500	Tube cannot be operated above 90kV and R500 is also restricted to 90kV. 90kV tube overload occurs at 0.8 secs. Connect time tap H thus	40kΩ	0.8	16

Dynamax HD40 1.0mm 50Hz Single Phase

mA	Limits	Resistance Value	Time Tap number (seconds)	mA Tap number
50	No restrictions. Connect time tap C thus		0.01	1
100	Tube can be operated at 125kV and above. 125kV overload occurs at 1.6 secs. Connect time tap D thus		1.2	10
200	Tube cannot be operated above 105kV. 105kV tube overload occurs at 0.02 secs. Connect time tap E thus	39k	0.02	16

Dynamax HD40 2.0mm 50Hz Single Phase

300	Tube can be operated at 125kV and above. 125kV tube overload occurs at 0.12 secs. Connect time tap F thus		0.1	16
400	Tube cannot be operated above 110kV. R500 is also restricted to 110kV. 110kV tube overload occurs at 0.01 secs. Connect time tap G thus	33k	between 0.01 and 0.04	17
500	Tube cannot be operated above 90kV. R500 is also restricted to 90kV. 90kV tube overload occurs at 0.01 secs. Connect time tap H thus	66k	between 0.01 and 0.02	17

5.4.3 Time and mA Overload Setting for Tubes Capable of Operating Beyond the R500 125kV Restriction

NOTE: On delivery, the R500 Overload Board is set up for a Dynamax 50/69 and a Dynamax HD 40 tube.

At certain mA values the characteristics of both of these tubes call for the insertion of additional resistance in the Seconds Voltage Resistance Decade.

As these are non-adjustable preferred Ohmic values, it may be found that on certain mA settings, the overload circuit will not accurately follow the tube rating graphs.

If this is encountered, the resistors associated with the mA concerned can be replaced with adjustable multi-turn 100k Ohm potentiometers STOCK NO X210-973 as supplied with the DHSS Kit.

Adjustment details follow in sub-paragraph 5.4.4.

A The following procedure is applicable for tubes to be set up on GPA links.

For tubes to be set up on the GPB links, adopt the same procedure substituting GPB links for GPA links.

B The starting point is always on the Seconds Voltage Resistance Decade using the high kV low time overload graph.

Refer to the example tabulated on page 42 for the D40 2 MM focal spot tube working at 300mA.

With 125kV and 300mA selected tube overload will occur when the time switch is advanced to 0.12 seconds.

The next time down will therefore be the starting point on the Seconds Voltage Resistance Decade which is 0.1 seconds. Connect this tap to terminal F on the GPA mA seconds terminal strip.

C Connect a wander lead to terminal F on the GPA mA volts terminal strip.

D Switch ON the R500 and compensate.

E Select 300mA.

F Select the lowest kV at which it will be possible to overload the tube within the 5-second range of the time switch (in this example 60 kV).

G Advance the time switch to the overload time of 4 secs.

H With caution, touch the free end of the wander lead in sub-paragraph 5.4.3C to each terminal on the mA Volts Resistance Decade working from left to right until the overload lamp lights. Temporarily secure the tap.

J Select 125kV.

K Select 0.01 seconds.

L Advance the timer switch and check that the overload lamp lights at 0.12 secs.

If the overload lamp lights too soon, move the 0.1 second wander lead tap on the seconds voltage resistance decade one terminal at a time working from left to right until the overload lamp just lights at 0.12 secs.

If the lamp lights too late, transfer the above wander lead one terminal at a time working from right to left until the lamp just lights at 0.12 secs.

M Select 60kV.

N Advance timer switch and check that the overload lamp lights at 4 secs.

If the lamp lights too soon, move the wander lead on the mA Voltage Resistance Decade one terminal at a time working right to left until the overload lamp just lights at 4 secs.

If the lamp lights too late, transfer the above wander lead one terminal at a time working left to right until the overload lamp just lights at 4 secs.

O Repeat sub-paragraphs 5.4.3J to N until the 125kV and 60kV overload operating conditions are correct.

P Check all other kV/time overload points at 70, 80, 90, 100 and 110kV. If there is any discrepancy, readjust the wander leads on the seconds voltage and mA Voltage Resistance Decades to obtain an overall compromise.

5.4.4 Time and mA Overload Settings for Tube and Generator High mA kV Restrictions Below 125kV

Examples: A Dynamax Super 50/69 0.6mm focus tube can be taken up to 90kV at 200mA but not 100kV.

The R500 should not be operated above 110kV at 400mA and on 500mA it should not be operated above 90kV.

The R500kW/time Overload Circuit is designed to follow rating charts starting at the 125kV short time point down to the low kV long time points.

If kV overload restrictions such as those cited in the above examples have to be imposed, then the characteristics of the kW/time circuit must be modified by adding resistance to the Seconds Voltage Resistance Decade.

The kV restriction to be imposed will therefore be dependent on the value of resistance to be added.

This is critical, because the Overload Circuit must now be ON from 125kV down to the restricted kV point and from then onwards it must follow the tube rating graphs from the restricted kV short time point down to the low kV long time points.

A Materials required for two varieties of tube:

6 off — Potentiometers multi-turn 100k Ohm STOCK NO X210-973

3 metres — Connecting wire 24/0.02mm flexible

12 off — Terminals spade crimp 4 BA STOCK NO 6233-201

The above items should be provided with DHSS KIT M12116

B Connect potentiometers rheostat fashion as shown:

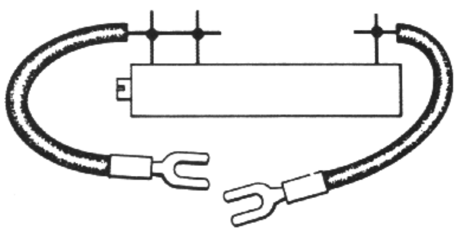


Fig.23 Potentiometer Connector

C The following procedure applies to tubes to be set up on the GPA links.

For tubes to be set up on the GPB links, substitute GPB for GPA.

D The starting point is always on the Seconds Voltage Resistance Decade using the restricted portion of the high kV short time tube rating curve.

Refer to the example tabulated on page 41 for the Dynamax Super 50/69 0.6mm tube at 200mA.

This tube cannot be operated at 100kV so it will be restricted at 90kV to be on the safe side.

90kV overload occurs at 0.5 secs which will be the starting point.

E Connect a 100k Ohm potentiometer between the 0.5 second tap on the Seconds Voltage Resistance Decade and terminal E on the GPA mA seconds terminal strip. Turn the potentiometer fully counter-clock for zero resistance.

F Connect a wander lead to terminal E on the GPA mA Voltage Terminal Strip.

G Switch ON the R500 and compensate.

H Select 200mA.

J Select the lowest kV which will overload the tube within the 5-second time range of the time switch (70kV at 5 seconds in this example).

K Advance the timer switch to 5 seconds.

L With caution, touch the free end of the wander lead in sub-paragraph 5.4.4F to each terminal on the mA Voltage Resistance Decade working from left to right until the Overload Light just comes ON. Temporarily secure the wander lead to this tap.

M Select 90kV.

N Select 0.5 secs.

O Insert resistance in the 0.5 sec potentiometer until the Overload Light just comes ON.

P Select 70kV.

Q Check that the Overload lamp just lights when the timer switch is advanced to 5 seconds.

If it does not light, move the wander lead temporarily secured on the mA Voltage Resistance Decade one tap at a time to the right until it does light.

If the lamp lights too soon, move the wander lead one tap at a time to the left until the light can just be made to light at 5 seconds.

R Select 90kV.

S Select 0.5 seconds

T The Overload lamp should only just light.

To establish this, turn the 0.5 sec potentiometer counter-clock until the lamp goes out, then increase the resistance until the lamp just lights.

If the lamp is off increase the resistance of the potentiometer further until it lights.

U Repeat sub-paragraphs 5.4.4P to T until correct operation of the Overload Circuit is achieved at the 90kV 0.5 second and 70kV 5 second overload points.

V Check all the intermediate kV/time overload factors. If there is any discrepancy, compromise by shifting the 100k Ohm wander lead tap on the Seconds Voltage Resistance Divider to a neighbouring terminal. Left to make light come ON early and vice versa.
In this example the tapping point could be anywhere between 0.16 and 0.5 sec

W Switch OFF the R500.

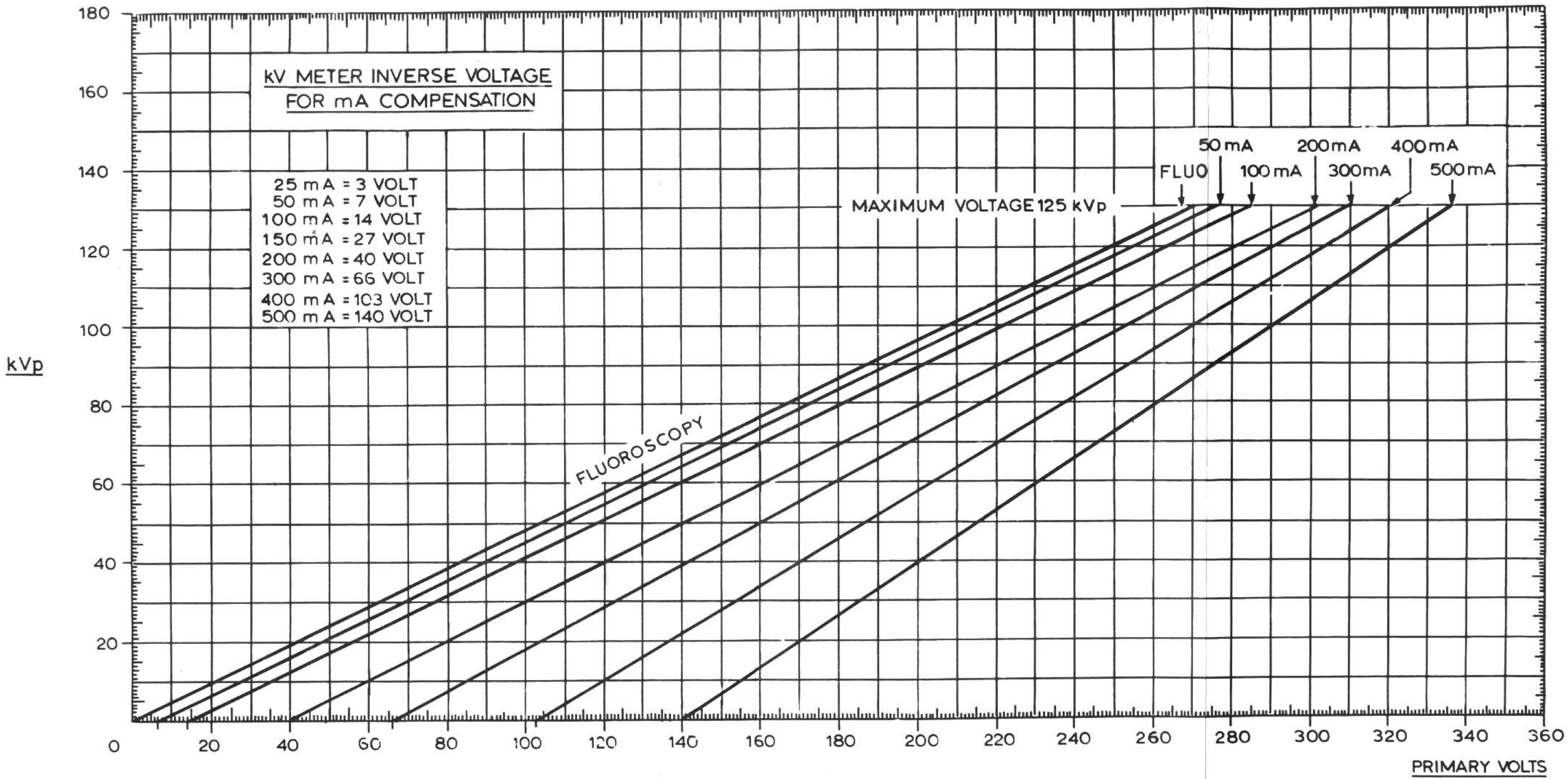


Fig.24 kV Meter Inverse Voltage for mA compensation

Fig No. 24

5.5 kV Meter Calibration to HT Primary Volts

5.5.1 Fluoroscopy

A Undo the two securing fasteners for Chassis TI and withdraw from the rear of the Console. See illustration on page 57, Fig 27.

B Connect a 300 Volt a.c. FSD meter to terminals 2 and 111 on Chassis TI. These terminals supply the primary of the HT Transformer during the fluoroscopy mode of control.

C Switch ON the R500 and compensate to align the pointer of the mA meter with the red datum mark.

D Press the Fluoro kV Meter pushbutton on the facia panel.

E Set the Fluoro kV Control to obtain readings on the test voltmeter as tabulated below and note the kV Meter indication for each setting of the Fluoro kV Control.

TEST VOLTMETER READING	kV METER INDICATION
215 208	100
161 157	75
107 104	50

F If the indicated kV differs from the test figures tabulated above, adjust potentiometer P7 on Chassis TI for an overall compromise.

G If it is not possible to obtain 215 Volts on the test voltmeter when the Fluoro kV Control is turned fully clockwise, change the Fluoro kV Variac tapping point from Fuse 16 to Fuse 18 on the panel illustrated in page 57, Fig 27.

H Switch OFF the R500.

J Disconnect the test voltmeter and resecure Chassis TI.

5.5.2 Radiography

A On the potentiometer and fuse panel illustrated on page 56, turn the following line resistance kV compensation potentiometers fully counter-clockwise.

P1	50mA
P2	100mA
P3	200mA
P4	300mA
P5	400mA
P6	500mA

1) Done

Final adjustment of the above will be dealt with in paragraph 5.7

B On the same panel, turn the following mA compensation potentiometers for the kV meter fully counter-clockwise.

P17	50mA
P18	100mA
P19	200mA
P20	300mA
P21	400mA
P22	500mA

Do not Touch Factory Set! only move if kV meter Reading can not be altered by moving P1 to P6

C On the kV meter mA Compensation Transformer TR16 mounted on the front left of the Control Console base confirm that the secondary winding is connected as follows:

TAP No	WIRE IDENT.	WIRE COLOUR
7 Volt	C	White
14 Volt	D	Red
40 Volt	E	Yellow
66 Volt	F	Green
103 Volt	G	Blue
140 Volt	H	Black

D Connect a 400 Volt a.c. FSD voltmeter to the top left-hand terminal on Radiography Contactor X and the bottom pair of linked terminals on Premagnetisation Contactor PM illustrated on page 11, Fig 5.

These are the supply terminals for the primary of the HT Transformer during the radiography mode of control.

E Switch ON the R500 and compensate.

F Set the Radiography kV Controls to obtain readings on the test voltmeter as tabulated below for each position of the mA Switch and check that 125kV is indicated on the kV meter in each case.

mA SELECTED	TEST VOLTMETER READING VIA kV CONTROLS	kV METER INDICATION	POTENTIOMETER TO ADJUST FOR 125kV
50	275 268	125	P17
100	286 281	125	P18
200	301 296	125	P19
300	310 300	125	P20
400	320 314	125	P21
500	337 336	125	P22

G Correct any kV Meter discrepancy by adjustment of the potentiometer applicable to the mA selected.

H Switch off the R500 and disconnect the test voltmeter.

5.6 Adjustment of Tube mA

A Connect the primary of the HT Transformer.

B To screen from the Console, temporarily link terminal 24 to 34 on JB4 and use the Fluoro Timer on the control facia as the fluoro switch.

C To set up the undertable tube mAs output from the Console, temporarily link terminal 22 to 34 on JB4 and use the Prep/ Expose switch on the control facia.

5.6.1 Broad Focus Pre-Heat Adjustment for All Tubes

A Disconnect the broad and fine tube filament supply wires at terminals 10 and 11 on the HT Transformer.

B Switch ON the R500 and compensate.

C Select Tube 1 (undertable).

D Press the Fluoro kV Meter button and set the Fluoro kV control to indicate 70kV on the meter.

E Switch On the Fluoro Timer and record the reading on the mA meter 0-10 mA scale.

This will be very small because it will only be recording the HT secondary capacitive current.

F Switch OFF the Fluoro Timer.

G Switch OFF the R500.

H Reconnect the broad focus wire to terminal 10 on the HT Transformer.

J Switch ON the R500.

K When Ready Lamp lights, switch ON the Fluoro Timer.

L Note the tube emission on the mA meter which must be 0.1mA in excess of the reading recorded in sub-para 5.6.1 E.

If the pre-heat emission is incorrect, adjust the tapping band on resistance R10 (see Fig 27 illustration on page 57) until 0.1mA is added to the capacitive current recorded in sub-para 5.6.1 E.

SWITCH OFF R500 WHEN ADJUSTING R10.

5.6.2 Fluoro mA Adjustment

A Check that the R500 is OFF.

B Reconnect the fine focus wire to terminal 11 on the HT Transformer.

C Switch ON and compensate the R500.

D Select tube 1.

E Switch ON the Fluoro Timer and select 70kV.

F Increase the Fluoro mA. With the Fluoro mA control turned fully clockwise, the mA meter should not indicate more than 5mA.

If necessary, adjust the tapping band corresponding to tube 1 on resistance R12 on page 57, Fig 27 until this value is obtained.

SWITCH OFF R500 WHEN ADJUSTING R12.

5.6.3 Fine Focus Pre-heat Adjustments for Remaining Tubes

A For these tests it will be more convenient to 'screen' the remaining tubes from the Fluoro controls on the Console.

Additional temporary links must therefore be added to JB4 as follows:

Operate Tube 2 — Link terminals 147, 148 and 149
Operate Tube 3 — Link terminals 147 and 150
Operate Tube 4 — Link terminals 147 and 151.

B Repeat sub-paragraph 5.6.2C.

C In sub-paragraph 5.6.2 D select the tube to be adjusted.

D Repeat sub-paragraphs 5.6.2E and F.

E In sub-paragraph 5.6.2F adjust the R12 tapping band corresponding to the tube undergoing adjustment for 5mA maximum emission.

5.6.4 Fluoro mA Capacity Compensation

A Select Tube 1.

B Switch ON the Fluoro Timer switch and select 100kV and 5mA on the Fluoro Controls.

C Adjust P11 on Chassis T1 until the mA meter reading begins to decrease.

Continued adjustment in the same direction will cause the mA to decrease further until a point is reached when it will begin to rise again.

The correct adjustment is the minimum mA which can be obtained on the mA meter.

D Switch off the R500.

5.6.5 Radiography Exposure Timer Check

A Connect the signal lead of an unearthed DM64 or equivalent memory oscilloscope to terminals 1 and 2 on Radiography Contactor X. (Lines 1 and 2 to primary of HT Transformer)

B Switch ON and check line-volts compensation.

C Set controls to 0.02 sec 60kV and 50mA.

D Take a radiography exposure and check that the trace indicated on the CRO corresponds with the specimen trace reproduced below, Fig 25.

I	First half-cycle	— Time for exposure contactor to close
II	Second half-cycle	— Premagnetization time HT transformer
III IV	Last two half-cycles	— Actual exposure time HT transformer

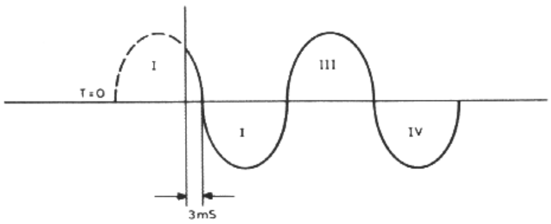


Fig.25 Typical Trace for a 0.02 Second Exposure

E Repeat this test at different exposure times between 0.01 and 0.25 seconds (e.g., 0.01, 0.05, 0.1 0.2 and 0.25 seconds) and check that there is always one extra half-cycle displayed.

F If the Timer is inaccurate, refer to the setting up procedure contained in the servicing section of this manual before proceeding with the radiography mA adjustments.

5.6.6 Radiography mA Adjustments

A The non-radiation producing element of mA which is emitted as a result of the 10 millisecond pre-magnetisation period prior to a radiographic exposure is unimportant in single-phase machines.

This factor can therefore be ignored in the calculation of mAs.

B The Tube Filament Drive Adjusting Resistances are illustrated on page 57, Fig 27.

R11 is used for tubes 1 and 2

R14 is used for tubes 3 and 4

Each has 2 sets of sliding cursors which are colour-coded for tube identification and also letter-coded for mA identification as per the table below:

	WHITE	RED	YELLOW	GREEN
C	TUBE 1 50mA	TUBE 2 50mA	TUBE 3 50mA	TUBE 4 50mA
D	TUBE 1 100mA	TUBE 2 100mA	TUBE 3 100mA	TUBE 4 100mA
E	TUBE 1 200mA	TUBE 2 200mA	TUBE 3 200mA	TUBE 4 200mA
F	TUBE 1 300mA	TUBE 2 300mA	TUBE 3 300mA	TUBE 4 300mA
G	TUBE 1 400mA	TUBE 2 400mA	TUBE 3 400mA	TUBE 4 400mA
H	TUBE 1 500mA	TUBE 2 500mA	TUBE 3 500mA	TUBE 4 500mA

C Connect an mAs meter to the external mAs meter link and adjust all the tube mA values at 75kV by means of the sliding cursors tabulated above.

D If there is insufficient adjustment to set up the high mA values, return all sliding cursors to the bottom of their travel. Move the 125V wander lead tap on TR7 to the next highest voltage and repeat the procedure in sub-para 5.6.5 C.

TR7 is the stabilised filament drive transformer and it is mounted in the bottom compartment of the Console above Chassis T6.

5.6.7 Space Charge Compensation

A Take a series of radiographic exposures at different kV settings on every position of the mA switch as tabulated below:

mA SELECTED	kV SETTINGS			
50	50	75	100	120
100	50	75	100	120
200	50	75	100	120
300	50	75	100	120
400	50	75	110	—
500	50	75	90	—

B Compare the mAs meter readings obtained within the kV range specified for each setting of the mA switch.

The overall variation should not exceed ±5% of the nominal value measured at 75kV, e.g., for a nominal value of 20mAs a change of 2mAs is permissible within the kV range specified.

C Adjustment facilities are available on the secondary of Space Charge Compensation Transformer TR6, illustrated on page 57, Fig 27.

There are 6 wander lead taps idented as follows:

WANDER LEAD IDENT	CORRESPONDING mA
C	50
D	100
E	200
F	300
G	400
H	500

If the indicated mA goes higher when the kV is increased, move the wander lead corresponding to the mA selected to a higher tap number and vice versa.

D If all tubes are of the same type, the space charge compensation for one should be adequate for the others.

In an installation with very different foci, such as 0.3 and 1mm and 1 and 2mm, not all the foci can be compensated within ±5%. A compromise will have to be made.

5.7 Final Calibration of kV Meter to Line Resistance

A It is strongly recommended that an approved kV measuring device is used for these tests such as a Voltix Shock Proof High Voltage Measuring Probe with suitable CRO or a Wisconsin Penatrometer Cassette. If these are available, proceed as detailed in METHOD 1.

B If an approved kV measuring device is not available, proceed as detailed in METHOD 2 but note that this is not considered accurate especially on the 400 and 500mA bands of the R500.

5.7.1 Method 1 with kV Measuring Device

A With the mA Switch at 50mA, set the kV meter to indicate 75kV.

B Take a suitable exposure and note the reading recorded on the kV measuring device.

If this differs from the kV meter indication, take more exposures with the kV coarse and fine controls reset accordingly until the kV measuring device records 75kV peak.

C Adjust Potentiometer P1 referred to in sub-para 5.5.2 A to bring the pointer of the kV meter back into coincidence with the 75kV datum line.

The kV meter is now compensated to pre-select the actual kV which will be generated ON LOAD.

D Repeat this procedure for 100, 200, 300, 400 and 500mA using Potentiometers P2 to P6 respectively.

5.7.2 Method 2 Without kV Measuring Device

CAUTION: AVOID OVERHEATING X-RAY TUBES BY KEEPING EXPOSURE TIMES AS SHORT AS POSSIBLE WHEN OBSERVING ON LOAD kV METER READINGS.

A With the mA Switch at 50mA, set the kV Meter to read 75kV.

B Press the Radiography Expose Button and note the kV Meter reading ON LOAD.

C When the exposure is terminated, recalibrate the kV Meter to indicate the kV noted ON LOAD by adjusting Potentiometer P1 referred to in sub-para 5.5.2 A.

The kV Meter is now compensated to pre-select the actual kV which will be generated ON LOAD.

D Repeat the procedure for 100, 200 and 300mA using Potentiometers P2, P3 and P4 respectively.

E At 400 and 500mA it will be difficult to observe the ON LOAD kV Meter readings on account of the exposure time limitations.

kV compensation will therefore have to be estimated by multiplying the kV drop noted at 100mA by a factor of 4 and 5 respectively.

These corrections can be applied by adjustment of Potentiometer P5 (400mA) and P6 (500mA).

6 FINAL TESTS

A Remove all temporary connecting links.

B Check all modes of control for correct functioning.

C Take a stepwedge film for record purposes and recheck that the correct mAs is indicated for each exposure.

D Remove the test mAs meter and reconnect the mAs meter link.

E If exposure counters are fitted, record their readings.

F Replace all Control Console, Junction Box and HT Transformer Tank covers.

7 HANDING OVER

A Demonstrate the equipment to the user and ensure that they know how to use it.

B Ensure that the user has a copy of Operating Instruction No.2276.

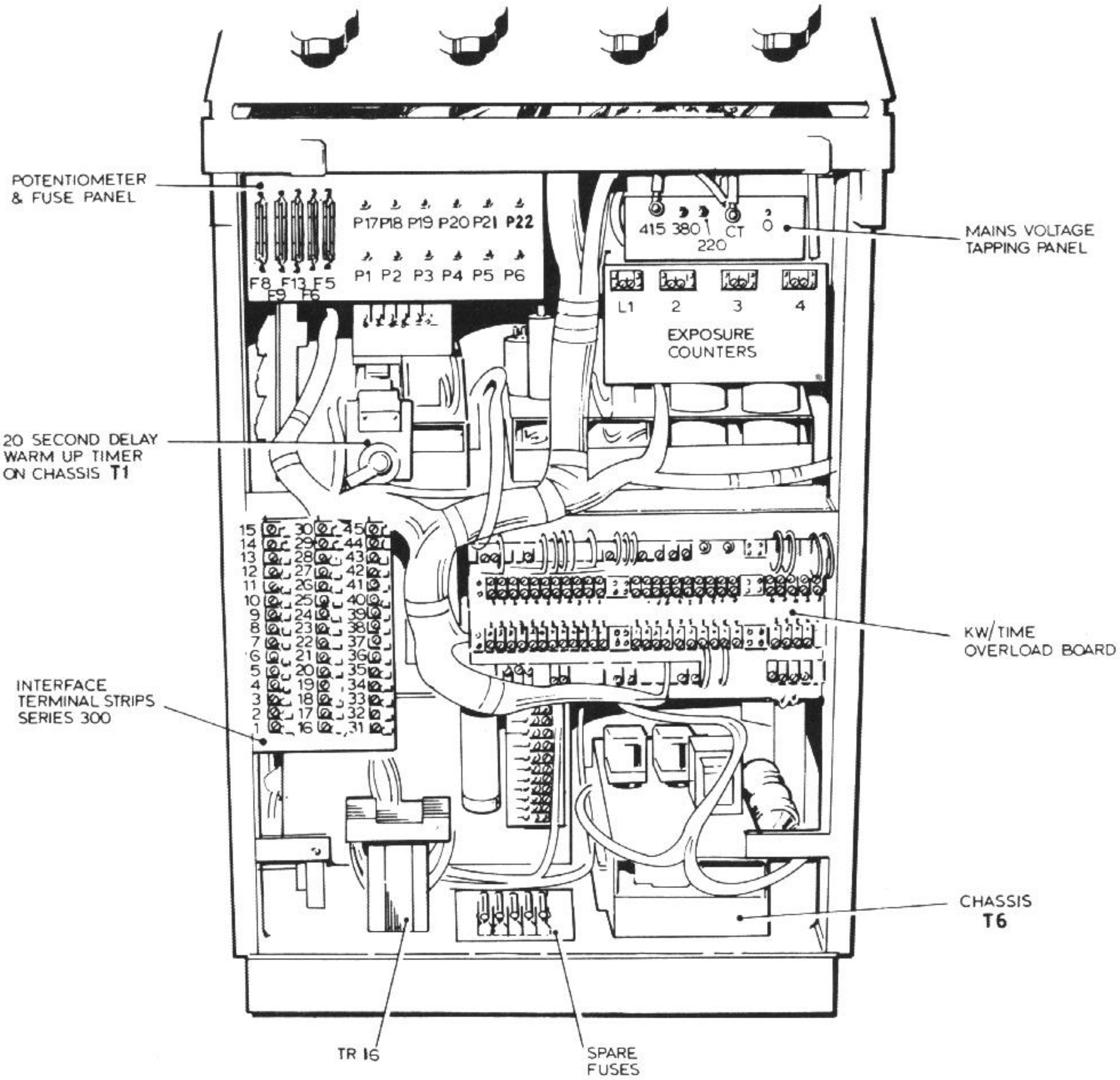


Fig.26 Control Console Front View

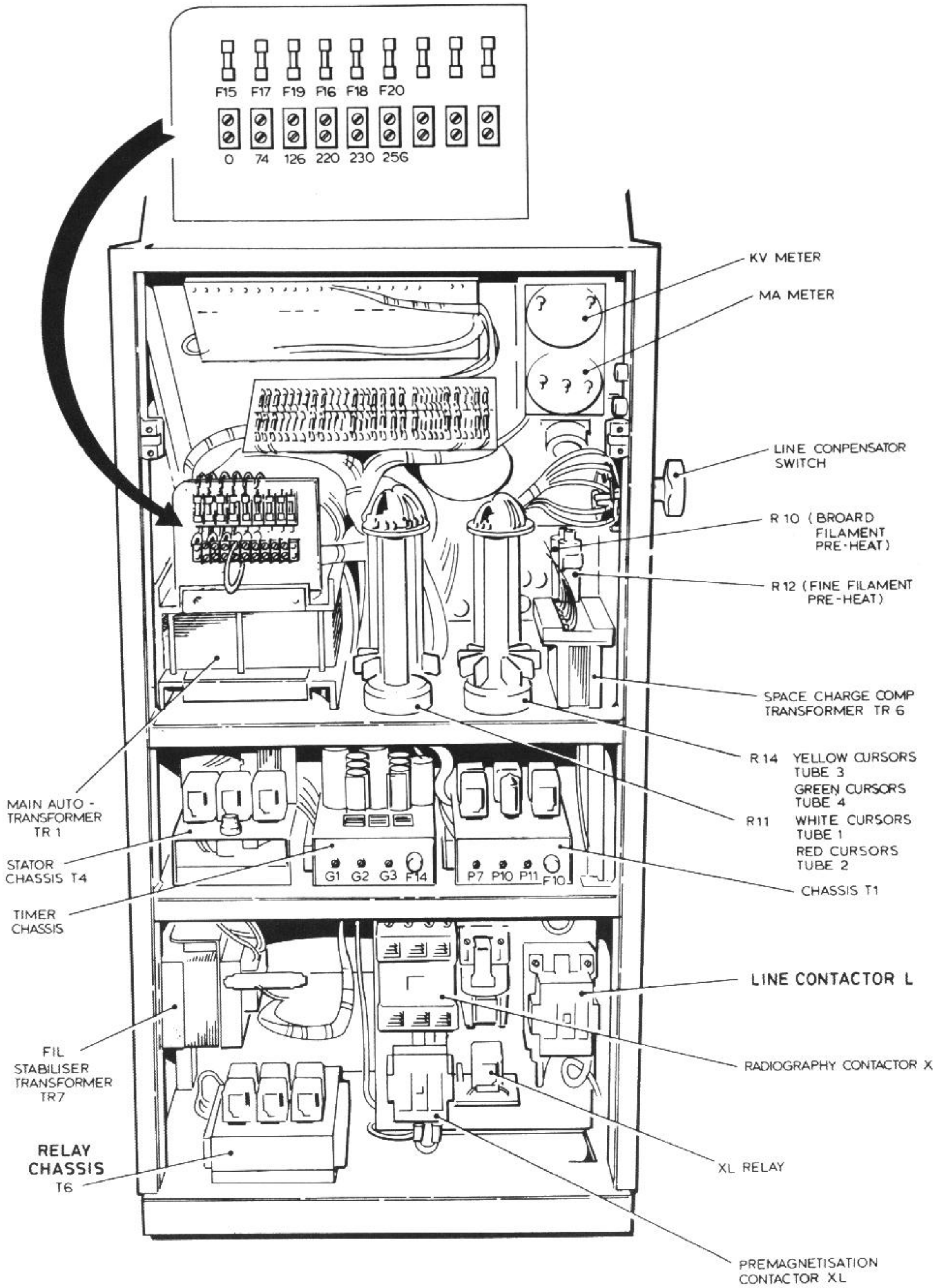


Fig.27 Control Console Rear View

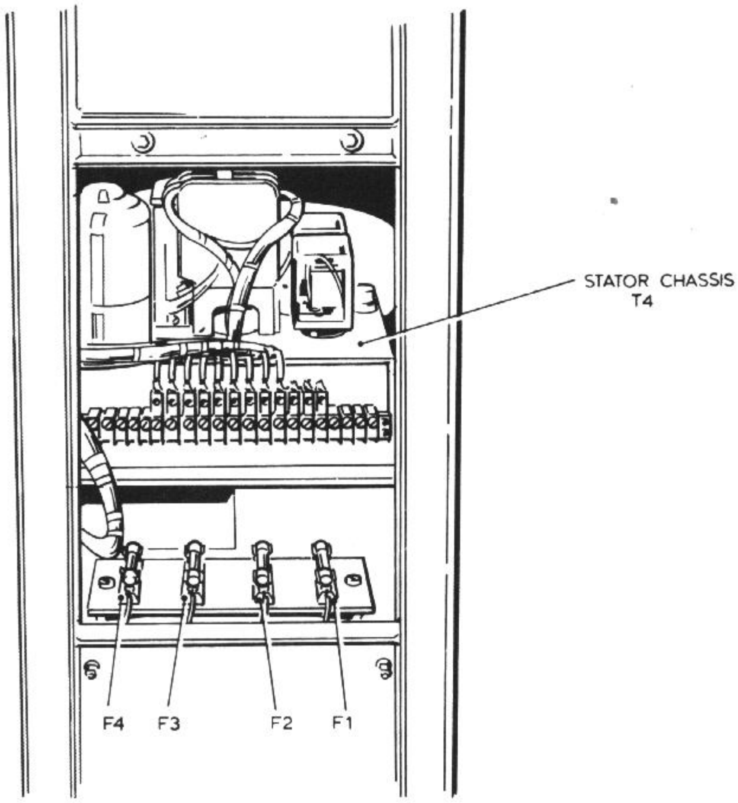


Fig.28 Control Console Side View

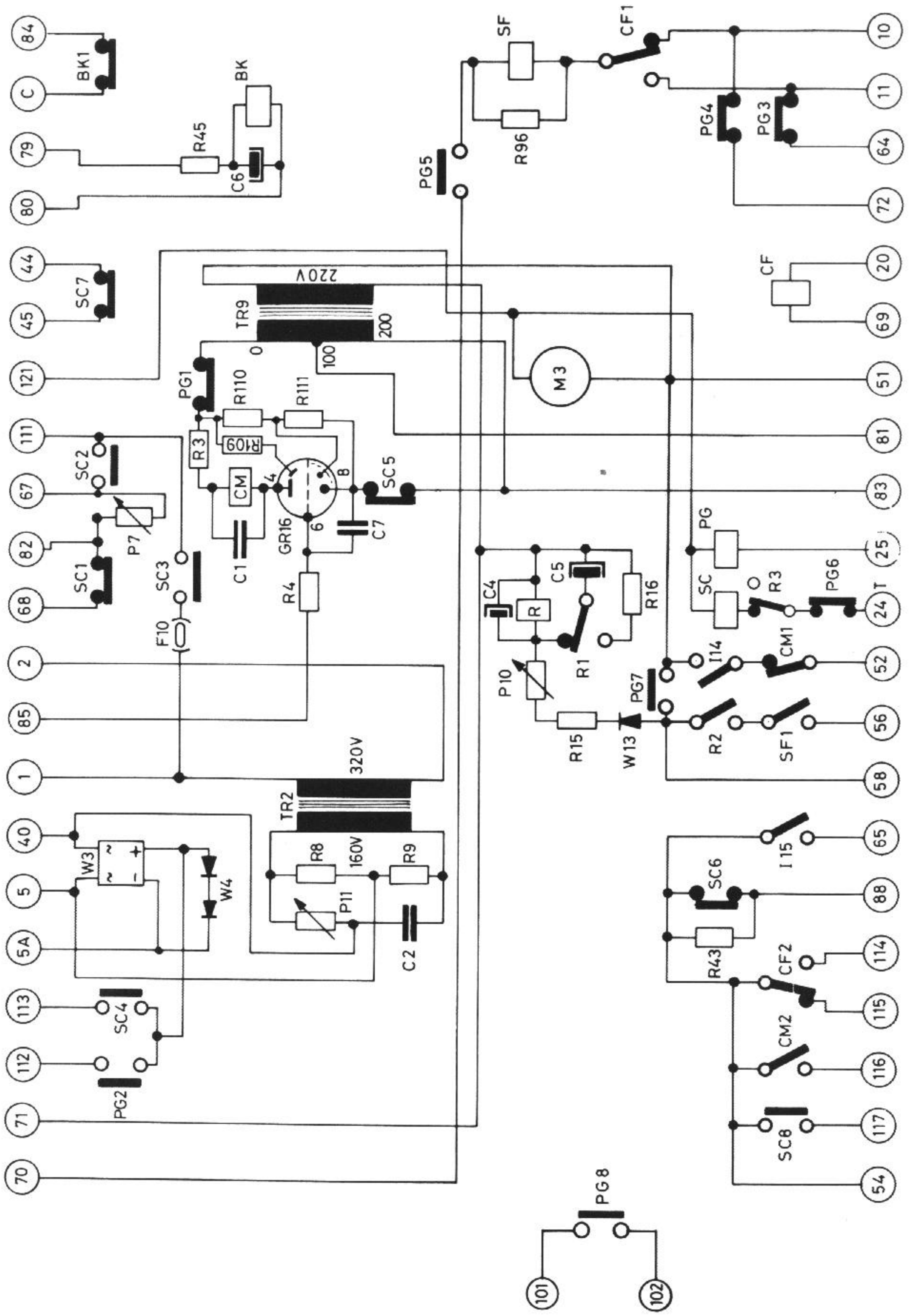


Fig 29   T1 Chassis Circuit

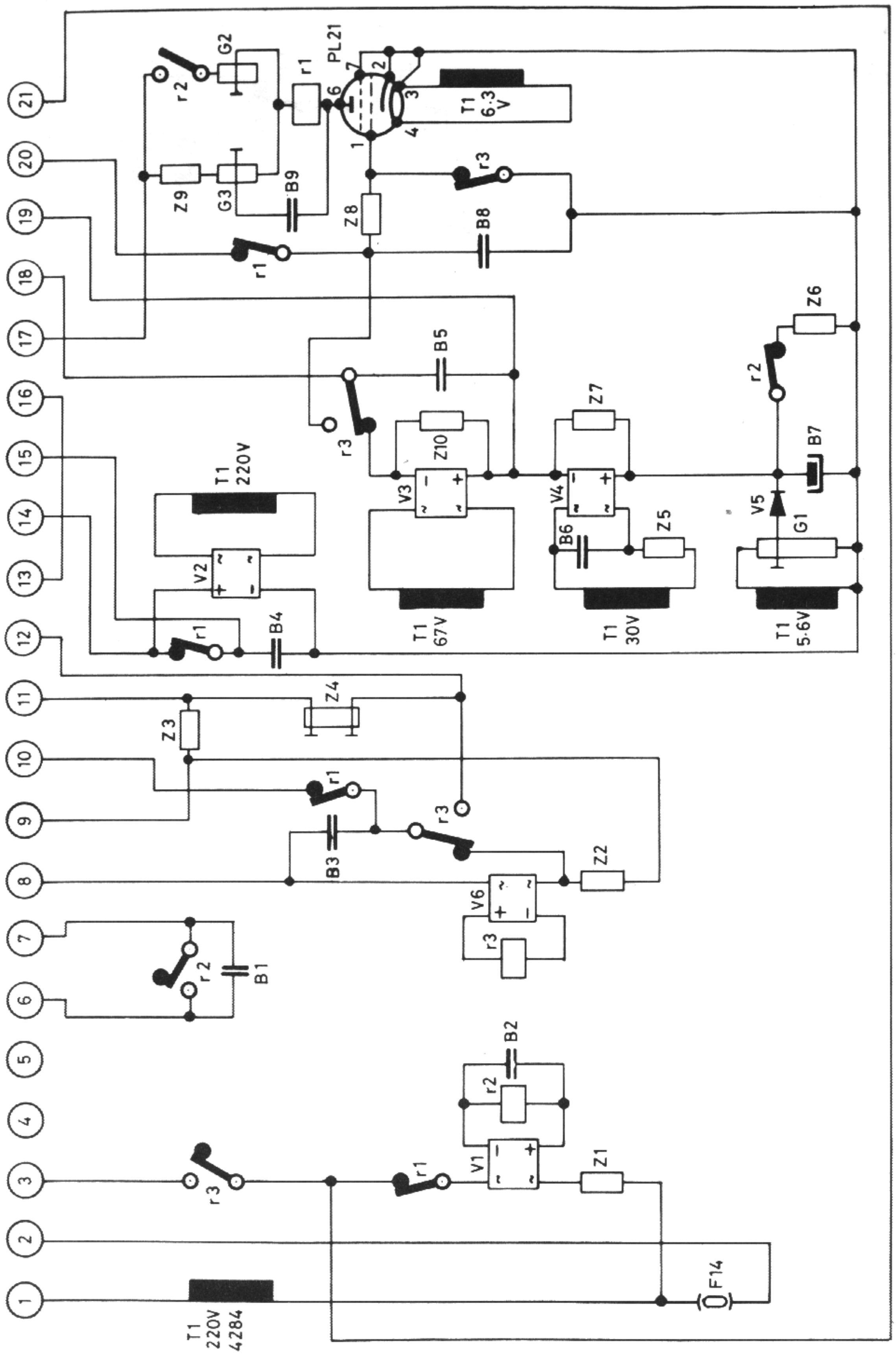


Fig 30 Timer Chassis Circuit

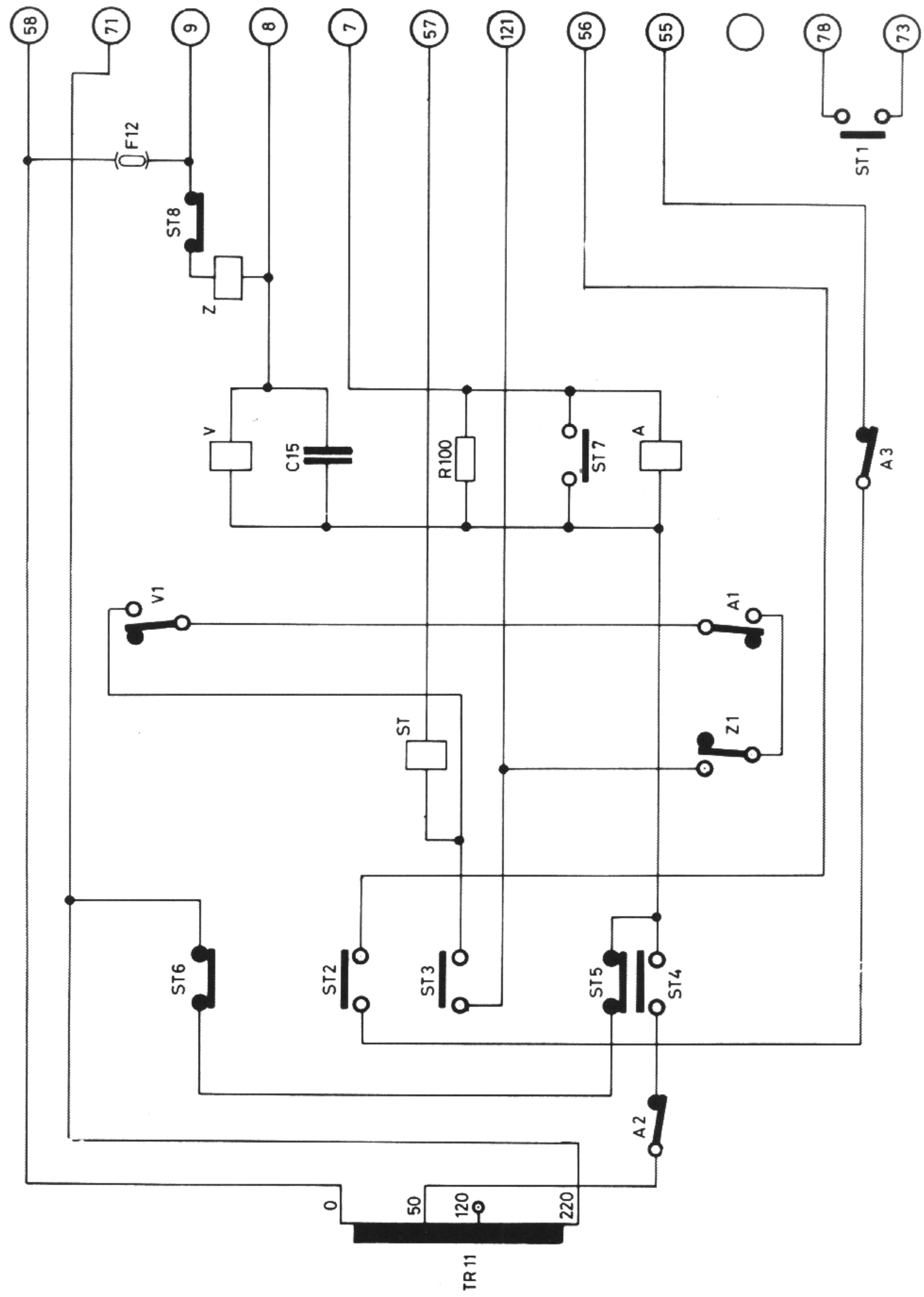


Fig 31 T4 Stator Chassis Circuit

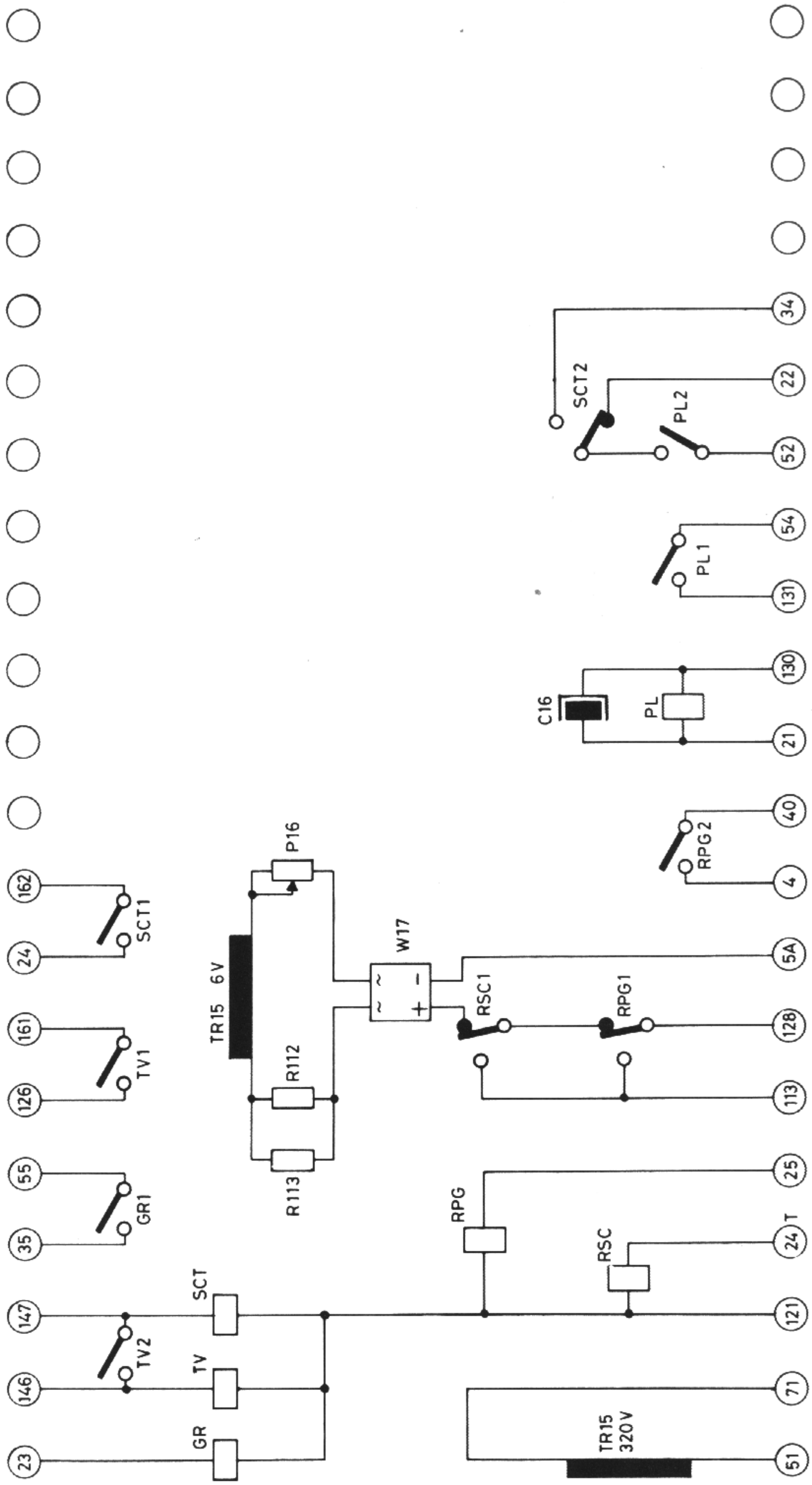


Fig 33 T6 Relay Chassis Panel Circuit

COMPONENT VALUES

Resistors

R1			
R2	82 K.Ω	0.5W	Carbon
R3	220 Ω	1W	Carbon
R4	2.7 M.Ω	0.5W	Carbon
R5	100 K.Ω	0.5W	Carbon
R6	3.5 Ω	80W	Wire wound
R7	3.5 Ω	80W	Wire wound
R8	82 K.Ω	0.5W	Carbon
R9	82 K.Ω	0.5W	Carbon
R10	180 Ω	70W	Wire wound
R11	150 Ω	140W	Wire wound
R12	112 Ω	70W	Wire wound
R13	11 Ω	16W	Wire wound
R14	150 Ω	140W	Wire wound
R15	3.900 Ω	5W	Wire wound
R16	100 Ω	1W	Carbon
R17	0.27 Ω	5W	Wire wound

Linear Potentiometers

P1	1 K.Ω	2.5W
P2	1 K.Ω	"
P3	2.5 K.Ω	"
P4	5 K.Ω	"
P5	5 K.Ω	"
P6	5 K.Ω	"
P7	10 K.Ω	"
P8	100 K.Ω	0.5W
P9	47 Ω	50W
P10	5 K.Ω	2.5W
P11	25 K.Ω	2.5W
P12	100 K.Ω	0.5W
P13		
P14	25 Ω	2.5W
P15	25 Ω	"
P16	250 Ω	"
P17	10 K.Ω	"
P18	10 K.Ω	"
P19	10 K.Ω	"
P20	10 K.Ω	"
P21	10 K.Ω	"
P22	10 K.Ω	"
G1	50 Ω	"
G2	10 K.Ω	"
G3	2.5 K.Ω	"

Timer Resistance Decade

R18	1.5 K.Ω + 0Ω	0.5W	carbon	time 0.01 sec.
R19	2.2 K.Ω + 0Ω	"	carbon	time 0.02 sec.
R20	3 K.Ω + 0Ω	"	carbon	time 0.03 sec.
R21	3.9 K.Ω + 0Ω	"	carbon	time 0.04 sec
R22	4.7 K.Ω + 0Ω	"	carbon	time 0.05 sec.
R23	4.7 K.Ω + 510Ω	"	carbon	time 0.06 sec.
R24	6.2 K.Ω + 680Ω	"	carbon	time 0.08 sec.
R25	6.8 K.Ω + 1.8KΩ	"	carbon	time 0.10 sec.
R26	9.1 K.Ω + 910KΩ	"	carbon	time 0.12 sec.
R27	11 K.Ω + 2.2KΩ	"	carbon	time 0.16 sec.
R28	15 K.Ω + 1.8KΩ	"	carbon	time 0.20 sec.
R29	18 K.Ω + 2.7KΩ	"	carbon	time 0.25 sec.
R30	22 K.Ω + 2 KΩ	"	carbon	time 0.30 sec.
R31	30 K.Ω + 2 KΩ	"	carbon	time 0.40 sec.
R32	39 K.Ω + 1 KΩ	"	carbon	time 0.50 sec.
R33	47 K.Ω + 1 KΩ	"	carbon	time 0.60 sec.
R34	62 K.Ω + 2 KΩ	"	carbon	time 0.80 sec.
R35	68 K.Ω + 12 KΩ	"	carbon	time 1.00 sec.
R36	91 K.Ω + 5 KΩ	"	carbon	time 1.20 sec.
R37	110 K.Ω + 18 KΩ	"	carbon	time 1.60 sec.
R38	150 K.Ω + 10 KΩ	"	carbon	time 2.00 sec.
R39	220 K.Ω + 20 KΩ	"	carbon	time 3.00 sec.
R40	300 K.Ω + 20 KΩ	"	carbon	time 4.00 sec.
R41	390 K.Ω + 10 KΩ	"	carbon	time 5.00 sec.

Resistors Continued

R42	180 K.Ω	70 W.	Wire wound
R43	10 K.Ω	1 W.	Carbon
R44			
R45	68 K.Ω	1 W.	Carbon
R46	100 K.Ω	0.5 W.	Carbon
R47	11 K.Ω	16 W.	Wire wound
R48	11 K.Ω	16 W.	Wire wound
R49	47 K.Ω	1 W.	Carbon

Time Overload Analog Resistors

R50 to R72 4.7KΩ 0.5W Carbon

mA Overload Analog Resistors

R73 to R95 4.7KΩ 0.5W Carbon

Resistors continued

R 96	27 Ω	5W.	Wire wound
R 99	1.8KΩ	5W.	Wire wound
R109	4.7MΩ	0.5W.	Carbon
R110	1MΩ	0.5W.	Carbon
R111	330KΩ	0.5W	Carbon
R112	820 Ω	1W	Carbon
R113	1000 Ω	1W	Carbon
R114	10 Ω	15W	Wire wound
R115	10 Ω	15W	Wire wound
R116	10kΩ	7W	Wire wound
R117	10KΩ	7W	Wire wound
R118	47KΩ	1W	Carbon
R119	47KΩ	1W	Carbon
R120	27 Ω	1W	Carbon
R121	10 Ω	1W	Carbon
R122	22 Ω	1W	Carbon
R123	10 Ω	1W	Carbon
R124	47 Ω	1W	Carbon
R125	56 Ω	1W	Carbon

Z1	5.6KΩ	5W	Wire wound
Z2	3.9KΩ	5W	Wire wound
Z3	33KΩ	0.5W	Carbon
Z4	63 Ω	30W	Wire wound
Z5	6.8KΩ	1W	Carbon
Z6	10KΩ	0.5W	Carbon
Z7	10KΩ	0.5W	Carbon
Z8	470KΩ	0.5W	Carbon
Z9	3.9KΩ	5W	Wire wound
Z10	220KΩ	1W	Carbon

Capacitors

C1	Metallized paper	Siemens	1 μF.	250 V.d.c.
C2	Metallized paper	Siemens	0.47μF.	250 V.d.c.
C3	Oil paper	Icar	6.3 μF.	650 V.a.c.
C4	Metallized paper	Siemens	1 μF.	250 V
C5	Electrolytic	Siemens	100 μF.	350/380 V.d.c.
C6	Electrolytic	Siemens	100 μF.	25/35 V.d.c.
C7	Styroflex	Siemens	220 μF.	500 V.d.c.
C12	Electrolytic	Siemens	10 μF.	350/380 V.d.c.
C15	Oil paper	Icar	2 x 20 μF.	450 V.a.c.
C16	Electrolytic	Siemens	100 μF.	25/35 V.d.c.
B1	Metallized paper	Siemens	0.1 μF.	1.000 V.d.c.
B2	Metallized paper	Siemens	0.47μF.	400 V.d.c.
B3	Anti-inductive paper	Siemens	2 x 0.2 μF.	500 V.d.c.
B4	Metallized paper	Siemens	4 μF.	400 V.d.c.
B5	Metallized paper	Siemens	4 μF.	400 V.d.c.
B6	Metallized paper	Siemens	1 μF.	250 V.d.c.
B7	Electrolytic	Siemens	100 μF.	35 V.d.c.
B8	Styroflex	Siemens	1.000 pF.	500 V.d.c.
B9	Metallized paper	Siemens	2 μF.	400 V.d.c.

Contactors		Motors	
PG	220V. 50 Hz.	M1 Motor	24 V d.c
SC	220V. 50 Hz.	M2 Motor	220 V a.c
ST	220V. 50 Hz.	M3 Motor	220 V a.c
L	220V. 50 Hz.		
X	160V. 50 Hz.		
PM	220V. 50 Hz.		

Relays		Fuses	
Z	RCP 8 110V 50 Hz	F1	3A
V	RCP 8 220V 50 Hz	F2	3A
A	RCP11 1.5A 50 Hz	F3	3A
R	RCP 8 110V.d.c.	F4	3A
BK	RCP 8 24V.d.c.	F5	6A
SF	RCP 8 6V 50 Hz	F6	6A
CM	RCP 8 110V.d.c.	F7	0.5A
CF	RCP 8 24V.d.c.	F8	6A
RM	RCP 8 24V.d.c.	F9	6A
RPG	RCP 8 220V 50 Hz	F10	6A
RSC	RCP 8 220V 50 Hz	F11	0.5A
PL	RCP 8 12V.c.c.	F12	8A
GR	RCP 8 220V 50 Hz	F13	3A
TV	RCP 8 220V 50 Hz	F14	0.5A
SCT	RCP 8 220V 50 Hz	F15	12A
XL	RCP 8 110V.c.c.	F16	12A
		F17	8A
r1	60 V.d.c.	F18	8A
r2	60 V.d.c.	F19	8A
r3	60 V.d.c.	F20	8A
		F21	3A
		F22	3A

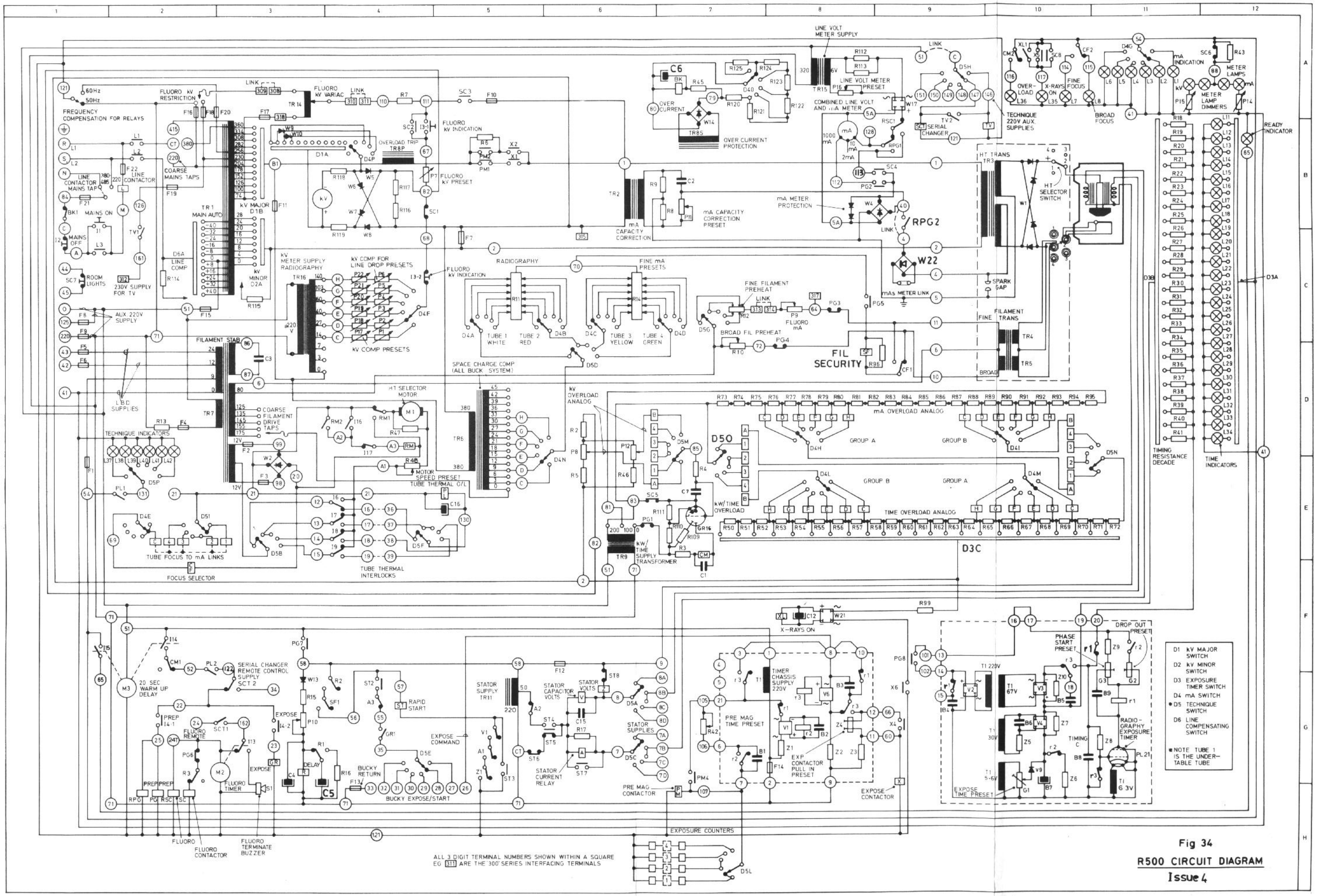


Fig 34
R500 CIRCUIT DIAGRAM
Issue 4

(2277/4/1082)

9 TECHNICAL DESCRIPTION Refer to Fig 34, page 65.

9.1 Main Auto Transformer

A. This is a single phase transformer which can be manually adjusted to operate on power supplies as follows:

180 - 268 volts
340 - 428 volts
375 - 463 volts

> It is not recommended to use the 180 - 268 volt supply because the line resistance to an X-ray department is invariably too high for unrestricted power output.

B. Fixed taps are provided at 220V, 380V and 415V for coarse adjustment to the prevailing mains supply.

C. A hand operated line compensation switch D6A is provided for fine adjustment as follows:

i) 6 x 8 volt steps to increase the output voltage by 48 volts
ii) 5 x 8 volt steps to decrease the output voltage by 40 volts

D. Line compensator switch D6A is a break before make switch. For this reason R114 is connected between the switch pole and a low voltage tap on the Auto Transformer to prevent circuit tripping when the switch is rotated in between studs. This resistor also serves as an inductive bypass to diminish contact flash over during tap selection.

E. The power supply is normally provided from 2 phases and is connected to the Auto Transformer via contacts 1 and 2 of the Line Contactor.

Contact L3 provides a hold on circuit for the Contactor coil after the Mains ON/push button I1 has been released.

The coil circuit is broken when either the mains OFF push button I2 is depressed or the contact BK1 opens as a result of excessive current in the HT Transformer.

F. The Neutral supply line is only required for the Line Contactor coil circuit.

The coil is nominally rated at 220 volts.

In countries where the prevailing mains supply is 110 volts it would be normal practice to connect two phases to the Auto Transformer with the coarse tap set for 220 volts. In this case the Line Contactor coil would be connected across the two incoming phases.

For the more common 220 and 240 volt supplies it would not be possible to connect the coil across two phases because the phase to phase voltage would be in excess of 380 volts.

A facility is therefore provided to connect the coil across one phase and neutral for these supplies.

This facility is shown on Fig 5 and the circuit is displayed in Grid Ref. 2B of Fig 34, page 65.

G. The main auxiliary lines from the Auto Transformer are connected to terminals 51 and 71.

The potential of these lines should be 220 volts when the Line Compensator Switch is correctly set.

H. On 50Hz supplies, terminal 121 is common to terminal 71.

The 220 volt ac relay circuits are supplied from terminals 51 and 121 but they will only function correctly if the 220 volt supply is delivered at 50Hz.

On 60Hz supplies the impedance of the relays will increase which means that the applied voltage will have to be increased by a proportionate amount.

A 50-60Hz link is therefore included (see grid reference 1A of Fig 34) which will add a voltage increment to terminal 121 when the link is set for 60Hz operation.

J. As stated in para 9.1G the voltage across lines 51 and 71 should be 220 volts when the Line Compensator Switch is correctly set.

The correct setting is indicated on the dual line volts/mA meter when the pointer is coincident with the red datum line.

During the standby mode of control, this meter acts as a voltmeter.

When the apparatus is raised to the fluoro or radiography modes of control, this meter records tube mA.

K. Transformer TR15 (grid reference 8A) has the primary side connected to terminals 51 and 71.

The secondary winding is connected to Bridge Rectifier W17 via voltage multiplier resistor R112, R113 and calibrating rheostat P16.

During standby the DC voltage output from W17 is connected to the dual line volts/mA meter via relay contacts RSC1 and RPG1.

RSC1 changes over to make the meter read on the 0 - 10mA scale during fluoro exposures and also disconnects the line volts source.

RPG1 changes over to let the meter read on the 0 - 1000mA scale during radiography exposures in conjunction with PG2.

9.2 <u>The kV Meter Calibration Circuits</u> (Fig 35 page 74)

A. The kV Meter effectively monitors the voltage applied to the primary of the HT Generator from the coarse and fine kV Selectors.

It is calibrated to enable the radiographer to pre-select the kV required prior to a Fluoroscopy or Radiographic exposure, and it also indicates the amount of kV compensation required for each value of mA selected.

B. If a load is connected to the output of the HT Generator, then a drop in kV must be expected due to:-

i) The inherent internal losses of the entire system comprising the resistance of the connecting wiring and associated switches, the copper losses of the transformer windings and the resistance of the X-ray tube rectifiers.

ii) The external losses comprising the resistance of the conductors in the hospital supply.

C. The inherent internal losses are known and compensation is built in at the factory from figures obtained from the R500 Rating Chart.

The external losses are not known in advance and will vary from location to location. Thus additional compensation will have to be carried out on site by the installation team.

9.2.1 Inherent Compensation Radiography

A. Compensation for the inherent voltage drop on load is obtained from figures on the R500 Rating Chart, See page 46.

For an HT Generator output of 125kV, the off load primary voltage must be increased to the following values for each change in mA.

50mA	275 volts
100mA	286 volts
200mA	301 volts
300mA	310 volts
400mA	320 volts
500mA	337 volts

If the kV Meter is to indicate 125kV for each of these mA values, then clearly the voltage applied to the kV meter terminals must be backed off by an equivalent amount in each case.

Thus at 100mA the voltage is backed off by an amount equal to the difference of the 100mA and 50mA HT Generator primary voltage which is 11 volts.

This will necessitate re-adjustment of the kV Selector to restore the kV meter reading to 125kV which will increase the primary voltage of the HT Generator by 11 volts, the compensation required for 100mA.

B. In practice this is achieved by injecting anti phase voltages from taps on TR16 secondary in series with the kV meter supply source.

The magnitude of these voltages will be dependent on the load thus a different tap must be selected for each position of mA switch wafer D 4 F.

C. Fine calibration of the kV meter can be obtained on each mA range by adjustment of the corresponding potentiometers P17 - P22.

These are normally adjusted prior to leaving the factory but it is advisable to check calibration again on installation as per the figures specified in page 48.

NOTE When setting up the inherent compensation, potentiometers P1 to P6 should be set to minimum resistance.

9.2.2 External Compensation Radiography

A With the internal compensation correctly set up to the R500 Rating Chart, it is a simple matter to cater for the external voltage drop on load.

The difference between the off load kV meter reading and the on load kV meter reading must be noted, after which the relevant potentiometers P1 to P6 should be adjusted to subtract this difference from the off load meter reading.

This increases the backing off voltage to the kV meter which calls for re-adjustment of the kV Selector to re-align the meter pointer with the 125kV datum line. Thus the primary volts to the HT Generator is boosted to the value required for correct kV compensation.

9.2.3 OTHER CIRCUIT CONSIDERATIONS RADIOGRAPHY

A At 300, 400 and 500mA a condition occurs at the low end of the kV selector switches where the backing off voltage from TR16 balances the kV meter source voltage.

This would cause the kV meter to read zero for each of the following mA and kV switch settings.

mA Switch at 300mA Coarse kV switch at stud 2
mA Switch at 400mA Coarse kV switch at stud 3
mA Switch at 500mA Coarse kV switch at stud 4

B Continued reduction of kV from each of the conditions itemised above would make it possible for the backing off voltage to exceed the decreasing kV meter source voltage and so cause the kV meter reading to rise from zero.

Facilities are therefore provided to short circuit the kV meter on all the mA and kV selector switch combinations which could give false meter readings.

C This is achieved by diodes W9 and W10 in conjunction with mA switch wafer D4P and kV switch wafer D1A which short circuits the kV meter on each of the following switch positions:-

300mA Coarse kV selector studs 1 and 2
400mA Coarse kV selector studs 1, 2 and 3
500mA Coarse kV selector studs 1, 2, 3 and 4

9.2.4 Fluoro kV Indication

A The kV meter automatically indicates radiography kV during the standby mode of control.

B To preselect fluoro kV it is necessary to depress Fluoro kV push button I3.

It has two contacts as follows:

i) I 3-2 (See Fig 35 and also grid 4c of Fig 34)

Disconnects the radiography kV indication voltage source from the kV meter

ii) I 3-1 (Grid 4B of Fig 34)

Connects the fluoro kV indication voltage source from the fluoro kV variac to the kV meter via terminal 110, R7, terminal 111, terminal 67, kV meter calibrator P7, terminal 82, Bridge rectifier W5, W6, W7 and W8 and R119 multiplier.

The kV meter negative terminal is connected back to the main auto transformer TR1 via R118 multiplier, bridge rectifier W5-W8, fuse 7, terminal 2 and the kV minor switch D2A.

C Potentiometer P7 calibrates the kV meter to the HT primary volts as tabulated in page 47, para 5.5.1 E.

D On switching the apparatus to the fluoro mode of control, the kV meter is switched to indicate fluoro kV as follows:

i) Read para 9.2.4 (B(i) and substitute I 3-2 for Fluoro Contactor SC/1 contact.

ii) Read para 9.2.4 B(ii) and substitute I 3-1 for Fluoro Contactor SC/2 contact.

9.3 <u>kW/Time Overload Circuit Fig 35</u>

Ref Diagram on page 74.

CAUTION HIGH VOLTAGE

The appearance of the Overload Board on the R500 is similar to that on the R703 but the operating voltages are in the region of 110 Volts AC

BE WARNED NOT TO TOUCH TERMINALS ON THIS BOARD WHEN THE MACHINE IS SWITCHED ON.

A Cold Cathode Trigger Tube GR16 is supplied with 200 volts AC from the secondary of TR9. The primary winding of TR9 is supplied with 220 volts from auxiliary lines 51 and 71.

The priming anode is connected to the 200 volt anode supply via R109 and the junction of potential dividing chain R110/R111 connected across the same supply feeds the priming cathode.

Resistance R3 in series with the operating coil of relay CM forms the anode load of the trigger tube with C1 to provide a hold on voltage for relay CM during the non-conducting half cycles when GR16 extinguishes.

The trigger tube will only fire when the grid to cathode potential rises sufficiently positive. This is determined by a voltage analog representing the kW/time rating of the X-ray tube deployed. (In this explanation it will be tube 1 connected for Group A).

B The voltage applied to the kV meter circuit at terminal 82 and 2 is directly proportional to tube kV and if the exposure time and mA switches are set to minimum, e.g. 0.01 secs and 50mA, then terminal 2 will be at the same potential as GR16 cathode. Thus the only voltage which can influence GR16 grid is the voltage which exists between the slider of P8 and terminal 2.

The maximum permissable radiography kV for the R500 at 50mA is 125kV. If the kV switches are set to indicate 126kV on the kV meter then the voltage which is tapped from P8 slider with respect to GR16 cathode should be just sufficient to trigger the tube. This will occur at a point on the AC sine wave when GR16 grid potential is rising positively with respect to its cathode. Naturally, for this to happen, it is important that the grid and anode voltages are in phase with one another.

Relay CM will energise to block the radiography prepare functions and switch on the Overload Indicator lamp.

When the anode and grid potentials go negative during the non conducting half cycles GR16 extinguishes but relay CM holds on with stored voltage from C1 which is just sufficient to prevent relay chatter in between conducting half cycles.

This condition will persist until the kV is reduced at which point there will be insufficient potential across P8 junction and R5 to retrigger the tube on a conducting half cycle. Relay CM will therefore drop out when the charge on C1 diminishes.

C The other tube overload parameters namely mA and Time are served with adjustable resistance decade networks. These derive their supply from the 100 volt tap on TR9 secondary.

The mA overload resistance decade comprising R73 to R95 is connected directly to the 100 volt supply and a voltage analog representing tube mA (50mA on the diagram) is passed to the time overload resistance decade comprising R50 to R72. via the 50mA tap, switch wafers D4H and D5N.

The 50mA tap on the time overload resistance decade is connected to the trigger tube cathode via switch wafers D4M and D50 and this determines the starting point from which the time switch D3C can select a voltage analog representing time at 50mA. Thus the output from the time switch represents a voltage analog proportional to the time selected at 50mA.

D Connected between the grid of GR16 and the output of time switch wafer D3C, is the portion of P8 and R5 in series across which the kV voltage analog is developed. GR16 grid potential is therefore raised by a further increment which in total is the voltage analog representing kV, mA and time, hence kW/time.

If the X-ray tube parameters are such that overloading would occur at 125kV, 50mA and 2 secs, then it must not be possible to exceed the maximum kV restriction of the R500 if the timer switch is set for a time less than 2 seconds.

This requirement is satisfied if the 50mA tap from mA switch wafer D4M is connected to the 1.8 second tap on the time overload resistance decade. This ensures that the potential of terminal 2 is always at the same potential as GR16 cathode on time switch settings between 1.8 seconds and 0.01 seconds, thus on exposure times below 2 seconds, the only potential which exists between grid and cathode is the kV voltage analog developed between P8 slider and terminal 2 (cathode) and if this is increased beyond 125kV, it will activate the overload.

If the time switch setting is now increased to 2 seconds with a kV selection of 125kV, the slider of switch D3C will connect to the 2 second point on the overload resistance decade. Because this portion of the resistance decade is connected between the 50mA tap on the mA overload resistance decade via switch wafers D4H and D5N: and terminal 83 on the mA resistance decade via the 50mA tap on the time resistance decade, switch wafers D4M and D50, the potential of terminal 2 will become slightly positive with respect to GR16 cathode. This is now in series with the kV voltage analog potential which will raise the grid to cathode voltage sufficiently to cause GR16 to strike.

E In order to set up the kW/time overload circuit to follow the 50mA rating curve of the X-ray tube down to the low kV long time overload parameters, it is necessary for the time switch to follow a potential gradient on the time resistance decade which will activate the trigger tube at all the correct overload kV/time switch settings from 2 seconds to 5 seconds, for successive reductions in kV. This potential gradient is decided by the voltage which is applied to the time resistance decade from the 50mA tap on the mA resistance decade.

If it is assumed that the X-ray tube overloads at 60kV, 50mA and 5 seconds then it is first necessary to reset the kV and time switches to 60kV and 5 seconds respectively. The 50mA tap on the mA resistance decade must then be connected to the mA resistance which just activates the trigger tube.

If GR16 was not already triggered, then the 50mA tap on the mA resistance decade should be moved in steps towards terminal 81 which will increase the voltage applied to the time resistance decade which in turn will raise the grid to cathode volts to restore the loss in kV analog voltage across terminals 82 and 2.

F In cases where the deployed tube is restricted to a kV which is less than the maximum kV restriction of the R500, it will be necessary to modify the characteristics of the Overload Board by adding additional resistance.

If a Dynamax Super 50/69 tube with a 0.6mm focus is taken as an example it is evident from the rating chart that it must not be operated up to 125kV at 200mA. At 200mA the restriction is 90kV at 0.5 seconds.

It is therefore no longer possible to take the starting point in the setting up procedure as 0.4 seconds at 90kV because the 200mA tap on the time resistance decade will be at the same potential as GR16 cathode. Thus with a grid to cathode potential representing 90kV, it will be possible to raise the kV to 126kV before activating the overload circuit.

In order to prevent this from happening it will be necessary in this case to connect resistance between the 0.5 second tap on the time resistance decade and the 200mA position of switch wafer D4M.

This resistance will introduce an additional potential difference between the time resistance decade 0.5 second tap and GR16 cathode which will be added in series with the kV voltage analog potential between GR16 and terminal 2.

The value of this resistance should drop just sufficient voltage to raise GR16 grid level to the striking point and so activate the overload relay CM.

In this condition it will not be possible to deactivate the overload circuit if the time switch is turned back to a lower time. In other words, the overload circuit is locked to a maximum of 90kV.

The low kV/long time overload parameters can still be catered for by applying the same reasoning as in sub paragraph E.

G On 400 and 500mA, the R500 itself is restricted to 110kV and 90kV respectively. In these two cases it is also necessary to add resistance using the same reasoning as derived in sub paragraph F. For example, a Dynamax Super 50/69 tube with 1.3mm focus can go up to 125kV at 400mA but at this mA it must be restricted to the 110kV limitation of the R500. A perusal of the tube rating chart will reveal that at 110kV and 400mA the tube will overload at 0.8 seconds. A sufficient amount of resistance must therefore be inserted between the 0.8 second tap on the time resistance decade and the 400mA position of switch wafer D4M to just activate the overload circuit at 110kV and 0.8 second. In this condition it should not be possible to deactivate the overload circuit if the time switch is turned back to a lower time.

9.4 <u>H.T. CHANGEOVER CIRCUIT Refer to Figs 36 and 37, pages 75 and 78</u>

A Select Tube 1 with switch D5 as shown in Fig 36. The motor M1 will be stationary, and the 24V a.c. output from the secondary of transformer TR7 is applied via fuses F2, F3 to the rectifier W2. After rectification the positive d.c. is routed via line 21, relay PL, line 130, switch D5F, line 36, over pressure cut-out, microswitch I6, line 12, switch D5B to centre tap (zero) on TR7, thus completing the circuit for tube 1 thermal interlock.

B Relay PL (Tube thermal overload) is energised and contact PL1 will close causing the appropriate indicator lamp L37-L42 to display the tube and technique selected. Contact PL2 closes in the fluoro, radiography exposure control circuits. GRID REF 2F of FIG 34. Relay CF is also energised causing contact CF1 to changeover from Broad to Fine Focus (line 10 to 11). Contact CF2 changes over the indicator lamp from Broad to Fine Focus thus lighting L7.

9.4.1 <u>MOTOR AND DRIVE SELECTOR DESCRIPTION</u>

A The tube selector drive motor shaft extends into the HT transformer tank. It is driven by a permanent magnet 24 volt DC motor operating on 12 volts with dynamic braking provided by resistor R47.

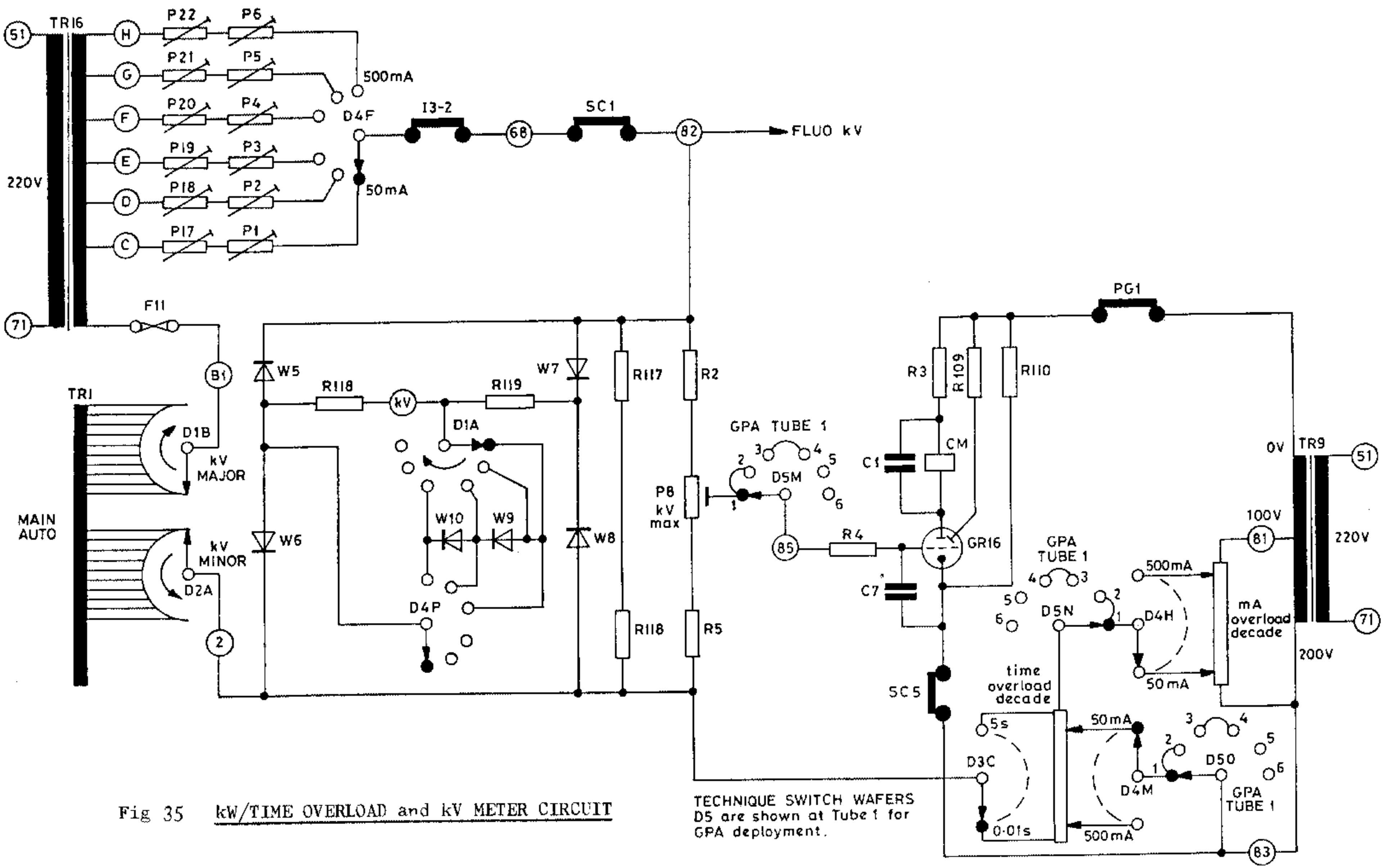


Fig 35 kW/TIME OVERLOAD and kV METER CIRCUIT

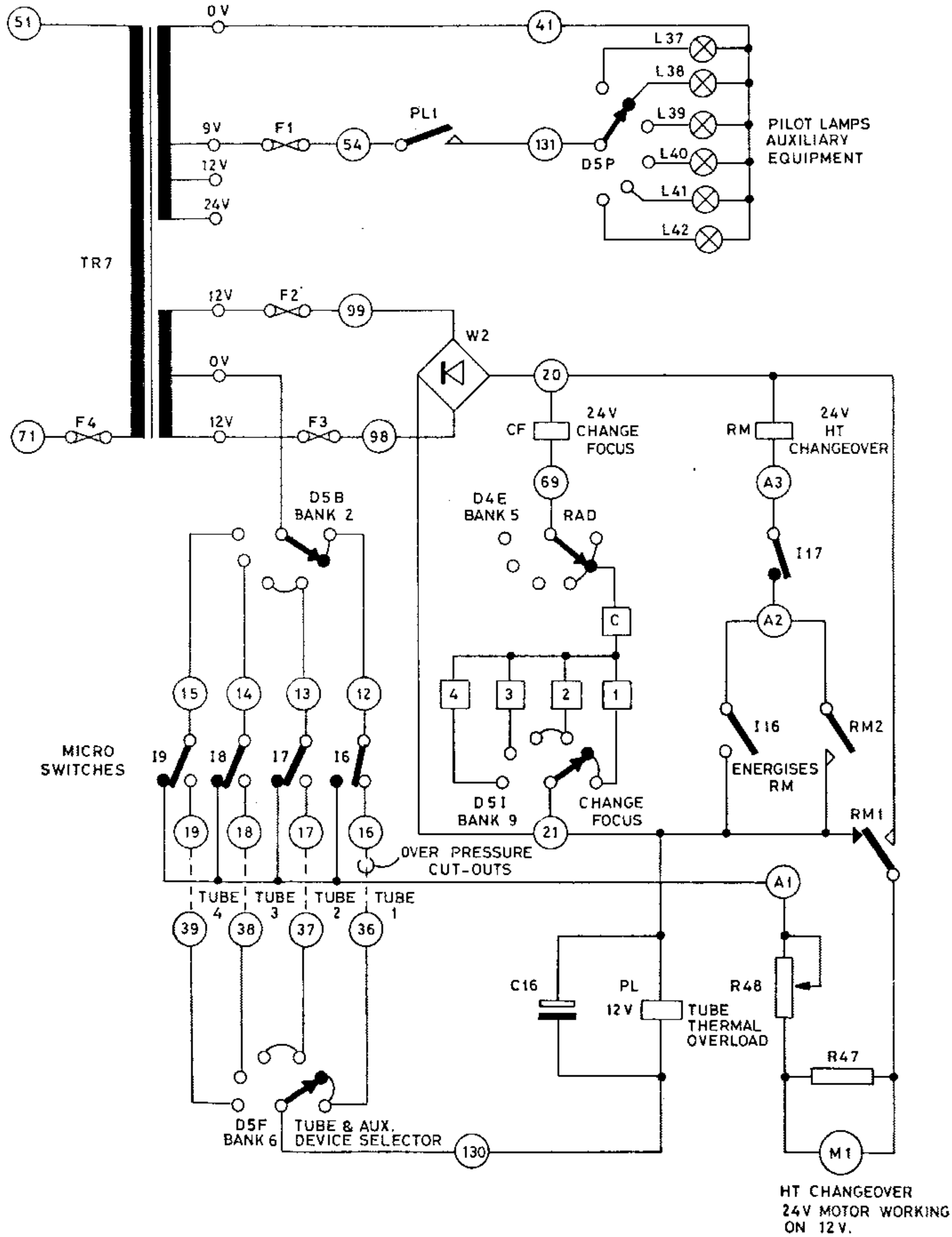


Fig 36 HT CHANGEOVER CIRCUIT

Above the tank, a cam plate is fixed to the shaft. A 'T' plate on the bottom of the shaft has contacts which are connected to the HT transformer rectifiers and filament transformers by means of flexible wires.

B When the shaft rotates, the contacts make with spring finger contacts adjacent to each tube anode and cathode receptacle and so connects the supplies to the tube selected. Hence the peculiar numbering of the HT receptacles.

C A mechanical drive motor stop is provided on the cam plate as a safety measure to prevent the internal flexible wires on the tube selector switch from snapping should the motor attempt two revolutions of the cam plate under fault conditions.

9.4.2 <u>FUNCTION OF MOTOR REVERSING RELAY AND MICRO SWITCHES</u>

A When RLRM is de-energised the cam plate will rotate clockwise during tube selection.

When it is energised, the cam plate will rotate counter clockwise during tube selection.

B The following micro switches are arranged around the cam plate as illustrated in Fig 37, page 78.

Micro Switch I6	Tube 1 selector motor stop.
Micro Switch I7	Tube 2 selector motor stop.
Micro Switch I8	Tube 3 selector motor stop.
Micro Switch I9	Tube 4 selector motor stop.
Micro Switch I16	Closes when selector drive stops at tube position 1 and prepares motor to reverse if tubes 2, 3 or 4 are subsequently selected.
Micro Switch I17	Opens when selector drive stops at tube position 4 and prepares motor to reverse if tubes 3, 2 o 1 are subsequently selected.

<u>NOTE</u> When the cam plate is driven to stop at tube 1 or tube 4 positions, there is in each case a slight overshoot after which the motor will reverse, and stop precisely at the selected tube position.

9.4.3. <u>CIRCUIT EXPLANATION</u>

A <u>Tube 1 Selected</u> In the circuit diagrams, tube 1 is selected and consequently micro switch I6 is open. RL RM is connected to the +ve and -ve terminals of rectifier W2 via micro switch contact 116 which is closed and micro switch contact 117. Relay contacts RM/1 and RM/2 change over.

B Tube 2 Selected

Switch D5 will be at position 3 (Tube 2). A positive supply is connected to left hand motor terminal from the 0 volt tap on TR7 via switch D5B, micro switch I 7 and speed control R48. The right hand motor terminal is connected to the -ve side of W2 via RL contact RM/1.

The motor drives the cam plate counter clockwise until I7 opens at tube 2 position.

Micro switch contact I16 opened during this sequence but hold on contact RM/2 provides an alternative path for RL RM which remains energised until the supply is broken by I17 which opens when tube 4 is selected.

C Tube 3 Selected

The sequence is the same for Paragraph 9.4.3B above except that micro switch I8 opens to stop drive selector at tube 3 position.

D Tube 4 Selected

Read as for Paragraph C above and insert I9 for I8 and tube 4 for tube 3.

Micro switch contact I17 also opens and breaks supply to RL RM. Both contacts revert to positions shown in diagram.

E Tube Selector Returned from Tube 4 to Tube 1

This time the right hand terminal of the drive motor is supplied from W2 positive via RL contact RLM/1. The left hand terminal is connected to the -ve 0 volt tap on TR7 via R48, micro switch I6 and switch bank D5B.

The drive motor will drive back to tube 1 position and stops when micro switch I6 opens. Contact I16 will also reclose to establish the conditions outlined in Paragraph 9.4.3A.

F Select from Tube 3 to Tube 2 with RL RM Closed

If RL RM is energised, then the tube selector switch was previously at tube 1.

Micro switch I7 is closed and the motor cam plate will be driven counter clockwise to tube 4 position after which micro switch contact I17 will de-energise RL RM to reverse motor. The motor cam plate will therefore drive clockwise and stop at Tube 2 position when I7 opens.

This sequence is the same for any other combination backwards eg tube 2 to tube 1 or tube 3 to tube 1.

G Select from Tube 2 to Tube 3 with RL RM Open

This time if RL RM is de-energised, the tube selector switch must have been at tube 4 or the X-ray console was switched on with the switch positioned at tube 2, tube 3 or tube 4.

Micro switch I8 will be closed and the motor will drive clockwise to tube 1 position after which micro switch contact I16 will close to energise RL RM and reverse motor. The motor cam plate will therefore drive counter clockwise and stop at tube 3 position when I8 opens.

This sequence is the same for any other combination forwards eg tube 2 to tube 4 or tube 3 to tube 4.

H Exposures are not possible during the process of selecting a tube because relay PL will be open thus the Prepare/Expose line is open circuited by contact PL/2 until the next tube is connected.

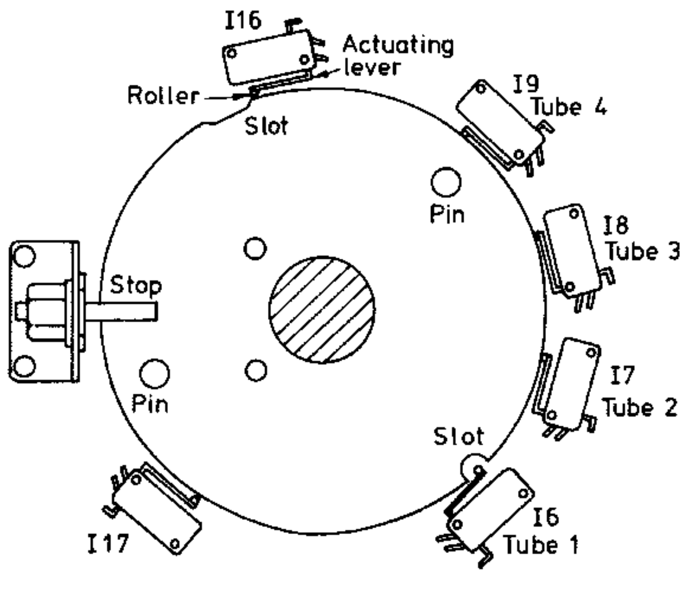


Fig 37 HT CHANGEOVER SWITCH CAM AND MICRO SWITCHES

9.5 TUBE FILAMENT CIRCUIT (Fig 38, page 81)

A The tube filament stabiliser transformer TR7 is specially wound with a capactive loaded secondary which provides a degree of stability in the outputs from the other secondary windings.

B The primary is fed with 220 volts from lines 51 and 71 and is protected by Fuse 4. R 13 improves the transformer regulation.

C In addition to the Tube Filament Circuits, this transformer also provides 9 volts for the Indicator Lights and 12 volts or 24 volts to the X-ray LBDs from taps on a second secondary winding.

D A third 2 x 12 volts secondary winding supplies 24 volts for the Change Focus relay CF and the HT Change Over Drive Motor relay RM.

It also provides 12 volts for the HT Change Over Drive Motor M1 and Tube Thermal Overload relay PL.

NOTE: Drive Motor M1 is a 24 volt motor operating on a 12 volt supply.

E The main secondary winding is tapped at 0 volts, 80, 125, 135, 145, 155 and 175 volts.

The 80 volt tap is employed for the broad focus pre-heat and fine focus fluoro emission control circuits.

On this apparatus, the fine focus is always employed for fluoro exposures regardless of the focus selected. Pre-heating of the broad focus is therefore provided to facilitate rapid boosting to the emission required when broad focus is selected for radiography exposures.

F Broad focus filament transformer TR5 is supplied via pre-heat rheostat R10, terminal 72, Contactor PG4 and terminal 10. The return to the 0 volt tap is via line 6.

G Fine focus filament transformer TR4 is supplied via technique selector switch wafer D5G, pre-heat rheostat R12, fluoro mA Control P9, Terminal 64, Contactor PG3 and terminal 11. The return to the 0 volt tap is via line 6. Contacts PG3 and PG4 disconnect the pre-heat circuits during radiography prep and expose.

H The 125 volt to 175 volt taps on TR7 main secondary winding provides coarse adjustment of the tube emission required for radiography.

The choice of tap is therefore dependent on the types of tubes deployed, but in all cases, care must be taken not to tap off more voltage than is required for maximum tube output on the fine adjustment rheostats R11 and R14.

J The output from the above coarse tap is connected in series with the secondary of Space Charge Compensation Transformer TR6 (Circuit ref 5D).

The primary of this transformer is connected across the poles of the kV Major and Minor switches D1B and D2A respectively.

A voltage proportional to kV is therefore induced in TR6 secondary which opposes the filament transformer drive voltage.

This causes the filament emission to decrease if the kV is increased and if the taps on TR6 secondary are correctly set, the tube mA should remain substantially constant over the range 50kV to 125kV.

Separate taps are available for each position of the mA switch wafer D4N to preserve the correct balance between the applied filament drive volts which is proportional to mA and the opposition kV related volts induced in TR6 secondary.

K The modified output from the taps on TR6 secondary winding is routed to the radiography mA fine adjustment rheostats R11 and R14 via mA switch wafer D4N and Technique switch wafer D5D.

Switch wafer D5D selects the rheostat applicable to the tube and technique selected as follows:

i) Tube 1 Techniques 1 and 2

To one of the white sliding cursors on R11 via a position of mA switch wafer D4A.

ii) Tube 2 Techniques 3 and 4

To one of the red sliding cursors on R11 via a position of mA switch wafer D4B.

iii) Tube 3 Technique 5

To one of the yellow sliding cursors on R14 via a position of mA switch wafer D4C.

iv) Tube 4 Technique 6

To one of the green sliding cursors on R14 via a position of mA switch wafer D4D.

Each of the coloured sliding cursors mentioned above are letter coded to correspond with selected mA as follows:

C	50mA
D	100mA
E	200mA
F	300mA
G	400mA
H	500mA

L During radiography prep and expose, the output from the relevant rheostat (in this case R11 adjusted for 100mA on tube 1) is passed to terminal 11 of fine filament transformer TR4 via terminal 70, prep contactor PG5 current sensing relay coil SF (shunted with R96) and tube focus selector relay contact CF1.

This relay is normally energised via mA switch wafer D4E (grid ref. 2E) when 50, 100 or 200mA is selected.

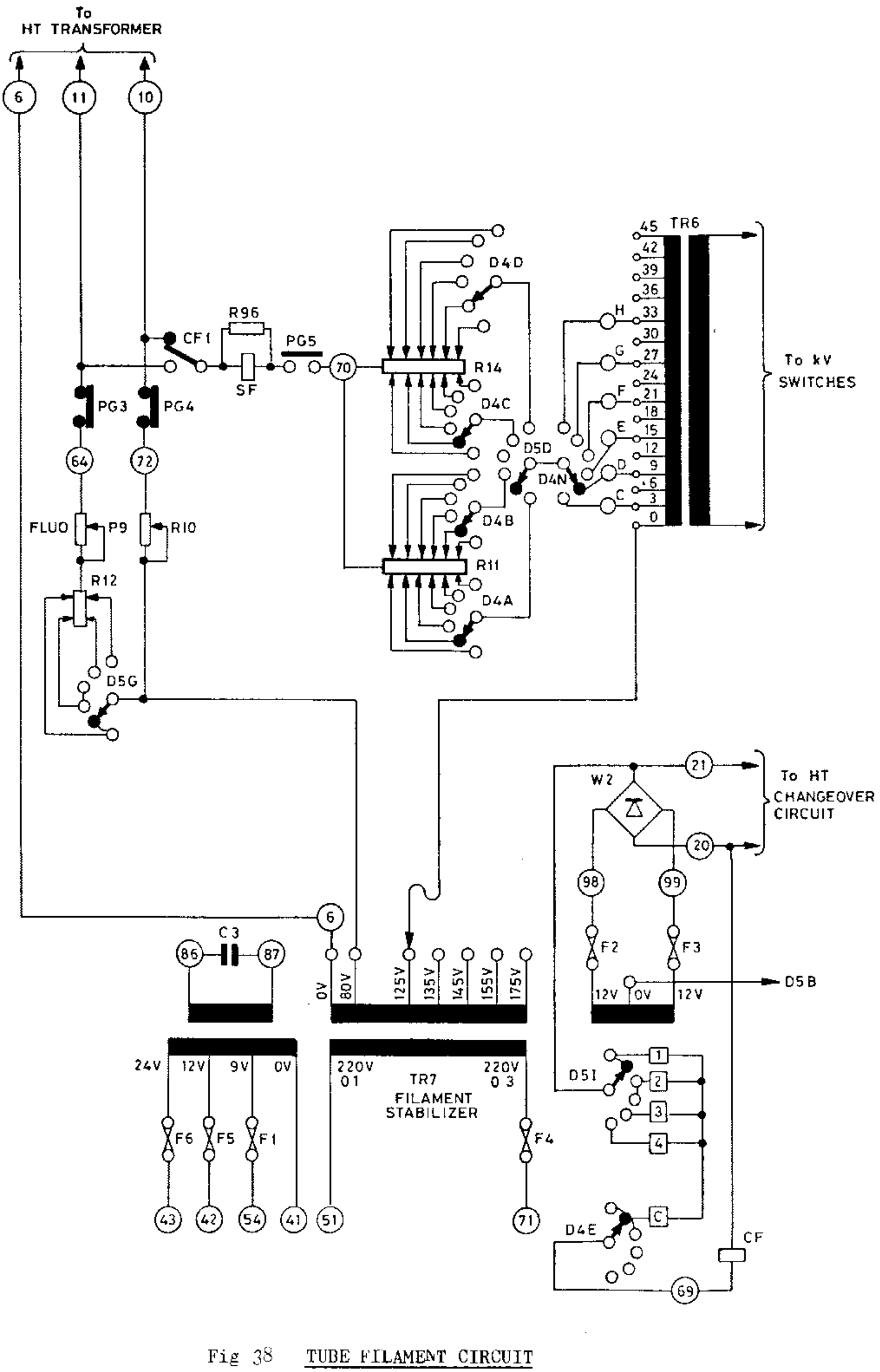


Fig 38 TUBE FILAMENT CIRCUIT

M Filament security relay contact SF1 closes in the tube stator activating circuitry and clears the way for a radiographic exposure.

This safety feature is desirable on account of the mA related kV compensation circuits referred to on page 67 which would generate dangerously high kV if exposures are attempted on a tube with an open circuited filament.

N The common return line for both filament transformers is from terminal 6 to the 0 volt terminal on TR7.

9.6 TUBE STATOR CIRCUITS (FIG 39)

For simplicity only the stator for tube 1 has been shown in the circuit diagram on page 83. Switch D5A/D5C has been omitted but is shown in Fig 34 Grid Ref 6G.

PREPARE

A RL Contact PG/7 is closed.

Tube Stator Supply Transformer TR11 is supplied with 220 volts from line 71 via terminal CT, and the return side is connected to line 51 (Zero volts) via terminal 58 and Prep Contactor PG/7 contact.

B The stator main winding is therefore supplied with 220 volts from TR11 via relay contacts ST/6, ST/5 and current sensing relay A terminal 7 and tube selector switch wafer D5C. Contacts ST/6 and ST/5 are in series to share the arcing when they separate at the end of the rapid start sequence.

C The stator capacitive winding is also supplied from the same source via relay contacts ST/6, ST/5, phase shift capacitor C15 terminal 8 and tube selector switch wafer D5A.

D The common of both windings are taken back to 0 volts on TR11 via terminal 9, fuse 12 and terminal 58.

E Current sensing relay A closes in the stator main winding line. Voltage sensing relay V in parallel with C15 closes in stator capacitive winding line and the voltage sensing relay Z in parallel with the stator capacitive winding also closes.

F Relay A, V and Z are stator interlocks to prevent radiographic exposures being made should the anode remain stationary through any of the following faults:

i	Open circuit main stator winding	RLA will open
ii	Open circuit capacitive stator winding	RLV will open
iii	Short circuited phase shift capacitor C15	RLV will open
iv	Short circuited capacitive stator winding	RLZ will open

G Relay A is now closed.

Contact A/1 completes a link in the supply line to stator supply changeover relay ST.

Contact A/2 opens temporarily in the 50 volt RUN supply line from TR11 in preparation for the changeover from rapid start to run.

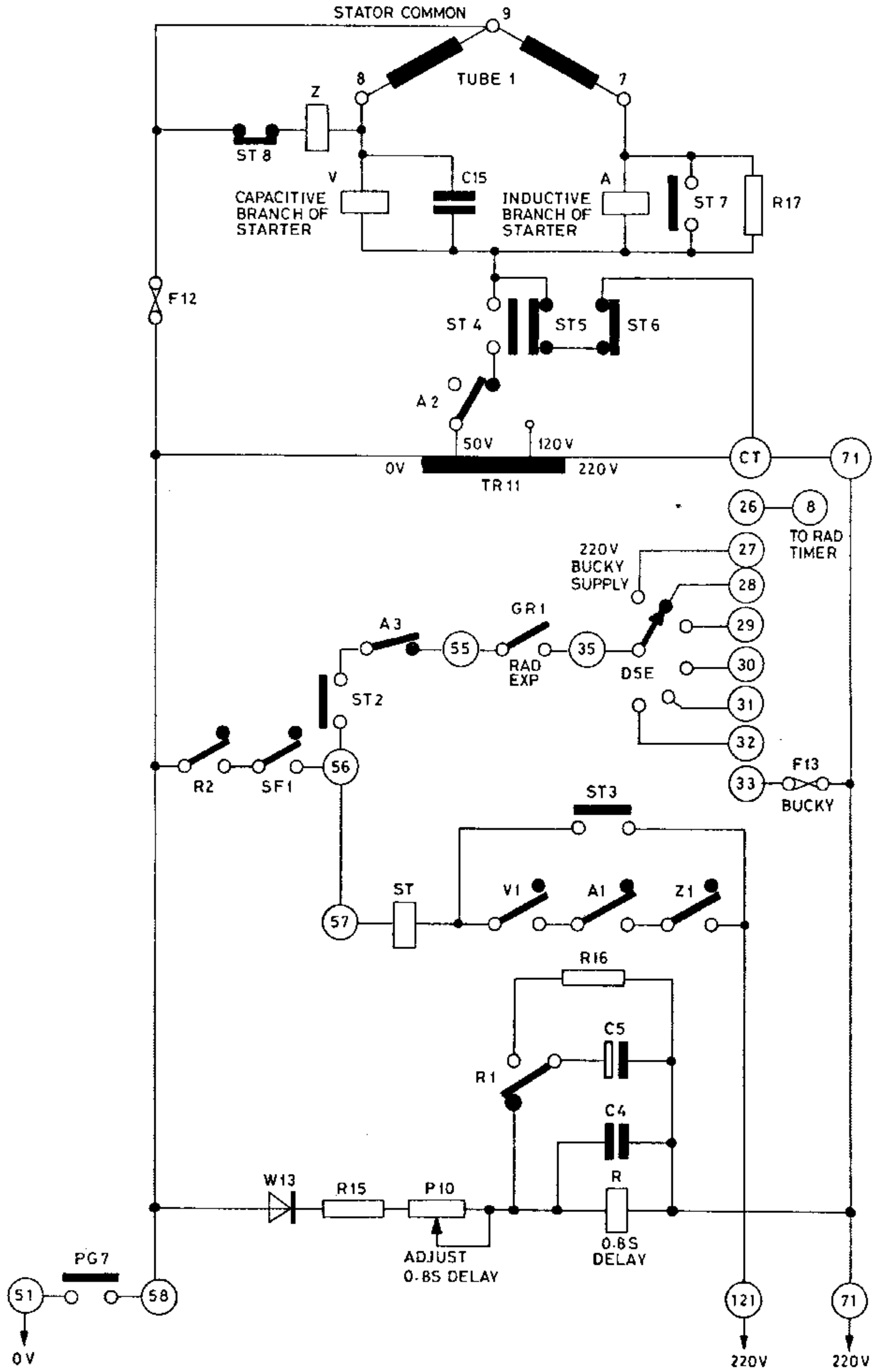


Fig 39 TUBE STATOR CIRCUIT

Contact A/3 opens in the exposure line to the radiographic timer thus preventing an exposure being made until the stator has successfully been switched from rapid start to run.

H Relay contacts Z/1, A/1 and V/1 are now all closed in the line supplying the tube stator relay ST from line 121 and when the preparatory delay period has terminated, contact R/2 of the delay relay will complete ST circuit to line 51 via PG/7 contact and Filament Security relay contact SF1.

J Relay ST is now energised.

Contacts ST/4, ST/5 and ST/6 changeover to reconnect the stator windings from the 220 volts tap to the 50 volt tap on TR11. There will be a short delay before the stator actually runs at 50 volts because contact A/2 is still open. This delay in switching the stator instantly from 220 volts to 50 volts eliminates the vicious arcing which would otherwise occur when contact ST/4 closes.

Contact ST/2 closes and completes a further link in the interlock switching chain to the exposure timer.

Contact ST/8 breaks the supply to relay Z to prevent this relay from chattering after the stator supply changes over from 220 volts to 50 volts.

Hold on contact ST/3 short circuits the stator interlock contacts Z/1, A/1 and V/1 to prevent tripping of the exposure when relays A Z and V become de-energised at the end of the rapid start period.

Contact ST/7 closes short circuiting the stator main winding current sensing relay A3.

K Contact A/2 connects the stator supply line to the 50 volt tap on TR11.

Contact A/1 opens in the supply line to relay ST but has no effect because contacts Z1, A1 and V1 are already short circuited by contact ST/3.

Contact A/3 recloses and completes all the interlock switching in the expose line to the timer facilitating a radiographic exposure when the expose button is pressed.

9.7 FLUOROSCOPY MODE OF CONTROL (Fig 40, page 90)

9.7.1 CONTROL CIRCUITS

A When the R500 is switched ON, a delay period of 20 seconds is introduced by Motor M3 connected across the 220 volt line 51 and 121.

This permits sufficient time for the thyratron in the Radiographic Exposure Timer to reach operating temperature.

B Two contacts on the Timer Motor change over after 20 seconds.

I15 Closes to switch on the Ready Indicator Light. (Grid Ref 12B in Fig 34)

I14 Closes in the Fluoro/Radiography control circuit.

The Fluoroscopy Timer Switch M2 must be switched ON and the Technique Selector Switch D5 must be turned to positions 1 or 2. (Tube 1 undertable).

C Switch wafer D4H connects Serial Changer Remote Relay SCT to lines 51 and 121.

Contact SCT/1 Closes in the Fluoroscopy Contactor control circuit.

Contact SCT/2 Connects terminal 34 to the remote fluoro/radiography prep/expose switches via fuse 15, terminal 51, 20 second Delay Switch contact I14, Tube kW/time Overload Relay contact CM1, terminal 52 and Tube Thermal Overload Relay contact PL2.

D The external fluoro switch is normally connected to terminals 34 and 24.

When this switch is closed, Fluoro Contactor SC is energised from terminal 34 via Fluoro Switch, terminal 24, relay contact SCT/1, terminal 162, Fluoro Timer Switch Contact I13, terminal 24T, Prep Contactor PG6 and Delay relay contact R/3.

The other side of Contactor SC is returned to terminal 121.

Terminal 24T also provides 220 volts to start up Fluoro Timer Motor M2 and energise relay RSC.

Contact RSC/1 Changes over and disconnects the mA meter from the line volts indication circuit and prepares the meter to indicate fluoro mA on the 0 - 10mA scale. (Grid Ref 9B of Fig 34).

Contact SC/1 Disconnects the radiography indication voltage from the kV meter (see Fig 35).

Contact SC/2 Connects the fluoro indication voltage to the kV meter.

Contact SC/3 Connects the output of Fluoro kV Variac TR14 to the HT Transformer at terminal 1 via terminal 110, surge limiter R7, terminal 111 and Fuse 10.

The return side from terminal 2 on the HT Transformer is taken back to the Main Auto TR1 via the radiography kV minor selector switch D2A.

Contact SC/4 Connects the +ve terminal of tube mA bridge rectifier W4 to the mA meter via terminal 113, relay contacts RSC/1 and RPG/1 and terminal 128.

the -ve meter terminal is taken direct to the -ve terminal of W4 via line 5A.

Contact SC/5 Opens in the cathode circuit of Cold Cathode Trigger Tube GR16 (see Fig 35).

This prevents transient voltage surges inherent within the Fluoro Switching Circuits from tripping the kW/time overload and consequently the fluoro exposure via relay contact CM1.

Contact SC/6 Opens to dim the kV and mA meter illumination lights. (Grid Ref 12A of Fig 34)

Contact SC/7 Opens to switch off the Red Room Light. (Grid 1C of Fig 34)

Contact SC/8 Closes to switch IN the X-rays ON indicator Lamp L35. (Grid 10A of Fig 34)

E When the Timer Motor M2 drives back to zero seconds.

Contact I13 Changes over and breaks the supply to the Fluoro control circuit which reverts to the standby condition.

With the Fluoro Push Button still depressed, the supply will now be diverted to the Fluoroscopy Termination Buzzer S1.

9.7.2 HT Circuit, mA Meter and mA Capacitive Correction Circuits

A The outer terminals of TR3 secondary winding are attached to the input of a full wave silicon bridge rectifier. The DC output of the bridge is passed to the X-ray tube anode and cathode via the respective contacts of the motor driven tube selector switch.

B Earthing of the transformer secondary is essential, and the connection is made at terminal 5, which is the centre tap of the transformer.

This minimises the insulation problem by reducing the overall electrical strain to earth by half the output voltage.

C The inner ends of each split secondary, namely terminals 4 and 5, are joined together by the mA and mAs meter rectifiers designated in Fig 34 (grid 9C) as W4 and W22 respectively. The only safe place to monitor the tube mA is between the two half secondary windings, because this point is at earth potential. Should this circuit become accidentally disconnected, then the spark gap connected between the two main secondary windings will prevent terminal 4 from becoming dangerously live with voltage.

D The AC input to bridge rectifier W22 from terminal 4 is always shorted by a link, which is only removed when it is required to connect an external mAs meter for radiographic exposure tests.

E The circuit to the mA meter from W4 +ve is continued via the CCTV link across Prep Relay contact RPG2, terminal 40, bridge rectifier W4 ac input and +ve output, Fluoro Contactor SC4, terminal 113, relay contacts RSC/1, RPG1 and terminal 128.

Operation of the meter is on the 0 - 10mA scale and the negative is returned to W4 -ve via line 5A and hence to terminal 5.

F The link across RPG2 contact is removed if a CCTV system with a separate fluoro mA meter has to be installed.

Contact RPG2 short circuits the CCTV mA meter during radiographic prep and expose to prevent meter damage arising from the higher radiographic mA.

G When the output of an HT generator is full wave rectified, alternating current must flow in its secondary winding. The whole secondary circuit is highly capacitive to earth through the medium of the insulation around each of the many thousands of coil turns and indeed the insulation of each HT cable connecting the X-ray tube.

The net result of this stray capacity is an output current which is higher than the true tube current, and its total value will equal the vector sum of the true tube mA, and the capacitive leakage mA.

At max kV, the magnitude of this capacitive current can be as high as 3mA. Obviously this will result in very misleading readings on the mA meter especially with CCTV systems.

On radiography, this phenomenon would hardly be noticed because of the high mA used, but on fluoroscopy, something must be done to correct the meter, so that it will only record true mA.

H A capacitive by pass across the meter is the conventional approach to the problem. If a variable capacitor was connected across the meter rectifier and adjusted so that the current passing through it is the same as the stray capacitive current, then the meter would register true tube mA.

Unfortunately the size of capacitor required (up to 1μF) precludes the use of a variable capacitor which is only available in mmf sizes, so a fixed capacitor must be used and some means found to synthetically vary its capacitance.

J This is effectively achieved by inserting in series with the capacitor, a variable source of backing off voltage to control the magnitude of the capacitive current.

The backing off voltage is derived from transformer TR2 (grid reference 6B in Fig 34).

The primary winding is connected across the primary of the HT transformer and is protected by fuse 7.

The output from TR2 secondary is therefore proportional to kV and this is applied to the input of an AC bridge network comprising R9 and R8 in one limb and C2 and P11 in the other limb. The output of the bridge is connected to the AC input of mA meter bridge rectifier W4.

K P11 can be adjusted to alter the magnitude and phase angle of the current delivered at the output of the bridge to null the stray capacitive current flowing in the mA meter.

It is adjusted during a fluoroscopy exposure in such a direction as to make the mA meter reading decrease. Continued adjustment in the same direction will further reduce the meter reading and then it will start to rise. The correct point of adjustment is the dip in the meter reading where the current indicated on the dial is a minimum.

If a dip is not obtainable, then the phasing of the backing off winding is wrong. This being so, the meter reading would rise linearly or fall linearly according to which way P11 is turned.

9.8 RADIOGRAPHY PREPARATION AND EXPOSURE MODES OF CONTROL

9.8.1 Preparation Control Circuits (Fig 40 page 90)

A When the R500 is switched ON, a delay period of 20 seconds is introduced by Motor M3 connected across the 220 volt line 51 and 121.

This permits sufficient time for the thyratron in the Radiographic Exposure Timer to reach operating termperature.

B Two contacts on the Timer Motor change over after 20 seconds.

I 15 Closes to switch on the Ready Indicator Light. (Grid ref 12B in Fig 34)

I 14 Closes in the Fluoro/Radiography control circuit.

C On depressing prep button I 4-1, Contactor PG and relay RPG are supplied from terminal 51 via 20 second delay micro switch I 14, tube kW/time relay contact CM/1, terminal 52, tube thermal overload relay contact PL/2, serial changer remote relay contact SCT/2, terminal 22 and terminal 25.

The return line for both relays is via terminal 121.

D If serial changer remote relay SCT is energised (eg undertable tube selected) the above circuit will be completed via the table prep switch by way of terminals 34 and 25.

E RPG/1 Closes and disconnects the mA meter from the line volts indication source (see Fig 34 grid 9B).

RPG/2 Closes but is only effective if CCTV is employed (see para 9.7.2 F).

PG/1 Opens in the anode circuit of cold cathode trigger tube GR16 (see Fig 35).

This prevents transient voltage surges inherent within the prep/expose control circuits from triggering the kW/time overload circuit and consequently the radiographic exposure via relay contact CM/1 in para 9.8.1 C above.

PG/2 Connects the 0 - 1000mA terminal on the mA meter to the tube mA monitoring circuits described in para 9.7.2.

PG/3)
PG/4) Disconnects the tube filament preheat circuits (fig 34 grid ref 8C and Fig 38)

PG/5 Closes to boost the selected tube filament to the emission required for the mA selected (Fig 34 grid ref 8C and Fig 38).

PG/6 Opens in fluoro contactor SC control circuit to block fluoro exposures during radiography.

If contactor SC is not released when changing from fluoro to radiographic exposure, it would be possible to short circuit a section of the main auto transformer via contact SC/3 and contacts X/1, X/2, PM/1 and PM/2 of the radiography expose and premagnetisation contactors.

PG/7 Closes to supply 220 volts to the prep delay relay and tube stator control circuits (see grid ref 3F of Fig 34 and also Fig 40).

PG/8 Closes in thyratron PL21 anode circuit to prime the timer in readiness for the radiography expose mode of control. (Fig 34 grid ref 9G).

F The time taken to operate delay relay R is dictated by the time constant of the following components in grid ref. 3 and 4G of Fig 34.

C4, C5, R15, P10 and the resistance of relay R coil.

P10 is adjusted for a time delay of 0.8 seconds which is normally sufficient to boost the tube filament as described in para 9.5 and also to accelerate the tube stator to synchronous speed as described in para 9.6.

G After the delay period relay R closes

Contact R/1 Disconnects capacitor C5 which now discharges through R16, in readiness for the next "Prepare". C4 and C5 in parallel govern the relay closing time in conjunction with P10 and the opening time is governed by C4 on its own. (Grid ref 4G in Fig 34).

Contact R/3 Changes over to prevent Fluoro Exposures from being initiated immediately after a Radiography Exposure. In this condition the Delay relay R is held on by capacitor C4 to allow sufficient time for the boosted filament to cool to the Fluoro emission temperature. (Grid ref 2G in Fig 34).

Contact R/2 Closes in the ST relay circuit and if the interlocks are all completed the relay contacts will change over to reduce the stator volts from the rapid start to the run condition. (Grid ref 4G in Fig 34 and also Fig 39).

9.8.2 Expose Control Circuits (Fig 40)

A With the tube filament fully boosted and stator accelerated to the run condition the following safety interlocks in the exposure timer start circuit will become unblocked:

i) Relay contact SF/1 Mentioned in para 9.5M
ii) Relay contact A/3)
iii) Contactor contact ST/2) Mentioned in para 9.6G and J

B Pressure on the expose button I 4-2 will energise timer command relay GR with 220 volts from line 51 via 20 second delay contact I 14, tube kW/timer overload relay contact CM/1, terminal 52, tube thermal overload relay contact PL/2, serial changer remote relay SCT/2 and terminal 23.

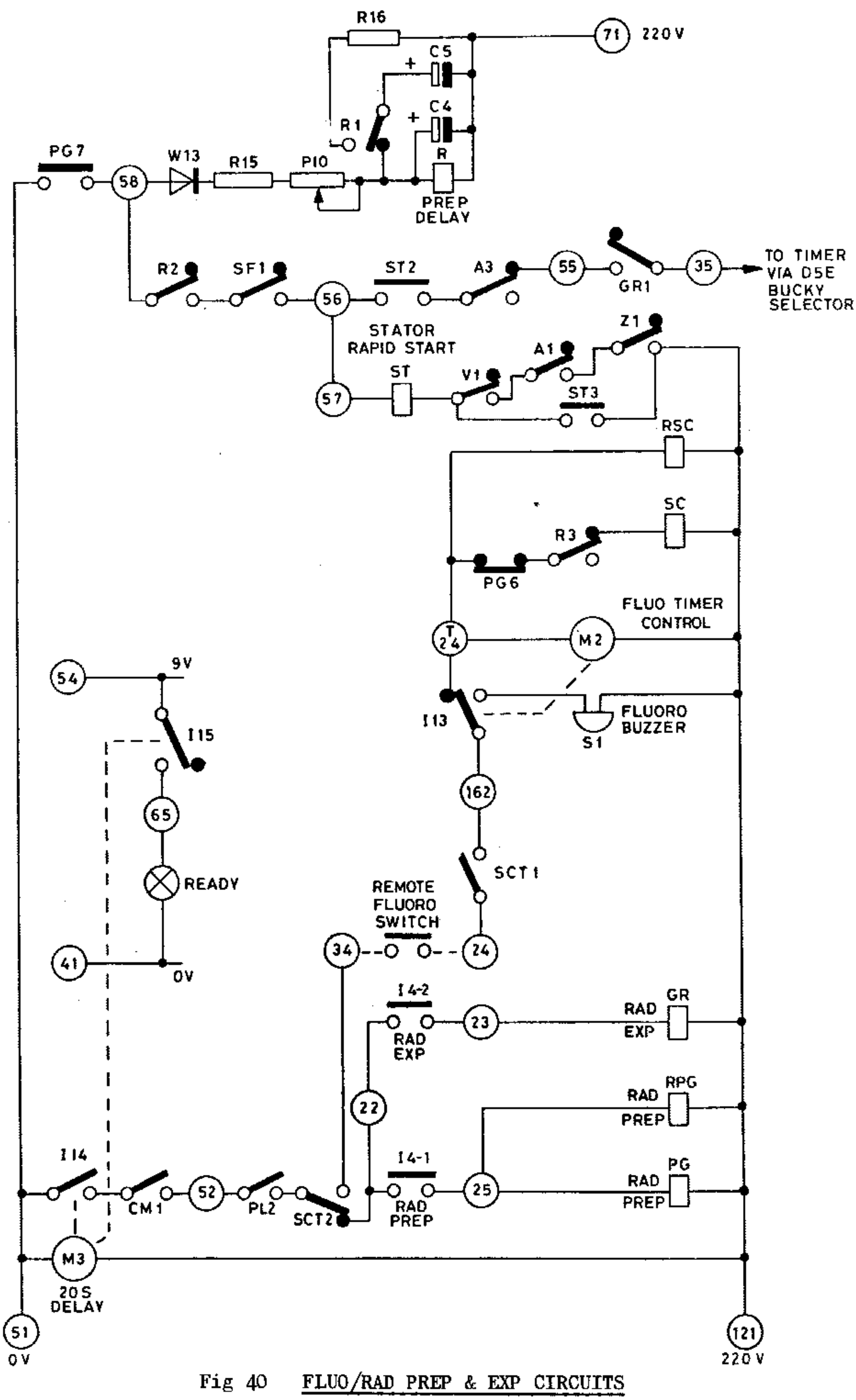


Fig 40 FLUO/RAD PREP & EXP CIRCUITS

(2277/1/780)

C If serial changer remote relay SCT is energised (eg undertable tube selected) then the above circuit to relay GR will be completed via the table expose switch by way of terminals 34 and 23.

D GR/1 Completes the final link in the exposure timer command chain to the bucky start terminals 27 to 32 as follows:

220 volts from line 51 via contactor PG/7, terminal 58, delay relay contact R/2, filament security relay contact SF/1, terminal 56, stator rapid start contactor ST/2, stator main interlock relay contact A/3, terminal 55 and terminal 35 to technique switch wafer D5E.

E Switch D5E (grid ref 4G in Fig 34) routes the exposure timer start supply to terminal 26 via the expose contacts in the selected bucky.

Up to six buckies can be connected between terminal 26 and terminals 27 to 32.

Terminal 33 serves as the common return for all bucky start solonoids.

Any technique terminals 27 to 32 which do not require buckies must be linked direct to terminal 26.

F The connection between terminal 26 and the linked terminals 3, 8 and 10 on the timer chassis (see Grid ref 8F of Fig 34 and Fig 41) completes the expose start circuit to the timer.

9.8.3 <u>RADIOGRAPHY EXPOSURE TIMER</u>

A <u>RADIOGRAPHY PREPARE MODE OF CONTROL FIGS 41, 42, 43, 44</u>

1 The PRIMARY of TIMER POWER SUPPLY TRANSFORMER T1 is already supplied with 220V from lines 51 and 71 during STANDBY MODE of CONTROL.

2 RELAY CONTACT PG/8 closes in THYRATRON PL21 anode circuit.

3 The 220V output from SECONDARY of T1 is rectified and smoothed via BRIDGE RECTIFIER V2 and CAPACITOR B4 and applied to anode of THYRATRON PL21 via RELAY CONTACT PG/8, RESISTORS Z9,G3 and RELAY r1 coil.

4 RELAY CONTACT r3 of RELAY r3 short circuits the grid and cathode of THYRATRON PL21. The thyratron will therefore trigger and energise RL r1.

5 RELAY CONTACT r1 in the EXPOSURE COMMAND RL r3 circuit changes over removing the short circuit across the AC input to BRIDGE RECTIFIER V6 in readiness for RL r3 to close when the RADIOGRAPHY EXPOSE MODE OF CONTROL commences.

6 RELAY CONTACT r1 in series with the TIME SWITCH RESISTOR DECADE opens and disconnects the EXPOSURE TIME RC CIRCUIT until the commencement of the RADIOGRAPHY EXPOSE MODE OF CONTROL.

7 RELAY CONTACT r1 in series with the AC input to BRIDGE RECTIFIER V1 opens and prevents RL r2 from closing until after the RADIOGRAPHY EXPOSE MODE OF CONTROL has commenced.

8 RELAY CONTACT r1 disconnects SMOOTHING CAPACITOR B4 from the THYRATRON HT supply, thus the anode of the thyratron is now supplied with full wave rectified unsmoothed DC volts. RELAY r1 is however slugged by CAPACITOR B9 which prevents relay buzz in this condition.

B RADIOGRAPHY EXPOSE MODE OF CONTROL

1 The AC input to BRIDGE RECTIFIER V6 is supplied with 220V from TERMINAL 51 via RELAY CONTACTS PG/7, R/2, SF/1, TERMINAL 56, RL CONTACTS ST/2, A/3, TERMINAL 55, RL CONTACT GR/1, TERMINAL 35, BUCKY SELECTOR SW BANK D5E (if used), and associated connecting links to TERMINAL LINK 26 and TERMINAL 8 of the TIMER RELAYS BOARD. The other AC input to BRIDGE RECTIFIER V6 is connected to the return line TERMINAL 71 via RESISTOR Z2 and TERMINAL 9 of the TIMER RELAY BOARD.

2 RELAY r3 connected across BRIDGE RECTIFIER V6 is energised.

3 CONTACT r3 in series with the AC input to BRIDGE RECTIFIER V1 closes but has no effect until CONTACT r1 re-closes.

4 CONTACT r3 changes over to connect EXPOSURE CONTACTOR X circuitry but has no effect until its neighbouring contact r1 re-closes.

5 CONTACT r3 connecting the grid of THYRATRON PL21 to the potential of its cathode opens.

6 CONTACT r3 in the RC time switch resistor bank connects the -ve plate of TIMING CAPACITOR B5 to the grid of THYRATRON PL21.

7 There are now three voltage sources connected in series between grid and cathode of THYRATRON PL21.

A A positive bias voltage of 5.6V which is half wave rectified by V5 and smoothed by B7. This voltage is adjustable to calibrate the exposure times to the time switch by means of potentiometer G1.

B A negative voltage of 30V which is full wave rectified by BRIDGE RECTIFIER V4 but is unsmoothed. This voltage is phase shifted by CAPACITOR B6 and RESISTOR Z5 so that when the exposure time is terminated the +ve bias voltage can re trigger the THYRATRON at a precise point on the input waveform to the HT GENERATOR and hence de-energise the Main EXPOSURE CONTACTOR X when the GENERATOR current is passing through zero.

C A voltage of 67V, also -ve and stored by capacitor B5 which was charged to this level via full wave BRIDGE RECTIFIER V3 and RELAY CONTACT r3. This voltage will drain from the commencement of the exposure through the bank of the timing resistors selected by the TIME SWITCH and at the termination of the exposure the grid voltage will be the 5.6V positive voltage superimposed with the negative phasing voltage so that when the phasing voltage is zero the grid voltage will be positive or nearly positive.

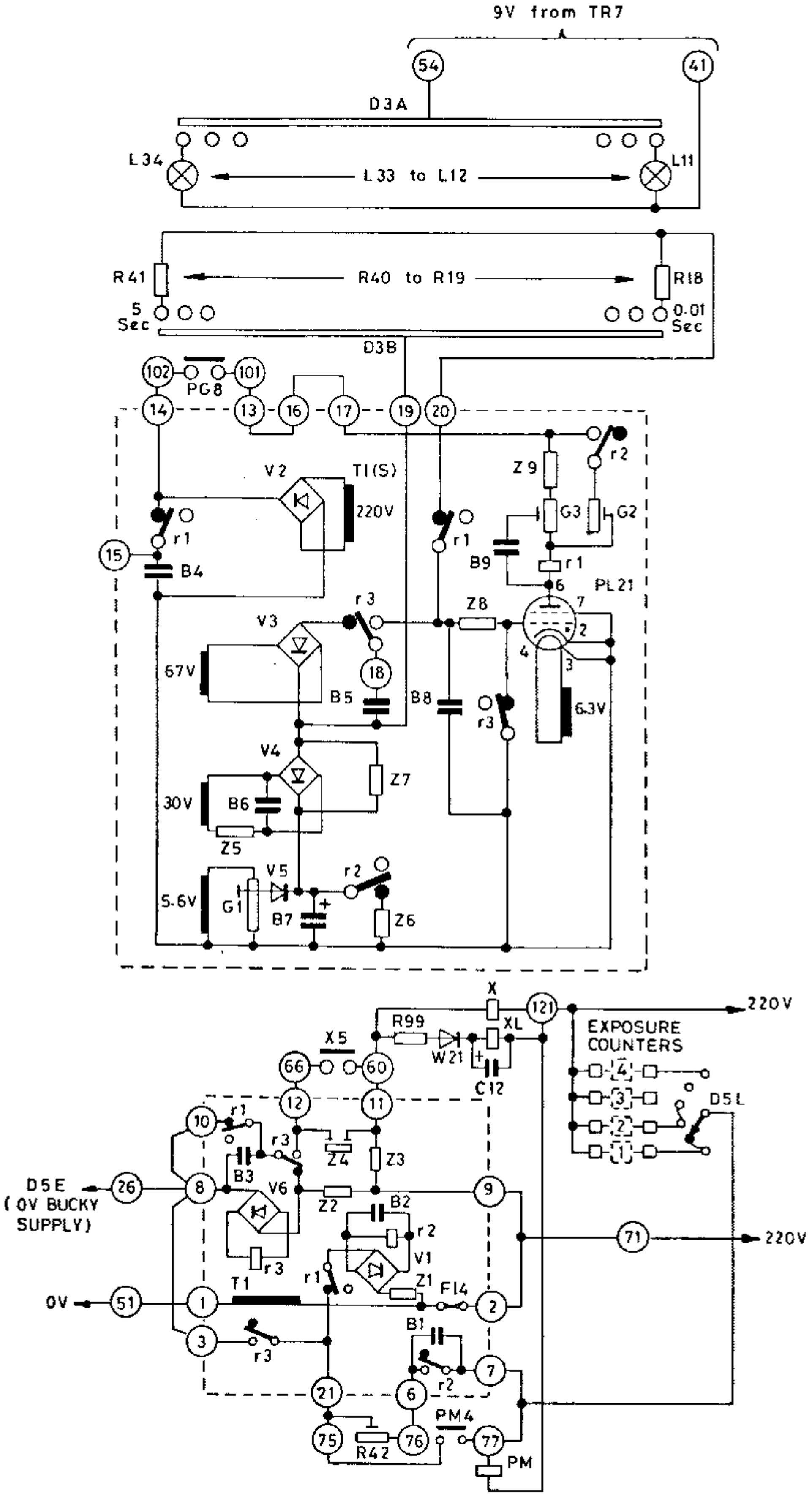


Fig 41 TIMER CIRCUIT

(2277/1/880)

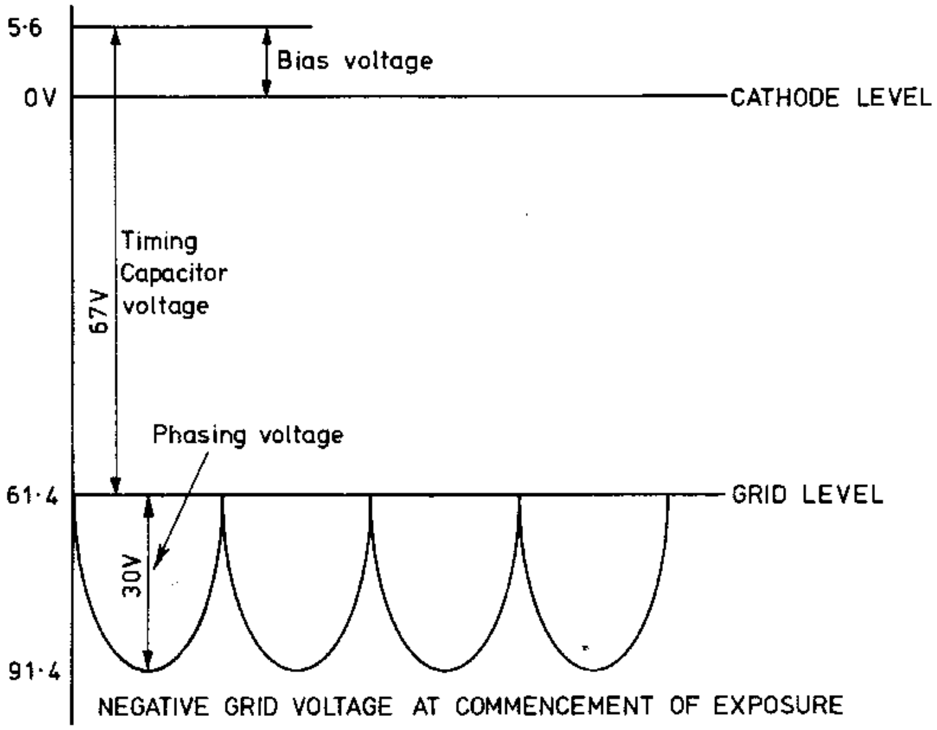


Fig 42 PL21 GRID VOLTAGE LEVEL PRIOR TO EXPOSURE

8 The grid of THYRATRON PL21 is thus -ve with respect to its Cathode but being a thyratron it remains ignited until the anode voltage approaches zero during the conducting half cycle.

9 When the THYRATRON PL21 extinguishes, the anode voltage is nearly zero but RELAY r1 remains energised from the charge left on CAPACITOR B9. The time taken for the capacitor to discharge through RELAY r1 coil is dictated by the adjustable resistance G3. This therefore determines the point at which the EXPOSURE CONTACTOR X comes in with respect to the mains supply reference phase and it is desirable that this should take place at current zero. (Start of t4 below).

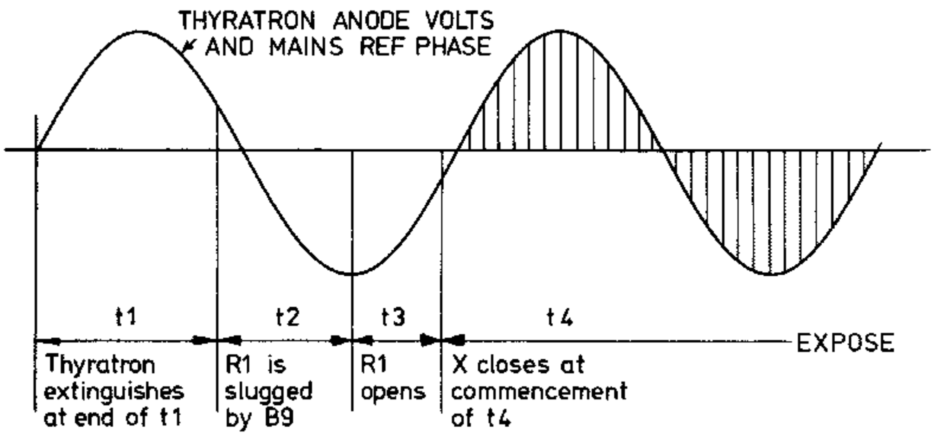


FIG 43 EXPOSURE PHASED START

10 RELAY r1 therefore opens at the end of t2 above.

11 RELAY CONTACT r1 in CR time constant circuit connects the selected time switch resistors across TIMING CAPACITOR B5. The capacitor thus commences its discharge cycle.

12 RELAY CONTACT r1 in HT supply reconnects SMOOTHING CAPACITOR B4 thus restoring smoothed DC to thyratron anode in preparation for re-triggering at the end of the exposure.

13 RELAY CONTACT r1 in EXPOSURE CONTACTOR X circuit re-closes and connects X to 240V supply. Adjustable RESISTANCE Z4 in series with EXPOSURE CONTACTOR X provides fine adjustment of phasing to the mains supply so that the closing of the contactor coincides with the commencement of t4 above. This point is arrived at by judicious adjustment of G3 connected to r1 slugging capacitor and contactor series resistance Z4. When the EXPOSURE CONTACTOR X closes, Z4 is short circuited by CONTACT X/4 thus strengthening the hold on current to prevent contact bounce.

14 CONTACT r1 in series with contact r3, AC input to RECTIFIER V1 and RESISTOR Z1 re-closes, and RELAY r2 is supplied with the DC output voltage of RECTIFIER V1.

15 CONTACT r2 disconnects RESISTOR Z6 in parallel with THYRATRON DC bias voltage CAPACITOR B7. This resistor prevents B7 charging up to the voltage of rectifier V4 during standby and prep. If Z6 is however left in circuit during an exposure, the capacitor B7 would follow voltage drops resulting in the 5.6 volt secondary winding by discharging through the resistance to the new voltage level. These voltage drops could vary with the exposure factors selected. eg. High kV or high mA would result in a small reduction of voltage applied to T1 which would be reflected in the 5.6 volt bias circuit. This is critical and if it varies over a number of different exposures, then the exposure times would vary.

16 CONTACT r2 connects adjustable RESISTOR G2 in parallel with part of the THYRATRON PL21 anode load resistance G3 and Z9, but has no affect until THYRATRON re-ignites.

17 CONTACT r2 closes in TIMER RELAYS BOARD and supplies 220V to CONTACTOR PM via a CONTACT of r3 and R42. The adjustment of R42 dictates the point in the AC $\frac{1}{2}$ cycle when PM should close and this should be just after the instant when the MAIN EXPOSURE CONTACTOR X has <u>fully</u> closed.

18 Contacts PM1 and PM2 close and short circuits the surge limiting resistor R6 in series with HT TRANSFORMER PRIMARY CIRCUIT this saving deterioration caused by arcing on the MAIN EXPOSURE CONTACTS X/1 and X/2. When PM contacts close, CONTACT PM/4 short circuits R42 and thus provides a firm hold on current to prevent contact bounce.

19 The TIMING CAPACITOR B5 is discharging through the selected resistors on the time switch resistor decade and the negative voltage on the THYRATRON grid commences to rise exponentially towards the positive region at a time dictated by the CR time constant of the timing network.

20 When TIMING CAPACITOR B5 is nearly discharged, the +ve bias voltage from CAPACITOR B7 will raise the grid of the THYRATRON to a level where one +ve voltage spike will trigger the valve at a point in time when the phasing pulses from BRIDGE RECTIFIER V4 are at zero potential.

21 The phase displacement with respect to the main reference phase caused by CAPACITOR B6 and RESISTOR Z5 in the grid phasing circuit should cause triggering of the THYRATRON, followed by the opening of the Main Exposure Contactor X at a point in time when the phase of the HT primary current is approaching zero.

22 The triggering of the Thyratron re-energises relay r1 which breaks the supply to Main Exposure Contacts X. The exact point in time where Contactor X opens is determined by the adjustment of G2 which was switched in parallel with part of PL21 anode load G3 and Z9 after the commencement of the exposure. Hence the reason for restoring the smoothed DC anode supply. Early opening of Contactor X will require less resistance in G2. Late opening of Contactor X will require more resistance in G2.

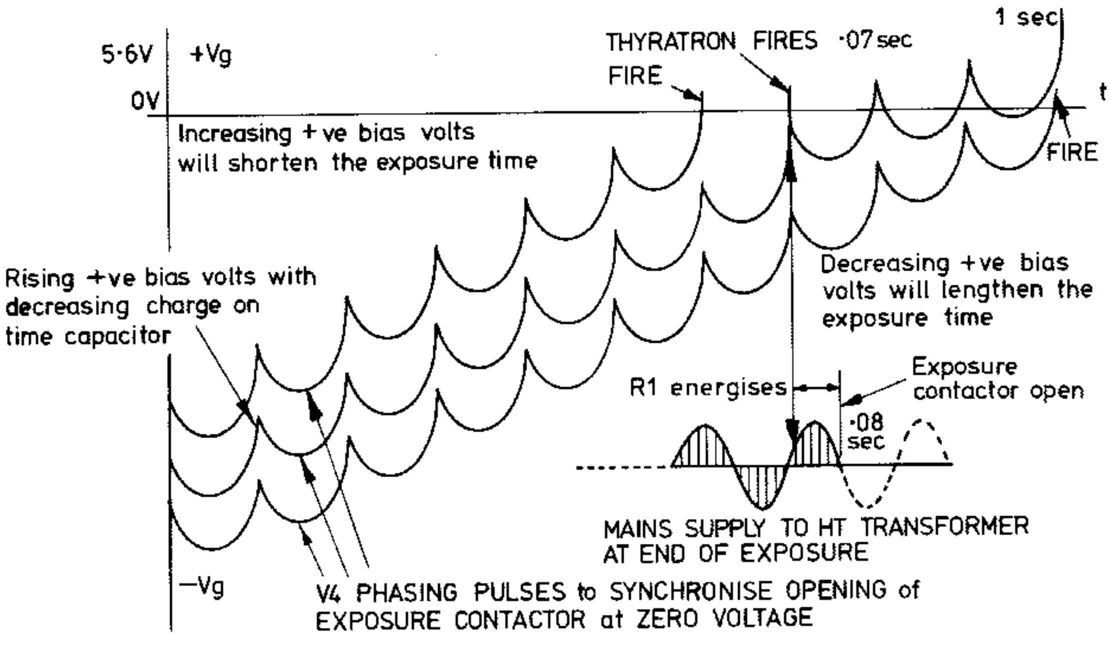


FIG 44 EXPOSURE PHASED TERMINATION

23 The following example should clarify the exposure termination conditions. If the Time Switch is set to .08 secs the THYRATRON will fire just after .07 secs and the MAIN EXPOSURE CONTACTOR should open at .08 secs just before the next zero point on the HT Transformer mains input phase cycle.

24 CONTACT r1 in HT Supply circuit disconnects SMOOTHING CAPACITOR B4. RELAY r1 is slugged by CAPACITOR B9 when the ANODE VOLTS of the THYRATRON reverts to the unsmoothed full wave rectified condition thus preventing relay chatter.

25 CONTACT r1 supplying BRIDGE RECTIFIER V1 and RELAY r2 opens and the three r2 relay contacts change over RESISTOR G2 in THYRATRON anode load is disconnected and the RESISTOR Z6 is reconnected across 5.6V bias voltage CAPACITOR B7.

26 Contact r1 in TIMER RC network opens but has no purpose until the commencement of the next exposure.

27 A repeat exposure is not possible until the expose button is released which will de-energise RELAY r3, and Pre Magnetisation Contactor PM.

28 With the prepare button still pressed, the circuit is back in the original condition with the TIMING CAPACITOR B5 recharged in readiness for a repeat exposure.

Should a fault occur to stop conduction of the THYRATRON during the PREPARE MODE OF CONTROL it is not possible to EXPOSE, because CONTACTS r1 and r3 in TIMER RELAYS BOARD short circuit r3 BRIDGE RECTIFIER V6 input and thus prevent closure of the EXPOSURE CONTACTOR X when the circuit is raised to the EXPOSE MODE OF CONTROL.

9.8.4 Radiography Overcurrent Circuit Breaker

A The primary of a heavy duty current transformer TR8 (grid ref 4B in Fig 34) is connected in series with the coarse kV selector D1B and terminal 1 on the HT tank when contacts X1, X2, PM1 and PM2 close during a radiography exposure.

B TR8 secondary winding (grid ref 7A of Fig 34) provides a d.c. voltage to terminals 79 and 80 across which is connected circuit breaker relay BK and voltage dropper R45. Capacitor C4 smoothes the full wave rectified d.c. supply.

C A universal shunt comprising resistors R120 to R125 is connected in parallel with terminals 79 and 80 when 50mA is selected via switch wafer D40 (grid ref 7A of Fig 34).

D Resistors R125, R124, R123, R122 and R121 are switched out of circuit one at a time for each increase in mA so maintaining the same voltage level across terminals 79 and 80 regardless of the mA selected.

E Normally the above voltage is just below the threshhold level required to energise relay BK.

F If a fault condition, such as a gassy X-ray tube, too much filament drive or faulty HT Transformer, causes the transformer load current to increase, then sufficient voltage will be generated in TR8 secondary to operate relay BK which in turn will open circuit the hold on supply to line contactor M between terminals C and 84 in grid ref 1B of Fig 34 and so isolate the R500 from the mains supply.

10 R500 SERVICE NOTES

10.1 Radiographic Timer Setting Up Procedure

The radiographic timing system fitted to the R500 will operate consistently over a long period without need for adjustment. However, when it becomes necessary to replace contacts, it is essential to set the spacing correctly and adjust both the electrical operation of the contactor and the electronic timer.

10.1.1 Tools and parts required

Cathode Ray Oscilloscope type DM64
Metric feeler gauges
Normal engineers tools
A set of replacement radiographic contacts
complete with packing shims

10.1.2 Fitting New Contacts

Remove flash covers from contactors X and PM and assemble new contacts <u>without</u> shims as illustrated below.

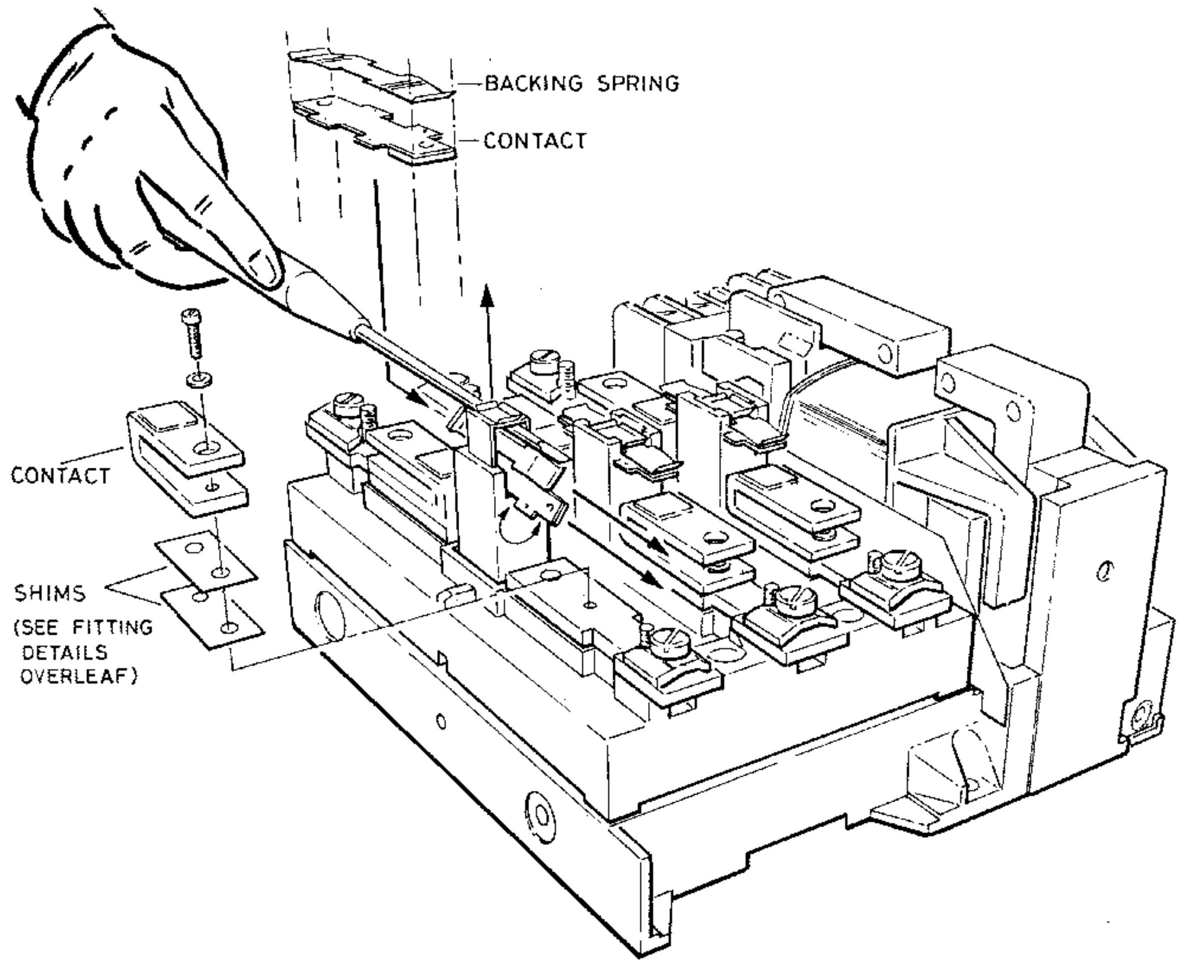


Fig 45 ILLUSTRATION OF CONTACTORS X AND PM

Operate contactors by hand and ensure all contacts meet simultaneously as illustrated below. Use shims if necessary.

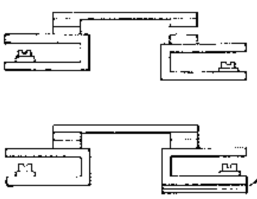


FIG 46 CONTACTOR SHIMMING

Finally, 'bed in' contacts by operating electrically about 25 times and re-check all contacts for simultaneous operation. Repeat adjustments if necessary.

10.1.3 ELECTRONIC TIMER PRELIMINARY ADJUSTMENTS

a. Connect the signal lead of an unearthed DM64 or equivalent memory oscilloscope to terminals 1 and 2 of the main radiographic contactor X (primary wires of HT transformer).

b. Switch ON and check line volts compensation.

c. Set controls to 1 second, 60kV and 50mA.

d. Take a radiographic exposure and measure the duration as indicated by the waveform duration on the CRO. Adjust potentiometer G1 on Timer Chassis for an exposure not exceeding 1 second.

e. Switch OFF.

CAUTION .... If a fault condition prevents the timer from terminating the exposure, disconnect the primary of the HT transformer before proceeding further.

10.1.4 Exposure Timer Phased Start Adjustment G3

a. Connect the signal lead of the CRO to the coil terminals of the main exposure contactor X.

b. Switch ON and check line volts compensation.

c. Set controls to 0.02 seconds, 60kV and 50mA.

d. Take a series of radiographic exposures and observe each trace on the CRO. Any inaccuracies in the exposure time can be ignored at this stage. It is most important that the start of each exposure must commence from the zero volts line on the CRO see Fig 47.

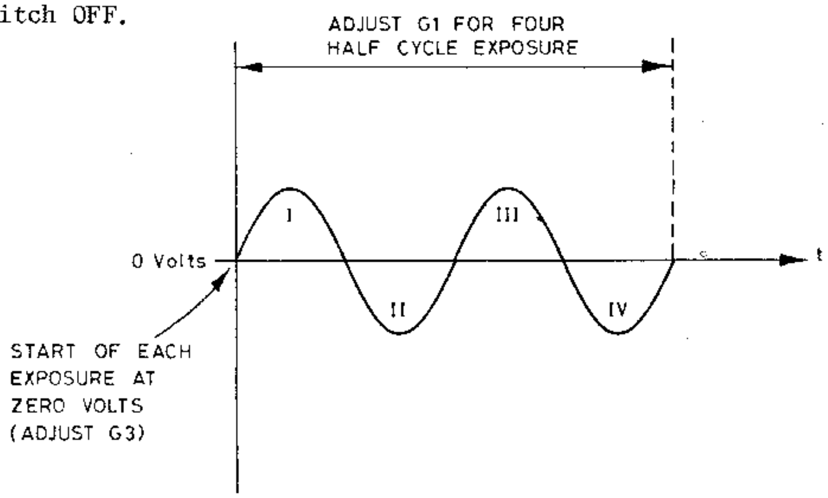
c. Adjust potentiometer G3 in Timing Chassis T3 so that the trace can be seen rising or falling from the zero volts line at the commencement of each exposure.

NOTE .... The trace can rise in a positive or a negative direction because this timer does not have a synchro phased memory circuit to degauss the HT transformer at the start of each successive exposure.

10.1.5 <u>Exposure Time Duration Adjustment G1</u>

a. Adjust potentiometer G1 in Timer Chassis T3 to terminate the exposure after four half-cycles (see Fig 47).

b. Switch OFF.



I	-	First $\frac{1}{2}$ cycle	- Time for exposure contactor to close
II	-	Second $\frac{1}{2}$ cycle	- Premagnetization time of HT transformer
III	-	Third $\frac{1}{2}$ cycle	- Actual exposure time
IV	-	Fourth $\frac{1}{2}$ cycle	

Fig 47 <u>Specimen trace for adjustment of G1 and G3</u>

10.1.6 <u>Exposure Contactor Pull In Adjustment Z4</u>

a. Connect the CRO signal leads to terminals 1 and 2 of the main radiographic contactor X.

b. Switch ON and check line volts compensation.

c. Set controls to 0.02 seconds, 60kV and 50mA.

d. Take several exposures and compare the CRO trace with that given in Fig 48. Adjust Z4 in Timer Chassis T3 so that the exposure commences approximately 3 m.secs before the waveform first passes through the zero volts line.

(See Fig 48 overleaf)

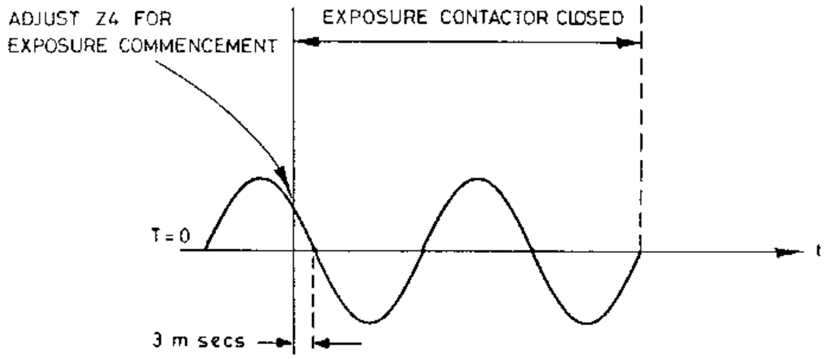


Fig 48 Specimen trace for Adjustment of Z4

10.1.7 Exposure Contactor Drop Out Adjustment G2

a. Check line volts compensation, set controls to 0.02 seconds, 60kV and 50mA and ensure CRO is still connected to terminals 1 and 2 of contactor X.

b. Take a series of radiographic exposures and adjust potentiometer G2 on the timer chassis to produce the correct trace as indicated below. G2 is correctly adjusted when the contactor X drops out approximately 2 m.secs before voltage zero on the CRO display as shown below. This should coincide with minimum arcing when Contactor X drops out.

c. Switch OFF.

I	First $\frac{1}{2}$ cycle	–	Time for exposure contactor to close
II	Second $\frac{1}{2}$ cycle	–	Premagnetization time HT transformer
III IV	Last two $\frac{1}{2}$ cycles		Actual exposure time HT transformer

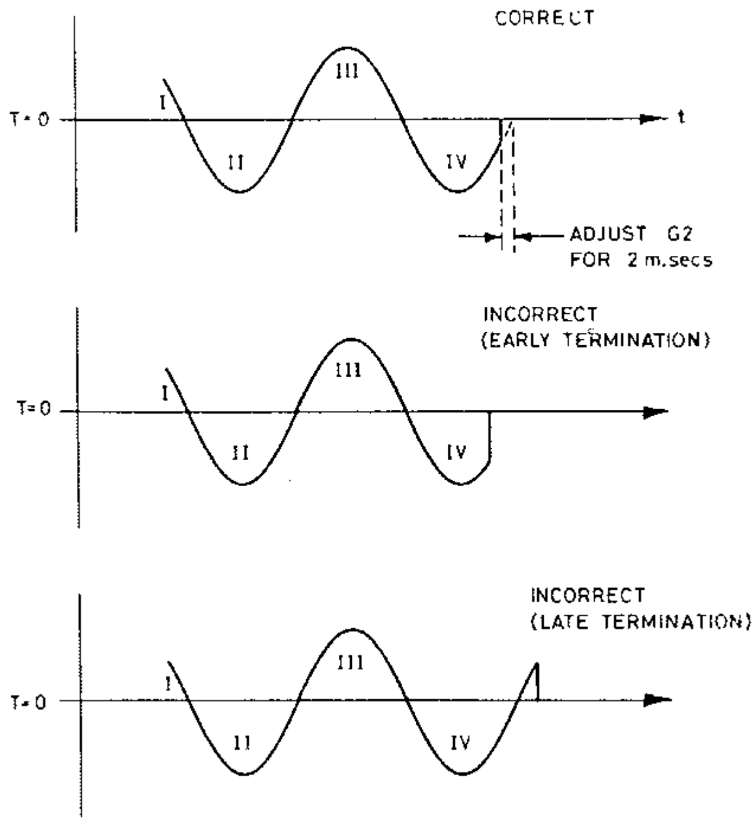


Fig 49 SPECIMEN TRACE FOR ADJUSTMENT OF G2.

10.1.8 Premagnetization Contactor closing adjustment R42

a. R42 is in series with the coil of contactor PM. It controls the time taken for the contactor to short circuit the HT transformer primary surge limiting resistor R6 after closure of the main radiography contactor X.

b. Connect the CRO across R6. This resistor is located on the lower front left side of the control. Set CRO timebase to 10m.secs/cm.

c. Switch ON, check line volts compensation and set controls to 0.1 secs, 60kV and 50mA.

d. Take several exposures and measure the time duration of the voltage waveform across R6, which should be 10 m.secs. Adjust R42 so that the waveform duration is 10m.secs.

e. Switch OFF.

10.1.9 Alternative method of Adjusting R42 using VOLTIX kV attenuator

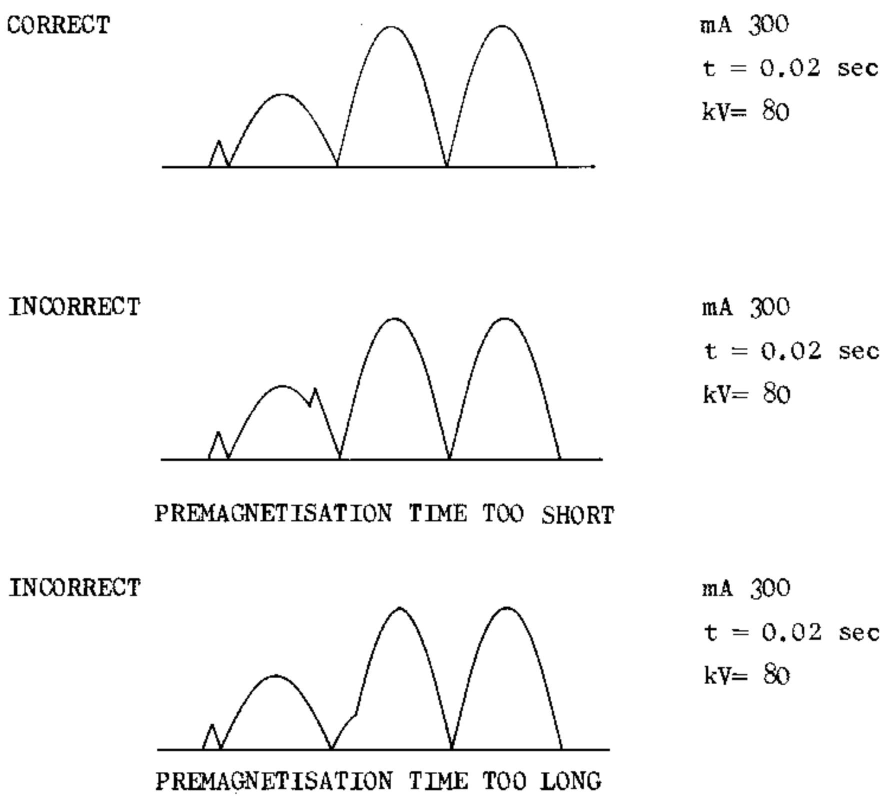


Fig 50 SPECIMEN kV TRACE FOR ADJUSTMENT OF R42.

10.1.10 Final Checks

a. Connect the CRO to terminals 1 and 2 on Radiography contactor X.

b. Switch ON, check line volts compensation and set controls to 0.01 secs, 80kV and 300mA.

c. Take a series of radiographic exposures and confirm that the traces displayed on the CRO are consistant with the exposure time selected.

d. Repeat this test over a number of exposures from 0.01 secs to 0.25 secs and confirm that for each exposure time selected, there is always one extra half cycle displayed i.e. exposure time plus premagnetization time. This may necessitate minor readjustment of G1 on the Timer Chassis.

e. If an exposure time error occurs on any particular setting of the time switch which cannot be resolved by minor adjustment of G1 then change the value of the corresponding resistor in the Exposure Timer decade R18 to R41.

f. Finally confirm that the start and finish of waveforms coincide with the CORRECT trace illustrated in Fig 49. Should an incorrect trace by obtained then carry out setting up procedure outlined from paragraph 10.1.6.

10.2 R500 ROUTINE MAINTENANCE SCHEDULE

Relevant Publications: R500 Installation & Service Instruction No 2277
Routine Inspection Report IR

Test Equipment Required:

A. Multi meter

B. 500 Volt Megger

C. Earth Bond Tester

D. mAs Meter

E. Storage CRO

F. Step Wedge

Procedure: Complete routine inspection report in the order tabulated below including those tasks not listed on the IR.

1.	Overall External Examination	Task No. of IR
A.	Note appearance and cleanliness of equipment	
B.	Examine the following interconnecting cables for damage and pay particular attention to tightness of securing cleats and P clips at vacuflex and cable entry points. i Vacuflex from Control Unit to JB4 ii Vacuflex from HT Tank to JB4A iii Tube stator cables iv Tube thermal switch cables v Tube HT cables	16
C.	Clean and examine all HT cable receptacles for flash over tracking and if condition is satisfactory regrease with recommended insulating medium before re-assembly.	17
D.	Check secureness of all switch knobs and examine for cracks	1

2.	Maintenance - HT Tank	Task No.
A.	Remove all panel covers.	
	Check that all terminals are tight.	15
B.	Examine HT selector drive shaft and micro switch cam plate for excessive backlash.	6

2.	HT Tank (Continued)	Task No.
C.	Remove cover from HT selector drive motor and check condition of commutator brushes. Replace if brushes are worn down to less than 3mm.	6
D.	Check that the spark gap assembly is securely held in its pair of spring clips.	
E.	Wipe clean all traces of spilt transformer oil.	
F.	Check that the oil level is not below 2.5cm from the top of the tank when cold.	
G.	Check that the vent in the air breather screw is clear.	

3.	Maintenance - Wall Boxes	Task No.
A.	Remove panel covers from JB4, JB4A and the X-ray Tube Selected lights and Auxiliaries Box.	
	Check that all terminals are tight	15
B.	Examine the contacts of all relays for contact pitting.	
	On those which are not encapsuled, check freedom of armature movement paying particular attention to the spring tension of normally closed contacts wired for use.	

4.	Maintenance - Control Console	Task No.
A.	Remove all cover panels.	
	Check that all meters indicate zero and adjust if necessary.	4
B.	Check that all terminals are tight.	15
C.	Check that all fuses are secure.	
D.	Carry out earth continuity and earth insulation safety checks and confirm that the figures recorded comply with those specified in page 37, para 5.2 of INST 2277.	Earth Continuity Insulation Resistance
E.	Switch ON the apparatus and check that the 20 second delay timer functions correctly.	

4	Control Console (Continued)	Task No.
F.	Confirm that 220 volts a.c. is obtained across terminals 220 and 0 when the pointer of the line volts indication meter is coincident with the red datum line.	4
G.	Check that all display lamps are taskworthy.	2
H.	Test the functioning of the kW/time overload circuits against the published parameters for the X-ray tubes deployed and readjust if necessary. Details are contained in pages 38 to 44 of para 5.4 to INST 2277.	14
J.	Press the fluoro kV meter button and check that it is possible to change the kV meter indication by moving the kV control.	4
K.	Take a fluoro exposure on all tubes and confirm that the tube mA in each case remains stable over the entire kV range. In this instance the kV meter should indicate fluoro kV direct without having to depress the above button. See pages 19 and 50 of INST 2277 for test links to be made when screening with non fluoro tubes.	9 8 4
L.	Ensure that a maximum of 5mA can be obtained by means of the fluoro mA control and check capacity compensation as detailed in page 50 para 5.64 of INST 2277. NOTE This can be less if an image intensifier with CCTV is fitted but it must be compatible with the requirements of the system installed.	
M.	Check the accuracy of the fluoro timer and confirm that the buzzer sounds when the timer resets to zero.	9
N.	Depress the radiography prep button and check that the correct tube stator rapidly accelerates. Repeat this test for all tubes.	21
O.	Check that it is not possible to go into prep when the thermal switch on each tube selected is operated by hand.	20
P.	Check that the prep/expose button has 2 distinct pressures when going through prep into expose.	7
Q.	Select 50mA and 60kV. Depress the radiography prep/expose button fully to expose and measure the prep to expose delay time. This should be between 0.8 and 1 second and can be adjusted if necessary by means of P10 on Chassis T1.	11 21

4.	Control Console (Continued)	Task No.
R.	Select each bucky in turn and make an exposure. Check that the exposure does not commence until after the correct bucky grid is set in motion.	
S.	Verify that the X-rays ON lamp gives adequate indication particularly on 0.01 second exposures.	13
T.	Switch OFF apparatus. Remove the flash covers from radiographic contactors X and PM, and examine the contacts.	12
	If extensive pitting is evident, recommend early replacement.	
U.	Connect an mAs meter to the mAs test link terminals. Switch ON apparatus and compensate.	18
	Take a series of radiographic exposures at 75kV and 20mAs over the entire range of the mA switch and note the figures on the test mAs meter.	
	If only slight differences are noted between actual mAs and preselected mAs, readjust tube mA as required with reference to page 51 para 5.6.6 of INST 2277.	
V.	If the difference above exceeds 5mAs, verify the accuracy of the exposure timer by means of a CRO and the information contained in pages 99 to 103 of INST 2277.	5
W.	Check the space charge compensation as specified in page 52 para 5.6.7 of INST 2277.	18
X.	Remove test mAs meter and replace link. Remove excess dust from interior compartments and replace all panel covers.	
Y.	Take a series of step wedge radiographs for record purposes.	19
Z.	Complete Routine Inspection Report Sheet noting any items which require further work.	

Installation and Service

ROENTGEN 500

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.

(2277/2/282)

CONTENTS OF SUPPLEMENT SECTION

PICKER INTERNATIONAL LIMITED

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

Supplement No 2370
(March 1981)
to Inst No 2277

R500 GENERATOR

MODIFICATION TO IMPROVE RELIABILITY OF DELAY TIMER MOTOR M3

NOTE.... Units from Serial No Y029 onwards modified ex-works

References: A RD Relay Modification Kit Stock No 1286-653
B Page 26 of Inst No 2277

BACKGROUND

1. The clutch mechanism in the 20 sec Delay Timer Motor M3 can become affected by mechanical shock when prep and exposure contactors pull in. This results in malfunctioning of micro switches I14 and I15 which can interrupt the prep and expose switch functions.

ACTION

2. If this is encountered Reference A is available which will render it unnecessary to replace Timer Motor and Micro Switch Assemblies which are otherwise taskworthy.

3. To confirm if the above assemblies are otherwise taskworthy check for excessive clutch slip which would cause inconsistencies in the 20 second delay run up time after switching ON. Replace the assembly if necessary and then carry out the modification.

AIM OF MODIFICATION

4. To initiate a relay (RL RD) at the end of the 20 second delay period which will switch off the timer motor M3 and also bypass contacts I14 and I15 to provide an alternative secure hold-on circuit for the prep and expose switching functions. The Timer Motor M3 will remain idle until the X-ray is switched ON again. This arrangement substantially reduces wear and tear on the motor clutch mechanism.

INVENTORY OF MODIFICATION KIT

5. 1 off Relay, plug in, B11A, 220 ∿ 3 c/o contacts with wires attached to base mounted on bracket ready drilled complete with quantity 2 fixing screws, nuts and washers.

EMBODIMENT OF MODIFICATION

6. Fit and wire as illustrated on page 2

CONNECTION OF PREP/EXPOSE INTERLOCKS DETAILED IN REFERENCE B

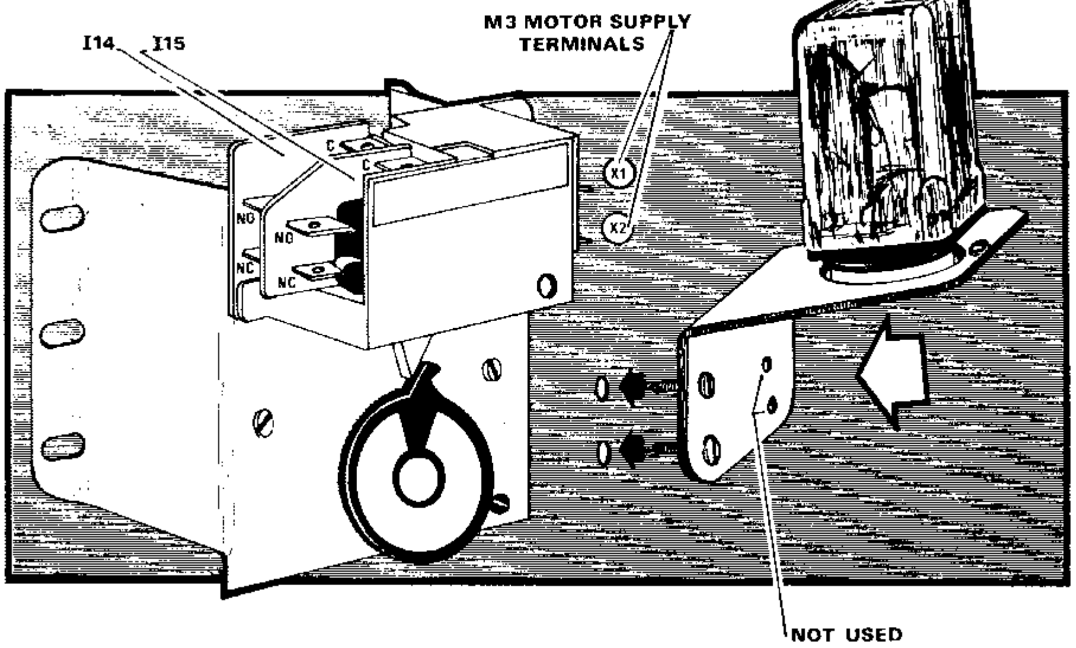
7. Wiring which was originally done on installation as per the above reference should be rewired to conform with the revised circuit on page 2.

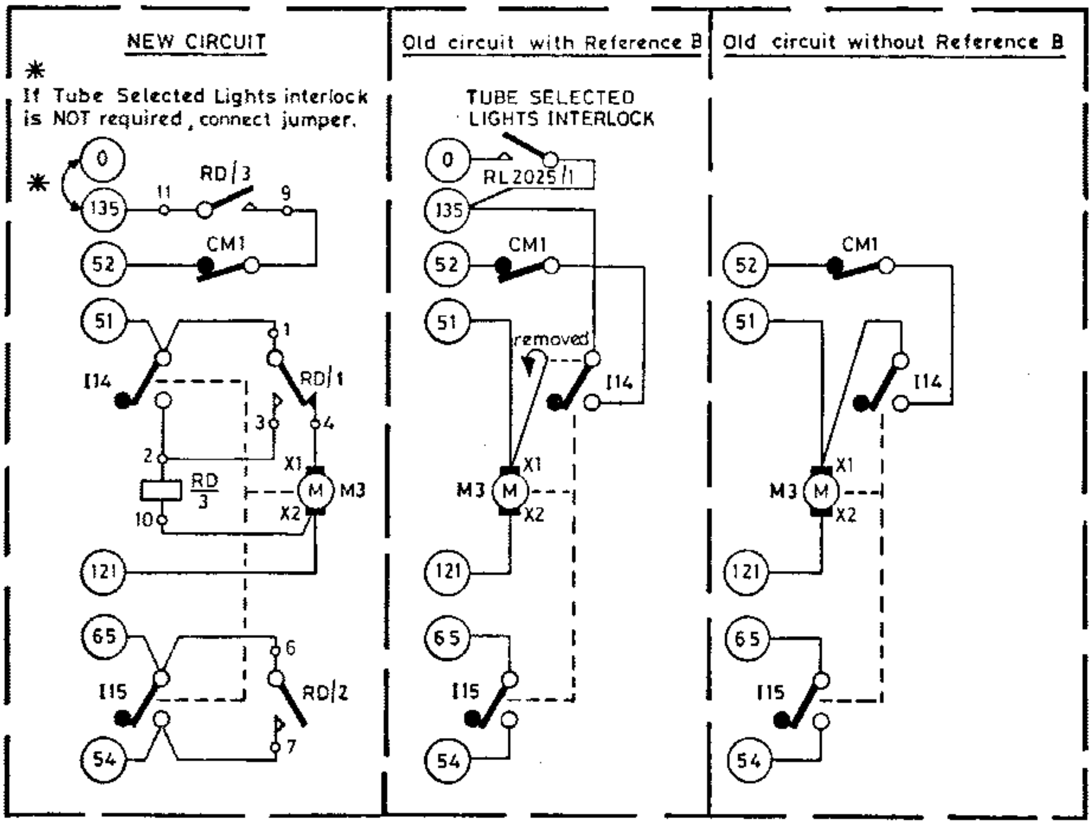
8. No additional wiring is required for new equipments modified ex Works.

When a tube selected lights panel has to be installed it will now only be necessary to remove a link connected between terminals 0 and 135 on the left hand side of the Console.

NOTE....On some models terminal 135 may still be designated 35

9. In Inst 2277 discard existing Reference B (page 26) and insert new Issue 2 attached.





NEW CIRCUIT ... Reconnect existing wires as shown above. If the old circuit was not wired as per Reference B, run an extra wire from Terminal 135 to pin 11 on RLRD base.

Terminal 135 is situated on the second row of the horizontal main terminal strips running down the left side of the Control Console.

Note ... This terminal may be numbered 35 on early models.

Insert this supplement in the Supplement Section of Instruction No 2277.

PICKER INTERNATIONAL LIMITED

P.O. Box No. 2, East Lane, Wembley,
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Supplement No 2392
(December 198?)
to Inst No 2277

R500 GENERATOR

METER ILLUMINATION LAMPS

Background

Difficulty has arisen in replacing the illumination lamps in kV and mA meters on site. The following is a recommended procedure;

Action

1) Remove four screws on the back of the meter case which secure the glass bezel.

2) Separate glass bezel from meter case.

3) Remove scale (two screws).

4) Unclip defective lamp and unsolder the wire pig tails from the lamp supply terminals.

5) Fit new lamp assembly (Stock No LS 1205).

6) Re-assemble meter.

Insert this supplement in the Supplement Section of the R500 manual, No 2277.

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Supplement No 2416
(June 1982)
to Instruction No 2277

R500 with Senate table & Kompact S80

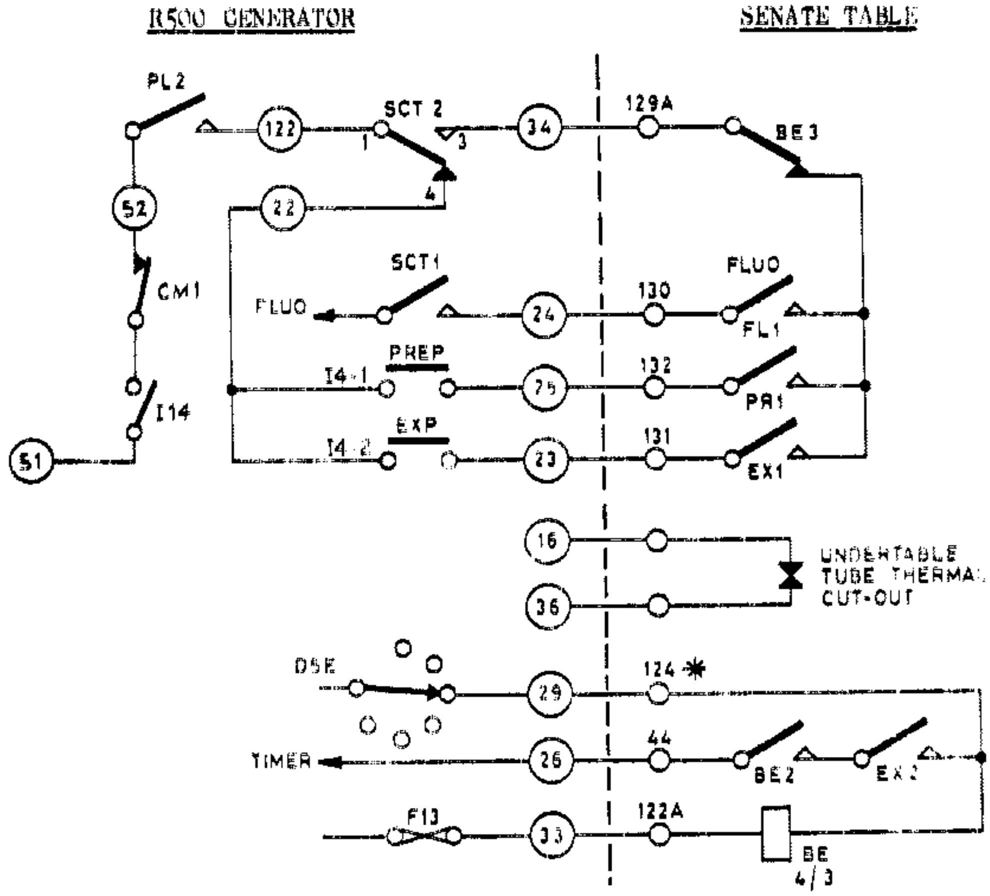
Reference A: Inst No 2277 Page 25 Para 4.8.6 (R500 Service manual)

PROCEDURE

1. Connect Senate table Exposure Control Circuits as below.
2. Reference A does not apply to the KS80 because video blanking is built in.

3. Interface the R500, KS80 and Senate table as detailed on page 3.

NOTE ... the TV relay is reconnected to provide an uninterupted supply to the KS80 when the R500 is switched on.



*If Sectograph 40 is being installed, wire lead 124 as per following:-

SECTOGRAPH 40 ATTACHMENT DETAILS

a. This can be incorporated with technique 3 (table bucky) by means of an additional Secto Select Relay which will insert the secto exposure contact in series with the table bucky expose circuit when the Secto control Box is switched on. When the Secto control is off, the secto contact will be short circuited to permit normal overtable exposures to be made.

Cnt ......

Continued,

b. Materials required

Relay 590 type, Stock No RS1730

Fasteners for above

Wire 24/0.2mm

c. Fitting and connection details

i On the underside of the main JB paxolin board behind the terminal 30 end of the middle terminal strip, mount the relay and make sure that there is sufficient electrical clearance between the relay contacts and the JB metal base plate.

ii Wire the coil of the relay to terminals 1 and 2 of the 300 series terminal strips.

iii Wire the pole of the relay contact to terminal 29.

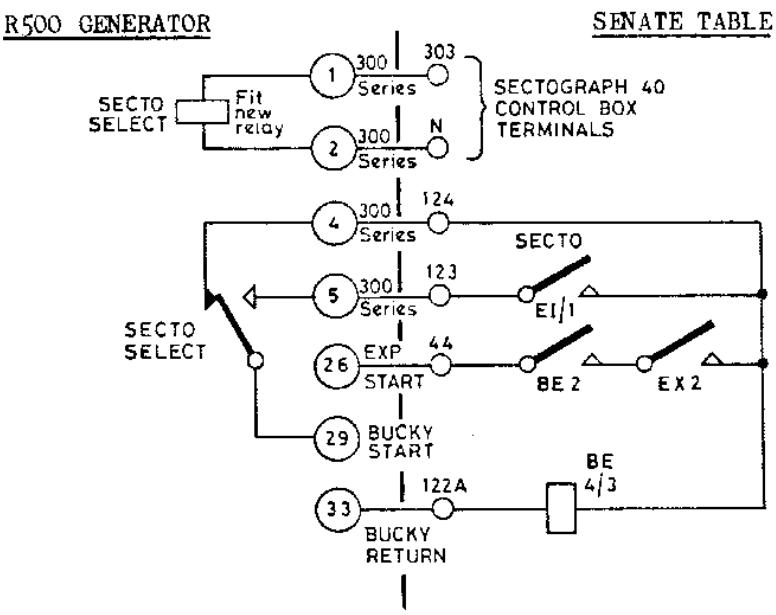
iv Wire the normally closed contact to terminal 4 of the 300 series terminal strip.

v Wire the normally open contact to terminal 5 of the 300 series terminal strip.

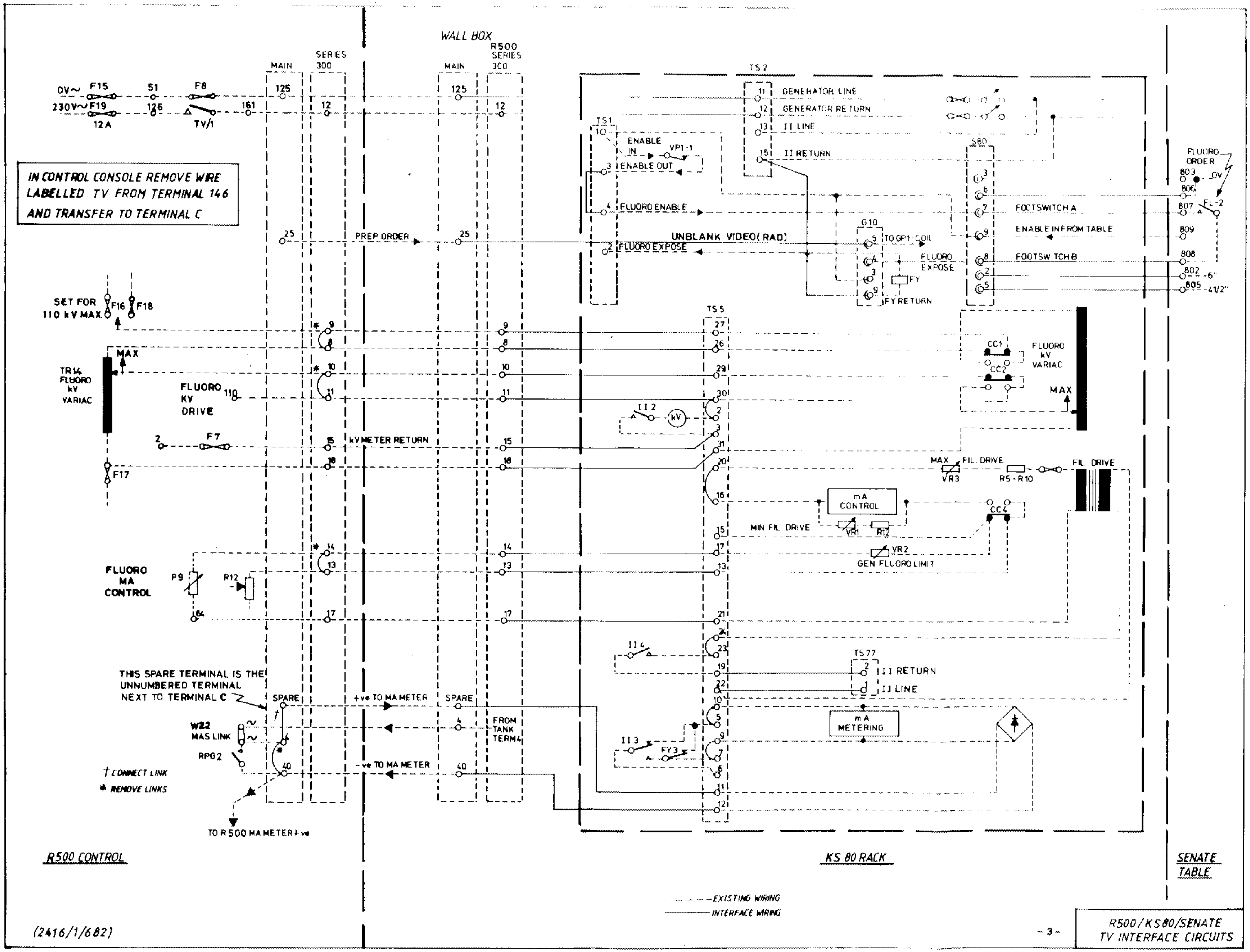
vi Transfer table connection 124, located on terminal 29 to terminal 4 on the 300 series terminal strip.

vii Connect terminal 123 on the table to terminal 5 on the 300 series terminal strip.

viii From the Secto Control Box, wire terminals 303 and N to terminals 1 and 2 on the 300 series terminal strips.



Insert this supplement in the Supplement Section of R500 Service Manual No 2277.



R500/KS80/SENATE TV INTERFACE CIRCUITS