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

INSTRUCTION NO 1699
(August 1978)

IMPORTANT

Before commencing installation or service work refer to the supplements in the rear of this manual.

MX4 MOBILE

Series 2

INSTALLATION & SERVICE NOTES
Instruction No 1699

WARNING!

Before attempting to use test instruments refer to page 65.

Full precautions must be taken to guard against electric shock or exposure to X-radiation. (See page 5B for details).

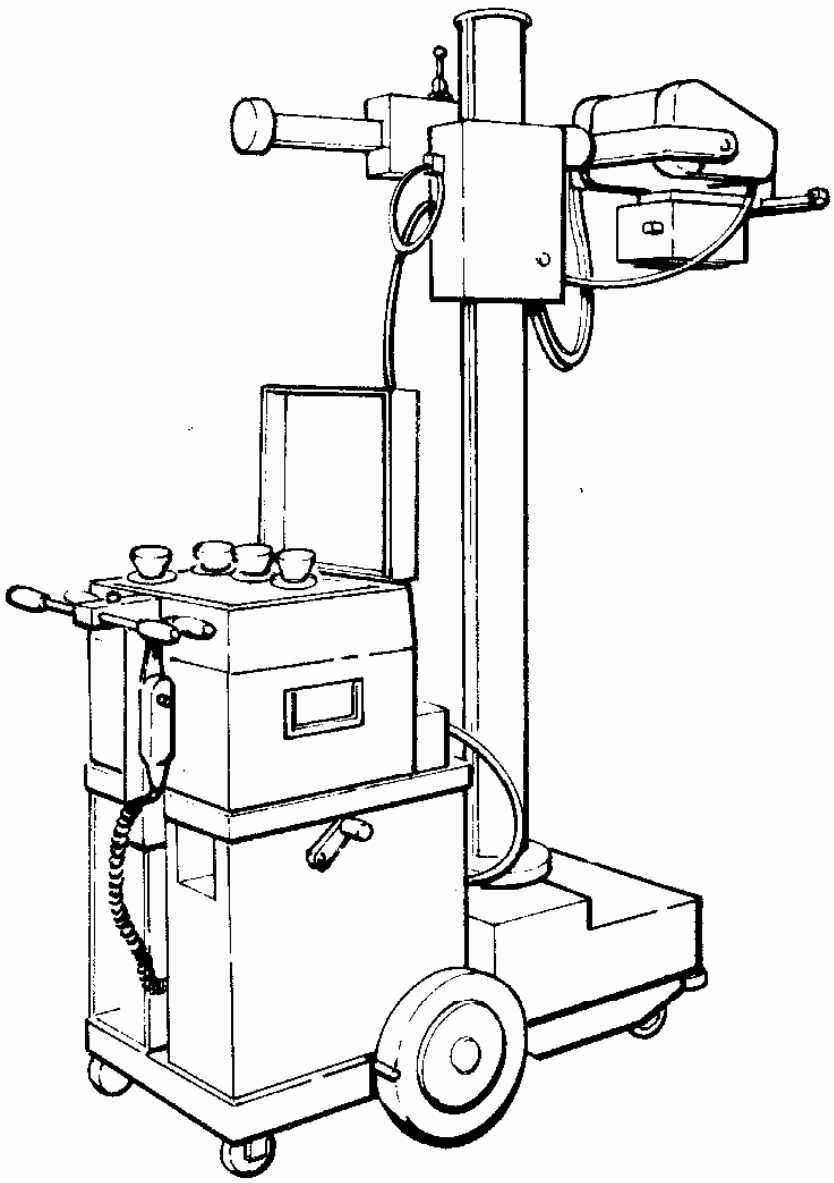


Fig 1 Series 2 MX4 on Mobile Base
Hand Driven Model

Installation Instruction and Service Notes for MX4 Series 2 Mobile Model

Contents

SERVICE NOTES

See separate contents list on page 64.

1. GENERAL INFORMATION - MX4 Series 2

These instructions relate to both 50Hz and 60Hz units except where stated.

1. Mains Supply: 210V to 250V.

2. Maximum Mains Impedance: 0.3Ω at 240V 50Hz.at supply socket with standard (10m) mains cable for full output.

3. Current Loading: 96Amps for 0.1sec.
60Amps for 0.2sec.
30Amps for 2.0sec.
10Amps continuous.

4. Radiographic Output: 75mA up to 125kV.
100mA up to 100kV.
150mA up to 66kV.

5. mA Values: 50mA, 75mA, 100mA, 125mA and 150mA.

6. Timer Scale: 0.02sec to 5sec on 50Hz (0.016sec to 5sec on 60Hz) with pre-reading mAs indicator.

7. An overload circuit prevents a radiographic exposure, and a visible indication is given,when factors selected are outside the working range of the X-ray tube.

The unit is not protected against rapidly repeated exposures.

8. An exposure counter is fitted internally on to UK units.

9. The batteries of the motor drive unit must be kept clean and fully charged. Details are given on page 58.

10. WARNING .... DO NOT attempt to check continuity of or use a Megger on thyristors (SCRs).

DO NOT check continuity of the memory relay contacts. [See page 65 for details].

Full precautions must be taken to guard against electric shock or exposure to X-radiation. [See page 5B overleaf].

11. Test Instruments and Adjustment Tool

For installation work the following items are required:-

Special thin flat 3/16 in BSF spanner (for adjusting LBD) Stock No.SS 2028

mAs meter
Step wedge
Spinning top
Ardran cassette
Earth continuity tester

} Available at Branches.

For service work the tool and instruments listed above may be required, as well as the following items:-

Multimeter (Avo 8 or 9) (DO NOT use to check memory relay, transistors or thyristors - see page 65 for details).

Transistorised continuity tester.

500V Megger (Refer to page 65 for use).

RADIATION HAZARDS & SAFETY PRECAUTIONS

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

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

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

ELECTRIC SHOCK HAZARD

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

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

EXPLOSION HAZARD

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

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

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

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

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

2. INVENTORY of COMPONENTS. Fig 2

Refer to packing notes supplied with the apparatus for complete list of items provided.

One X-ray tubehead (1) complete with gimbal and supply cables 34kg (75lb).

One Demarcator Light Beam Diaphragm (2). Hand Model 7kg (15lb) or Motorised model 8kg (18lb) depending on installation.

One Control Unit (3) 39kg (85lb).

One Mobile Base, Hand Driven 210kg (465lb) or Motor Driven 240kg (527lb), comprising:

One Column Assembly (4).

One Main Base Assembly (6) complete with Handswitch and Mains Cable.

Two Security Screws (5).

One Crossarm Assembly (7)

NOTICE .... If any part or parts of the apparatus have been damaged in transit notify GEC Medical Equipment Limited or Agency within 24 hours and retain packing material for insurance assessor.

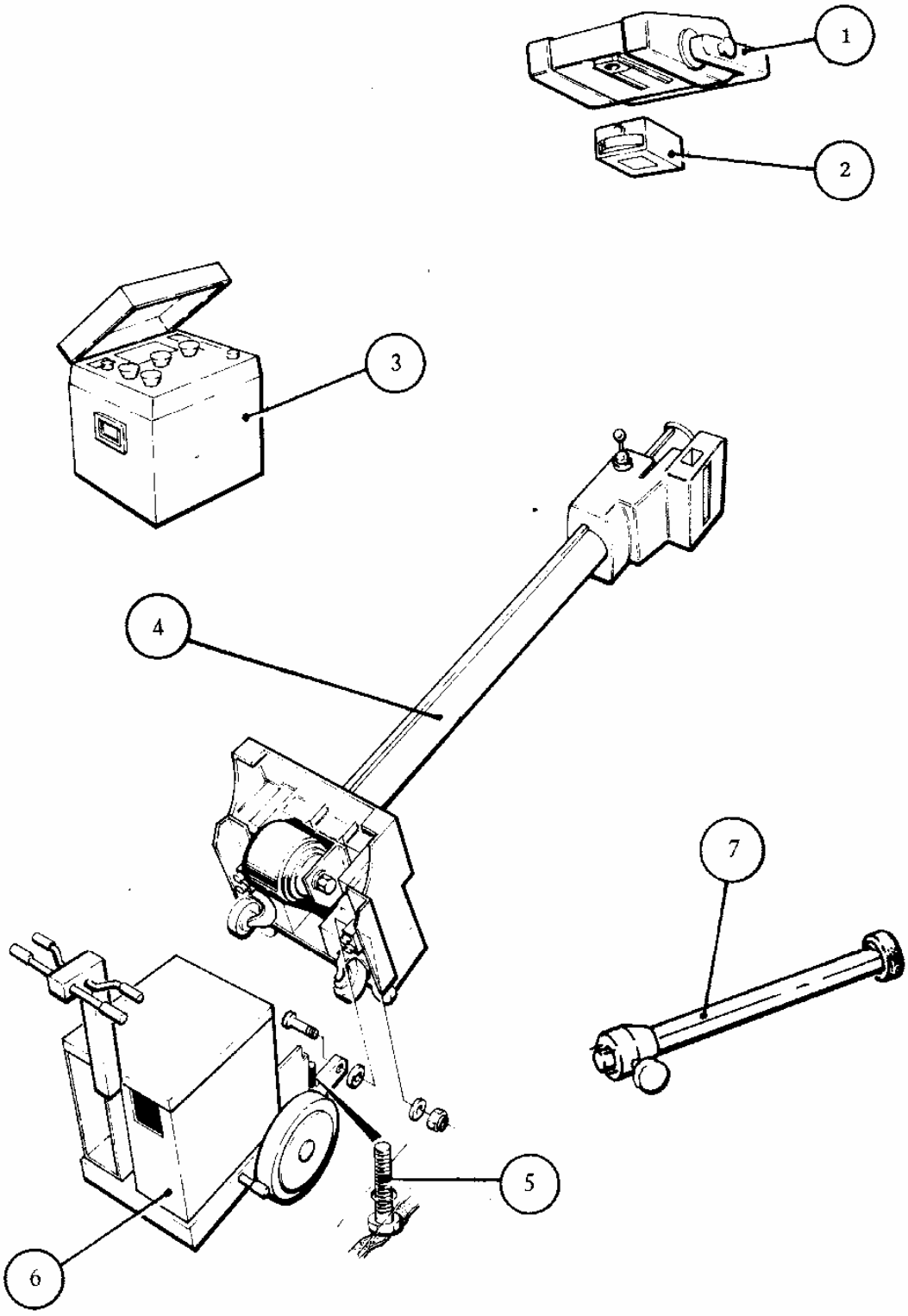


Fig 2 Components

3. ASSEMBLING MOBILE BASE Fig 3

Fit the column assembly to the main base assembly as shown in Fig 3 using the two bolts, four washers and two nuts provided.

Continue the assembly as described in page 8B.

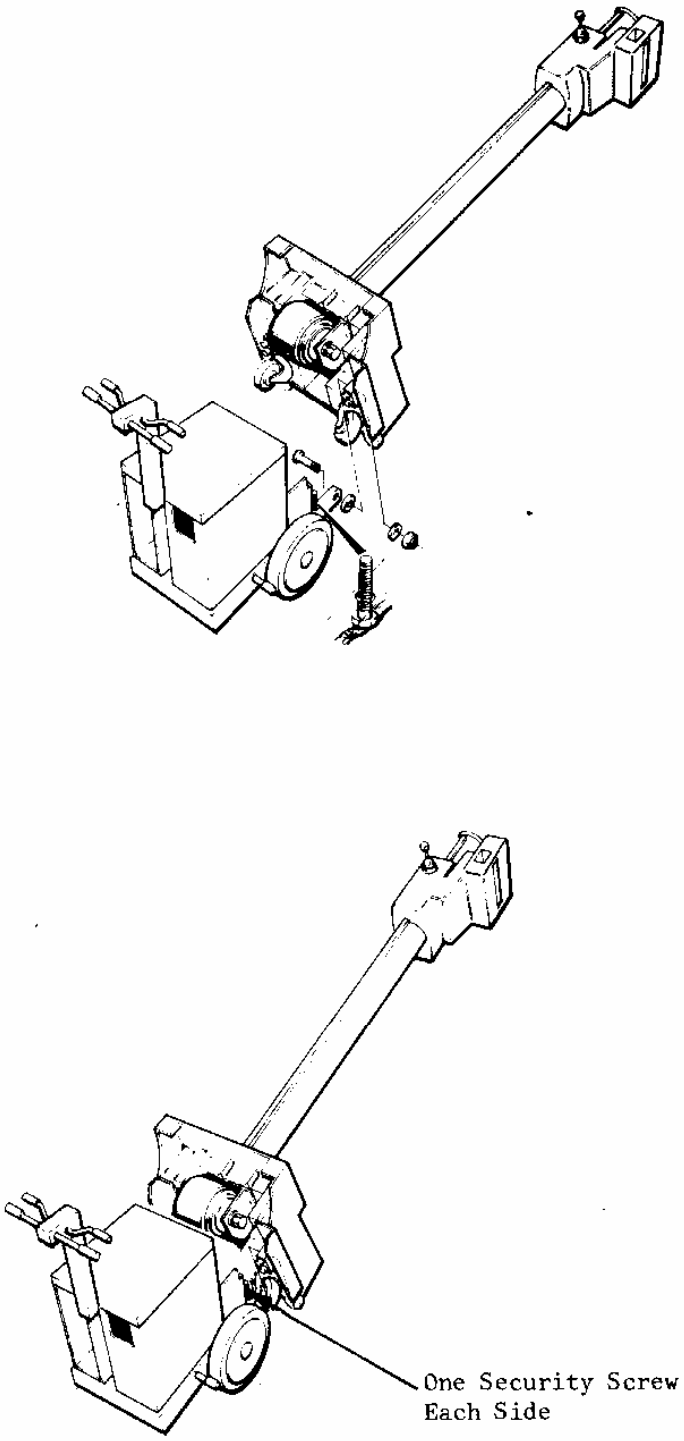


Fig 3 Assembling Mobile Base

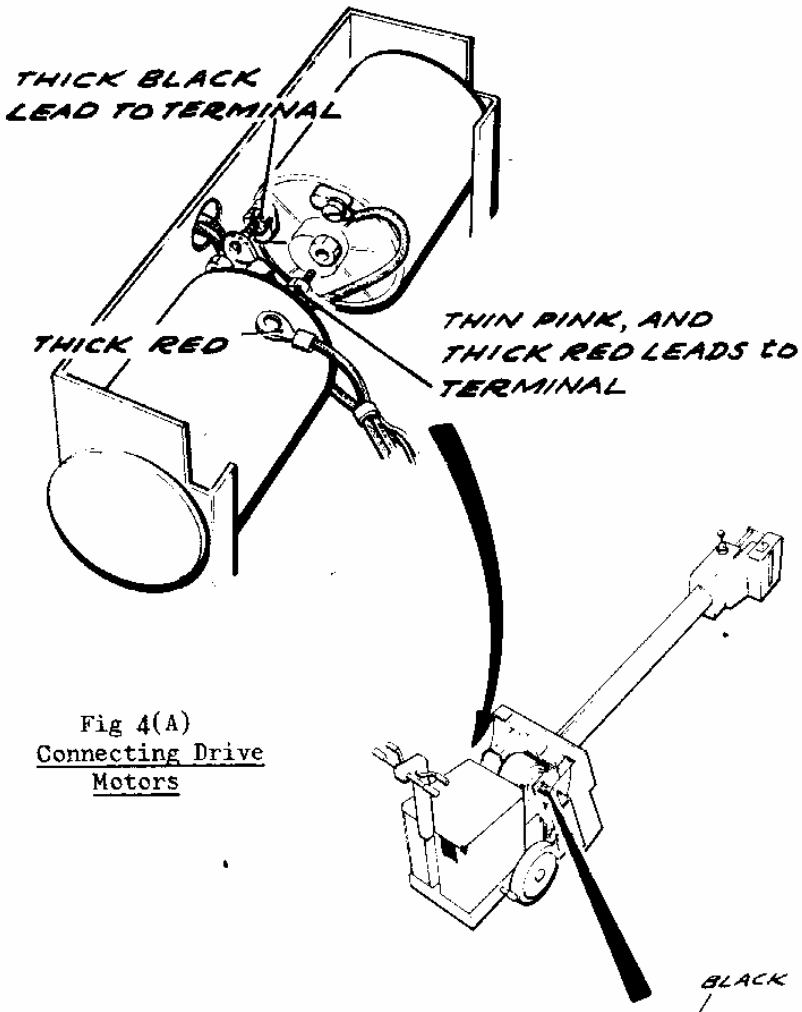


Fig 4(A)
Connecting Drive
Motors

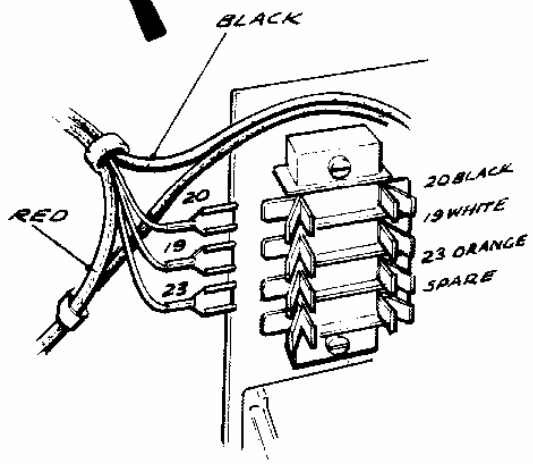


Fig 4(B)
Terminal Strip Connections

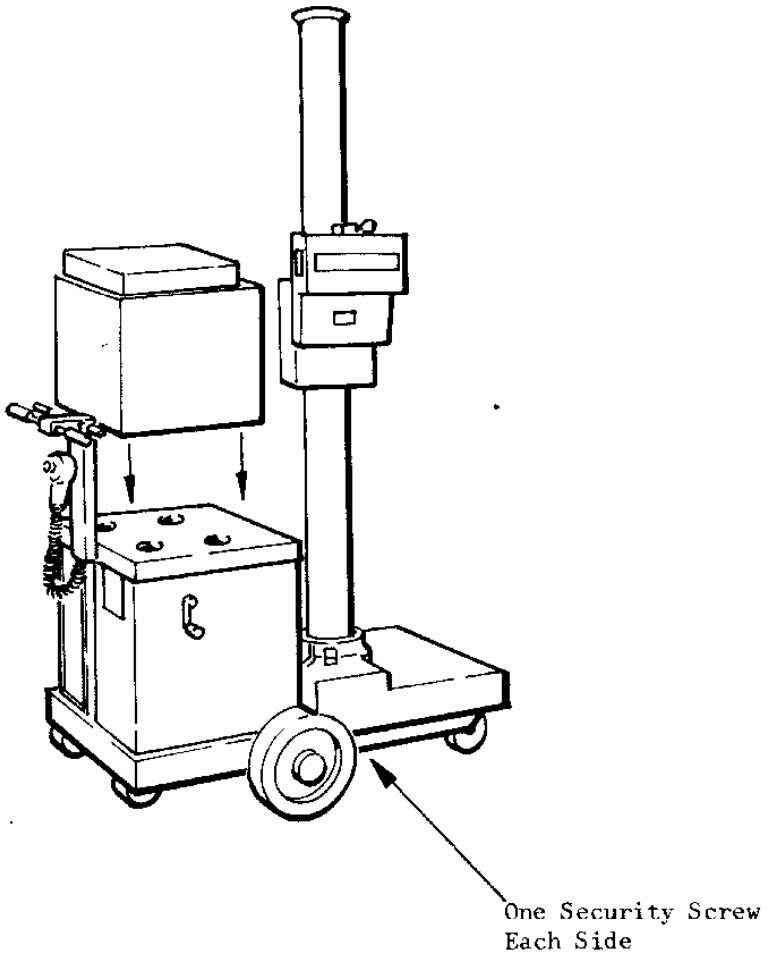


Fig 5 Completion of Mobile Base Assembly and Placing Control Unit on Base.

4. FITTING THE CROSSARM Fig 6

WARNING . . . . . NEVER rely on the spring-loaded brake to secure the carriage when fitting the crossarm.

Unless the crossarm is to be fitted with the carriage at the top of the column, secure the carriage with strong rope.

Remove the end stop and buffer from the crossarm.

Remove the tray containing the counterweights from inside the crossarm.

Ensure that the crossarm travel brake is in the released position.

WARNING . . . . . The bearings can be damaged if the crossarm is not entered STRAIGHT into the rollers. DO NOT damage the magnetic brake.

Push rollers apart before fitting crossarm. Fit the crossarm into the carriage with the rotational brake knob on the right when facing the gimbal-end of the column.

Secure the crossarm in a suitable position by operating the crossarm travel brake.

Slide the counterweights and tray into the crossarm.

Refit the buffer and end stop.

5. TYING DOWN THE CROSSARM Fig 7

Before working with the carriage part-way down the column secure the carriage at the required height with strong rope.

Use pieces of rag as illustrated to prevent the rope being damaged by the edges of the mobile base.

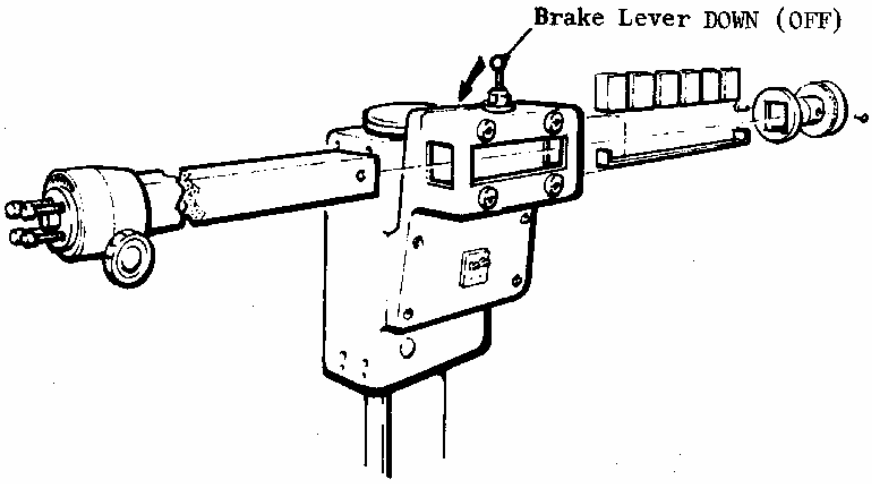


Fig 6 Fitting the Crossarm

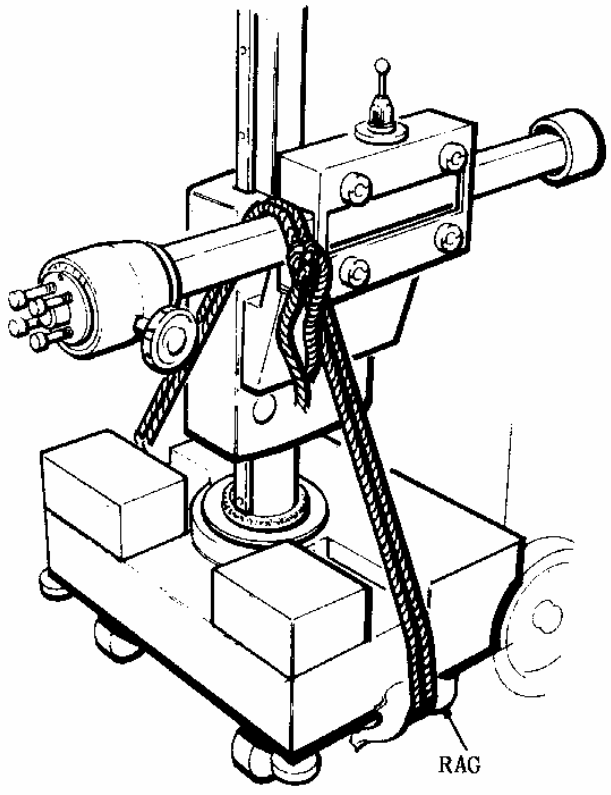


Fig 7 Tying Down the Crossarm

6. FITTING HEAD and GIMBAL to CROSSARM

Secure the crossarm at a convenient working height as described in 5, page 10.

Prevent unwanted movement of the crossarm boss by operating the crossarm travel brake and the rotation brake.

Remove the four socket-head screws from the crossarm boss, leaving the scale and spacer disc in place. Ensure that the two grubscrews in the spacer disc do not protrude towards the scale.

Lift the head and gimbal, and fit the gimbal onto the spigot of the crossarm boss. Continue supporting the head until the subsequent clamping is adequate.

Feed a socket-head screw through one of the holes in the gimbal and through a hole in the spacer disc, turning the spacer if necessary. Retain the screw by inserting it by a few turns.

Insert the remaining three socket-head screws, working the gimbal along the locating pin by turning each of the socket-head screws in sequence until they are fully tightened. At some time during this process it will be found unnecessary to continue supporting the head.

Release the rotation brake, and rotate the head until the top surface of the gimbal and the top surface of the crossarm are parallel (eg both horizontal by a spirit level). Apply the rotation brake.

Rotate scale until 0^{o} mark is aligned with fixed mark on crossarm boss.

Turn the two grubscrews to secure the scale.

Final adjustment of tubehead alignment is made by means of the two Allen screws A on Fig 8.

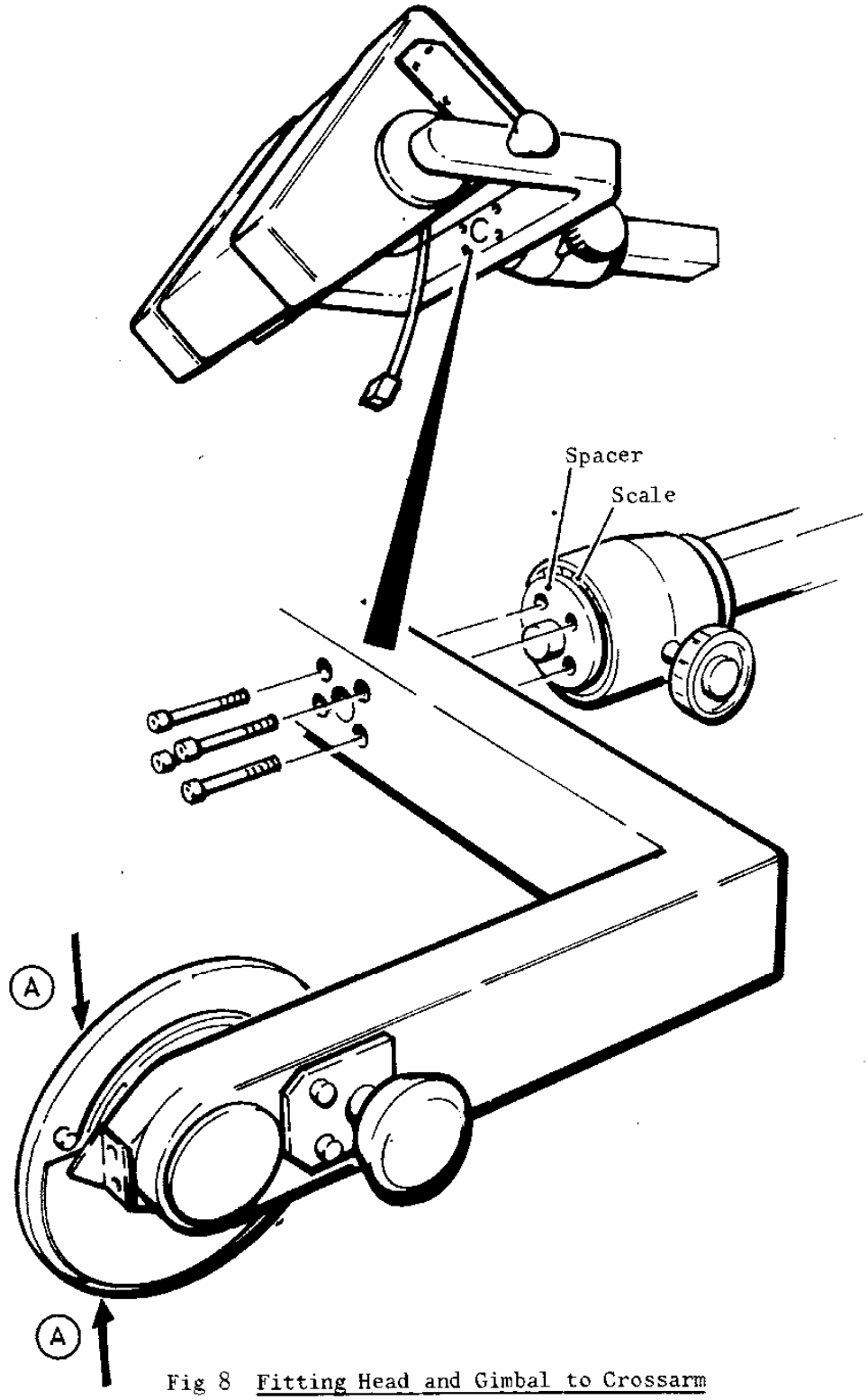


Fig 8 Fitting Head and Gimbal to Crossarm

7. CHECKING CONNECTIONS of CABLES at HEAD

Remove cover from X-ray head. See Fig 9 on facing page.

Check connections as shown in list below with particular attention to the notes.

4-Core Cable

HEAD Lead		HEAD Term	JB Term	LBD Connector	
Green/Yellow	to	E	E	1	LBD Earth
Black	to	E	E	2	
Brown	to	50	50	3	LBD Switch
Blue	to	50	50	3	

6-Core Cable [See Note 1]

HEAD Lead Colour or CORE No				HEAD Term	JB Term	Function
Yellow	or	1	to	105		(Meter Supply)
Blue	or	2	to	121 - [Note 2]		(0 Volt end of filament transformer)
Green	or	3	to	S6 or 108 [Note 3]		(Controlled end of filament transformer)
Red	or	4	to	62		(Stator Main Supply)
White	or	5	to	61		(Stator Capacitor Supply)
Black	or	6	to	63		(Stator Common Return)

5-Core Cable

HEAD Lead		HEAD Term	JB Term	Function
Blue	to	50		(10V/12V AC to LBD)
White	to	50		(10V/12V AC to LBD)
Red	to	P1		(Primary of HV transformer)
Black	to	P2		(Primary of HV transformer)
Green	to	E		(Earth)

Note 1. The six core cable may have white leads marked with CORE No or have coloured leads.

Note 2. The lead for terminal 121 at head must be connected to the special terminal in the control, identified by "CABLE 121 FROM MX4 HEAD" - see pages 26 and 27.

Note 3. If thermal interlock switch S6 is fitted, the green or Core No 3 lead must be connected to the normally closed (NC) terminal of S6. If there is no thermal interlock switch fitted, connect the green or Core No 3 lead to terminal 108 in the head.

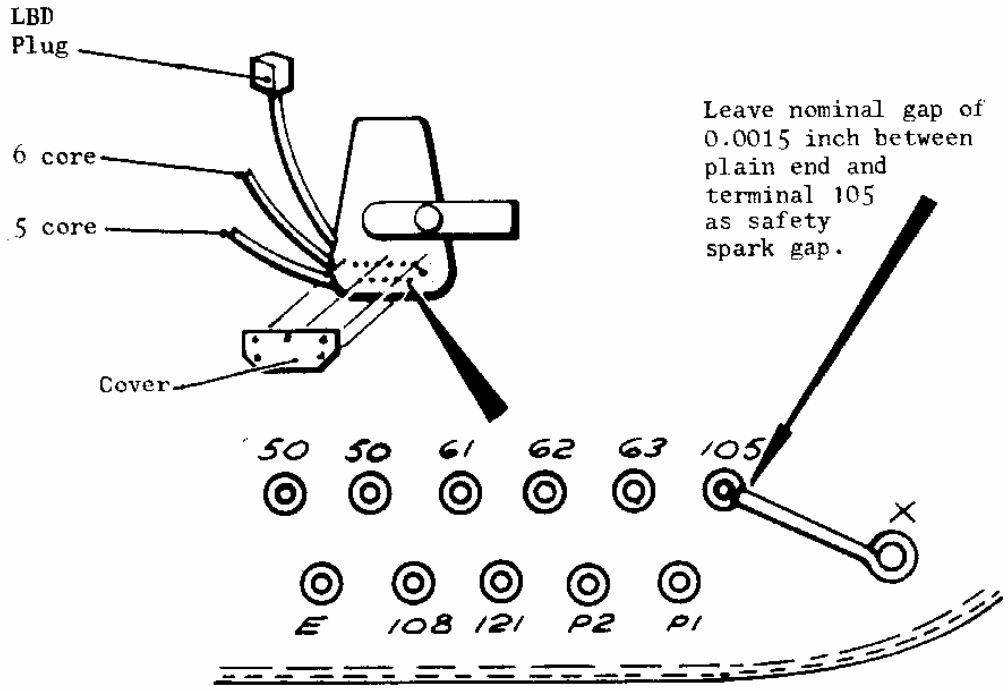


Fig 9 Electrical Connections at Head

8. FITTING DEMARCATOR to X-RAY TUBE

[For comprehensive DEMARCATOR information, see Instruction No.2180]

The alternative assembly using the Stylos type of switchbox is described in 9, page 18.

Dismantle Demarcator as shown in Fig 10.

Discard packing plates (B) and (C).

Place two adjustment screws (with their washers) in the front holes of plate (D).

Fit plate (D) and plate (K) to the tubehead using the appropriate four screws, which must be fully tightened, and MUST NOT "BOTTOM".

Insert the remaining two adjustment screws (with their washers) into the rear holes in the Demarcator by only a few turns.

Discard two filters (G). Fit two filters (F) to Demarcator to make a total of not less than 2mm Aluminium equivalent. (Each filter is 0.5mm thick. The X-ray head is 0.4mm Al equivalent and the Demarcator 0.8mm Al equivalent).

Set indicator (N) on back of Demarcator to show 1mm added filtration.

Fit cone (E) to Demarcator.

Assemble by lifting Demarcator complete with (E) and (F) up to the tubehead, hooking the rear adjustment screws into the slots in plate (D), and inserting the front adjustment screws into the Demarcator by a few turns.

Use a thin flat spanner (eg Terry) to just tighten the adjustment screws.

Fit switchbox (H) to plate (K), including spacers (J).

Fit handle (L) to plate (K).

Adjustment of the Demarcator will be performed near the end of the installation work, and is described in 28, page 54.

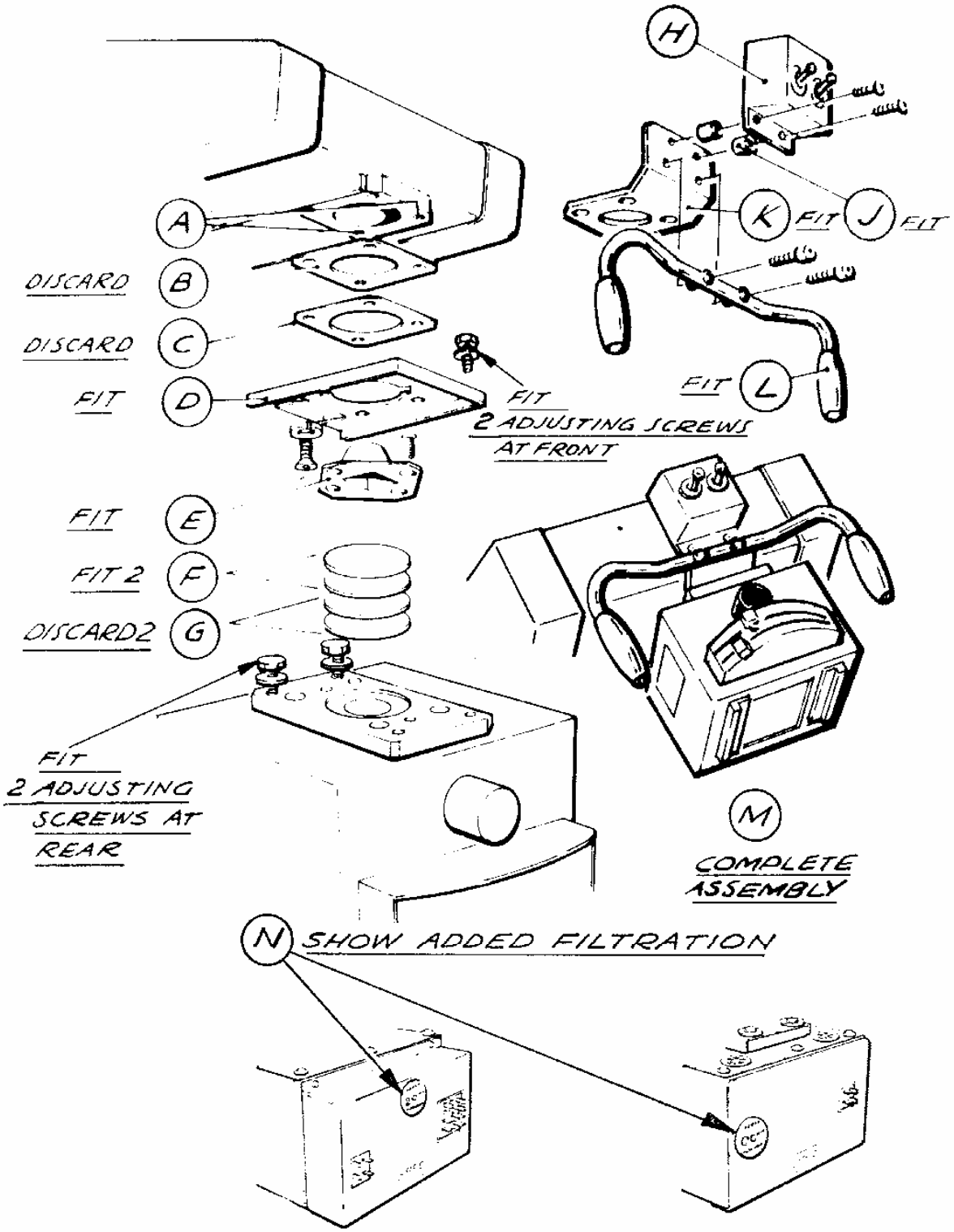


Fig 10 Fitting Demarcator to X-ray Tube with Early Type Switchbox and Setting Filtration Indicator

9. FITTING DEMARCATOR to MX-4 with STYLOS TYPE SWITCHBOX

Dismantle Demarcator as shown in Fig 11.

Discard packing plate (C) and plate (D).

Place two adjustment screws (with their washers) in the front holes of switchbox (H).

Fit switchbox (H) and packing plate (B) to the tubehead using the appropriate four screws, which must be fully tightened, and MUST NOT "BOTTOM".

Insert the remaining two adjustment screws (with their washers) into the rear holes in the Demarcator by only a few turns.

Discard two filters (G). Fit two filters (F) to Demarcator to make a total of not less than 2mm Aluminum equivalent. (Each filter is 0.5mm thick. The X-ray head is 0.4mm Al equivalent and the Demarcator 0.8mm Al equivalent).

Set indicator (J) on back of Demarcator to show 1mm added filtration.

Fit cone (E) to Demarcator.

Assemble by lifting Demarcator complete with (E) and (F) up to the tubehead, hooking the rear adjustment screws into the slots in switchbox (H), and inserting the front adjustment screws into the Demarcator by a few turns.

Use a thin flat spanner (eg Terry) to just tighten the adjustment screws.

The Demarcator will be adjusted towards the end of the installation work, and is described in 28, page 54.

[For comprehensive DEMARCATOR information, see Instruction No.2180]

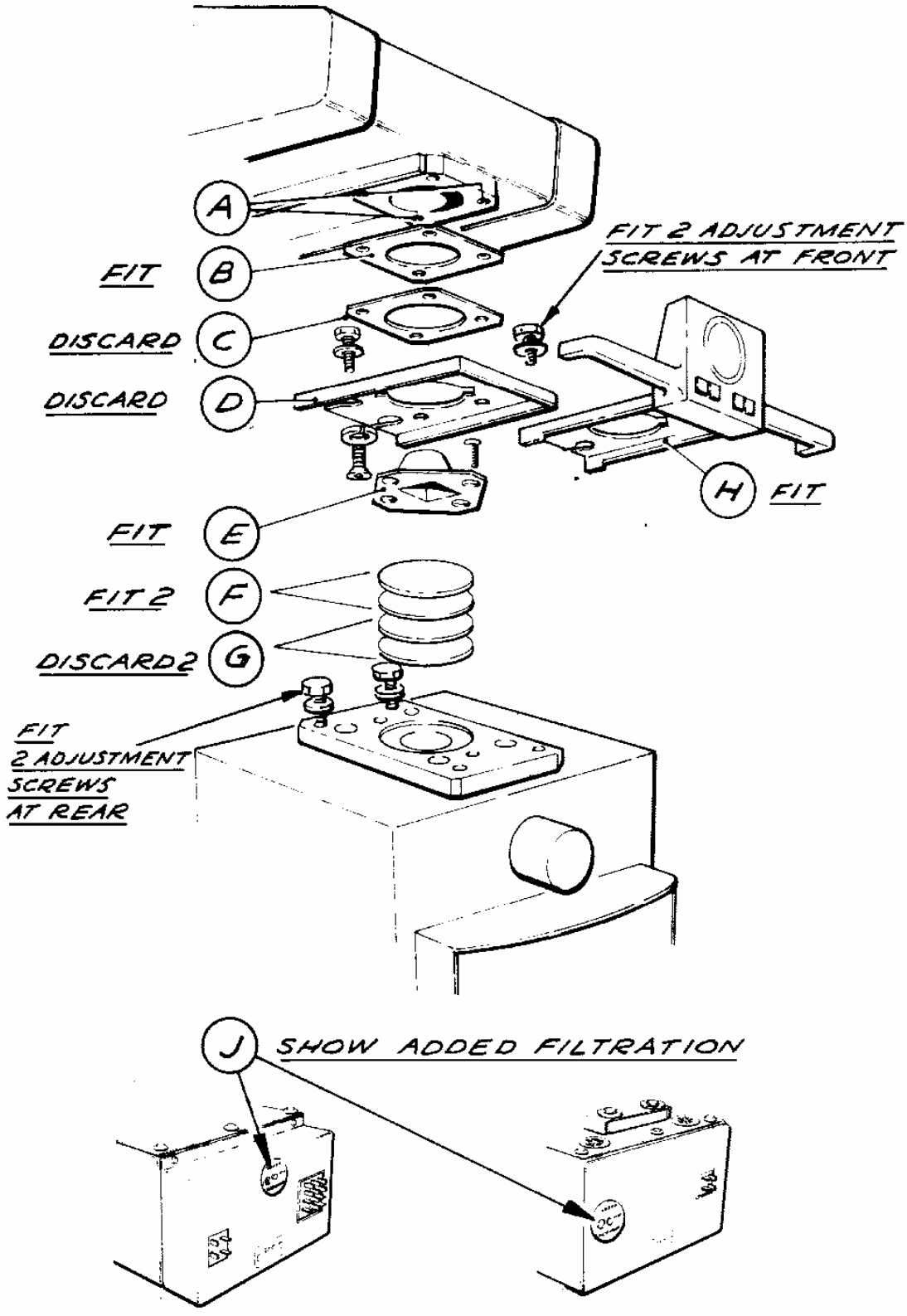


Fig 11 Fitting Demarcator to X-ray Tube with Later Type Switchbox and Setting Filtration Indicator

10. REMOVING COVERS and NOTES ON RETAINING RELAYS. Fig 12.

(1) Remove both handles.

(2) Lift cover straight upwards and off.

Ensure that each relay is fully entered into its socket and retained by clip before refitting cover.

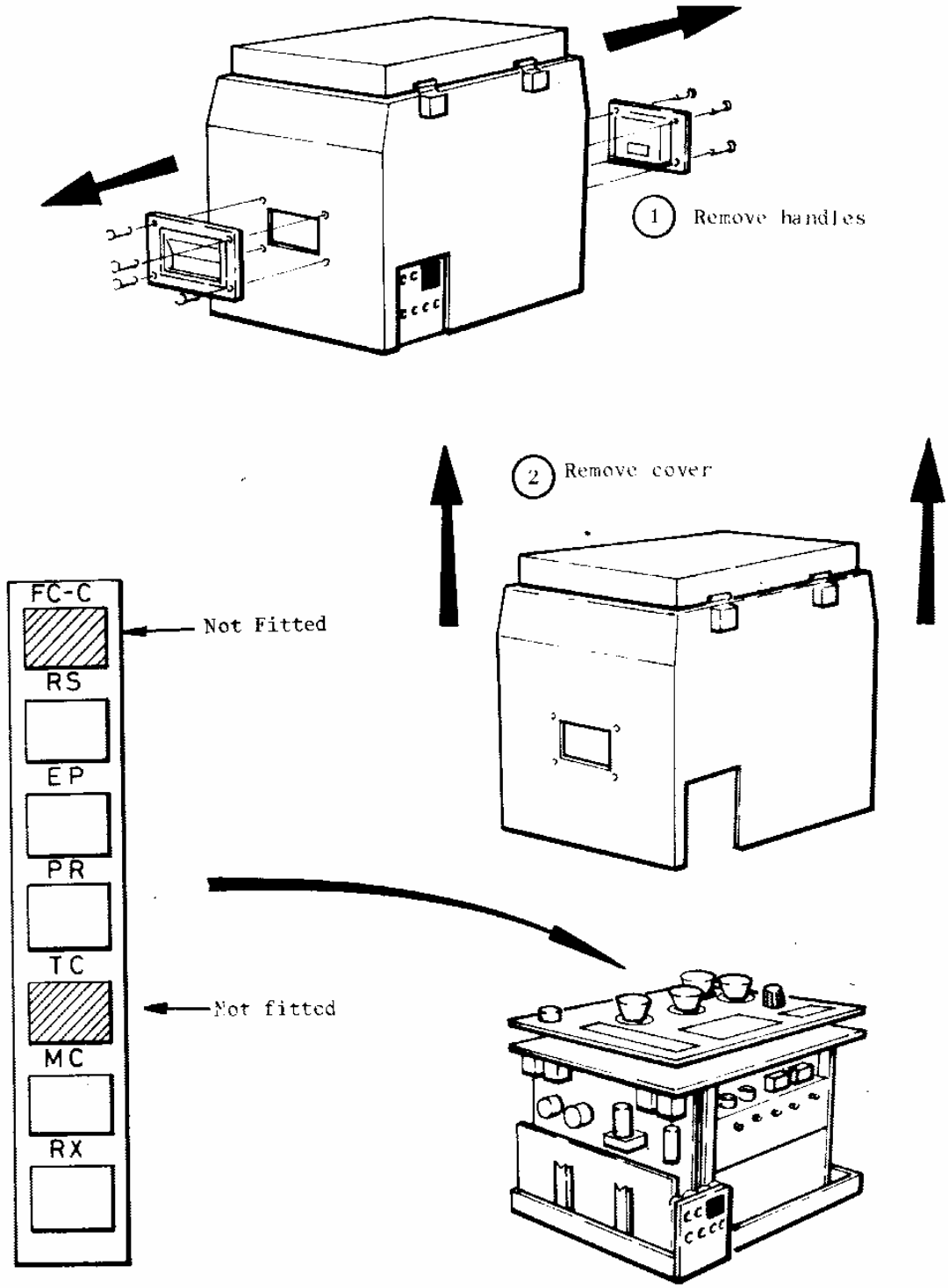


Fig 12 Removing Control Cover

11. GENERAL NOTES ON FITTING CABLES INTO CLAMPS Fig 13, 14 & 15.

Unplug the three Potter Bucky leads from terminal panel and disconnect the earth lead from terminal E.

Remove the screws from the four bottom clamps.

Release the clamp carrier plate from the unit by removing the two fixing screws (see Fig 13. Note nuts and washers).

Feed cables through appropriate entries while keeping the carrier plate close to its correct position. (See pages 24 to 31 for details).
When the positions of the cables in the clamps have been determined mark the cables with a pencil to show where they must enter the clamps.

Loosely reassemble the clamps (see Fig 15) with the carrier plate just away from the unit, using the pencil marks to locate the cables in the clamps.

Refit the carrier plate to the unit, placing the cables in their required positions. Fully tighten the clamps.

Reconnect the Potter Bucky leads as listed in Section 16, page 32. Any connections that differ from the list must be corrected, and the corresponding idents fitted.

The earth lead may be loosely connected at this stage because other earth leads will also be connected to terminal E.

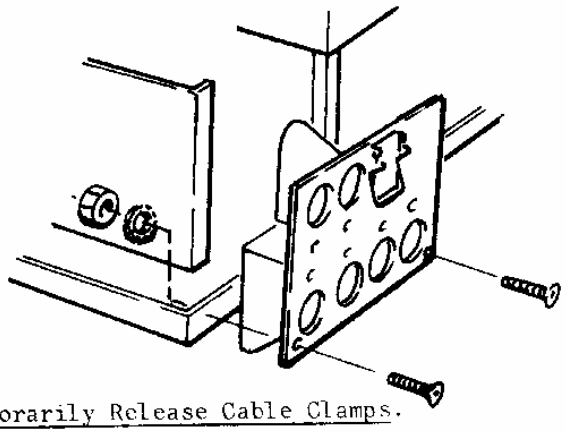


Fig 13 Temporarily Release Cable Clamps.

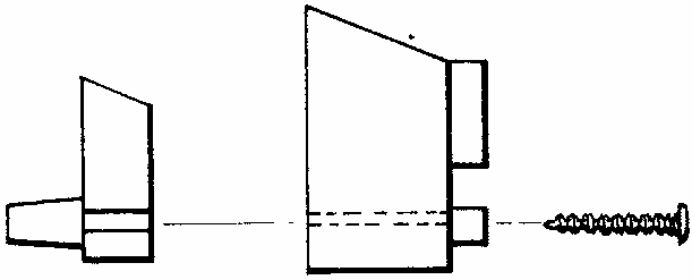


Fig 14 Cable Clamps. Exploded View.

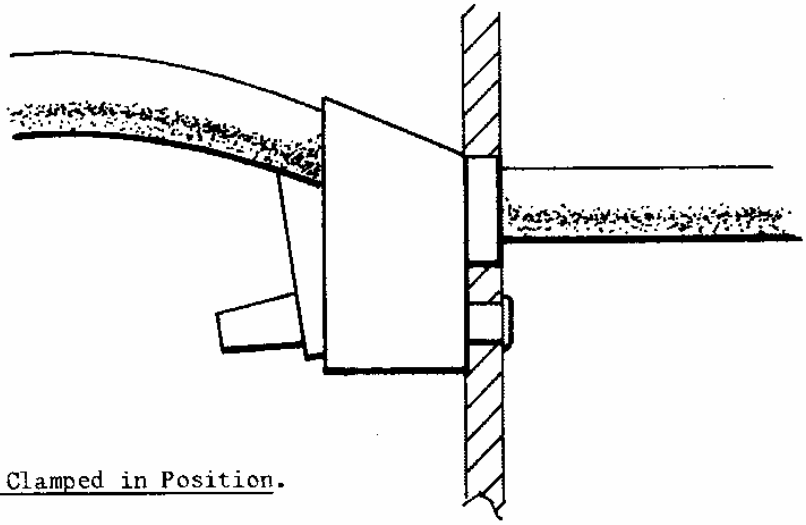


Fig 15 Cable Clamped in Position.

12. Layout of Head Cables Fig 16

Arrange the head cables as shown in Fig 16. Check that all movements of the head, crossarm and column can be made without difficulty.

Ensure that the cables keep their position on the crossarm by tying them on with strapping.

Note how the head cables pass through the mobile base before entering the cable clamps.

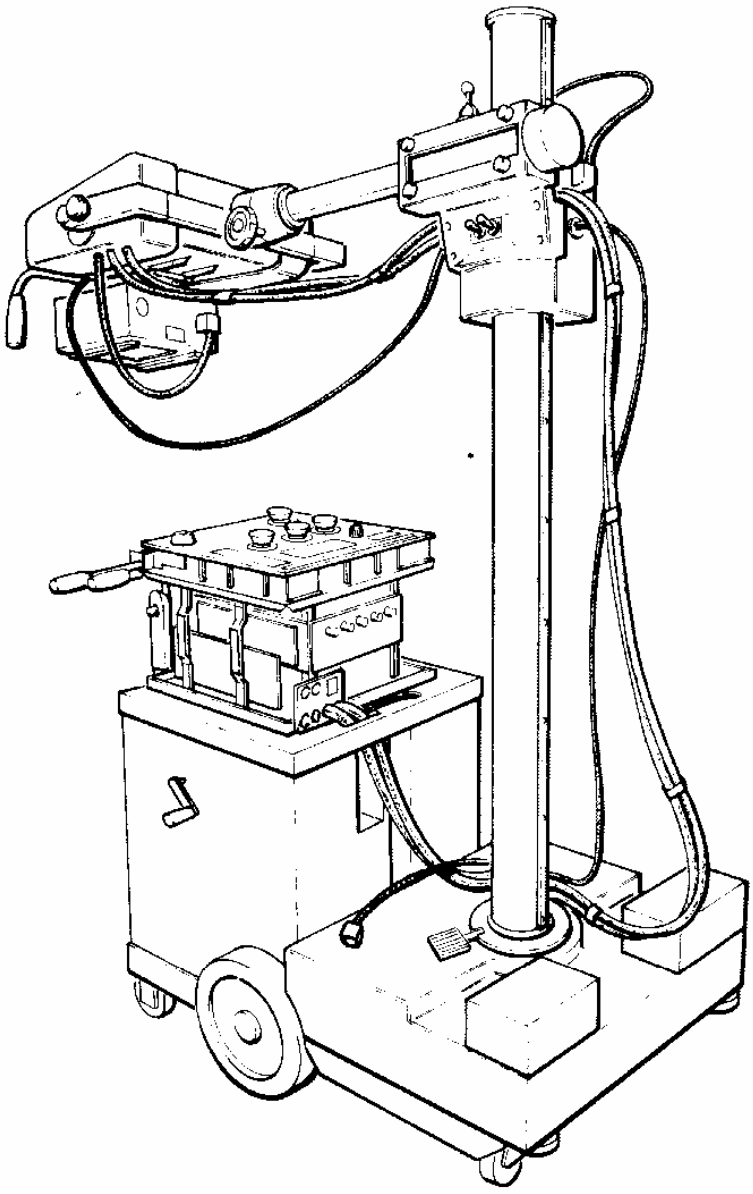


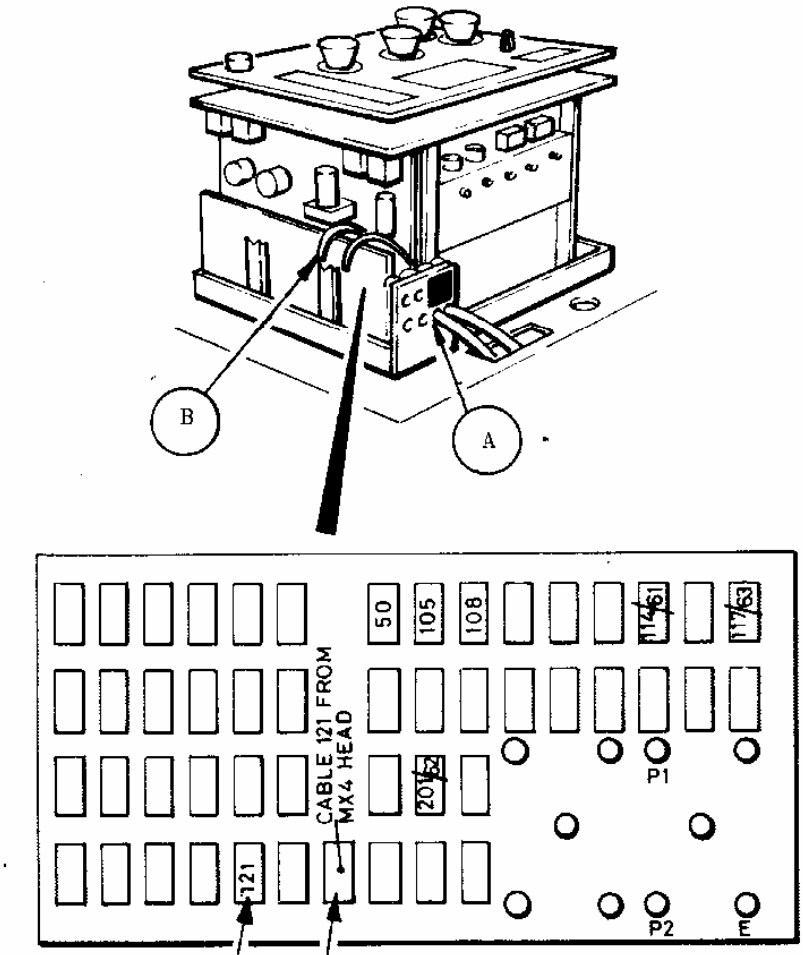
Fig 16 Layout of Head Cables

13. CONNECTING HEAD CABLES at CONTROL UNIT

Pass the head cables through the mobile base and through the cable clamps (A) Fig 17, then lay the cables over the terminal board (B)

Use the cable clamps as described in Section 11, page 22, stripping back the cables as required.

Connect the leads of the head cables to the terminals in the control (see Fig 17) by reference to the idents on each lead.



IMPORTANT

Use terminal marked "CABLE 121 FROM MX4 HEAD" for blue lead or CORE No 2.

DO NOT use terminal marked "121" for head lead.

Fig 17 Connecting X-ray Head Leads at Control Unit

14. CONNECTING HANDSWITCH CABLE Fig.20

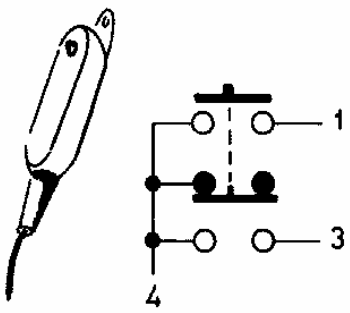
Pass the handswitch cable through the clamp as in "11", page 22. Note that it may be necessary to release the cable in the main base and pull the cable through the grommet. Ensure that the grommet remains in its correct position and remember to tighten the clamp.

Connect the handswitch lead to the low voltage panel as shown in list below:-

N.B. .... If coloured leads have been used in the handswitch cable, check the circuit — connections MUST be correct. [See Supplement No.1888 at the back of the manual].

The terminal numbers; 29, 27, etc relate to other units.

Handswitch



Handswitch Core No		LV Panel Term No
1	Connect to	131 LV
3	Connect to	132 LV
4	Connect to	51 LV

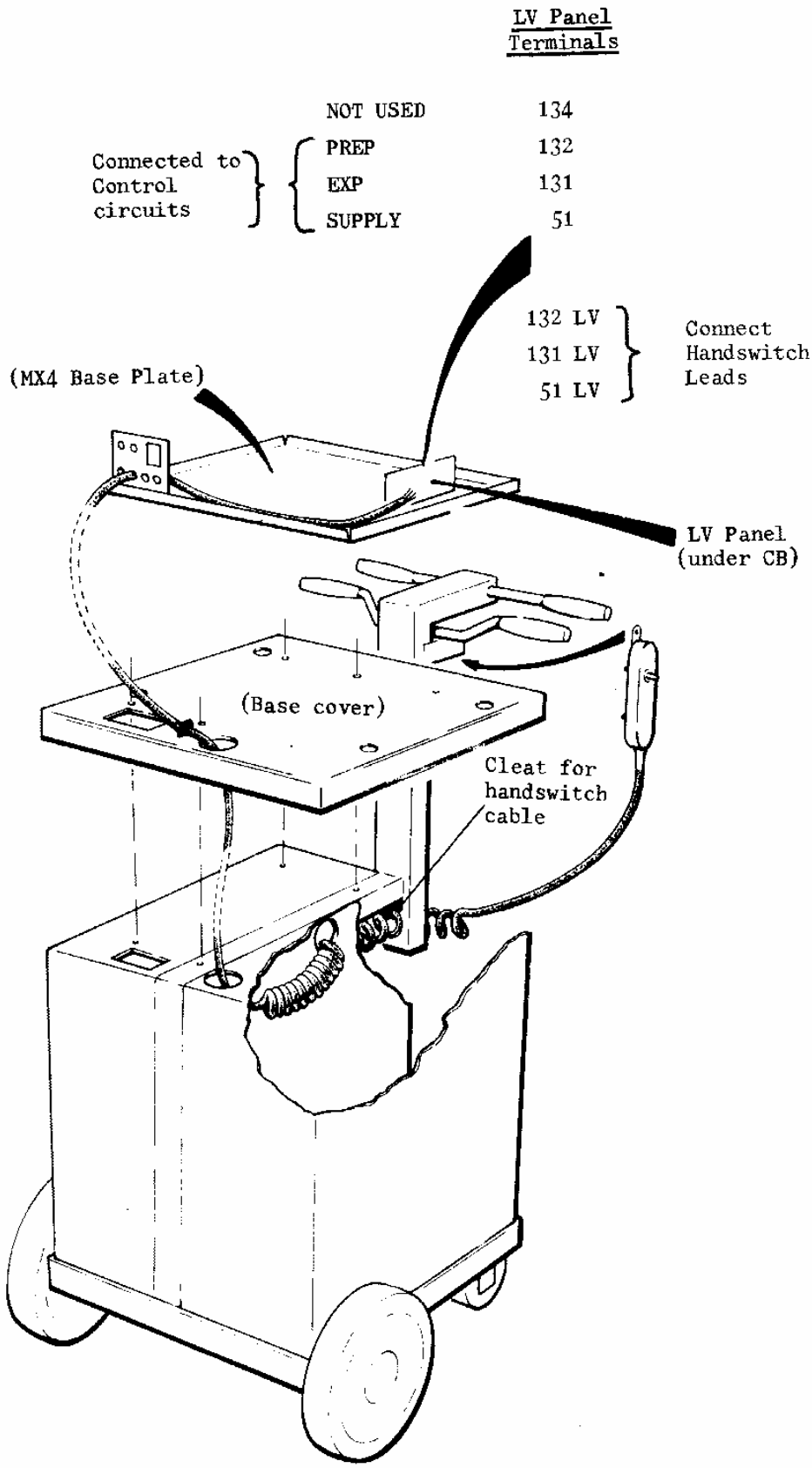


Fig 20 Exploded and Cut-away Views of MX4 Control and Base to Show Handswitch Cable Run

15. CONNECTING MAINS CABLE at CONTROL and BRAKE CABLE at BASE Fig 22

Check prevailing supply voltage by consulting hospital electrician or electricity supply authority.

Loosen cable clamp and pass mains cable through the entry shown in Fig 22. Use the clamp as described in 11, page 22. The required state of the mains cable is shown in Fig 21 below.

Connect mains leads as listed below:-

Brown (or Red) to L (Line)

Blue (or Black) to N (Neutral)

Yellow/Green (or Green) to E (Earth)

Connect blue tap lead idented SEL to terminal, 210V, 220V, 230V, 240V or 250V, nearest to 10V above the prevailing mains supply voltage.

Tighten cable clamp.

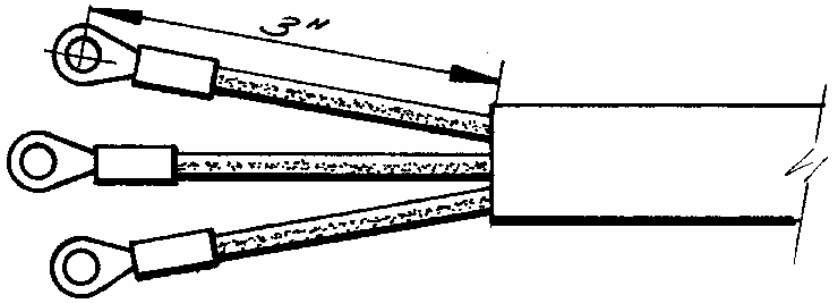


Fig 21 Preparing the Mains Cable

Insert the brake plug into its socket on the mobile base and fit the spring clip. On some bases the spring clip is seen attached on the left of the socket and is difficult to fit over the plug. For these bases use a tool such as a hook made from steel wire to fit the clip.

Strap cables together as shown in Fig 22 using strapping, or lacing cord.

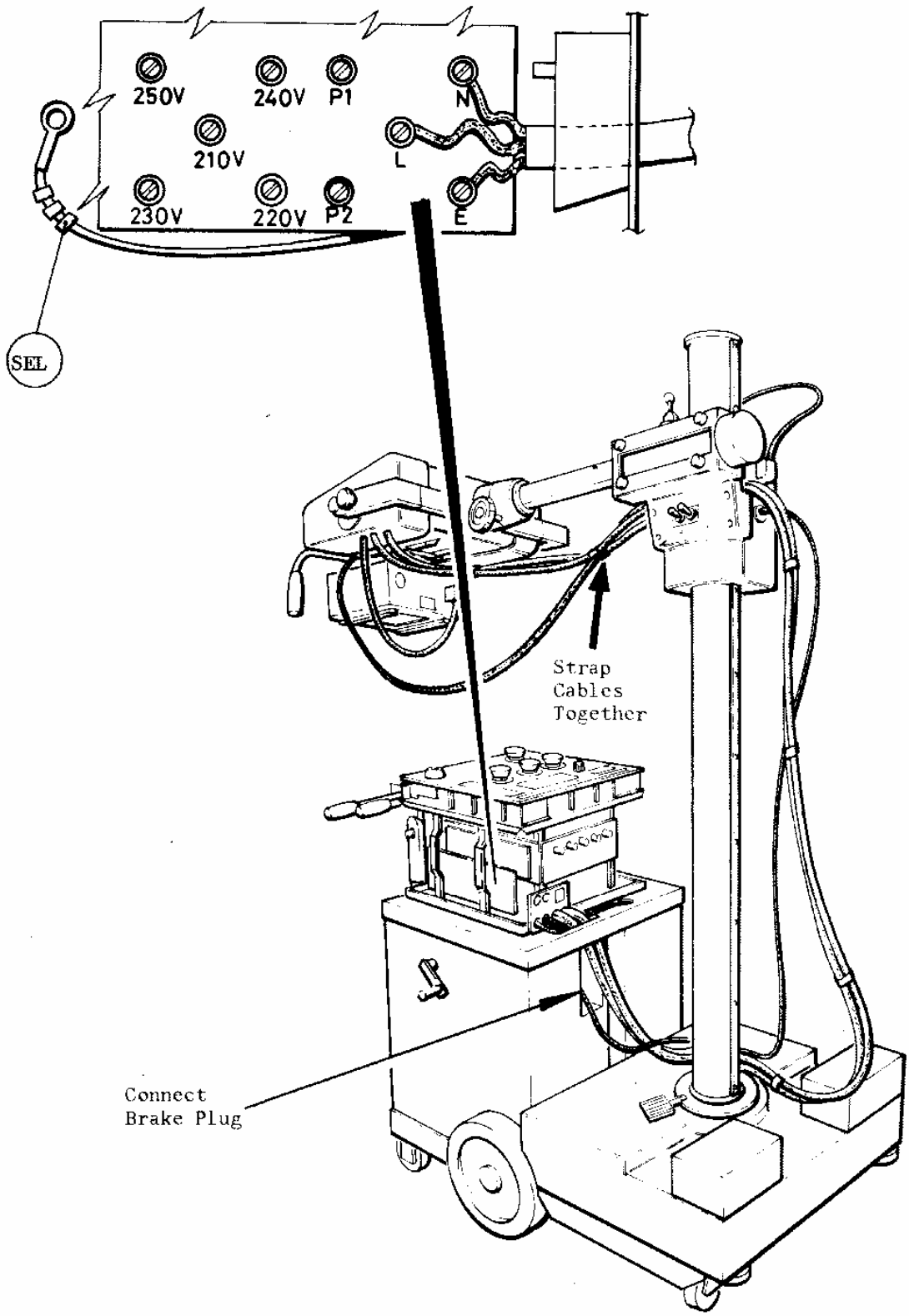


Fig 22 Connecting Mains Cable at Control and Fitting Brake Supply Connector.

YM Series Potter Bucky with
Interchangable Grid.

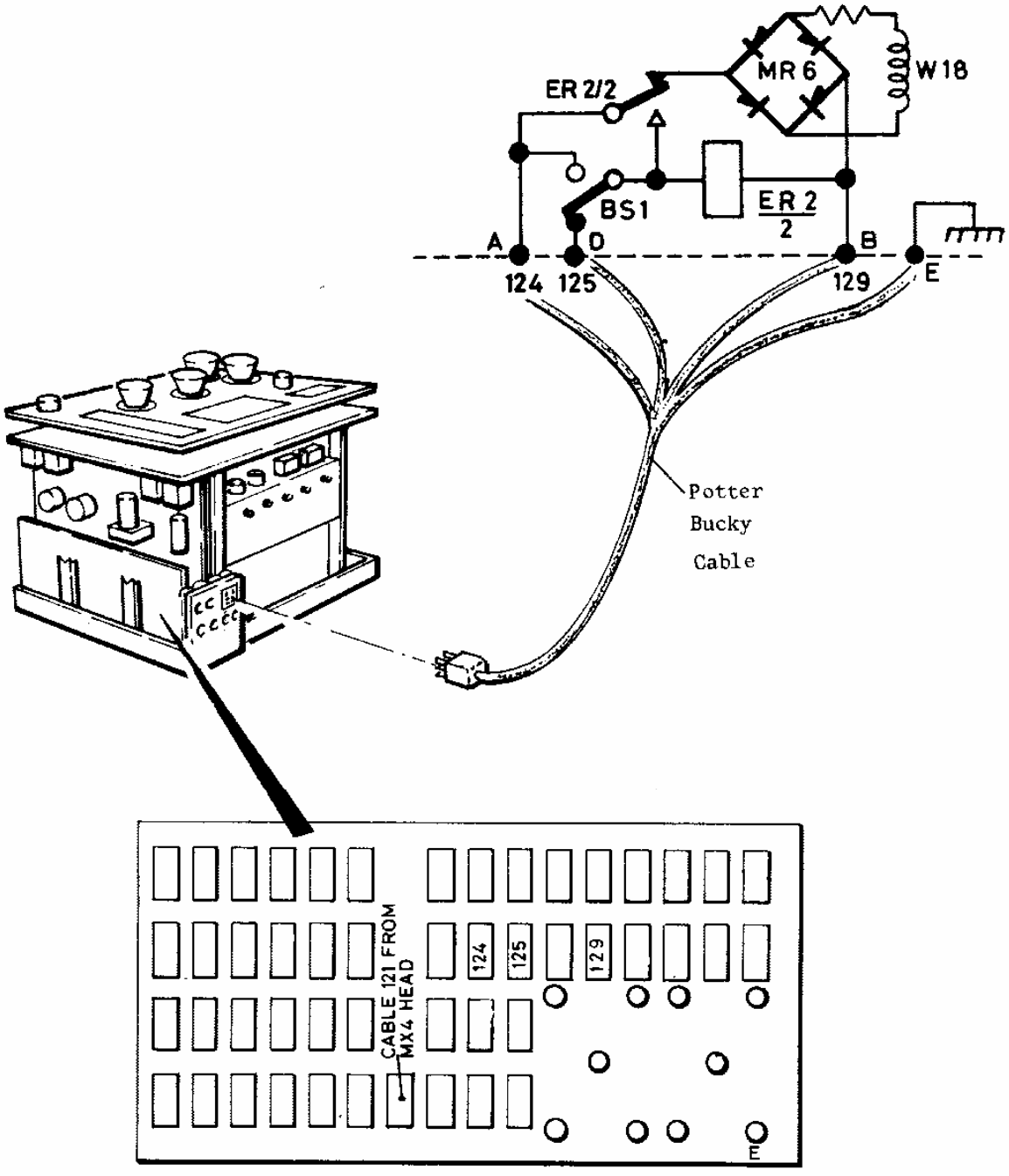


Fig 23 Connecting Potter Bucky

17. CHECKING EARTHING of LBD CONNECTOR COVER and CONNECTING SUPPLY CABLE

On Demarcator LBDs Serial No AH 201 and onwards heavy duty Multicon connectors are used, each retained by a spring clip.

IMPORTANT .... Each connector cover must be earthed to pin 1 as illustrated in Fig 24 using 16/0.20 (14/0.0076) green/yellow lead.

The hand model LBD has one four pole connector, wired as follows:-

Demarcator Connections

Lead Colour	Connection from head terminal	LBD connector terminal
Brown	50	3
Blue	50	3
Black	E	2
Green/Yellow	E	1

The motorised model has one four pole and one twelve pole connector, and wiring details are given in the separate instruction No 1833 supplied with the Twin-head unit.

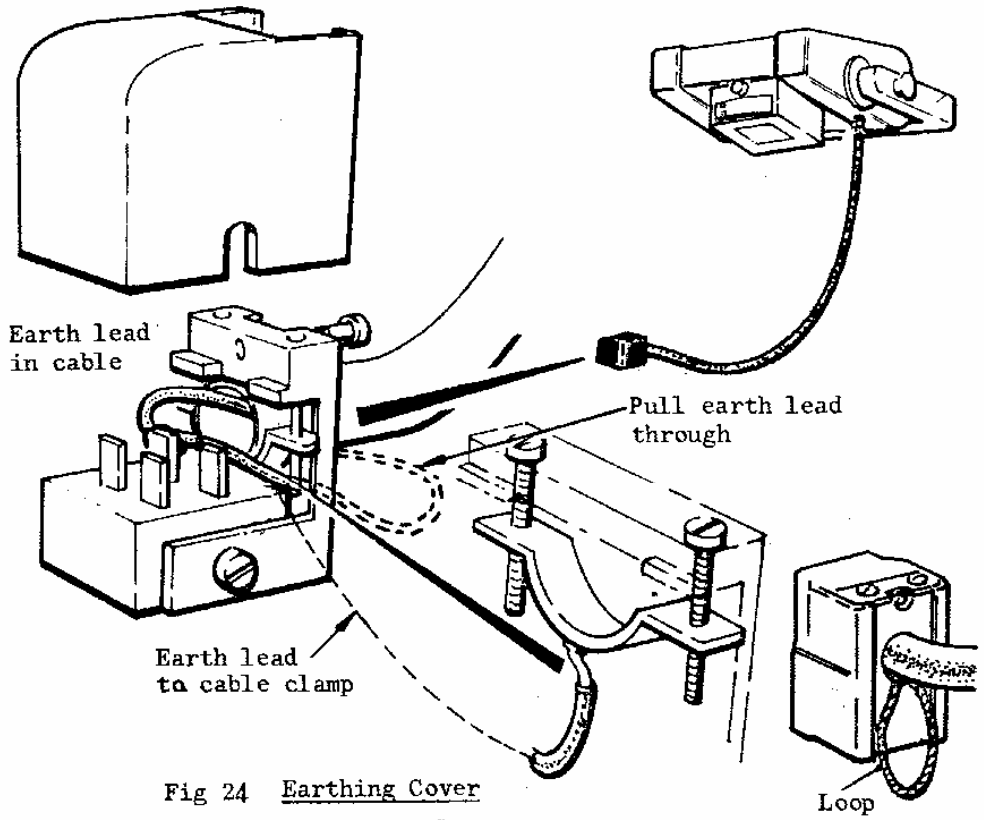


Fig 24 Earthing Cover via Cable Clamps

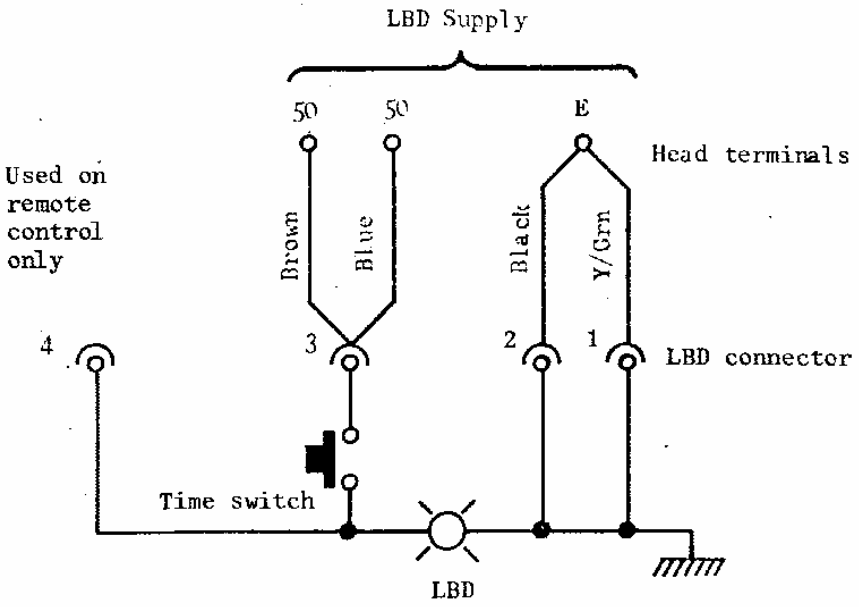


Fig 25 Four pole Connector Wiring

18. CONNECTING DEMARCATOR LBD. Fig 26

Close the shutters (A) in direction of arrow ready for test exposures.

For the hand model, fit the four-pole connector to the back of the LBD as indicated at (B),

or

For the motorised model, fit the four and twelve-pole connectors (C).

19. CONNECTING EXTERNAL mAs METER. Fig 27

Fit mAs meter jack into socket indicated in Fig 27.

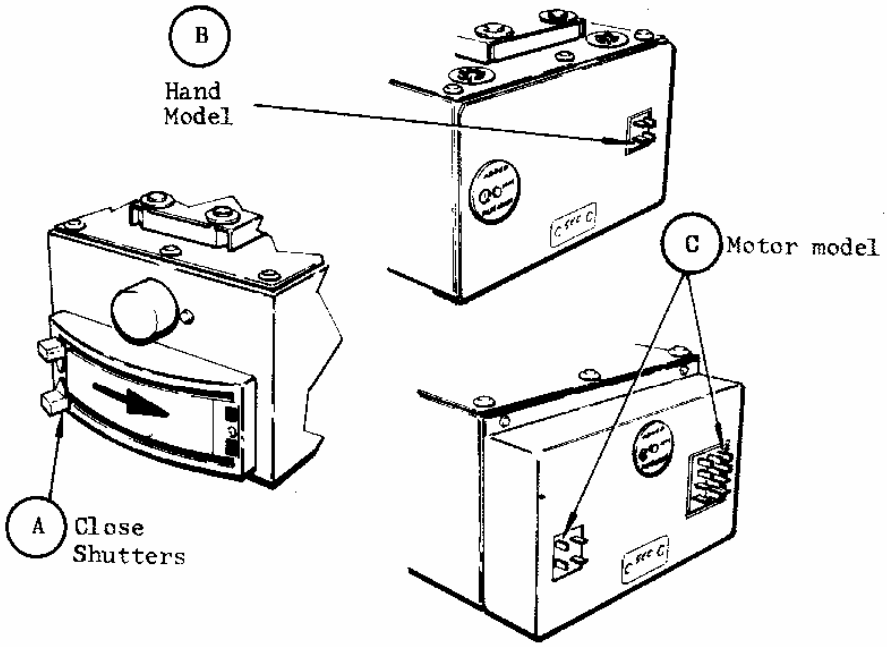


Fig 26 Close Shutters and Fit Connector(s)

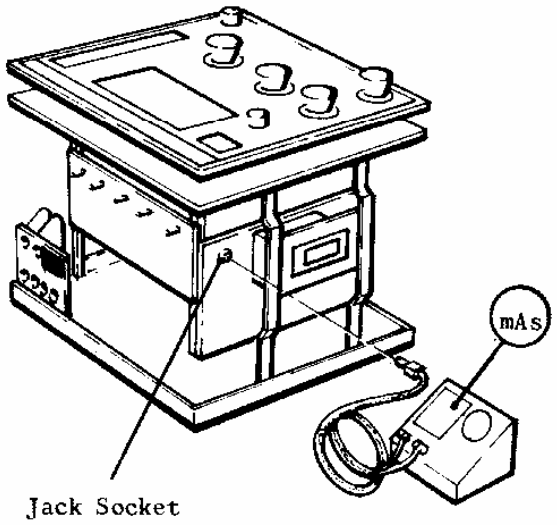


Fig 27 Connect External mAs meter

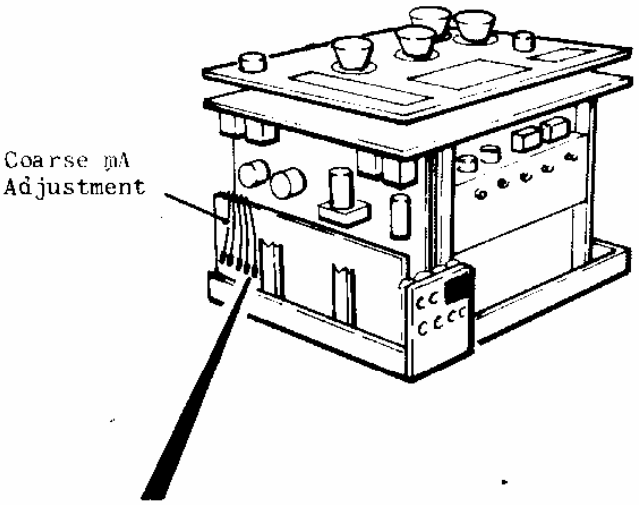
20. PRELIMINARY CONNECTIONS of mA TAP LEADS. Fig 28

Check that the brown lead idented FIL is connected to the 30V tap.

Check that the five yellow leads idented 50, 75, 100, 125 and 150 are connected to voltage terminals listed in Fig 28.

WARNING . . . USE terminals marked with "V" for voltage for mA tap lead connections.

Some other terminals on the same board have similar figures. These other terminals without the "V" are on a different part of the circuit.



Lead Ident	Normally on Terminal
FIL.	30V
50 (mA)	115V
75 (mA)	120V
100 (mA)	130V
125 (mA)	135V
150 (mA)	140V

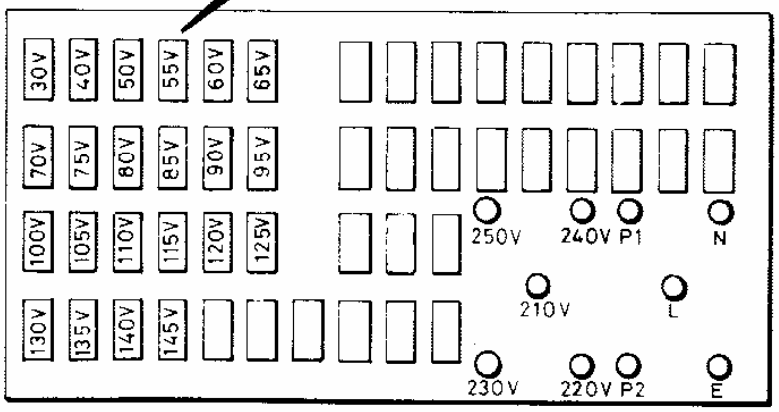


Fig.28 **Preliminary Positions of mA Tap Leads**

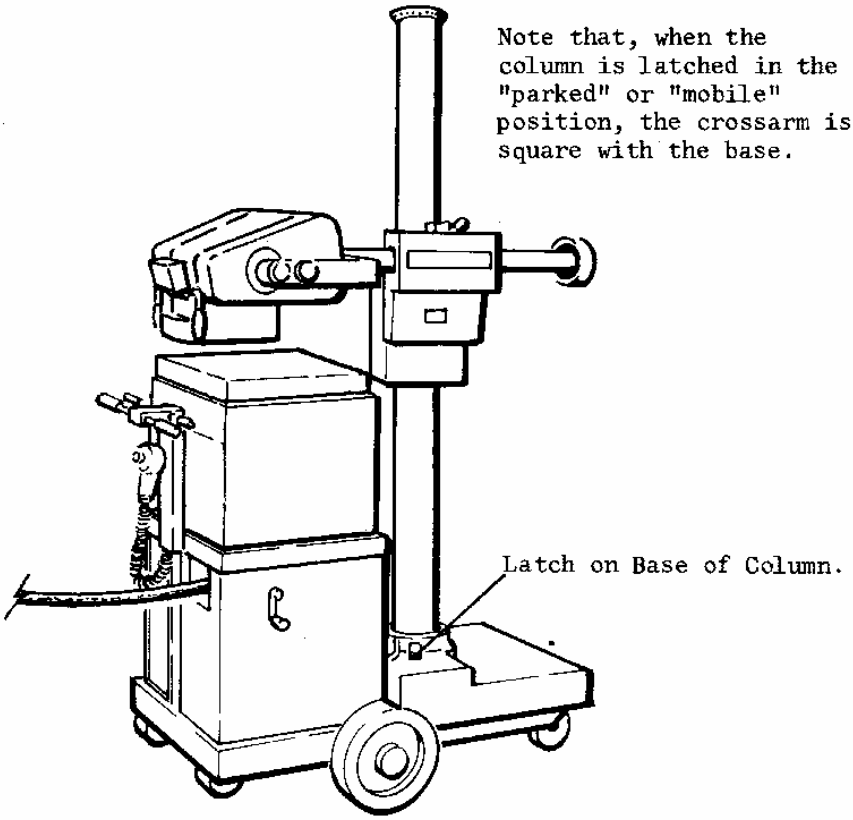


Fig 28a Position of Column Ready for Parking

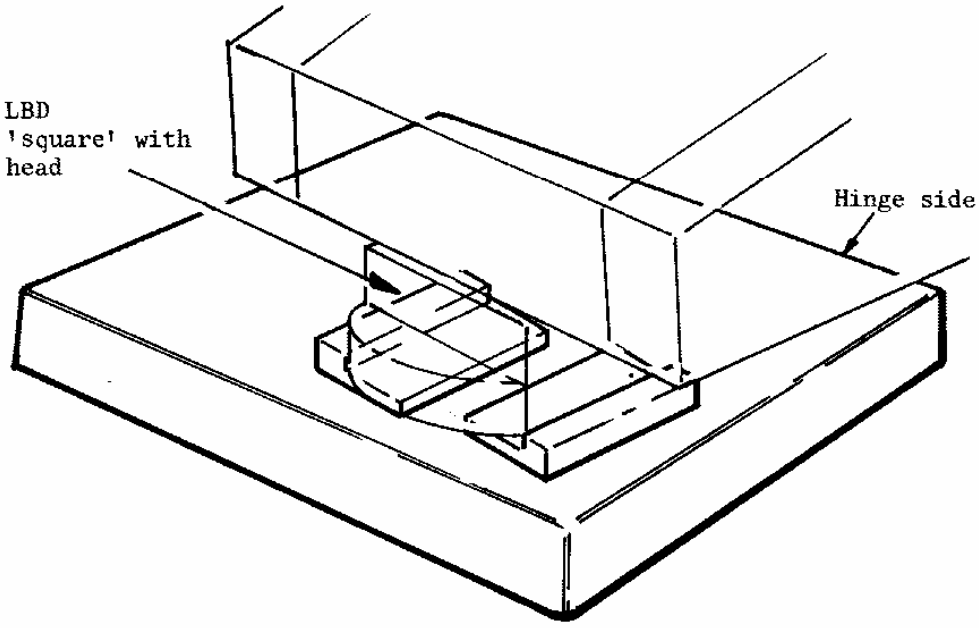


Fig 28b Position of LBD on Buffers

IMPORTANT NOTICE...REFER TO SUPPLEMENT No 2332 IN REAR OF THIS MANUAL

21. CONNECTING MAINS CABLE at PLUG Fig 29, 30 and 31

Check that the full 9 metres (30 ft) of mains cable can be pulled out from the storage box. Rewind the cable and fit the mains plug. The plug type will be dependant on the outlet socket. If a 13A socket is to be used, connect the Walsall plug as described below. Additional details in Supplement No.1733 at the back of this manual.

If a 30A Walsall plug is to be used, refer to Supplement No.1903 at the back of this manual.

Components

1 off Walsall Type S 32A12 (Red Top 13A) plug
3 off AMP Type 32994-3BA 12-10 Tags (X 711-111) } (GEC ref PSD 1451)

Strip Wire as shown in Fig 29.

Solder tags onto conductors as shown in Fig 30.
Fit tag threaded post in plug. Allow terminal nut to bend tag as it is screwed down. See Fig 31.

Fit cable clamp.

ENSURE that TERMINAL NUTS and CABLE CLAMP are TIGHT.

IMPORTANT. . . Make a complete check of earth continuity.

IMPORTANT NOTICE...REFER TO SUPPLEMENT No 2332 IN REAR OF THIS MANUAL.

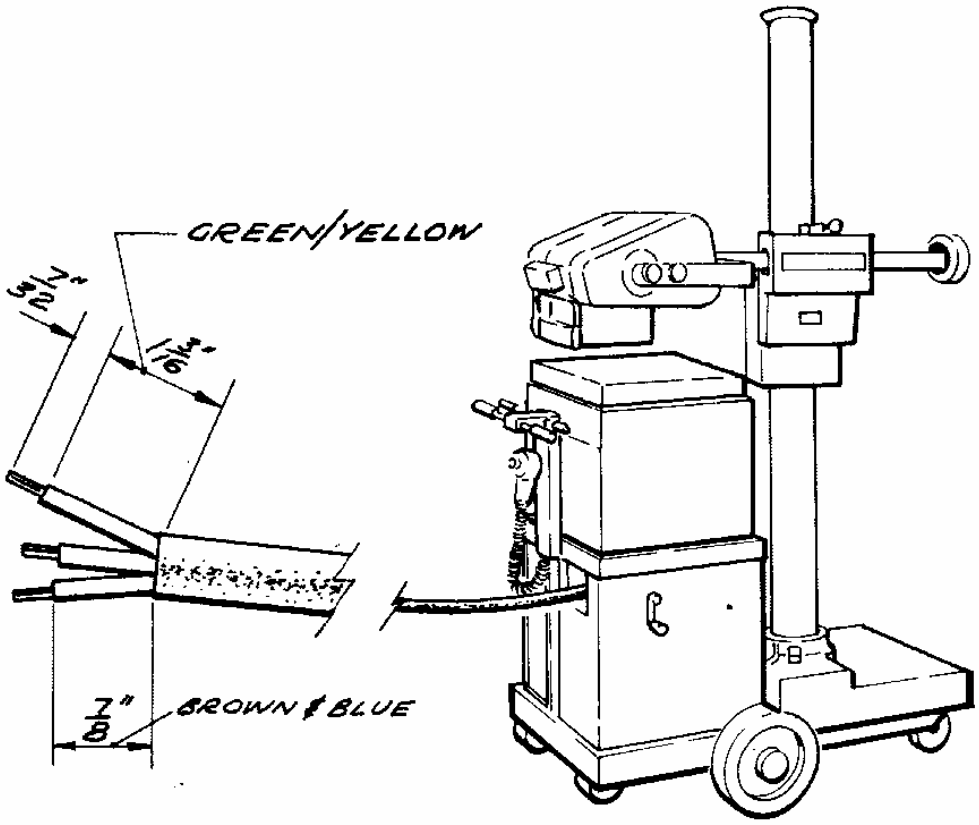


Fig 29 Stripping Mains Cable

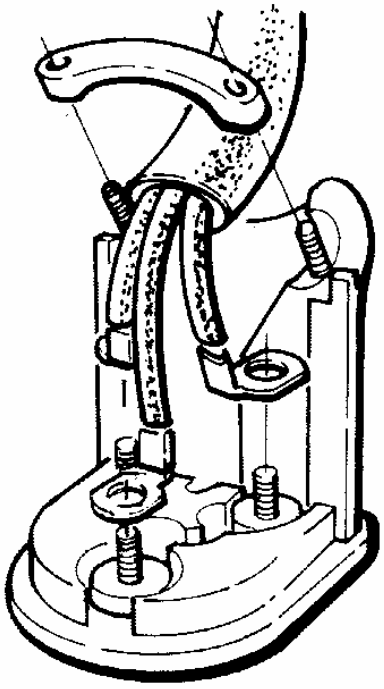


Fig 30 Arrangement of Tags

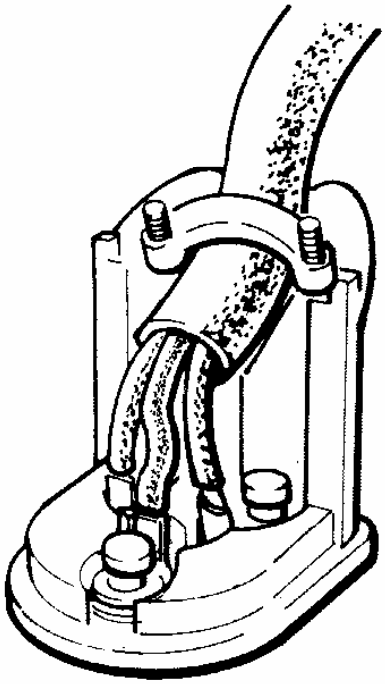


Fig 31 Cable Connected

22. SWITCHING ON X-RAY UNIT Fig 32

WARNING . . On motorised model fit key into handle - see Fig 44, page 61 and switch ON by turning key clockwise.

Check that blue and red battery leads are isolated.

Switch ON by following the sequence below.

(1) Close circuit breaker.

(2) Observe reference meter  and:-

(3) Adjust mains voltage compensator control  until needle of meter is in red sector.

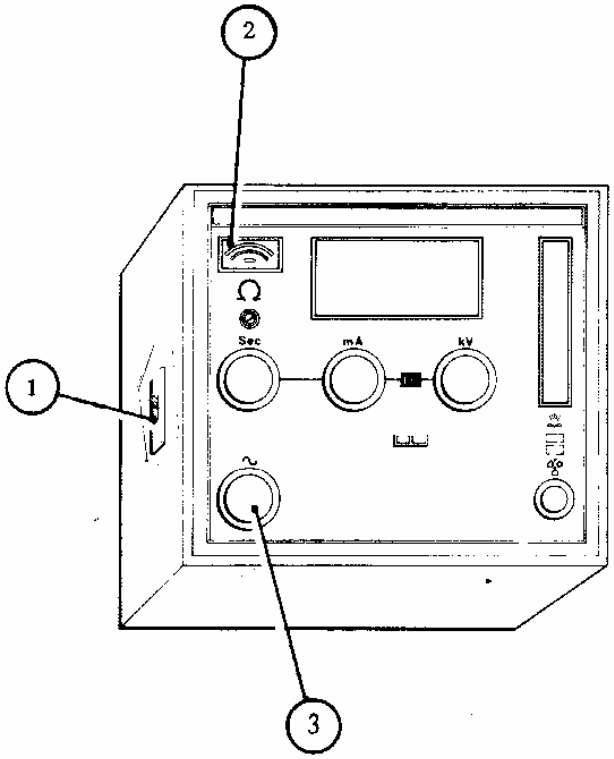


Fig 32 Switching ON X-ray Unit

23. PRELIMINARY RADIOGRAPHIC EXPOSURE SETTINGS. Fig 33.

(1) Check that circuit breaker (CB) and wall isolator are OFF.

(2) Set timer control (Sec) to 1.0 Second.

(3) Set tube current control (mA) to 50mA.

(4) Set tube voltage control (kV) to 45kV.

(5) Potter Bucky button  must be UP.

(Press to set button UP - Bucky OFF).

(Press to set button DOWN - Bucky ON).

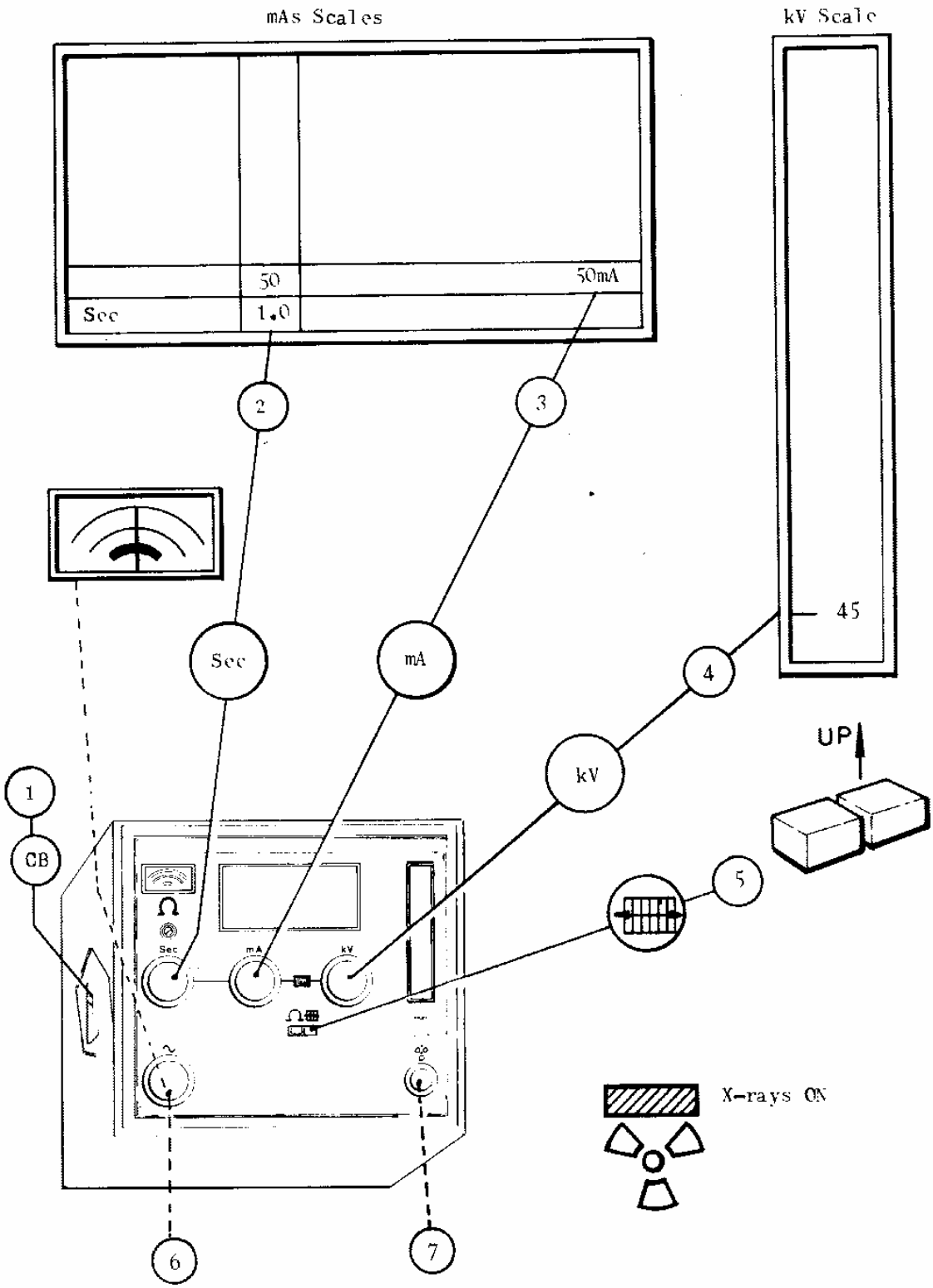


Fig 33 Preliminary Radiographic Exposure Settings

24. PRELIMINARY 50mA ADJUSTMENT. Fig 34 and 33

Check that the yellow lead idented (50) is connected to 115V.

Other yellow leads idented 75, 100, 125 and 150 must be connected to voltage terminals listed in Fig 28, page 39.

Set (R25) to mid-position.

Refer to Fig 33, page 45 and switch ON circuit breaker (CB), then make an exposure by completing the sequence below.

WARNING . . . . DO NOT overheat tube by repeated exposures.

On DHSS units, check that the exposure counter records each exposure.

(6) Check reference meter and adjust mains voltage compensator until needle is in the red sector of the meter.

(7) Press the exposure button to the prepare position (first position of button) and check that the stator rotates. The reference meter should set to zero ready to indicate tube mA.

Press the button fully IN to the expose position and the meter should show approximately 50mA on the 200mA scale, and the X-rays ON indicator should glow.

Switch OFF at wall isolator and circuit breaker (CB) before changing taps. Refer to Fig 34, page 47.

If not 50mA, adjust (R25). If 50mA not obtainable, change 50mA tap lead [idented (50)] to next voltage terminal and re-check mA. Reset R25 and 50mA tap lead position until approximately 50mA is obtained. Correct setting must be made after mains padder resistor R1 is set, as detailed in Section 25, page 48.

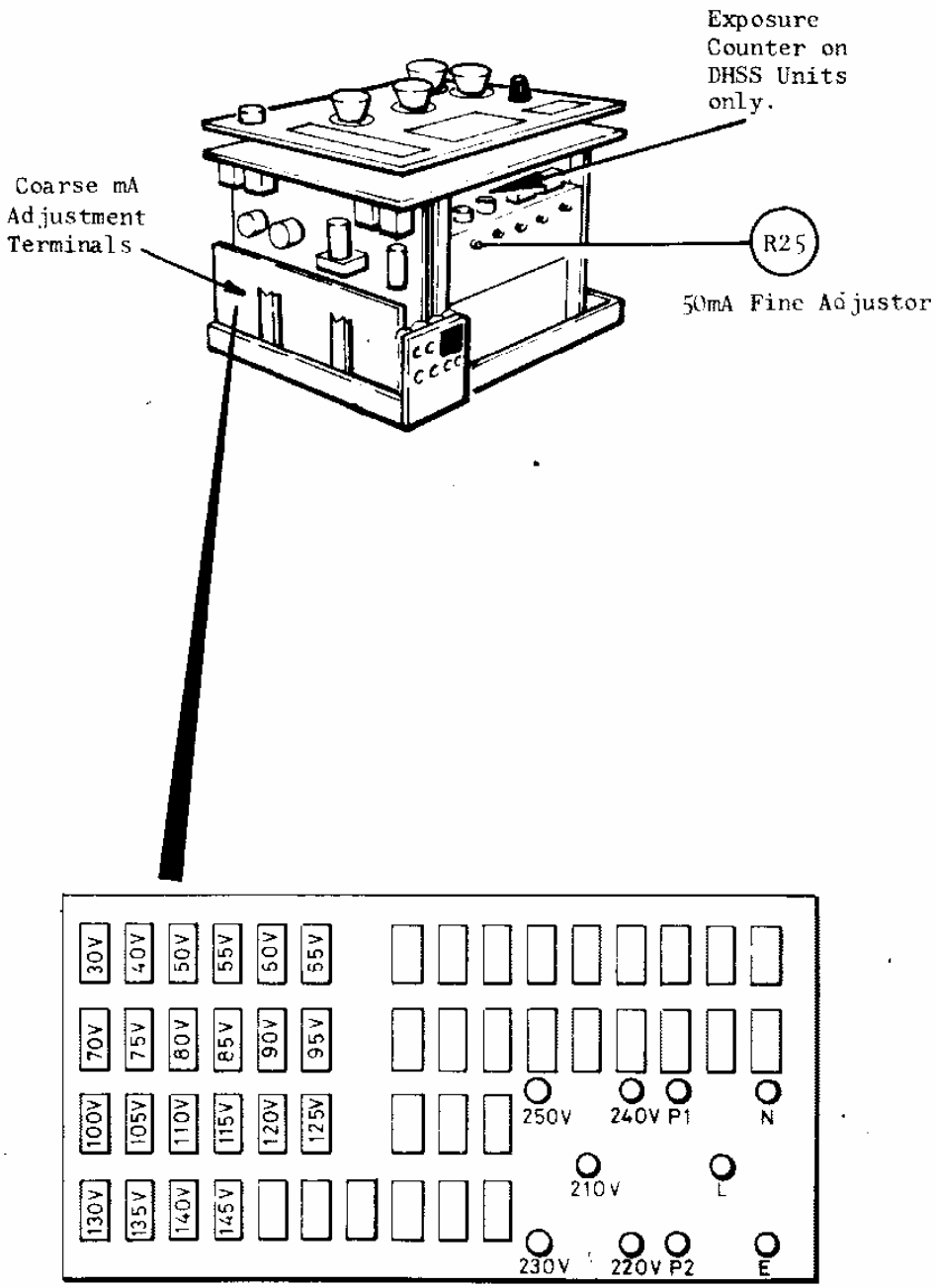


Fig 34 Preliminary 50mA Adjustment

25. SETTING MAINS PADDER RESISTOR R1. Fig 35.

WARNING .... DO NOT overheat the tube by repeated exposures.
Refer to Section 26, page 50.

All the following tests and adjustments must be made at the same mains supply socket.

Set time mA and kV controls and follow sequence listed below.

(1) Set timer (Sec) control to 1.0 second.
(2) Set radiographic (mA) control to 50mA.
(3) Set radiographic (kV) control to 78kV.

} Approximately 4000 Heat Units for each exposure.

(4) Button must be UP.

(5) Check reference meter , needle must be in red sector —— Adjust by (6) if necessary.

(7) Press and hold IN button .

(8) Press the exposure button to prepare and observe position of needle on meter . Press the exposure button fully IN.

The mains padder resistor is set correctly when an exposure does NOT cause the needle to move from the reading during "prepare".

Release both buttons.

If an exposure makes the needle move to the left, turn the padder resistor control slightly clockwise . Repeat the test from (7) onward until the needle remains stationary when an exposure is made.

If an exposure makes the needle move to the right, turn the padder resistor control anticlockwise . Repeat the test from (7) onwards until the needle remains stationary when an exposure is made.

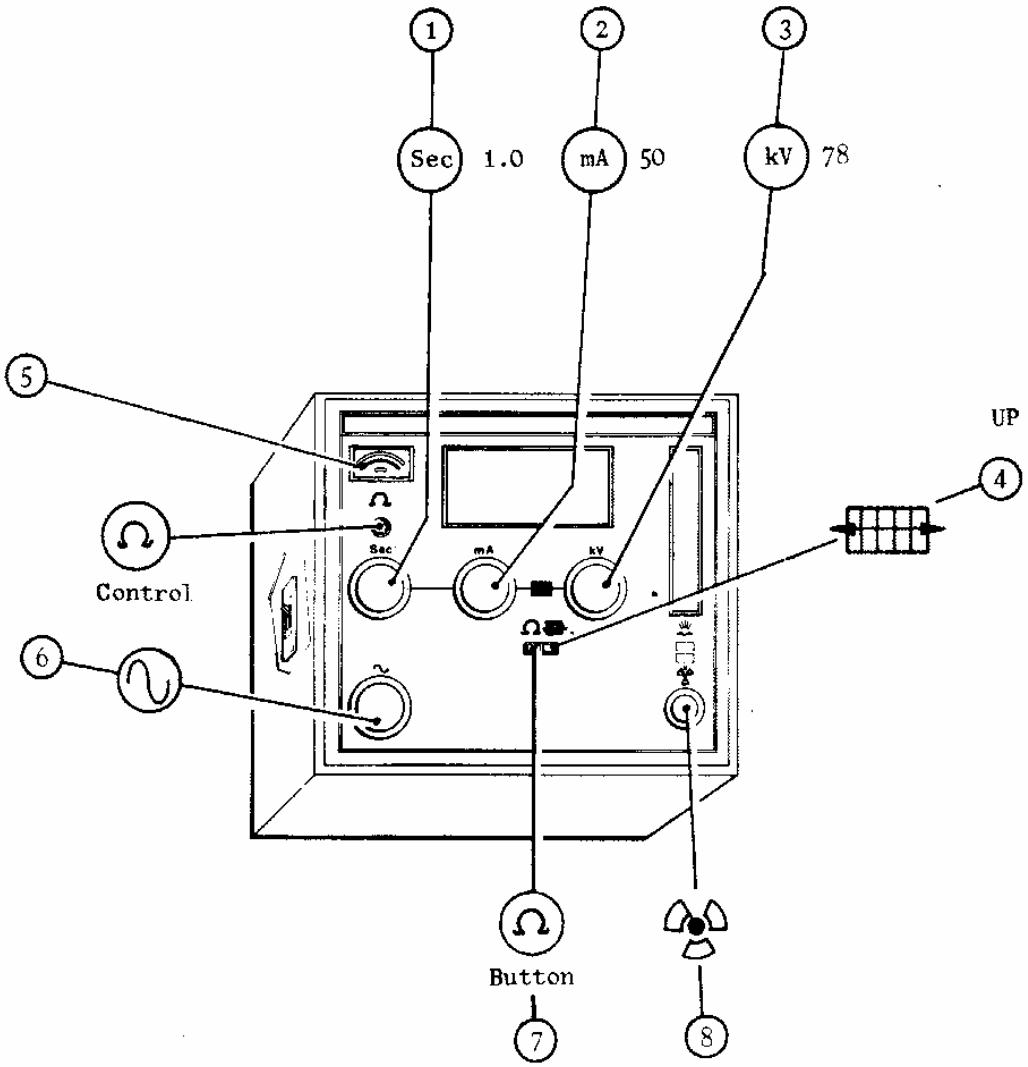


Fig 35 Setting Mains Padder Resistor R1

11. CHECKING OVERLOAD CIRCUIT

1. **WARNING. . . .** DO NOT overheat the X-ray tube. Refer to Fig 36 and 37.

The overload circuit gives protection only for a single exposure.

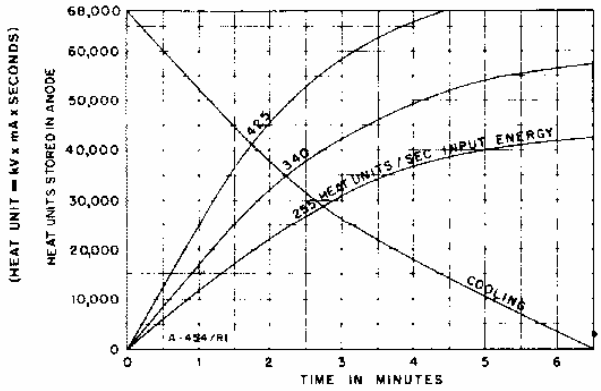


Fig 36 Anode Thermal Characteristics

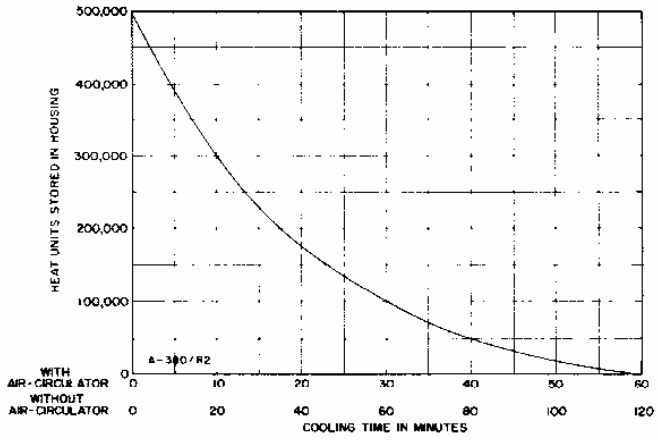


Fig 37 Tube Cooling Chart.

2. mA, kV and time factors are related and when an overload condition is selected an amber light glows indicating PREPARE BLOCKED and no exposure is possible.

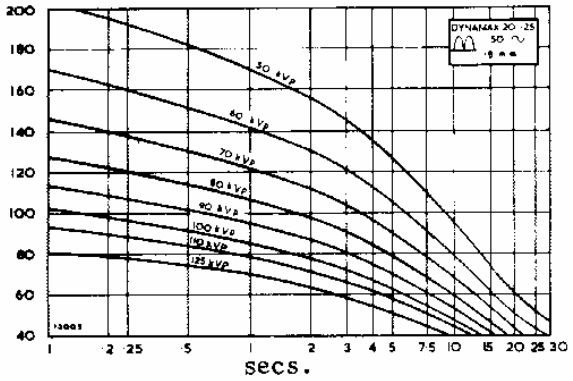
The PREPARE BLOCKED circuit MUST operate at approximately 95% rating when the timer setting is increased, and should clear at approximately 85% when the timer setting is decreased.

3 Check the function of the overload circuit against the rating chart by selecting the lowest time setting and the highest kV and highest mA settings. Increase the setting of the timer in single steps and prove that the interlock is operating by rotating the timer control one step into the overload condition so that the PREPARE BLOCKED light glows.

Check that ALL remaining overload positions of the timer control show PREPARE BLOCKED.

4 Continue the check at the next lower mA setting at maximum kV. Check that the overload interlock is working by rotating the timer control one step into the overload condition to produce PREPARE BLOCKED. There is no need to check all of the remaining steps of the overload condition as the circuit will have been checked in the tests, as in 3 above.

5 Repeat the check given in 4 above for all remaining mA values.



(Rating Chart for 60Hz not available at time of going to print).

Fig 38 Rating Chart 0.8mm 50Hz

6 If the overload circuit is not correctly set, adjust (R69) by a small amount (See Fig 39 below) and recheck ALL functions of the overload circuit by reference to 2 on page 50, and 3, 4, and 5 above.

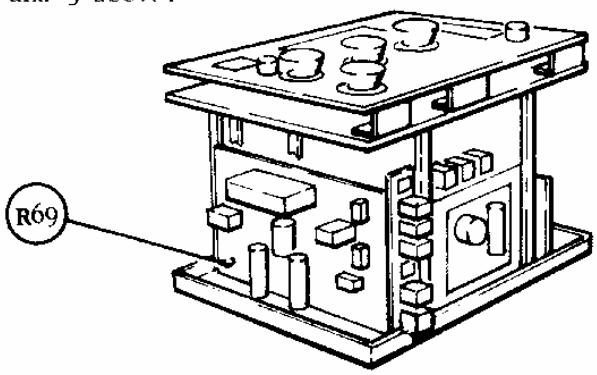


Fig 39 Overload Adjustment

27. ADJUSTING RADIOGRAPHIC mA. Fig 40.

R1, the mains padder resistor, MUST be set correctly before final adjustment of the 50mA value, or any other mA value.

Details of setting the mains padder R1 are given in Section 25, page 48.

WARNING. . . . . DO NOT overheat the X-ray tube. Switch OFF at wall isolator before changing tap leads.

1. 50mA Adjustment

Switch ON the X-ray control unit.

Set the controls to 50mA, 1.0Sec and 70kV.

Make an exposure and check that the tube current is 50mA on the control unit reference meter. (The external mAs meter should read 50mAs).

If not 50mA, adjust R25. See Fig 40. If 50mA not obtainable, change tap lead idented 50 to next voltage position and re-check mA (and mAs). Re-set R25 and 50mA tap lead until 50mA (50mAs) is obtained.

Continue other mA settings by reference to paragraphs below.

2. 75, 100, 125, and 150mA Adjustments

If not already correctly set, adjust the mains padder resistor R1, and the 50mA tube current by reference to 1 above, then continue adjustment of 75mA below.

Leave kV control set to 70kV. Turn mA control to 75mA and timer control to 0.16Sec, as shown in the list below. Check that the needle of the reference meter is in the red sector. If necessary adjust the mains voltage compensator.

Observe the mAs meter and make an exposure. The meter should show 12mAs.

If setting is incorrect, adjust R24 slightly, and repeat the test. (Reset mAs meter to zero before each exposure). If 12mAs not obtainable by adjustment of R24, reposition tap lead idented 75 to the next voltage tapping and repeat until 12mAs is obtained.

When 75mA tube current is correct, set other mA values as shown in the table below, and set the appropriate fine adjustor and tap lead as required to obtain the correct value of mAs.

mA	Sec	Scale mAs	Meter mAs	Fine Adjustor	Tap lead Ident	(Normally connected to)
75	0.16	12	12	R24	75	120V
100	0.12	12	12	R23	100	130V
125	0.10	12.5	11.5	R22	125	135V
150	0.08	12	11	R21	150	140V

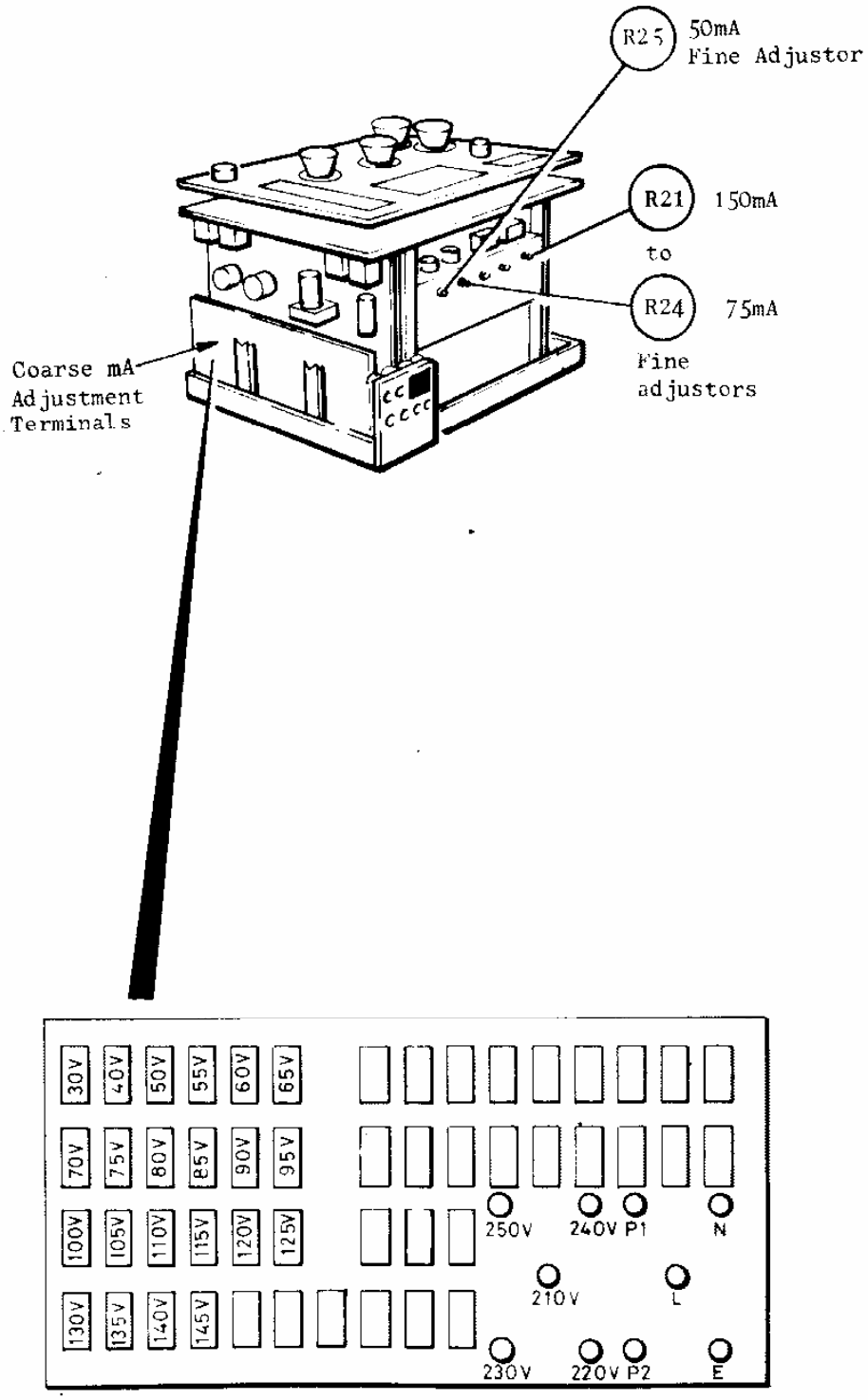


Fig 40 50, 75, 100, 125 and 150mA Adjustments

28. ADJUSTING LBD and MAKING FINAL RADIOGRAPHIC TESTS. Fig 41.

WARNING . . Full precautions must be taken to guard against exposure to X-radiation.

1. Adjusting Light and X-ray Beams.

Open the shutters. Arrange the X-ray tube head vertically over a cassette or fluorescent screen at a distance of approximately 30 inches.

Alignment should be as illustrated in Fig 41.

To obtain correct alignment, slightly loosen the four screws (A) using a thin flat spanner, move the body of the LBD; fully retighten screws and check alignment. Note that a small movement of the LBD body produces a large movement of the area illuminated. DO NOT adjust the three lamp mounting screws (B).

Fit covers. Refer to page 21.

2. Timer Check

Make a spinning top test.

At 0.02Sec there MUST be exactly 2 spots, and NO errors up to 0.16Sec. (16 spots).

Make several exposures and spinning top tests on one film at low mA and kV settings to ensure that the timer is working consistantly. An error of $\pm$ 1 spot is permitted at 0.2Sec (20 spots).

Check the 5Sec position of the timer; tolerance $\pm$ 0.5Sec.

3. Ardran-Crooks Cassette Test

Check the kV value by using an Ardran cassette according to its instructions, with the unit set to 100mA, 0.3Sec (30mAs) 70kV. For FFD, see "Instructions for use of Ardran-Crooks Cassette" supplied with each cassette.

4. Stepwedge Record

Take a stepwedge film for record purposes.

For handdriven model, continue Section 29, page 56.
For motordriven model, continue Section 30, page 58.

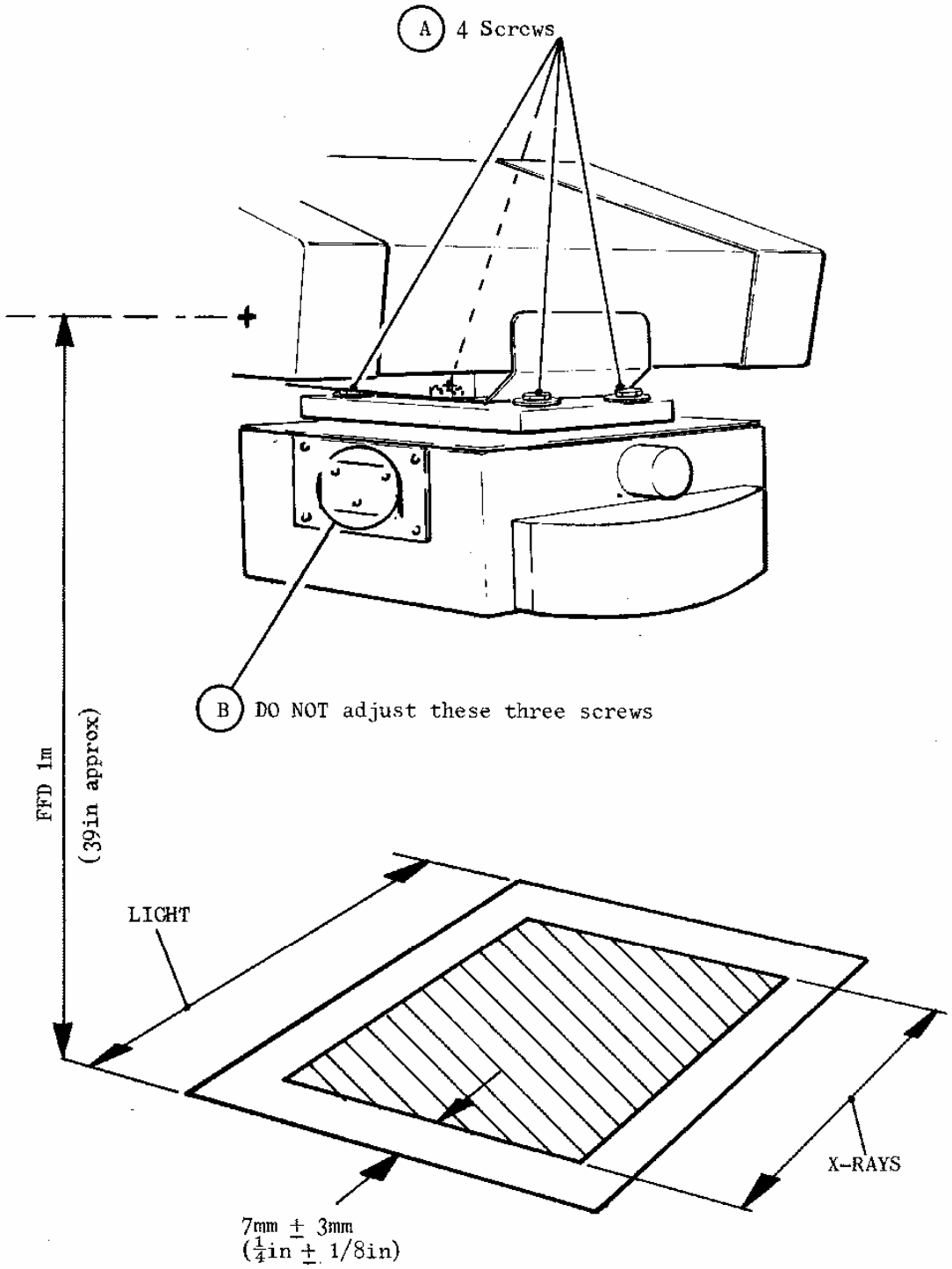


Fig 41 Adjusting LBD Beam

29. MOVING THE HAND DRIVEN MODEL Fig 42

Before moving the MX4, position the X-ray head so that it is just above the control unit. See that all the head, crossarm, and column locks have been set to prevent unwanted movements.

Unplug the Potter Bucky and mains connectors, and turn the cable handle clockwise ↷ to wind in the mains cable.

Release the brakes by pulling the brake handle towards the control handle. The brakes may be locked in the OFF position by fully depressing the brake catch button while the brake and control handles are held close together. Release the handles BEFORE releasing pressure on the button.

The unit may now be moved by pushing or pulling on the control handles.

To put the brakes ON from the locked-off position, squeeze the brake handle towards the control handles until the brake catch button pops up, then release the handles.

Continue with HANDING OVER, Section 32, page 62.

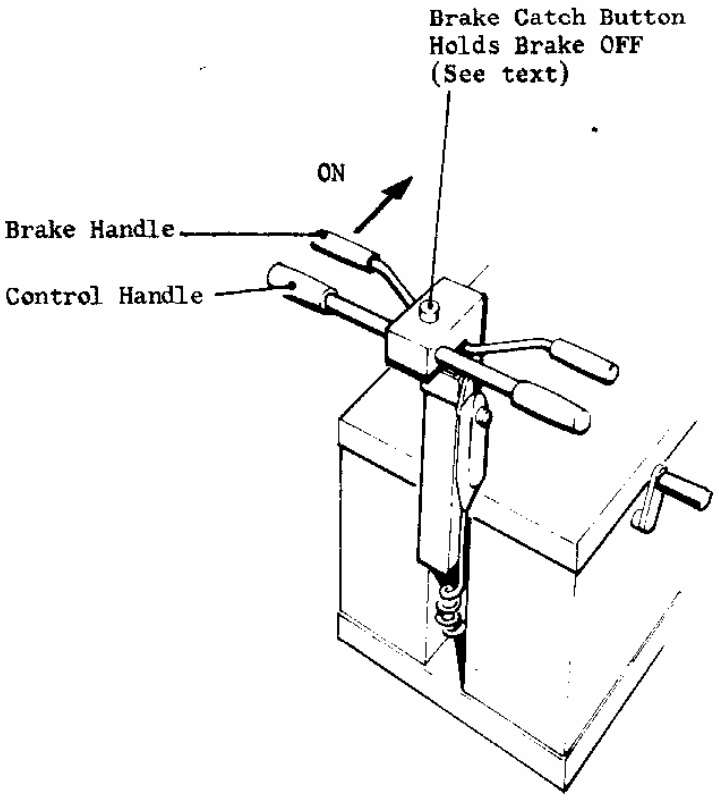


Fig 42 Moving the Hand Driven Model

30. FILLING and FITTING BATTERIES Fig 43

If the batteries are in the "dry charged" state, prepare them for use according to the manufacturer's instructions supplied with the batteries. A copy of these instructions, "IMPORTANT NOTICE", is at the front of this manual.

WARNING .... Ensure that there are no obstructions inside the battery compartments (Projecting screws, loose nuts or other items likely to damage the batteries).

Arrange the leads as indicated in Fig 43. See that the batteries are clean and dry, and lower them into the compartments.

Fit the battery leads. Note that the RED lead goes to the POSITIVE lug of one battery, and the BLUE lead goes to the NEGATIVE lug of the other battery.

To connect the battery leads, feed each bolt through the battery lug from the outside of each battery (as illustrated), and put the lead tag and then a washer onto the bolt, and clamp the tag and washer with a nut. DO NOT assemble with the bolt in the opposite direction because the battery connection will short circuit to the lid of the battery compartment.

IMPORTANT NOTICE

PLEASE READ THESE INSTRUCTIONS CAREFULLY BEFORE FILLING AND FITTING YOUR BATTERY

GENERAL

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

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

PUTTING INTO SERVICE

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

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

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

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

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

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

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

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

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

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

BATTERY MAINTENANCE AND CARE

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

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

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

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

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

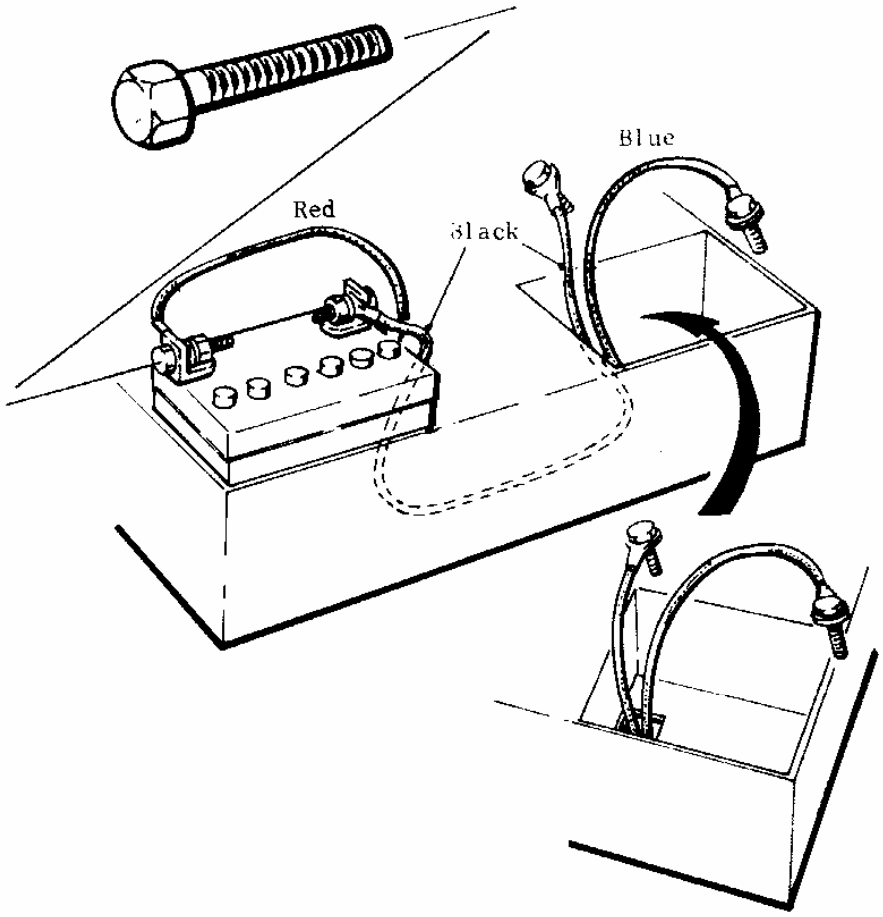


Fig 43 Connecting Batteries

31. DRIVING the MOTOR DRIVEN MODEL Fig 44

Before moving the MX4, position the X-ray head so the it is just above the control unit. See that all the head, crossarm, and column brakes have been set to prevent unwanted movements.

Unplug the Potter Bucky and mains connectors and turn the cable handle (F) clockwise to wind in the mains cable (G).

To release the brakes, squeeze the brake handle (D) towards the control handle (E) causing the brake catch button (A) to pop up, then release the brake handle. The unit is now free to move. The motor driven unitcan be pushed and maneouvered easily by hand without operation of the motor drive.

For motor drive operation, insert the key into the switch (B) and switch ON by turning key clockwise. Press the black button (H) for normal speed. For high speeds or driving up inclines, press the black button (H), and the red button (J) when moving.

The red button can be pressed when the unit is stationary, but this can result in slipping of the drive wheels and possibly cause damage to the tyres or floor covering.

CAUTION .... When the unit is parked apply the brakes by squeezing the brake handle (D) towards the control handle, and retain the brake in the ON position by pushing and holding IN button (A), then releasing the brake handle (D) before releasing button (A).

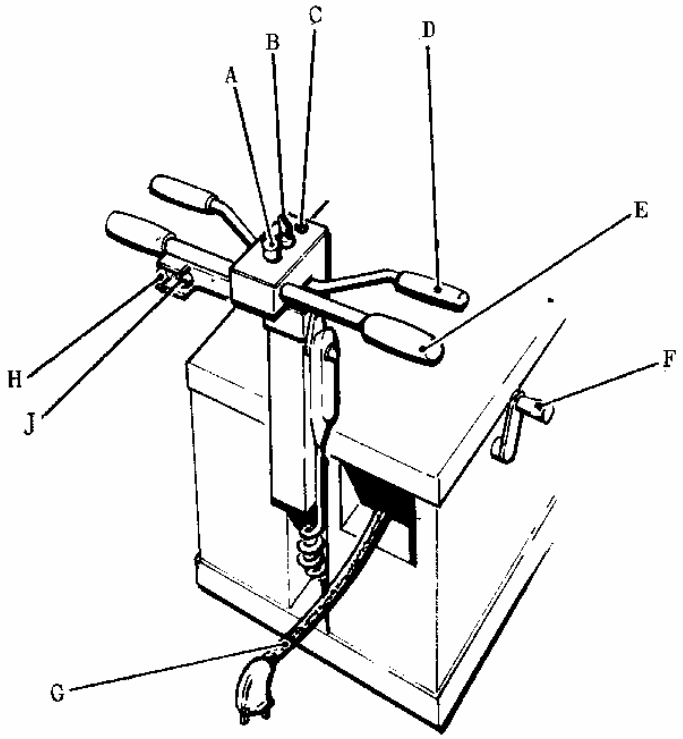


Fig 44 Driving the Motor Driven Model

32. HANDING OVER

On U.K. units record the exposure counter reading.

Ensure that the unit has been demonstrated to the operator, and that the operator understands how to use all the controls.

Hand over the unit with Operating Instruction No.1700 to the operator.

SERVICE SECTIONS

CONTENTS LIST of SERVICE SECTIONS

33. GENERAL IMPORTANT SERVICING NOTES.

1. WARNING .... ALWAYS switch OFF when handling the apparatus and/or when making adjustments.

DO NOT use a buzzer to check continuity of the memory relay contacts - see Section 3 below.

DO NOT attempt to check continuity of thyristors (SCRs) or transistors, see Section 4 & 5 overleaf.

FULL PRECAUTIONS MUST BE TAKEN TO GUARD AGAINST THE POSSIBILITY OF ELECTRIC SHOCK AND/OR EXPOSURE TO X-RADIATION AND/OR OTHER INJURY TO PERSONNEL.

Refer to SAFETY PRECAUTIONS SECTION 1A PAGE 5B

This manual contains only notes on the components and circuits used on the MX4, Series 2. For fundamental details of transistor, thyristor and electronic circuits, refer to standard commercial text books.

When carrying out service work the information contained in the instruction sections, pages 8 to 62, must be used in conjunction with the following notes.

2. Test Instruments

2a. mAs Meter, Penatrameter (Ardran type) Cassette, Stepwedge and Spinning Top are all required for installation work and can be used on service work.

For service work the items in sections 2b to 2e below may also be required.

2b. Transistorised continuity tester for checking the timer and control circuits, the thyristor circuits and the memory relay contacts.

2c. Multimeter with at least 20kΩ/V on all DC voltage ranges (eg AVO 8 or 9). See paragraphs 3, 4 and 5 below.

2d. 500V Megger. When a Megger is used for tests on the main circuit DISCONNECT ALL connections to low-voltage circuits by withdrawing ALL connector plugs from the main PCB and WITHDRAW the timer card from its socket. Identify and disconnect the leads from the thyristor panel.

Note that relays RX, RS, EP, PR and MC operate at 110V; WITHDRAW all these relays before carrying out Megger tests.

2e. Oscilloscope. Refer to page 75 for precautions.

3. Memory Relay Contacts

DO NOT USE A BUZZER TO CHECK CONTINUITY OF THE MEMORY RELAY CONTACTS. Use a transistorised continuity tester.

The mercury-wetted contacts of the bi-stable phase-memory relay have only light current capacity and can be easily damaged by, for instance, the current from a buzzer.

If a transistorised continuity tester is not available, an Avometer or other test meter with a resistor of approximately 1500 ohms in series with one of the meter leads can be used to carry out tests.

4. Thyristors or Silicon Controlled Rectifiers (SCRs).

On no account must a Megger, ohmmeter or buzzer be connected across the gate/cathode junction of a thyristor. A thyristor must be tested only in a properly arranged test circuit. The thyristor must be disconnected when checking continuity with an instrument other than a transistorised continuity tester.

5 Transistors and Control Circuits.

DO NOT use a buzzer or low voltage ohmmeter for checking continuity of transisters or the X-ray control circuit; use a transistorised continuity tester.

6. Filament Primary Supply Relay, FL .

If the filament supply circuit is open, then the filament line relay FL will not operate and the supply to the exposure switch will be open. (Both the filament line relay FL and memory relay are current operated).

7. CIRCUIT BREAKER.

The circuit breaker can be reset by pressing the lever past the normal OFF position to reset the trip mechanism. Allow a few seconds for the damped movement of the magnetic trip to revert to the normal position, after the trip has been reset, before recommencing a test sequence.

If the circuit breaker trips out immediately after being reset, check the circuit and clear the fault before continuing tests. Note that a fault may be in the circuit or in the circuit breaker (or both).

34 DESCRIPTION OF FUNCTIONING OF THE CONTROL UNIT WITH DESCRIPTION OF POTTER BUCKY CIRCUIT

COMPRISING

34A SUMMARY OF RELAY OPERATION SEQUENCES

This summary and the index on page 69 are intended to provide rapid access to the section/s of the circuit description relevent to the fault to be cured.

Relays are energised (unless qualified) in the order shown when reading downwards. Some essential requirements for operation are included in the sequence in [] brackets.

RADIOGRAPHIC PREPARE SEQUENCE

(See Section 3, page 71, for details).

Press to PREPARE - No overload selected.

RS, MC

[Stator circuit complete.]

SC, SM.

PR

[Tube filament current flows.]

FL

EP

CO A, CO B.

FL (De-energised)

DD (About 1 second after PREPARE.)

RS (De-energised.)

RADIOGRAPHIC EXPOSE SEQUENCE

(See Section 4, Page 71B, for details).

[DD is energised]

Press to EXPOSE.

[Operates Potter Bucky, if selected, via line 124.]

[Potter Bucky supplies power to RX via line 125.]

RX

(Exposure ended by timer, or releasing button.)

34B INDEX OF RELAYS AND RELAY CONTACTS USED IN THE DESCRIPTION

34C. FUNCTION OF THE X-RAY CIRCUIT OF THE MX4 SERIES 2 MOBILE MODEL.

1. General Information

Refer to circuit "Derived from Issue 4 of MD3587".

The MX4 series 2 Static and Mobile units and the R201 have a number of components in common. There are some components not fitted to PCB's of the MX4 units.

Note that the mobile unit has no facility for fluoroscopic exposures.

On the mobile unit the mains padder resistor is set by the operator at each mains outlet socket.

There is no facility for adjusting "Capacity current".

An important point on the MX4 Series 2 units is that the terminal 121 on the X-ray control tubehead MUST be connected to a special terminal marked 'CABLE 121 FROM MX4 HEAD' in the control unit.

On the static unit relay TC is omitted and not required. On the mobile unit both TC and FC C relays are not required.

Letters and numbers in () brackets after a symbol indicate the zone on the circuit in which the component can be found.

To find a relay, or relay contact set, without unnecessary reading of the description, look for the number in the wide left-hand margin. The required reference will be found on the same line in the text.

2. Switching ON to the Stand-by Condition

The circuit diagram shows the switched-OFF condition.

Mains switch/MCB (1A) closed. Main autotransformer T1 (1B) energised, and compensated supply is produced between 121 and 122.

The primary of mA tap transformer T4 (9A) is energised from 121 and 122, heating tube filament for stand-by condition.

Other sub-circuits energised from 121 and 122 are:- overload circuit, delay circuit, lamp circuits, and the timer circuit.

If the settings of the control are such as to produce an overload condition the neon N2 (12C) will glow, and no
OR3 exposure will be possible because contracts OR3 (11B) will be open. Reset kV, mA and/or time controls to a lower position to remove overload condition.

3. Radiographic Prepare Sequence

OR3 RS MC	Exposure button (10A) pressed to the prepare position connects 121 to line 132 and, if overload contacts OR3 (11B) are closed, simultaneously energises rapid start relay RS (11C) for the stator, and meter changeover relay MC (12C).
RS1 RS1	Contacts RS1 (6A) change over and approximately 148 volts is applied to the stator circuit via R20 (5A), and the anode starts rapidly. [RS1 reverts to normal after approximately 1 second].
MC1,MC2	Contacts MC1 & MC2 (7E) change over from the reference voltmeter to the mA meter configuration (0-200mA).
SC, SM	If the stator circuit is complete, protection relays SC (6A) and SM (6B) are energised.
SC1, SM1 PR	Contacts SC1 and SM1 (12C) close, energising prepare relay PR.
PR1 FL	Contacts PR1 (7C) change over the tube filament supply circuit from the stand-by condition to the radiographic condition. Relay FL (9B) is energised if the filament circuit is complete.
PR2 RX1	Contacts PR2 (6F) close to complete secondary side of the supply to the timer. [Awaits closure of contacts RX1 on exposure before timer starts to function].
PR3	Contacts PR3 (12J) change over the base connection of Q6 to start the delay sequence of one second to allow the X-ray tube filament to attain radiographic working temperature, and to allow the anode to run up to full speed. [For full function of delay circuit. See section 5, page 71B].
PR4	Contacts PR4 (5J) open the supply to the overload circuit, preventing operation of overload relay once an exposure sequence has started.
FL1 EP	Contacts FL1 (11C) close, energising extra-prepare relay EP.
EP1 RS1 RS	Contacts EP1 (5B) close part of the (approximately) 40V supply circuit to contacts RS1. [After the initial delay of approximately one second RS drops out, and the 40V maintains the rotation of the anode].
EP2	Contacts EP2 (7D) short circuit resistor R9. [This facility is required to change the characteristics of the meter circuit when making adjustment to the mains padder resistor. See separate note, Mains Padder Resistor Adjustment].
EP3	Contacts EP3 (5F) close to provide the power supply for the timer circuit.
EP4 CO A, CO B	Contacts EP4 (11D) close to complete the circuit of CO A and CO B relays.

CO A 1-2,3-4,5-6	Contacts CO A 1-2 (3B), CO A 3-4 (4B) and CO A 5-6 (4D) all close to provide part of the HT primary circuit ready for the exposure.
CO A 7-8	Contacts CO A 7-8 are not used.
CO B 1-2 RX	Contacts CO B 1-2 (10C) close part of circuit to radiographic exposure relay RX. [Exposure held off until end of delay and closure of exposure switch].
CO B 3-4,FL FL1 FP,CO B 5-6	Contacts CO B 3-4 (8B) short circuit FL relay to eliminate the coil resistance from the filament circuit once continuity of the circuit has been established. Contacts FL1 (11C) open, but the circuit to FP relay (11D) is maintained by CO B 5-6.
CO B 5-6	Contacts CO B 5-6 (11C) [see CO B 3-4 above].
CO B 7-8	Contacts CO B 7-8 are not used.
DD	After a delay of approximately one second [from the start of the prepare sequence while C9 (13J) charges via R79 and R80 resistors and contacts PR3] the delay relay DD (14J) is energised.
DD1	Contacts DD1 (13H) close to lock on transistor Q6.
DD2	Contacts DD2 (12J) open to provide part of dual delay function for delayed drop-out of DD relay when the prepare button is released.
DD3 RX	Contact DD3 (10B) close part of the exposure circuit to RX relay.
DD4,RS	Contacts DD4 (11D) open. RS relay drops out, its contacts revert to normal, and the anode runs on from a 40V supply.
DD	When DD relay is energised the prepare sequence is completed, and closure of the exposure switch starts the exposure sequence.

4. Radiographic Expose Sequence

RX
RX1

Closure of exposure switch (10A) completes circuit to RX relay (10D). RX1 contact (6F) closes to start timer exposure sequence. Output of unijunction Q204 (8F) triggers thyristors SCR1 and SCR2 (4B) in the heavy current circuit, and the exposure starts. Capacitor C205 (7G) charges up from the stabilised DC supply in the timer. At the end of the time determined by the setting of S5 switch bank 3 (10F), the base of Q203 is driven sufficiently positive so that Q203 conducts and short circuits C206 (8F), and oscillation of Q204 stops. The exposure is terminated by the self-quenching action of the last thyristor in operation.

(RM)

The actual start of the timer sequence is determined by the position of the memory relay contacts. For full function of timer see section 7, page 72A.

The timer circuit has an inherent hold-on facility, and no repeat exposure is possible until the exposure switch has been released out through the prepare position to the stand-by position.

Note also that the exposure can be terminated at any time by the "Dead Man's Handle" effect on releasing the exposure switch button. See Section 7a, page 72B.

5. Delay Circuit Function See Zones 11H to 14J.

A delay is necessary at the start of an exposure sequence to allow time for the temperature of the X-ray filament to rise to the radiographic working value, and for the anode to attain working speed.

The delay period is approximately one second, and is controlled by the setting of R79 (12H).

Another delay is necessary when the prepare/expose button is released at the end of an exposure. This delay period is approximately one second, and is controlled by the setting of R81 (12J).

Both R79 and R81 are set by the factory and need no further adjustment.

In the stand-by condition of theX-ray control, the delay circuit is supplied with 24V DC stabilised by D5 (12J).

DD

Transistor Q3 is off and DD relay is not energised.

PR3

On prepare, contacts PR3 change over. C9 begins to charge up via R79 and R80, the base Q6 goes positive, and Q6 switches on. Q5 switches on, Q4 switches off, Q3 switches

DD

on and DD is energised approximately one second after change-over of PR3.

DD1

DD1 closure applies a hold-on bias to the base of Q6 and the charge on C9 rapidly rises to a maximum.

DD2

DD2 opens and remains open until the end of the sequence.

DD3,DD4 — DD3 and DD4 contacts function has already been explained in the explanation of the prepare condition (page 71).

PR3 — When prepare is released, PR3 reverts to normal and C9 starts to discharge through R81 and R82. When the voltage on the base of Q6 has fallen to a sufficiently low value Q6 is cut off; Q5 is cut off, Q4 is switched on, Q3 is

DD — switched off and the DD relay is de-energised. This takes approximately one second, to allow the tube filament temperature to fall to the stand-by value.

DD1 — DD1 opens ready for the start of the next prepare sequence.

DD2 — DD2 closes to remove the remainder of the charge from C9.

6. Overload Detection Circuit Function

The overload detection circuit is required to prevent an exposure in excess of the rating of the X-ray tube for a single exposure.

When an overload condition is selected by a combination of kV, mA and time control settings, the prepare circuit is

OR3 — blocked by the opening of the overload relay contracts OR3 (11B). Also the "prepare blocked" lamp, N2 (12C), glows. Reduction of the settings of kV, mA and/or time controls

OR3 — removes the block by closure of contracts OR3 in the prepare circuit, and the "prepare blocked" lamp goes out.

In the stand-by condition of the X-ray control, the overload relay circuit is supplied, via secondary 3 on transformer T4, with stabilised 12V DC (4H).

In the following explanation the negative rail from MR3 is used as a zero-voltage reference.

An input signal voltage proportional to kV, mA, and time settings, is applied to the base of Q2 (7H). This input voltage is derived from a voltage proportional to the kV selected. This voltage is applied to the primary of T3 (7C), and a voltage proportional to the mA selected is tapped off from secondary 2 of T3 (4J) via bank 2 of mA switch S4. This output is rectified and smoothed, and applied to the base of Q2 via R68 and the resistance selected by "timeswitch S5 bank 1".

Assume an overload condition has been selected. Q2 is cut

OR — off; Q1 conducts and OR is energised.

By resetting kV, mA and/or time controls to a lower position, the signal voltage applied to the base of Q2 becomes less negative and Q2 turns on; Q1 is cut off and

OR,OR3 — OR relay drops out. Contacts OR3 (11B) close in the prepare line permitting an exposure sequence to start.

C5 is a slugging capacitor for relay OR.

OR — D3 limits the back-emf from OR when Q1 switches off.

OR1,OR2 — Contacts OR1 and OR2 are not used.

7. Timer Circuit Function

The timer controls the duration of the X-radiation exposure.

T4 secondary 2 (4G) supplied AC to MR202, and the rectified output is used as a phasing trigger for switching on Q201 (6F). The phased signal will be applied either via C202 or
(RM) 203 depending on which way the memory relay contacts rest at the end of the previous exposure. The phasing is required so that the HT transformer primary current at the start of an exposure will be in the correct direction with respect to the residual magnetism in the HT transformer core.

Prepare

Power supply to the timer circuit is not connected until
EP3 the extra prepare relay contacts EP3 (5F) close during the
PR2 prepare sequence. Contacts PR2 (5F) close at the end of the prepare sequence. Switching transistor Q202 (6F) is held off because its base-emitter junction is reverse-biased by the voltage across R201. This is the end of the prepare sequence on the timer.

Expose

The timer exposure sequence starts when RX1 contact (6F) closes. The base of Q201 goes positive, and the transistor is switched on the phasing signal from the memory relay contacts via R204. Q201 conducts and its collector goes negative and switches on Q202; Q202 collector circuit being completed to negative via bleeder resistor R207. The collector of Q202 is positive and holds
RX1 on Q201 via R214 so that, should contacts RX1 bounce on closure, the conduction of transistors Q202 and Q201 is not interrupted.

The power supply to the oscillator circuit of Q204 (8F), and to the timer resistance chain [R41 to R59] and C205 capacitor circuit (7G) is completed.

RX2 RX2 contacts (8F) are open and C205 starts to charge through R215, R60 and a part of the resistor chain R41 to R59, depending on the timer control setting, as soon as Q202 conducts. Q203 is cut-off at this stage because its emitter is positively biased from R216 (5F), the short time pre-set control.

The oscillator circuit of Q204 operates at approximately 3kHz [determined by the values of R208 and C206]. Transistor Q205 is a driver which delivers a continuous stream of pulses from the oscillator circuit to the gates of the thyristors, SCR1 and SCR2. One of the thyristors will conduct and complete the circuit to the primary of the HT transformer, and the X-ray exposure will start. The other thyristor will conduct on the alternate half cycles and the exposure will continue until the end of the time set by time control switch S5 bank 3.

The charge on C205 rises to a point where Q203 conducts and short circuits C206, and the oscillator ceases to function. The thyristor which is switched on will

continue to conduct to the end of the half cycle, will then self quench, and the X-ray exposure will cease.

While the exposure button remains pressed fully in the timer circuit will stay in this condition.

7a. Additional Notes on Timer Circuit Function

The exposure can be terminated before the normal time has elapsed by releasing the handswitch button from the expose to the stand-by or prepare position. Relay RX de-energises, contracts RX2 close, and the base of Q203 is rapidly driven positive. Q203 conducts, short cirucits C206, and the oscillation ceases. The thyristor working at that particular instant continues to conduct to the end of that half cycle, and then the exposure is cut off.

RX
RX2

If the exposure button is released to the prepare position contacts RX1 will open, but Q201 will hold themselves on in a 'non-repeat' condition. No repeat exposure is possible because the charge on C205 holds Q203 in conduction, shorting C206, and preventing the oscillator from working.

If the exposure button is released completely the circuit reverts to the stand-by condition, and a repeat exposure is possible after the normal delay of approximately 2 seconds. [One second for the delay circuit to drop-out the DD relay and another one second for the normal prepare before DD is energised.]

DD
DD

WARNING.... DO NOT overload the X-ray tube by repeat exposures. See Page 58 for rating charts.

When the exposure button is released to the stand-by position at the end of an exposure, the circuit reverts to the condition shown. Because the supply voltage has been switched off by the opening of PR2 and EP3 contacts, C205 discharges through D203 and R207 ready for the next exposure.

PR2,EP3

8. Main Autotransformer T1 and Associated Components

Transformer T1 is basically used as an autotransformer. It has an extra winding - coil 8 - which supplies the LBD and the auxiliary lamps.

The mains voltage ["line"] compensator switch (2J) is set so that the reference voltmeter (7E) is on the datum mark.

Resistor R2 (2D) is inserted near the mid-point of the main auto-transformer winding. It has been adjusted to set the resistance of the main winding of T1 to a design value, and MUST NOT BE RESET.

Resistors R3 and R4 (1 H/J) maintain the circuit when the mains voltage compensator control is moved from one stud to the next, reducing sparking at the switch contacts.

Resistor R1 - the mains padder resistor - is adjusted to make up the resistance of the mains supply to T1 to a design value.

Current overload protection is provided in one of the mains supply lines by MCB (1A).

9. Remote exposure control

Remote radiographic exposure control must be connected in parallel with the prepare/expose switch on the X-Ray control unit. Terminals 121, 131, 132 and, where a metallic handswitch or serial changer switch is used, earth.

10. Potter Bucky Circuit Function See Fig 44A

Refer to the Potter Bucky Circuit below, and to zone 9C of the main circuit MD3612.

The radiographic exposure relay RX 10D is energised on expose.

The zero voltage line is 129.

With the Potter Bucky switched in (9C), 240 volts is applied to terminal 124 on the control and terminal A on the Potter Bucky.

MR6 energised solenoid W18 and the grid is moved to one side on its spring mountings, causing microswitch BS1 to change over. Relay ER2 is energised and contacts ER2/2 change over. The grid is released, and starts to vibrate on its mounting springs, and contacts BS2 revert to the normal position shown on the Potter Bucky circuit. Relay ER2 is held on by its own contact, and the circuit to terminal 125 is completed by contacts BS1. RX relay in the X-ray control unit is energised, and an exposure takes place.

The Bucky grid will continue to vibrate for some time after the end of the exposure and contacts BS will remain as shown in the Bucky circuit. Also relay ER2 will be de-energised, and its contacts will revert to the position shown when the exposure switch button is released.

A plug and a socket are used to connect the control unit to the Potter Bucky. The Potter Bucky frame must be earthed.

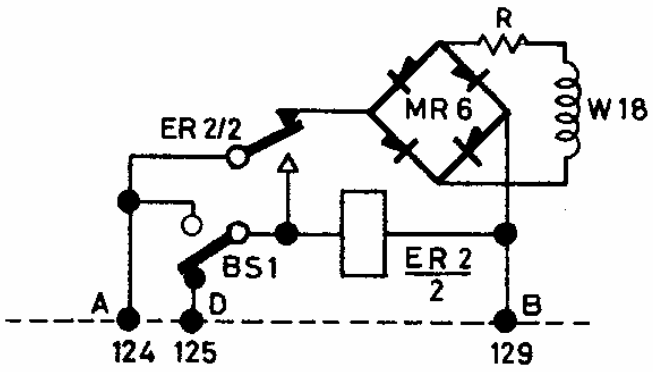


Fig 44A. Circuit of YM Series Potter Bucky with Interchangable Grid.

On some Buckys a resistor, R, will be connected in series with the solenoid W18.

35. USING AN OSCILLOSCOPE.

The following is important information concerning the general use of an oscilloscope.

WARNING . . . . DISCONNECT and INSULATE the oscilloscope earth lead in the mains supply plug.

Stand the oscilloscope on an INSULATING surface.

DO NOT touch the casing of the oscilloscope, nor allow the casing to touch an earth.

DO NOT overheat the X-ray tube by repeated exposures.

For most measurements, BOTH input connections of the oscilloscope will be "live" with respect to earth, therefore the casing will be "live", hence the WARNING list above.

The X-ray tubehead can be used as the load when making tests.

If there is a possibility of overloading the X-ray tube, use a dummy load to complete the thyristor circuit.

IMPORTANT .... The dummy load must be of low resistance so that the memory relay will be operated on each test.

The dummy load can be anything from a 20Ω 40Watt resistor to a 2kW or 3kW domestic electric heater. Note that the resistor will become hot when repeated tests are made. kV and mA controls must be set to a low value.

Short leads must be used to reduce the possibility of pick-up on the oscilloscope leads.

DISCONNECT and ISOLATE leads P1 and P2 inside the X-ray control unit if a dummy load is to be used. Connect dummy load to terminals P1 and P2. (See Fig 45 below).

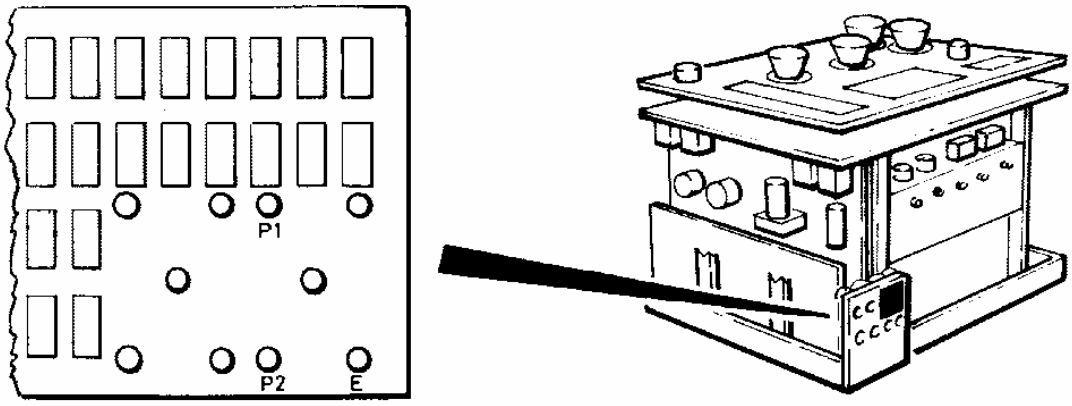


Fig 45 P1 and P2 Terminals

36. CHECKING TIMER

The mAs meter is used to set up the radiographic mA values in conjunction with the timer no matter what method is used for checking the accuracy of the timer.

Remove the control cover - see Section 10 page 14.

Set the controls as shown in Fig 46 below.

Use the settings for (Sec) given in the appropriate following section.

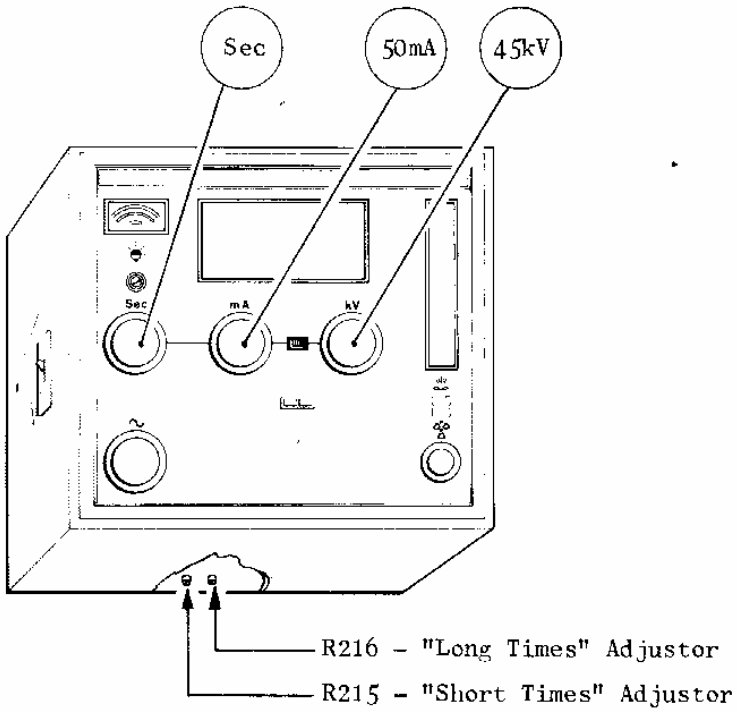


Fig 46 Control Settings for Timer Test and Locations of R215 and R216.

If an oscilloscope is available, proceed as detailed in Section 36A, page 77.

If an oscilloscope is not available but a spinning top is, proceed as detailed in Section 36B, page 81.

If neither an oscilloscope nor a spinning top is available but an mAs meter is, proceed as detailed in Section 36C, page 83.

36A Oscilloscope Traces of P1-P2 Voltage (50Hz Supply, see note below for 60Hz).

This section is intended for checking that:-

(i) The timer gives correct exposures on the shorter time settings.

(ii) The 5 seconds setting of the timer is correct.

(iii) The memory relay RM and the timer "phased start" circuit are working correctly.

These memory functions are checked by seeing that the first half-cycle of an exposure is ALWAYS of OPPOSITE polarity to the last half-cycle of the preceding exposure. That is, for a timer setting giving an EVEN number of mains half-cycles ALL traces will be identical.

NOTE:- Each correct "short time" exposure has an EVEN number of half-cycles, and each has been drawn with its first half-cycle positive. The actual polarity observed will depend on the oscilloscope connection, but the "follow on" MUST be correct.

A test exposure with an ODD number of half-cycles is used to ensure that the memory relay has changed over.

AT EACH TIMER SETTING REPEATED EXPOSURES SHOULD BE MADE TO CHECK FOR CONSISTENT OPERATION.

The result of each timer setting should be noted, but no adjustment should be made until all the required timer settings have been checked.

Set timer to 5 seconds and make an exposure at 45kV and 50mA.

Use stopwatch to check duration - should be between 4.5s and 5.5s.

Note on 60Hz Supply

Each half-cycle at 50Hz has a duration of 0.01s. With a 60Hz supply 2 half-cycles should be produced for a timer setting of 0.016s, 4 for 0.033s, and 6 for 0.05s.

Set the timer to 0.02 seconds. Make an exposure as described in Section 25 page 48, and the trace should be as shown in Fig 47. The "follow on" trace is also shown.

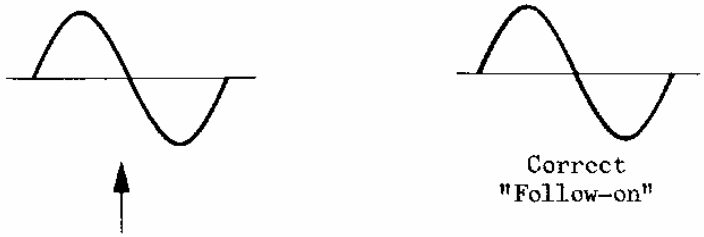


Fig 47. CORRECT Trace for 0.02 Seconds Timer Setting

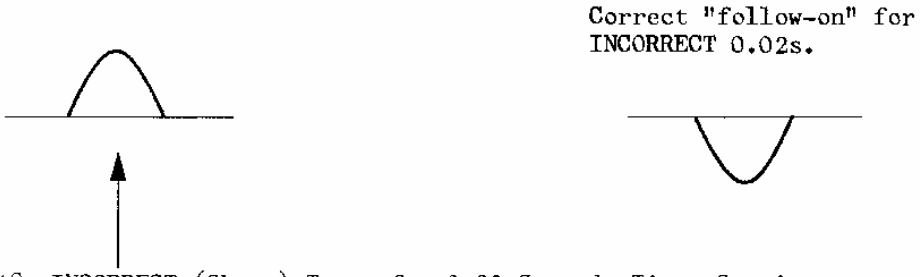


Fig 48 INCORRECT (Short) Trace for 0.02 Seconds Timer Setting.

Fig 49 INCORRECT (Long) Trace for 0.02 Seconds Timer Setting

If time INCORRECT (Fig 48 or 49) proceed to 0.04s check (on next page).

Fig 50 Memory Function INCORRECT on 0.02 Seconds Timer Setting

If Fig 47 trace is obtained the memory relay contacts need not have changed over. Proceed to Memory Check (page 79).

If Fig 50 is (sometimes) obtained the "phased start" circuit is not working and/or the memory relay is not changing over consistently. See note on page 79, and page 72A for timer circuit description.

If fig 48 or 49 is obtained consistently proceed to 0.04s check, page 80. These traces contain an odd number of half-cycles, which is the requirement for the memory check of page 79.

Memory Check

Obtain a 0.03s exposure by misadjusting R215 (NOTING CORRECT POSITION FOR RESETTING), or by shunting timer chain.

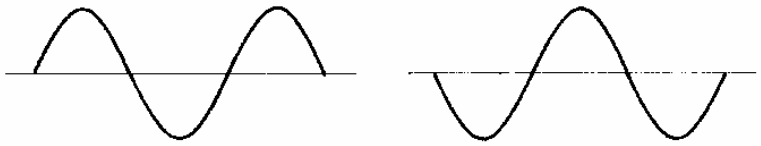


Fig 51 CORRECT "Follow-On" of 0.03 Seconds Trace

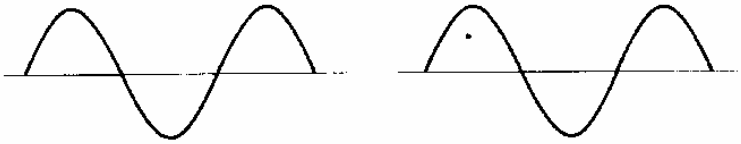


Fig 52 INCORRECT "Follow-On" of 0.03 Seconds Trace

If memory INCORRECT (Fig 52) CLEAR FAULT, return timer circuit to original condition, and repeat tests starting with 0.02s setting.

NOTE .... The memory relay requires a minimum current of 5A for operating. See Section 35, page 75, for description of an adequate test load.

If memory CORRECT (Fig 51) return timer circuit to original condition, and proceed to 0.04s check overleaf.

Set the timer to 0.04 seconds. Make an exposure, and the trace should be as shown in Fig 53 below.

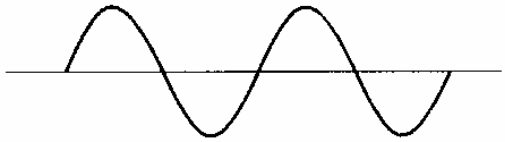


Fig 53 CORRECT Trace for 0.04 Seconds.

Memory should be correct.

Set the timer to 0.06 seconds. Make an exposure, and the trace should be as shown in Fig 54 below.

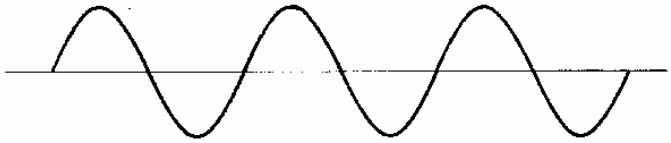


Fig 54 CORRECT Trace for 0.06 Seconds

Memory should be correct.

The long time adjustor R216 (Fig 46, page 76) is usually set at minimum (fully anticlockwise). If the exposure on the 5s setting is acceptable, it is best to leave R216 alone. Adjusting R216 will have a large effect on the short times.

Although the short times have only been checked up to 0.06s, they should be correct up to 0.16s. The 0.2s setting can be $\pm$0.01s. To correct the short times adjust R215 (Fig 46, page 76), which will not affect the long times. If R215 is adjusted, all the short time settings should be re-checked.

36B CHECKING THE TIMER USING A "SPINNING TOP"

This section is mainly intended for checking that the timer gives correct exposures on the shorter time settings using a "top" with one hole. The procedure can be simplified when using a 6-hole "top".

Set controls to 45kV and 50mA.

The result of each timer setting should be noted, but no adjustment should be made until all the required timer settings have been checked.

Set timer to 5 seconds and make an exposure.

Use stopwatch to check duration - should be between 4.5s and 5.5s.

Adjust the FFD to give mid-grey spots so that variations in alternate half-cycles may be apparent.

Set timer to 0.02 sec.

To economise on film use lead strips as a mask so that one quarter of the film is uncovered.

Place the "spinning top" centrally in the selected quarter of the film.

Spin the "top", and make an exposure (as described in section 25, page 48). Best results are likely if the exposure ends just before the "top" stops revolving.

Remove the "top" and move the mask to cover the used part of the film, and uncover another quarter.

Place the "top" centrally on the new quarter of film.

Set the timer to 0.04s.

Spin the "top", and make an exposure.

Continue this procedure for timer settings of 0.06s, and 0.08s.

While the film is being processed complete the sequence on a new film using timer settings of 0.1s, 0.12s, 0.16s and 0.2s.

Interpreting the Results

Any exposure consists of a sequence of X-radiation pulses.

Because the hole in the "top" scans a circle of film during an exposure each pulse of X-radiation produces an exposed spot on the film.

The exposure produces a number of spots, each spot representing 0.01s at 50 Hz. See page 77 for 60Hz working.

Counting the number of spots will be difficult if the "top" was spinning too slowly during the exposure, because the spots will overlap. Excessive speed of the "top" will also give trouble because spots produced near the end of the exposure will overlap spots produced near the beginning.

Required results:

Time in Seconds	Number of Spots		Required Accuracy
0.02	2		EXACT
0.04	4		EXACT
0.06	6		EXACT
0.08	8		EXACT
0.10	10		EXACT
0.12	12		EXACT
0.16	16		EXACT
0.20	20	$\pm$	1 SPOT

CHECK FOR CONSISTANT RESULTS.

The long time adjustor R216 (Fig 46, page 76) is usually set at minimum (fully anticlockwise). If the exposure on the 5s setting is acceptable, it is best to leave R216 alone. Adjusting R216 will have a large effect on the short times.

If short times are incorrect adjust R215 (Fig 46, page 76) slightly and recheck all short time settings. Adjusting R215 will not affect the long times.

"Half Waving"

If the HT is being half-wave rectified there will be half the expected number of spots. (as well as half the expected value of mA). These statements assume that the timer is working correctly and that the mA had been set correctly during installation.

36C Checking the Timer Using an mAs Meter

Remove control cover - section 10, page 20.

Connect mAs meter - section 19, page 36.

Set controls to 50mA and 45kV.

The result of each timer setting should be noted, but no adjustment should be made until all the required timer settings have been checked.

Set timer control to 5s. Make an exposure, and check duration with a stopwatch. Exposure should be between 4.5s and 5.5s.

Note on 60Hz Supply

All the "short" timer settings used in examples A, B and C below, are those on the 50Hz control. Each "short" exposure on the 60Hz control contains an EVEN number of mains half-cycles, as on the 50Hz control. If the timer of a 60Hz control is to be checked with an mAs meter, use the information on pages 83 to 86, and the note about 60Hz on page 77 to calculate the required mAs values.

Set timer control to 0.02s, and make an exposure (section 25, page 48). Read mAs and record value.

Continue recording mAs values with timer control set to each position in turn up to 0.2s.

CHECK FOR CONSISTENT RESULTS.

Example A below shows the tabulated results for a unit with the timer correctly adjusted up to 0.2s, as well as the 50mA value set correctly.

EXAMPLE A

Timer Sec	mAs reading
0.02	1.0
0.04	2.0
0.06	3.0
0.08	4.0
0.10	5.0
0.12	6.0
0.16	8.0
0.20	10.0 $\pm$ 0.5

If the timer setting (Sec) and/or mA value is incorrect mAs values will not all be the values predicted by applying the formula

$$mAs = (Sec) \times mA$$

Example B below shows a set of results where the timer is correct up to 0.2s, but the HT current is 45mA. (Explanation on page 86).

EXAMPLE B

Timer Sec	mAs reading
0.02	0.9
0.04	1.8
0.06	2.7
0.08	3.6
0.10	4.5
0.12	5.4
0.16	7.2
0.20	9.0

Example C below shows a set of results where the HT current is 50mA, but the timer is incorrect. (Explanation on page 86).

EXAMPLE C

Timer Sec	mAs reading
0.02	1.0
0.04	2.0
0.06	3.5
0.08	4.5
0.10	5.5
0.12	6.5
0.16	8.5
0.20	10.5

Incorrect adjustment of the timer, the mA value in use, or both, may be determined by the graphical method on page 85 or by direct interpretation of the tables as described on page 86.

The long time adjustor R216 (Fig 46, page 76) is usually set at minimum (fully anticlockwise). If the exposure on the 5s setting is acceptable, it is best to leave R216 alone. Adjusting R216 will have a large effect on the short times.

To correct an error in the short times slightly adjust R215 (Fig 46, page 76), which will not affect the long times. If R215 is adjusted all the short time settings must be re-checked.

If the HT current is incorrect as well as the setting of the short time adjustor it is probably safer to plot a graph of mAs reading against timer setting than to try to derive this information by inspection of the results.

Join up points with straight lines as on a medical temperature chart.

Join point for 0.02s to the origin (0 sec, 0 mAs).

The graphs below are of the previously quoted EXAMPLES A, B, AND C.

The resulting graph should be a straight line passing through the origin, the timer then being in correct adjustment up to 0.2s (see overleaf "Interpreting the Graph"). Note that the setting of R215 should not be a marginal one.

The graph with O points shows that the timer was correct up to 0.2s, and the slope gives the current as 50mA.

The graph with + points shows that the timer was correct up to 0.2s, and the slope gives the current as 45mA.

The graph with □ points shows that the timer is misadjusted, but correction should be possible by R215. The slope of the graph gives the current as 50mA.

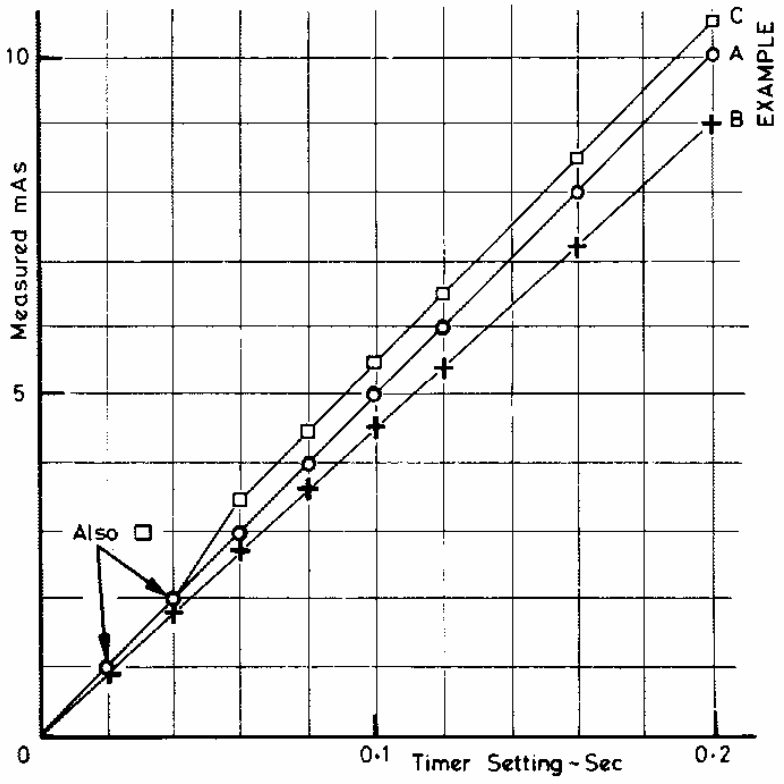


Fig 55 Graph for Timer Check Using an mAs Meter

Interpreting the Graph of mAs Reading/Timer Setting

Each point on the graph obeys the formula:

(Measured mAs) = (Actual mA) X (Actual Exposure in Seconds)

Assuming that the mA value is the same for each timer setting, any graph will be a straight line passing through the origin. The slope of the line is the actual mA value. (See lines for EXAMPLES A and B).

If the timer is out of adjustment the exposure duration will NOT be the same as the timer setting used.

Because the timer can only give exposure times that are an EXACT number of mains supply half-cycles (0.01 sec at 50Hz), PROVIDED THAT there is no timer fault other than misadjustment of R215, the graph for an incorrectly adjusted timer will have a kink in it corresponding to a step of 0.01s. This will not affect the slope of the rest of the line, the slope still being the actual mA value (see line for EXAMPLE C).

Interpreting the Tables of mAs Readings and Timer Settings

Although a graph is not going to be plotted it is helpful to first read the preceding section on interpreting the graph.

The formula for the slope of the graph lines* will be used in the following explanation. In this formula the "change" is the difference between pairs - expecially adjacent pairs - of results.

In EXAMPLE A (page 83) the formula is easily applied because the actual mA and actual exposures are the selected ones.

In EXAMPLE B (page 84) using the timer settings in the formula yields a result that is constant (45mA) even though it is not the selected value (50mA).

In EXAMPLE C (page 84) using adjacent pairs of results for the formula gives the selected value of 50mA EXCEPT for the increment from 0.04s to 0.06s. This exception is easily explained, remembering that:

(i) The mA value is independent of the timer settings.
(ii) actual exposure times are an EXACT multiple of 0.01s (at 50Hz).

Using (i), (ii), and the mAs increment of 1.5 (3.5mAs - 2mAs) shows that the ACTUAL time increased by 0.03s.

*Slope of line on these graphs is:

$$\frac{\text{Change in measured mAs}}{\text{Corresponding change in timer setting (sec)}}$$

This should be the selected value of mA.

37. TRACING WIRING USING THE TERMINATION AND LOOM LISTS

1. Some of the wiring can be traced by reference to the circuit drawing, but most wiring is inaccessible and the Termination and Loom Lists must be used to follow the wiring.

   The lists that follow are copies of the factory specifications and relate only to an unmodified unit.

2. Using the Termination and Loom Lists

   Consider the need to trace the wiring of FL relay coil (Zone 9B on Circuit "derived from MD3612"):-

   i) Use the Site Index on page 92, which shows that FL will be found on page 99. This page is a copy of Termination List MT3528 Sheet 2, and one of the connections to FL relay coil (FL P1) is found on the line with reference No 86.

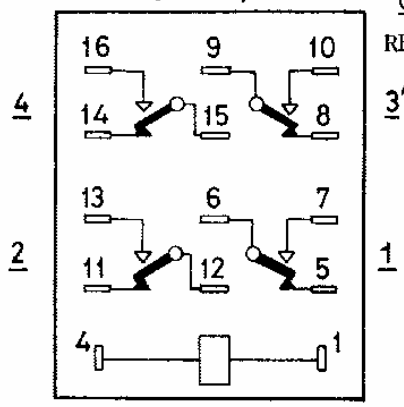
   ii) Refer to line No 86 on Loom List ML3528 Sheet 4, page 106. (The same number is used for corresponding Termination and Loom Lists).

   Reference 86 shows that FL P1 is at the "finish" end of an orange-coloured lead, which is soldered on ("finish Tag S"), and idented P1. The other end of the lead is therefore the "start", is idented COM, and is soldered ("Start Tag S") to the wiper ("COM") of switch 4 Bank 3 ("SW4 B3").

INTERNAL CONNECTIONS OF RELAYS

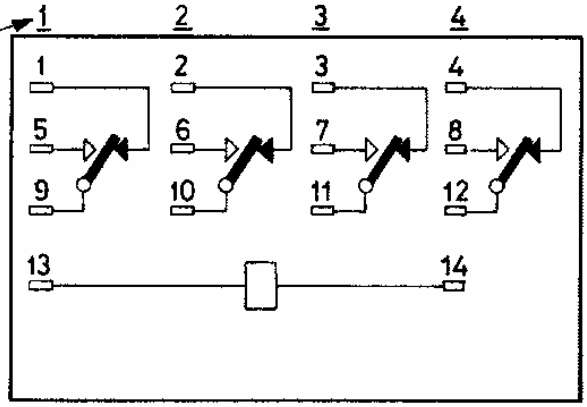
(From Spec No M115)

RELAYS :- DD, OR



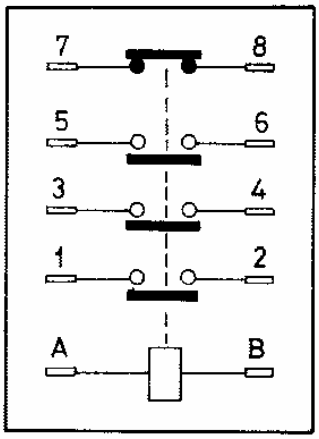
INTERNAL CONNECTIONS
OF RELAY TYPE PC4/CAB/12T
DAVALL - PERIVALE CONTROLS
PT No X510-226
VIEW ON SOLDER TAGS

RELAYS :- EP, MC, PR, RS, RX



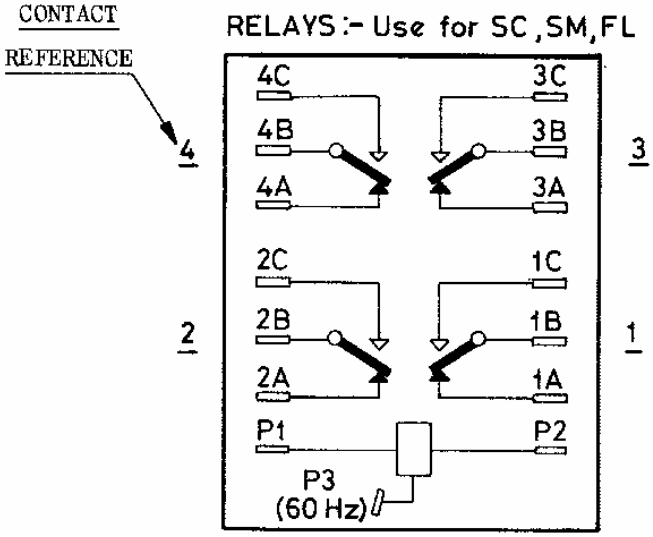
INTERNAL CONNECTIONS OF
RELAY TYPE KH17 A11
POTTER AND BRUMFIELD
PT No X510-945
VIEW ON SOLDER TAGS

RELAYS :- CO-A, CO-B



INTERNAL CONNECTIONS
OF RELAY TYPE EE3250
SIMMONDS AND ROBINSON
PT No X510-944
VIEW ON FASTON TAGS

RELAYS :- Use for SC, SM, FL



INTERNAL CONNECTIONS
OF RELAY TYPE 590
MAGNETIC DEVICES LTD

VIEW ON SOLDER TAGS

ABBREVIATIONS USED IN TERMINATION AND LOOM LISTS FOR MX4 SERIES 2 MOBILE

A	Amplok connector (followed by connector number and pole number)
A	Anticlockwise end of potentiometer when viewed on spindle.
A	One end of a two-terminal component - likely to be left or top.
A	Lamp on left-hand side of panel when viewed from front.
AP	Amplok M Series pin.
AS	Amplok M Series socket.
B	Switch bank - numbered from control knob end.
B	Lamp on right-hand side of panel when viewed from front.
B	One end of a two-terminal component - likely to be right or bottom.
B	Wiper of a potentiometer.
BL	Blue (lead colour).
BN	Brown (lead colour).
BK	Black (lead colour).
C	Capacitor.
C	Cathode (of a thyristor).
C	Common connection of a changeover switch.
C	Clockwise end of potentiometer when viewed on spindle.
CC	Comboline connector.
CO-A	Changeover relay A.
CO-B	Changeover relay B.
COM	Wiper of rotary switch.
CP	Comboline connector pin - used on pointed circuit boards.
CR	Radiographic exposure counter.
CS	Comboline socket (female connector).
D	Diode.
D	Diode bridge.
DD	Dual delay relay.
E	Earth.
EP	Extra prepare relay.
Ex	Exposure switch.
F	Faston "receptacle" - 250 series.
FL	"Filament line" relay.
FS	Fuse.
G	Grey (lead colour).
G	Thyristor gate.
G/BN	Grey and brown striped lead.
G/R	Grey and red striped lead.
GN/Y	Green and yellow striped lead - earth connection.
HS	Handswitch connection.
HSF	High speed fuse.

KV — kV scale lamp.

LP — Lamp.
LV — Low voltage panel connection (for handswitch).

M1 — Meter.
MA, mA — mA scale lamp.
MC — Meter change relay.
MCB — Miniature circuit breaker (ON/OFF switch on MX4).
MR — "Metal rectifier" - used for diode bridge.
M2.5R, M3R, M4R, M5R, M6R, M8R — Ring tag - used with:
- 6 BA
- 4 BA
- 3 BA
- 2 BA
- 0 BA or $\frac{1}{4}$inch
- 5/16 inch

N — Neon indicator lamp.
NC, N/C — "Normally closed" - the make contact of changeover contacts
NO, N/O — "Normally open" - the break contact of changeover contacts

O — Orange (lead colour).

P — Pink (lead colour).
P — Prepare switch.
PB — Pushbutton (Followed by pushbutton number and contact location).
POT — Identifies the two sections of R1, which are called -1 and -2.
PR — Prepare relay.
Prep. — Prepare switch.
PRI, PR1 — Primary winding

Q — Transistor.

R — Red (lead colour).
R — Resistor.
RL 1055 — "Prepare" relay on low voltage panel.
RL 1056 — "Expose" relay on low voltage panel.
RM — Memory relay.
RS — Rapid start relay.
RX — Radiographic Exposure Relay.

S — Solder to existing connection.
SC — "Stator capacitor" relay.
SCR — Thyristor (from "Silicon controlled rectifier").
Sec — Secondary winding.
SM — "Stator Main" relay.
SW, Sw — Rotary switch:-

1 Mains voltage compensator.
2 Radiographic kV control.
3 Fluoroscopic kV control.
4 Radiographic mA control.
5 Timer control (Sec).

T1 — Main autotransformer.
T2 — "Line drop compensation" transformer.
T3 — Space charge compensation transformer.
T4 — Auxiliary autotransformer.
T202 — Thyristor driver transformer.
T1010 — Low voltage panel transformer (on panel).
TB — Terminal board.
Time, TIME — Exposure time scale.
Timer, TIMER — Number gives location on timer PCB edge connector.
TP — Terminal on main terminal panel.
TS, T/S — Terminal strip.

V — Violet (lead colour).
V — Volts.

W — White (lead colour).

Y — Yellow
Y/GN — Yellow and green striped lead - earth connection.

INDEX OF SITES ON THE TERMINATION LISTS*

(Site symbols are defined on pages 89 to 91.)

*If a termination list was not available the corresponding loom list was used.

T4 SELF LEADS (From ML 3262 Issue 1 Sheets 1 & 2)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
1	BL	–	–	T4-PR1-0	122	F	TP 122	
2	BL	–	–	T4-PR1-30	30	F	TP 30V	
3	BL	–	–	T4-PR1-40	40	F	TP 40V	
4	BL	–	–	T4-PR1-50	50	F	TP 50V	
5	BL	–	–	T4-PR1-55	55	F	TP 55V	
6	BL	–	–	T4-PR1-60	60	F	TP 60V	
7	BL	–	–	T4-PR1-65	65	F	TP 65V	
8	BL	–	–	T4-PR1-70	70	F	TP 70V	
9	BL	–	–	T4-PR1-75	75	F	TP 75V	
10	BL	–	–	T4-PR1-80	80	F	TP 80V	
11	BL	–	–	T4-PR1-85	85	F	TP 85V	
12	BL	–	–	T4-PR1-90	90	F	TP 90V	
13	BL	–	–	T4-PR1-95	95	F	TP 95V	
14	BL	–	–	T4-PR1-100	100	F	TP 100V	
15	BL	–	–	T4-PR1-105	105	F	TP 105V	
16	BL	–	–	T4-PR1-110	110	F	TP 110V	
17	BL	–	–	T4-PR1-115	115	F	TP 115V	
18	BL	–	–	T4-PR1-120	120	F	TP 120V	
19	BL	–	–	T4-PR1-125	125	F	TP 125V	
20	BL	–	–	T4-PR1-130	130	F	TP 130V	
21	BL	–	–	T4-PR1-135	135	F	TP 135V	
22	BL	–	–	T4-PR1-140	140	F	TP 140V	
23	BL	–	–	T4-PR1-145	145	F	TP 145V	
24	BL	–	–	T4-PR1-240	121	F	TP 121	
25	BL	–	–	T4 Sec 1-0	S1	S	T4 TS 1	
26	BL	–	–	T4 Sec 1-32	S2	S	T4 TS 2	
27	BL	–	–	T4 Sec 2-0	S3	S	T4 TS 3	
28	BL	–	–	T4 Sec 2-24	S4	S	T4 TS 4	
29	BL	–	–	T4 Sec 3-0	S5	S	T4 TS 5	
30	BL	–	–	T4 Sec 3-16	S6	S	T4 TS 6	

FILAMENT CONTROL PANEL LOOM (From MT3523 Issue 4 Sheet 1 of 1.)

REF	SITE	COLOUR	IDENT	TAG	REF	SITE	COLOUR	IDENT	TAG
~~10~~	~~R21-1~~	~~Y~~	~~21~~	~~S~~					
11	R21-2	Y	150	S					
~~9~~	~~R22-1~~	~~Y~~	~~22~~	~~S~~					
12	R22-2	Y	125	S					
~~8~~	~~R23-1~~	~~Y~~	~~23~~	~~S~~					
13	R23-2	Y	100	S					
~~7~~	~~R24-1~~	~~Y~~	~~24~~	~~S~~					
14	R24-2	Y	75	S					
~~6~~	~~R25-1~~	~~Y~~	~~25~~	~~S~~					
15	R25-2	Y	50	S					
~~1~~	~~SW4-B3-1~~	~~O~~	~~1~~	~~S~~					
~~2~~	~~SW4-B3-2~~	~~O~~	~~2~~	~~S~~					
~~3~~	~~SW4-B3-3~~	~~O~~	~~3~~	~~S~~					
~~4~~	~~SW4-B3-4~~	~~O~~	~~4~~	~~S~~					
~~5~~	~~SW4-B3-5~~	~~O~~	~~5~~	~~S~~					
~~6~~	~~SW4-B4-1~~	~~Y~~	~~1~~	~~S~~					
~~7~~	~~SW4-B4-2~~	~~Y~~	~~2~~	~~S~~					
~~8~~	~~SW4-B4-3~~	~~Y~~	~~3~~	~~S~~					
~~9~~	~~SW4-B4-4~~	~~Y~~	~~4~~	~~S~~					
~~10~~	~~SW4-B4-5~~	~~Y~~	~~5~~	~~S~~					
~~1~~	~~T3-7~~	~~O~~	~~7~~	~~S~~					
~~2~~	~~T3-10~~	~~O~~	~~10~~	~~S~~					
~~3~~	~~T3-11~~	~~O~~	~~11~~	~~S~~					
~~4~~	~~T3-11~~	~~O~~	~~11~~	~~S~~					
~~5~~	~~T3-11~~	~~O~~	~~11~~	~~S~~					
11	*	Y	150	F					
12	*	Y	125	F					
13	*	Y	100	F					
14	*	Y	75	F					
15	*	Y	50	F					

* Terminated by Test Room.

FILAMENT CONTROL PANEL LOOM (From ML3523 Issue 3 Sheet 1 of 1)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
1	O	1	S	SW4 B3-1	7	S	T3-7	
2	O	2	S	SW4 B3-2	10	S	T3-10	
3	O	3	S	SW4 B3-3	11	S	T3-11	
4	O	4	S	SW4 B3-4	11	S	T3-11	
5	O	5	S	SW4 B3-5	11	S	T3-11	
6	Y	1	S	SW4 B4-1	25	S	R25-1	
7	Y	2	S	SW4 B4-2	24	S	R24-1	
8	Y	3	S	SW4 B4-3	23	S	R23-1	
9	Y	4	S	SW4 B4-4	22	S	R22-1	
10	Y	5	S	SW4 B4-5	21	S	R21-1	
11	Y	150	S	R21-2	150	F	TP 140V	
12	Y	125	S	R22-2	125	F	TP 135V	
13	Y	100	S	R23-2	100	F	TP 130V	
14	Y	75	S	R24-2	75	F	TP 120V	
15	Y	50	S	R25-2	50	F	TP 115V	
16								
17	*	-	S	R21-2	-	S	R21-3	
18	*	-	S	R22-2	-	S	R22-3	
19	*	-	S	R23-2	-	S	R23-3	
20	*	-	S	R24-2	-	S	R24-3	
21	*	-	S	R25-2	-	S	R25-3	

* 22 SWG Tinned Copper, and not part of loom.
(Conductors are 14/0·0076 unless stated otherwise)

INTERCONNECTION CABLE LOOM HEAVY LEADS (From MT 3527 Issue 3 Sheets 1 & 2)

REF	SITE	COLOUR	IDENT	TAG
5	TP-N	BL	N	M5R
14	TP-L	BL	L	M5R
8	TP-P1	BL	P1	M5R
7	TP-P2	BL	P2	M5R
15	TP-SEL	BL	SEL	M5R
16	TP 250V	BK	250V	M5R
30	TP 240V	BL	240V	M5R
17	TP 121	BN	121	F
19	TP 122	R	122	F
20	TP 129	W	129	F
18	TP 50	BK	50	F
13	CO A1	BL	A1	F
12	CO-A2	BL	A2	F
10	CO A3	BL	A3	F
9	CO A4	BL	A4	F
6	CO A5	BL	A5	F
7	CO A6	BL	A6	F
11	SCR-1	BL	SCR-1	
			Cathode	M6R
10	SCR-2	BL	SCR-2	
			Cathode	M6R
12	HSF 1A	BL	A	M5R
11	HSF 1B	BL	B	M5R
9	RM A	BL	RMA	M5R
8	RM B	BL	RMB	M5R
3	SW1-COM	BL	1COM	M5R
1	SW1-COM	BL	1COM	M5R
21	SW1-5	V	27	M5R
29	SW1-7	BL	25	M5R
6	SW2-COM	BL	2COM	M3R
25	T2 TS 2	R	2	S
3	T2 PR1-2	BL	PR2	S
4	T2 PR1-3	BL	PR3	S
31	TP 220V	BL	220V	M5R
30	SW4 B1-4	BL	8	M3R
31	SW4 B1-3	BL	10	M3R
32	R1 POT1-1	BL	1	S
32	R1 POT1-2	BL	2	S
33	R1 POT2-1	BL	1	S
33	R1 POT2-2	BL	2	S

REF	SITE	COLOUR	IDENT	TAG
13	SW4 B1 COM	BL	4COM	M3R
14	MCB-ON	BL	L	M5R
15	MCB-OFF	BL	SEL	M5R
22	R5-1	V	27	S
23	R5-1	V	27	S
24	R5-2	R	2	S
26	R1 POT1-1	BL	1	S
28	R1 POT1-3	BL	3	S
5	R1 POT2-3	BL	3	S
26	R1 POT2 1	BL	1	S
4	R1 POT2-1	BL	1	S
28	R1 POT2-3	BL	3	S
29	R3-1	BL	1	S
2	R3-2	BL	2	S
2	R4-1	BL	1	S
1	R4-2	BL	2	S
25	FS1-A	R	1A	S
19	FS1-B	R	122	S
16	FS2 A	BK	250V	S
17	FS2 B	BN	121	S
18	FS4 B	BK	50	S
23	FS5 A	V	5A	S
20	FS5 B	W	129	S
21	T2 TS1	V	27	S
22	T2 TS1	V	27	S
24	T2 TS2	R	2	S
~~27~~	~~R1 POT1-1~~	~~BL~~	~~2~~	~~S~~
~~27~~	~~R1 POT2-2~~	~~BL~~	~~2~~	~~S~~

INTERCONNECTION CABLE LOOM HEAVY LEADS (From ML 3527 Issue 3 Sheets 1&2)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
1	BL	1COM	M5R	SW1 - COM	2	S	R4 - 2	
2	BL	1	S	R4 - 1	2	S	R3 - 2	
3	BL	1COM	M5R	SW1 - COM	PR2	S	T2-PR1-2	
4	BL	PR3	S	T2-PR1-3	1	S	R1-POT2-1	
5	BL	N	M5R	TP-N	3	S	R1-POT2-3	
6	BL	2COM	M3R	SW2-COM	A5	F	CO-A-5	
7	BL	P2	M5R	TP-P2	A6	F	CO-A-6	
8	BL	P1	M5R	TP-P1	RMB	M5R	RM-B	
9	BL	RM-A	M5R	RM-A	A4	F	CO-A-4	
10	BL	A3	F	CO-A-3	SCR-2	M6R	SCR-2 Cathode	
11	BL	B	M5R	HSF 1-B	SCR-1	M6R	SCR-1 Cathode	
12	BL	A2	F	CO-A-2	A	M5R	HSF 1-A	
13	BL	4COM	M3R	SW4-B1-COM	A1	F	CO-A-1	
14	BL	L	M5R	TP-L	L	M5R	MCB-ON	
15	BL	SEL	M5R	MCB-OFF	SEL	M5R	TP-SEL	
16	BK*	250V	M5R	TP-250V	250V	S	FS 2-A	
17	BN*	121	F	TP-121	121	S	FS 2-B	
18	BK*	50	F	TP-50	50	S	FS 4-B	
19	R *	122	F	TP-122	122	S	FS1-B	
20	W *	129	F	TP-129	129	S	FS 5-B	
21	V *	27	S	T2 TS-1	27	M5R	SW-1-5	
22	V *	27	S	T2 TS -1	27	S	R5-1	
23	V *	5A	S	FS5-A	27	S	R5-1	
24	R *	2	S	T2 TS-2	2	S	R5-2	
25	R *	2	S	T2 TS-2	1A	S	FS1-A	
26	BL	1	S	R1-POT1-1	1	S	R1-POT 2-1	
~~27~~	~~BL~~	~~2~~	~~S~~	~~R1-POT1-2~~	~~2~~	~~S~~	~~R1-POT 2-2~~	
28	BL	3	S	R1-POT1-3	3	S	R1-POT 2-3	
29	BL	25	M5R	SW1-7	1	S	R3-1	
30	BL	240V	M5R	TP-240V	8	M3R	SW4 B1-4	
31	BL	220V	M5R	TP-220V	10	M3R	SW4 B1-3	
32	BL	1	S	R1-POT1-1	2	S	R1-POT1-2	
33	BL	1	S	R1-POT2-1	2	S	R1-POT2-2	

* Conductors are 40/0·0076.
(Conductors are 70/0·0076 unless stated otherwise.)

TIMER AND RELAY CHASSIS LOOM (From MT. 3528 Issue 5 Sheet 1 of 5)

REF	SITE	COLOUR	IDENT	TAG
33	RS - 1	BN		S
43	RS - 5	P		S
31	RS - 9	W		S
32	RS - 9	W		S
57	RS - 13	O	13	S
59	RS - 13	O	13	S
33	EP - 5	BN	5	S
111	EP - 6	BL		S
5	EP - 7	V		S
62	EP - 8	G		S
41	EP - 9	BK	9	S
109	EP - 10	R	10	S
1	EP - 11	G/BN		S
64	EP - 12	G/R		S
74	EP - 13	O	13	S
123	EP - 13	O	13	S
45	EP - 14	Y	14	S
65	EP - 14	BN	14	S
88	PR - 1	BN		S
68	PR - 3	P	3	S
83	PR - 4	R	4	S
87	PR - 5	P		S
6	PR - 6	P	6	S
70	PR - 7	O	7	S
89	PR - 9	W		S
10	PR - 10	BK		S
69	PR - 11	R	11	S
80	PR - 12	BN	12	S
55	PR 13	O	13	S
45	PR 14	Y	14	S
47	PR 14	Y	14	S
112	MC 1	V	1	S
110	MC 2	O	2	S
107	MC 5	R	5	S
106	MC 6	W	6	S
103	MC 9	BK	9	S
102	MC 10	R	10	S
51	MC 13	O	13	S
47	MC 14	Y	14	S
48	MC 14	Y	14	S
18	RX 2	R		S
22	RX 2	R		S
6	RX 5	P		S
7	RX 5	P		S
58	RX 7	V		S
91	RX 8	G		S
8	RX 9	W		S
17	RX 10	BK		S
56	RX 11	G/BN		S
114	RX 12	BK	12	S
50	RX 13	O	13	S
48	RX 14	Y	14	S
49	RX 14	Y	14	S

TIMER AND RELAY CHASSIS LOOM (From MT 3528 Issue 5 Sheet 2 of 5)

REF	SITE	COLOUR	IDENT	TAG
32	SC P1	W	P1	S
25	SC P2	R		S
55	SC1-B	O	1B	S
56	SC1-B	G/BN	1B	S
44	SC1-C	BN	1C	S
42	SM P1	BN	P1	S
34	SM P2	O	P2	S
44	SM 1B	BN	1B	S
59	SM 1C	O	1C	S
60	SM 1C	BL	1C	S
86	FL P1	O	P1	S
121	FL P1	O	P1	S
122	FL P2	G	P2	S
93	FL P2	Y	P2	S
74	FL 1B	O	13	S
57	FL 1C	O	1C	S
58	FL 1C	V	1C	S
24	C1 1	BN	C1	S
25	C1 2	R	C2	S
11	C201 +ve	R		S
16	C201 -ve	BK		S

REF	SITE	COLOUR	IDENT	TAG
19	R215 1	BN		S
21	R215 3	O		S
9	R216 1	BN		S
23	R216 2	R		S
15	R216 3	O		S
51	PB1-A1	O	A1	S
7	Timer 40	P	40	S
8	Timer 39	W	39	S
9	Timer 38	BN	38	S
10	Timer 37	BK	37	S
5	Timer 36	V	36	S
11	Timer 35	R	35	S
12	Timer 34	V	34	S
2	Timer 31	R	31	S
4	Timer 30	Y	30	S
13	Timer 28	O	28	S
3	Timer 27	O	27	S
15	Timer 26	O	26	S
14	Timer 23	G	23	S
16	Timer 22	BK	22	S
17	Timer 19	BK	19	S
19	Timer 17	BN	17	S
27*	Timer 15	R	15	S
26*	Timer 14	Y	14	S
29**	Timer 10	Y	10	S
30**	Timer 9	R	9	S
23	Timer 2	R	2	S
18	Timer 1	R	1	S

* Twisted pair.
** Twisted pair.

TIMER AND RELAY CHASSIS LOOM (From MT 3528 Issue 5 Sheet 3 of 5)

REF	SITE	COLOUR	IDENT	TAG
108	TP Earth	Y/GN		M5R
115	TP Earth	Y/GN		M5R
78	TP P1	BN	P1	M5R
79	TP P2	R	P2	M5R
41	TP 240V	BK	240V	M5R
71	TP 131	V	131	F
98	TP 131	BN	131	F
97	TP 132	R	132	F
124	RX-7	R	7	F
104	TP 105	P	105	F
64	TP 122	G/R	122	F
77	TP 122	G/R	122	F
94	TP 125	P	125	F
113	TP 30V	W	30V	F
92	TP 121	BN	121	F
100	TP 121	BN	121	F
49	TP 130V	Y	130V	F
24	TP 61	BN	61	F
34	TP 63	O	63	F
31	TP 62	W	62	F
89	TP 108	W	108	F
88	Wander TP Lead	BN	FIL	F
26	SCR1-G	Y	1G	F
27	SCR1-C	R	1C	F
29	SCR2-G	Y	2G	F
30	SCR2-C	R	2C	F
13	RM NO	O	NO	M2 5R
12	RM NC	V	NC	M2 5R
14	RM 'A'	G	COM	M2 5R
61	SM-1C	G	SM	S
62	CO A-B	G	AB	F
63	EP-8	G		S
61	CO B-A	G	BA	F
63	CO B-B	G	BB	F
75	CO B-1	P	B1	F
50	CO B-2	O	B2	F
121	CO B-4	O	B4	F
122	CO B-3	G	B3	F
124	CO B-5	R	B5	F
123	CO B-6	O	B6	F
~~72~~	~~TP 130~~	~~BK~~	~~130~~	~~F~~

REF	SITE	COLOUR	IDENT	TAG
120	R2 1	BN		S
116	R2 2	G	2	S
117	SW 2 COM	W	COM	M3R
120	R20-A	BN	A	M2 5R
43	R20-B	P	B	M2 5R
102	M1 +ve	R		M3R
103	M1 -ve	BK		M3R
104	CC 1-5	P		CS
106	CC 1-9	W		CS
~~72~~	~~CO A-8~~	~~BK~~	~~A8~~	~~F~~

TIMER AND RELAY CHASSIS LOOM (From MT 3528 Issue 5 Sheet 4 of 5)

REF	SITE	COLOUR	IDENT	TAG
107	CC2-2	R		CS
108	CC2-3	Y/GN	3	CS
76	CC3-2	R		CS
60	CC3-6	BL		CS
81	CC3-7	V		CS
73	CC3-10	BK		CS
80	CC4-1	BN		CS
82	CC4-4	Y		CS
101	CC4-5	P		CS
84	CC4-8	G		CS
85	CC4-9	W		CS
69	CC5-2	R		CS
70	CC5-3	O		CS
71	CC5-7	V		CS
96	CC5-10	BK		CS
65	CC6-1	BN		CS
68	CC6-5	P		CS
66	CC6-8	G		CS
67	CC6-9	W		CS
109	CC7-2	R		CS
110	CC7-3	O		CS
111	CC7-6	BL		CS
112	CC7-7	V		CS
113	CC7-9	W		CS
114	CC7-10	BK		CS
119	FS3 - A	BK	3A	S
42	FS3 - B	BN	SF	S

REF	SITE	COLOUR	IDENT	TAG
1	T4 S1	G/BN	S1	S
66	T4 S1	G	S1	S
2	T4 S2	R		S
67	T4 S2	W	S2	S
3	T4 S2	O		S
4	T4 S4	Y		S
84	T4 S5	G	S5	S
85	T4 S6	W	S6	S
87	T3-1	P	1	S
117	T3-9	W	9	S
116	T3-8	G	8	S
82	T3-13	Y	13	S
92	CR1-Pin1	BN	1	CS
91	CR1-Pin3	G	3	CS
83	SW4-B2 -COM	R	COM	S
86	SW4-B3 -COM	O	COM	S
93	SW4-B4 -COM	Y	COM	S
119	SW4-B1-5	BK	6	M5R
101	SW 5-B1 -COM	P	1COM	S
22	SW 5-B2 -COM	R	2COM	S
81	SW 5-B1-22	V	22	S
21	SW 5-B2-23	O	23	S
79	N1 P2	R	N1	S
78	N1 P1	BN	N1	S
76	N2 Red	R	N2	S

TIMER AND RELAY CHASSIS LOOM (From MT 3528 Issue 5 Sheet 5 of 5)

REF	SITE	COLOUR	IDENT	TAG
77	N2 122	G/R	N2	S
94	PB1-A1	P	A1	S
96	PB1-A2	BK	A2	S
95	PB1-A3	Y	A3	S
118	kV Lamp Outer	Y/GN	L	S
99	Prep.SW 1 -C.	BN	C	S
73	Prep.SW 1 -N/C	BK	NC	S
97	Prep.SW 1 -N/C	R	NC	S
98	Ex.SW 3	BN	3	S
100	Ex.SW 4	BN	4	S
99	Ex.SW 4	BN	4	S
115	Top Panel Earth 1	Y/GN		M5R
118	Top Panel Earth 1	Y/GN		M5R
125	RX-12	G/R	12	S
125	EP-12	G/R	12	S
126	COA-A	G	A	F
126	SM-1C	G	SM	S
127	CC3-3	O		CS
127	TP-121	O	121	F
128	CC6-4	Y		CS
128	RS-14	Y	14	S
129	Meter LP-A	G	VA	S
129	kV Lamp -B	G	kV	S
130	TP121	BN	121	F
131	TP122	R	122	F
132	TP51LV/ HS	BN	51LVHS	F
133	TP131	BN	131	F
134	TP132	R	132	F

REF	SITE	COLOUR	IDENT	TAG
130	T1010 0V	BN	0V	S
131	T1010 250V	R	250V	S
132	LVTB51	BN	51	F
133	LVTB131	BN	131	F
134	LVTB132	R	132	F

TIMER AND RELAY CHASSIS LOOM (From ML3528 Issue 5 Sheet 1 of 5)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
1	G/BN	S1	S	T4 - S1	-	S	EP-11	
2	R		S	T4 - S2	31	S	TIMER 31	
3	O		S	T4-S3	27	S	TIMER 27	
4	Y		S	T4-S4	30	S	TIMER 30	
5	V		S	EP-7	36	S	TIMER 36	
6	P	6	S	PR-6		S	RX-5	
7	P		S	RX-5	40	S	TIMER 40	
8	W		S	RX-9	39	S	TIMER 39	
9	BN		S	R216-1	38	S	TIMER 38	
10	BK		S	PR-10	37	S	TIMER 37	
11	R		S	C201+ve	35	S	TIMER 35	
12	V	NC	M2-5R	RM NC	34	S	TIMER 34	
13	O	NO	M2-5R	RM NO	28	S	TIMER 28	
14	G	COM	M2-5R	RM A	23	S	TIMER 23	
15	O		S	R216-3	26	S	TIMER 26	
16	BK		S	C201-ve	22	S	TIMER 22	
17	BK		S	RX10	19	S	TIMER 19	
18	R		S	RX 2	1	S	TIMER 1	
19	BN		S	R215-1	17	S	TIMER 17	
20								
21	O		S	R215-3	23	S	SW5 B2-23	
22	R		S	RX-2	2COM	S	SW5 B2-COM	
23	R		S	R216-2	2	S	TIMER-2	
24	BN	61	F	TP 61	1	S	C1-1	
25	R		S	SC P2	2	S	C1-2	
26	Y	1G	F	SCR1-G	14	S	TIMER 14	Twisted Pair
27	R	1C	F	SCR1-C	15	S	TIMER 15	Twisted Pair

(Conductors are 14/0·0076 unless stated otherwise.)

TIMER AND RELAY CHASSIS LOOM (From ML3528 Issue 5 Sheet 2 of 5)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
29	Y	2G	F	SCR2-G	10	S	TIMER 10)	Twisted Pair
30	R	2C	F	SCR2-C	9	S	TIMER 9)	
31	W		S	RS-9	62	F	TP - 62	
32	W		S	RS-9	P1	S	SC P1	
33	BN		S	RS-1	5	S	EP-5	
34	O	63	F	TP 63	P2	S	SM P2	
35								
36								
37								
38								
39								
40								
41	BK	240V	M5R	TP 240V	9	S	EP-9	
42	BN	SF	S	FS3-B	P1	S	SM P1	
43	P		S	RS-5	B	M2-5R	R20-B	
44	BN	1C	S	SC-1-C	1B	S	Sm1-B	
45	Y	14	S	EP-14	14	S	PR-14	
46								
47	Y	14	S	PR-14	14	S	MC-14	
48	Y	14	S	RX-14	14	S	MC-14	
49	Y	130V	F	TP 130V	14	S	RX-14	
50	O	13	S	RX-13	B2	F	CO B2	
51	O	13	S	MC-13	A1	S	PB1-A1	
52	Y	132	F	TP 132	A2	S	PB1-A2	
53								
54								
55	O	13	S	PR-13	1B	S	SC1-B	
56	G/BN		S	RX-11	1B	S	SC1-B	

(Conductors are 14/0·0076 unless otherwise.)

TIMER AND RELAY CHASSIS LOOM (From ML 3528 Issue 5 Sheet 3 of 5)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
57	O	13	S	RS13	1C	S	FL 1-C	
58	V	1C	S	FL 1C		S	RX - 7	
59	O	13	S	RS-13	1C	S	SM 1-C	
60	BL	1C	S	SM-1-C		CS	CC3-6	
61	G	BA	F	CO-B-A	SM	S	SM-1-C	
62	G		S	EP 8	AB	F	CO A-B	
63	G	BB	F	CO-B-B		S	EP-8	
64	G/R	122	F	TP 122		S	EP-12	
65	BN		CS	CC6-1	14	S	EP-14	
66	G		CS	CC6-8	S1	S	T4 S1	
67	W		CS	CC6-9	S2	S	T4 S2	
68	P		CS	CC6-5	3	S	PR-3	
69	R		CS	CC5-2	11	S	PR-11	
70	O		CS	CC5-3	7	S	PR-7	
71	V		CS	CC5-7	131	F	TP 131	
~~72~~	~~BK~~	~~130~~	~~F~~	~~TP130~~	~~A8~~	~~F~~	~~CO A-8~~	
73	BK		CS	CC3-10	NC	S	PREP.Sw.1 N/C	
74	O	1B	S	FL1-B	13	S	EP 13	
75	P	125	F	TP 125	B1	F	CO B1	
76	R		CS	CC3-2	N2	S	N2 Red	
77	G/R	122	F	TP-122	N2	S	N2 122	
78	BN	P1	M5R	TP P1	N1	S	N1 P1	
79	R	P2	M5R	TP P2	N1	S	N1 P2	
80	BN		CS	CC4-1	12	S	PR-12	
81	V		CS	CC3-7	22	S	SW5 B1-22	
82	Y		CS	CC4-4	13	S	T3 13	
83	R	COM	S	SW4 B2-COM	4	S	PR4	
84	G		CS	CC4-8	S5	S	T4 S5	

(Conductors are 14/0·0076 unless stated otherwise)

TIMER AND RELAY CHASSIS LOOM (From ML 3528 Issue 5 Sheet 4 of 5)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
85	W		CS	CC 4-9	S6	S	T4-S6	
86	O	COM	S	SW4 B3 COM	P1	S	FL P1	
87	P		S	PR 5	1	S	T3 1	
88	BN		S	PR 1	FIL	F	TP Wander Lead	
89	W		S	PR 9	108	F	TP-108	
90								
91	G		S	RX-8	3	CS	CR1 Pin 3	
92	BN	121	F	TP 121	1	CS	CR1 Pin 1	
93	Y	COM	S	SW4 B4 COM	P2	CS	FL P2	
94	P	125	F	TP 125	A1	S	PB2-A1	
95	Y	124	F	TP 124	A3	S	PB2-A3	
96	BK		CS	CC5-10	A2	S	PB2-A2	
97	R	132	F	TP 132	NC	S	Prep.Sw.1 N/C	
98	BN	131	F	TP 131	3	S	Ex.Sw.3	
99	BN	C	S	Prep.Sw.1C	4	S	Ex.Sw.4	
100	BN	121	F	TP 121	4	S	Ex.Sw.4	
101	P		CS	CC4-5	1COM	S	Sw5 B1 COM	
102	R		M3R	M1+ve	10	S	MC10	
103	BK		"	M1-ve	9	S	MC9	
104	P	105	F	TP 105	-	CS	CC1-5	
105								
106	W		CS	CC1-9	6	S	MC6	
107	R		CS	CC2-2	5	S	MC5	
108	Y/GN	3	CS	CC2-3		M5R	TP EARTH	
109	R		CS	CC7-2	10	S	EP 10	
110	O		CS	CC7-3	2	S	MC 2	
111	BL		CS	CC7-6		S	EP 6	
112	V		CS	CC7-7	1	S	MC 1	

(Conductors are 14/0·0076 unless stated otherwise.)

TIMER AND RELAY CHASSIS LOOM (From ML3528 Issue 5 Sheet 5 of 5)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
113	W		CS	CC7-9	30V	F	TP 30V	
114	BK		CS	CC7-10	12	S	RX 12	
115	Y/GN*		M5R	Top Panel Earth Point 1		M5R	TP EARTH	
116	G	2	S	R2-2	8	S	T3-8	
117	W	COM	M3R	SW2-COM	9	S	T3-9	
118	Y/GN	L	S	kV.Lamp Outer		M5R	Top Panel Earth Point 1	
119	BK	3A	S	FS3-A	6	M5R	SW4-B1-5	
120	BN		S	R2-1	A	M2-5R	R20-A	
121	O	P1	S	FL-P1	B4	F	CO-B4	
122	G	P2	S	FL-P2	B3	F	CO-B3	
123	O	13	S	EP-13	B6	F	CO-B6	
124	R	7	S	RX-7	B5	F	CO-B5	
125	G/R	12	S	RX-12	12	S	EP-12	
126	G	A	F	COA-A	SM	S	SM-1C	
127	O		CS	CC3-3	121	F	TP-121	
128	Y		CS	CC6-4	14	S	RS-14	
129	G	VA	S	Meter Lamp A	kV	S	kV.Lamp B	
130	BN	121	F	TP121	0V	S	T1010 0V	
131	R	122	F	TP122	250V	S	T1010 250V	
132	BN	121	F	TP121	51	F	LVTB 51	
133	BN	131	F	TP131	131	F	LVTB 131	
134	R	132	F	TP132	132	F	LVTB 132	

* Conductor is 40/0·0076.
(Conductors are 14/0·0076 unless stated otherwise.)

T3 SELF LEADS (From ML 3249 Issue 1 Sheet 1 of 1)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
1	R	-	-	T3 Sec 1	-	S	T3 T/S 1	
2	O	-	-	T3 Sec 1	-	S	T3 T/S 2	
3	Y	-	-	T3 Sec 1	-	S	T3 T/S 3	
4	P	-	-	T3 Sec 1	-	S	T3 T/S 4	
5	BL	-	-	T3 Sec 1	-	S	T3 T/S 5	
6	V	-	-	T3 Sec 1	-	S	T3 T/S 6	
7	G	-	-	T3 Sec 1	-	S	T3 T/S 7	
8	BN	-	-	T3 PR1	-	S	T3 T/S 8	
9	BK	-	-	T3 PR1	-	S	T3 T/S 9	
10	W	-	-	T3 Sec 1	-	S	T3 T/S 10	
11	G/BN	-	-	T3 Sec 1	-	S	T3 T/S 11	
12	R	-	-	T3 Sec 2	13	S	T3 T/S 13	
13	O	-	-	T3 Sec 2	1	S	SW4-B2-1	
14	Y	-	-	T3 Sec 2	2	S	SW4-B2-2	
15	P	-	-	T3 Sec 2	3	S	SW4-B2-3	
16	BL	-	-	T3 Sec 2	4	S	SW4-B2-4	
17	V	-	-	T3 Sec 2	5	S	SW4-B2-5	
18	G	-	-	T3 Sec 2	6	S	SW4-B2-6	

INTER-SWITCH HEAVY LEAD LOOM (From ML 3529 Issue 1 Sheet 1 of 1)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
1	BL	31	M5R	SW1-1	31	M3R	SW2-15	
2	BL	23	M5R	SW1-9	23	M3R	SW2-12	
3	BL	21	M5R	SW1-11	21	M3R	SW2-11	
4	BL	19	M5R	SW1-13	19	M3R	SW2-10	
5	BL	18	M5R	SW1-14	18	M3R	SW2-9	
6	BL	28	M5R	SW1-4	28	M3R	SW2-14	
7	BL	25	M5R	SW1-7	25	M3R	SW2-13	

(Conductors are 70/0·0076 unless stated otherwise.)

mA and TIMER LAMP LOOM (From MT 3546 Issue 1 Sheet 1 of 1)

REF	SITE	COLOUR	IDENT	TAG	REF	SITE	COLOUR	IDENT	TAG
1	Time - A Outer	Y/GN	-	S	23	Time A Centre	G	TA	S
1	MA1 - A Outer	Y/GN	-	S	15	Time B Centre	G	TB	S
2	MA1 - A Outer	Y/GN	-	S	23	Time B Centre	G	TB	S
2	MA2 - A Outer	Y/GN	-	S	24	MA1 - A Centre	G	1A	S
3	MA2 - A Outer	Y/GN	-	S	25	MA2 - A Centre	G	2A	S
3	MA3 - A Outer	Y/GN	-	S	26	MA3 - A Centre	G	3A	S
4	MA3 - A Outer	Y/GN	-	S	27	MA4 - A Centre	G	4A	S
4	MA4 - A Outer	Y/GN	-	S	28	MA5 - A Centre	G	5A	S
5	MA4 - A Outer	Y/GN	-	S	17	MA1 - B Centre	G	1B	S
5	MA5 - A Outer	Y/GN	-	S	24	MA1 - B Centre	G	1B	S
12	MA5 - A Outer	Y/GN	-	S	18	MA2 - B Centre	G	2B	S
6	Time B Outer	Y/GN	-	S	25	MA2 - B Centre	G	2B	S
13	Time B Outer	Y/GN	-	S	19	MA3 - B Centre	G	3B	S
6	MA1 - B Outer	Y/GN	-	S	26	MA3 - B Centre	G	3B	S
7	MA1 - B Outer	Y/GN	-	S	20	MA4 - B Centre	G	4B	S
7	MA2 - B Outer	Y/GN	-	S	27	MA4 - B Centre	G	4B	S
8	MA2 - B Outer	Y/GN	-	S	21	MA5 - B Centre	G	5B	S
8	MA3 - B Outer	Y/GN	-	S	28	MA5 - B Centre	G	5B	S
9	MA3 - B Outer	Y/GN	-	S	22	Meter Lamp Centre	G	M	S
9	MA4 - B Outer	Y/GN	-	S	22	Time B	G	2	S
10	MA4 - B Outer	Y/GN	-	S	15	SW4 - B8 COM	G	COM	S
10	MA5 - B Outer	Y/GN	-	S	17	SW4 - B8 1	G	1	S
12	MA5 - B Outer	Y/GN	-	S	18	SW4 - B8 2	G	2	S
13	Chassis Earth 2	Y/GN	-	M5R	19	SW4 - B8 3	G	3	S
14	Chassis Earth 2	Y/GN	-	M5R	20	SW4 - B8 4	G	4	S
14	Meter Lamp Outer	Y/GN	-	S	21	SW4 - B8 5	G	5	S

"A" Lamps on L.H. side of panel viewed from front.
"B" Lamps on R.H. side.

(1699/2/1074)

mA AND TIMER LAMP LOOM (From ML 3546 Issue 1 Sheet 1 of 1)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
1	Y/GN	-	S	TIME A-E		S	mA-1 A-E	
2	Y/GN	-	S	mA-1 A-E		S	mA-2 A-E	
3	Y/GN	-	S	mA-2 A-E		S	mA-3 A-E	
4	Y/GN	-	S	mA-3 A-E		S	mA-4 A-E	
5	Y/GN	-	S	mA-4 A-E		S	mA-5 A-E	
6	Y/GN	-	S	TIME B-E		S	mA-1 B-E	
7	Y/GN	-	S	mA-1 B-E		S	mA-2 B-E	
8	Y/GN	-	S	mA-2 B-E		S	mA-3 B-E	
9	Y/GN	-	S	mA-3 B-E		S	mA-4 B-E	
10	Y/GN	-	S	mA-4 B-E		S	mA-5 B-E	
11								
12	Y/GN	-	S	mA-5 A-E		S	mA-5 B-E	
13	Y/GN	-	S	TIME B-E		M5R	Chassis Earth 2	
14	Y/GN	-	S	Meter Lamp E		M5R	Chassis Earth 2	
15	G	COM	S	SW4-B8-COM	TB	S	TIME B	
16								
17	G	1	S	SW4-B8-1	1B	S	mA-1 B	
18	G	2	S	SW4-B8-2	2B	S	mA-2 B	
19	G	3	S	SW4-B8-3	3B	S	mA-3 B	
20	G	4	S	SW4-B8-4	4B	S	mA-4 B	
21	G	5	S	SW4-B8-5	5B	S	mA-5 B	
22	G	M	S	Meter Lamp A	2	S	TIME B	
23	G	TA	S	TIME A	TB	S	TIME B	
24	G	1A	S	mA-1 A	1B	S	mA-1 B	
25	G	2A	S	mA-2 A	2B	S	mA-2 B	
26	G	3A	S	mA-3 A	3B	S	mA-3 B	
27	G	4A	S	mA-4 A	4B	S	mA-4 B	
28	G	5A	S	mA-5 A	5B	S	mA-5 B	

(Conductors are 14/0·0076 unless stated otherwise)

RADIOGRAPHY SWITCH LOOM (From MT 3557 Issue 1 Sheet 1 of 1)

REF	SITE	COLOUR	IDENT	TAG	REF	SITE	COLOUR	IDENT	TAG
1	Sw4 B3-1	O	1	S					
2	Sw4 B3-2	O	2	S					
3	Sw4 B3-3	O	3	S					
4	Sw4 B3-4	O	4	S					
5	Sw4 B3-5	O	5	S					
6	Sw4 B4-1	Y	1	S					
7	Sw4 B4-2	Y	2	S					
8	Sw4 B4-3	Y	3	S					
9	Sw4 B4-4	Y	4	S					
10	Sw4 B4-5	Y	5	S					
1	T3 - 7	O	7	S					
2	T3 - 10	O	10	S					
3	T3 - 11	O	11	S					
4	T3 - 11	O	11	S					
5	T3 - 11	O	11	S					
6	R25 - 1	Y	25	S					
7	R24 - 1	Y	24	S					
8	R23 - 1	Y	23	S					
9	R22 - 1	Y	22	S					
10	R21 - 1	Y	21	S					

RADIOGRAPHY SWITCH LOOM (From ML3557 Issue 1 Sheet 1 of 1)

REF	COLOUR	START IDENT	START TAG	START	FINISH IDENT	FINISH TAG	FINISH	REMARKS
1	O	1	S	SW4 B3-1	7	S	T3- 7	
2	O	2	S	SW4 B3-2	10	S	T3-10	
3	O	3	S	SW4 B3-3	11	S	T3-11	
4	O	4	S	SW4 B3-4	11	S	T3-11	
5	O	5	S	SW4 B3-5	11	S	T3-11	
6	Y	1	S	SW4 B4-1	25	S	R25-1	
7	Y	2	S	SW4 B4-2	24	S	R24-1	
8	Y	3	S	SW4 B4-3	23	S	R23-1	
9	Y	4	S	SW4 B4-4	22	S	R22-1	
10	Y	5	S	SW4 B4-5	21	S	R21-1	

(Conductors are 14/0·0076 unless stated otherwise.)

T1 SELF LEADS (From MT3622 Issue 2 Sheet 1 of 1.)

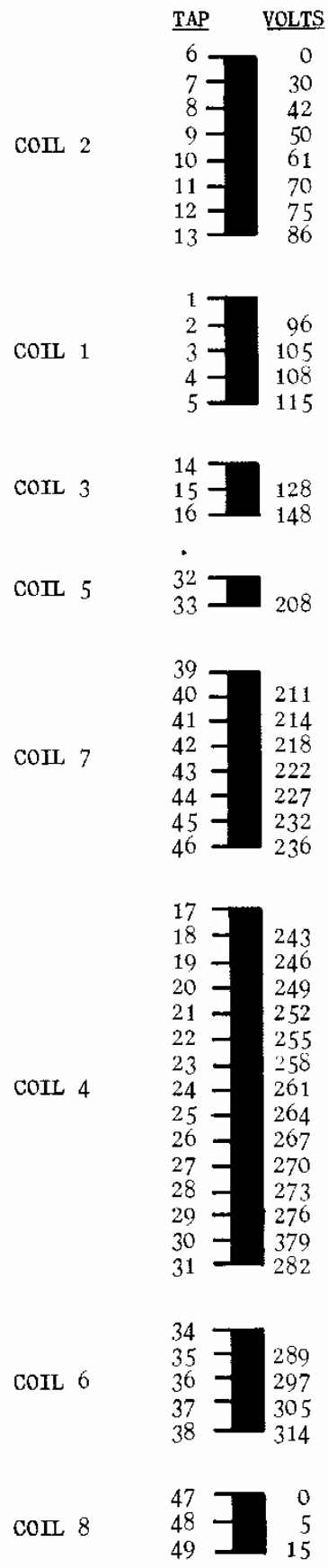
REF	SITE	COLOUR	IDENT	TAG	REF	SITE	COLOUR	IDENT	TAG
7	TP 250V	BL	7	M5R					
8	TP 240V	BL	8	M5R					
9	TP 230V	BL	9	M5R					
10	TP 220V	BL	10	M5R					
11	TP 210V	BL	11	M5R					
47	TP EARTH	BK	47	M5R					
12	T1 T/SA	BL	12	M3R					
2	T1 T/SB	BL	2	M3R					
3	T1 T/SC	BL	3	M3R					
4	T1 T/SD	BL	4	M3R					
15	T1 T/SE	BL	15	M3R					
16	R2 - 1	BL	16	S					
32	R2 - 2	BL	32	S					
48	Meter								
	Lamp A	BK	48	S					
49	FS4 A	BK	49	S					
30	SW1-2	BL	30	M5R					
29	SW1-3	BL	29	M5R					
27	SW1-5	BL	27	M5R					
26	SW1-6	BL	26	M5R					
25	SW1-7	BL	25	M5R					
24	SW1-8	BL	24	M5R					
22	SW1-10	BL	22	M5R					
20	SW1-12	BL	20	M5R					
33	SW2-1	BL	33	M3R					
39	SW2-1	BL	39	M3R					
40	SW2-2	BL	40	M3R					
41	SW2-3	BL	41	M3R					
42	SW2-4	BL	42	M3R					
43	SW2-5	BL	43	M3R					
44	SW2-6	BL	44	M3R					
45	SW2-7	BL	45	M3R					
46	SW2-8	BL	46	M3R					
17	SW2-8	BL	17	M3R					
18	SW2-9	BL	18	M3R					
19	SW2-10	BL	19	M3R					
21	SW2-11	BL	21	M3R					
23	SW2-12	BL	23	M3R					
28	SW2-14	BL	28	M3R					
31	SW2-15	BL	31	M3R					
34	SW2-15	BL	34	M3R					
35	SW2-16	BL	35	M3R					
36	SW2-17	BL	36	M3R					
37	SW2-18	BL	37	M3R					
38	SW2-19	BL	38	M3R					
6	SW4-B1-5	BL	6	M3R					
1	SW4-B1-2	BL	1	M3R					
13	SW4-B1-2	BL	13	M3R					
5	SW4-B1-1	BL	5	M3R					
14	SW4-B1-1	BL	14	M3R					

38. TRANSFORMER SPECIFICATIONS.

This section contains extracts from the full specifications in the references quoted.

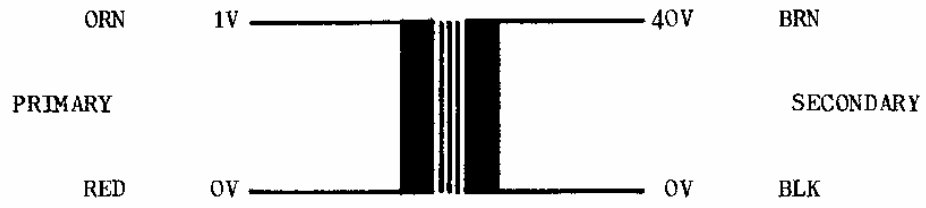
Transformer		From Spec	Page
T1	Main Autotransformer	M100	116
T2	Auxiliary Stabilisation Transformer	M102	117
T3	kW-mA Transformer	M103	117
T4	Auxiliary Autotransformer	M101	118

TRANSFORMER T1
(From Spec M100)



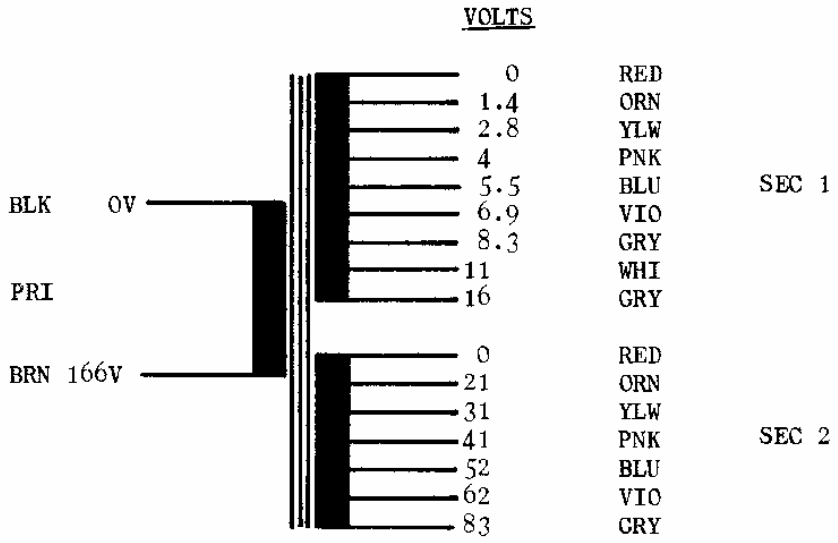
1699/2/1074)

TRANSFORMER T2 (From Spec M102)



No-load current 40mA.

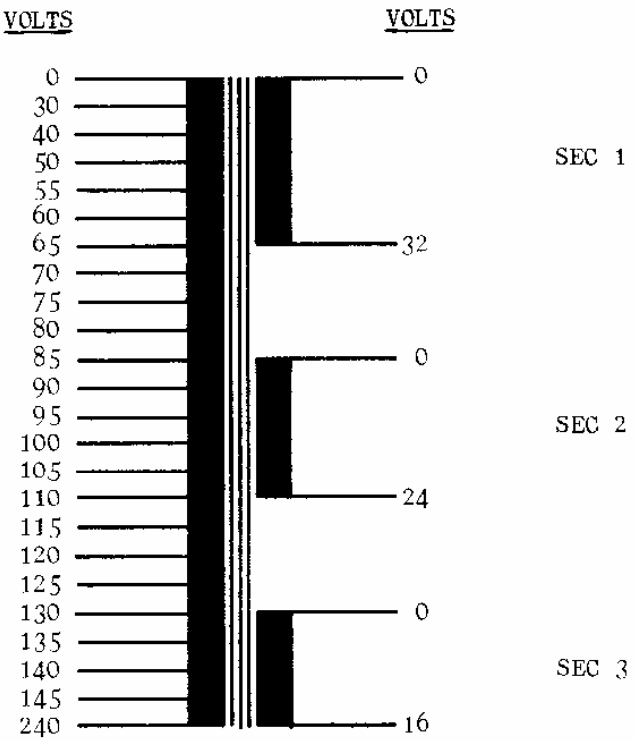
TRANSFORMER T3 . (from Spec M103)



No-load current 10mA.

TRANSFORMER T4

(From Spec M101)



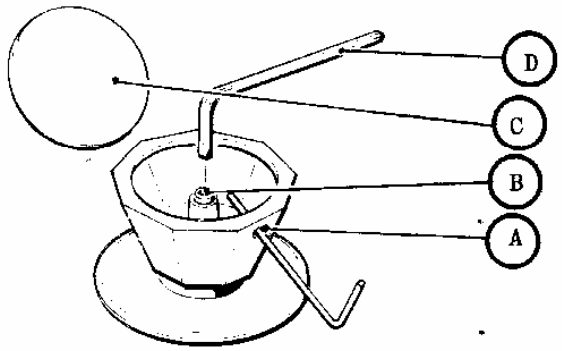
No-load Current 20mA

39 REMOVING and REPLACING CONTROL KNOBS

Large Control Knobs

Insert a thin tool, such as an Allen key, through the holes (A) in the side of the knob, and push off the trim disc (C).

Use a suitable Allen key (D) to loosen the Allen screw (B) that clamps the collet.



Remove the knob from its shaft by pressing on the head of Allen screw (B) while pulling on the knob as illustrated below.

If the knob cannot be removed as described, maintain the pull on the knob while gently tapping the head of the Allen screw (B) with a mallet.

DO NOT attempt to prise off the knob, or the front panel will be damaged.

(Continued Overleaf)

Small Control Knob

To remove the small control knob loosen the central screw that clamps the collet, and pull off the knob.

Replacing the Control Knobs

Before replacing a control knob see that the collet clamping screw is loose.

Slide the knob onto its shaft.

Fully tighten the collet clamping screw, ensuring that the knob clears the front panel.

For a large control knob replace the trim disc.

40. INDEX FOR REPLACEMENT COMPONENTS LIST

Circuit No Extract from MD 3612 Apparatus MX4 Series 2 MOBILE

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		CAPACITORS		
C1	X190-011	Motor Starter Capacitor 25µF S-8850/1 (TCC)		
C 2	X121-301	Electrolytic Capacitor 50µF 25V (RS)		
C 3				
C 4	121-301	Electrolytic Capacitor 50µF 25V (RS)		
C 5	X121-301	Electrolytic Capacitor 50µF 25V (RS)		
C 6	X131-001	Capacitor 0.1µF Tol 20% 250V (ITT)		
C 7	X190-060	Electrolytic Capacitor 2µF 500V (RS)		
C 8	X190-040	Electrolytic Capacitor 500µF 50V (RS)		
C 9	X121-302	Electrolytic Capacitor 100µF 25V (RS)		
C 20	X131-112	Capacitor 0.047µF Tol 20% 250V C280 (Mullard)		
C 21	X131-112	Capacitor 0.047µF Tol 20% 250V C280 (Mullard)		
C 201	X121-310	Electrolytic Capacitor 1000µF 50V (RS)		
C 202	X131-005	Capacitor 0.47µF Tol 20% 250V MPT 1 (ITT)		
C 203	X131-005	Capacitor 0.47µF Tol 20% 250V MPT 1 (ITT)		
C 204	X131-003	Capacitor 0.22µF Tol 20% 250V MPT1 (ITT)		
C 205	X131-011	Capacitor 4.7µF Tol 10% 250V MPT1 (ITT)		
C 206	X131-112	Capacitor 0.047µF Tol 20% 250V C280 (Mullard)		
C 1020	X121-317	Capacitor 470µF 25V (RS)		On Low-Voltage Panel

Circuit No Extract from MD 3612 Apparatus MX4 Series 2 MOBILE

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		DIODES and RECTIFIERS		
D 1	X318-028	Zener Diode BZY95-C20 (Mullard)		
D 2	X318-023	Zener Diode BZY95-C12 (Mullard)		
D 3	X316-003	Silicon Diode BYX36-600 (Mullard)		
D 4	X314-004	Rectifier Diode OA202 (Mullard)		
D 5	X318-030	Zener Diode BZY95-C24 (Mullard)		
D 6	X316-003	Silicon Diode BYX36-600 (Mullard)		
D 201	X318-028	Zener Diode BZY95-C20 (Mullard)		
D 202	X318-015	Zener Diode BZY96-C5V6 (Mullard)		
D 203	X314-004	Rectifier Diode OA202 (Mullard)		
D 204	X314-004	Rectifier Diode OA202 (Mullard)		
D 1011	X315-025	Silicon Bridge Rectifier REC70 (RS)		On Low-Voltage Panel
MR 1	X314-027	Encapsulated Bridge Rectifier OSH01-400 (Mullard)		
MR 2	X314-027	Encapsulated Bridge Rectifier OSH01-400 (Mullard)		
MR 3	X314-027	Encapsulated Bridge Rectifier OSH01-400 (Mullard)		
MR 4	X314-027	Encapsulated Bridge Rectifier OSH01-400 (Mullard)		
MR 5	X314-027	Encapsulated Bridge Rectifier OSH01-400 (Mullard)		
MR 201	X314-026	Encapsulated Bridge Rectifier OSH01-200 (Mullard)		
MR 202	X314-026	Encapsulated Bridge Rectifier OSH01-200 (Mullard)		

Circuit No Extract from MD 3612 Apparatus MX4 Series 2 MOBILE

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		FUSES		
FS 1	X572-005	5 Amp Fuse F-130 (Bulgin)		
FS 2	X572-005	5 Amp Fuse F-130 (Bulgin)		
FS 3	X572-005	5 Amp Fuse F-130 (Bulgin)		
FS 4	X572-001	10 Amp Fuse F-36 (Bulgin)		
FS 5	X572-005	5 Amp Fuse F-130 (Bulgin)		
HSF 1	X570-909	High Speed Fuse Link E1000/55 (Int. Rect)		
		TRANSISTORS		
Q 1	X332-002	Transistor BFY 51 (Mullard)		
Q 2	X332-010	Transistor BC 109 (Mullard)		
Q 3	X332-014	Transistor BFX 30 (Mullard)		
Q 4	X332-016	Transistor BC 107 (Mullard)		
Q 5	X332-016	Transistor BC 107 (Mullard)		
Q 6	X332-016	Transistor BC 107 (Mullard)		
Q 201	X332-002	Transistor BFY 51 (Mullard)		
Q 202	X332-014	Transistor BFX 30 (Mullard)		
Q 203	X332-010	Transistor BC 109 (Mullard)		
Q 204	X333-002	Unijunction Transistor 2N2160 (Int.Rect)		
Q 205	X332-002	Transistor BFY 51 (Mullard)		

(1699/2/1074)

Circuit No Extract from MD 3612 Apparatus MX4 Series 2 MOBILE

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		RESISTORS		
R 1	X211-405	Rotary Potentiometer D/G 1RO 50w L.50 (Berco)		
R 2	X290-010	Resistor R709 One tapping band RAH/KO (Berco)		
R 3	X290-020	Power Resistor Section 17R5 (RS)		
R 4	X290-020	Power Resistor Section 17R5 (RS)		
R 5	X290-011	Resistor 26R1 One tapping band RAH/KO (Berco)		
R 6				
R 7				
R 8				
R 9	X242-422	Carbon Resistor 68R ± 10% Type 8 (Erie)		
R 10				
R 11				
R 12	X290-018	Resistor 66RO ± 2% Supplied with V/M (E. Turner)		
R 13	X290-017	Resistor 98RO ± 2% Supplied with V/M (E. Turner)		
R 14	X290-016	Resistor 13K1 ± 2% Supplied with V/M (E. Turner)		
R 15	X242-456	Carbon Resistor 1K8 ± 10% Type 8 (Erie)		
R 16	X212-410	Rotary Potentiometer 1KO ± 10% 3w CLR901C (Colvern)		
R 17	X242-404	Carbon Resistor 1K5 ± 10% Type 8 (Erie)		
R 18	X242-421	Carbon Resistor 2K2 ± 10% Type 8 (Erie)		
R 19	X252-015	Resistor 30R ± 5% 5w (RS)		
R 20	X290-039	Resistor 15R ± 10% RAU/K1 (Berco)		

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		RESISTORS - Cont'd -		
R 21	X212-310	Potentiometer 20R 3w CLR4001/9S (Colvern)		
R 22	X212-310	Potentiometer 20R 3w CLR4001/9S (Colvern)		
R 23	X212-310	Potentiometer 20R 3w CLR4001/9S (Colvern)		
R 24	X212-310	Potentiometer 20R 3w CLR4001/9S (Colvern)		
R 25	X212-310	Potentiometer 20R 3w CLR4001/9S (Colvern)		
R 41	X244-155	Metox Resistor 16K2 ± 2% MR5 (Welwyn)		
R 42	X244-155	Metox Resistor 16K2 ± 2% MR5 (Welwyn)		
R 43	X244-155	Metox Resistor 16K2 ± 2% MR5 (Welwyn)		
R 44	X244-155	Metox Resistor 16K2 ± 2% MR5 (Welwyn)		
R 45	X244-155	Metox Resistor 16K2 ± 2% MR5 (Welwyn)		
R 46	X244-170	Metox Resistor 33K2 ± 2% MR5 (Welwyn)		
R 47	X244-170	Metox Resistor 33K2 ± 2% MR5 (Welwyn)		
R 48	X244-189	Metox Resistor 82K5 ± 2% MR5 (Welwyn)		
R 49	X244-189	Metox Resistor 82K5 ± 2% MR5 (Welwyn)		
R 50	X244-189	Metox Resistor 82K5 ± 2% MR5 (Welwyn)		
R 51	X244-189	Metox Resistor 82K5 ± 2% MR5 (Welwyn)		
R 52	X244-203	Metox Resistor 162K ± 2% MR5 (Welwyn)		
R 53	X244-203	Metox Resistor 162K ± 2% MR5 (Welwyn)		
R 54	X244-203	Metox Resistor 162K ± 2% MR5 (Welwyn)		
R 55	X244-218	Metox Resistor 332K ± 2% MR5 (Welwyn)		
R 56	X244-218	Metox Resistor 332K ± 2% MR5 (Welwyn)		
R 57	X244-237	Metox Resistor 825K ± 2% MR5 (Welwyn)		

Circuit No Extract from MD 3612 Apparatus MX4 Series 2 MOBILE

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		RESISTORS - Cont'd -		
R 58	X244-237	Metox Resistor 825K ± 2% MR5 (Welwyn)		
R 59	X244-237	Metox Resistor 825K ± 2% MR5 (Welwyn)		
R 60	X244-114	Metox Resistor 2K26 ± 2% MR5 (Welwyn)		
R 61	X231-152	Resistor 20R ± 10% 3w W21 (Welwyn)		
R 62	X231-153	Resistor 150R ± 10% 3w W21 (Welwyn)		
R 63	X231-143	Resistor 7R5 ± 10% 3w W21 (Welwyn)		
R 64	X242-455	Carbon Resistor 3K3 ± 10% Type 8 (Erie)		
R 65	X242-406	Carbon Resistor 1K0 ± 10% Type 8 (Erie)		
R 66	X242-457	Carbon Resistor 820R ± 10% Type 8 (Erie)		
R 67	X242-455	Carbon Resistor 3K3 ± 10% Type 8 (Erie)		
R 68	X242-410	Carbon Resistor 10K ± 10% Type 8 (Erie)		
R 69	X212-405	Rotary Potentiometer 25K ± 10% 3w CLR901C (Colvern)		
R 70	X252-014	Resistor 250R ± 5% 5w (RS)		
R 71	X231-153	Resistor 150R ± 10% 3w W21 (Welwyn)		
R 72	X242-428	Carbon Resistor 1K2 ± 10% Type 8 (Erie)		
R 73	X242-407	Carbon Resistor 390R ± 10% Type 8 (Erie)		
R 74	X242-421	Carbon Resistor 2K2 ± 10% Type 8 (Erie)		
R 75	X242-410	Carbon Resistor 10K ± 10% Type 8 (Erie)		
R 76	X242-428	Carbon Resistor 1K2 ± 10% Type 8 (Erie)		
R 77	X242-428	Carbon Resistor 1K2 ± 10% Type 8 (Erie)		
R 78	X242-409	Carbon Resistor 22K ± 10% Type 8 (Erie)		
R 79	X212-409	Rotary Potentiometer 10K ± 10% 3w CLR901C (Colvern)		
R 80	X242-455	Carbon Resistor 3K3 ± 10% Type 8 (Erie)		

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		RESISTORS - Cont'd -		
R 81	X212-405	Rotary Potentiometer 25K ± 10% 3w CLR901C (Colvern)		
R 82	X242-455	Carbon Resistor 3K3 ± 10% Type 8 (Erie)		
R 106	X244-112	Metox Resistor 2K05 ± 2% MR5 (Welwyn)		
R 107	X244-112	Metox Resistor 2K05 ± 2% MR5 (Welwyn)		
R 108	X244-105	Metox Resistor 1K47 ± 2% MR5 (Welwyn)		
R 109	X244-105	Metox Resistor 1K47 ± 2% MR5 (Welwyn)		
R 110	X244-103	Metox Resistor 1K33 ± 2% MR5 (Welwyn)		
R 111	X244-114	Metox Resistor 2K26 ± 2% MR5 (Welwyn)		
R 112	X244-112	Metox Resistor 2K05 ± 2% MR5 (Welwyn)		
R 113	X244-127	Metox Resistor 4K22 ± 2% MR5 (Welwyn)		
R 114	X244-120	Metox Resistor 3K01 ± 2% MR5 (Welwyn)		
R 115	X244-120	Metox Resistor 3K01 ± 2% MR5 (Welwyn)		
R 116	X244-151	Metox Resistor 13K3 ± 2% MR5 (Welwyn)		
R 117	X244-123	Metox Resistor 3K48 ± 2% MR5 (Welwyn)		
R 118	X244-131	Metox Resistor 5K11 ± 2% MR5 (Welwyn)		
R 119	X244-118	Metox Resistor 2K74 ± 2% MR5 (Welwyn)		
R 120	X244-120	Metox Resistor 3K01 ± 2% MR5 (Welwyn)		
R 121	X244-118	Metox Resistor 2K74 ± 2% MR5 (Welwyn)		
R 122	X244-148	Metox Resistor 11K5 ± 2% MR5 (Welwyn)		
R 123	X244-131	Metox Resistor 5K11 ± 2% MR5 (Welwyn)		
R 124	X244-131	Metox Resistor 5K11 ± 2% MR5 (Welwyn)		
R 125	X244-191	Metox Resistor 90K9 ± 2% MR5 (Welwyn)		

Circuit No Extract from MD 3612 Apparatus MX4 Series 2 MOBILE

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		RESISTORS - Cont'd -		
R 201	X231-102	Resistor 220R ± 10% 3w W21 (Welwyn)		
R 202	X242-451	Carbon Resistor 180K ± 10% Type 8 (Erie)		
R 203	X242-430	Carbon Resistor 33K ± 10% Type 8 (Erie)		
R 204	X242-455	Carbon Resistor 3K3 ± 10% Type 8 (Erie)		
R 205	X242-421	Carbon Resistor 2K2 ± 10% Type 8 (Erie)		
R 206	X242-457	Carbon Resistor 820R ± 10% Type 8 (Erie)		
R 207	X242-428	Carbon Resistor 1K2 ± 10% Type 8 (Erie)		
R 208	X242-468	Carbon Resistor 5K6 ± 10% Type 8 (Erie)		
R 209	X242-433	Carbon Resistor 47R ± 10% Type 8 (Erie)		
R 210	X242-433	Carbon Resistor 47R ± 10% Type 8 (Erie)		
R 211	X242-453	Carbon Resistor 20R ± 10% Type 8 (Erie)		
R 212	X242-402	Carbon Resistor 470R ± 10% Type 8 (Erie)		
R 213	X242-444	Carbon Resistor 8K2 ± 10% Type 8 (Erie)		
R 214	X242-410	Carbon Resistor 10K ± 10% Type 8 (Erie)		
R 215	X212-405	Rotary Potentiometer 25K ± 10% 3w CLR901C (Colvern)		
R 216	X212-401	Rotary Potentiometer 25R ± 10% 3w CLR901C (Colvern)		
R 217	X242-431	Carbon Resistor 10R ± 10% Type 8 (Erie)		
R 218	X242-401	Carbon Resistor 47K ± 10% Type 8 (Erie)		

Circuit No Extract from MD 3612 Apparatus MX4 Series 2 MOBILE

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		RELAYS		
CO A	X510-944	Contactor 200-250V Coil. Type E3250 (Simmonds and Robinson)		
CO B	X510-944	Contactor 200-250V Coil. Type E3250 (Simmonds and Robinson)		
DD	X510-226	Relay Type PC4/T21/4CA-185 OHMS (Perivale)		
EP	X510-945	Plug-in relay 115V Coil. Type KHU-17A11 (Potter and Brumfield)		
FL	X511-137	Relay Type 590 TS21395 (Mag. Dev.)		
MC	X510-945	Plug-in relay 115V Coil. Type KHU-17A11 (Potter and Brumfield)		
OR	X510-226	Relay Type PC4/T21/4CA - 185 OHMS (Perivale)		
PR	X510-945	Plug-in relay 115V Coil. Type KHU-17A11 (Potter and Brumfield)		
RL1055	X510-226	Relay Type PC4/T21/4CA-185 OHMS(Perivale)		On Low-Voltage Panel
RL1056	X510-226	Relay Type PC4/T21/4CA-185 OHMS(Perivale)		On Low-Voltage Panel
RM	X510-930	Phase Sensitive Current Relay (Elliott Bros.)		
RS	X510-945	Plug-in Relay 115V Coil. Type KHU-17A11 (Potter and Brumfield)		
RX	X510-945	Plug-in Relay 115V Coil. Type KHU-17A11 (Potter and Brumfield)		
SC	X511-120	Relay Type 590 TS 7711 (Mag. Dev.)		
SM	X511-121	Relay Type TS7712 (Mag. Dev.)		

(1699/2/1074)

Circuit No Extract from MD 3612 Apparatus MX4 Series 2 MOBILE

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		THYRISTORS		
SCR 1	X314-037	Thyristor CR230-703A (AEI)		
SCR 2	X314-037	Thyristor CR230-70A (AEI)		
		TRANSFORMERS		
T 1	MC3025	Auto-transformer (factory)		
T 2	MB3029	Aux. Stabilisation transformer (factory)		
T 3	MB3033	kW-mA transformer (factory)		
T 4	MB3027	Aux. Auto-transformer (factory)		
T 202	X339-006	Thyristor trigger circuit transformer WF3811 (Mullard)		
T1010	X630-154	12V Miniature Mains Transformer (RS)		On Low-Voltage Panel
		SWITCHES		
S 1	X541-019	Rotary Switch 18 Position Model 6107A(Berco)		
S 2	X541-018	Rotary Switch 24 Position Model 6108A(Berco)		
S 4a	X541-020	Rotary Switch 12 Position Model 6106A(Berco)		
S 4b	X545-023	Rotary Switch 12 Position Type DH (NSF)		
S 5	X545-025	Rotary Switch 24 Position Type G (NSF)		

Circuit No Extract from MD 3612 Apparatus MX4 Series 2 MOBILE

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		SWITCHES - Cont'd -		
M.Imp	X560-138	Push-Button switch, Single Pole, Type 514-800 (Crouzet)		
PB1-2	X560-151	Push-button switch, 2-way TDMA (Forder Graham)		
EX	X560-115	Push button switch, Single Pole, Type 602-100 (Crouzet)		
PR 1	X552-301	Sub-Miniature Microswitch, 11-SM-1-T (Honeywell)		
PR 2	X552-301	Sub-Miniature Microswitch, 11-SM-1-T (Honeywell)		
		CIRCUIT BREAKER		
MCB	X510-324	Circuit Breaker, 40 Amp Type C50/40 (Crabtree)		
		INDICATORS		
N 1	X350-929	Neon Indicator, Red, with Resistor SL59 (Arcolectric)		
N 2	X350-930	Neon Indicator, Amber, with Resistor SL59 (Arcolectric)		
		VOLTMETER		
V/M	X610-238	Voltmeter 1mA FSD Model 642 (E. Turner)		

(1699/2/1074)

Circuit No Extract from MD3612 Apparatus MX4 Series 2 MOBILE

Symbol	Stock No	Description of Component	Circuit Zone	Remarks
		MISCELLANEOUS		
	X351-112	MES Lamp 6.3V 0.115A OS-76 (Osram)		
	X450-218	MES Lampholder (RS)		
	MA3059	Control knob assembly		
	X930-312	Knob N260 (Berco)		Set Ω

41. CHANGING THE COUNTERBALANCE CABLE

The counterbalance cable stock No is CS1812.

The springs of the counterbalance unit are likely to be damaged by such things as the counterbalance cable breaking, or the spring drum being turned backwards. If damage has occurred the complete unit MUST be replaced (see page 140). NO ATTEMPT should be made to replace a broken spring because the process is dangerous. The stock No of the unit is HS1127.

1. Unplug the brake connector from the carriage, and unlace the leads so that the head can be taken away from the crossarm.

   If the counterbalance cable is intact, tie down the crossarm, using strong rope and rag, as shown in Fig 56.

   If the cable has broken the safety brake will have locked on. Be very careful if the brake has to be released, as the carriage will then fall unless restrained.

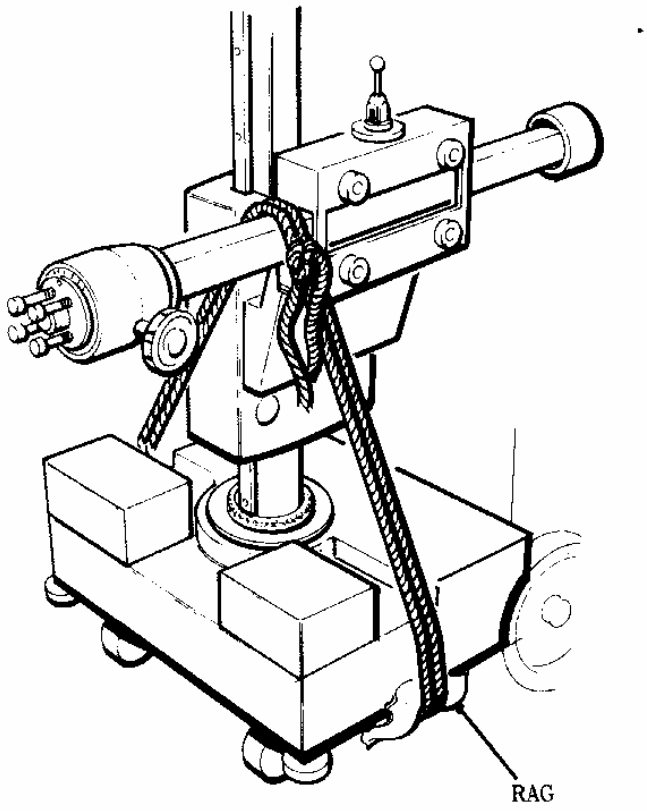


Fig 56 Tie Down the Crossarm (Shown without head)

Detach the head and gimbal from the crossarm. The method of fixing is shown in Fig 57.

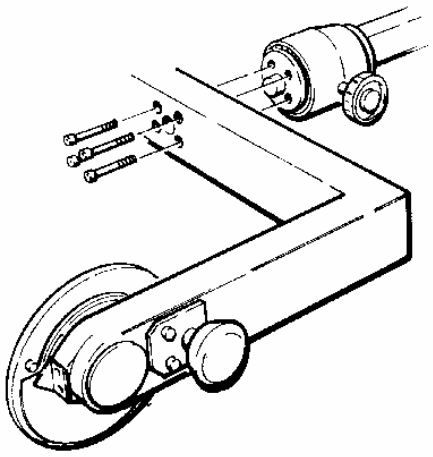


Fig 57. 4 Allen Screws Clamp Gimbal to Crossarm Boss. (Head omitted for clarity).

Hold down the crossarm, release rope, and allow the crossarm to rise SLOWLY to the top of the column.

(If the cable has broken this will not happen. See corresponding note on page 134).

Arrange a support, such as a strong wooden box, about 18" high on to which the column can be lowered so as to rest as shown in Fig 58.

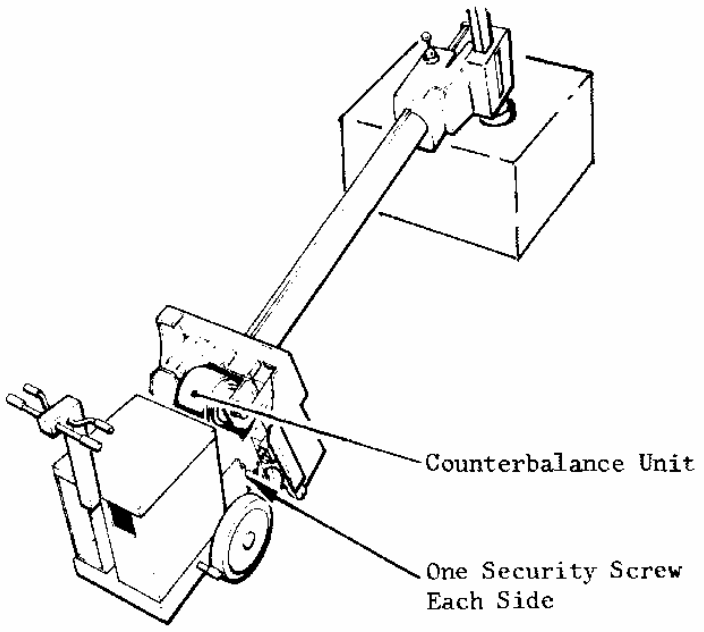


Fig 58 Column Lowered (Shown without control unit)

Chock the large wheels to prevent the base moving while the column is being lowered.

Undo the two security screws, and carefully lower the column onto the support (Fig 58).

2. If the counterbalance cable is intact, the counterbalance unit (Fig 59) must now be unwound so that the cable is JUST slack. The number of turns made must be counted (usually 28 to 30) so that the unit can be reset for the original cable tension.

(If the cable has broken the counterbalance unit springs will have unwound, and the unit must be replaced as described in section 7, page 140).

Undo the screw securing the pawl of the counterbalance unit, (F) in Fig 59, so that the pawl is free to move.

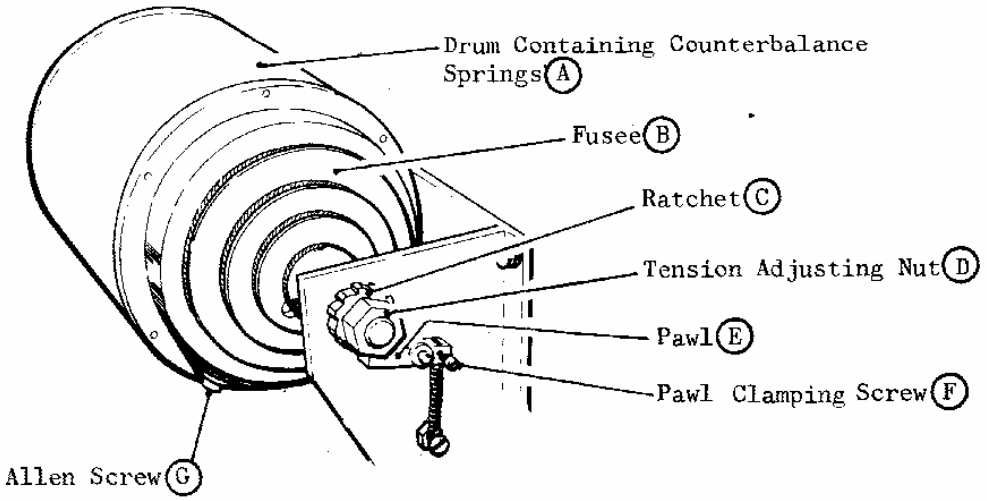


Fig 59 Counterbalance Unit.

Place a well-fitting spanner on the tension adjusting nut (D) and turn it slightly to take the load off the pawl (E). The ratchet (C) can now be "slipped" by keeping the pawl away from the teeth while allowing the springs in (A) to unwind under control of the spanner.

When the spanner has moved to a limit, re-engage the pawl (E) so the spanner can be safely removed from the nut.

Replace the spanner on the nut (D) and keep repeating the above procedure for "slipping" the ratchet until the cable is JUST slack, noting the amount the drum (A) rotates in the process.

NEVER turn the spring drum backwards, or the springs can become detached from the arbor.

If the old cable is intact attach its end to the end of the new cable, and use it later to draw the new cable through the column.

3. The pulley assembly must now be detached from the column (see fig 60).

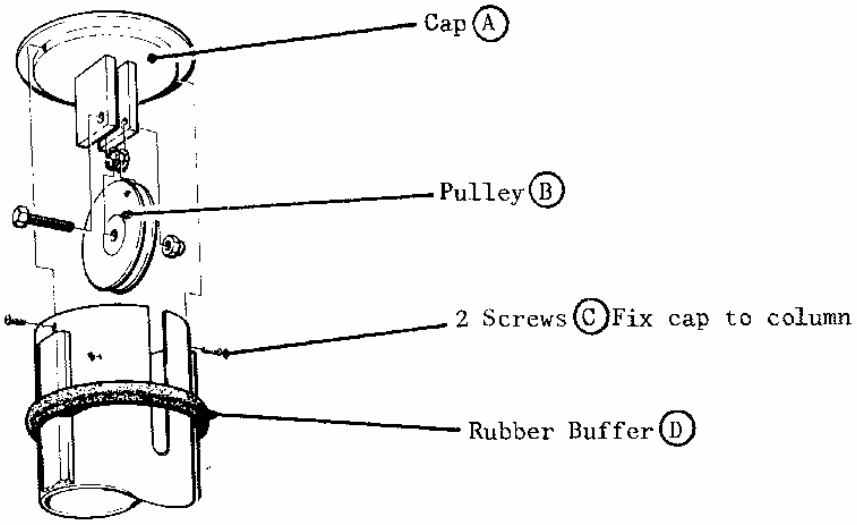


Fig 60 Pulley Assembly.

Move the carriage several inches down the column.

Pull the rubber buffer (D) down the column to uncover the two screws (C), and remove the screws.

Extract the pulley assembly from the column.

The old cable can now be taken from the column and over the pulley (B), and is now only attached to the safety brake in the carriage.

4.

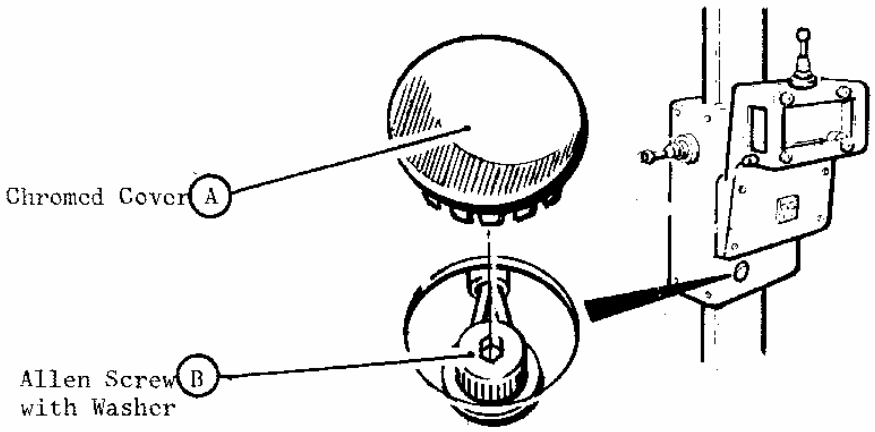


Fig 61 Connection of Counterbalance Cable to Safety Brake

Carefully prise off the cover (A), Fig 61.

Undo the Allen screw (B), and remove it and its washer.

Withdraw the cable from the carriage.

If the crossarm has to be removed from the carriage use the installation instruction, Section 4 page 10, for guidance.

If the carriage has to be removed from the column it must be taken STRAIGHT off. Correspondingly when replacing it feed it STRAIGHT on.

Fitting the new cable is mainly the reverse of removing the old cable.*

With the cable over the pulley (B) (Fig 60) refit the pulley assembly to the column. Replace and fully tighten the screws (C). Slide the rubber buffer (D) back up to the cap (A).

If the carriage was removed, refit it.
If the crossarm was removed, refit it.

Position the carriage end of the new cable (see Fig 61) using a tool such as a piece of stiff wire. Replace the Allen screw (B) and its washer.

5. Lay, or wind, the new cable into the groove of the fusee (B) (Fig 59), being careful not to tighten or loosen the counterbalance springs, and secure the cable end with the Allen screw and washer (G).

*Some replacement cables have an "adjustor" fitted, and a ferrule about half-way along the cable.

Fit this type of cable with only the end of the adjustor screw through the slot in the counterbalance unit. The rest of the adjustor (and the ferrule) will therefore be in the column.

The adjustor nuts should be tight against each other, but in normal use the adjostor is only retained in the slot by its own weight. The adjustor does not require further action.

Using the spanner on nut (D) JUST take up the slack in the cable, than wind up the counterbalance spring drum (A) by the same number of turns as it was unwound.

Lock the pawl (E) by turning the screw (F) so that it projects through the hole provided in the side plate of the counterbalance unit.

6. Release the Safety brake (Fig 6) by inserting the Allen key into the Allen screw (B) , and moving the safety brake towards the top of the column using the Allen key as a lever.

Carefully raise the column into its correct position. Replace and fully tighten the security screws (Fig 3).

Tie down the crossarm to a convenient working level for replacing the head and gimbal as described in Section 5 page 10.

Replace the chromed cover - (A) in Fig 6.

Fit the head and gimbal as described in Section 6, page 12. Remove the rope.

Anything that was altered to give freedom of head movement should now be restored.

The counterbalancing of the head should now be checked. It should be good above the middle of the column (the most used part), with no tendency to fall. A slight rise is permitted with the carriage below the middle position. Add or remove crossarm counterweights (Part No XA 315145) to achieve correct counterbalancing. See Section 4, page 10.

If counterbalance unit was changed proceed to Section 8, page 140.

If the counterbalance unit was not changed proceed to Section 9, page 140.

7. To replace the counterbalance unit remove the counterbalance cable from the fusee as described above.

Disconnect and remove the control unit. Lift up the other part of the base so that the underneath of the base is visible as in Fig 62.

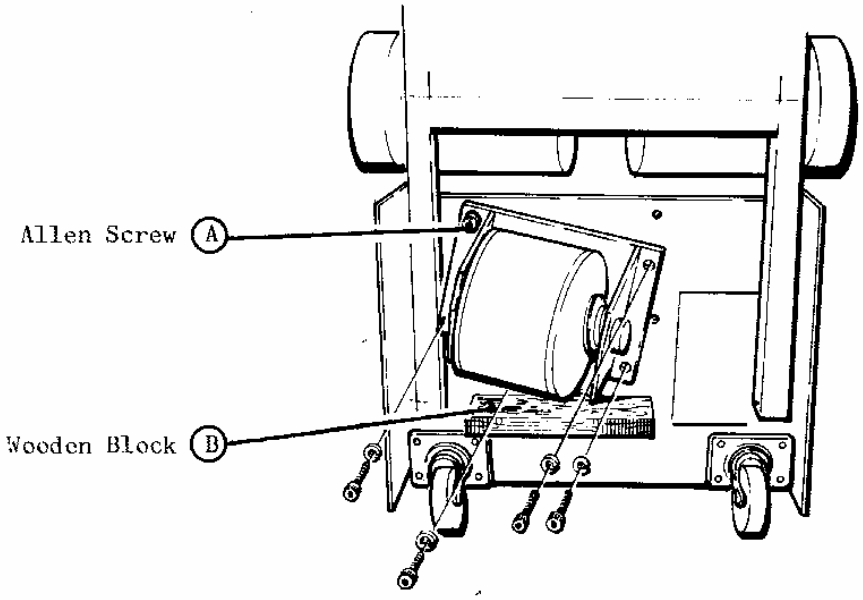


Fig 62 Underside of Mobile Base Showing Counterbalance Unit.

Replace the two security screws.

Place a block of wood on which the counterbalance unit can rest as shown at (B) in Fig 62.

Loosen the Allen screw (A) , and remove the other four as shown. The unit can then rest on the wooden block.

Remove the Allen screw (A) , and take the counterbalance unit from the mobile base.

Fit the new counterbalance unit using the reverse of the procedure described above for removing the old unit.

Proceed with Section 3, page 4.

8. If the counterbalance unit was changed, replace the control unit on the base. Reconnect the control unit as described in the installation instruction, starting at Section 10, page 20. Then proceed to Section 9 below.

9. If the racebar on which the safety brake operates has been damaged, clean it up with a fine file.

Make sure that all the functions of the mobile unit operate properly.

42. CHECKING THE TUBEHEAD.

Faulty tubeheads must be returned to the factory for repair. Because a tubehead can only be checked from the outside it is tempting to believe that the tubehead is faulty when the fault is elsewhere.

To help prevent tubeheads from being returned for repair unnecessarily the following list is provided. In this list it is assumed that the tubehead is faulty, and the fault, and a test for it, are described under a heading of the reported fault.

No Exposure

(i) If the filament circuit of the X-ray tube is incomplete relay PR is energised in prepare, but relay FL is not. There will be 30V RMS between head terminals 108 and 121 on standby, and this voltage will rise to the preset radiographic value for prepare. If this voltage is present, alternative proofs of an incomplete filament circuit are (a) "boosted" current through head terminals 108 and 121 is much lower than 290mA for 50mA setting, or (b) filament not glowing.
CAUTION-PREVENT "EXPOSE" WHEN VIEWING FILAMENT.

(ii) If the stator circuit is broken relay RS is energised in prepare, but relay SM and/or relay SC not energised. Also (after the 1 second boost) there will be about 40V RMS between head terminals 63 and 62, and between 63 and 61, but no anode rotation will be heard. (Stator runs with 0.44A through terminal 61, and 1.7A through 62).

Another check is to measure the stator resistance, which is 80Ω between head terminals 61 and 62.

High mA

(i) If the tube insert is gassy the tube HT current will be higher than the selected value, even though the HT voltage and the filament supply are correct.

(ii) If the HT rectifiers contain a short circuit the symptoms will correspond to (i) above, and "thin films" will result.

Low kV.

If there are shorted turns in the HT transformer the kV will be lower than the selected value. Although the mA value will be near the selected value and P1-P2 voltage might be slightly low, the proof is a large increase in HT transformer primary current. For settings of 45kV and 50mA the normal primary current will be about 30A RMS, with 80V RMS between P1 and P2.

The fault described should not be ignored, because it might give worse trouble later.

Unusual Head Sounds

(i) Hisses or "Cracks".

If electrical breakdown is taking place in the head, hisses or cracks will be heard coming from the head. The mA meter might flick when a "crack" is heard.

Contamination of the tubehead oil by dirt or air bubbles will cause breakdown. To check the presence of air bubbles, see section below "Leaks in Tubehead (ii)".

(ii) Slow Anode Run-up, Normal Slowing Down.

If there are shorted turns in the stator winding the anode will be heard to run-up slowly during prepare, and will not reach full speed. The stator voltage will be low during boost due to excessive voltage drop across R20 (5A). On returning to stand-by the anode slows down normally.

(iii) Slow Anode Run-up, Rapid Slowing Down.

If the anode bearing is stiff the anode will be heard to run-up slowly during prepare, and will not reach full speed. On returning to stand-by the anode will slow down rapidly under the braking influence of the stiff bearing.

Leaks in the Tubehead.

(i) If the tubehead is imperfectly sealed the oil will leak out, and might even drip from the tubehead. Look for oil on the seams at the ends of the tubehead, and around the X-ray port. The leak will allow air to enter the tubehead, and might give effects as (ii) below.

(ii) If the tubehead has air in its oil the insulation of the oil will be reduced, and electrical breakdown might take place. It should be possible to see the air bubbles by looking into the tubehead through the window. To do this uncover the window by removing the Demarcator, etc. Turn the tubehead so that the window is on top, and is just the highest part of the tubehead. Slight rocking of the tubehead will help bring any bubbles into sight at the rim of the window.

See section above "Unusual Head Sounds (i)" for symptoms of air in the oil.

No mA on Meter, but Exposure Correct

If the HT transformer spark gap becomes short-circuited the mA meter is bypassed, and shows zero mA. Disconnect lead from head terminal 105, and connect an AC current meter between head terminal leads 105 and E. Meter should normally read 55mA RMS for 50mA setting.

Consider carefully resetting spark gap to value shown in Fig 9, page 15.

MX4 MOBILE

Series 2

SUPPLEMENT SECTION

KEEPING YOUR MANUAL UP TO DATE

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

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

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

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

CONTENTS OF SUPPLEMENT SECTION

SUPPLEMENT No 1511/Oct 73
(Issue 3)
to Instruction Nos 1062/866,
931/1166
and 1699/1073

MX4 Series 2

MOTOR DRIVEN MOBILE UNITS

Serial Letters XS

Installation and Service Notes for Motor Drive

1. General Information

Attached are drawings, Dia Inst 2964 showing complete wiring arrangement of the motor drive components, and Dia Inst 2965 showing Schematic Circuits of the transformer/charger panel and the contactor panel.

Dia Inst 3313 illustrates the connection of the two parts of the base on installation work.

A circuit of the mains supply and brakes for the vertical column and crossarm, Dia Inst 2559, is attached.

An extract, page 5A and 5B, from the Operating Instruction No 930 is provided for reference purposes.

An explanation of the function of the motor drive circuit is given below and the associated schematic circuit Dia Inst 2826, with parts list, is attached.

The transformer/charger panel is in the side of the control stand and the contactor panel under the base. See inset, top right hand corner of Dia Inst 2964.

The batteries are delivered dry-charged and must be treated in accordance with the manufacturer's instructions, (supplied with the batteries) before they are fitted into the mobile base. General information on battery charging is given in the supplement to the operating instructions, pages 5A and 5B attached.

Note that, if a battery terminal is accidentally earthed to the frame of the mobile base, the control circuit is by-passed and the unit can run away in some circumstances.

A copy of this supplement, No 1511/Oct 73, must be fitted to the front of Installation Instruction No 1062/866, and Service Instruction No 931/1166, for series 1 MX4 controls, and into the Service Section of Instruction No 1699 for the MX4 Series 2 controls. Discard previous issues of Supplement No 1511.

2. Circuit Functions Refer to Dia Inst 2826.

When the X-ray unit is not required, the mains supply lead should be connected to a live socket and the key switch set to OFF.

With the keyswitch set to OFF, contact KS1 is closed, and KS2 is open, as shown in Dia Inst 2826. With no supply on L and N (that is - mains OFF) and RC1 contact closed, no current flows through RC relay because the circuit is blocked by diode D3.

Battery voltage appears across terminal 15(+) and 26(-). As soon as the mains supply is switched ON, the batteries start to charge and voltage across terminals 15 and 26 rises slightly. The voltage continues to rise as the batteries are charged.

Voltdrop across R1, due to charging current, causes L1 to light.

When the voltage across the battery reaches 29·5V, relay RC operates; contacts RC1 open and charging current ceases. Off-load voltage across terminals 12 and 15 rises slightly and holds RC in the operated position until the mains supply is switched off.

The batteries will run down over approximately a five week period, even though the unit is not used, and will not be recharged until the mains supply is broken and reconnected, or switched OFF and ON at the mains supply.

3. Adjustment

Ensure that the MX4 control unit is switched OFF.

Switch OFF and disconnect unit from mains supply. Ensure that the mains supply plug is not earthed or short circuited. (Because, when adjustments are made, the plug will be LIVE).

Remove the winding handle and covers from the side of the stand.

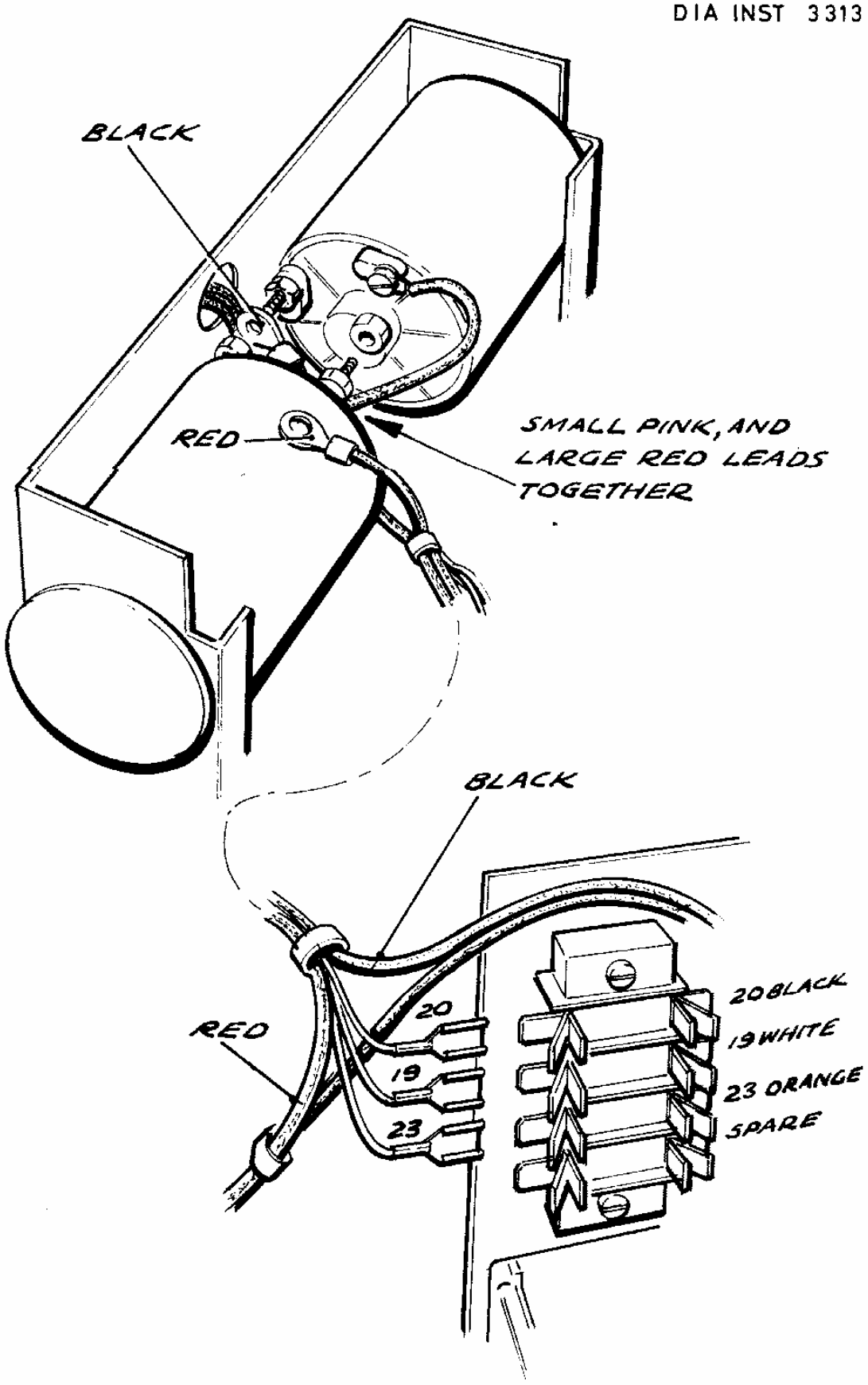
Remove 1A and 5A fuses from the transformer/charger panel.

Connect a Variac or other variable supply to the primary of transformer W6 (see Dia Inst 2826).

Starting at low input to W6, increase voltage from the Variac; Relay RC should operate at 29·5V. If necessary, adjust P1 and re-check operation of relay on rising voltage. Voltage can be checked at terminals 15(+) and 12(-).

Refit fuses and check that charging current flows.

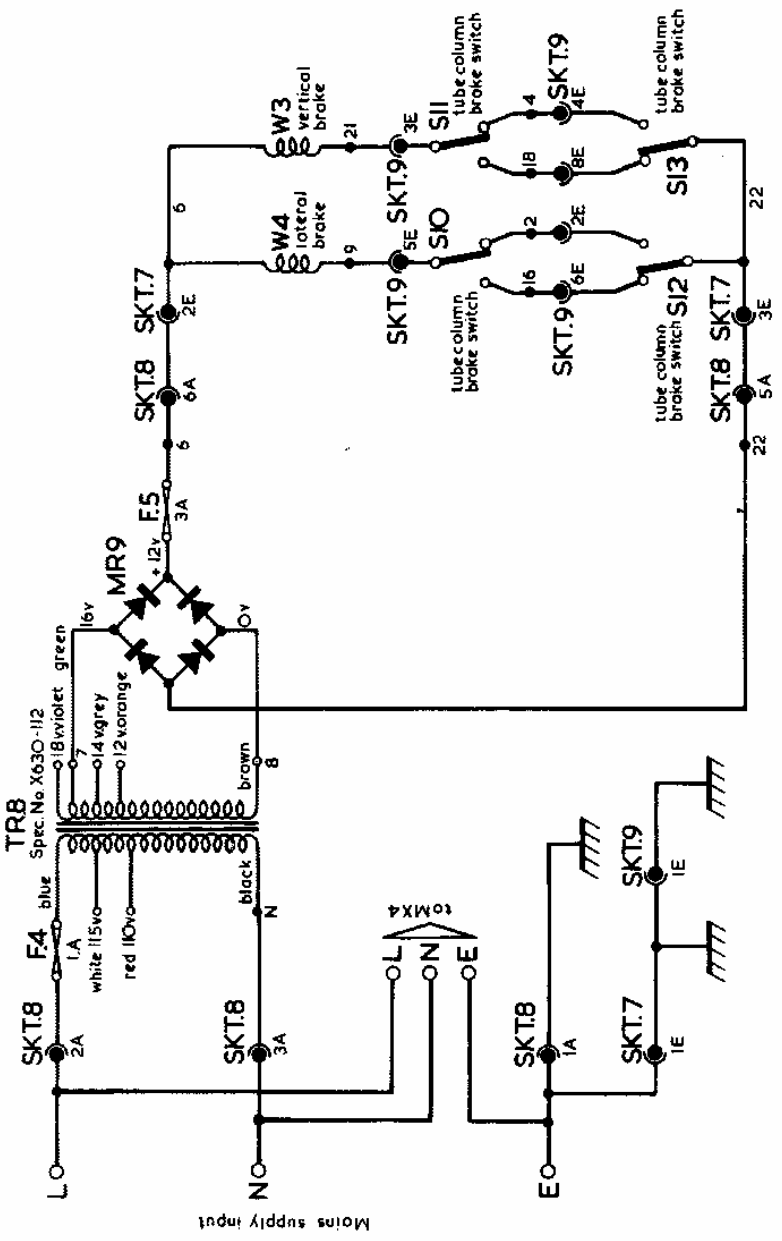
Refit all covers and make complete check of MX4 motor drive and X-ray function.



INTERCONNECTIONS in BASE OF MX4

(TP 65/1/1173)

Dia Inst 2559
(Issue 2-3/70)



(TPS-65/1/770)

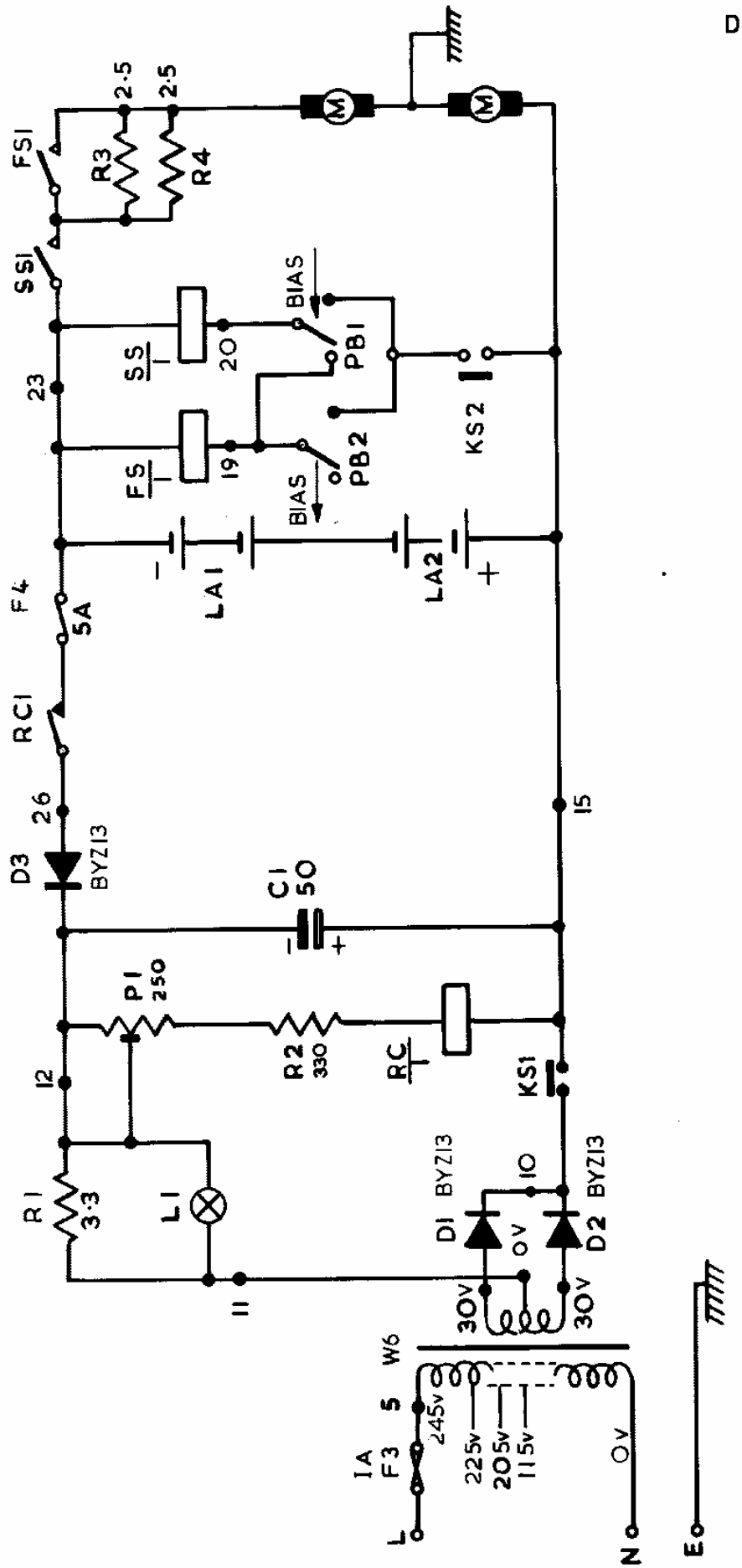
MX4 MOTOR DRIVE UNIT

SPARE PARTS LIST (Refer to Dia Inst 2826)

WHEN REQUESTING SPARE PARTS, ALWAYS QUOTE THE FULL DESCRIPTION AND STOCK NO OF THE ITEM. FOR ITEMS NOT LISTED GIVE THE FULLEST DESCRIPTION INCLUDING A ROUGH SKETCH IF POSSIBLE.

SYMBOL	DESCRIPTION	STOCK NO
W6	Charging Transformer	(X630-139)
F3	Input Fuse, 1A (X572-003)	FS 1030
F4	Output Fuse, 5A (X572-005)	FS 1052
D1, D2, D3	Diodes, BYX 38-300 or BYZ 13	(X316-019)
C1	Capacitor, Radio Spares Electrolytic 50mfd	(X190-054)
RC1	Charging Relay, PC2 HD Cab/6	(X510-215)
R1	Lamp Resistor 3.3Ω 10w (X231-312)	RS1020
R2	Relay Resistor 330Ω 10w (231-320)	RS 1694
P1	Trimming Pot 250Ω 3w	(X215-908)
KS1-2	Keyswitch Bulgin S.320 (X532-006) with spare key (X532-007)	KS 1065
	Spare key only (X532-007)	KS 1066
PB1	Push Button Switch with Black cap (X560-139)	PS 1391
PB2	Push Button Switch with red cap (X560-139)	PS 1392
L1	LES Pilot 12-14V 0.75w (X350-924)	LS 1151
LA1, LA2	12V Batteries (Lucas BHNS/7A-8)	(X993-701)
FS1	Fast Speed Relay (X511-307)	RS 1829
SS1	Slow Speed Relay (X511-307)	RS 1829
R3, R4	Slow Speed Resistor 2.5Ω (X222-103)	RS 1830
M1	Drive Motor Right Hand (X620-122)	MS 1227
M2	Drive Motor Left Hand (X620-123)	MS 1228

(Retyped 1073)



MX3 & MX4 MOTOR DRIVE UNIT CIRCUIT

(TP 65/2/670)(XD 61812)

Supplement to Operating Instructions, No.930, for MX4 Mobile Motor-Driven Units

1. General Information

The MX4 Mobile Unit, Series 2 Type, has a change in the design of the base, and a motor drive may be fitted.

2. Motor Drive Operation

The motor drive is battery operated, and the batteries are automatically charged every time the MX4 supply cable is plugged into a live socket. The charging operation is indicated by a red lamp (1). Refer to sketch below and details overleaf.

To operate the motor drive unit ensure that the mains plug has been removed from the wall socket. Wind in the mains cable. Fit the key into the switch (2) and switch ON by turning the key clockwise. If the brake is latched on, squeeze the brake handle (3) towards the control handle (7) and the brake catch button will be released and rise. Relaxation of pressure on the handle (3) will release the brakes.

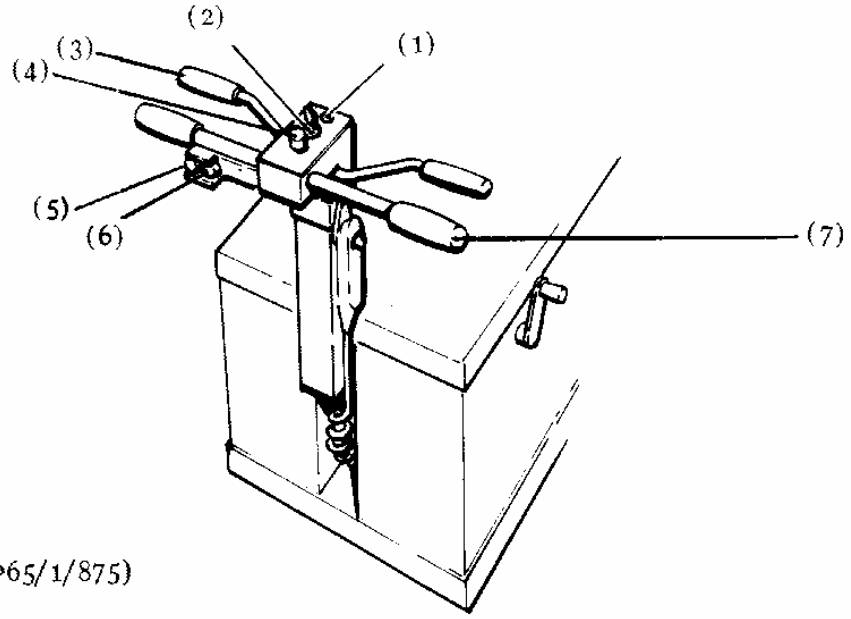
Pressure on the black button (5) will cause the motor drive to assist forward movement at normal speed.

For driving up inclines the motor unit can be operated in boosted condition by pressing the black button (5); and once the unit is moving, press the red button (6).

The red button (6) can be pressed when the unit is stationary but this can cause slipping of the drive wheels and possible damage to the tyres or floor.

CAUTION.... When the unit is parked, apply the brake.

Squeeze the brake handle (3) towards the control handle (7). Press and hold IN the brake catch button (4), then release the handles BEFORE releasing the button. The brake will then be held ON.



(TP65/1/875)

3. Battery Charging and Maintenance

IMPORTANT.... Switch off the X-ray control unit whilst the batteries are being charged.

The motor driven unit incorporates a battery charger. To charge the batteries, plug the unit into a mains socket, switch ON the socket and switch OFF the key switch on the unit (2 - anticlockwise).

The red warning-lamp (1) glows when the batteries are being charged. When the batteries reach the fully-charged state the charger automatically switches off, and the indicator lamp goes out. Should the apparatus be left connected to a live mains and be unused for a long period, the battery voltage will fall and the mains supply must be switch OFF and ON again to re-establish the circuit.

The batteries and compartments must be kept clean and dry. Electrolyte from the cells is "gassed" out in the charging operation and, if not cleaned off, will cause corrosion of the batteries and compartments.

The battery terminal connections should be clean, tight and lightly greased with petroleum jelly.

Batteries should be maintained in fully-charged condition.

When possible follow the battery manufacture's instructions for maintenance. Where no manufacture's instructions are available, follow the general guidance below.

The batteries should be charged at weekly intervals. Top-up the cells using only distilled water so that the separators are just covered. Where the unit is moved infrequently, the batteries should be charged at intervals not greater than 3 weeks. The charging period will be approximately 24 hours; leave the batteries on charge until the red lamp is extinguished.

GEC Medical Equipment Limited
East Lane Wembley
Middlesex HA9 7PR England

SUPPLEMENT No.1888
(August 1975)
to Instruction No1699

FITTING LOW VOLTAGE HANDSWITCH PANEL to:- MX4 Series 2 Units up to Serial No ZY 290

General Information

To isolate the exposure handswitch from the nominal 240V supply in the X-ray control unit, a double-wound transformer and relays are used on a low voltage (LV) panel. (The LV panel will be fitted by the factory on units of Serial No ZY 291 onwards).

Components Kit of Parts KS 1139

1 Instruction No 1888
1 LV Panel (MB 3558)
4 Hex spacers (MA 3692)
8 M4 x 8mm Lg Ch Hd Screws, steel (30523-016)
8 M4 single coil washers, steel (30823-203)
2 Helsyn sleeves H15 (X741-603)
1 Insulated Faston connector (X710-941)
2 Faston receptacles (X710-910)
7 Ring tags 4BA (X711-101)
10m 14/0076 Yellow wire (1343-2009)

Modifications

Before attempting modifications, check that the unit is operating correctly.

In cases where holes have not been provided, ensure that no swarf falls into the control, when drilling.

The location for fitting the LV panel inside the X-ray control unit is indicated in Fig 1. Reposition R20 first, as indicated by (1). Read the notes below and continue as indicated by (2) and (3) on Fig 1.

Where possible all leads to and from the panel must be twisted together to avoid interference with SCRs or transistors.

The panel MUST be earthed. Refer to the circuit Fig 2, page 3. Connect LV panel terminal 131, 51 and 132 to the main terminal panel TP (in parallel with the existing switch in the control unit) as shown in the circuit. Use sleeving provided at soldered connection of leads 121 and 122 on transformer T1010. Wiring must be secured to prevent damage. Re-use original handswitch or fit handswitch provided. The handswitch cable will have to be pulled through, or fitted,as illustrated in Fig 3, page 4. See WARNING on circuit drawing for earthing of metal-cased handswitch. Check circuit of handswitch and connect to terminal indicated on LV panel.

After modification, check that the unit is still operating correctly.

References

A copy of this instruction should be bound into the back of Instruction No 1699. Make a note of the LV panel instruction in the Supplement Section of the manual.

Fig 1 Repositioning R20 and Fitting LV Panel

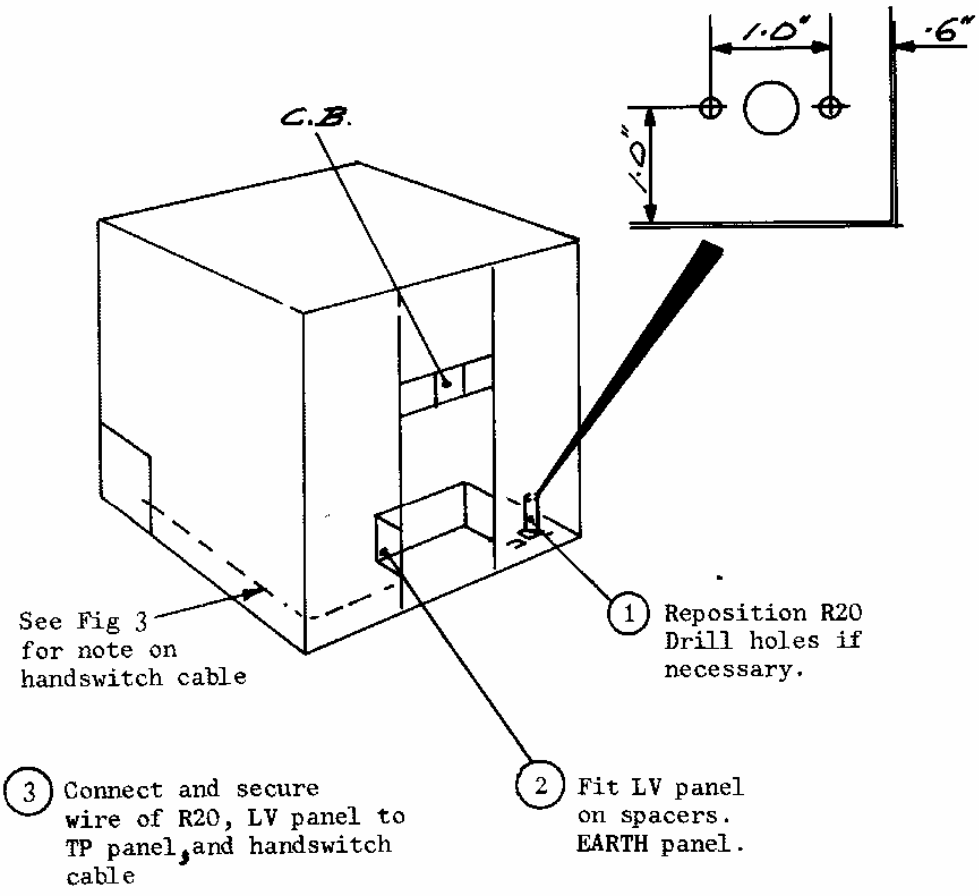
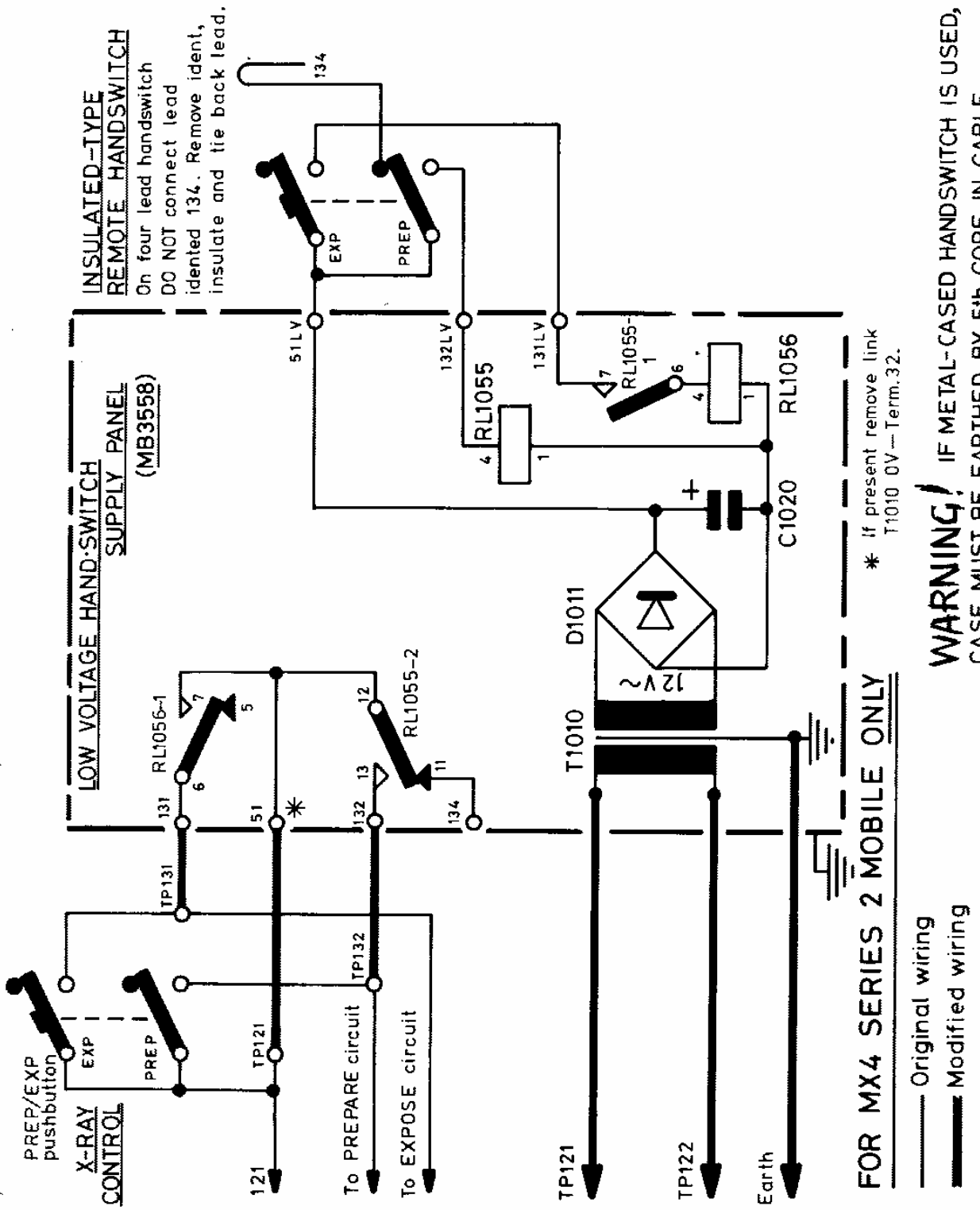


Fig 2 LV Panel Connection for Series 2 MX4



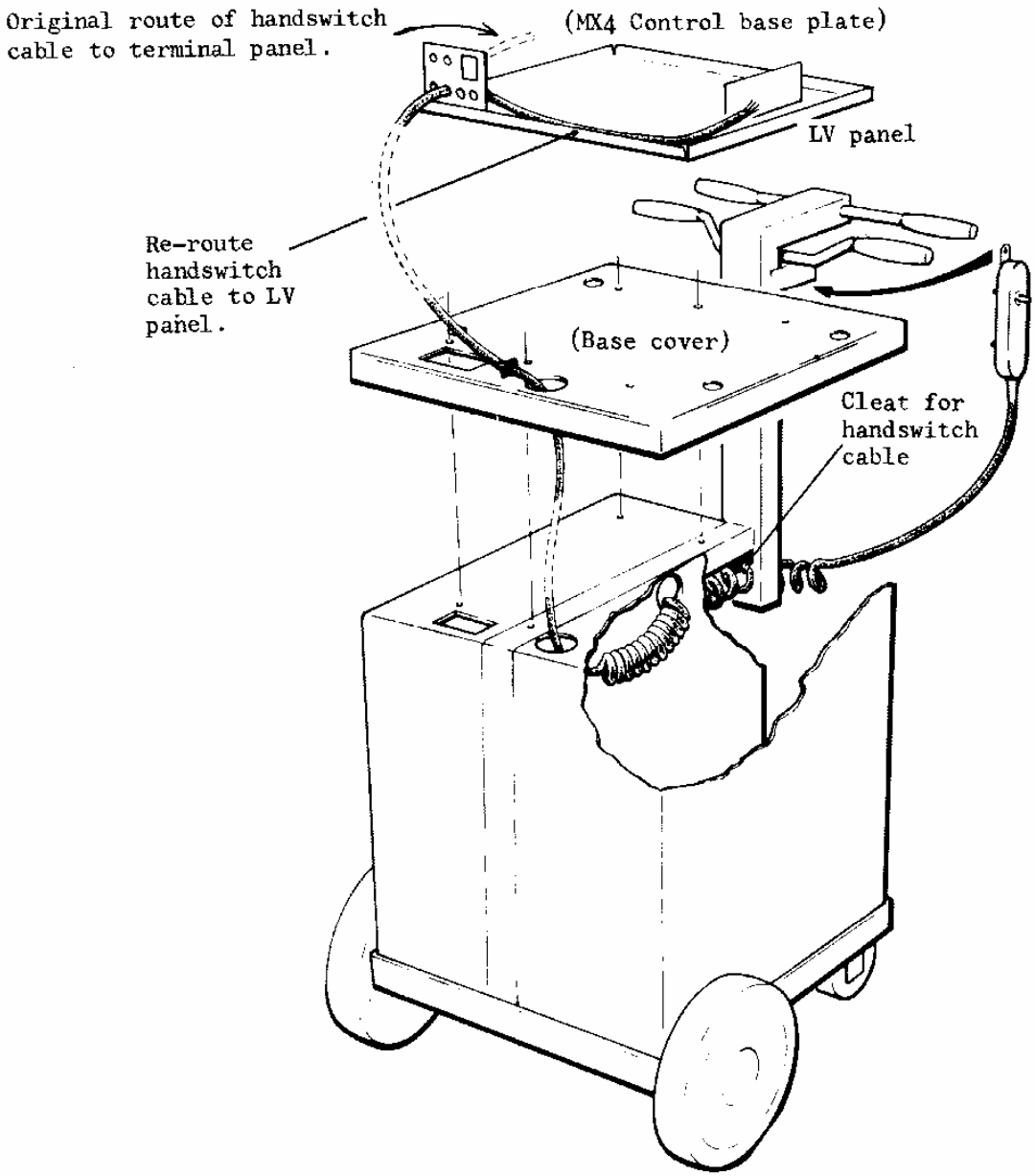


Fig 3 Exploded and Cut-away Views of MX4 Control and Base to Show Handswitch Cable Run

GEC Medical Equipment Limited
P O Box 2 East Lane Wembley
Middlesex HA 9 7 PR England

SUPPLEMENT NO.2202
to Instruction No.1699
ISSUE 2
(December 1978)

MODIFICATIONS FOR ISOLATION OF MX-4 CONTROL FROM BATTERY CHARGER UNIT

Certain modifications have been made to the MX-4 battery driven mobile unit, which prevent the control unit (and the X-ray tube filament) from being energised when the batteries are being charged, ie when the unit is parked and plugged in.
This prevents the control unit from being left on and also unauthorised persons from making an exposure when the batteries are being charged.
The introduction of an isolating relay (contactor) into the charging unit (see fig.1 overleaf) has necessitated modifications to the charging circuit (see wiring and circuit diagrams).
On some earlier MX-4 mobiles it was possible to engage the motor drive with the keyswitch in the OFF position while charging the batteries. This has been corrected by the introduction of two diodes, D4 and D5, into the circuit.

DETAILS OF MODIFICATIONS

1. The introduction of an isolating contactor (from MX-4 serial number CR 241 onwards) switches off the control unit during battery charging.

2. The introduction of two diodes BYX 36-150 (from MX-4 serial number CR 266 onwards) prevents the motor drive operating when the keyswitch is in the OFF position.

3. R5 (51Ω, 9W) becomes 47Ω, 25W metal cased which should be bolted onto the chassis above the contactor (see fig.2), which will act as a heat sink.

4. R1 (3.3Ω, 10W) becomes 2.2Ω, 25W metal cased which should be bolted onto the terminal board (see fig.2). This resistor has been changed as the modified unit will exceed 10W. The reduced resistance is to increase the charge current and to reduce lamp brightness.

5. P1 (250Ω, 3W) becomes 500Ω, 3W to increase the resistance range so that compensation for differences in relay contact pressure can be made more easily.

6. R2 (330Ω, 10W) becomes 270Ω type W21 to match the new potentiometer. High wattage is not required.

7. F3 (1A) becomes 2A.

Some earlier MX-4 mobiles (before serial number CR 280) have not received modifications 3-7. Therefore R1 and R5 should be replaced at the earliest opportunity with the metal cased resistors (stock numbers 5464-909 and 5464-917 respectively) and mounted as shown in fig.2.

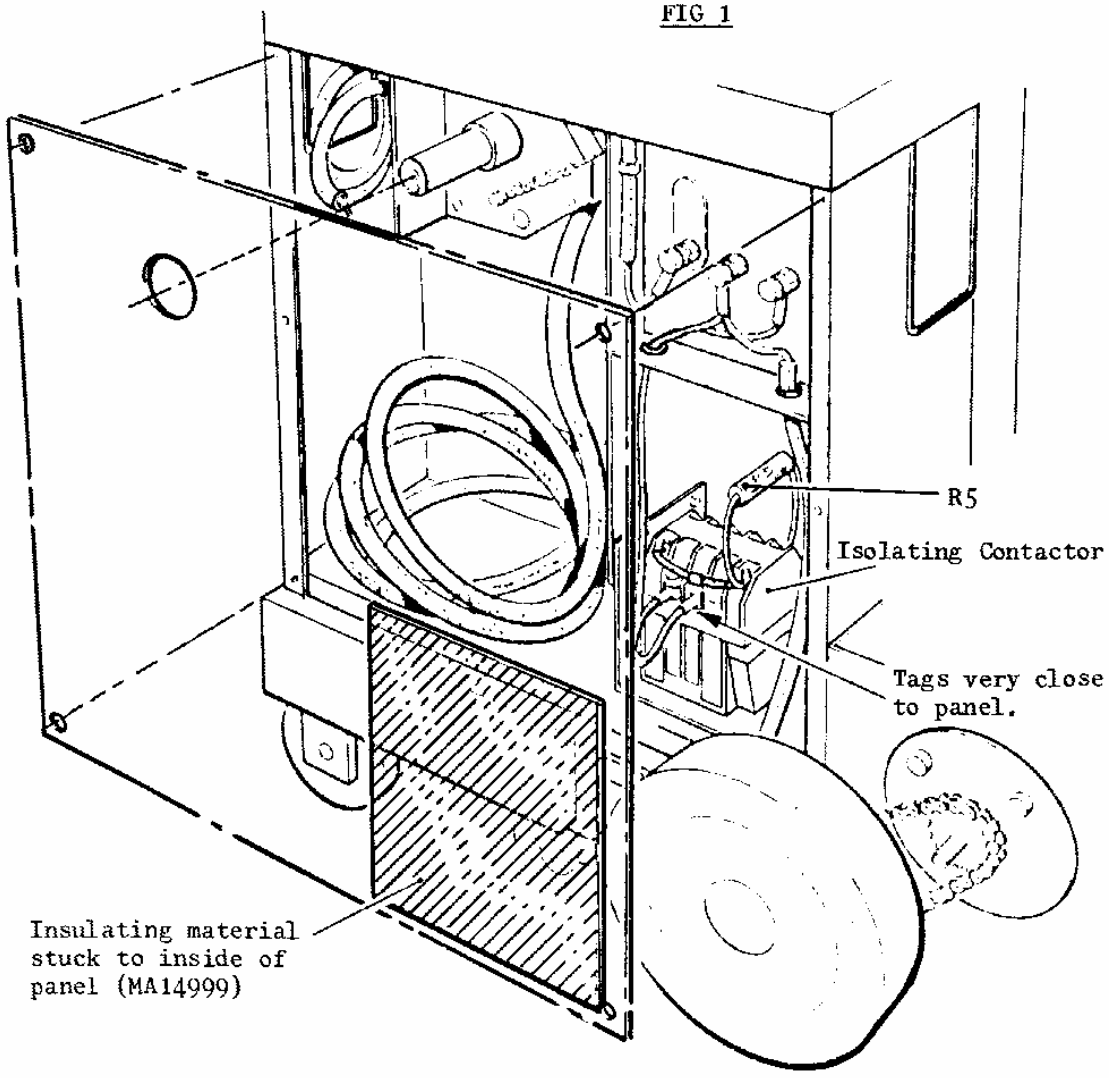
NOTE.... Some units after serial number CR 280 have had all the modifications except no.3, but R1 has been bolted to where R5 should be. Where this applies, R1 should be re-positioned and the new R5 bolted in place, (see fig 2).

> **CAUTION**
>
> R1 and R5 (BEFORE modifications 3 and 4 - serial numbers CR 280) become very hot during operation, so they must be mounted in such a way so as to be clear of other components and wires, (see R5 in fig 1).

Unfortunately, it has been found that the tags on the contactor can touch the side panel. In order to ensure complete safety, it is necessary for a piece of insulating material to be stuck to the inside of the side panel. Fig 1 shows where to position the insulating material.

All MX4's having a contactor must be fitted with the insulating material.

FIG 1



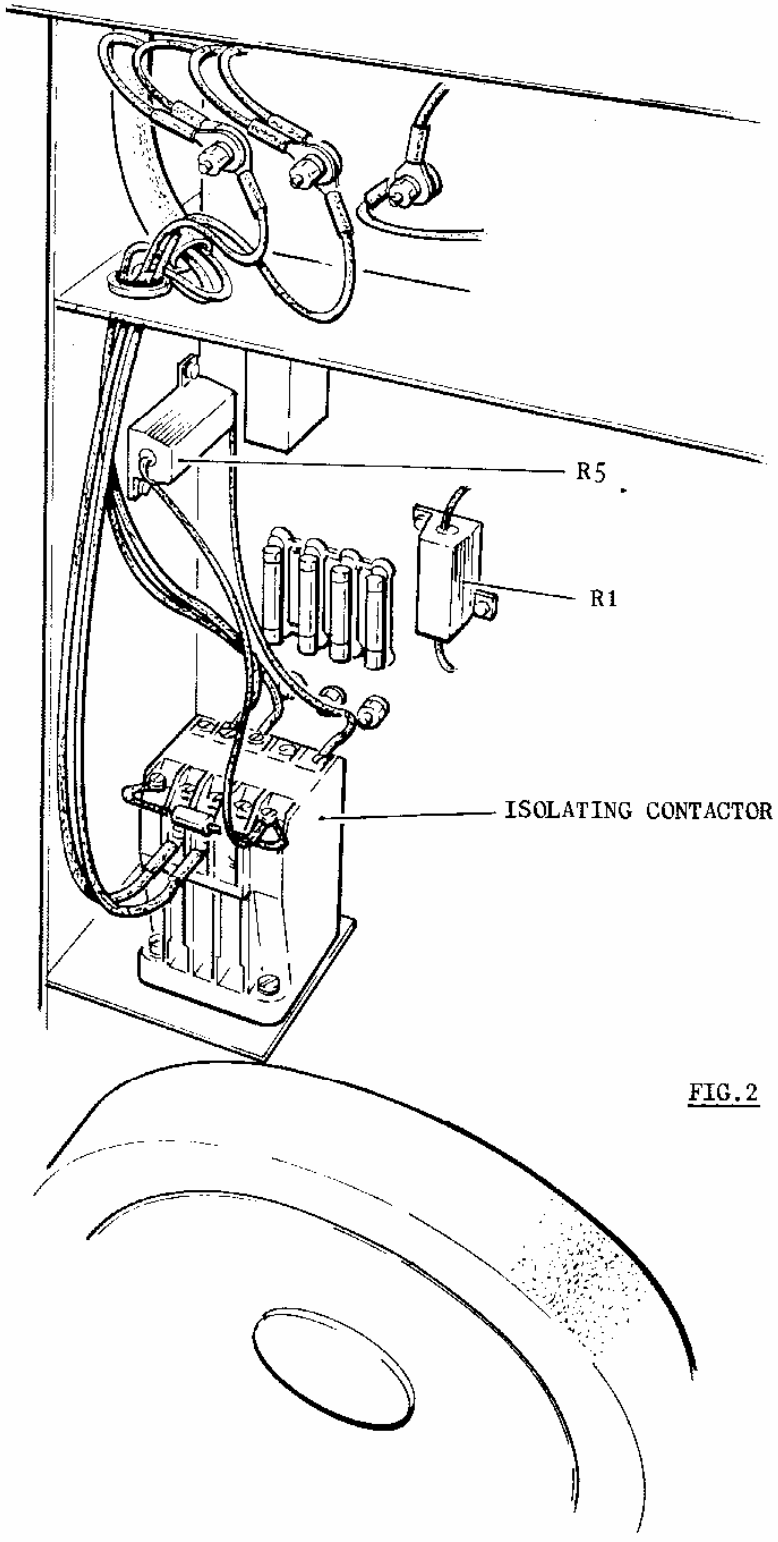


FIG.2

Later MX4 mobiles will have the isolating contactor re-positioned in the factory to obviate the problem of the contactor tags shorting out. (See fig 3 below.)

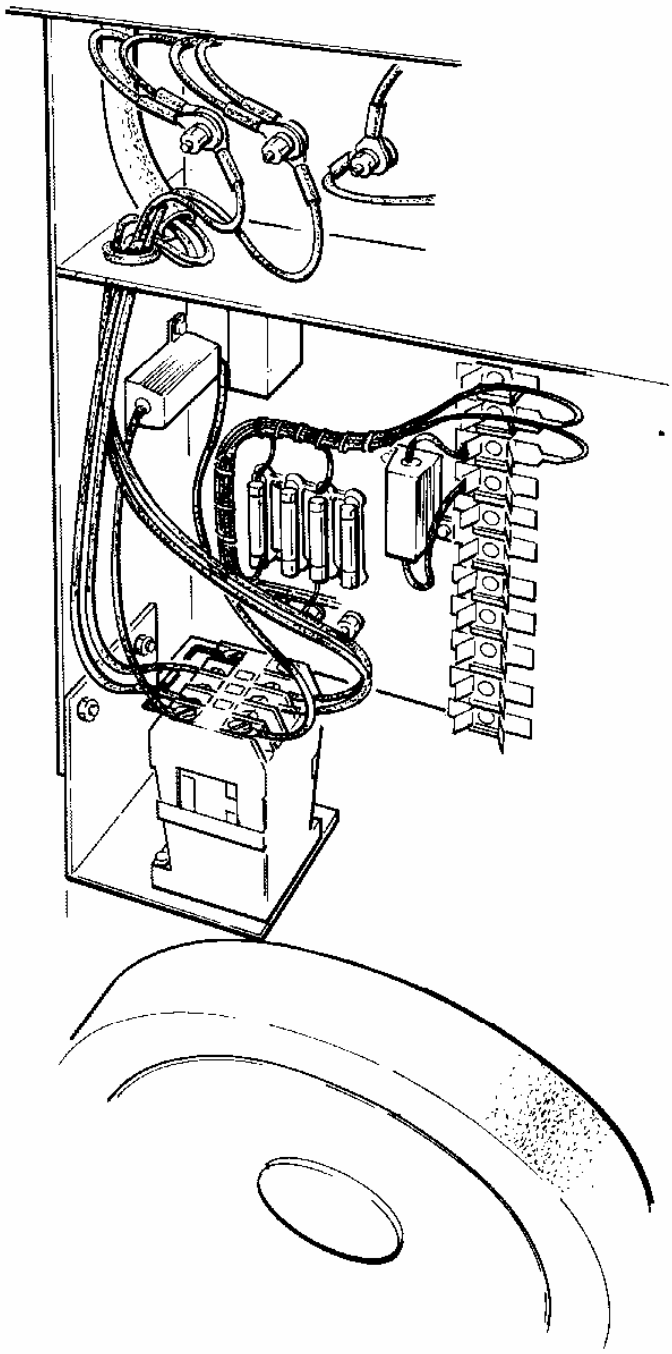
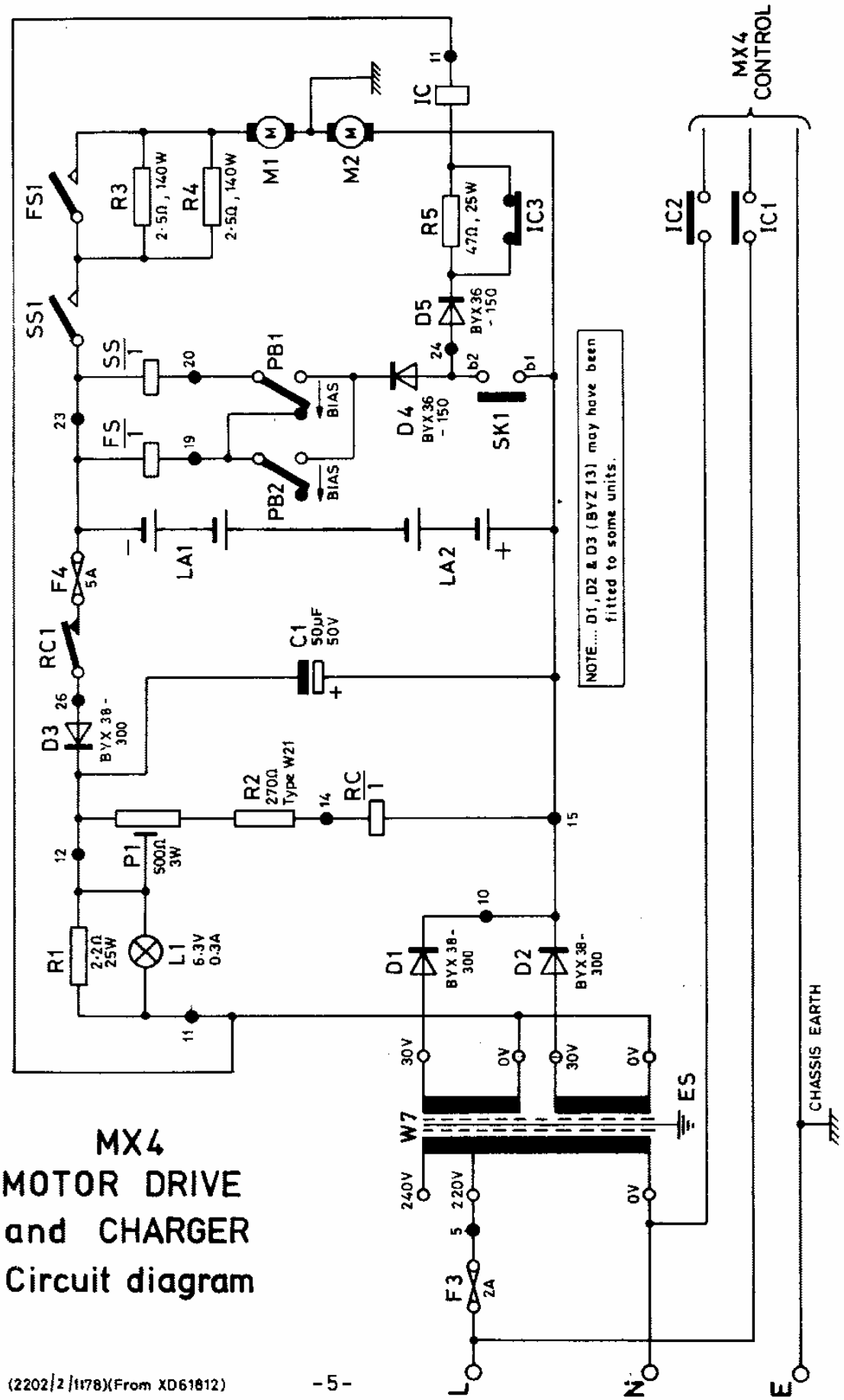
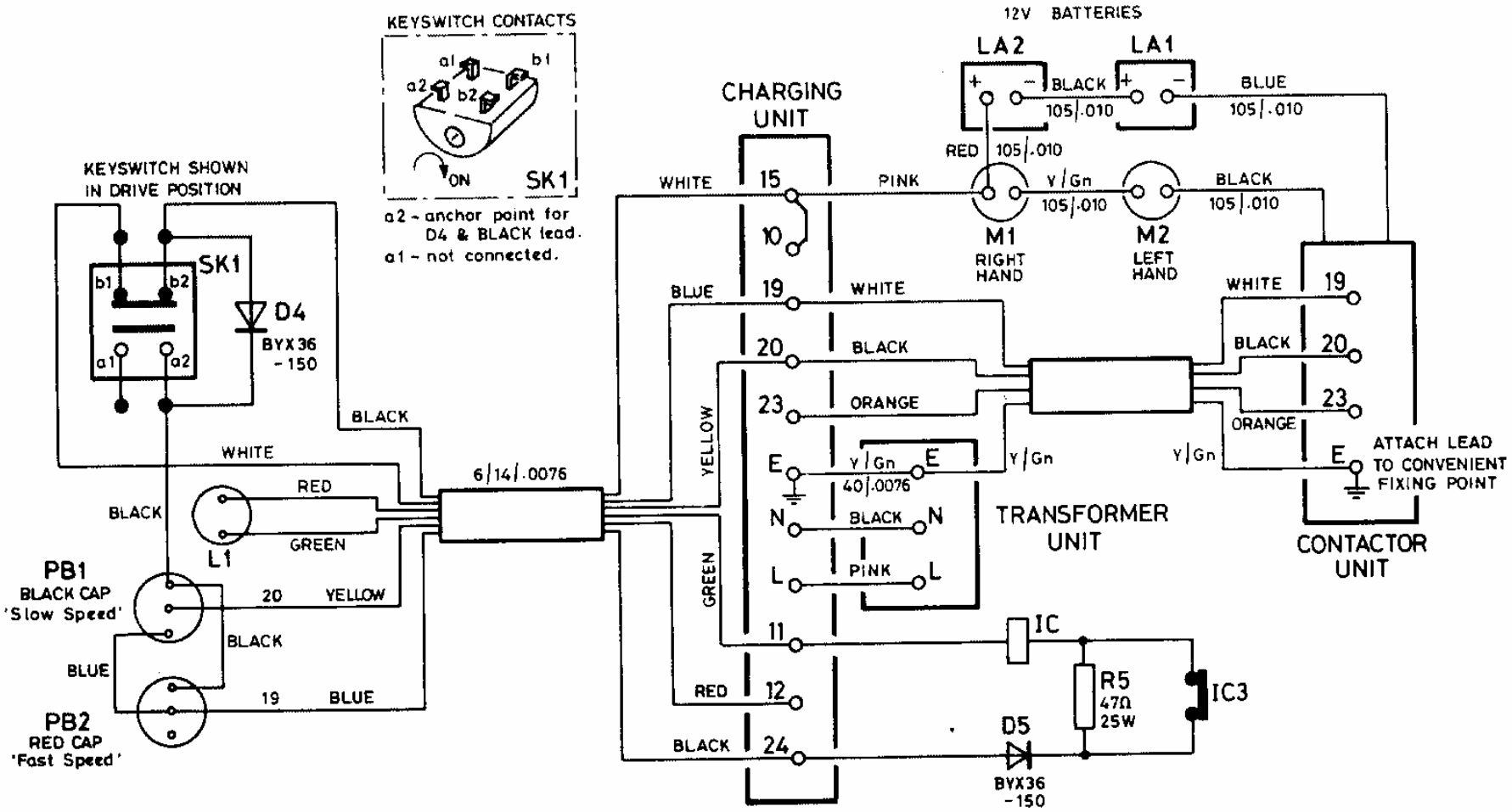


FIG 3



MX4
MOTOR DRIVE and CHARGER
Circuit diagram



MX4 - MOTOR DRIVE and CHARGER Wiring Diagram

(2202/2/279)(From XC61811)

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

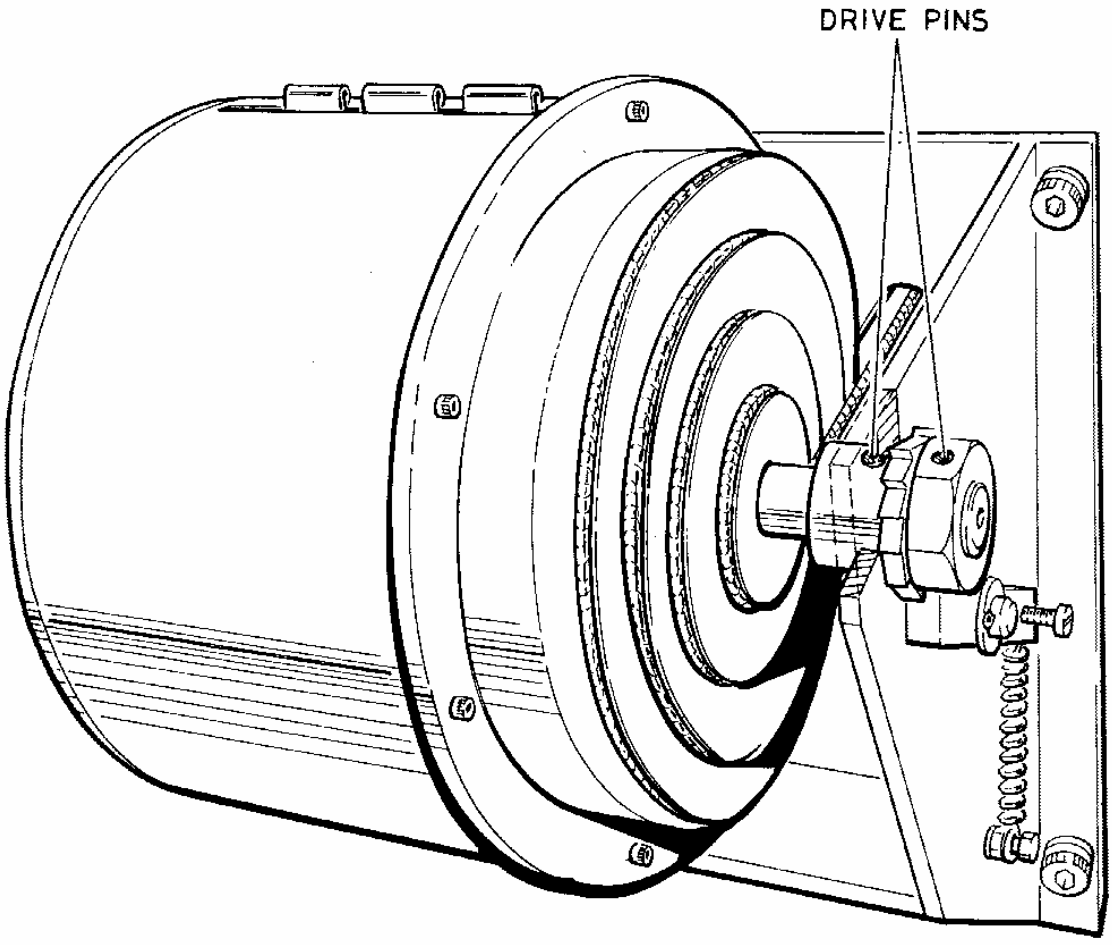
Supplement No 2275
(May 1979)
to Instruction No 1699

Replacement Spring Drum Assembly (Metric) for MX4 Mobiles

As from May 1979 the spring drum assembly (part no HS1127) for MX4 mobiles will be metricated. This includes the two holes in the shaft of the drum which accommodate the drive pins retaining the tension adjusting nut and the ratchet wheel.

As a result, these spring drums are suitable for direct replacement in metric and imperial MX4 mobiles. However, if a replacement spring drum is required for imperial MX4 units, the two holes in the metric drum shaft must be enlarged to take the old imperial size pins. These 6mm holes must be drilled out to $\frac{1}{4}$in. When this has been done, the tension adjusting nut, ratchet wheel and washer can be replaced and the imperial drive pins inserted into position.

For details on replacing and counterbalancing the spring drum, refer to pages 136 - 140 in Instruction No 1699.



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

Supplement No 2278
(Issue 2 November 1980)
to Instruction No 1699

MX4 MOBILE

PRODUCTION CHANGES TO DRIVE UNIT, BATTERY CHARGER, EXPOSURE WARNING LAMP and EXPOSURE BUTTON

Modifications have been made to the mains input control circuit on MX4 mobiles. When the drive key is removed, the unit cannot be driven nor can the X-ray control be switched on, thus preventing unauthorised operation. The circuit is, however, arranged so that the mains supply lead can be plugged into a power socket enabling the drive batteries to be charged.

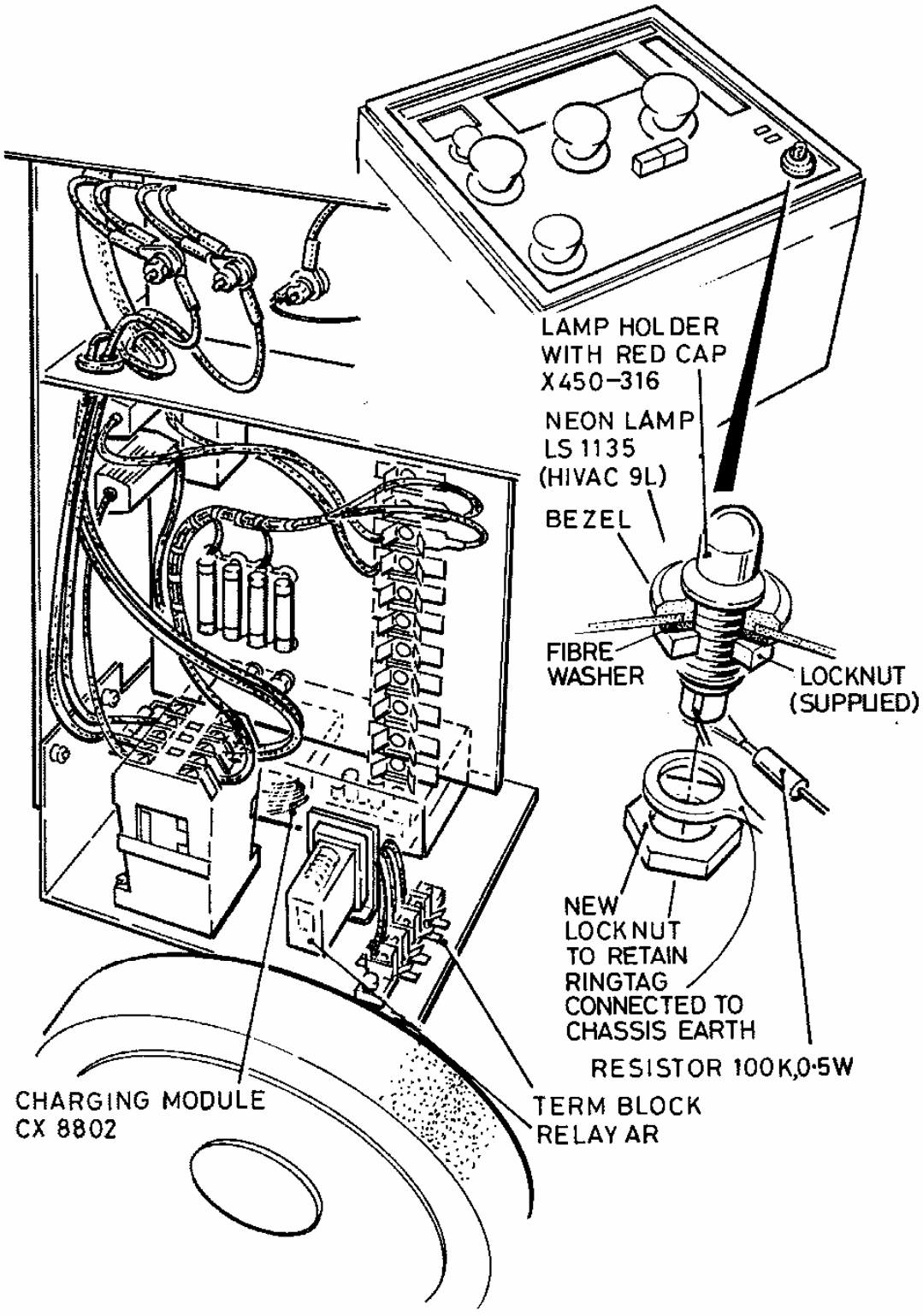
In order to provide this facility an isolating contactor has been fitted to the MX4 mobile base and two diodes introduced to interlock the motor drive and keyswitch. The opportunity has also been taken to revise the old battery charge circuit and a more efficient p.c.b. has been fitted. The following illustrations and circuit diagrams show the new arrangements which will be included from unit serial number CR386. (Please note that some interim modifications were made from units serial number CR241 and details of these changes are illustrated on supplement No 2202, see yellow index sheet in Inst 1699).

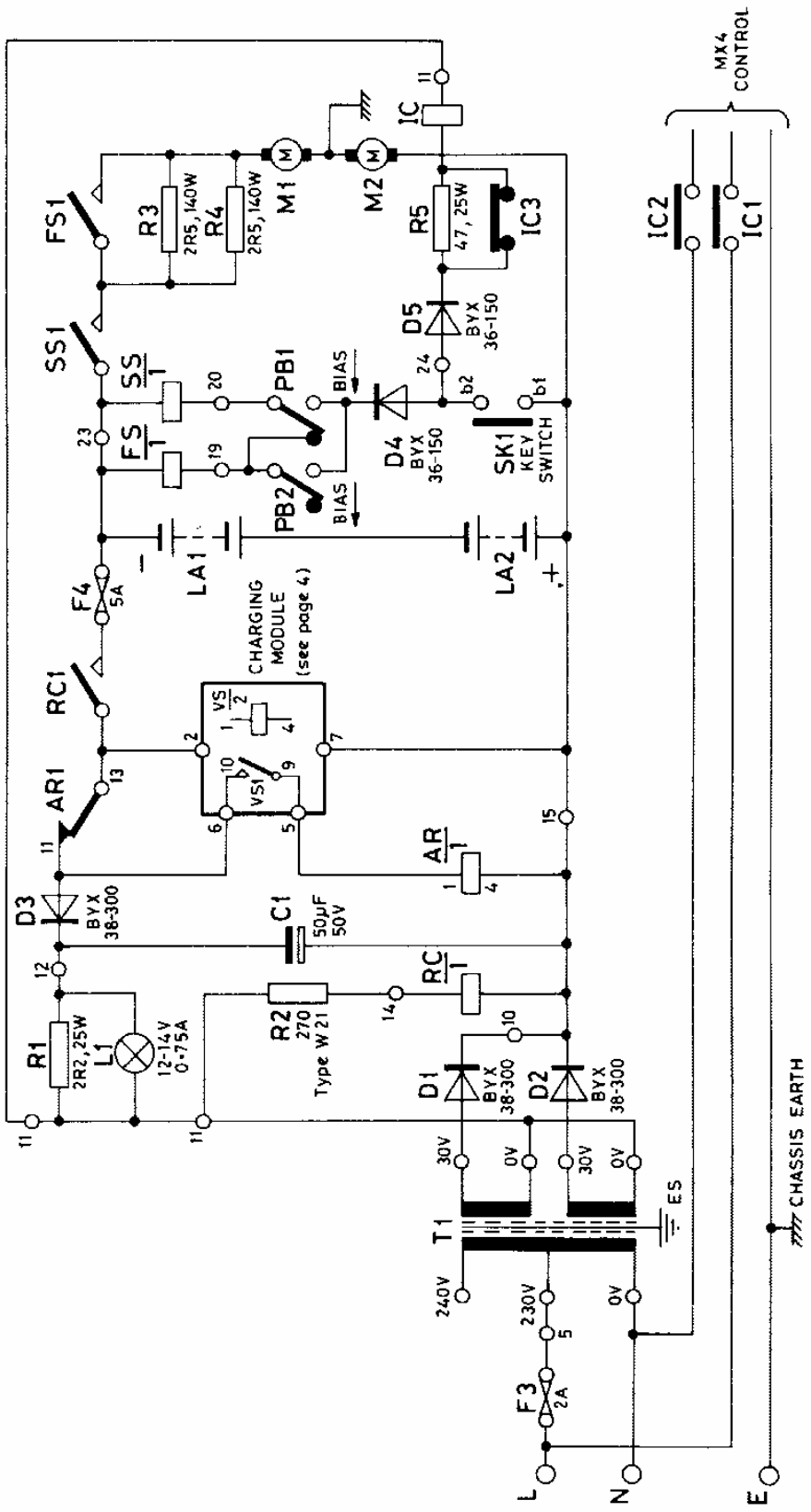
Also, these new production mobiles will be equipped only with an exposure handswitch and the expose button fitted to the control panel will be omitted (this is to ensure the operator may stand well away from the X-ray area). In place of the control exposure button an exposure warning lamp is fitted. This large red lens is clearly visible from all angles and is an improvement on the present recessed lamp fitted beneath the plastic panel.

All these modifications may be fitted to a field unit should up-dating be required.

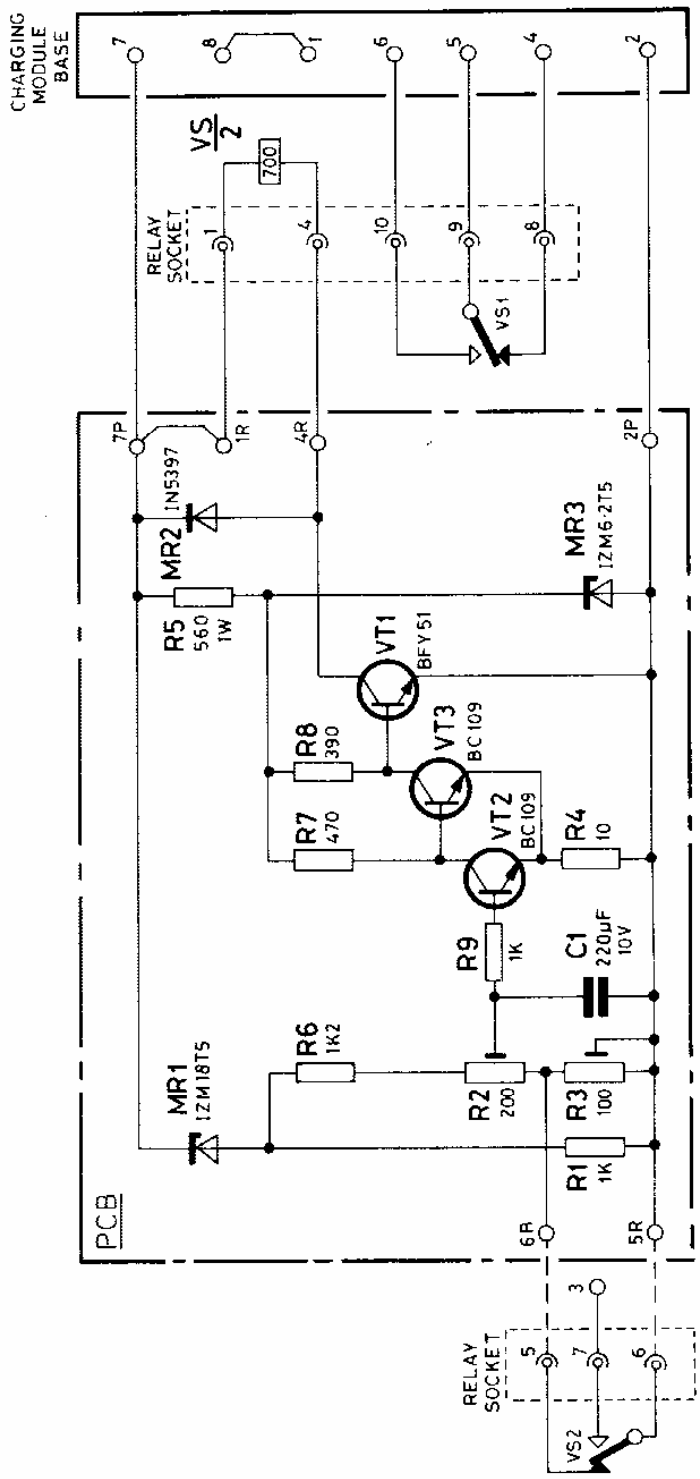
Discard all existing copies of this supplement and insert this copy in the Supplement Section of Instruction No 1699.

Continued overleaf....


LAMP HOLDER
WITH RED CAP
X450-316
NEON LAMP
LS 1135
(HIVAC 9L)
BEZEL
FIBRE
WASHER
LOCKNUT
(SUPPLIED)
NEW
LOCKNUT
TO RETAIN
RINGTAG
CONNECTED TO
CHASSIS EARTH
RESISTOR 100K,0·5W
CHARGING MODULE
CX 8802
TERM BLOCK
RELAY AR



MX4 MOBILE MOTOR DRIVE and CHARGER CIRCUIT

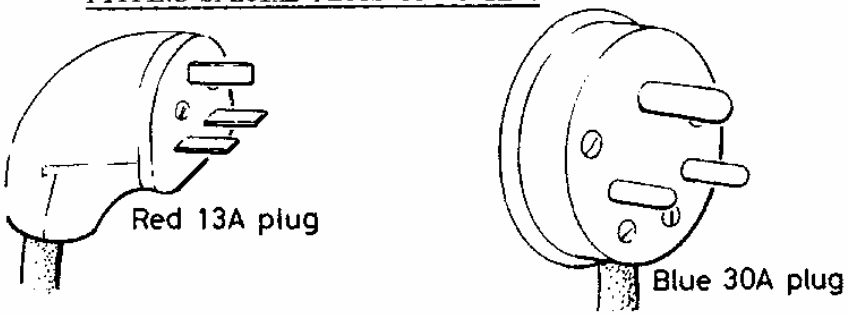


MX4 CHARGING MODULE CIRCUIT DIAGRAM

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

Instruction No 2332
ISSUE 2 May 1981
(Replaces Instructions
No 1733 and 1903)

FITTING SPECIAL PLUGS TO MOBILES



Fitting Mains Supply Cable to Special Unfused RED X-ray only 13 amp Plug

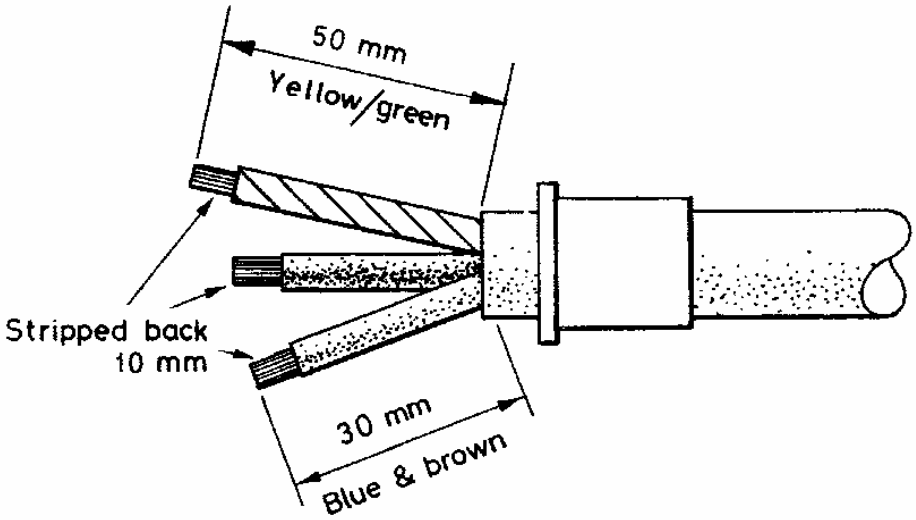
Great care must be used in terminating this heavy mains cable to the comparatively small plug. It is essential to read these instructions carefully and bend the tags as shown. If they are formed wrongly, scrap the tag. DO NOT RE-FORM. Use a new tag. Spares are provided.

1 Kit of parts - Stock No 1285-117

- 1 13A Walsall Plug- Type S 32A12 (GEC ref 6354-001)
- 6 AMP Type 32994-3BA 12-10 Tags (GEC ref 6232-221) *
- 6 Tags as above with insulating sleeves (GEC ref 6232-521)
- 1 Sleeve Grommet (Helvin ref No 3731). Required for mains cables of less than 15mm (9/16 in) outside diameter. (GEC ref 6255-015)

2 Strip wire as shown below.

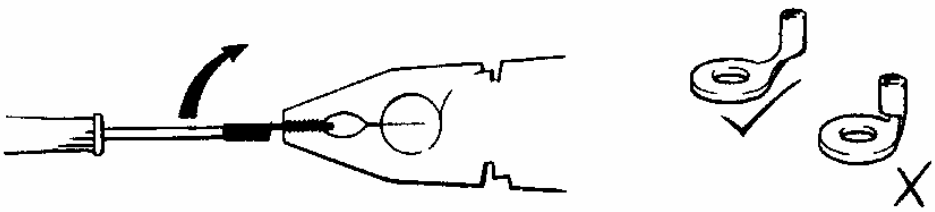
N.B....If cable diameter exceeds 15mm the sleeve grommet may be discarded.



(* Equivalent to Walsall Elpress Tags type B4643R)

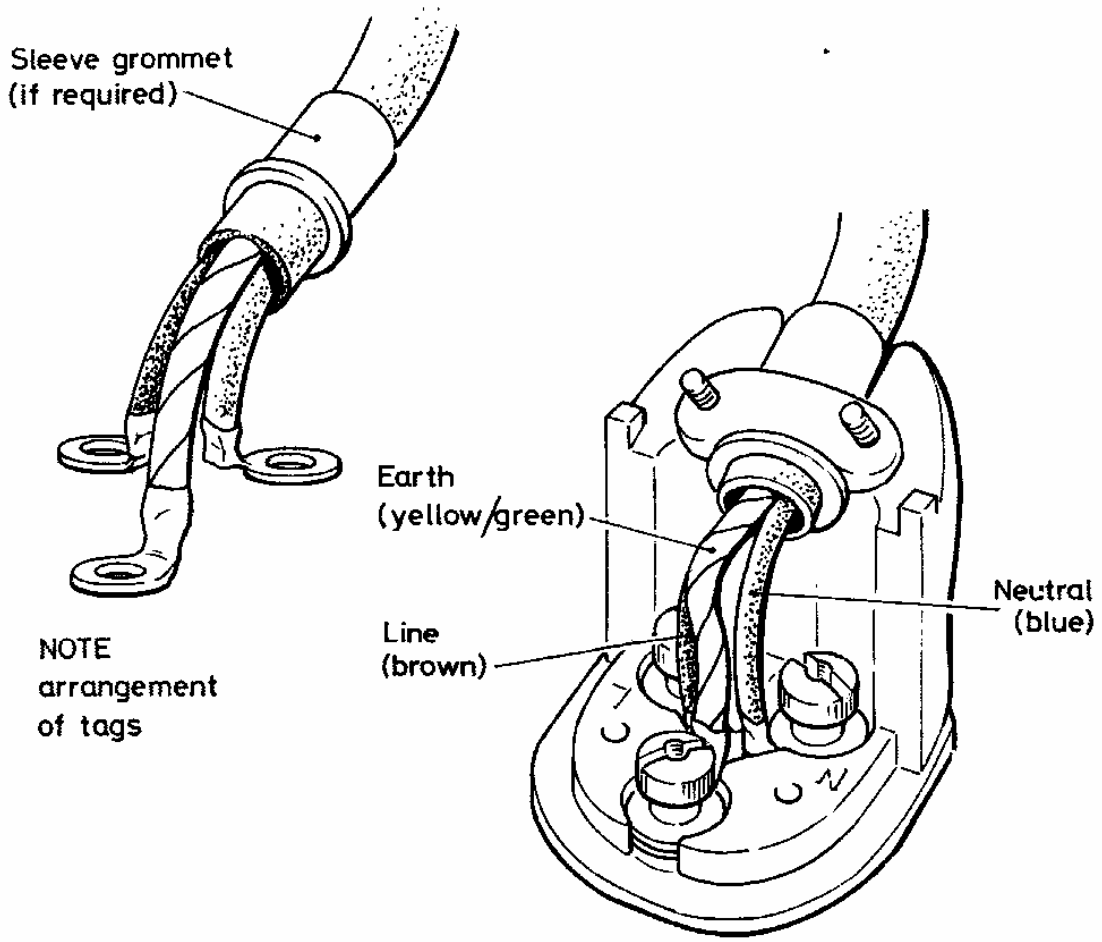
Continued overleaf.....

3 Bend tags to shape using pliers and small screwdriver as shown, then crimp or solder.



Normally the tag should be crimped. If your crimping tool is designed for use with insulated tags, use as directed and cut away the insulating sleeve afterwards. If a crimping tool is not available, the wire may be soldered into position. Full flow of solder through the tag must be achieved. Excess solder which would prevent 'seating' must be avoided.

Try each finished tag for flat seating and clearance from moulding, before fitting the terminal nut and tightening down.



Place tags in position and screw down as shown above.

ENSURE that TERMINAL NUTS are FULLY TIGHTENED, but NOT OVERSTRAINED.

Fit cable clamp and tighten down securely.

Fitting Mains Supply Cable to BLUE 30amp Plug (A274/A11)

(Stock No PS1470, Code No 6312-275).

Prepare cable as shown below.

When wiring plug, earth lead must be long and folded inside the plug as illustrated below. This ensures earth lead is the last to break should cable be pulled out of plug.

Ensure that the cable clamp is tight, and that the terminal screws are fully tightened.