THE TEL-X-OMETER, TEL. 580

PART 1 : INSTRUCTION MANUAL.

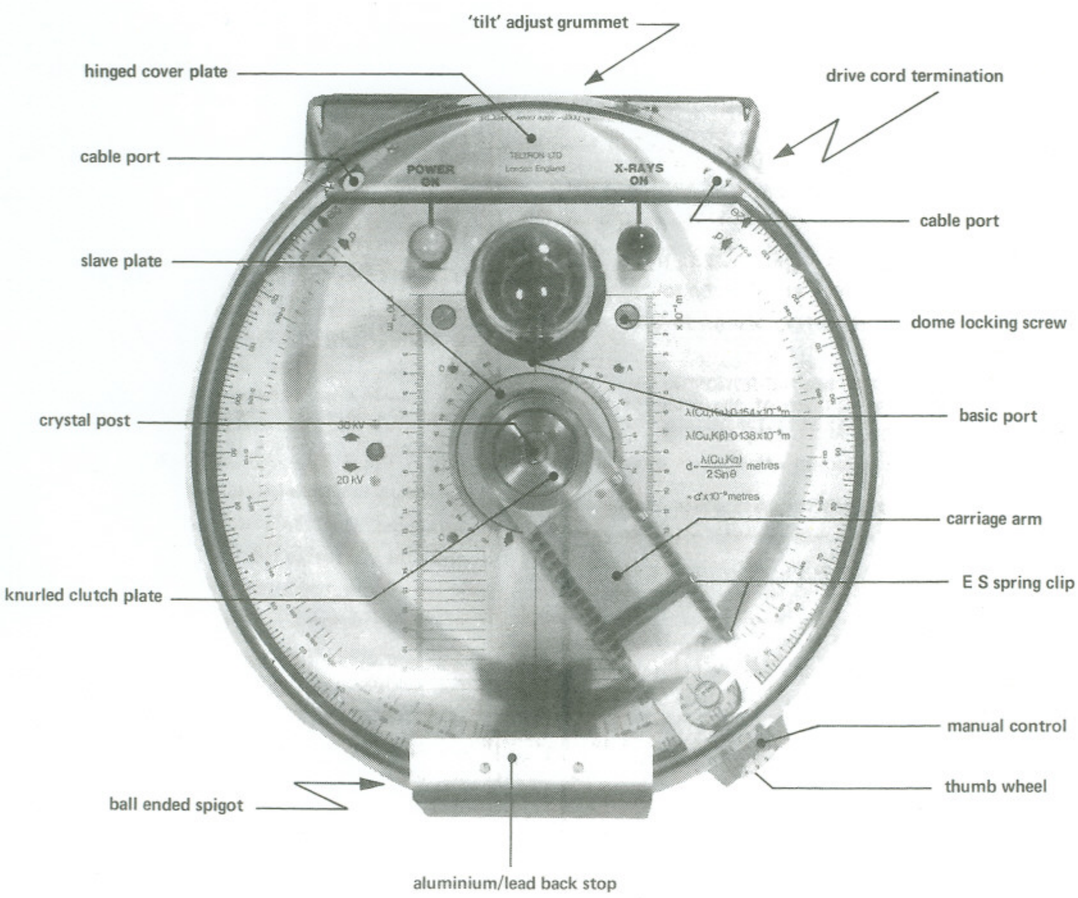

FIG. 1 – IDENTIFICATION

1.0 INTRODUCTION

The physics teachers and research scientists who helped to formulate the "TELTRON APPROACH TO ATOMIC PHYSICS" reasoned that had refractory metals and good high vacuum equipment been available to the genuises of the "golden era" at the turn of the century, then thermionic emission would have replaced the traditional gas discharge as the vehicle of atomic physics investigations.

2.0 The Free Electron

It was on this basis that the historical sequence of the evolution of this subject was disregarded and SERIES A, "THE PRODUCTION AND PROPERTIES OF THE FREE ELECTRON", was prepared; although it differs from the chronological evolution, the presentation and understanding of the argument is very much simplified and expenditure in terms of both finance and time is reduced to a minimum.

Series A starts with a simple Thermionic Effect experiment in air; this dictates the need for an evacuated experimental zone and the thermionic diode is introduced, followed by the triode and the development of a simple diode electron gun. Producing free electrons in this manner a series of crucial steps is recommended and all the experimental apparatus necessary to perform these steps is available.

The entire programme of experiments is designed such that a thorough examination of each phenomenon suggests the nature of the next crucial step.

At the culmination of Series A the electron has been produced and "weighed and measured"; but during the series, the phenomenon of the glowing of a luminous screen is not explained and similarly a limitation of 5000 volts is seemingly arbitrarily imposed for accelerating voltages. The discriminating physicist will seek both an explanation to the luminescence and a verification that the properties of the electron are unchanged by accelerations induced by more than 5000 volts.

3.0 The Bonded Electron

A re-examination of the Luminescent Tube, TEL 522 introduces SERIES B, "A CONCEPT OF THE ELECTRON WITHIN THE ATOM", leading to field emission, isotopes and electron energy levels.

4.0 High Voltage Acceleration

The employment of accelerating voltages of the order of 30,000 volts introduces SERIES D, "THE PRODUCTION, PROPERTIES AND USES OF X-RAYS".

A simple evacuated thermionic diode is postulated having an anode which can tolerate the increased wattage dissipation required when a potential difference of 30,000 volts is imposed across the cathode and anode.

In November 1895 similar very high accelerating voltages were being employed by Professor Wilhelm Röntgen in his laboratories at Würzburg in Bavaria.

Clearly the use of 30,000 volts will introduce a hazard to health and through Röntgen's work it is known that additional hazards will exist which require the use of special apparatus - the TEL-X-OMETER, TEL 580.

5.0 TEL–X–OMETER, TEL 580

The packaging of the instrument has been carefully designed to ensure that units are delivered in the same condition as they leave the factory. If any damage is apparent when the packing case is opened the supplier of the equipment should be notified immediately and the instrument should not be used.

All accessories, kits and items are packed separately but, with the exception of the Filmpaks, there is space allocated for every item in all the kits within the large Accessory Box, marked TEL 582/3/4.

6.0 COMMISSIONING THE INSTRUMENT

Lift the instrument out of the box and remove all packing materials, including the plastic bag which houses the power supply lead; place the spare fuses and the miniature jack-plug contained in the plastic bag into the Accessory Box TEL582/3/4.

6.1 Mains Power Supply

Attach a plug to the power supply cable in accordance with the wiring instruction sheet.

With the transparent plastics Scatter Shield closed, tilt the instrument onto its hinge and ensure that the Power Selector on the underside of the instrument indicates the correct mains voltage; to re-adjust the selector pull out the black plug and replace, with the arrow pointing towards the legend which corresponds to the power supply available in the laboratory.

Check that both the Power Fuse and the EHT Fuse are securely screwed in.

6.2 Radiation Warning Sign (Ref, ICRP Publication 13, para 20)

Remove the yellow, black and white radiation warning card from the top lining board of the packing case; cut out the appropriate sign and affix to "the entrance to the enclosure or room containing the Tel-X-Ometer".

6.3 Mechanical Inspection

The transparent plastics Radiation Scatter Shield which completely encloses the experimental zone (ref: ICRP para 17) is normally locked in the 'safe" position by a ball-ended spigot.

This spigot locates in a key-hole slot situated behind the aluminium back-stop displaying the International Radiation Symbol (ref: ICRP para 19 and see Fig.1).

To open the unit the entire Scatter Shield should be displaced sideways with respect to the hinge; the spigot will automatically line up with the left hand or right hand release port and the Shield can be lifted; the cover is self-supporting when it has been lifted beyond the vertical line of the hinge.

Check that no visible screws have been loosened in transit; that the spectrometer arm can be moved around to the scale limits in both directions; that the lenses on the signal lamps are tight etc.

Lower the Shield to the locked 'operating' position; repeat the opening procedure in the opposite direction.

6.4 Safety Interlocks (ref, ICRP para 18)

To become familiar with the interlock system, displace and open the radiation Scatter Shield and remove the two screws which retain the hinge cover plate, see Fig.1; remove the plate.

Open and close the Scatter Shield observing the operation of the interlock system at the hinge; note the ball and socket indication of the central position; note that the Shield cannot be moved in a sideways direction when it is open; note the "fail-safe" duplication of interlocks. Replace and screw down the hinge cover plate.

Using a wide bladed screw driver turn the large screw-heads located at each side of the lead-glass dome, see Fig. 1; note that each screw-head controls a plastics plate which locks the glass dome in position and at the same time activates a micro-switch fixed underneath each locking plate; when these plates are unlocked the lead-glass dome can be removed for access to the X-ray tube.

Return each screw-head to the dome-locked position, close the Scatter Shield and slide to the central position.

6.5 Initial Switch On (ref: ICRP para 21)

Connect the mains supply to the unit by depressing the POWER ON switch (WHITE) on the control panel; the unit will only function when the Time Switch is rotated to the required time factor. When this is performed both the filament of the X-ray tube and the POWER-ON lamp (WHITE) will be illuminated.

6.6 Condensation

After the instrument has experienced changes in the temperature and the humidity of the surrounding air a slight condensation is sometimes apparent inside the lead-glass dome; the Tel-X-Ometer warms up after a short period in operation but at no time should any part of the instrument seem too hot to the touch of the hand.

The operating temperature is sufficient to evaporate any condensation and it is therefore recommended that only the filament is energised for the first five minutes; if, on depressing the X-RAYS ON button (RED), a faint 'crackling' noise is heard then some electrical discharge due to dampness is evident and the equipment should be allowed to run for a further five minutes with only the filament operating.

6.7 X-Rays On/X-Rays Off Procedure (ref: ICRP para 18)

To switch off the EHT, displace the Scatter Shield sideways with respect to the hinge.

Replace the Shield in the central locked position and depress the X-RAYS ON button; the X-RAYS ON lamp (RED) will be illuminated.

If, at the first attempt, the red lamp does not illuminate, check that the Shield is correctly centred; if centralisation is not properly effected the micro-switches at the hinge will not activate the EHT circuit and the red lamp will not illuminate; centralise the Shield correctly and again depress the X-RAYS ON button.

6.8 Electronic Charge Persistence

The EHT for the unit is derived from a solid state invertor circuit, followed by a Cockcroft-Walton type multiplier to provide a smooth d.c. output. In operation, the capacitors in this circuit become charged; the EHT circuit is well insulated for 30,000 volts and when the EHT is switched off the charge on these capacitors persists for many hours. In the absence of special precautions, this charge would be a hazard to technicians who may wish to perform service work on the electronic circuit or to change the X-ray tube; there would also be a radiation hazard if the filament should be energised some hours after the unit had been switched off whereupon an X-ray pulse would be emitted whether the Shield be safely in position or not.

A special protection circuit has therefore been incorporated which provides a short energy-pulse to the filament immediately after the power to the unit has been disconnected; this pulse serves to discharge the EHT circuit and can be observed as a bright flash each time the instrument is de-energised by switching off the "POWER-ON" control.

6.9 Visible and Audible Signals (ref: ICRP para 19)

The X-RAYS ON lamp (RED), the POWER ON lamp (WHITE) and the filament itself can all be readily observed from all around the instrument.

The EHT generator operates at high frequency (R.F.) which provides an audible indication that the instrument is operating.

An additional external and even remote indicator can be connected, if required, by inserting the jack-plug provided into the "monitor tube current" socket recessed in the control panel; any such external circuit must operate at 50 μA, the normal tube current.

6.10 Radiation levels (ref: ICRP para 17)

If it is desired to monitor the radiation level around the instrument, due attention should be directed to the R.F. field which can induce false readings in the radiation monitor; to verify the readings observe the effect of a piece of lead sheet in various positions about the detector; if the readings can be made to fall below 0.5 mR/hr at a distance of 50mm from the external surface without placing the lead directly between the detector and the X-ray tube anode then the R.F. field is "swamping" an otherwise "safe level" reading.

The Tel-X-Ometer is certified by the British National Radiation Protection Board as complying with all Codes of Practice recommended by the International Commission on Radiological Protection; the instrument is also approved by the British Government Department of Education and Science for use in educational establishments under the provisions of Administrative Memorandum 1/65.

6.11 Manufacturer's Serial Number

The Tel-X-Ometer is convection cooled, the air being drawn in through a wire mesh underneath the unit and expelled around the perimeter of the top of the cylindrical metal housing.

The Serial Number of each unit is visible through the wire-mesh on the underside of the instrument and is affixed to the shroud of the EHT transformer.

7.0 SERVICING & MAINTENANCE

As with all Teltron equipment the Tel-X-Ometer has been designed to withstand the abuse and misuse which all apparatus used for course demonstration and student practical work traditionally experiences and it will operate for long periods without the need for maintenance.

Some items however will require attention at some time during the useful life of the instrument - the two indicator lamps, fuses, the relay and the X-ray tube.

The indicator lamps and the X-ray tube have a nominal life in excess of 1,000 hours and replacement will be infrequent.

7.1 Replacement of "POWER-ON" and "X-RAYS ON" Lamps.

Switch off and disconnect from mains supply.

Open Shield and unscrew the coloured polystyrene lens.

With the end of a piece of stiff plastic tubing about 10mm in diameter unscrew and remove the bulb.

Similarly insert and screw in the new bulb.

Replace lens.

7.2 Replacement of "POWER FUSE" and "EHT FUSE"

These fuses are readily accessible on the underside of the instrument and will only require replacement if a fault occurs in the power unit circuits or if an incorrect fuselink has been used.

Note that the EHT fuse (see circuit diagram, FS.2) must be either a

1 Amp, Delay Type (originally supplied)

or 2 Amp, Quick Blow Type.

The only other fuselink, FS.3 is provided to protect expensive components in the event of an abnormal failure and as such it is located within the instrument.

7.3 Access to the Electronic Components

Switch off and disconnect from mains supply.

Open Shield and remove hinge cover plate.

Unscrew the lock nut retaining each end of the spectrometer-arm drive cord, located at the back of the apparatus underneath the hinges, see Fig.1.

Carefully release, in turn, each end of the drive cord, keeping it under tension and affix it with a piece of adhesive tape to the respective vertical side of the Manual Control, made of orange plastics material.

From inside the hinge chamber remove the two screws used for terminating the drive-cord.

Close the Scatter Shield.

Invert the instrument onto a piece of soft cloth and remove the four screws fixing the flange of the cylindrical body to the base-casting of the spectrometer table.

Lift the flanged cylindrical housing by tilting it upwards and away from the hinge region and carefully guide it away from the multi-plug cable connector; disconnect the cable connector.

The electronic components on the printed circuit board are now accessible.

7.4 Replacement of Fuselink FS. 3

This fuse protects the supply to the heater voltage stabiliser and is fitted in an open fuseholder mounted on the printed circuit board close to one of the transistor cooling plates.

It will require replacement only if the output terminals of the stabiliser are shorted externally or if an internal short occurs in the stabiliser circuit itself.

FUSE TYPE: 2 Amp Quick Blow Type.

7.5 Replacement of Interlock Relay

The relay controls the interlocked switching of the EHT generator and the correct function of the safety discharge circuit.

Spring off the retaining clip; unplug and replace the relay; replace spring clip.

8.0 FAULT FINDING

It is recommended that unless professional facilities are available the rectification of only minor and obvious faults are attempted by the user; for more obscure faults the instrument should be returned to the supplier.

8.1 Elementary Fault: Indicator lamp fails to operate and the tube filament fails to illuminate.

Possible Causes:
- Mains plug defective.
- Timer switch not operated.
- Power fuse defective.
- Diodė bridge D2 -D5 or D6 -D9 defective.
- Transformer T.1 defective.

8.2 Elementary Fault: "POWER ON" lamp fails to operate but tube filament does illuminate.

Possible Causes:
- Indicator lamp defective.
- EHT fuse defective.
- EHT stabiliser defective.
- EHT oscillator defective.

Operate "X-RAYS ON" momentarily and observe "X-RAYS ON" lamp - switch off instrument.

If lamp operates, then "POWER ON" lamp or the associated wiring is defective.

If X-Rays On lamp does not illuminate, check EHT fuse; if replacement fuse blows when power is switched on, check EHT stabiliser.

If EHT fuse blows check oscillator transistors for VCE short or collector to chassis short.

8.3 Elementary Fault: "POWER ON" lamp operates but tube filament fails to illuminate.

Possible Causes:
- Tube pin contact defective.
- Tube heater coil defective; check continuity.
- Filament supply fuse defective.
- Filament supply stabiliser defective; check input voltage before fuselink.
- Filament supply wiring defective; check heater supply on pins 6 and 13.

9.0 REPLACEMENT OF X-RAY TUBE, TEL 581

IMPORTANT: If a tube is being replaced due to a faulty filament, ensure that at least 6 hours has elapsed since the instrument was last operated; the discharge protection circuit (see 6.8) depends on the illumination of the filament for correct operation; if the filament is not operating, the capacitors in the EHT circuit must be allowed sufficient time to discharge.

9.1 Disconnect the unit from main supply.

9.2 Displace and open the Scatter Shield (see 6.3) and remove the lead glass dome (see 6.4).

9.3 If a tube is being replaced, carefully lift off the top cap connector and remove the tube by pulling in a vertical direction.

9.4 Examine the new tube and ensure that the anode has not been dislocated in transit.

9.5 Orient the new tube such that the bubble window is facing the crystal post; then push the pins of the tube into the base connector, ensuring that the axis of the helical filament is in the direction $2\theta = \theta = 0^{\circ}$.

NOTE: The bubble window may be slightly offset, but the important feature to line up is the filament.

9.6 Carefully replace the top cap connector.

9.7 Replace the lead glass dome and lock in position.

9.8 Place the 1 mm Collimator, TEL 582.001 in the Basic Port with the slot HORIZONTAL.

9.9 Place the 1 mm Collimator Slide, TEL 562.015 at E.S.13 with the slot HORIZONTAL.

9.10 Mount the G/M tube and holder at E.S.22. Connect to the Ratemeter (polarising supply about 420 volts).

9.11 Select 30KV and close and centre the Scatter Shield with the Carriage Arm in the zero position.

9.12 Connect a 100 µA meter to the 'Monitor Tube Current' jack socket on the control panel, using the jack plug provided.

9.13 Switch Power On; the filament should be illuminated if the time switch is not in the off position; if it does not illuminate, proceed as in para. 8.0.

9.14 Operate 'X-Rays On' button; the Red Indicator Lamp should illuminate (see 6.7).

9.15 Check that the tube current can be varied from 20 to 80 µA and set at 50 µA.

IF THE TUBE CURRENT CANNOT BE VARIED UP TO 80 µA REPORT THIS TO THE SUPPLIER OF THE INSTRUMENT. (Adjustment can be undertaken by a trained technician).

9.16 'Height' Adjustment

Remove the lower black rubber grummet located just below the hinge extension.

The screw-head thus exposed controls the "height" of the X-ray tube.

9.17 Using a screwdriver, slowly rotate the screwhead and at the same time observe the Ratemeter.

Note that the count rate depends on the height of the tube; obtain a peak count rate and replace the black grummet.

Before commencing experimental work with the Tel-X-Ometer, carry out the "tilt" adjustment procedure as detailed in para 14.0.

10.0 EXPERIMENTAL TECHNIQUES

10.1 Primary Beam:

The X-ray emission from the tube is collimated at the lead glass dome to be a circular beam of 5mm diameter, see Fig.1; this primary beam diverges from the Basic Port to give a useful beam diameter at the Crystal Post of 15mm diameter, at Experimental Station (ES) 13 of 20mm diameter and at Experimental Station (ES) 30 of 38mm diameter.

Where the primary beam impinges on the lead back-stop it has a diameter of 60mm and a penumbral width of approximately 20mm.

With the unit operating at 30kV and 50 μA the intensity of radiation in the useful beam at 20cm (ES.28) from the focus is about 2 rads per minute.

10.2 Primary Collimators:

The primary beam can be collimated to a fine circular beam using the 1mm diameter Collimator TEL 582.002 and to a ribbon beam using the 1mm Slot Collimator, TEL 582.001; each of these collimators is installed by inserting the 'O' ring shank into the Basic Port and pushing it home; the 'O' ring retains the collimator in position and allows exchange of the collimators even when they become warm.

The collimators should be rotated when they are inserted to ensure that they are securely seated.

The 1mm Slot Collimator can be rotated in position to provide a vertical ribbon of X-rays, a horizontal ribbon or any diametrical ribbon.

10.3 Secondary Collimators:

There are two secondary collimators, a 1mm Slot Collimator, TEL 562.015 and a 3mm Slot Collimator, TEL 562.016.

Each of these collimators is slide mounted and can be positioned in any E.S. on the Spectrometer Arm.

Always use an E.S. Spring Clip, see Fig.1, when positioning these collimators (and indeed any of the experimental slides) to ensure that all the slides are centred on the X-ray beam by pressing them against the numbered side of the carriage which acts as a datum.

The E.S. Spring Clips can be easily repositioned by springing open the toothed jaw on the outside face of the plastics carriage. Six of these E.S. Spring Clips are provided, four on the Spectrometer Arm and two on the Auxiliary Carriage.

10.4 Auxiliary Slide Carriage, TEL 582.005:

A demountable Auxiliary Slide Carriage is included.

Using this carriage, Experimental Stations 1 to 4 can be placed in the X-ray beam in a variety of positions.

Some of the experiments recommended in this booklet require this carriage to be mounted in two particular modes.

Mode H (Horizontal) The hole in the end face of the Auxiliary Carriage is placed over the Basic Port in the glass dome and then held in that position by one or other of the Primary Collimators. In this mode the axis of the centre of each experimental slide is HORIZONTAL and is transcribed by the X-ray beam.

Note that the Carriage Arm is now restricted to a maximum 2θ angle of 100°.

Mode V (Vertical) The end face of the Auxiliary Carriage is placed over the minor diameter of the Knurled Clutch Plate screwed over the Crystal Post, see Fig.1; the crystal mounting jaw and screw should be removed. In this mode the axis of the centre of each experimental slide is VERTICAL and co-incident with the pivot axis of the spectrometer table.

The X-ray beam now passes through the slides at right angles to the centre line axis. The height of the Auxiliary Carriage can be adjusted by screwing the Clutch Plate up or down accordingly.

10.5 Knurled Clutch Plate

When the Clutch Plate is screwed down it exerts pressure on a spring plate which in turn engages the 2:1 spectrometer drive mechanism. When it is unscrewed it disengages the drive mechanism. This permits the Crystal Post to be manually positioned in any desired orientation with respect to the Carriage Arm.

10.6 The 2:1 Spectrometer Mechanism:

Open the Scatter Shield and rotate the Carriage Arm until the cursor gives an accurate no-parallax zero reading on the 2θ scale.

Release the drive by unscrewing the Clutch Plate and push the Slave Plate (the inner rotating plate engraved with two datum lines, see Fig.1) round until the datum lines are accurately opposite the zeros on the θ scale. It may be necessary to "mean out" small zero-reading differences on each side of the θ scale.

Check that the Carriage Arm cursor is still at zero on the 2θ scale and screw in the Clutch Plate to engage the 2:1 drive mechanism.

Now rotate the Carriage Arm through 90° (2θ) and note that the crystal Slave Plate moves through 45° (θ).

10.7 Choice of operating side:

Close the Scatter Shield - note that the Shield can be displaced in two directions; always slide the Shield to the same side as that of the Carriage Arm. Note that the gap between the Shield and the spectrometer table, where the Carriage Arm normally freely rotates, is eliminated on one side of the instrument, depending on the direction of displacement at the hinge.

To transfer the Carriage Arm to the opposite side, rotate the arm to the smallest angle possible, about 11° (2θ); now open the Shield by sliding away from the Carriage Arm and then rotate the arm through the zero axis to the opposite side.

10.8 Fine and Coarse Controls:

The Carriage Arm is terminated outside the Shield with an orange plastics Manual Control; measurements can be made at the cursor to an accuracy of 15 minutes of arc.

To achieve fine adjustment of the Carriage Arm, rest the hand on the base flange of the Tel-X-Ometer or on the bench top and using the thumb rotate the knurled aluminium drive wheel protruding from the Manual Control.

To achieve fine measurements line up the cursor exactly on the most convenient 2θ graduation which is central within the region requiring detailed examination; hold the Manual Control rigidly in this position and "slip" the Thumb Wheel against the friction of the drive cord until the zero on the Thumb Wheel scale aligns exactly with the pointer.

Now the Thumb Wheel can be moved $\pm 4^{\circ}$ (2θ) about the preset centre line by an amount which can be measured at the Thumb Wheel scale to an accuracy of 5 minutes of arc; this amount should be added or subtracted from the selected cursor setting according to the direction of movement of the arm.

10.9 Mounting of cubic crystals:

Select the LiF crystal (BLUE) from the box of accessories and place one of the short edges onto the step in the Crystal Post; ensure that a long broad face, a (100) cleavage plane, is butting against the chamfered protrusion of the post, see Fig.2. Screw up the clamp until the crystal is held securely by the rubber jaw.

Ensure that the crystal is vertical and flat on the step.

THE EXPERIMENTAL FACE OF THE CRYSTAL IS THAT FACE WHICH IS COINCIDENT WITH THE CHAMFER ON THE POST.

10.10 Mounting of Geiger Muller Tube:

Plug the G/M tube MX168 (TEL 546) into the Holder, TEL 547.

Place the square flange of the holder in E.S.26 on the carriage arm without use of an ES Spring Clip, ensuring that the co-axial cable is leading out from the underside and that the end-window of the G/M tube is facing the Crystal Post. It is advisable to leave the plastics guard over the end-window unless very feeble count rates are to be monitored.

The co-axial cable can be trailed out from the Shield beside the Manual Control.

10.11 General Facilities:

There are two radiation-proof ports located at each end of the hinge cover plate for introducing large cables, vacuum pipes, etc. into the experimental zone.

There are four blind holes on the surface of the spectrometer table for the mounting of innovative experiments of the teachers' or pupils' choice; these holes are 4mm diameter, located around the θ Scale and marked A, B, C and D.

11.0 MONITORING INSTRUMENTS:

During Bragg Diffraction experiments (from Experiment D.14) count rates of 800 to 1,000 counts per second are experienced for CuKα reflections from the Lithium Fluoride crystal. Count rates of up to 500 cps are more normal for the other three crystals, NaCl, KCl or RbCl.

Background count rates vary from up to 300 cps at the top of the "whale-back" down to 10 cps at the tail-off.

For crystallography experiments therefore a Ratemeter capable of integrating up to 2000 cps is recommended.

For measurements in the main X-ray beam it should be noted that the normal intensity of radiation will saturate the G/M tube; the MX168 has a dead time of 100 microseconds and hence the G/M tube will saturate at a count rate of 10,000 cps; the X-ray tube current must be reduced to about 5 μA to prevent saturation and achieve a count rate of about 7,000 cps. For quantitative experiments in the main beam therefore a Ratemeter capable of integrating up to 7/8000 cps is recommended.

The X-ray tube current should NOT be adjusted without monitoring the current, using the jack-plug provided and an external 100 μA or 150 μA meter.

NEVER EXCEED 80 MICROAMPS.

The polarising supply for the MX168 G/M tube should be variable from 250 to 450 volts d.c.; the threshhold voltage is about 370 volts d.c.

When varying the tube current from 20 to 80 μA the EHT will remain constant within 5% of the selected value, 20 or 30 kV. Conversely, when varying the EHT from 30 to 20 kV the regulation is such that the tube current will remain constant within 5%.

12.0 OPERATIONAL ALIGNMENT:

The Tel-X-Ometer has been carefully aligned during the final stages of factory inspection; but to verify that the pre-set-alignment has not been disturbed during transit it is recommended that the following tests be performed.

12.1 Place the 1mm Collimator, TEL 582.001 in the Basic Port and the 1mm Collimator Slide, TEL 562.015 at E.S.30 and ensure that both collimators are vertical.

12.2 Zero-set and lock the Slave Plate and the Carriage Arm cursor as precisely as possible.

12.3 Spring a Spindle Clip TEL 567.008 over the chamfered Crystal Post and carefully insert a Glass Fibre TEL 567.004 to be truly vertical, see Fig.3.

12.4 With the Scatter Shield open, operate the POWER ON switch and sight through the collimators to view the reflection of the tube filament in the copper target anode.

The Glass Fibre should normally be observed as central in the "viewing column" created by the two collimators, i.e. the direction of the primary beam and it should be possible to obtain an uninterrupted view of the anode past each side of the fibre; the glass dome can be rotated by a small amount if the two dome-locks are unscrewed.

12.5 Remove the Glass Fibre and the Spindle Clip.

13.0 EXPERIMENTAL VERIFICATION:

Mount the LiF Crystal (Blue) in the Crystal Post (see "Induced Dislocation", Part 2, para D.27.30).

13.1 Check that the cursor is at zero reading (2θ) and again sight through the collimators; the direction of the primary beam should lie in the surface of the crystal, as does the axis of rotation.

13.2 The normal to the reflecting face of the crystal should bisect the angle between the primary beam and the centre line of the Carriage Arm; for Bragg reflection experiments the arm should always be moved to the same side of the crystal as that occupied by the chamfered Crystal Post protrusion.

13.3 Move Collimator (1mm) 562.015 to E.S.18 and mount Collimator (3mm) 562.016 at E.S.13. Mount the G/M tube and Holder at E.S.26.

Connect to the Ratemeter and energise the polarising supply to the G/M tube (400 - 420 volts d.c).

13.4 Check that the voltage selector indicates 30kV.

13.5 Move the Carriage Arm through at least 15° (2θ) in the direction to detect Bragg Reflection.

13.6 Close and centre the Scatter Shield.

13.7 Depress the "X-RAYS ON" button; the RED signal lamp should be illuminated.

13.8 Verify that a strong CuKα reflection (high ratemeter count rate) is evident at a 2θ angle of $45^{\circ} \pm 30'$.

Record the 2θ angle of the peak reflection.

IF THE PEAK OF THE REFLECTION LIES OUTSIDE THIS TOLERANCE THEN THE X-RAY TUBE SHOULD BE ADJUSTED FOR 'TILT' AS IN PARA. 14.

Now record the equivalent reflection on the opposite side of the table.

13.9 Return the Carriage Arm to about 12° (2θ) and open the Shield by displacing it away from the arm.

13.10 Unscrew the Clutch Plate, rotate the Slave Plate (and thereby the Crystal) through 180° and again zero-set the Slave Plate and the Carriage Arm as precisely as possible.

13.11 Repeat stages 13.5 to 13.8 and record the 2θ angle of the peak CuKα reflection.

13.12 The Mean Reading of the reflections recorded at 13.8 and 13.11 should be 44° 56' ± 12'.

WHEN MAKING ACCURATE ANGULAR MEASUREMENTS EXPERIMENTAL ERRORS SHOULD BE MINIMISED BY EMPLOYING THIS TECHNIQUE OF TAKING A MEAN OF THE EQUIVALENT READING AT EACH SIDE OF THE SPECTROMETER TABLE.

13.13 The Tel-X-Ometer is now commissioned and certified as capable of measuring angular deflections (2θ) to an accuracy of ± ½%.

14.0 "TILT" ADJUSTMENT OF X-RAY TUBE:

Before proceeding with this adjustment carefully repeat both paras 12 and 13 to ensure that no alignment errors have been introduced.

14.1 Remove the upper black rubber grummet located just below the hinge extension.

The screw-head thus exposed controls the "tilt" of the X-ray tube about a central position.

14.2 Set the cursor of the Carriage Arm at the exact mean of the reading measured at para. 13.8 and the true Bragg angle (2θ) for LiF of 44° 56'.

14.3 Obtain a peak count rate by carefully adjusting ONLY the 'tilt-control' without displacing the Carriage Arm.

14.4 Now seek and record a peak reflection by displacing the Carriage Arm only, without operating the tube tilt-control.

14.5 Set the cursor at the exact mean of the reading measured at para 14.4 and the true Bragg angle 44° 56' (2θ).

14.6 Iteratively repeat paras 14.2, 14.3 and 14.4 until the cursor peak reading falls within the tolerance 45° ± 30'.

14.7 Replace the black rubber grummet and carry out recommendations 13.9 to 13.12.

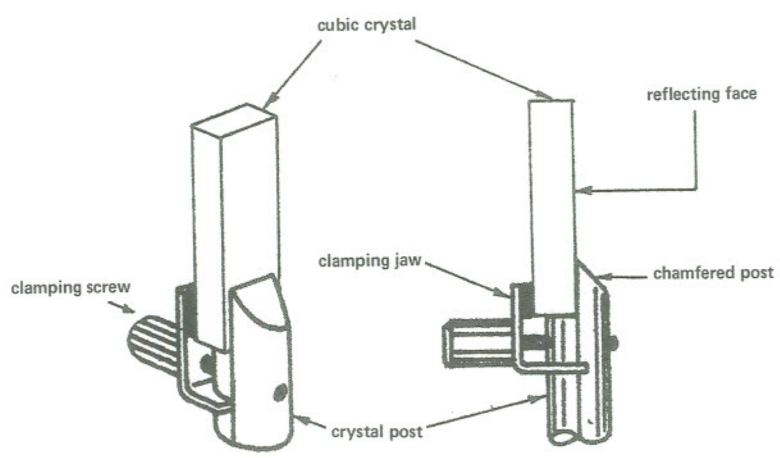

FIG. 2 MOUNTING OF CUBIC CRYSTALS

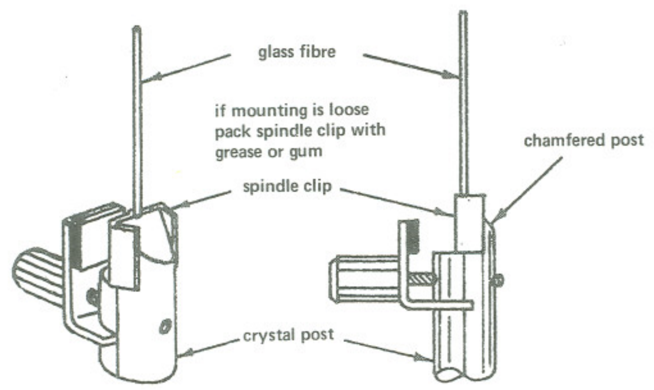

FIG. 3 MOUNTING OF GLASS FIBRES

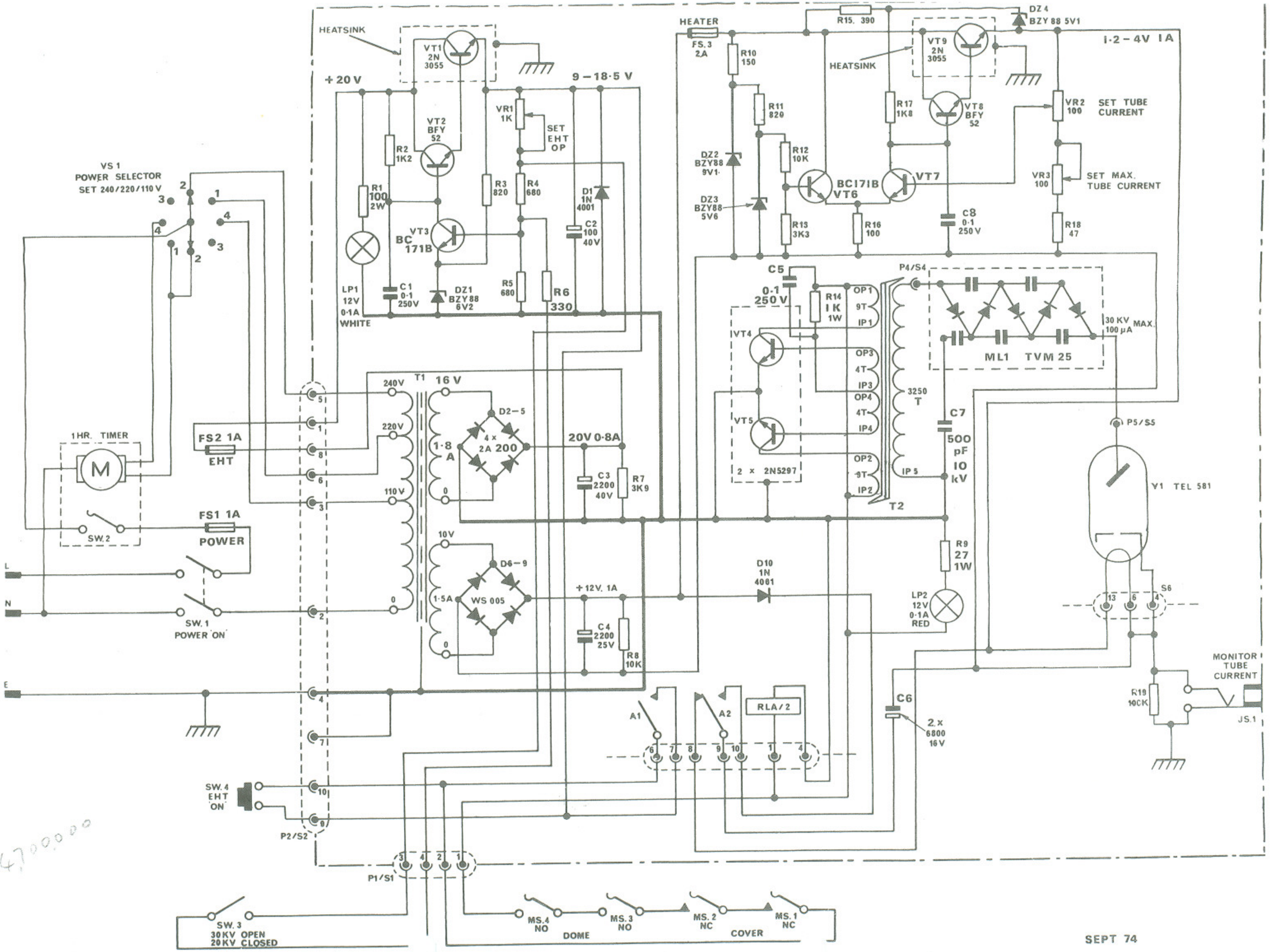

FIG. 4 — TEL-X-OMETER, TEL. 580 : CIRCUIT DIAGRAM.