BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL

PRACTICAL ELECTRONICS

COMPONENTS LIST AND STUDY INSTRUCTIONS FOR STEP NO.1

INSTRUCTIONAL MATERIAL

1. "Principle of Operation of a Cathode Ray Oscilloscope"
2. "Electronic Components", Part A dealing with resistors and capacitors
3. Practical Work Instructions for this Step, which includes preparing the Matrix Board, and Tag Strips, and determining the values of resistors and capacitors supplied.
4. Diagrams. Figs. 1, 2 and 3.

COMPONENTS SUPPLIED

1. Front Panel, ready engraved. This will not be used until Step No. 2. Take great care not to damage the surface of the panel.
2. Set of resistors attached to card (8 resistors) ✓
3. Set of capacitors attached to card (7 capacitors) (C4 TO Follow)
4. 1 - Matrix Board 149mm x 114mm x 1.6mm, drilled with 58 x 42 - 1.3mm holes at 0.1" (0.254mm) pitch.
5. 1 - 36-way Tag Strip 117mm x 38mm
6. 120 - Terminal Pins (double ended) 1.3mm dia., 12mmlong TO Follow
7. 15 - Terminal Pins (single ended) 1.3mm dia., 7 mm long ✓

9. 1 - Pack of hardware (bolts, nuts, washers etc.) comprising:-

   4 B.A. parts
   - 3 - 1" long cheesehead bolts
   - 1 - ¾" long " "
   - 5 - ½" long " "
   - 1 - ⅜" long countersunk bolts
   - 2 - ¼" long cheesehead bolts
   - 12 - nuts
   - 12 - washers
   - 2 - solder tags, double ended
   - 4 - ½" long spacers

NOTE ALL LERNAKIT STUDENTS.

The supply of all electronic components is subject to availability from manufacturers and this means that you may receive types of components which appear to vary slightly from descriptions or illustrations shown in our instructions. In every case, however, the component supplied has been checked to ensure that it will be an adequate substitute and will perform its function electronically exactly as required in our apparatus or experimental work.

As examples we would advise you

(1) Certain resistors may be of $\frac{1}{2}$ watt type instead of $\frac{1}{4}$ watt or may be 10% instead of 5%. A little extra space may be needed to mount such resistors but this can usually be done without difficulty.

(2) Capacitors - all types. Models and types are continually changing and this in fact gives you experience in handling new types. New types are often of the 'block' or mini-box shape with short leads. These leads can be inserted directly through the holes in the perforated board - but you may need to solder extra wire to the ends so as to lengthen them. Values printed may differ slightly, e.g. a 16 mfd may be used in place of a 15 mfd or 10 mfd 25 volt can be used instead of a 10 mfd 10 volt (a <u>higher</u> voltage rating is always OK to use - not the other way round).

In fact, therefore, some improvisation may be necessary from time to time in the course which is in itself a way of gaining practice AND experience - it is impossible for us to guarantee that all components are <u>exactly</u> as described in our text - but they <u>will</u> be exactly to specification for doing their jobs in the circuit concerned.

Please note that some components may also run quite hot when operating. In the case of the C.R.O. - this will be evident in the case of transistors VT2, VT3 and resistor R7. Heat is quite normal - but of course it should not cause discolouration.

<u>Electrolytic capacitors</u>

These are not always marked with a + or a - to show the polarity. However, the connection which is joined, or comes from, the <u>CASE</u> or container of the capacitor is always the <u>NEGATIVE</u> . Careful examination will show that the other connection (the +ve) is insulated from the case.

6 B.A. parts

2	-	¾" long cheesehead bolts
4	-	½" long " "
4	-	¼" long " "
4	-	¼" long countersunk bolts
14	-	nuts
14	-	washers
2	-	⅜" long spacers

Changes in components, wires etc.

From time to time, we may make small changes in types of components supplied due to supply problems or changes made by components manufacturers. For example a 22K potentiometer may be supplied instead of a 20K type or a ½ watt resistor instead of a ¼ watt type or a 0.047 mfd. 500 volt capacitor instead of a 0.05, 350v capacitor. These changes will make no difference to the operation of the equipment. A note will normally be made on the contents note or with the component saying what substitution has been made.

STUDY INSTRUCTIONS

1. Carefully study the manual "Electronic Components" Part A.
2. Study the resistors and capacitors, attached to the cards, but do not remove them from the cards. By noting the colour codes, write down the value of each component, beside it, on the card. These components will be used in later steps.

   With Step No. 2, you will be given an answer sheet, so that you can check the values.
3. Read "Principle of Operation of a Cathode Ray Oscilloscope" to obtain a general idea of how such an instrument operates.
4. Carry out the work described on the Practical Work Instruction Sheet attached.

NEXT STEP

In the next step you will:-

1. Study variable resistors and switches
2. Commence assembly of the Front Panel of the Oscilloscope.
3. Commence drawing the circuit diagram of the instrument.

INTRODUCTION

During the first 12 steps of the Course we are going to be concerned with the following Programme:-

1. Learning about all the principal components used in electronics, their properties, how to recognise them in practice, by drawings and circuit symbols and to be accustomed to handling and using them in assembly work.

2. Building an Oscilloscope in order to learn the art of assembly and wiring and, most important, how this is related to a CIRCUIT DIAGRAM OR SCHEMATIC so that the latter can be fully understood.

   We deliberately have not used printed circuitry in this exercise as it would then be impossible or extremely difficult for students to follow each operation.

   Students are not expected to understand the operation of the CRO circuitry at this stage nor the functions of the various components used in the circuit.

   In the second part of the course, steps 13-18 we shall cover both the theory and practical of all the basic electronic circuits using the oscilloscope to show how these circuits behave in operation.

   At the end of the course we shall return to the oscilloscope and explain how its circuitry actually operates.

PRACTICAL WORK INSTRUCTIONS

STEP NO. 1 (SEE FIGS. 1, 2 and 3)

1.1 PREPARATION OF TAG STRIPS

Using a fine-tooth saw, cut the 36 way tag strip into two parts to form a 26 way, and a 10 way strip as shown in Fig. 1.

NOTE: These tag strips will be referred to in later assembly instructions as follows:-

10 way tag strip - Tag Strip No. 1 (TS1)

26 way tag strip - Tag Strip No. 2 (TS2)

STEP 1 - FIG 1

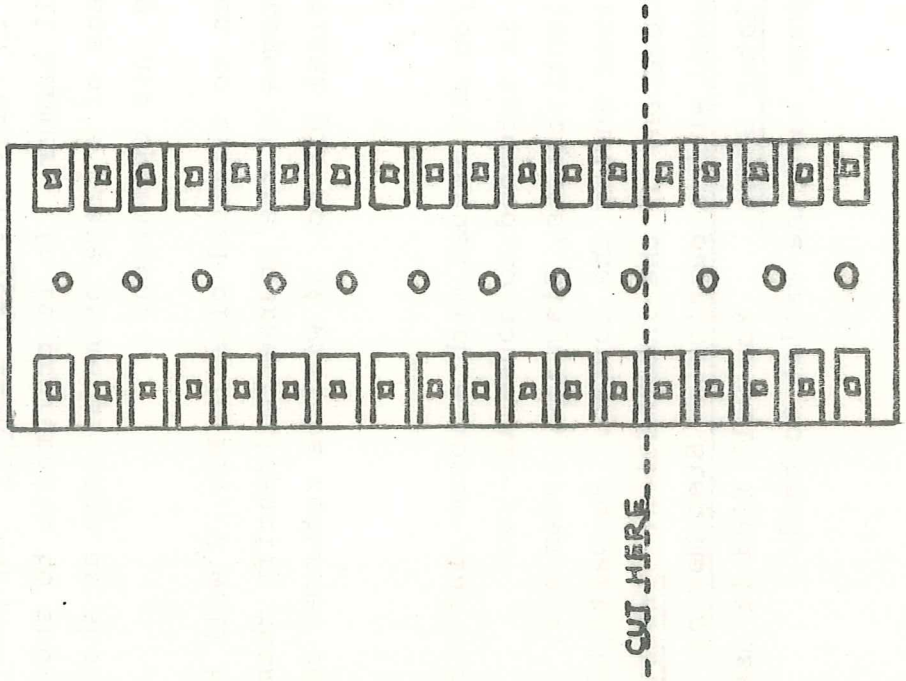


FIG 1. PREPARATION OF TAG STRIPS.

1.2 PREPARATION OF MATRIX BOARD

(a) We commence by drilling 3 holes which will be used later for supporting the board and fixing it to the CRO chassis. Drill 3 holes approximately 0.15" diameter in the board, in the positions shown on Fig. 2. If you have no means of measuring a drill diameter precisely, choose one which will be large enough to provide a good clearance for a 4 B.A. screw, whilst allowing plenty of material around the hole to support a nut. If you do not possess a drill (hand or electric) - the holes can be made by using the point of a scissors blade - gradually and very gently making the hole large enough for a 4 B.A. screw to enter. Use the scissors point on each side of the board whilst gradully enlarging the hole. See diagram below.

Check carefully that you have chosen the correct positions for the holes before drilling them. You will notice that Fig. 2 has a graticule drawn on it which is accompanied by two inch scales. The crossing points on the graticule correspond with the centres of the small holes already provided in the board, which are 0.1" (2.54mm) apart in both directions. The centres of the three 0.15" (4mm) diameter holes coincide with three of the existing holes. You can therefore locate the required positions, either by counting the number of holes from the 'O' lines on the graticule in both directions, or by using a rule calibrated in tenths of an inch.

The board is somewhat fragile so be careful not to bend it during drilling or it may break. If possible, hold it in a vice with the hole being drilled as close as possible to the jaws. If you do not have a vice the board can be held firmly on a bench or on a piece of softwood whilst you work on it.

Drg No. SC 133

PERFORATED CHASSIS BOARD

MATRIX - 58 x 42 HOLES 1·3 mm dia @ 2·54 mm pitch

SCALE - approx 2× ACTUAL SIZE

STEP 1 - FIG 2

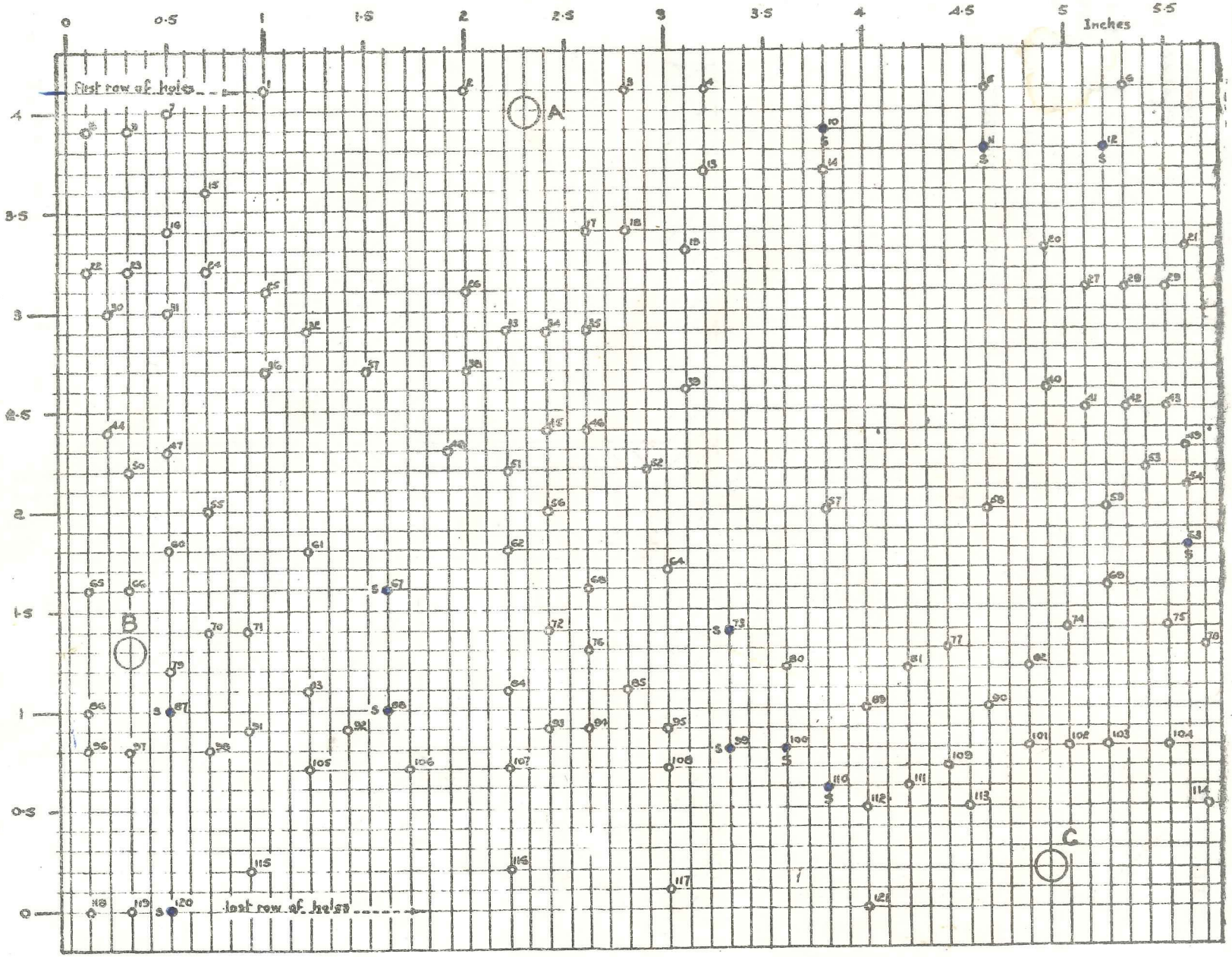
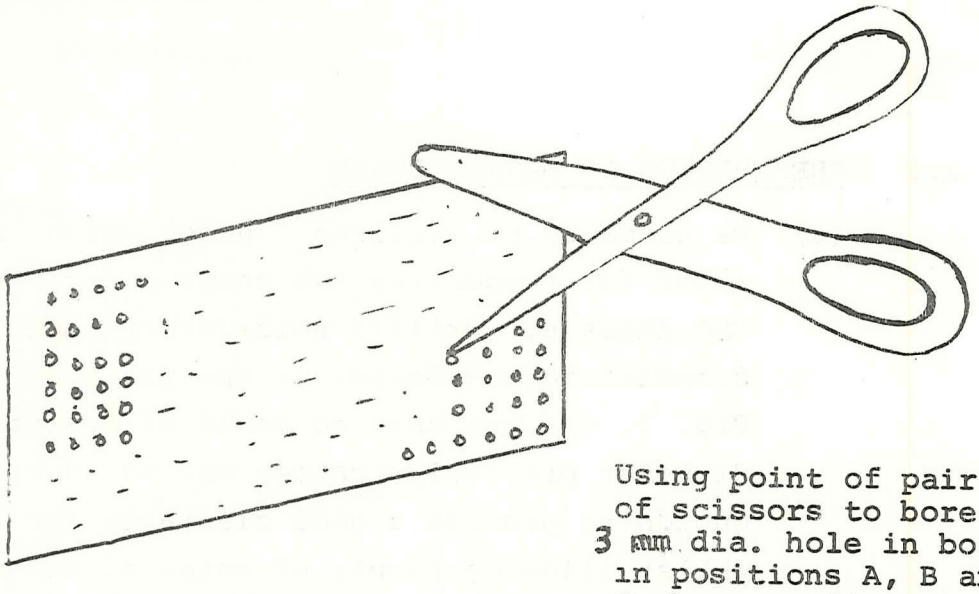


FIG. 2 POSITION OF TERMINAL PINS & FIXING HOLES

A; B; and C show position of 3mm holes to be drilled.



Using point of pair of scissors to bore out a 3 mm dia. hole in board in positions A, B and C shown on diagram Fig.2.

1.2 (b) Fit the terminal pins in the holes in the Matrix Board indicated on Fig. 2, starting with No. 1 and proceeding in order to No. 121. You will notice that some holes shown on Fig. 2 have a letter 'S' against them. This indicates that single ended pins should be used in these holes.

Make sure you have the board the right way round before inserting the pins i.e. the single drilled hole at the top, with the board in front of you. We shall call the side of the board now facing you "the front of the board" and the other side "the back of the board". It may be as well to mark the front by means of a small piece of self adhesive tape stuck on the front of the board.

The terminal pins have a shoulder on them with a knurled area beneath it, which grips the inside surface of the hole into which it is inserted. You will find that the knurl can be lightly pushed into a hole by hand, but do not attempt to push a pin into a hole until the shoulder makes contact with the board. surface. This will require considerable force which will almost certainly result in cracking the board, unless special precautions are taken.

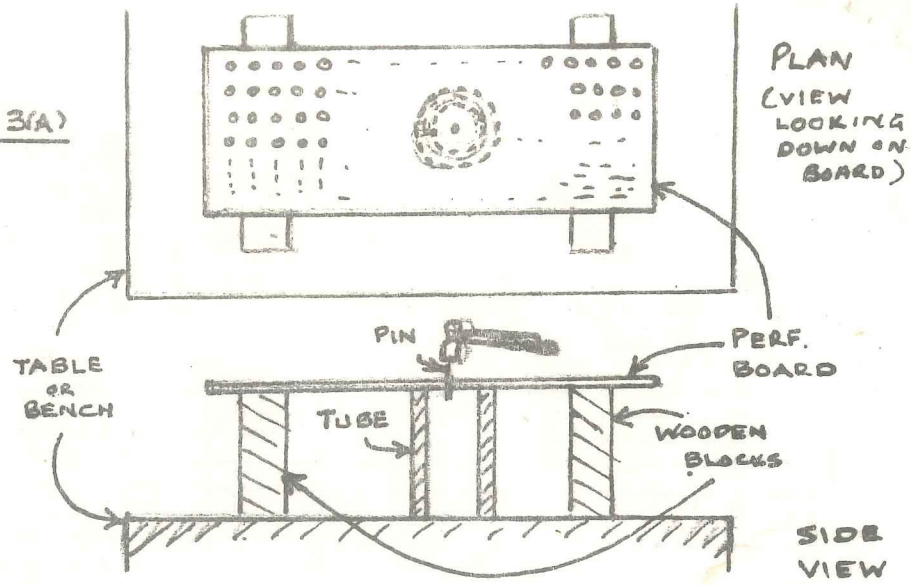
Insert all pins from the front of the board, using only sufficient force to prevent them falling out again. (N.B. - Single Ended pins project at the back of the board).

When you are sure that all pins are in their correct positions, support the back of the board immediately around each pin in turn, and very lightly tap the pin home with a small hammer. It is preferable to support the board by means of a piece of metal tube as shown in Fig. 3 during this operation.

The numbers given to terminal pins in Fig. 2 will be used in later stages of the Course to identify them. For example terminal pin No. 34 will be referred to as "T 34".

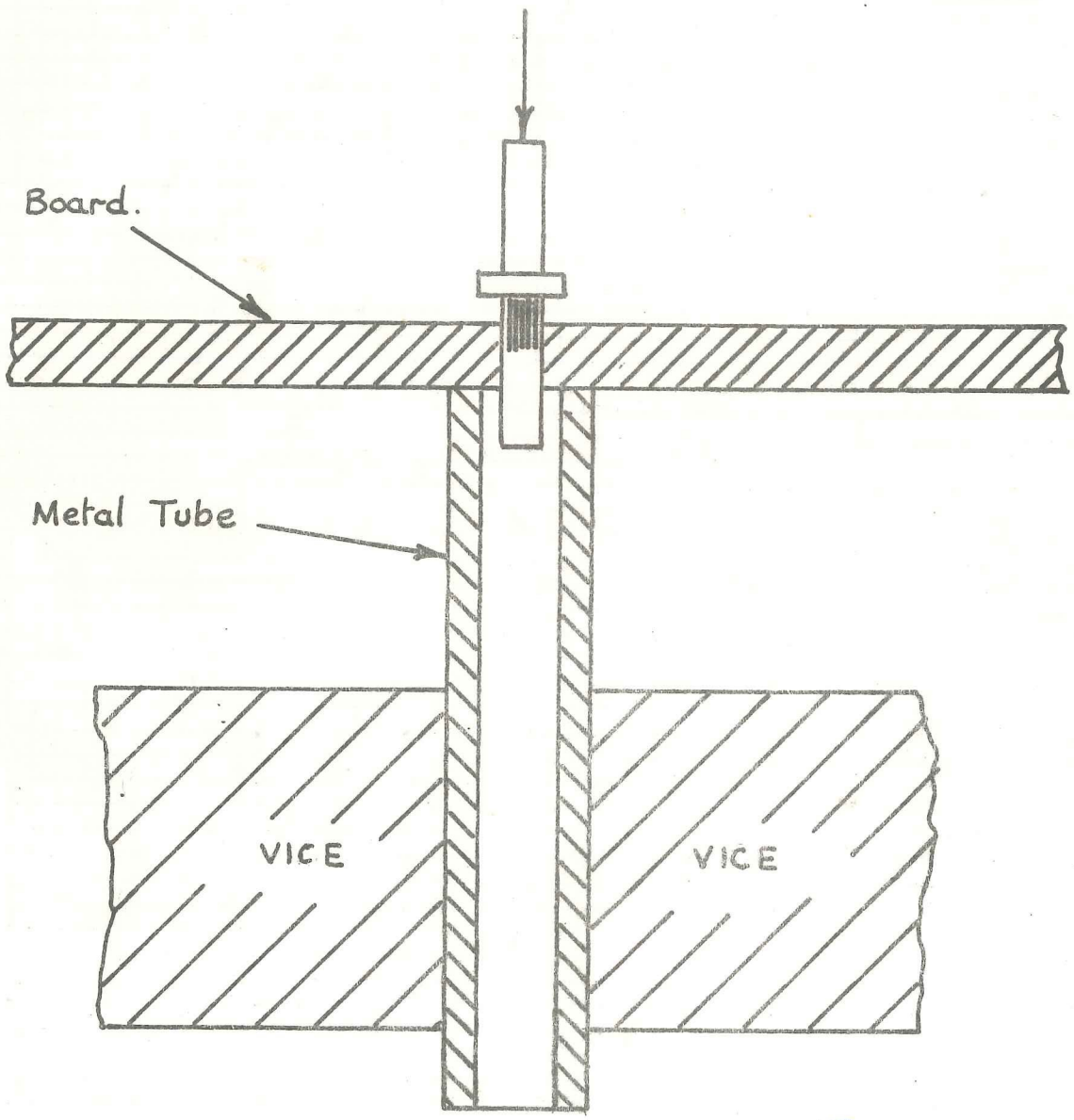
NOTE: With this Step you are issued with a loose-leaf binder or wallet which is intended to house all your Practical Work Instructions, Diagrams, notes etc. as you receive them during the Course. Be particularly careful not to lose any of the information. Instructions and Diagrams issued with a particular Step may be referred to in later Steps. You will find it useful therefore to always have the wallet to hand.

FIG 3(A)



STEP 1- FIG 3

Tap lightly a number of times with a small hammer.



IF VICE NOT AVAILABLE - SUPPORT BOARD BETWEEN WOODEN BLOCKS AS SHOWN IN FIG 3(A) ABOVE

FIG. 3 FITTING TERMINAL PINS

BRITISH NATIONAL RADIO AND ELECTRONIC SCHOOL

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COMPONENTS LIST AND STUDY INSTRUCTIONS FOR STEP NO.2.

INSTRUCTIONAL MATERIAL

1. "Electronic Components" Part B on Switches, and Relays (with Appendix on Valves, Metal Rectifiers and Sundries).
2. "Circuit Diagrams" Leaflet describing the use of the circuit diagrams provided with the Course.
3. First Circuit Diagrams for Step No. 2.
4. Practical Work Instructions for this Step.
5. Answer Sheets for Resistor and Capacitor Cards
6. Diagrams Figs. 4, 4A and 5.

COMPONENTS:

Potentiometers (Variable Resistors)

1 - 20 Kohm or 22 Kohm pot. (RV2) Y shift control
1 - 50 Kohm or 47 Kohm pot. (RV6) X shift control
1 - 500 Kohm or 470 Kohm pot. (RV4) Focus control
1 - 500 Kohm or 470 Kohm pot. with switch (RV5, S2). Brilliance control combined with on/off switch.

Switch

1 - 3 - pole, 4-way switch (S1) for timebase range control

Sundries

1 - Pointer Knob for ¼" spindle
8 - ¾" dia. knobs for ¼" spindle
2 - Hoods for C.R.T.
1.9" (22mm) length (6mm) ¼" square plastic foam with self adhesive backing.

STUDY INSTRUCTIONS

1. Using the two Answer Sheets, check that you wrote down the right values for the resistors and capacitors supplied in Step No. 1. If not correct, alter your sheet accordingly, and make sure you understand why you made mistakes.

2. Carefully read Part B of "Electronic Components" paying special attention to the section on switches.

3. Carry out all the practical work described on the sheet attached (instructions 1-5 and Preparation of the C.R.T. Hood)

4. Read carefully Pages 3 to 7 of this step on 'Circuit Diagrams'

PRACTICAL WORK INSTRUCTIONS

STEP NO. 2

Assembly of Front Panel

This stage is concerned with fitting certain components to the C.R.O. front panel. Refer to Figs 4 and 5 for component layout information and make sure that the items are arranged exactly as shown. The variable resistors (or potentiometers) have been given identification numbers (RV7 etc.) which will be used frequently during the practical course.

1. Lightly fix the 3-pole 4 way 'T/B RANGE' switch (S1) to the front panel (washer between switch and front panel), then fit the pointed control knob to its shaft. Rotate the switch until the pointer of the knob lines up with the engraving on the front panel for all four positions, then carefully remove the knob and tighten the fixing nut of the switch. Replace the knob afterwards. If S1 has a protruding

tag beside the shaft, this tag should be cut off or bent back against the switch before fitting it to the front panel.

If the switch is contained in a plastic case similar to that shown in Fig. 3 of the Electronic Components Manual, Part B, the locating peg projection should be filed off, so that the switch can seat correctly on the panel surface.

2. Fit the 500 K-Ohm variable resistor fitted with a switch to the front panel hole labelled "Brill On/Off". This is the BRILLIANCE control (RV5) and combines the MAINS ON/OFF switch (S2). Fit its control knob.

3. Fit a 500 K-Ohm variable resistor to the front panel hole labelled 'FOCUS'. This is the FOCUS control (RV4). Fit its control knob.

4. Fit a 50K variable resistor in the front panel hole labelled 'X-SHIFT'. This is the X-shift control (RV6). Fit its control knob.

5. Fit a 20 K variable resistor in the front panel hole labelled 'Y-SHIFT'. This is the Y shift control (RV2). Fit its control knob.

This completes the assembly of the components associated with Step No. 2. Thoroughly check the positions of the components against the layout diagrams of Fig. Nos. 4 and 5.

6. Preparation of C.R.T. Retaining Hood

Remove the protective material from the adhesive backing of the foam strip and carefully stick the foam around the inside surface of one of the Hoods, ensuring that the edge of the foam is flush with the outer surface of the mounting flange as shown in Fig. 4A. This Hood will be described as "The C.R.T. Retaining Hood" when fitted in a later step.

STEP NO. 2 - USE OF CIRCUIT DIAGRAMS

Three copies of the Circuit Diagram for the Oscilloscope are included with the Instruction Material for this Step, the purpose of which are described in paragraph 3(a), (b), and (c) below.
Before referring to these paragraphs, however, you should give

some time to studying the outline copy of the Circuit Diagram, particularly to discover the way in which the diagram is laid out. It is important that such diagrams should convey in the simplest possible manner, exactly how the equipment functions.

You should note the following points:-

1. The Circuit Diagram <u>does not show every wire</u> exactly as it appears in the actual equipment. To do so would produce a very confusing diagram. However, the diagram must of course be electrically correct. In practice this means for example that points connected to a common supply rail, are in fact shown connected together on the diagram, but they may not be connected in the same order, or in the same manner, in the actual equipment. This will become clear as you carry out your work.

2. The diagram is arranged to follow the flow of d.c. current or signal as nearly as possible as it occurs in the actual equipment. To this end:-

    (a) The most positive supply rail appears at the top of the paper or section of the diagram, with less positive rails in magnitude order beneath it, followed by perhaps a zero voltage rail (ground) and negative supply rails in ascending order of magnitude as we proceed down the paper. This layout infers that d.c. currents will generally flow downwards on the paper in all parts of the circuitry.

    (b) For the same reason, all transistors are shown with their emitters (the electrode carrying an arrow on the circuit diagram) pointing downwards. The arrow in fact indicates the normal direction of d.c. current flow at the emitter.

    (c) The route followed by a signal through the circuitry, for example, starting at the Y input terminal and finishing at the cathode ray tube deflection plates,

is reflected in a steady flow of the diagram, in this case from left to right on the paper. It is not essential that the signal route should always be from left to right, so long as the route is well defined on the diagram.

3. Circuit Diagrams of the Oscilloscope Provided with a Number of Steps of this Course

(a) Green Copy (Students Trial Copy

This supplied so that you can make your own attempt to trace out the operations given in the Practical Work Instructions and Wiring Diagrams supplied with each step. You should do this with a coloured pencil, over-printing the appropriate lines on the circuit shown on the green sheet.

During the early part of the course, it may be difficult to carry out all this work. However after experience has been gained, it should become easier to complete without prior reference to the Yellow sheet. Do try and do as much as possible without looking at the yellow copies.

(b) Yellow Copy (Students Answer or Key Copy)

This is your Answer Sheet to the green copy. It shows in thick dotted lines, the part of the circuit dealt with in the step concerned. Check this against your own attempt on the green sheet and make sure you understand what has been done.

Note that each Yellow Diagram covers only the operations in the Step to which it refers. It does not repeat information given in previous steps.

As well as showing parts of the circuit in dotted lines, the instruction reference number, dealing with a

particular connection or component in your Practical Work Instructions, will often also be shown on the Yellow copy. Such instruction references are shown within a small circle thus: (32) These will be an aid to you, should you have difficulty in locating a connection. However not all instructions will be shown since this can clutter up the diagram unnecessarily. We aim to show all the most important references. In particular, when an instruction calls for a component to be fitted, the details of that component (its reference number and value, for instance) will generally be given on the circuit diagram, and not the instruction reference number. However, to assist you in the early stages, instruction references have been included on the diagrams for Steps Numbered 2 and 3 for all instructions. The few components fitted in Step 2 are also shown 'boxed' within a dotted line around them to aid recognition.

It will not be expected that you should mark up your green copy with as much detail as given on the yellow copy, especially in the later Steps, so long as you are satisfied that you have fully understood each instruction and its interpretation on the Circuit Diagram. The word 'interpretation' is chosen deliberately. You will need to bear in mind the content of paragraph (1) of this leaflet in order to interpret a number of connections correctly.

(c) White Copy

This is your MASTER SHEET which must be kept throughout the Course.

Carefully copy on to this sheet all the relevant information given on the Yellow Copy. Instruction references need not be included unless they are the only adequate way of indicating a particular operation.

Assembly/wiring operations should be shown by over-printing, preferably in coloured pencil or ball pen, and using the appropriate colours indicated in the yellow copy. (White may prove a difficult colour to use, in which case use an alternative, say pink, but ensure that you make a note of this at the bottom of the diagram).

As each step is completed, so more and more information will be added to this white master, until at the end of the Course, you will have a complete Master Circuit Diagram, which will then be checked by your Tutor.

If you should spoil or make a mistake on the white sheet, further copies can be obtained on request.

IMPORTANT NOTE ON CIRCUIT DIAGRAMS

Wires which cross but are not joined at the crossing point are shown thus  .

Wires joined are shown staggered thus  .

Now go ahead and complete green circuit diagram No. 2. showing the operations carried out in paras. 1 to 5 of the Practical Work Instructions (Page 3).

When finished, compare with the yellow copy as described above.

NEXT STEP NO. 3

In the next step we shall start the first wiring up work commencing with the switch and the potentiometers on the front panel.

STEP NO. 2

VALUES OF RESISTORS ON CARD (STEP NO.1)

No.	Circuit Ref.	Value	Colour Code
1	R4	470 ohms	Yellow, violet, brown
2	R21	1.2 Kohms	Brown, red, red
3	R7	100 Kohms (2 watt)	Brown, black, yellow
4	R1	100 Kohms	Brown, black, yellow
5	R9	1 Mohm	Brown, black, green
6	R20	10 Kohms	Brown, black, orange
7	R6	47 Kohms	Yellow, violet, orange
8	R19	820 Kohms	Grey, Red, Yellow

VALUE OF CAPACITORS ON CARD (STEP NO. 1)

No.	Circuit Ref.	Value	
1	C2	0.01 mF 500v	
2	C12	4700 pf OR 5000 pf in lieu	
3	C13	0.047mF	Yellow, violet, orange *
4	C16	0.1 mF	Brown, black, yellow *
5	C4	0.1mF 500 v or higher	
6	C14	0.47mF	Yellow, violet yellow *
7	C10	470 mF 25V	

* Capacitors supplied may not have been colour coded but marked with their actual values.

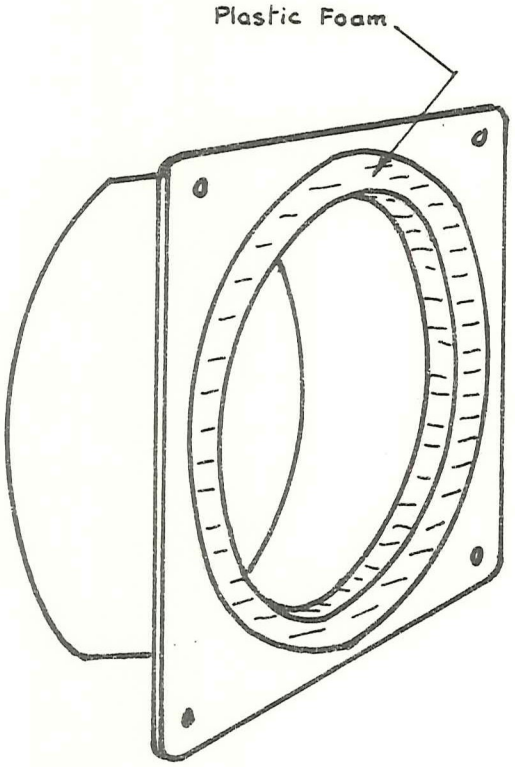

FIG4A. FITTING FOAM STRIP TO C.R.T. RETAINING HOOD.

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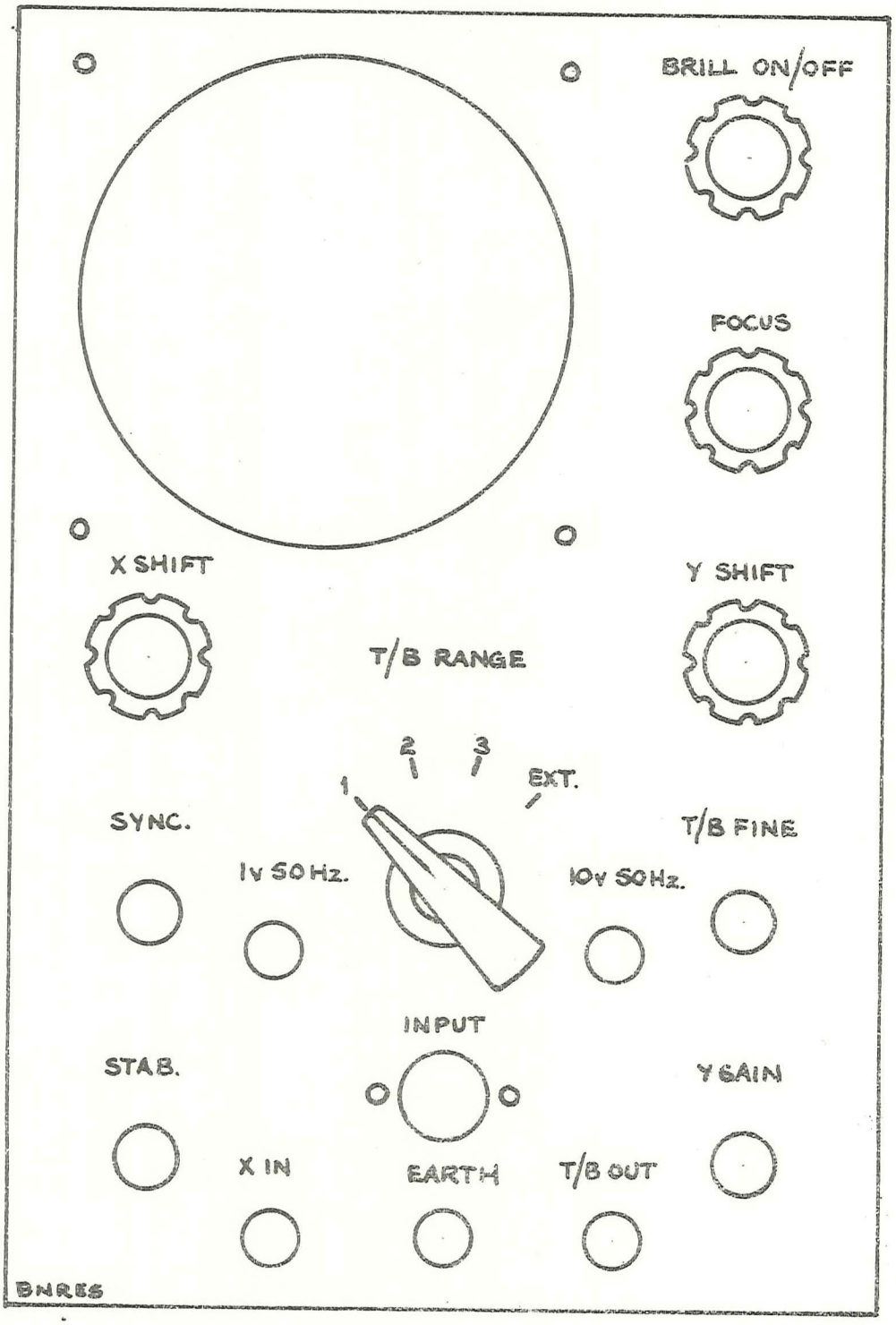

FIG.4. FRONT PANEL LAYOUT.

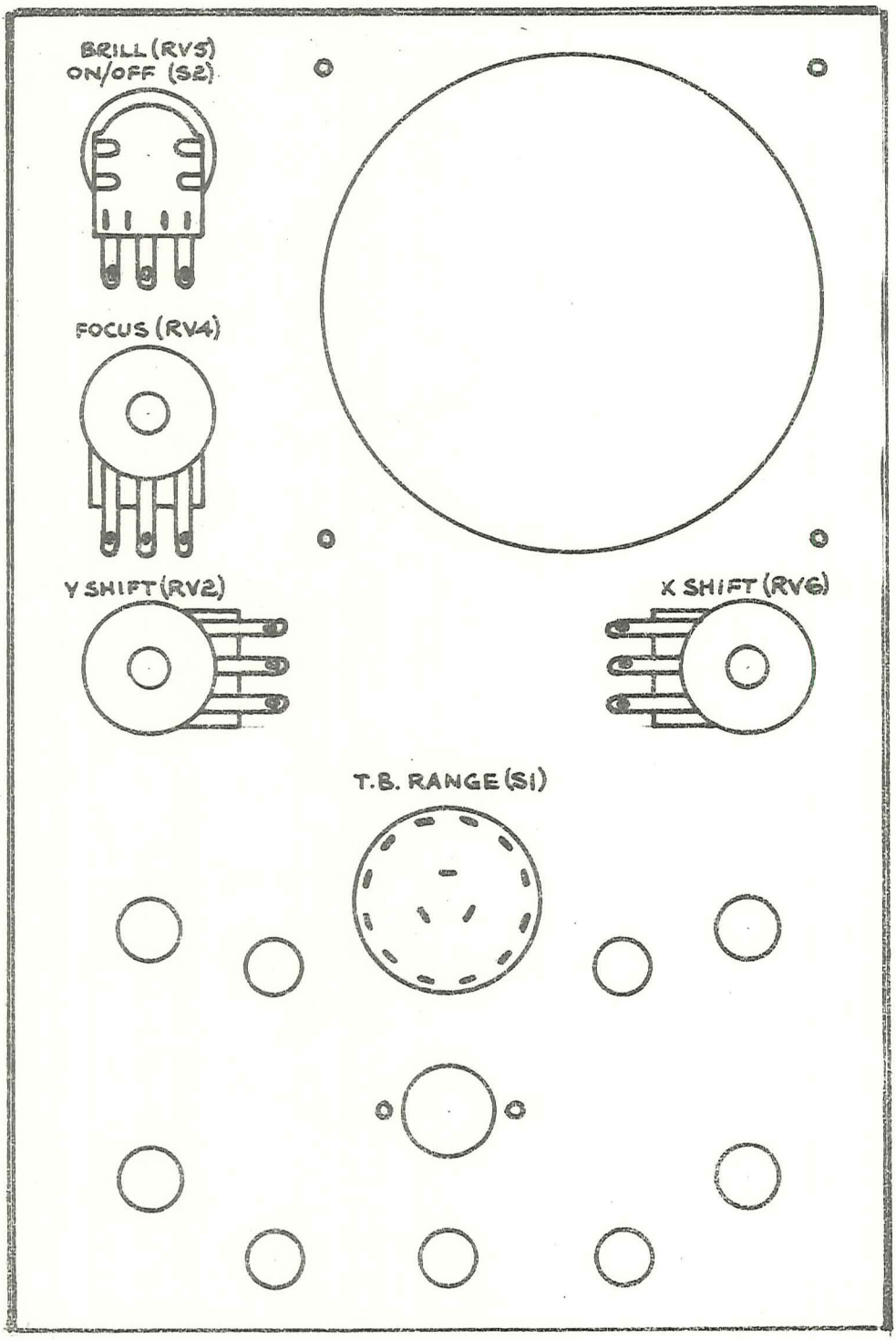

FIG.5. FRONT PANEL REAR.

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COMPONENTS LIST AND STUDY INSTRUCTIONS FOR STEP NO.3

INSTRUCTIONAL MATERIAL

1. Practical Work Instructions for this Step.
2. Circuit Diagram for Step No. 3
3. Diagrams Fig. 6, 7 and 8
4. Soldering Instructions

COMPONENTS

Potentiometers (Variable Resistors)

1 - 500 Kohm (or 470 kOhm) pot (RV3) timebase synchronisation control

2 - 1 Mohm pots. (RV1, RV8), Y-gain and timebase stability controls

1 - 5 Mohm (or 4.7 Mohm) pot (RV7), timebase fine frequency control.

Sockets

1 - 4mm panel mounting socket, black (SK2)
2 - 4mm panel mounting sockets, yellow (SK5, SK6)
1 - 4mm panel mounting socket, blue (SK4)
1 - 4mm panel mounting socket, red (SK3)
1 - Co-axial socket, panel mounting (SK1)

Miscellaneous

1 - 2ft. length resin cored solder
2 - ~~1.5v cells (to form 3V battery).~~
1 - 3.5v bulb
1 - bulb holder
2 - 4mm banana plugs, 1 red, 1 black
1 - Engraved graticule

2 - crocodile clips

1 - 1 ft. length sleeving 1½mm i/d

1 - 3 ft. length insulated wire with stranded conductor, white

1 - 4 ft. length 24 s.w.g. tinned copper wire

1 - 9 ft. length of 24 g insulated wire, white

1 - 8 ft. length of 24 g insulated wire, grey

1 - 4 ft. length of 24 g insulated wire, green

1 - 7 ft. length of 24 g insulated wire, yellow

1 - 2 ft. length of 24 g insulated wire, red

1 - 4 ft. length of 24 g insulated wire, blue

1 - 18 inch length of 24 g insulated wire, orange.

1 - 12 inch length of 24g insulated wire, violet.

Capacitors

1 - 0.01 µ F 500 v tub. polyester capacitor (C3)

STUDY INSTRUCTIONS

1. Study the instructions on soldering very carefully. Good soldering is ESSENTIAL in electronic work.

2. Carry out all the practical work described on the sheets attached (instructions 1 - 24)

3. Complete the green copy of the Circuit Diagram and compare your attempt with the yellow copy for Step No. 3. In case of difficulty, read again the leaflet entitled "Circuit Diagrams".

   Transfer the relevant information on the yellow sheet to your white master copy.

NEXT STEP

We commence laying out components and wiring on the Circuit Board. (Matrix Board).

PRACTICAL WORK INSTRUCTIONS FOR STEP NO.3.

FURTHER WORK ON ASSEMBLY OF FRONT PANEL

Carry out the following assembly work - with constant reference to Layout Diagrams Nos. 6 and 7.

1. Using two 6 BA ¼", round headed screws, nuts and washers, fit the co-axial socket(SK 1) to the front panel in the hole labelled 'INPUT'.

2. Fit the Red wander-plug socket (SK 3) to the hole labelled 'T/B OUT'. Do not over-tighten the fixing nut or the socket will be damaged.

3. Fit the Black wander-plug socket (SK 2) to the hole labelled 'EARTH'.

4. Fit the Blue wander-plug socket (SK 4) to the hole labelled 'X IN'

5. Fit the two Yellow wander-plug sockets (SK 5) and (SK 6) to the holes labelled 1 V50 HZ and '10V 50 HZ'.

6. Fit a 5 or 4.7 Mohm variable resistor to the front panel hole labelled 'T/B FINE'. This is the TIMEBASE FINE FREQUENCY control (RV 7).

7. Fit a 500 k Ohm variable resistor to the front panel hole labelled 'SYNC'. This is the SYNCHRONISATION control (RV 3).

8. Fit a 1 M ohm variable resistor to the front panel hole labelled 'STAB' This is the TIMEBASE STABILITY CONTROL (RV 8).

9. Fit a 1 M Ohm variable resistor to the front panel hole labelled 'Y-GAIN'. This is the Y-GAIN control (RV 1).

10. Using 4 - 6B.A. ½" long cheese headed screws, nuts and washers, fit the plastic hood and graticule to the Front Panel, with the graticule clamped between the hood and the front face of the panel as shown in Fig. 7. Do not fit the retaining hood prepared in Step 2 yet.

11. Fit two 6 B.A. solder tags (or one double ended tag) beneath the hood fixing where indicated on Fig. 8. (Remove any paint around fixing hole so as to obtain a good "earth" connection)

We now continue with connecting two capacitors (C_2 and C_3) associated

with the Brilliance and Focus controls on the Front Panel. Fig. 8 shows how this is done.

The connecting tags of the variable resistors have been arbitrarily numbered in Fig. 8 for ease of reference in the instructions. Tag 1 on each variable resistor represents the fully anti-clockwise position of the control, the wiper contact being given the number 2. Tag 3 represents the fully clockwise position.

WIRING INSTRUCTIONS

12. Connect a .01 mF 500 v capacitor (C2) between tag 2 of the Focus control (RV 4) and the earth tag under the fixing to the Hood (Fig. 8).

    Keep the capacitor leads as short as possible without stretching them, and sleeve the lead on the connection to RV4.

13. Connect a .01 mF 500 V capacitor (C3) between tag 2 of the Brilliance control (RV 5) and the other earth tag under the hood fixing. Sleeve the connection to RV5.

The following instructions deal with link wires to components on the Front Panel.

14. Connect a 2.2" (56mm) length of white wire between tag 2 of the Brilliance control (RV 5) and tag 3 of the Focus control (RV 4).

    NOTE The length of wire given, allows 0.2" (5mm) at each end for jointing, which must be stripped of insulation and firmly cleated to the appropriate tag before soldering. The process of stripping 0.2" of insulation will be referred to as preparing the wire in later instructions.

15. Prepare both ends of and connect a 83mm length of grey wire between tag 3 of the Y Gain control (RV1), and the central connection of the Input socket.

Dress this wire as close to the front panel and as far from the 'T/B out' socket as possible.

CAUTION: The dielectric material of the front panel sockets has a low melting point. Take care when soldering not to overheat to the point where the central connection moves within the material.

16. Prepare both ends of and connect a 2½" (64mm) length of green wire between tag 1 of the Y gain control (RV1) and the central connection of the Earth socket. Solder only the socket connection at this stage. Two other wires are yet to be connected to tag 1 of RV1.

17. Prepare both ends of and connect a 1.75" (44mm) length of green wire to tag 1 of RV1. Do not solder yet.

18. Prepare both ends of and connect a 1.2" (30mm) length of green wire to tag 1 of RV1. Solder all connections to tag 1.

PRACTICAL WORK FOR STEP 3 continued

19. Prepare both ends of and connect a 1.2" (30mm) length of yellow wire to tag 2 of RV1. This will provide the input connection to the Y amplifier, to be assembled later.

20. Prepare both ends of and connect a 0.8" (20mm) length of

yellow wire to the socket labelled 'X IN'.

The following instructions refer to links on the Timebase Range Switch S 1. (See Fig. 8.)

The connecting tags of the 3-pole 4-way 'T/B RANGE' Switch S 1 have been numbered in the diagram for ease of reference. These tags should be identified with the aid of a battery and bulb test circuit, explained on page 4 and Fig. 1 of Part B of the Manual - "Electronic Components'. In the oscilloscope, only two of the switch sections are used and these have been labelled A and B. These sections should be labelled correspondingly when you mark up your Circuit Diagram. The tag corresponding to the fully anticlockwise position of the switch, labelled-1 on the Front Panel, is also labelled 1 on the switch diagram, with a prefix A or B depending upon the section of the switch to which it belongs. Thus, the poles of the switch are AO and BO and the corresponding switch points are A 1 to A 4 and B 1 to B 4 respectively. The tags of the unused section of the switch have not been numbered.

Take great care in determining these connections. It is very easy to make a mistake, so double check every connection.

21. Connect terminal BO of the switch to terminal A1 with a short straight length of 24 g tinned copper wire having ensured that the terminals are clean. Kepp the connection on terminal BO as low down as possible - a further connection has to be made to this point later.

22. Connect terminal A1 to terminal A2 with a short link of 24 g tinned copper wire and having made the connection to A2 carry on with the same piece of wire to:- Para. 23

23. Connect terminal A2 to A3.

24. Fit two 6 BA ¼" long bolts to the 2 holes vacant on either side of the range switch. Secure on inside of front panel with washer and 6 BA nuts.

This completes the wiring associated with Step No. 3. Make the usual examination of your wiring, particularly to check the quality of your soldered joints. When you are satisfied that all is correct, proceed to Step No. 4.

NOTE 1 Some coaxial "INPUT" sockets now supplied have 2 connecting tags at the rear instead of only one (as shown in Fig. 6). If your socket is of the 2-tag type, the outermost of these tags should be connected to the "EARTH" socket using a short length of insulated wire.

NOTE 2 When fitting the 4mm (Wander plug) sockets to the front panel do make absolutely certain that there is no risk of a "Short Circuit". between the socket tag and the metal front panel.

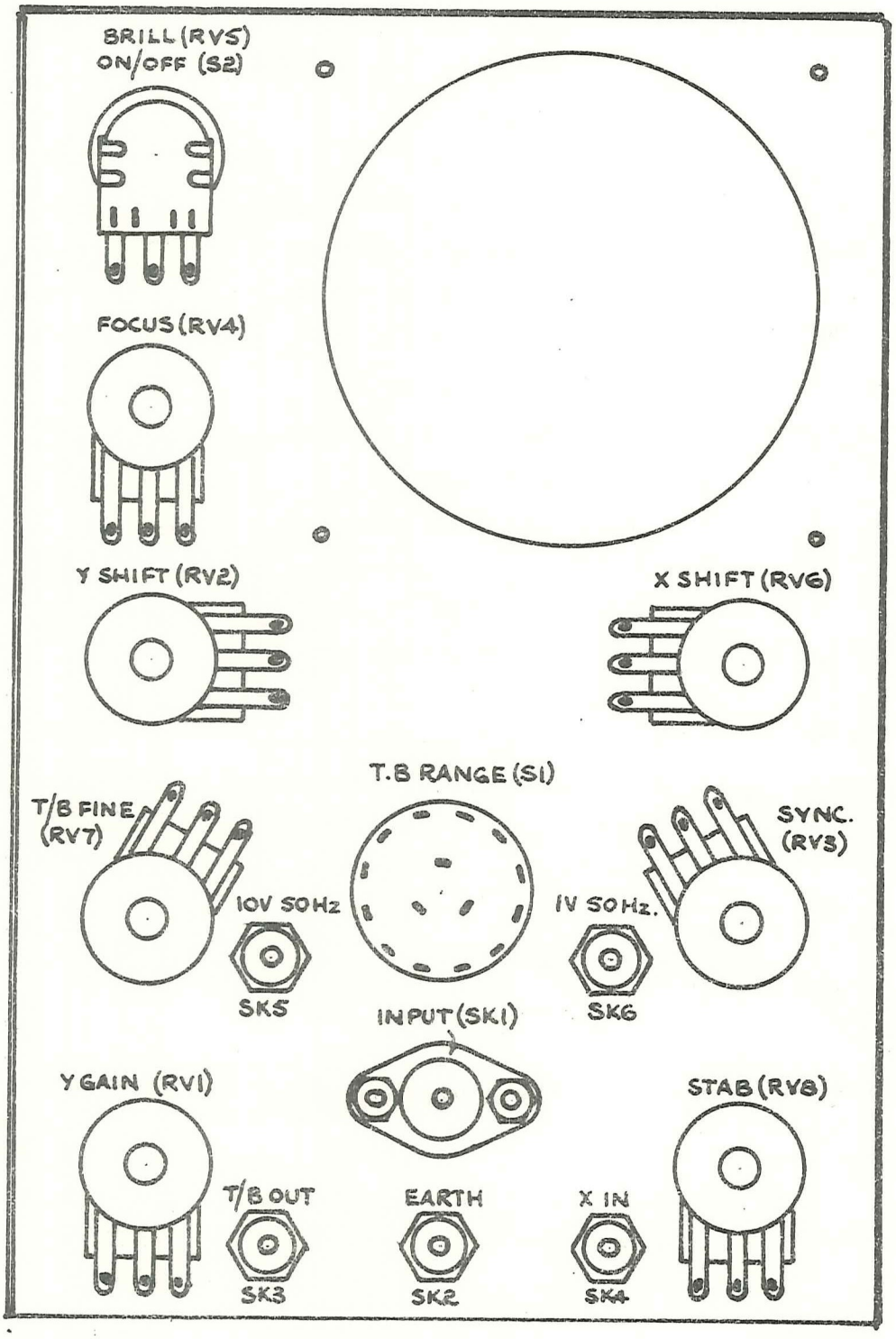

FIG. 6. FRONT PANEL REAR.

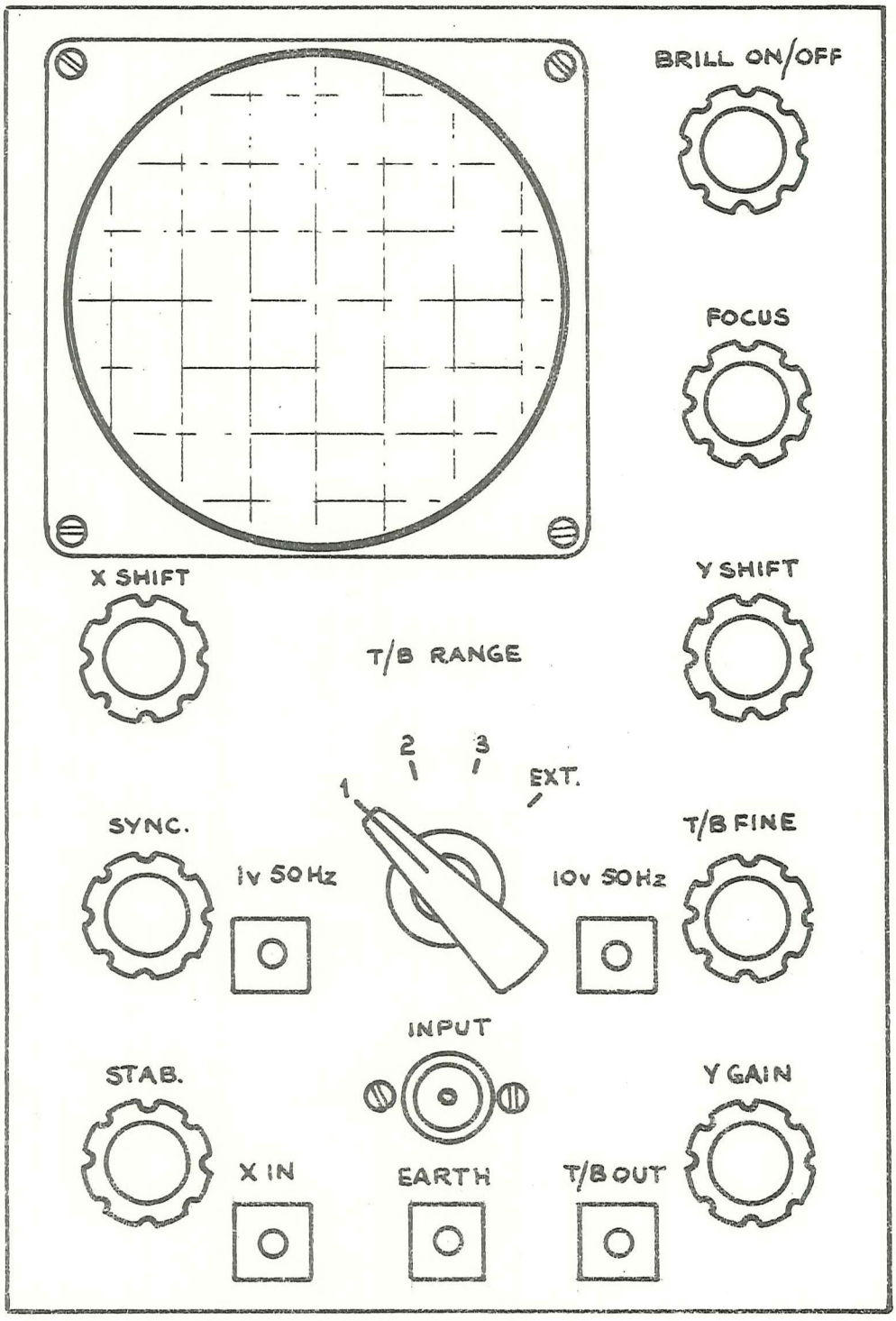

FIG 7. FRONT PANEL LAYOUT.

BRITISH NATIONAL RADIO AND ELECTRONICS SCHOOL

PRACTICAL ELECTRONICS

COMPONENTS LIST AND STUDY INSTRUCTIONS FOR STEP NO. 4.

INSTRUCTIONAL MATERIAL

1. Practical Work Instructions for this Step.

2. Circuit Diagram for Step No. 4.

3. Diagrams Figs. 9, 10, 11 and 12.

4. "Electronic Components" Part C "Semi-conductors"

COMPONENTS

Resistors

1 -	470 ohm	resistor (R3)	(yellow violet brown)
1 -	47k ohm	resistor (R5)	(yellow violet orange) [1 WATT]
1 -	470k ohm	resistor (R8)	(yellow violet yellow)
1 -	2.2 Mohm	resistor (R2)	(red red green)

Semiconductors

2 - IN914 diodes (D1 D2).
1 - BZY88/3.3v zener diode (D3)
1 - BC184 or BC184K transistor (VT1)
2 - BF259 transistors (VT2 VT3)

Hardware

1 - Oscilloscope chassis, drilled

STUDY INSTRUCTIONS

1. Read, very carefully, manual C on "Semi-conductors"

2. Carry out all practical work described (instructions 1 - 37)

3. Complete green copy of the Circuit Diagram to show the work you have done in this Step. Then compare with the yellow diagram for Step No. 4.

   Transfer the relevant information on the yellow sheet to your white master copy.

NEXT STEP

Wiring and components on the Circuit Board, associated with the X-amplifier.

PRACTICAL WORK FOR STEP NO. 4.

This step and the 3 which follow are concerned with components and the connections on the Matrix Board (Circuit Board) and these will be related to a particular area of the Circuit Diagram.

The complete circuit is built up from a combination of discreet 'building blocks' which are suitablyconnected together. Each building block can be given a name and in fact many of these blocks are commonly used in a wide variety of electronic equipment. The art of reading a circuit diagram is to be able to recognise these blocks as self contained circuit systems in themselves, and thus we can break down a complicated piece of circuitry, into its much simpler basic parts.

The 'building block' we shall deal with in this Step is the Y Amplifier which is actually a combination of two basic circuits very commonly used. Transistor VT1 forms what is termed an "Emitter Follower" and VT2 VT3 form a "Long Tailed Pair'.

All wiring and components must be connected in strict accordance with the Wiring Diagram Fig. 10 and the Component Layout Diagram Fig 9.

NOTE Fig. 9 - layout and placing of components on the circuit board and Fig 10 - wiring up on the back of the board are complete diagrams. You will not be doing all the wiring in one go - but gradually, step by step so that you will be referring to Figs 9 and 10 all the way through the Steps during the building programme.

Pay particular attention to the connections of transistors and diodes. Refer to the appropriate drawing for transistor connections, and remember that the band around a diode representing its cathode, must correspond with the position of the '+' sign. on Fig. 9.

GENERAL NOTES ON HANDLING COMPONENTS AND ON WIRING UP

With this step you now commence the real work - wiring up the components (and relating these operations to the circuit diagram). The following rules are important for success and in order that you obtain maximum benefit from the course:-

1. Take plenty of time - Especially if this type of work is new to you - it is essential to work slowly but steadily studying carefully each operation before you do it. Look to see what it means on the wiring and the circuit diagram. Then carry out the operation and re-check again that it corresponds to what you have done.

(2) Take great care with each joint. Make sure the surfaces and wire to be soldered are perfectly clean and ensure that your soldering is absolutely top quality work.

(3) As you carry out each operation, place a tick to signify this in the empty brackets provided at the end of each operation. You are then less likely to miss an operation. Remember it only takes one missing or mis-made operation to create a mysterious fault when eventually you 'switch on' on the C.R.O.!

(4) If you are in any difficulty at all refer to your Tutor immediately giving him full details of your problem.

WIRING ON THE BACK OF THE CIRCUIT BOARD FOR THE Y AMPLIFIER REFER TO FIG. 10.

Part of the wiring is to be carried out in insulated wire in various colours, and part in bare tinned copper wire.

The lengths of wire given in the instructions following include an allowance of 0.2" (5mm) at each end, which in the case of insulated wires should be stripped of insulation before cleating to the appropriate terminal and soldering in place. Keep all wires straight unless shown otherwise. (T2 and T3 means terminal No. 2 and terminal No. 3 as shown on Diagram Fig. 10).

Instruction No.		
1	Connect a 35mm length of red wire between T2 and T3	( )
2	Connect a 53mm " " blue " " T47 and T51	( )
3	Connect a 51mm " " blue " " T51 and T57	( )
4	Connect a 25mm " " yellow " T15 and T31	( )
5	Connect a 33mm " " yellow " T15 and T32	( )
6	Connect a 42mm " " orange " T24 and T55	( )
7	Connect a 53mm " " orange " T55 and T56	( )
8	Connect a 93mm " " orange " T56 and T63	( )
9	Connect a 38mm " " orange " T63 and T40	( )
10	Connect a 69mm " " green " T39 and T53	( )
11	Connect a 35mm " " 24g tinned copper wire between T1 & T2	( )
12	Connect a 20mm " " " " " " " T3 & T4	( )
13	Connect a 25mm " " " " " " " T37 & T48	( )
14	Connect a 20mm " " " " " " " T17 & T18	( )
15	Connect a 24mm " " " " " " " T34 & T46	( )
16	Connect a 24mm " " " " " " " T46 & T39	( )
17	Connect a 24mm " " " " " " " T45 & T52	( )
18	Connect a 26mm " " " " " " " T28 & T43	( )
19	Connect a 26mm " " " " " " " T27 & T42	( )
20	Connect a 22mm " " " " " " " T41 & T53	( )

NOTE: At the end of each operation we have put some blank brackets ( ). You should place a ✓ inside these when you complete each operation.

Make a thorough examination of your wiring to ensure its correctness and soundness of all soldered joints. When satisfied, proceed to the next paragraph.

We now proceed to connect the components on the front of the board associated with the Y Amplifier, and shown on Fig. 9.

PRACTICAL WORK FOR STEP NO. 4 continued

COMPONENTS ON FRONT OF THE BOARD FOR THE Y AMPLIFIER

Instruction No.							
21	Connect a	100 Kohm ½w	resistor	(R1)	between	T7 and T16	(✓)
22	Connect a	2.2 Mohm ½w	resistor	(R2)	"	T31 and T47	(✓)
23	Connect a	470 Ohm ¼w	"	(R3)	"	T36 and T37	(✓)
24	Connect a	470 Ohm ¼w	"	(R4)	"	T37 and T38	(✓)
25	Connect a	100Kohm 2w	"	(R7)	"	T47 and T48	(✓)
26	Connect a	47 Kohm 1w	"	(R5)	"	T1 and T25	(✓)
27	Connect a	47 Kohm 1w	"	(R6)	"	T2 and T26	(✓)
28	Connect a	470Kohm ½w	"	(R8)	"	T3 and T18	(✓)
29	Connect a	1 Mohm ½w	"	(R9)	"	T51 and T52	( )
30	Connect a	1.2 Kohm ¼w	"	(R21)	"	T27 and T41	( )
31	Connect a	10 Kohm ¼w	"	(R20)	"	T28 and T42	( )

32 Connect a IN914 diode (D1) between T17 and T35 (✓)
33 Connect a IN914 diode (D2) between T35 and T46 (✓)
34 Connect a BZY88/3.3v zener diode (D3) between T34 and T45 (✓)

35 Connect a BC184 transistor (VT1) to T15, T16, T24 (✓)
36 Connect a BF259 transistor (VT2) to T25, T32, T36 (✓)
37 Connect a BF259 transistor (VT3) to T26, T33, T38 (✓)

SEE FIG. 11 & 12

NOTE: Instructions 18 to 20 inclusive, 30 and 31 are not strictly concerned with the Y Amplifier itself, but with its calibration system.

Make a careful check of the work you have done, including the quality of the soldered joints. You have now made a very good start on the assembly and wiring work.

BRITISH NATIONAL RADIO AND ELECTRONICS SCHOOL

PRACTICAL ELECTRONICS

COMPONENTS LIST AND STUDY INSTRUCTIONS FOR STEP NO. 5

INSTRUCTIONAL MATERIAL

1. "Electronic Components" Part D - Inductors, Transformers, Plugs and Sockets
2. Practical Work Instructions for this Step.
3. Circuit Diagram for Step No. 5
4. Diagram Fig. 13 (Refer again to Figs 9 and 10)

COMPONENTS

Resistors

2 - 3.3 Kohm	resistors (R25, R26)	(orange, orange, red)
1 - 6.8Kohm	resistors (R22)	(blue, grey, red)
2 - 47 Kohm	resistors (R30, R24)	(yellow violet orange)
1 - 100 Kohm	resistors (R33)	(brown, black, yellow)
2 - 150 Kohm	resistors (R27, R28)	(brown, green, yellow)
1 - 220 Kohm	resistor (R32)	(red, red, yellow)
1 - 330 Kohm	resistor (R29) {1WATT}	(orange, orange, yellow)
1 - 1 Mohm	resistor (R23)	(brown, black, green)
1 - 1.5 Mohm	resistor (R31)	(brown, green, green)

CAPACITORS

1 - 0.1 mF 250v capacitor (C11) (brown black yellow)

SEMICONDUCTORS

1 - IN914 or IN4148 diode (D8)
1 - BC214 or BC214K transistor (VT6)
2 - BF 259 transistors (VT4 VT5)

STUDY INSTRUCTIONS

1. Read "Electronic Components" Part D with care

2. Carry out all practical work described (instructions 1 - 39)

3. Complete green copy of the Circuit Diagram, showing work carried out in this Step, and then compare with the yellow copy.

Transfer the information to your white Master Copy.

NEXT STEP

Circuit Board layout of components and wiring for the Timebase Generator

PRACTICAL WORK INSTRUCTIONS FOR STEP NO.5.

In this step we shall be concerned with the wiring and components on the Circuit Board for the X Amplifier. This is a very similar amplifier to the circuit used for the Y Amplifier dealt with in Step 4. It again consists of two basic circuits an "emitter follower" (VT6) and a "long tailed pair" (VT4 and VT5).

Again pay particular attention to soldered joints and the connections to diodes and transistors. For wiring and component layout see Fig. 9 and 10.

Wiring on the Back of the Circuit Board for the X Amplifier Fig. 10

The lengths of wire given in the instructions below, include an allowance of 5mm at each end for jointing. In the case of insulated wires this should be stripped of insulation before cleating

to the appropriate terminal and soldering in place.

Keep all wires as straight as possible unless shown otherwise on Fig. 10.

1. Connect a 30mm length of insulated red wire between T62 & T64 ( )
2. " a 74mm " " red wire between T4 & T64 ( )
3. " a 74mm " " blue wire between T44 & T115 ( )
4. " a 37mm " " green wire between T67 & T68 ( )
5. " a 53mm " " green wire between T73 & T74 ( )
6. " a 44mm " " green wire between T74 & T54 ( )

7. Connect a 17mm length of tinned copper 24 g wire between T49 & T53(
8. Connect a 15mm length of tinned copper 24 g wire between T49 & T54 ( )
9. " " 29mm " " " " " " " T73 & T76 ( )
10. " " 19mm " " " " " " " T68 & T76 ( )
11. " " 29mm " " " " " " " T67 & T71 ( )
12. " " 26mm " " " " " " " T71 & T98 ( )
13. " " 18mm " " " " " " " T98 & T87 ( )
14. " " 15mm " " " " " " " T87 & T79 ( )
15. " " 18mm " " " " " " " T60 & T66 ( )

16. " " 17mm " " " " " " " T66 & T65 ( )
17. " " 23mm " " " " " " " T72 & T93 ( )
18. " " 15mm " " " " " " " T93 & T94 ( )
19. " " 17mm " " " " " " " T88 & T92 ( )
20. " " 29mm " " " " " " " T106 & T116( )
21. " " 19mm " " " " " " " T44 & T47 ( )
22. " " 22mm " " " " " " " T50 & T55 ( )
23. " " 36mm " " " " " " " T61 & T62 ( )

Make a thorough examination of your work to ensure that it is correct, then proceed to the next paragraph.

The following instructions refer to components on the front of the Circuit Board, associated with the X Amplifier (See Fig. 9).

NOTE: Take particular care not to overheat the 0.1mF capacitor during soldering (instructions 35).

Components on the Front of the Board for the X Amplifier

23. Connect a 1.5Mohm ½W resistor (R31) between T50 and T66 ( )
24. Connect a 220 Kohm ¼W resistor (R32) between T60 and T79 ( )
25. Connect a 100 Kohm ¼W resistor (R33) between T65 and T86 ( )
26. Connect a 47 Kohm ¼W resistor (R30) between T56 and T72 ( )
27. Connect a 3.3 Kohm ¼W resistor (R25) between T105 and T106 ( )
28. Connect a 3.3 Kohm ¼W resistor (R26) between T106 and T107 ( )
29. Connect a 330 Kohm 1W resistor (R29) between T115 and T116 ( )
30. Connect a 150 Kohm ½W resistor (R27) between T61 and T83 ( )
31. Connect a 150 Kohm ½W resistor (R28) between T62 and T84 ( )
32. Connect a 6.8 Kohm ¼W resistor (R22) between T55 and T70 ( )
33. Connect a 47 Kohm ¼W resistor (R24) between T70 and T98 ( )
34. Connect a 1 Mohm ½W resistor (R23) between T91 and T115 ( )

35. Connect a 0.1 mF capacitor (C11) between T67 and T88 ( ) see Fig. 13

36. Connect a IN914 diode (D8) between T71 and T91 ( )

37. Connect a BC 214 transistor (VT6) to T76, T85 and T94 (See Fig. 11) ( )

38. Connect a BF 259 transistor (VT5) to T84, T93, and T107 (See Fig. 12) ( )

39. Connect a BF 259 transistor (VT4) to T83, T92, T105 (See Fig. 12) ( )

Make the usual careful check on your work making sure that the diode and transistors are connected correctly.
When you are satisfied, move on to Step No. 6.

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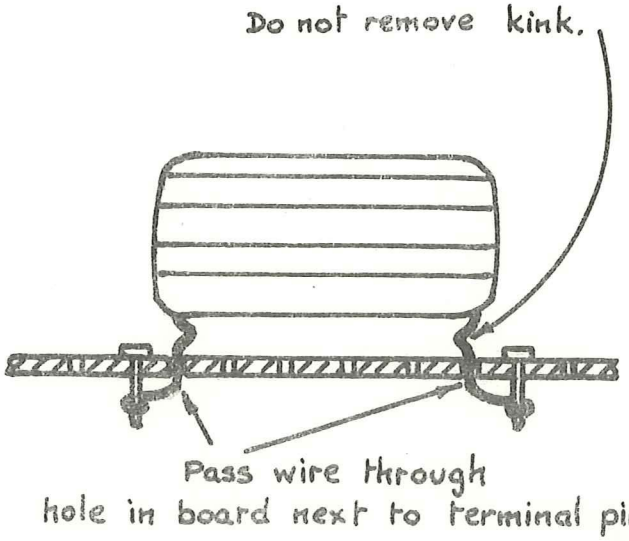


FIG. 13 - METHOD OF CONNECTING CAPACITORS TO BOARD - USING LEADS ON THESE COMPONENTS

BRITISH NATIONAL RADIO AND ELECTRONICS SCHOOL

PRACTICAL ELECTRONICS

COMPONENTS LIST AND STUDY INSTRUCTIONS FOR STEP NO. 6

INSTRUCTIONAL MATERIAL

1. "Electronic Components" Part E on Indicators and Displays

2. Practical Work Instructions for this step.

3. Circuit Diagram for Step No. 6.

4. Diagrams - None - refer again to Figs. 9 and 10.

COMPONENTS

Resistors

1 - 47 Ohm resistor (R35) (yellow violet black)
1 - 10 Kohm resistor (R36) (brown black orange)
1 - 100 Kohm resistor (R10) (brown black yellow)
1 - 150 Kohm resistor (R38) (brown green yellow)
1 - 330 Kohm resistor (R37) (orange orange yellow)
2 - 470 Kohm resistor (R15, R34) (yellow violet yellow)

Capacitors

1 - 0.1 mF 250V capacitor, (C1)

Semiconductors

2 - IN914 diode (D9 D10)
1 - IN 4007 diode (D4)
1 - BFY 50 transistor (VT7)
1 - NE555 or MC 1455 PI Integrated Circuit Timer, (IC1) 8 pin plastic package.

Hardware

1 - 8 pin dual in line IC. Socket
1 - 50 cm length of 24 s.w.g. tinned copper wire (to be used in Steps 6 and 7).

STUDY INSTRUCTIONS

1. Read "Electronic Components" Part E
2. Carry out all practical work described (instructions 1 - 43)
3. Complete green copy of the Circuit Diagram, showing work carried out in Step No. 6 and compare with the yellow copy.

   Transfer the information to your white master copy.

NEXT STEP

Completion of layout of components on the Circuit Board, and connections between these components.

PRACTICAL WORK INSTRUCTIONS FOR STEP NO. 6

This step covers the Circuit Board wiring and components for the Timebase Generator, the basis of which is the 555 Timer package (IC1). This integrated circuit is used in a wide variety of timing applications, and it will be useful to become familiar with it.

You will note that the 555 has eight pins and the plastic package itself has a small notch at one end. This notch is provided in order to identify pin No. 1 which is the pin in the right hand bottom corner, when the package is viewed from the top, with the notch downwards.

The pins on this package are fragile and should not be bent unduly, but it may be necessary to straighten the pins with the aid of a pair

of long nosed pliers in order that they will fit the socket provided. Do not however fit the 555 to its socket until the latter has been fitted to the board. You will notice that the socket is also provided with a notch in order to define the orientation of the package in its socket. Make sure you fit the socket to the board the correct way round (see Fig. 9). The socket connections are rather small to accommodate 24g wire, and for this reason a short length of 26g tinned copper wire is provided which can be more easily wrapped around the socket spills.

Wiring on the Back of the Circuit Board for the Timebase Generator Fig. 10

As in previous steps, the wire lengths given include 5mm at each end for jointing. Pay particular attention to keeping the connections to the IC socket straight and neatly cleated to the socket spills, in order to avoid possible short circuits across these connections.

Instruction No. 1

Insert the IC socket from the front of the board in the position shown in Fig. 10, and arrange to hold the socket in position by supporting it from beneath on suitable packing. (back of board uppermost). Instructions 2 - 9 inclusive refer to the connections to the socket.

Instruction No. 2 Connect a 23mm length of 26g tinned copper wire between pin 1 and T121 ( )

No. 3 Connect a 20mm length of 26g tinned copper wire between pin 2 and T 112 ( )

4 Connect a 17mm length of 26g tinned copper wire between pin 3 and T 110 ( )

5 Connect a 17mm length of 26g tinned copper wire between pin 4 and T 100 ( )

6 Connect a 17mm length of 26g tinned copper wire between pin 5 and T 99 ( )

7 Connect a 20mm length of 26g tinned copper wire between pin 6 and T 108 ( )

Instruction No.

8 Connect a 21mm length of 26g tinned copper wire between pin 7 and T 117 ( )

9 Connect a 25mm length of 26g tinned copper wire between pin 8 and T 100 ( )

10 Connect a 66mm length of red insulated wire between T64 and T69 ( )

11 Connect a 66mm length of orange insulated wire between T63 and T90 ( )

12 Connect a 61mm length of green insulated wire between T74 and T121 ( )

13 Connect a 25mm length of yellow insulated wire between T109 and T110()

14 Connect a 56mm length of blue insulated wire between T57 and T75 ( )

15 Connect a 18mm length of 24g tinned copper wire between T87 and T97 ( )

16 Connect a 17mm length of 24g tinned copper wire between T96 and T97 ( )

17 Connect a 25mm length of 24g tinned copper wire between T89 and T90 ( )

18 Connect a 21mm length of 24g tinned copper wire between T89 and T100( )

19 Connect a 17mm length of 24g tinned copper wire between T111 and T112()

20 Connect a 21mm length of 24g tinned copper wire between T101 and T113(

21 Connect a 21mm length of 24g tinned copper wire between T77 and T82 ( ).

22 Connect a 15mm length of 24g tinned copper wire between T102 and T103(

23 Connect a 15mm length of 24g tinned copper wire between T101 and T102 (

24 Connect a 19mm length of 24g tinned copper wire between T104 and T114(

25 Connect a 17mm length of 24g tinned copper wire between T75 and T78 ( )

Check your work very carefully before going on to the next paragraph.

The next set of instructions are concerned with fitting components to the front of the board in order to complete the circuitry of the Timebase Generator (see Fig 9).

Take care not to overheat polyester or polystyrene capacitors during soldering.

Components on the Front of the Board for the Timebase Generator

Instruction No.

26. Connect a 470 Kohm ½W resistor (R34) between T64 and T95 ( )
27. Connect a 47 Ohm ¼W resistor (R35) between T108 and T117 ( )
28. Connect a 330 Kohm ½W resistor (R37) between T69 and T103 ( )
29. Connect a 10 Kohm ¼W resistor (R36) between T77 and T109 ( )
30. Connect a 150 Kohm ¼W resistor (R38) between T74 and T102 ( )
31. Connect a 470 Kohm ½W resistor (R15) between T78 and T114 ( )
32. Connect a 100Kohm ½W resistor (R10) between T80 and T81 ( )

33. Connect a 0.1mF 500V capacitor (C4) between T113 and T114 ( ).

NOTE: If the 0.1mF capacitor supplied is fitted with radial leads, pass the leads through holes in the board and connect to the terminal pins underneath the board. 500V is the minimum rating. The capacitor supplied may have a higher rating.

34. Connect a 0.1 mF 250V capacitor (C1) between T81 and T111 (see Fig. 13) ( )

35. Connect a 0.1 mF 250 capacitor (C16) between T73 and T99 ( )

36. Connect a 0.47 mF 250V capacitor (C14) between T87 and T120 ( )
See Fig. 13

37. Connect a 0.047 mF 250V capacitor (C13) between T97 and T119 ( )
38. Connect a 4700 pf 160V capacitor (C12) between T96 and T118) ( ).
39. Connect a IN914 diode (D9) between T89 and T112) ( )
40. Connect a IN914 diode (D10) between T112 and T121 ( ).
41. Connect a IN4007 diode (D4) between T75 and T104 ( ).
42. Connect a BFY 50 transistor (VT7) to T82, T90 and T101 (See Fig. 12) ( )
43. Fit the integrated circuit 555 IC1 in its socket having ensured the pins are aligned correctly first. Do not force the package into the socket.

Make sure you have the 500 V capacitor at C4. Check for correct connections to diodes and transistor as well as the usual careful scrutiny, before commencing Step No.7.

BRITISH NATIONAL RADIO AND ELECTRONICS SCHOOL

PRACTICAL ELECTRONICS

COMPONENTS LIST AND STUDY INSTRUCTIONS FOR STEP No. 7

INSTRUCTIONAL MATERIAL

1. Practical Work Instructions for this Step.
2. Circuit Diagram for this Step.
3. Diagrams: Figs. 16,17,18 & 19.

COMPONENTS:

Resistors:

1 - 470Kohm miniature pre-set potentiometer (RV9)
1 - 2.2Kohm resistor (R18) (red red red)
1 - 4.7Kohm resistor (R17) (yellow,violet red)
1 - 15Kohm resistor (R 16) 1 watt type (brown,green,orange)
1 - 47Kohm resistor (R14) (yellow,violet orange)
1 - 470Kohm resistor (R39) (yellow violet yellow)
1 - 1Megohm resistor (R12) (brown black green)
1 - 1.5Megohm resistor (R13) (brown green green)

Capacitors

1 - 0.1mF, 250V capacitor (C17) (brown black yellow - if coded)
1 - 15mFd, 450 volt ---------- electrolytic capacitor (C8)
1 - 15mFd, 450 volt ---------- " " (C7)
1 - 470mF,25volt electrolytic capacitor (C9)
2 - 15mFd, 450 volt ---------- electrolytic capacitors (C5, C6),

Semiconductors

2 - IN4007 diodes (D5 D7)
1 - BY 127 diode (D6)

continued - next page.....

NOTE: Wherever 16mFd capacitors are mentioned in the wiring instructions,etc., a 15mFd type is now supplied for C5,C6,C7 & C8

Transformer

1 - Mains Transformer (TR1)

Primary OV 220/240V tapped at 110V Screen separate connection

Secondary (i) 6.3V @ 500 mA Secondary (ii) 15V @ 25mA

Secondary (iii) 230V @ 25 mA Secondary (iv) 300V @ 25 mA

Hardware

1 - C.R.T. mounting bracket
3 - 6BA $\frac{3}{4}$" (20mm) CH bolts
1 - 6BA nut and washer
3 - Spacers $\frac{3}{8}$" (10mm)
7 - $\frac{3}{8}$" (10mm) grommets

STUDY INSTRUCTIONS

1. Carry out all practical work described (instructions 1 - 50)

2. Complete green circuit diagram and then check against the yellow copy No. 7.

Transfer all information to your white master copy.

NEXT STEP

Providing Interconnecting leads to the back of the Circuit Board, fitting Front Panel to Chassis and carrying out some front panel wiring.

This step covers the remaining work necessary to complete the layout of the Circuit Board itself.

The circuitry we shall now be concerned with is as follows:-

(a) That associated with the +200V, +10V and -400V Power Supplied.

(b) That associated with the resistor chains used to apply the correct operating voltages to the cathode ray tube (C.R.T.)

The Power Supplies have a number of electrolytic capacitors used with them, and it is most important that these capacitors be connected in the correct manner. The '+' sign on one end of the capacitor must correspond with the connection shown with a similar sign on Fig. 9 (capacitors C9 and C10).

Only two of the electrolytic capacitors are mounted on the Circuit Board. The remainder are fitted elsewhere on the chassis and will be dealt with in later instructions.

The Power Supplies also include three diodes and of course it is equally important that these components are connected with their correct polarity.

Wiring on the Back of the Board for the Power Supplies and C.R.T. Circuits (Fig 10)

Instruction No. 1

Insert RV9, the 470K 'Astigmatism' control from the front of the board on the position shown in Fig. 10, and arrange to hold the potentiometer in position by supporting it from beneath on suitable packing ( ).

Instructions 2, 3 and 4 relate to the connections to this control, which, like the IC socket in the previous step, should be wired in 26g tinned copper wire.

Instruction No.

2. Connect the wiping contact of RV9 (labelled "W" on Fig. 10) to T11 using 26g tinned copper wire 15mm long ( ).

3. Connect contact A of RV9 to T10 using 26g tinned copper wire 15mm long ( ).

Instruction No.

4. Connect contact B of RV9 to T14 using 26g tinned copper wire 15mm long ( ).

5. Connect a 84mm length of green wire between T9 and T13 ( ).

6. Connect a 50mm length of green wire between T12 and T49 ( ).

7. Connect a 22mm length of 24g tinned copper wire between T 13 and T19 ( ).

8. Connect a 28mm length of 24g tinned copper wire between T19 and T39 ( )

9. Connect a 15mm length of 24 g tinned copper wire between T8 and T9 ( ).

10. Connect a 26mm length of 24g tinned copper wire between T4 and T10 ( ).

This completes the wiring on the back of the board which should now be a replica of Fig. 10. Check your work as usual before proceeding to the next paragraph.

The following instructions refer to components on the front of the board.

Components on the Front of the Board for the Power Supplies and C.R.T. Circuits

Instruction No.

11. Connect a 470 K ¼W resistor (R39) between T13 and T14 ( ).
12. Connect a 1 Mohm ½W resistor (R12) between T8 and T22 ( ).
13. Connect a 1.5 Mohm ½W resistor (R13) between T9 and T23 ( ).
14. Connect a 47 Kohm ¼W resistor (R14) between T30 and T44) ( )
15. Connect a 15 Kohm 1W resistor (R16) between T4 and T5 ( ).

NOTE: Fit R16 as close as possible to the top edge of the board in order to clear RV9.

16. Connect a 4.7 Kohm ¼W resistor (R17) between T57 and T58 ( ).
17. Connect a 2.2 Kohm ¼W resistor (R18) between T20 and T40 ( ).

18. Connect a 0.1 mF 250V capacitor (C17) between T11 and T12 See Fig. 13 ( ).

19. Connect a 470 mF 25V electrolytic capacitor (C10) between T19 and T20 (check polarity) ( ).

20. Connect a 470 mF 25V electrolytic capacitor (C9) between T39 and T40 (check polarity) ( ).

21. Connect a IN4007 diode (D5) between T5 and T6 ( ).

22. Connect a BY 127 diode (D6) between T58 and T59 ( ).

23. Connect a IN4007 diode (D7) between T20 and T21 ( ).

In addition to the usual inspection, make sure that the diodes are correctly connected (D6 is the opposite way round from D5 and D7) and also check the polarity of the electrolytic capacitors. When you are satisfied, proceed to the next paragraph.

The following instructions deal with mounting components on the chassis.

Mains Transformer

The primary winding of the transformer to which the mains supply will later be applied, has 3 wires brought out together on one side of the transformer, together with a screen connection. The blue wire is the common OV terminal, the black wire is the 110V terminal, the brown wire is the 220/240V terminal, and the green wire is the screen connection.

The connections to the four secondary windings are brought out together

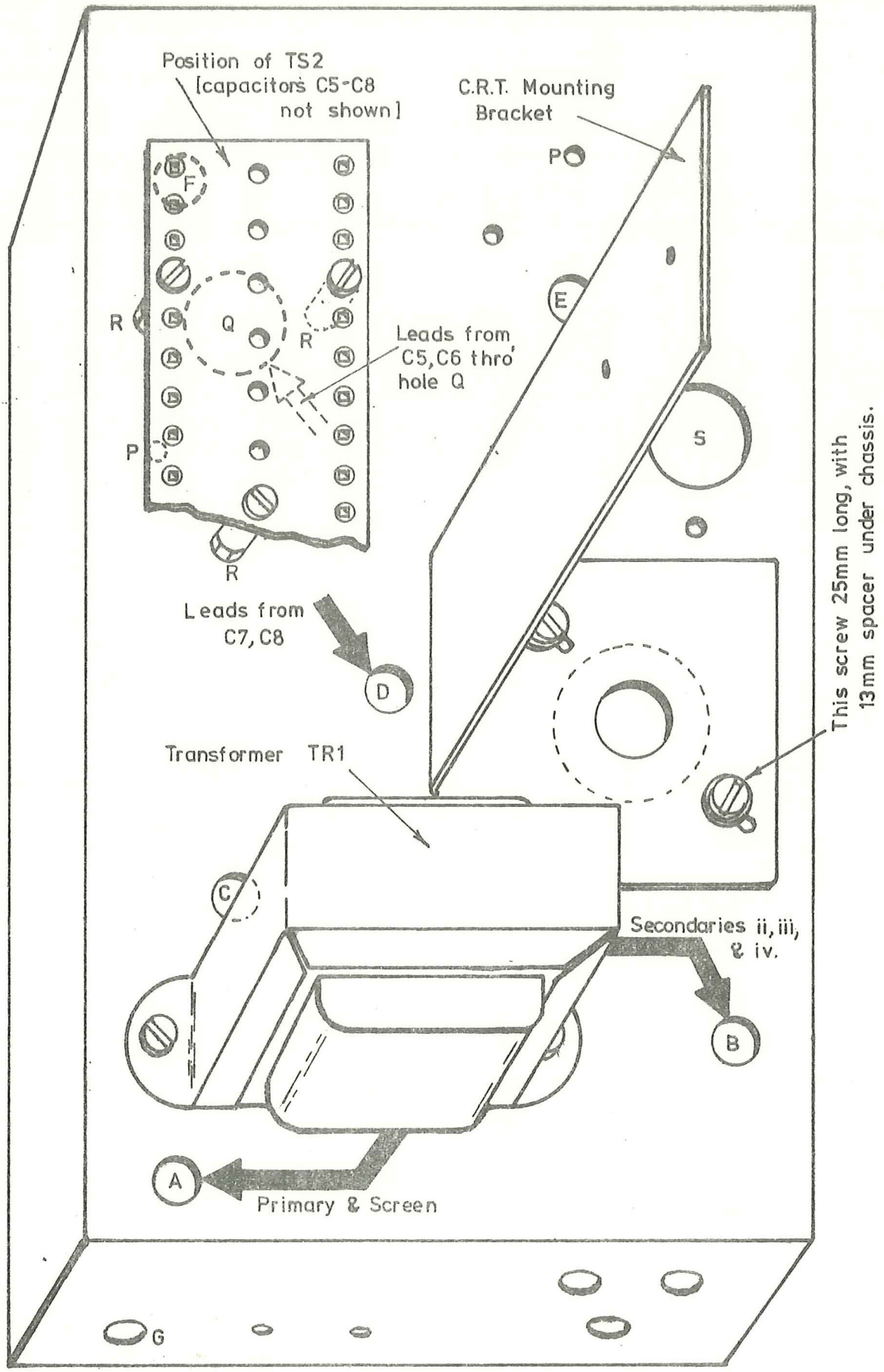
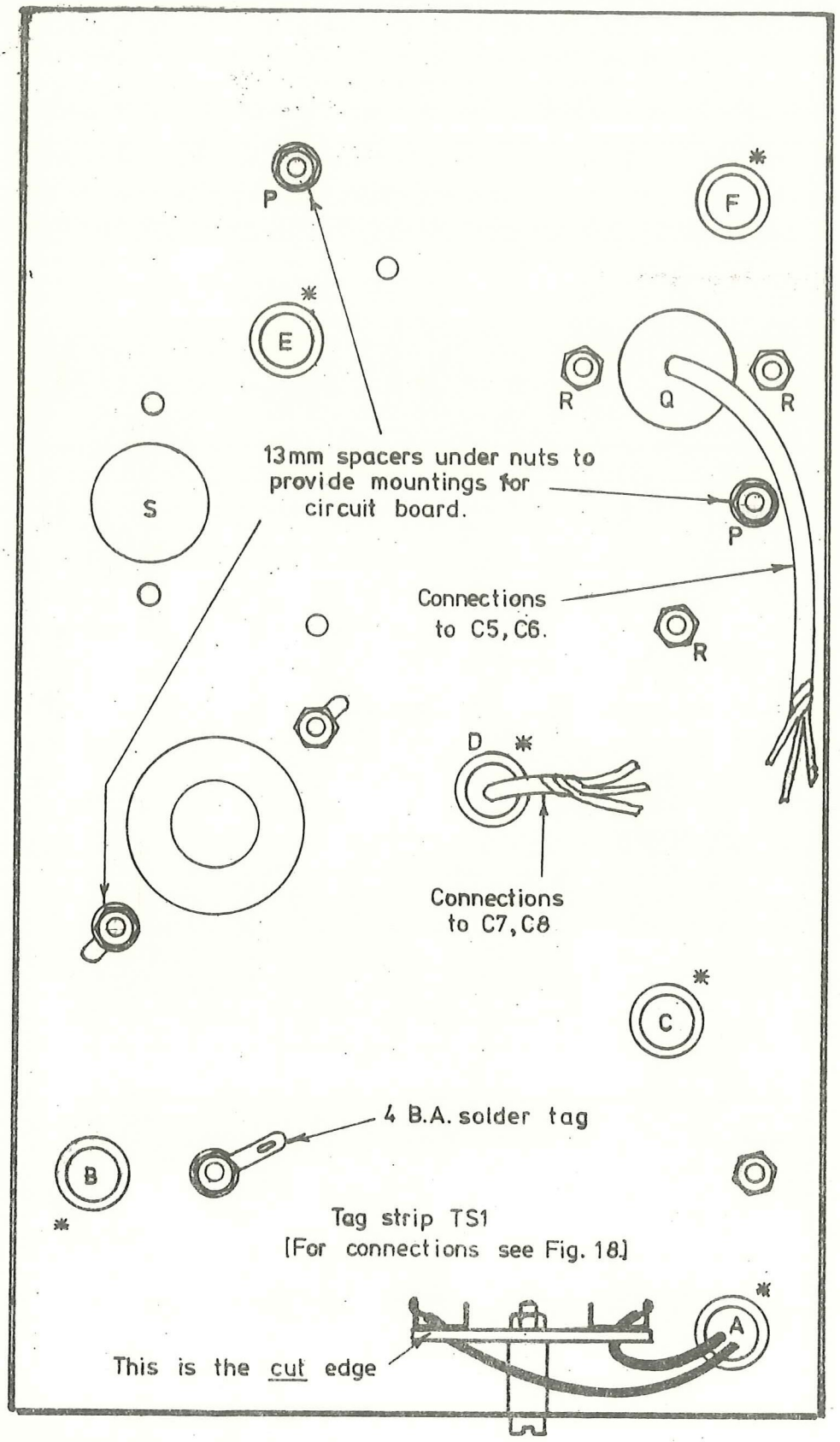


FIG. 16. ASSEMBLY OF COMPONENTS ON TOP OF CHASSIS.



* indicates - fit grommet.

FIG.17. UNDERSIDE OF CHASSIS.

on the other side of the transformer as follows:-

(i) A 6.3V (500 mA) winding to supply the C.R.T. heater. This has 2 yellow wires.

(ii) A 15V (25 mA) winding to provide the +10v d.c. supply. This has 2 orange wires.

(iii) A 230V (25mA) winding to provide the +200V d.c. supply. This has 2 red wires.

(iv) A 300V (25mA) winding to provide the -400V d.c. supply This has 2 violet wires

24. Twist tightly together each of the above pairs of wires:

(i) (ii) (iii) (iv) ( ).

25. Twist tightly together the three primary connecting wires, blue, black and brown ( ).

26. Fit ⅜" (10mm) grommets in each of the seven holes in the chassis marked A B C D E F and G (Figs. 17 and 18) ( ).

27. Carefully feed the primary and screen connections through the grommet in hole A, and the secondary connections (ii) (iii) and (iv) through the hole B (but not connections (i).
See Fig. 16 ( ).

28. Using two ½" (13mm) long 4 BA cheesehead screws, nuts and washers, fit the transformer to the chassis as shown in Fig. 16, and at the same time fit a 4 BA solder tag under one fixing (See Fig. 17) ( ).

Ensure that the transformer is correctly positioned, with the primary connections at the rear as shown in Fig. 16.

Instruction No.

29 Connect an 820 K ½W resistor (R19), between terminals Nos. 2 and 6 of the tag strip (TS1) prepared in Step No. 1 (See Fig. 18). ( ).

30 Mount the strip TS1 at the rear of the chassis, by means of a ½" (13mm) long spacer, and a ¾" (20mm) long 4 BA cheesehead screw, nut and washer. (See Figs. 17 and 18) ( )

31 Cut each of the primary connections to the transformer to a suitable length (about ½" (13mm) longer than strictly necessary) as required to connect to TS1 as follows:-

(a) Connect the brown wire to TS1 tag No. 2 (TS1/2), having passed it through the tag from the back of the strip (See Figs. 17 and 18) ( ).

(b) Connect the black wire to TS1/4 in a similar manner ( ).

(c) Connect the blue wire to TS1/9. ( ).

32 Cut the screen connection to a suitable length and connect to TS1/7 ( ).

33 Fit the C.R.T Mounting Bracket to the chassis as shown in Fig. 16 using one ½" (13mm) long 4 BA cheesehead screw, nut and washer, and one 1" (25mm) long 4 BA cheesehad screw, ½" long spacer, nut and washer. The long screw will provide one of the Circuit Board Mountings ( ).

34. Provide the remaining two Circuit Board mountings by fitting two 1" (25mm) long 4 BA cheesehead screws, and two ½" (13mm) long spacers with nuts and washers, in the holes marked P. (See Fig. 17)

Instruction No

35. Prepare Tag Strip No 2 (TS2) by removing the tags numbered 4 and 23 in Fig 19. The safest means of achieving this is to use a drill of approximately 3mm dia. However with care a sturdy pair of long nosed pliers may be used. If having grasped a tag the pliers are rotated, the tag can be rolled around the nose of the pliers in order to provide a firm grip. The tag can then be removed by forcing the nose of the pliers into contact with the board, and using them as a lever. ( )

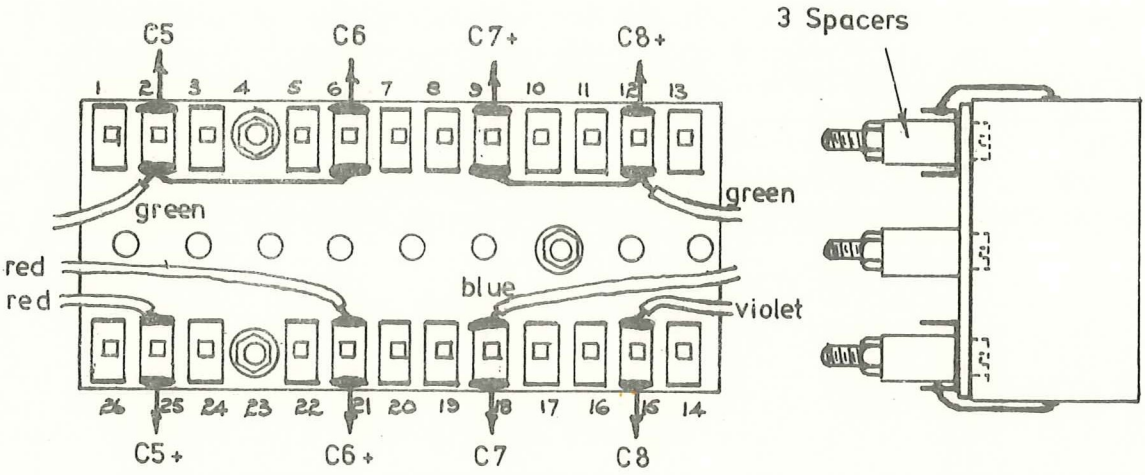
36. Fit three mountings to TS2 as shown in Fig 19, using 3, 20mm long 6BA cheesehead screws, nuts and washers and 3 $\frac{3}{8}$" (10mm) long spacers. ( )

37. Fit a 16 mF electrolytic capacitor (C5) to TS2 in the position shown in Fig 19. Ensure that the capacitor connection marked positive is connected to tag number 25. (C5 may in fact have any value between 15 and 33mF). ( )

38. Fit a 16mF electrolytic capacitor (C6) in the position shown in Fig 19. Ensure that the capacitor lead marked positive is connected to tag number 21. (C6 may in fact have any value between 15 and 33mF). ( )

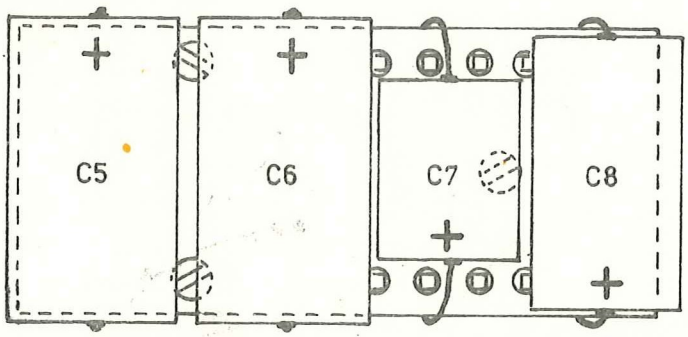
39. Fit an 8mF, 450V electrolytic capacitor (C7) in the position shown in Fig 19. Ensure that the capacitor lead marked positive is connected to tag number 9 (C7 may in fact have any value between 8 and 33mF) ( )

40. Fit a 16mF, 450V electrolytic capacitor (C8) in the position shown in Fig 19. Ensure that the capacitor lead marked positive is connected to tag number 12. (C8 may in fact have any value between 15 and 33mF) ( )



Connections and Mountings [Underneath]

End View.



Top View.

FIG.19. CONNECTIONS TO CAPACITORS C5, C6, C7, AND C8 ON TS2.

SC146,MOD1

SC 145

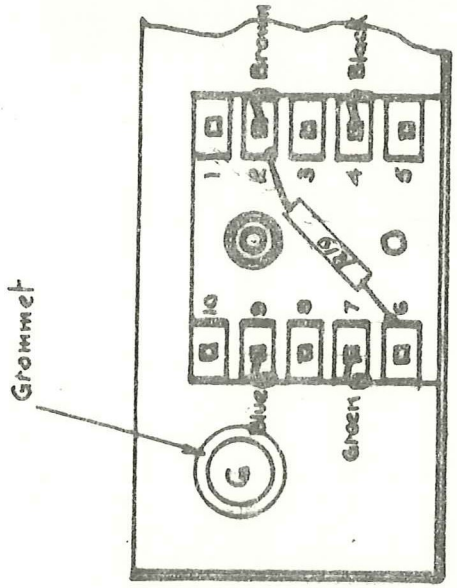


FIG.18. CONNECTIONS TO T81.

Instruction No

41. Connect a 38mm length of 24g tinned copper wire between the tags numbered 2 and 6, as shown in Fig 19. ( )

42. Connect a 32mm length of 24g tinned copper wire between the tags numbered 9 and 12, as shown in Fig 19. ( )

43. Connect a 180mm long red lead to tag number 21 as shown in Fig 19, ( )

44. Connect a 180mm long red lead to tag number 25 as shown in Fig 19.

45. Connect a 180mm long green lead to tag number 2, as shown in Fig 19. Twist this wire together with the two red wires connected to tag numbers 21 and 25. ( )

46. Connect a 152 mm length of green wire to tag number 12 as shown in Fig 19. ( )

47. Connect a 178 mm length of violet wire to tag number 15, as shown in Fig 19. ( )

48. Connect a 178mm length of blue wire to tag number 18 as shown in Fig 19. Twist this wire together with the green and violet wires connected to tag numbers 12 and 15. ( )

49. Check that your wiring of TS2 is a true replica of Fig 19. Check particularly that the negative terminals of C5 and C6 are connected together and to the green wire on tag number 2. Also be careful to ensure that the positive terminals of C7 and C8 are connected together and to the green wire on tag number 12. ( )

50. Pass the free ends of the leads connected to TS2 through holes 'D' and 'Q' from the top of the chassis, as shown in Figs 16 and 17. Mount the assembly in the position shown in Fig 16, using the three holes marked 'R'.

Instruction No

If necessary, adjust the position of the tag strip slightly so that its outer edge is parallel with the side of the chassis, before tightening the fixings.

Check your work as usual in this Step before proceeding to Step No 8. Ensure particularly that electrolytic capacitors, diodes, and the transformer primary winding connections to tag strip TS1 are all correctly wired.