

PRICE 10/6



**Assembling  
and  
Using Your...**



**F.M. TUNER**

**Comprising:**

**MODELS FMT-4U**

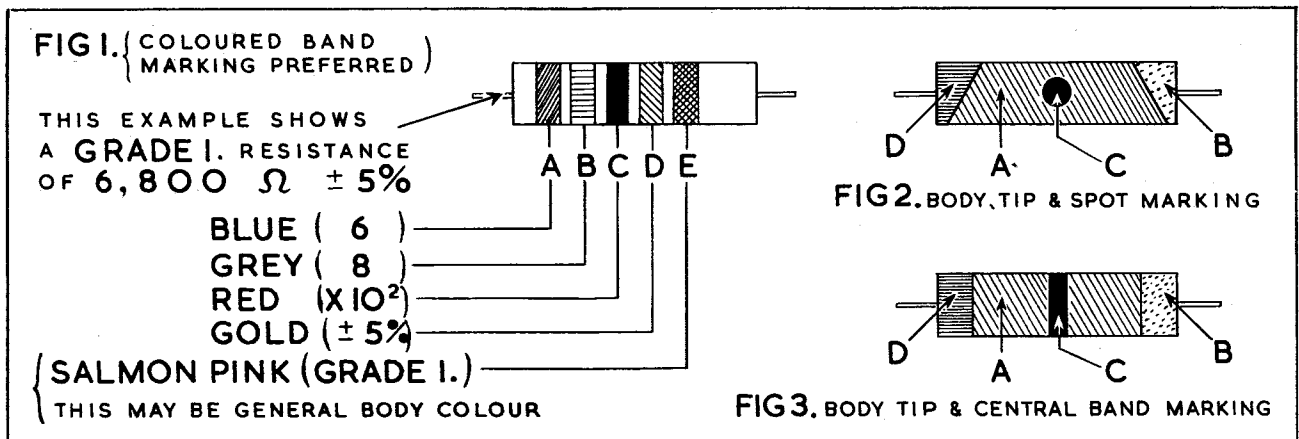
**and FMA-4U**

**DAYSTROM LIMITED**

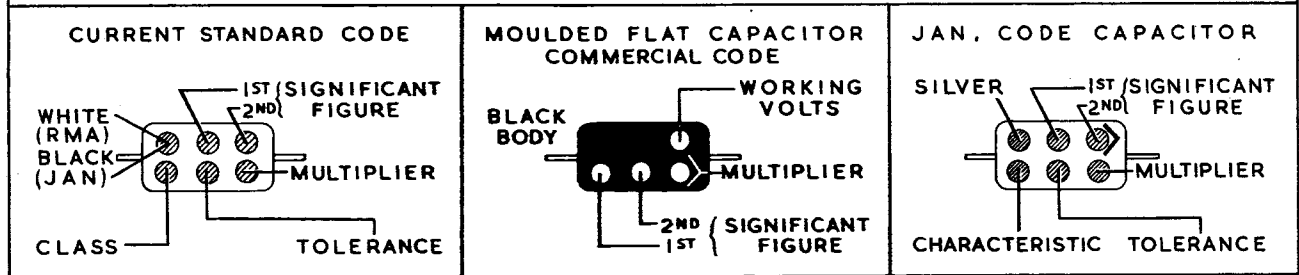
A Subsidiary of the Daystrom Group,  
Manufacturers of the world's finest  
Electronic Equipment in Kit Form

**GLOUCESTER, ENGLAND**

## COLOUR CODE FOR FIXED RESISTORS - (B.S.1852-1952) COLOUR BAND MARKING



### AMERICAN "RMA", "JAN" & COMMERCIAL CODING FOR MOULDED MICA CAPACITORS



#### COLOUR CODE FOR RESISTORS AND CAPACITORS

Colour	Value in Ohms or pF for Cols. A, B & C.				COL. D. (TOLERANCE RATING)			CAPACITORS COL. E. TEMP. COEFFICIENT per 10 <sup>6</sup> per °C.
	COL. A. 1st Figure	COL. B. 2nd Figure	COL. C. (MULTIPLIER)		Resistors	Ceramic Capacitors		
			Resistors ohms	Capacitors pF		Up to 10 pF	Over 10 pF	
BLACK	-	0	1	1	-	2 pF	+ 20%	0
BROWN	1	1	10	10	+ 1%	0.1 pF	+ 1%	-30
RED	2	2	100	100	+ 2%	-	+ 2%	-80
ORANGE	3	3	1,000	1,000	-	-	+ 2.5%	-150
YELLOW	4	4	10,000	10,000	-	-	-	-220
GREEN	5	5	100,000	-	-	0.5 pF	+ 5%	-330
BLUE	6	6	1,000,000	-	-	-	-	-470
VIOLET	7	7	10,000,000	-	-	-	-	-750
GREY	8	8	100,000,000	.01	-	0.25 pF	-	+30
WHITE	9	9	1,000,000,000	.1	-	1 pF	+ 10%	+100
SILVER			.01	-	+ 10%	-	-	
GOLD			.1	-	+ 5%	-	-	
SALMON			-	-	-	-	-	
PINK			-	-	-	-	-	
NO "D"								

COLOUR  
The Colour coding should be read from left to right, in order, starting from the end and finishing near the middle.

Standard <sup>±</sup> tolerances for resistors are:- Wire-wound: 1%, 2%, 5%, 10%. Composition, Grade 1: 1%, 2%, 5%. Grade 2: 5%, 10%, 20%. (20% is indicated by 4th (or 'D') colour). Grade 1: ("high-stability") composition resistors are distinguished by a salmon-pink fifth ring or body colour. (Reference: B.S.1852: 1952 B.S.I.).

N. B. High-Stability Resistors supplied with this kit are not as a rule colour coded but enamelled in one colour on which the value in Ohms is printed in figures. Capacitors supplied in this kit usually have their capacity clearly marked in figures. Some Capacitors coded as above also have additional "voltage rating" coding.

MODEL FM-4U

ERRATA

To facilitate your construction of this set with the maximum of ease, will you please insert the following alterations and additions in your Instruction Manual NOW.

Page		
3	Circuit Diagram	Amend C19 and C24 to read 5,000 pF.
10		Fourth step from the bottom of the page:- 'Figure 4' should read 'Figure 1'.
12	Steps 6 & 7	Reverse the order in which you do these two steps.
12	Step 8	Change reference D into P.
14	Step 1	Add NOTE: The mains transformer supplied may have three voltage tapings only, i.e. 100-125, 200-220, 225-250.
16	Step 14	See Pictorial 2 for lampholder tag numbering and route twisted pair through grommet GE.
18	Steps 5 & 6	Solder the centre screen on B7G and B9A valveholders.
18	Step 13	Note that only one earth tag can be soldered.
19	Mounting of Components to circuit board.	Refer to Pictorial 5. Identify the 2 pairs of 2,000 pF capacitors below the EF89 valveholders. Now change the right-hand capacitor <u>of each pair</u> to 5,000 pF.
23	Step 2	See inset Pictorial 2, and use the 6BA screw already fitted on the R.F. Unit.
23	Step 13	Add NOTE: The capacity of the cable supplied is approximately 10 pF/per foot.
23	Step 12	If the Tuner and Amplifier are separately earthed, a hum loop will result. Therefore it will be necessary to disconnect the (GREEN) earth lead on the Tuner. The Tuner will now be earthed via the braid wire of the screened lead.
26	Step 10	Delete this step and insert:- Mount 4 rubber feet to the base plate using 2BA x $\frac{1}{2}$ " screws.

Continued/.....

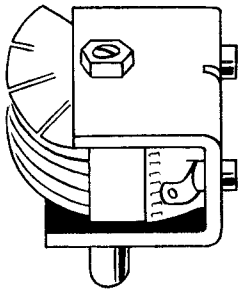
Continued/.....

-2-

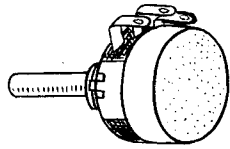
Page			
26	13th line from bottom of page	'valve show' should read 'values shown',	
	<b>PARTS LIST</b>	<b>* Correct the Part Numbers underlined:-</b>	
30	Resistors	* H- <u>104C10</u>	100 K $\Omega$
30	Capacitors	* 21- <u>502</u>	100 pF
30	Capacitors	21-510	Ceramic disc. Reduce quantity to 2.
30	Capacitors	21-522	Insert this new item. Qty. 2 5,000 pF (.005 $\mu$ F) 500 volt
30	Hardware	* 250- <u>504</u>	6BA x 5/16" c'sk screw
30	Hardware	250-513	Increase quantity to 6
31	Hardware	250-522	Change lengths to $\frac{1}{2}$ " and Part No. to <u>250-512</u> .
31	Hardware	* 252- <u>503</u>	2BA nut
31	Hardware	* <u>254-501</u>	6BA lockwasher
31	Miscellaneous	* 261-501	Rubber feet. Amend quantity to <u>4</u> .

# COMPONENT IDENTIFICATION CHART

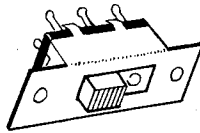
THESE COMPONENTS ARE NOT NECESSARILY IDENTICAL TO THE PARTS IN THIS KIT BUT ARE SUFFICIENTLY CLEAR TO HELP YOU IDENTIFY COMPONENTS IN GENERAL USE.



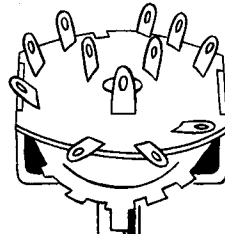
VARIABLE CAPACITOR.



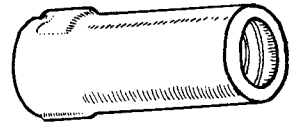
POTENTIOMETER.



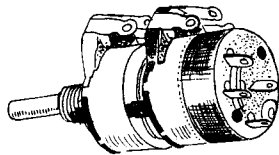
SLIDE SWITCH.



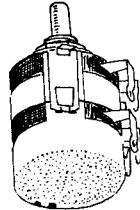
ROTARY SWITCH.



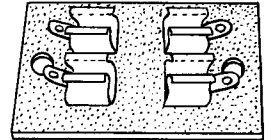
VALVE SCREEN.



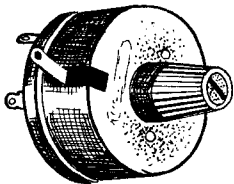
CONTROL POTENTIOMETER (DUAL WITH SWITCH.) OR



DUAL WITHOUT SWITCH.



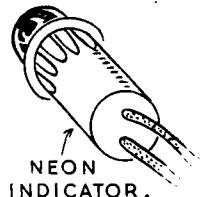
FUSE HOLDER.



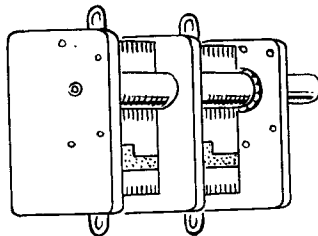
CONTROL POTENTIOMETER.



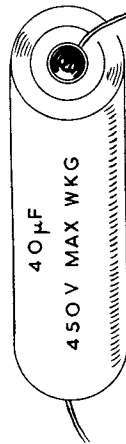
RUBBER FEET.



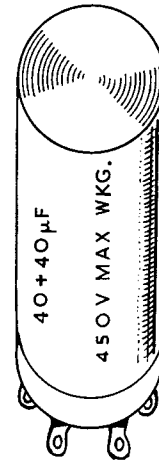
NEON INDICATOR.



GANGED VARIABLE CAPACITOR



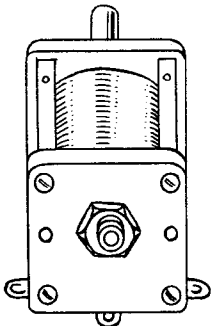
ELECTROLYTIC CAPACITORS.



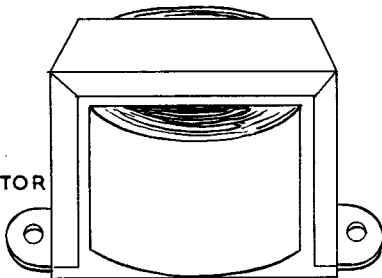
GROMMETS. RUBBER



FUSE HOLDER.



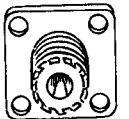
TRANSMITTER CAPACITOR



TRANSFORMER OR LF CHOKE.



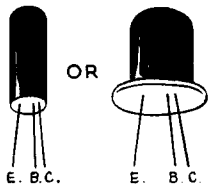
LAMP HOLDER.



COAXIAL SOCKET.



6-BA SOLDER TAG.



OR

E. B.C. TRANSISTOR.



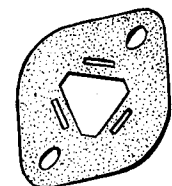
SPEEDNUT.



SPRING CLIP.



TRANSISTOR SOCKET.



MOUNTING PLATE FOR ELECTROLYTIC CAPACITOR



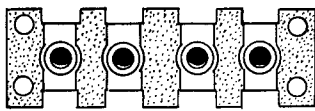
INPUT SOCKET.



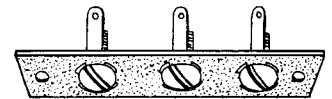
SOCKET. WANDER PLUG.



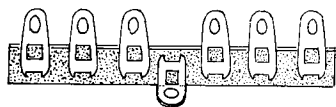
MOUNTING PILLAR.



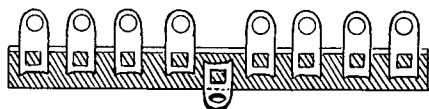
INPUT SOCKET (4 WAY)



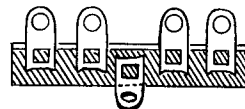
TERMINALS (3 WAY).



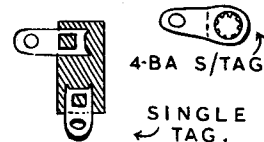
TAG STRIP (6 WAY.)



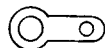
TAG STRIP. (8 WAY)



TAG STRIP. (4 WAY)



4-BA S/TAG  
SINGLE TAG.



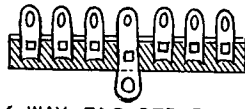
BA. SOLDER TAG.



BA. FLAT WASHER.



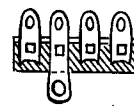
FIBRE WASHER.



6-WAY TAG-STRIP WITH EARTH.



SOCKET.



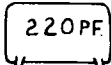
4-WAY T/S WITH EARTH.



PLASTIC CLIP (LARGE)



1/2 WATT RESISTOR.



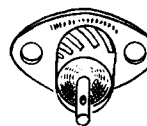
220PF  
SILVER MICA CAPACITOR.



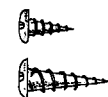
CHOKE



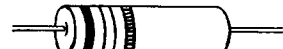
FEED THROUGH INSULATOR



COAXIAL SOCKET.



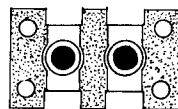
SELF-TAPPING SCREWS.



1- WATT RESISTOR.



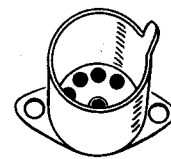
2000  
DISC CERAMIC CAPACITOR.



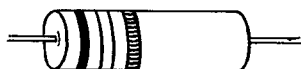
SOCKET (2 WAY)



CONTROL NUT & WASHER



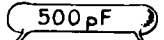
SKIRTED V/HOLDER



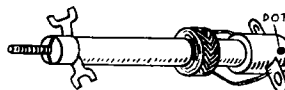
2- WATT RESISTOR.



RESISTOR METAL FILM.



500 pF  
TUBULAR CERAMIC CAPACITOR.



OSC. COIL



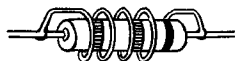
6-BA



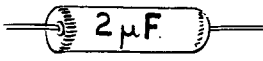
4-BA



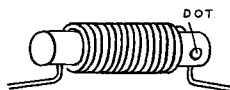
2-BA



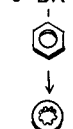
PARASITIC CHOKE



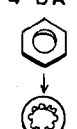
2 μF  
2 μF PAPER CAPACITOR.



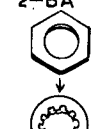
FILTER CHOKE OR COIL



6-BA



4-BA



2-BA



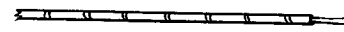
RF CHOKE OR COIL



MICA CAPACITOR



SCREENED WIRE.



INSULATED WIRE.



3 CORED INSULATED CABLE.



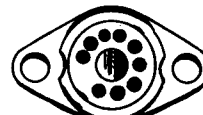
SLEEVING.



OSCILLATOR COIL.



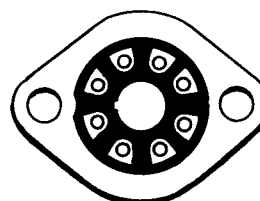
SPILL.



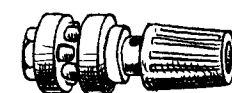
"NOVAL" V/HOLDER.



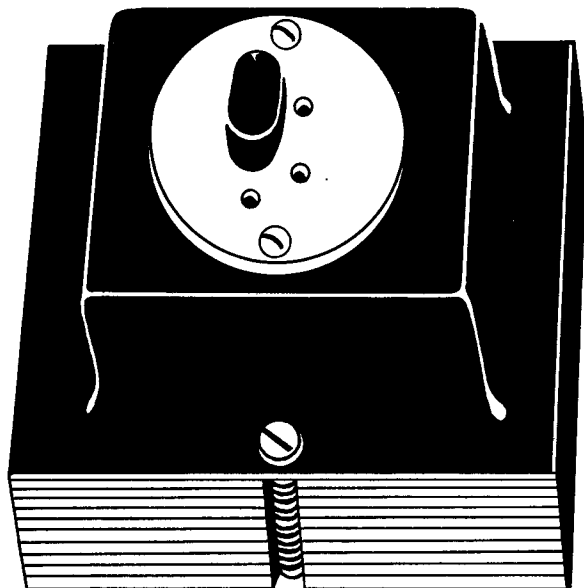
I.F. TRANSFORMER.



INTERNATIONAL 'OCTAL'.



TERMINAL (RED OR BLACK)

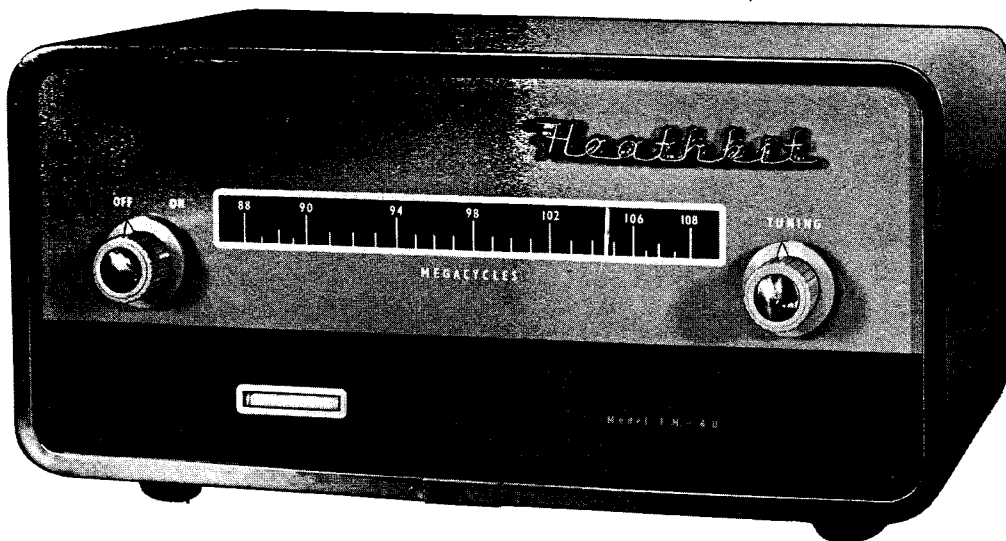


MAINS TRANSFORMER.

# HEATHKIT V.H.F. F.M. TUNER

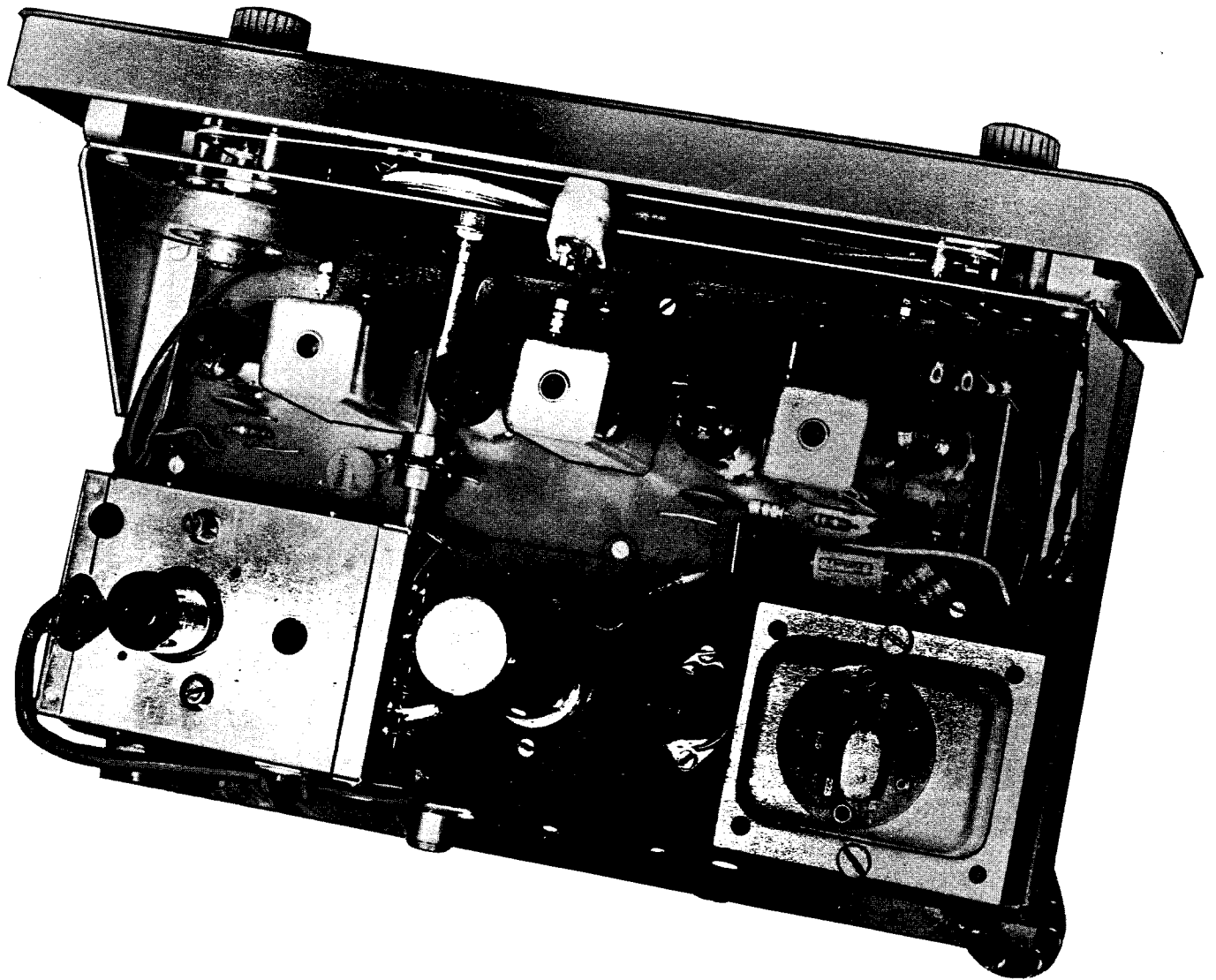
Comprising Model FMT-4U Tuning Unit  
and

FMA-4U, I.F. Amplifier with Power Supply.

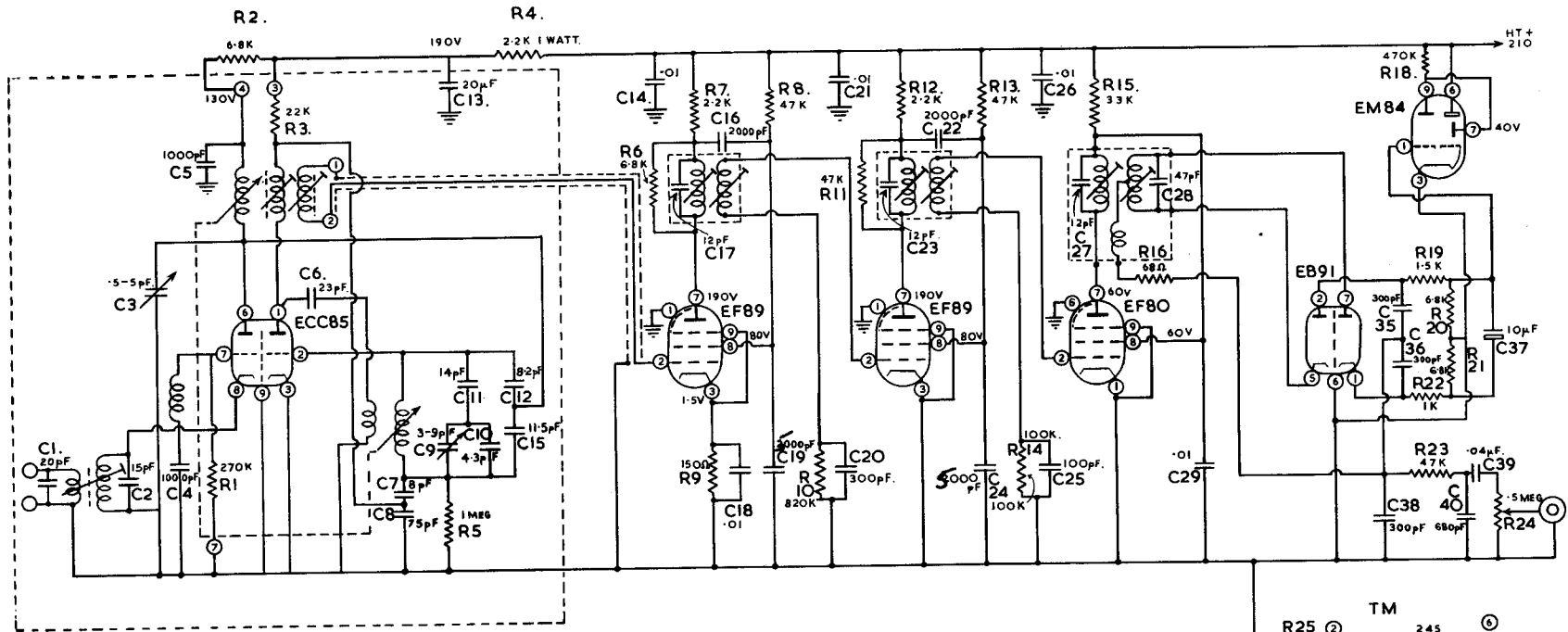


## SPECIFICATIONS

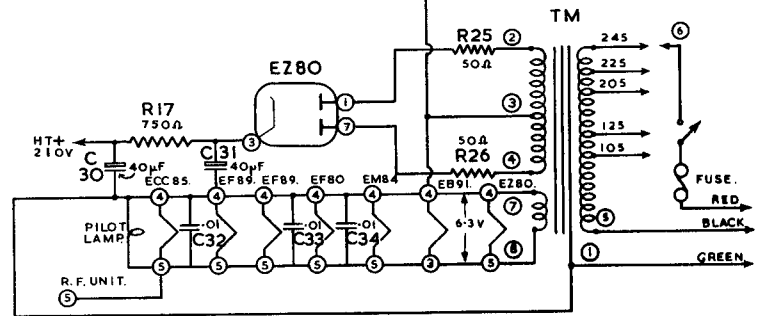
Tuning Range:.....	88 Mc/s to 108 Mc/s - full international band
I. F. Frequency:.....	10.7 Mc/s
I. F. Bandwidth:.....	300 Kc/s 3 dB down
Aerial Impedance:.....	75Ω Co-axial
Output Impedance:.....	100 KΩ approximately
Output Voltage:.....	Nominal 1 volt, 30% modulation, 20 μV input
Tuning Scale: .....	Length 6½", spinwheel drive
Valve Complement:.....	1 - ECC85 R.F. amp and additive mixer-osc. 1 - EF89 1st I. F. amp. 1 - EF89 2nd I. F. amp. and limiter 1 - EF80 3rd I. F. amp. and limiter 1 - EB91 discriminator (ratio detector) 1 - EM84 cathode-ray tuning indicator 1 - EZ80 rectifier
Power Requirements:.....	100/130V, 200/250V (5 tapings) 40-60 c/s, 30 watts 40-60 c/s, 30 watts
Shipping Weight:.....	14 lbs. 8 ozs.
Nett Weight: .....	9 lbs. 8 ozs.
Overall Dimensions:.....	12.1/8" long x 5½" wide x 7¼" deep
Finish: .....	Grey enamel with two-tone perspex panel to match







CIRCUIT DIAGRAM FOR  
HEATHKIT F.M. TUNER.  
MODEL FM-4U.





## INTRODUCTION

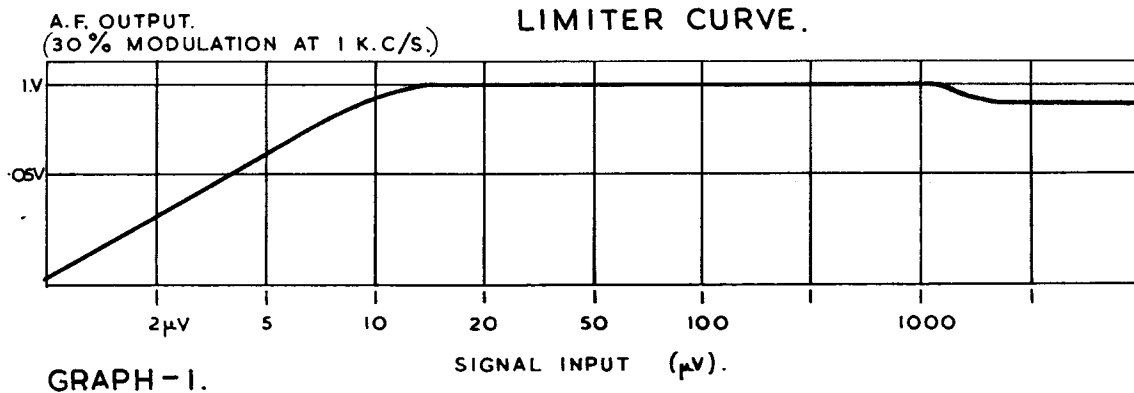
The Heathkit VHF Tuner model FMT-4 is a compact permeability tuned unit covering the full international band of 88 to 108 Mc/s. Completely self-contained, the whole unit is carefully screened in a robust metal box which effectively reduces oscillator radiation to limits well within those recommended by the British Radio Equipment Manufacturers' Association (BREMA).

Combined with the Heathkit FMA-4 I. F. amplifier, the two units then comprise a self-powered highly sensitive VHF tuner suitable for use with any high-fidelity amplifier and capable of a high standard performance under the most adverse conditions. The FMA-4 uses 3 I. F. stages (two of which also function as limiters) a double diode detector and a novel thermometer type cathode-ray tuning indicator. Negative feedback is used to give a wide flat top I. F. pass band with minimum side responses. A wide-band ratio discriminator with separate limiters is employed in preference to a Foster-Seeley phase detector as giving the following advantages:-

- a. Lower inter-station noise.
- b. Greater A. M. suppression.
- c. Superior performance at low signal levels.
- d. Easier alignment - an important point for home constructors.

The major defect of a ratio detector is the fact that balance and linearity is to a certain extent dependant on input voltage but this defect is overcome by using efficient limiting. The Graph shows that the input to the discriminator is held constant above a specific level by the limiter stages.

The use of a printed circuit board greatly facilitates the construction whilst guaranteeing a consistent performance. Two spare sockets are mounted at the rear of the chassis enabling an adaptor to be used for receiving stereophonic transmissions when these commence. Small physical size and an attractively styled exterior complete the picture and the tuner can be mounted in a cabinet or simply stood on a table or bookshelf. We trust that these Heathkit models will give you many pleasant hours of trouble-free reception.



### EXPLANATION OF TERMS USED IN THE SPECIFICATIONS

All electronic equipment must have a specification list stating in technical terms how the equipment will perform under various conditions of use. Therefore we present the following test results for the FM-4U Tuner and we shall attempt to explain a little of what each test means in practice.

We hope that this will make these values a little more useful and interesting to you, and possibly enable you to compare it with other tuner specifications.

Before we can begin with test results, we will give a very abbreviated explanation of some of the terms that must be used.

AM-FM: AM (Amplitude Modulation) and FM (Frequency Modulation) refer to the method in which intelligence (speech or music) is carried by the radio waves.

In Amplitude Modulation, you can say that the intelligence is carried by varying the size (amplitude) of the radio waves.

In Frequency Modulation, the intelligence is carried by varying the frequency of the radio waves. If this frequency were to vary widely enough, the position of the station on your tuning scale would actually move back and forth (very quickly, of course). In practise, though, it does not vary widely enough to be seen on the dial.

DEVIATION: On a transmitted FM signal, the intelligence is carried by varying the station's output frequency (89.2 megacycles for example) at the audio rate of the intelligence. Deviation is the amount (or number of kilocycles) that the signal varies, plus or minus, from its centre frequency in order to carry the required intelligence.

SENSITIVITY: Generally, sensitivity means how small a signal can this tuner receive and amplify into intelligible programme material.

PERCENTAGE OF MODULATION: This represents the amount of intelligence impressed on the FM signal. It is limited to a maximum deviation of plus or minus 75 Kc/s. This number of Kc/s deviation represents 100% modulation.

For example:- 22.5 Kc/s would be 30% modulation.  $\frac{22.5}{75} = .3$  or 30%

QUIETING: The application of an input signal, even though it may not be carrying any intelligence, causes a change of operating conditions in the tuner. This makes the valve noise, etc. from the tuner decrease or disappear altogether according to the signal strength. Measured in microvolts (millionths of a volt.)

SPECIFICATIONS

Quieting Sensitivity:..... 2.5 μV for 20 dB quieting.  
25 μV for full quieting (45 dB) (barely audible)

Sensitivity by itself is quite useless if the sound is masked by a lot of noise. This test is measured in decibels (units of sound).

Image Ratio: ..... Greater than 32 dB

This tuner is a super heterodyne and there always exists one other frequency besides the one you are tuned to that could enter the tuner, mix with the oscillator signal and thereby create a signal that would be amplified by the I. F. amplifiers. This test tells us how much the "image" would be held back if it were to arrive at your aerial socket, if the wanted and unwanted signals were the same strength.

I. F. Rejection: ..... Greater than 50 dB

This tells us that if an I. F. signal were to appear at the aerial socket at equal strength of the wanted signal, that the I. F. signal would be barely audible.

A.M. Suppression: ..... 30 dB

Since this is an FM tuner, it is highly desirable that any AM signals present at the aerial socket will not be heard in the output, as they will appear badly distorted. If an AM signal and an FM signal, each of the same strength, were present at the aerial socket, the AM audio output would be 30 dB smaller.

Local Oscillator Drift: ..... Less than †25 Kc/s.

This means that after a few minutes warmup time the tuner will remain in tune within the stated limits. This is very important, because it is annoying to constantly re-tune after the wanted station has been selected.

Frequency Response: ..... †2 dB from 20-20,000 c/s.

This tells us how equally all of the audio frequencies (20-20,000 cycles) are amplified through the complete tuner. It ensures that low notes will not be amplified less than high notes or vice versa.

Harmonic Distortion: ..... Less than 1%, 1 mV input, 1 Kc/s modulation and 75 Kc/s deviation

This tells us that a waveform on an incoming signal will not be distorted (misplaced) by more than 1%.



## PRELIMINARY NOTES AND INSTRUCTIONS

The Step-by-Step instructions given in this manual should be followed implicitly to ensure a minimum of difficulty during construction and a completely satisfactory result, including many years of accurate, trouble-free service from the finished instrument.

**UNPACK THE KIT CAREFULLY, EXAMINE EACH PART AND CHECK IT AGAINST THE PARTS LIST.** In so doing, you will become acquainted with the parts. If a shortage is found, attach the inspection slip to your claim and notify us promptly. Screws, nuts and washers are counted mechanically and if a few are missing, please obtain them locally if at all possible.

Lay out all the parts so that they are readily available in convenient categories. Refer to the general information inside the covers of this manual for instructions on how to identify components.

Moulded egg containers make handy trays for holding small parts. Resistors and capacitors may be placed in the edge of a corrugated cardboard box until they are needed.

Use lockwashers under all screws and nuts, and also between controls and the chassis. When shakeproof solder tags are mounted under nuts, the use of lockwashers is unnecessary.

Resistors and capacitors have a tolerance rating of  $\pm 10\%$  unless otherwise stated. Therefore a 100 K $\Omega$  resistor may test anywhere between 90 and 110 K $\Omega$ . Frequently capacitors show an even greater variation such as -50% to +100%. This Heathkit accommodates such variations.

Unless otherwise stated all wire used is insulated. Bare wire is only used where lead lengths are short and there is no possibility of a short circuit. Wherever there is a possibility of the bare wire leads of resistors or capacitors, etc., shorting to other parts or to chassis, such leads must be covered with insulated sleeving.

To facilitate describing the location of parts, all valveholders, controls, tag strips, etc., have been lettered or numbered. Where necessary all such coding is clearly shown in the illustrations. When instructions say, for example, "wire to socket G3", refer to the proper figure and connect a wire to tag 3 of socket G.

Valveholders illustrated in the manual are always shown with their tags numbered in a clockwise sequence, from the blank tag position or keyway, when viewed from underneath.

All rotary switch tags are numbered clockwise when viewed from the rear of the wafer, i. e. the end remote from the knob.

All resistors may be wired either way round.

All capacitors, excepting electrolytic capacitors, may be wired either way round unless otherwise stated.

Carefully letter and number tag strips, valveholders, transformers, etc. A wax pencil is ideal for this purpose.

When mounting resistors and capacitors make sure that the value can be read when in position.

Observe polarity on all electrolytic capacitors, i. e. RED = POSITIVE.

A circuit description is included in this manual so that those with some knowledge of electronics will be able to obtain a clearer picture of the actual functioning of this instrument. It is not expected that those with little experience will understand the description completely, but it should be of help in the event that they desire to become more familiar with the circuit operation and thus learn more from building the kit than just the placing of parts and the wiring.

Read this manual right through before starting actual construction. In this way, you will become familiar with the general step-by step procedure used. Study the pictorials and diagrams to get acquainted with the circuit layout and location of parts. When actually assembling and wiring, READ THROUGH THE WHOLE OF EACH STEP so that no point will be missed.

A tick (✓) should be made in the space provided at the beginning of each instruction immediately it has been completed. This is most important as it will avoid omissions or errors, especially whenever work is interrupted in the course of construction. Some Kit-builders have found it helpful in addition to mark each lead in the pictorial in coloured pencil as it is completed.

Successful instrument construction requires close observance of the step-by-step procedure outlined in this manual. For your convenience, some illustrations may appear in large size folded sheets. It is suggested that these sheets be fastened to the wall over your work area for reference purposes during instrument construction.

The Company reserves the right to make such circuit modification and/or component substitutions as may be found desirable, indication being by "Advice of Change" included in the kit.

NOTE: Daystrom Ltd. will not accept any responsibility or liability for any damage or personal injury sustained during the building, testing, or operation of this instrument.

ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT ONLY "60/40" RESIN CORE RADIO SOLDER BE PURCHASED.

**PROPER SOLDERING PROCEDURE**

Only a small percentage of Heathkit purchasers find it necessary to return an instrument for factory service. Of these, by far the largest proportion function improperly due to poor or improper soldering.

Correct soldering technique is extremely important. Good soldered joints are essential if the performance engineered into the kit is to be fully realised. If you are a beginner with no experience in soldering, half an hour's practice with odd lengths of wire and a valveholder, etc., will be invaluable.

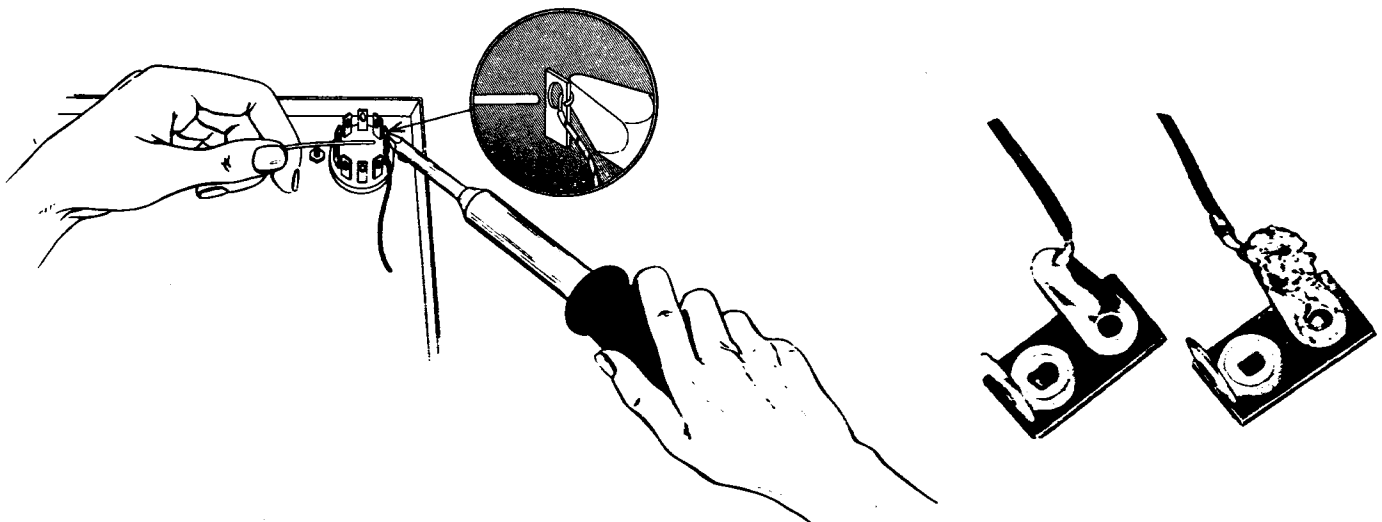
Highest quality resin-cored solder is essential for efficiently securing this kit's wiring and components. The resin core acts as a flux or cleaning agent during the soldering operation.

NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes or liquids. Such compounds, although not corrosive at room temperature, will form residues when heated. These residues are deposited on surrounding surfaces and attract moisture. The resulting compounds are not only corrosive but actually destroy the insulation value of non-conductors. Dust and dirt will tend to accumulate on these "bridges" and eventually will cause erratic or degraded performance of the instrument.

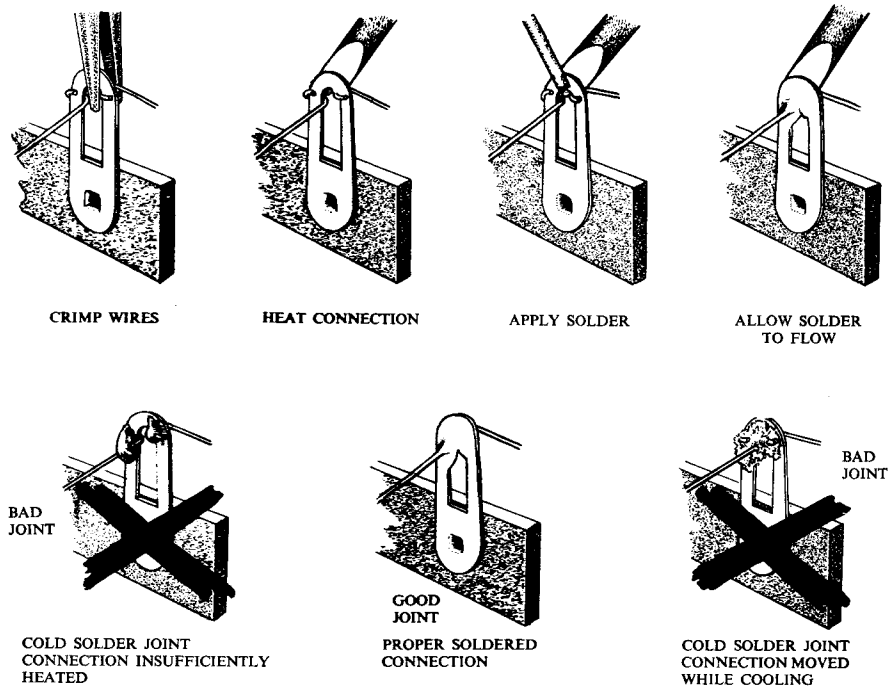
**IMPORTANT**

IN THE "STEP-BY-STEP" PROCEDURE the abbreviation "NS" indicates that the connection should not yet be soldered, for other wires will be added. At a later stage the letter "S" indicates that the connection must now be soldered. Note that a number appears after each solder (S) instruction. This number indicates the number of leads connected to the terminal in question. For example, if the instructions read, "Connect one lead of a 47 K $\Omega$  resistor to tag 1 (S-2)", it will be understood that there should be two leads connected to the terminal at the time it is soldered. This additional check will help to avoid errors.

When two or more connections are made to the same solder tag a common mistake is to neglect to solder the connections on the bottom. Make sure all the wires are soldered.



If the tags are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so a good mechanical joint is made without relying on solder for physical strength.



Typical good and bad soldered joints are shown above.

A poor soldered joint will usually be indicated by its appearance. The solder will stand up in a blob on top of the connection, with no evidence of flowing out caused by actual "wetting" of the contact. A crystalline or grainy texture on the solder surface caused by movement of the joint before it solidifies is another evidence of a "cold" connection and possible "dry" joint. In either event, reheat the joint until the solder flows smoothly over the entire junction, cooling to a smooth, bright appearance.

To make a good soldered joint, the clean tip of the hot soldering iron should be placed against the joint to be soldered so that the flat tag is heated sufficiently to melt the solder. Resin core solder is then placed against both the tag and the tip of the iron and should immediately flow over the joint. See illustrations. Use only enough solder to cover the wires at the junction; it is not necessary to fill the entire hole in the tag with solder. Don't allow excess solder to flow into valveholder contacts, ruining the sockets, or to creep into switch sockets and destroy their spring action. Position the work so that gravity tends to keep the solder where you want it.

A clean, well-tinned soldering iron is also important to obtain consistently perfect connections. For most wiring, a 25 to 50 watt iron, or the equivalent in a soldering gun, is very satisfactory. Keep the iron hot and its tip and the connections to be soldered bright and clean. Always place the solder on the heated "work" and then place the bit on top of the solder until it flows readily and "wets" the joint being made. Don't take the solder on to the bit and then try to bring it to the work directly from the soldering iron. Whenever possible a joint should be secured mechanically by squeezing tight with pliers prior to soldering it. The hot soldering bit should frequently be scraped clean with a knife, steel wool or a file, or wiped clean quickly by means of a rag or steel wool.

Don't apply too much solder to the soldered joint. Don't apply the solder to the iron only, expecting that it will roll down onto the connection. Try to follow the instructions and illustrations as closely as possible.

Don't bend a lead more than once around a connecting point before soldering, so that if it should have to come off due to a mistake or for maintenance it will be much easier to remove.

Follow these instructions and use reasonable care during assembly of the kit. This will ensure the deserved satisfaction of having the instrument operate perfectly the first time it is switched on.

The Heathkit printed circuit board comprises a high grade sheet of insulating material on which a specially processed gold-plated pattern has been produced. This replaces a high proportion of the wiring of the instrument, and almost all of that usually associated with a conventionally wired chassis. Performance variations due to errors and peculiarities of individual assembly techniques are eliminated by the use of the printed circuit. It also considerably simplifies construction and is labour-saving.

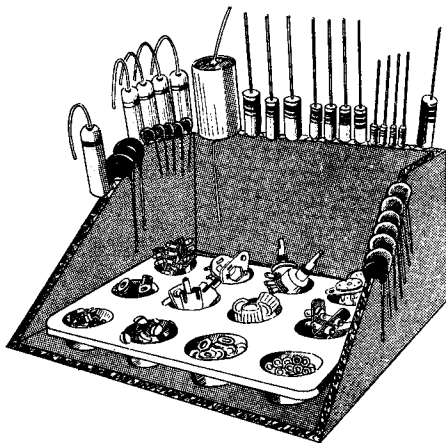
The basic soldering technique is only different in that less heat is required. We recommend the use of a very small electric soldering iron of about 25 watts rating and not exceeding 50 watts. A thin chisel bit of up to  $\frac{1}{4}$ " diameter rod is best. (See illustrations.)

Overheating will damage the printed circuit copper foil on the board and must be avoided. A "crackling" or "frying" noise (from the circuit board during soldering) is evidence that serious overheating has occurred.

The metal foil is on one side of the board. On the reverse side is printed the position of various components which are identified by their electrical value.

To install a capacitor or resistor, hold the component in one hand, and with the other hand bend both the lead wires downward to form a U-shaped unit. Then insert these leads through the holes indicated on the board, entering from the printed side so that the component is adjacent to the place marked for it on the board. Then bend the surplus wire leads upwards flat against the board, temporarily to secure the component. Usually several components are mounted in this manner and later soldered. After soldering, the surplus wire ends must be cut off close to the board.

Valveholders are mounted in a similar manner by inserting the socket tags in the appropriate holes in the board, after correctly aligning the socket as instructed, and then soldering the tags to the foil.



This illustration shows how resistors and capacitors may be placed in the cut edge of a corrugated cardboard carton until they are needed. Their values can be written on the cardboard next to each component.

### STEP-BY-STEP ASSEMBLY INSTRUCTIONS

The Heathkit FM-4U FM Tuner is a complex and critical instrument. We very strongly urge that the step-by-step instructions be followed exactly rather than constructing the unit from pictorial and circuit diagram alone. Special instructions regarding sequence of assembly and wire lengths are given to make the construction of the kit as easy as possible. Wiring and mounting parts improperly may result in instability and it may be necessary to re-do work previously accomplished.

The following instructions are presented in a simple, logical, step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before you start to do it. When the step is completed, check it off in the space provided.

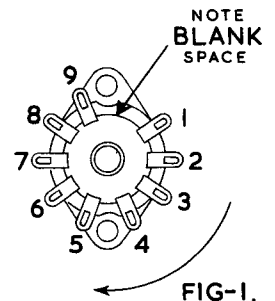
We suggest that you do the following before any work is started:-

1. Attach the large loose leaf Pictorials to the wall above your work space.
2. Go through the entire assembly and wiring instructions. This is an excellent time to read the entire instructions section through and familiarise yourself with the procedure.
3. Lay out all parts so that they are readily available. Refer to the general information inside the front and rear covers of this manual and also the loose leaf pictures of parts to help you identify components.
4. Make sure if there is an amendment sheet to this Manual, that you have made the alterations at the appropriate places.

#### MOUNTING COMPONENTS TO CHASSIS - PICTORIAL 1

##### INSIDE VIEW

- (\*) Place the chassis on the bench so that it corresponds to Pictorial 1.
- (✓) Mount the pre-set volume control at location AV.
- (✓) Mount the two-way (phono) audio socket at location AA. Use 6BA x  $\frac{1}{4}$ " binderhead screws.
- (✓) Mount the aerial socket at location AS. Use 6BA x  $\frac{1}{4}$ " binderhead screw and at the same time mount a 6BA solder tag as shown.
- (✓) Mount the stereo adaptor socket at location AD. Use 6BA x  $\frac{1}{4}$ " binderhead screws.
- (✓) Mount the fuseholder at location AF. Make sure the moulded pips on the fuseholder locate in the corresponding slots on the chassis. DO NOT OVERTIGHTEN the mounting nut, or fracture of the moulding may result.
- (✓) Insert a 3/8" grommet at location GM.
- (✓) Insert the remaining grommets in locations GA, GB, GC, GD and GE.
- (✓) Mount the capacitor mounting plate at location EC. Make sure you position the plate as shown in the pictorial. Use 6BA x  $\frac{1}{4}$ " binderhead screws.
- (✓) Refer to Figure 1 and note that the tags on valveholders are numbered in a clockwise direction starting from the blank space. Now mount a valveholder at location VR. Use 6BA x  $\frac{1}{4}$ " binderhead screws and at the same time, mount a 6BA solder tag as shown.
- (✓) Clip on the four J type speed nuts at the bottom chassis flanges.



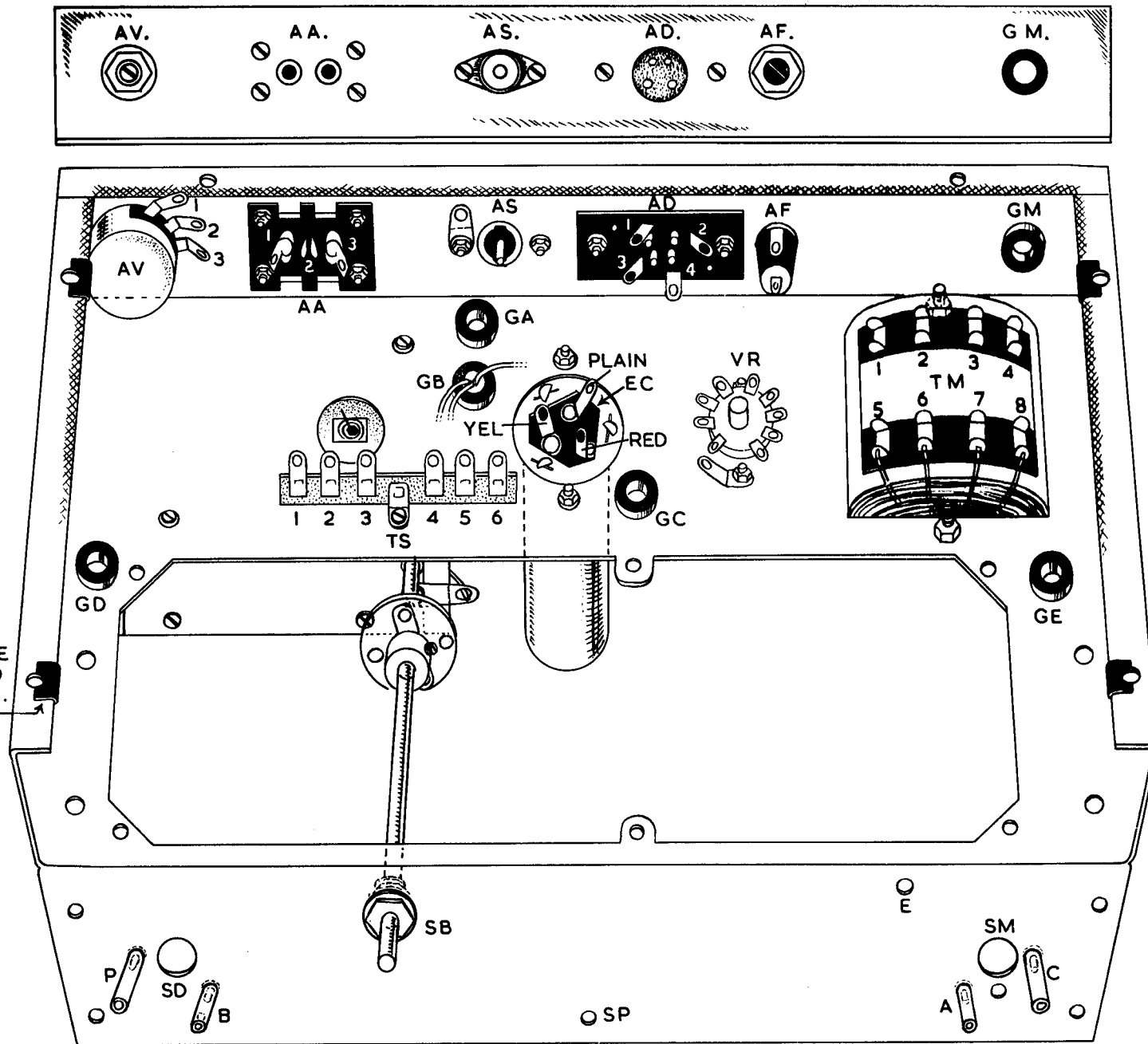
#### MOUNTING COMPONENTS TO CHASSIS - PICTORIAL 2

##### TOP VIEW

- (✓) Select the two support brackets and the two buffer brackets.
- (✓) In each buffer bracket insert two rubber buffers as shown in Figure 2.



J' TYPE  
SPEED  
NUTS.



PICTORIAL-1.

- (✓) On the chassis left hand side, mount a support bracket. First secure with two 4BA x 3/8" binderhead screws on the chassis top face.
- (✓) Now insert two 4BA x 3/8" binderhead screws through the holes in the support bracket and chassis front apron. At the same time mount a buffer bracket on the screws. See Figure 2.
- (✓) In the same manner, mount the other support bracket and buffer bracket to the chassis right hand side.

(✓) At locations A and B mount a 1/2" long 4BA tapped pillar. Use 4BA x 1/4" binderhead screws with a lockwasher inside the screw head.

(✓) Select the drive shaft assembly, remove the locknut if in position and place a flat washer over the threaded end. Fit to chassis at location SD, fit another flat washer and secure with the 3/8" locknut.

(✓) Select the rotary ON/OFF switch and mount to chassis at location SM. Secure using a flat washer and 3/8" locknut.

(✓) At location C, mount a 3/4" long 4BA tapped pillar. Use 4BA x 1/4" binderhead screws with a lockwasher inside the screw head.

(✓) At location P, mount another 3/4" long 4BA tapped pillar. Use 4BA x 1/4" binderhead screws with a lockwasher inside the screw head.

(✓) Select the threaded bush and remove the locknut if fitted. Place a flat washer on the threaded end. Insert in location SB, fit another flat washer and tighten the locknut finger tight.

(✓) Select the pilot lamp bracket and mount to chassis at location SP. Use a 4BA x 3/8" binderhead screw.

(✓) Select the lead flywheel and position on the inside of tuning shaft. Tighten grub screws.

(✓) Temporarily place chassis on one side and proceed as follows.

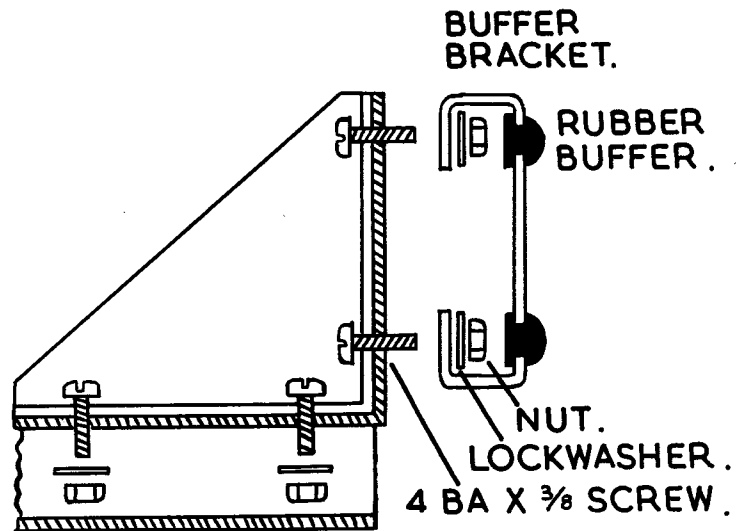


FIGURE-2.

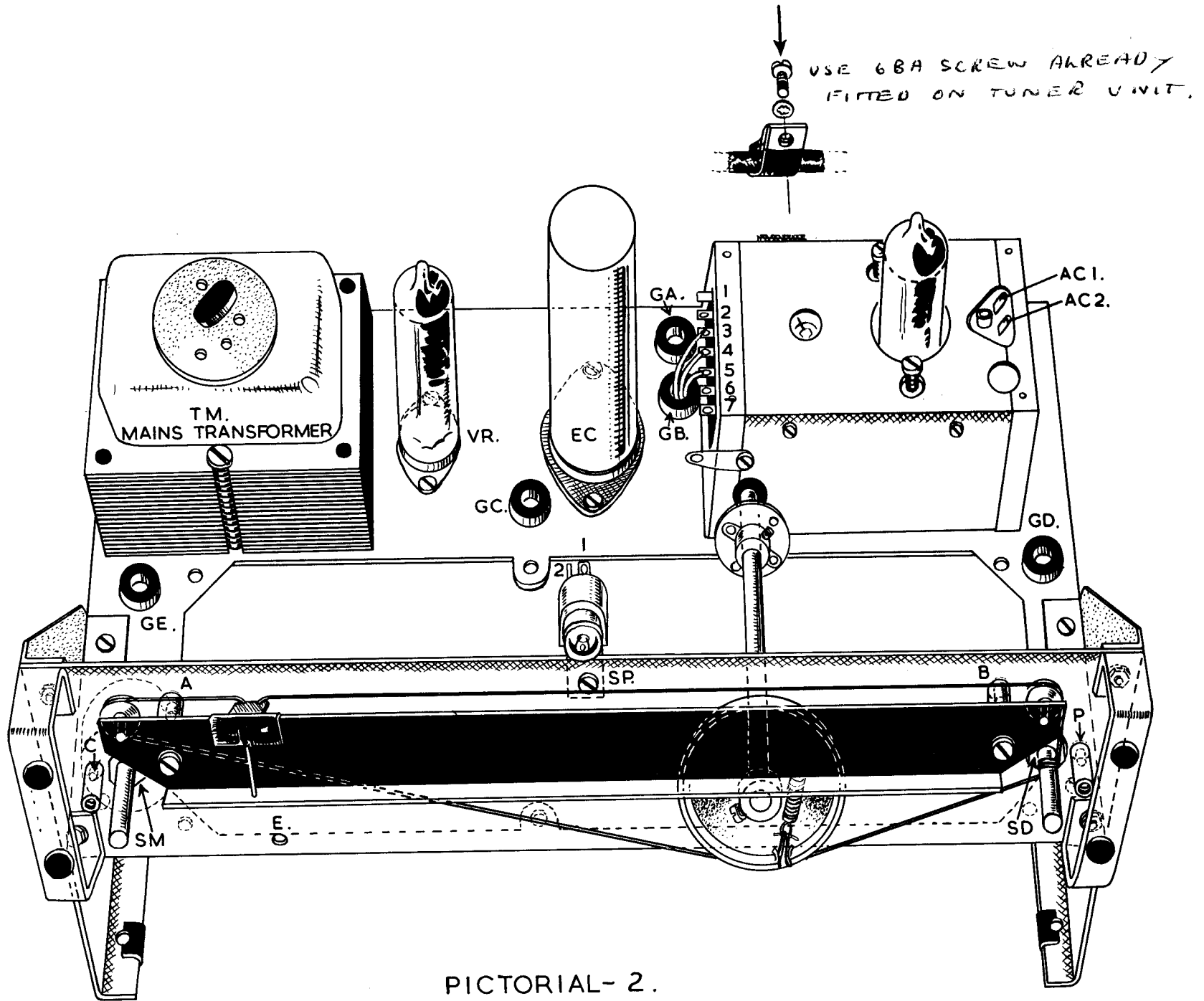
(✓) Select the RF tuning unit and remove the ECC85 valve and store it in a safe place.

#### TUNING UNIT - PICTORIAL 3

##### Special Note:

On either side of the ECC85 valve socket will be seen two protruding screws. DO NOT TURN THESE SCREWS as the factory alignment of this unit will be spoilt.

- (✓) Refer to Pictorial 3 and mount a 6BA solder tag above the tuning shaft. Use 6BA x 1/4" screws.
- (✓) The tuning unit has a row of seven tags for lead out wires. When wiring, use the top tag of the double tags.
- (✓) Connect a 3 1/2" length of RED wire to TU tag 3 (S-1).
- (✓) Connect a 5 1/4" length of YELLOW wire to TU tag 4 (S-1).
- (✓) Connect a 3 1/2" length of BROWN wire to TU tag 5 (S-1).
- (✓) Connect a short length of bare wire between TU tag 7 (S-1) and the 6BA solder tag (S-1). The unit is now ready for mounting to chassis.



PICTORIAL- 2.

## CHASSIS ASSEMBLY CONTINUED - PICTORIALS 1 and 2

- (✓) Mount the mains transformer at location TM. First remove the nuts from the 2BA screws, locate transformer in the chassis aperture as shown. Replace nuts and lock tight.
- (✓) Mount the tuning unit to chassis using three 6BA x  $\frac{1}{4}$ " screws and lockwashers. Under screws TS mount a 6-way tagstrip. DO NOT fully tighten these screws yet. Route all wires through grommet GB.
- (✓) Select the extension shaft, flexible coupling and tuning drum.
- (✓) Slide the extension shaft through the chassis apron bush at location SB.
- (✓) At the inside end of the bush, slide on the flexible coupling and lock the grub screws.
- (✓) Fit adaptor sleeve on tuning unit shaft. See Pictorial 3.
- (✓) Now align the extension shaft with tuning unit shaft and lock the grub screws on the flexible coupling.
- (✓) When the shaft is turning freely, tighten the tuning unit mounting screws and the threaded bush on the chassis apron.
- (✓) Turn the tuning shaft to the fully anticlockwise position.
- (✓) Position the drum on the tuning shaft with the cord slot facing the chassis bottom. Tighten screws.
- (✓) Select the guide plate assembly and mount to pillars A and B. Use 4BA binderhead screws with lockwashers under each screw head.
- (✓) Select the dial cord and route this cord as shown in Figure 3.

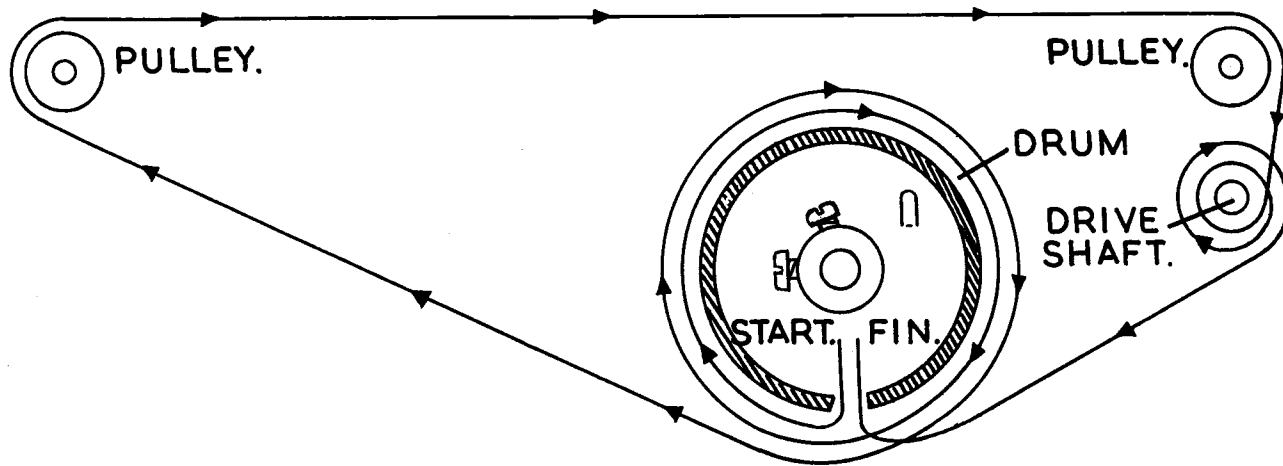
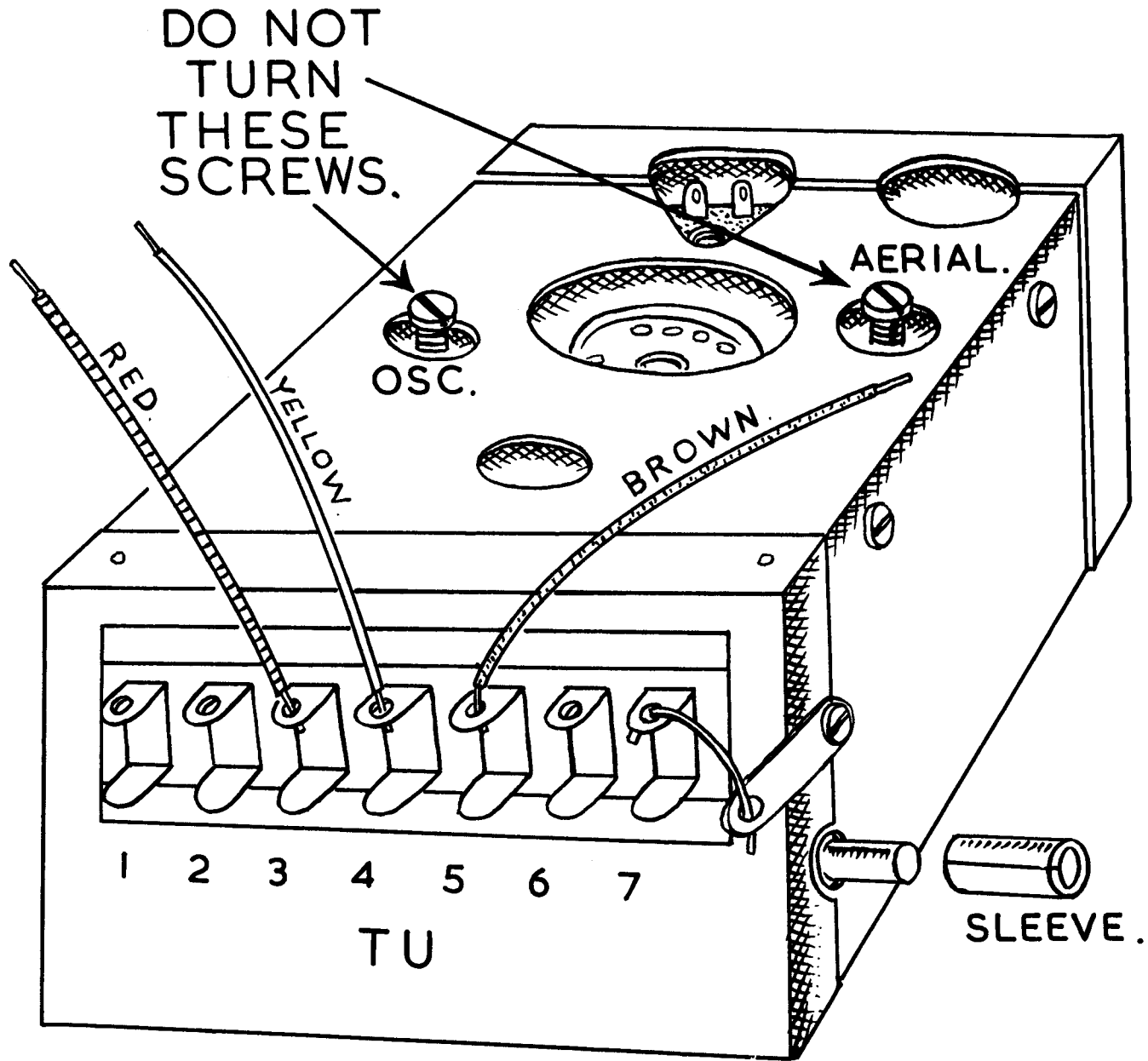


FIGURE-3.

- (✓) Holding the ends of the cord in place, slip the cord off each pulley into the space between pulley and guide plate.
- (✓) Loop both ends of the cord through one end of the tension spring and tie two knots as shown in Figure 4.
- (✓) Now hook the other end of the spring over the tag on the drum.
- (✓) Carefully lift the cord back on to the pulleys. The knob shaft should now turn the tuning unit shaft from one end of its stop to the other.
- (✓) If any slip occurs, place one drop of thin machine oil on the tuning unit shaft and pulleys bearing surfaces. Do not allow any oil to contact the dial cord. The dial cord must be tight to obtain correct operation.



FIGURE-4.



PICTORIAL-3.

- ( ) Select the dial pointer and bend the centre fork out slightly.
- ( ) Turn the tuning shaft to the fully anticlockwise position and place the pointer inside the top edge of the guide plate. Slide to the left hand side and lock the dial cord between the pointer forks approximately 1/8" from the pulley spacer.
- ( ) The pointer should now traverse freely from end to end.

#### CHASSIS WIRING - PICTORIAL 4

- (✓) Using bare wire and sleeving, connect a wire from solder tag VR (NS) to TM1 (S-1) and on to TM3 (NS).
- (✓) Using bare wire and sleeving, connect a wire from solder tag VR (NS) to VR5 (S-1).
- (✓) Using bare wire and sleeving, connect a wire from solder tag VR (NS) to TM7 (NS).
- (✓) Select the 40-40-20  $\mu$ F electrolytic capacitor and insert the three prongs in the slots at EC. Give each prong a slight twist.
- (✓) Using bare wire and sleeving, connect a wire from solder tag VR (S-4) to the nearest prong on EC (S-1).
- (✓) Select the two 50 $\Omega$  wire-wound resistors.
- (✓) Using sleeving at each end, connect a 50 $\Omega$  resistor between VR7 (S-1) and TM2 (S-1).
- (✓) Using sleeving at each end, connect a 50 $\Omega$  resistor between VR1 (S-1) and TM4 (S-1).
- (✓) Cut two 12" lengths of BROWN wire and twist together. Connect one end of this pair to the mains switch SM1 (S-1) and SM2 (S-1). See Figure 5.
- (✓) Now route this wire through grommet GE and connect one wire to TM5 (S-1) and the other wire to the fuseholder AF1 (S-1).
- (✓) Cut off a 12" length of BLACK and BROWN wire and twist together. At one end, connect the BLACK wire to lampholder tag 1 (S-1) and BROWN wire to tag 2 (S-1). Now connect the other ends. The BLACK wire to TM7 (NS) and BROWN wire to TM8 (NS). Insert lampholder in bracket at location SP. Screw in pilot lamp.
- (✓) Connect a 5" length of BROWN wire between TM8 (NS) and VR4 (NS).
- (✓) Connect a 5" length of BROWN wire between VR4 (S-2) and 6-way tagstrip TS5 (NS).
- (✓) Connect the BROWN wire from grommet GB to TS5 (NS).
- (✓) Connect a 2" length of RED wire between VR3 (S-1) and EC RED tag (NS).
- (✓) Connect a 2" length of RED wire between EC RED tag (S-2) and TS6 (NS).
- (✓) Select the 750 $\Omega$  wire-wound resistor and connect between TS6 (S-2) and TS3 (NS).
- (✓) Connect the YELLOW wire from grommet GB to TS4 (NS).
- (✓) Select a 6.8 K $\Omega$  resistor (BLUE, GREY, RED) and at each end place 5/8" sleeving. Connect between TS4 (S-2) and TS1 (NS).
- (✓) Connect a 3" length of YELLOW wire between EC YELLOW tag (S-1) and TS3 (NS).
- (✓) Connect a 4 1/2" length of YELLOW wire between TS1 (NS) and EC PLAIN tag (NS).
- (✓) Connect the RED wire from grommet GB to EC PLAIN tag (S-2).
- (✓) Select the 2.2 K $\Omega$  1 watt resistor (RED, RED, RED) and connect between TS1 (S-3) and TS3 (NS).
- (✓) Using bare wire and sleeving, connect a wire between volume control AV1 (NS) and audio socket AA2 (S-1).
- (✓) Using bare wire and sleeving, connect a wire between AV2 (S-1) and AA1 (S-1).

This completes the chassis wiring until the circuit board is fitted.

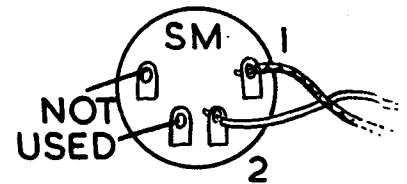
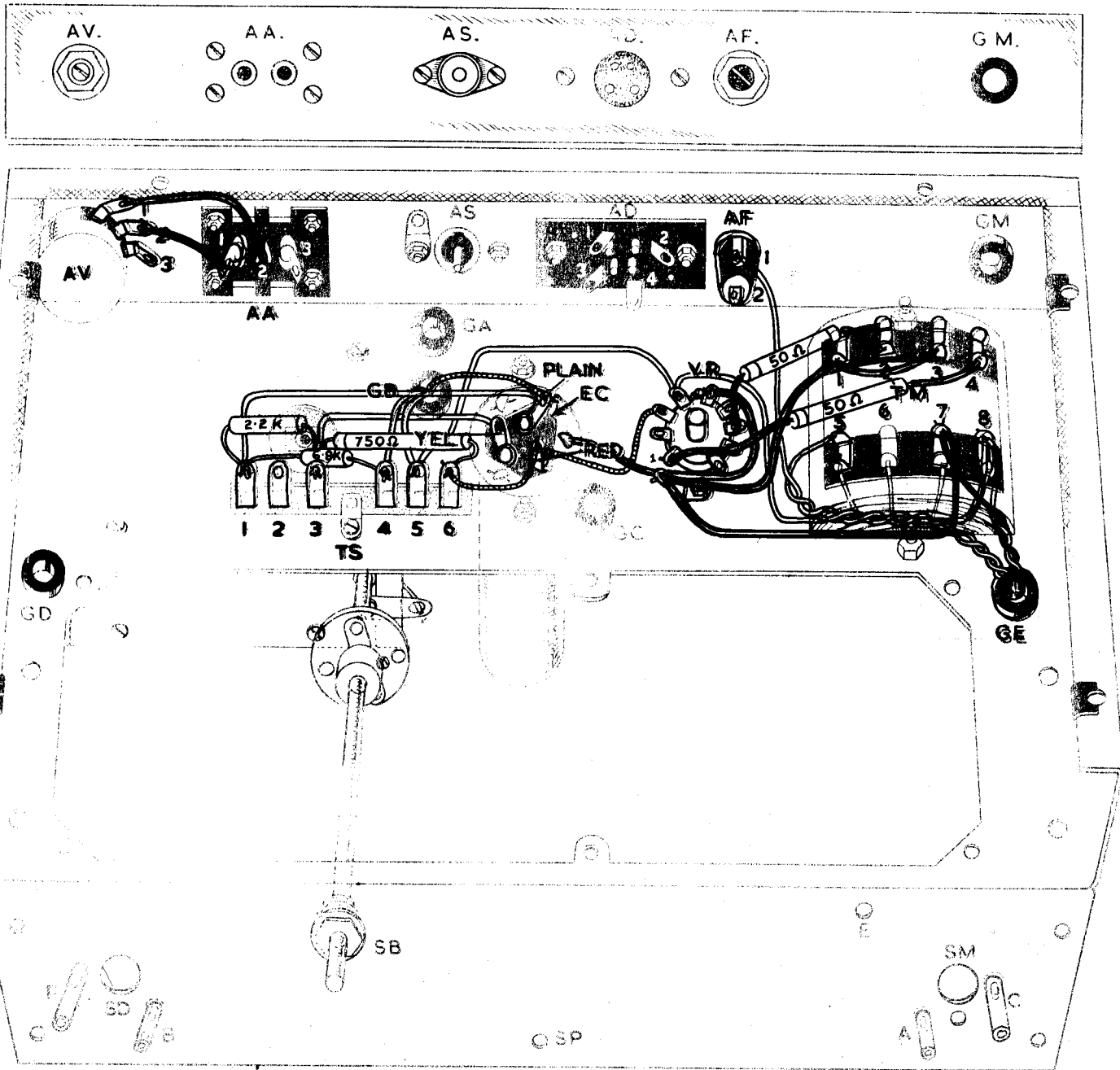


FIGURE-5.



J TYPE SPEED NUTS



PICTORIAL- 4.

## TUNING INDICATOR ASSEMBLY - FIGURE 6

- (✓) Select the other B9A chassis type mounting valvholder and refer to Figure 6.
- (✓) Cut a 6" length of BLACK and BROWN wire and twist together. Connect the BROWN wire to tag 5 (S-1) and the BLACK wire to tags 3 and 4. Solder each tag.
- (✓) Select a 470 K $\Omega$  resistor (YELLOW, VIOLET, YELLOW) then connect between valvholder tag 6 (NS) and tag 9 (S-1) from tag 9 continue the resistor wire back to tag 7 (S-1). Use sleeving.
- ( ) Select the EM84 tuning indicator and clip. Insert the EM84 in valvholder and position clip.

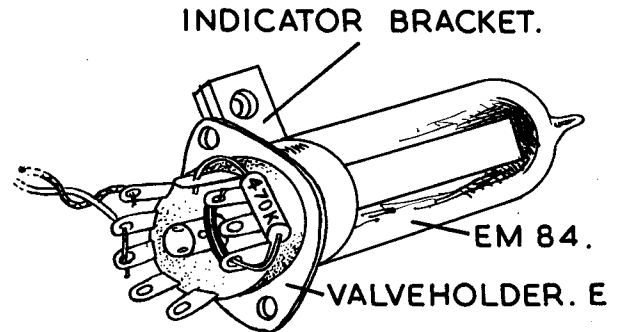


FIGURE-6.

This completes the assembly of tuning indicator.

## MOUNTING OF COMPONENTS TO CIRCUIT BOARD - PICTORIALS 5 and 6

Wiring Notes.

When mounting components to the circuit board, make sure each component sits as close as possible to the circuit board before soldering.

Bend resistor and capacitor wire ends to suit the hole locations. Refer to the parts list for resistor colour code identification. Refer to Figure 7 which shows you the difference between a good and bad soldered connection.

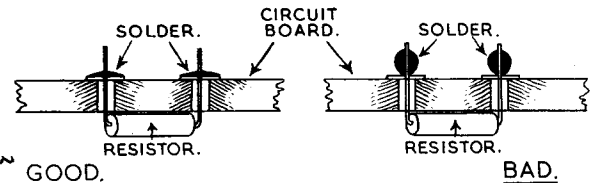
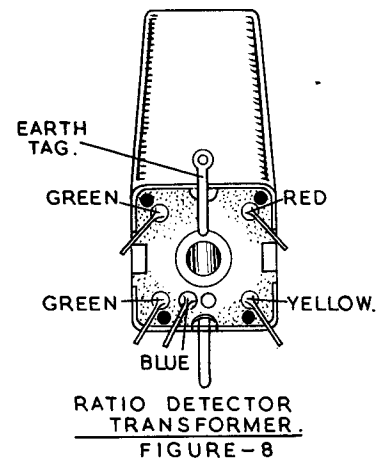


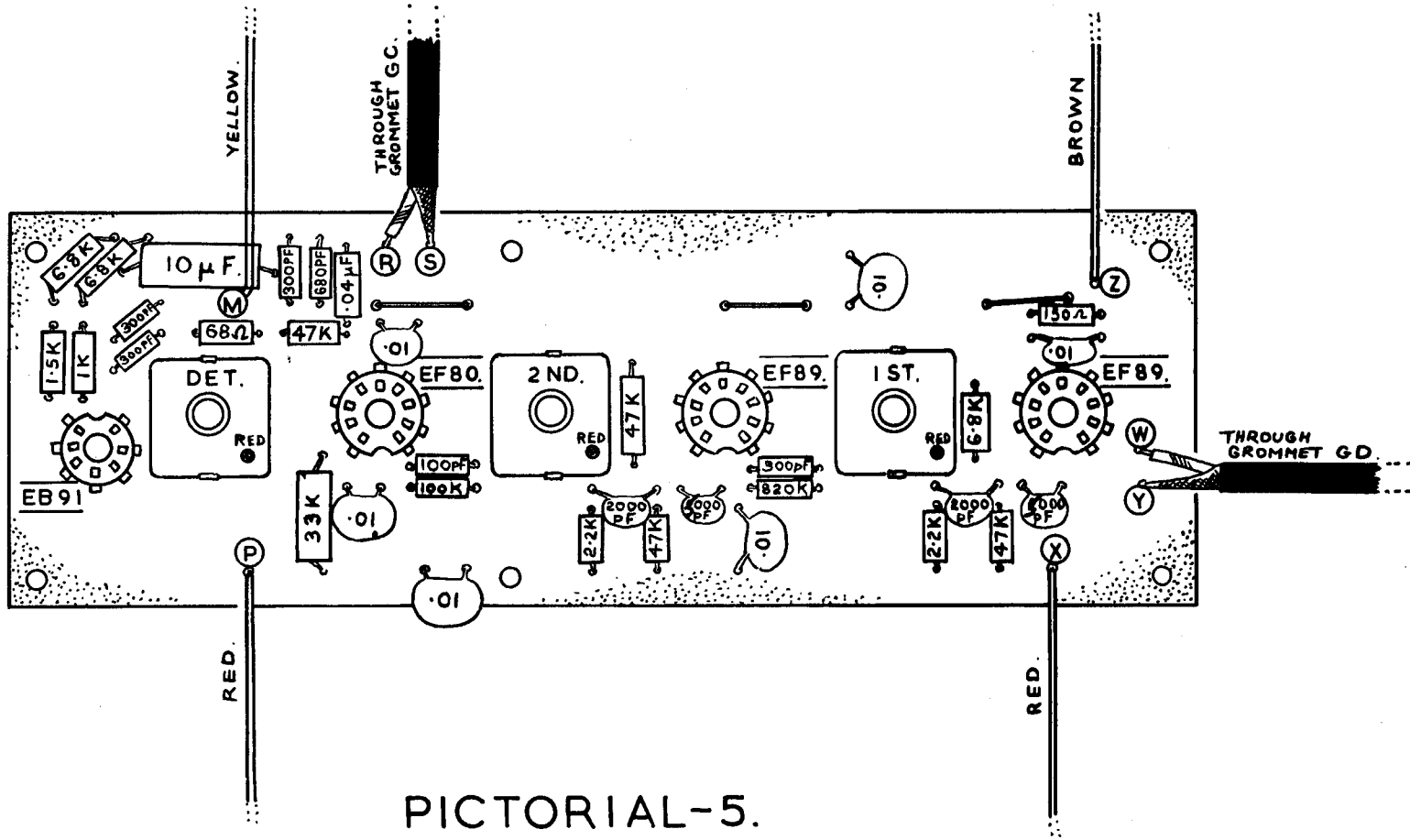
FIGURE-7.

- (✓) Mount and solder in position the B7G valvholder. *SOLDER ON CENTRE SCREEN*
- (✓) Mount and solder in position the three B9A valvholders. *SOLDER ON CENTRE SCREEN*
- (✓) Mount and solder all resistors in the places indicated. This operation is somewhat quicker if all resistors are mounted before soldering. After soldering, cut off all surplus wire as close as possible to the soldered joints.
- (✓) At location M, insert and solder a 7" length of YELLOW wire.
- (✓) Mount the 10  $\mu$ F electrolytic capacitor, connecting the RED end nearest the + sign.
- (✓) Mount and solder the remaining capacitors in the places indicated. Adopt the same procedure as previously used for resistors.
- (✓) Using bare wire, connect and solder the wire links at the places indicated.
- (✓) Select the ratio detector transformer. Refer to Figure 8 and note that this transformer has five wire connections and two tag connections on the side of its case.
- (✓) Now insert all tags and wires of the ratio detector in the holes of the circuit board at location DET, making sure the RED paint spot on the transformer corresponds with the printed RED spot on the circuit board. Solder each tag and wire, then cut off surplus wire close to the soldered joints.
- (✓) Select the I.F. transformer marked 2nd, and insert the wires and tags through the holes in the circuit board at location 2nd. Again making sure the printed and painted RED spots locate together. Solder each tag and wire then cut off surplus wire close to the soldered joints.

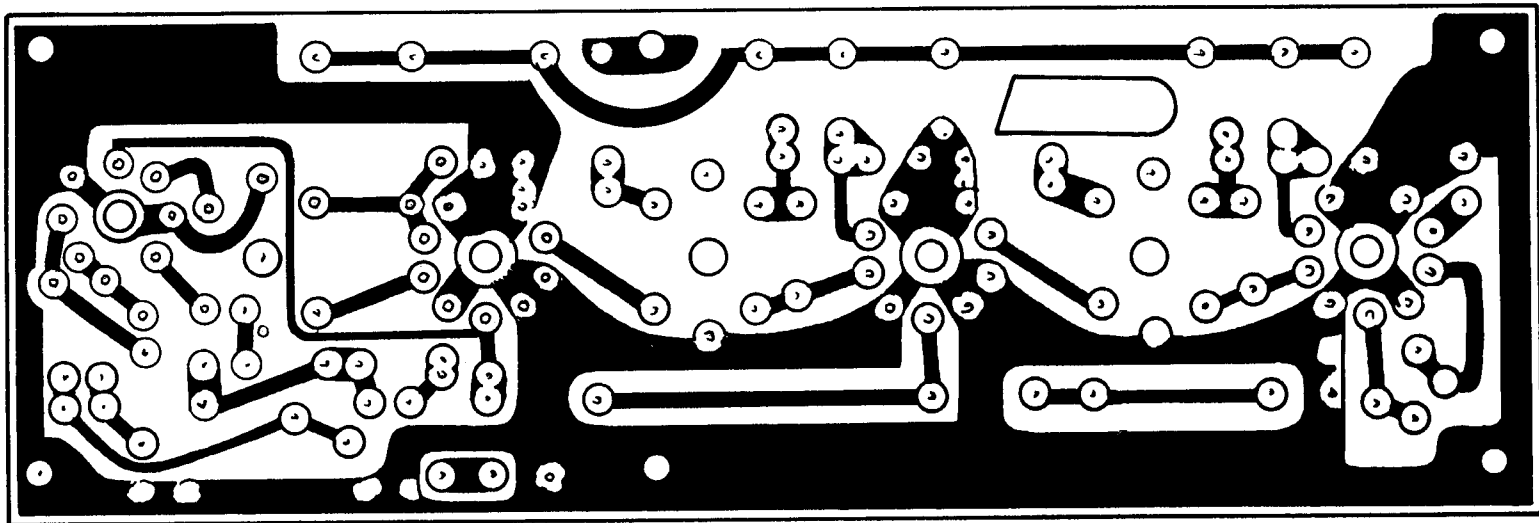
RATIO DETECTOR TRANSFORMER.  
FIGURE-8

NOTE  
THAT ONLY  
1 EARTH TAG  
CAN BE  
SOLDERED





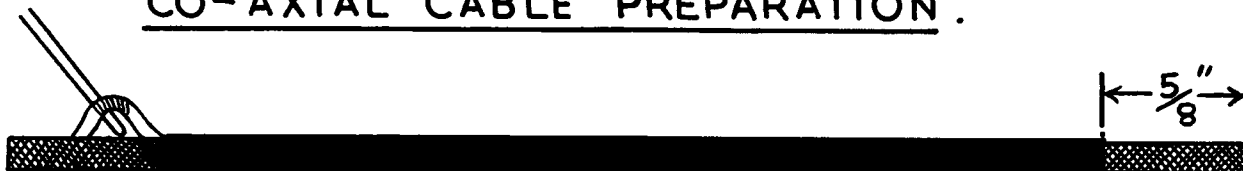
PICTORIAL-5.



PICTORIAL-6.

- (✓) Select the I. F. transformer marked 1st and insert the wires and tags through the holes in the circuit board at location 1st. Again making sure the printed and painted RED spots locate together. Solder each tag and wire, then cut off surplus wire close to the soldered joints.
- (✓) At location Z, insert and solder an 8" length of BROWN wire.
- (✓) At location X, insert and solder a 9" length of RED wire.
- (✓) At location P, insert and solder a 9" length of RED wire.
- (✓) Prepare a 9" length of co-axial cable as shown in Figure 9. Insert and solder the braided wire to location S and the inner wire insert and solder to location R.

### CO-AXIAL CABLE PREPARATION.



**AT EACH END STRIP OFF OUTER INSULATION  
AND WITHDRAW WIRE THROUGH THE BRAIDING.**

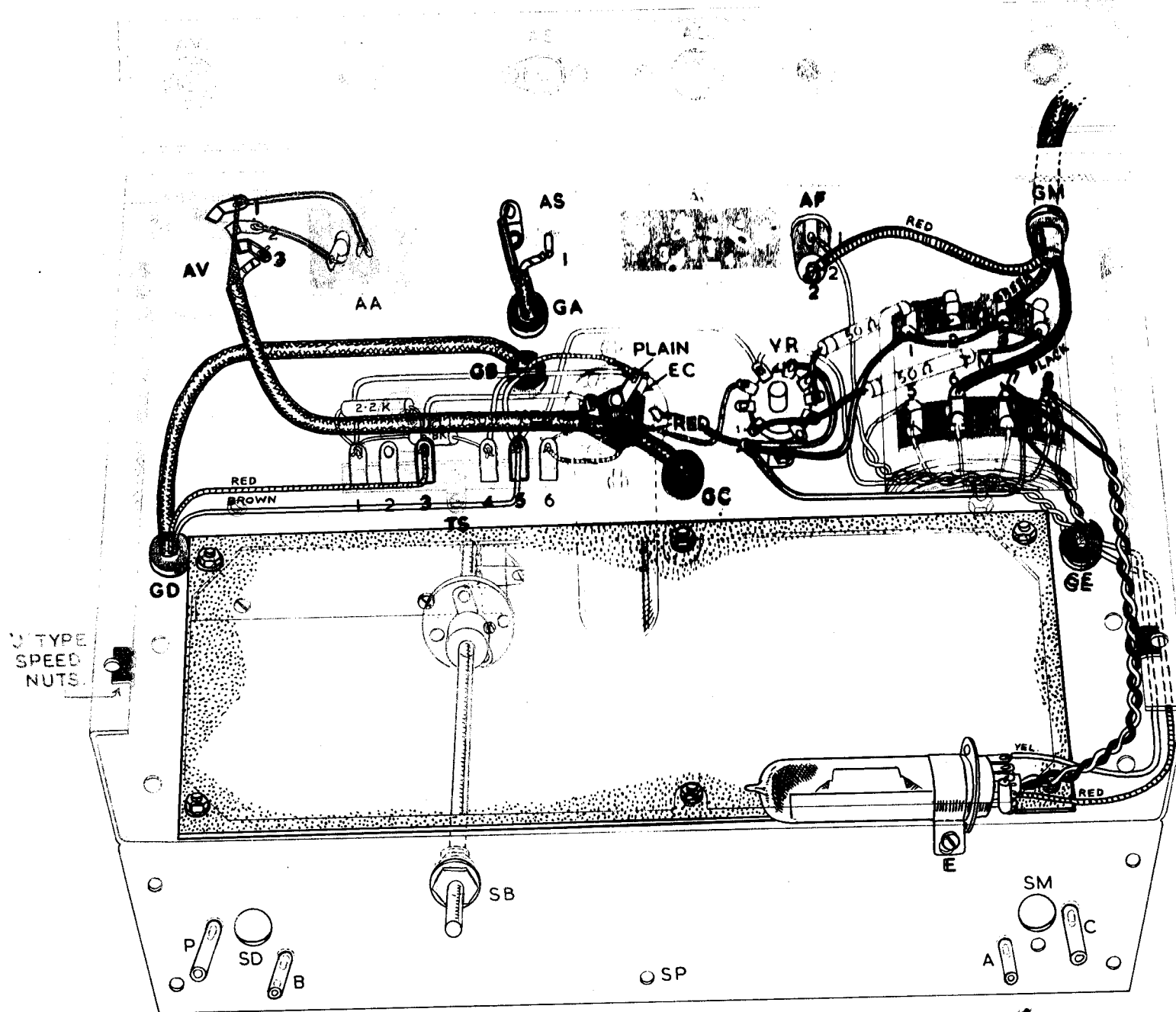


**FIGURE - 9**

- (✓) Prepare a 10 $\frac{1}{2}$ " length of co-axial cable as shown in Figure 9. Insert and solder the braided wire to location Y and the inner wire insert and solder to location W.
- (✓) The circuit board is now ready for mounting to chassis. First check all soldered joints and re-solder any that appear doubtful.

#### FINAL UNDER CHASSIS WIRING - PICTORIAL 7

- (✓) Now mount circuit board inside chassis using 6 - 6BA x  $\frac{1}{4}$ " binderhead screws. Make sure you do not trap any wires between circuit board and chassis when mounting. Temporarily remove flywheel, this will allow easy access for the circuit board mounting screw.
- (✓) Route the BROWN wire from location Z through grommet GD to TS5 (S-3).
- (✓) Route the RED wire from location X through grommet GD to TS3 (S-4).
- (✓) Replace flywheel.
- (✓) Route the co-axial cable from Y and W through grommet GD, then along the chassis and through grommet GB to TU1 (S-1) (braided wire) and TU2 (S-1) (inner wire).
- (✓) Route the co-axial cable from R and S through grommet GC to volume control AV3 (S-1) (inner wire) to AV1 (S-2) (braided wire).



PICTORIAL-7.

- (✓) Prepare a 10" length of co-axial cable as shown in Figure 9. Connect the inner wire to the aerial socket AS1 (S-1) and the braid wire to solder tag (S-1). Routing the cable through grommet GA to the triangular hole in the tuning unit AC, connect the braid wire to AC1 (S-1) and the inner wire to AC2 (S-1).
- (✓) Select the cable clamp and secure the cable to the tuning unit.
- (✓) Select tuning indicator EM84, with tuning indicator bracket and valveholder.
- (✓) Provisionally mount the tuning indicator assembly at location E using a 6BA x 1/4" binderhead screw.
- (✓) Route the YELLOW wire from location M on the circuit board through grommet GE to E tag 1 (S-1).
- (✓) Route the RED wire from location P on circuit board through grommet GE to E tag 6 (S-2).
- (✓) Connect the BLACK and BROWN twisted wire on E4 and 5 to mains transformer tag 7 (S-3) (BLACK wire) and tag 8 (S-3) (BROWN wire).
- (✓) Select the length of 3-core mains cable, insert one end through grommet GM for approximately 6". Strip off the outer insulation 3" exposing the BLACK, RED and GREEN wires.
- (✓) Connect the RED wire to AF2 (S-1).
- (✓) Connect the BLACK wire to TM6 (S-1).
- (✓) Connect the GREEN wire to TM3 (S-2). Then bind the cable end with adhesive tape.
- ( ) At the other end of the mains cable, connect a suitable 3-pin plug, RED wire to LIVE, BLACK wire to NEUTRAL and GREEN wire to EARTH.

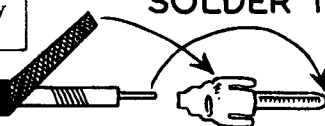
Alternatively you may require the mains cable to be connected to a common junction box, in either case the GREEN wire must always be earthed for your protection.

**COMPLETED CONNECTION.**



To compensate for cable capacity, when using longer cable lengths, reduce the value of C40 so that C40 and cable capacity is 700 pF.

**SOLDER TIP.**



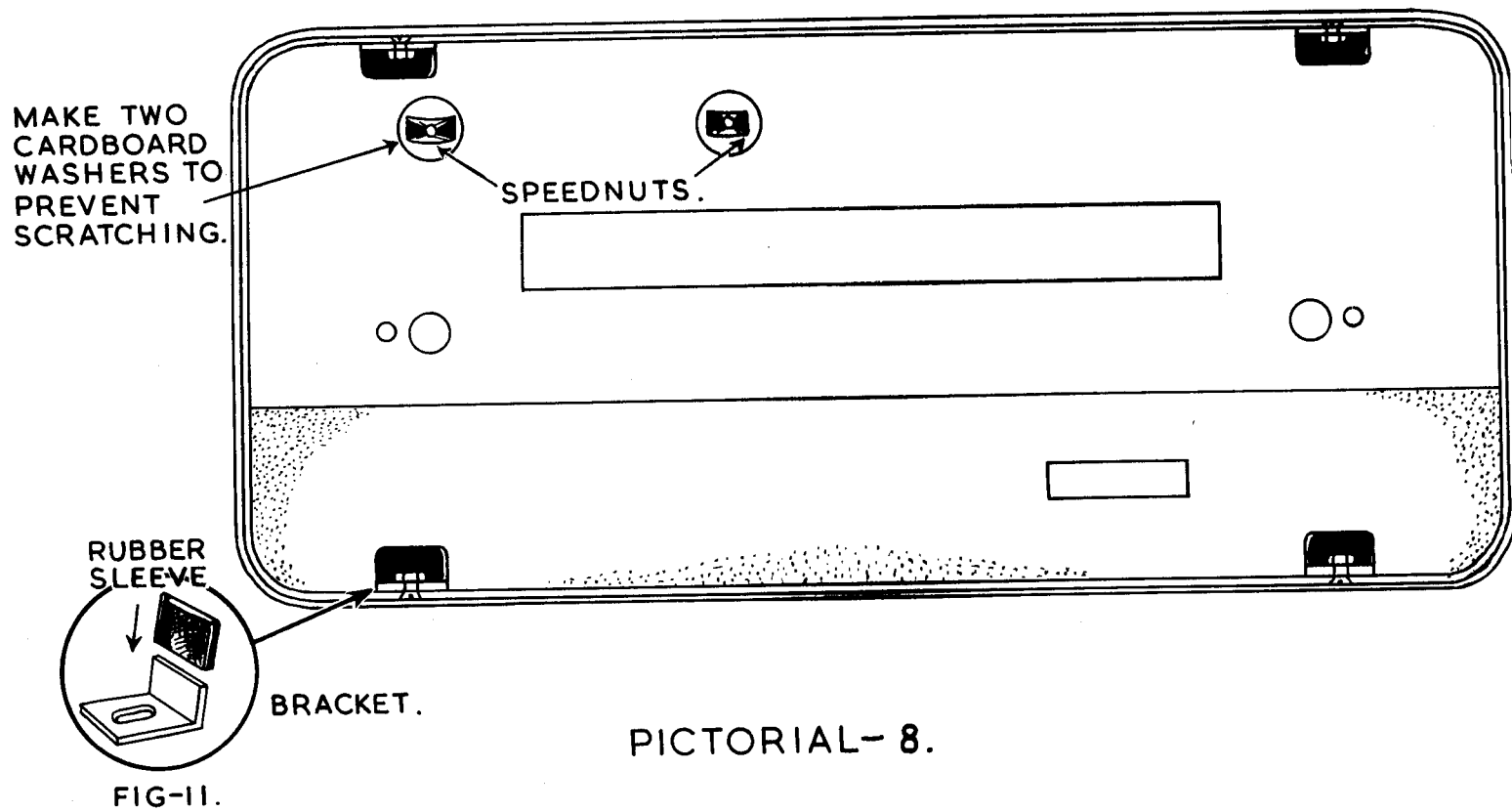
**FIGURE - 10.**

- ( ) Using the audio plugs and remainder of co-axial cable, make an amplifier connecting lead as shown in Figure 10.
- ( ) Examine all solder joints on the mains transformer, rectifier valveholder and electrolytic capacitors, separating any adjacent tags that are touching or nearly touching each other.
- ( ) Again examine the circuit board for badly soldered joints.

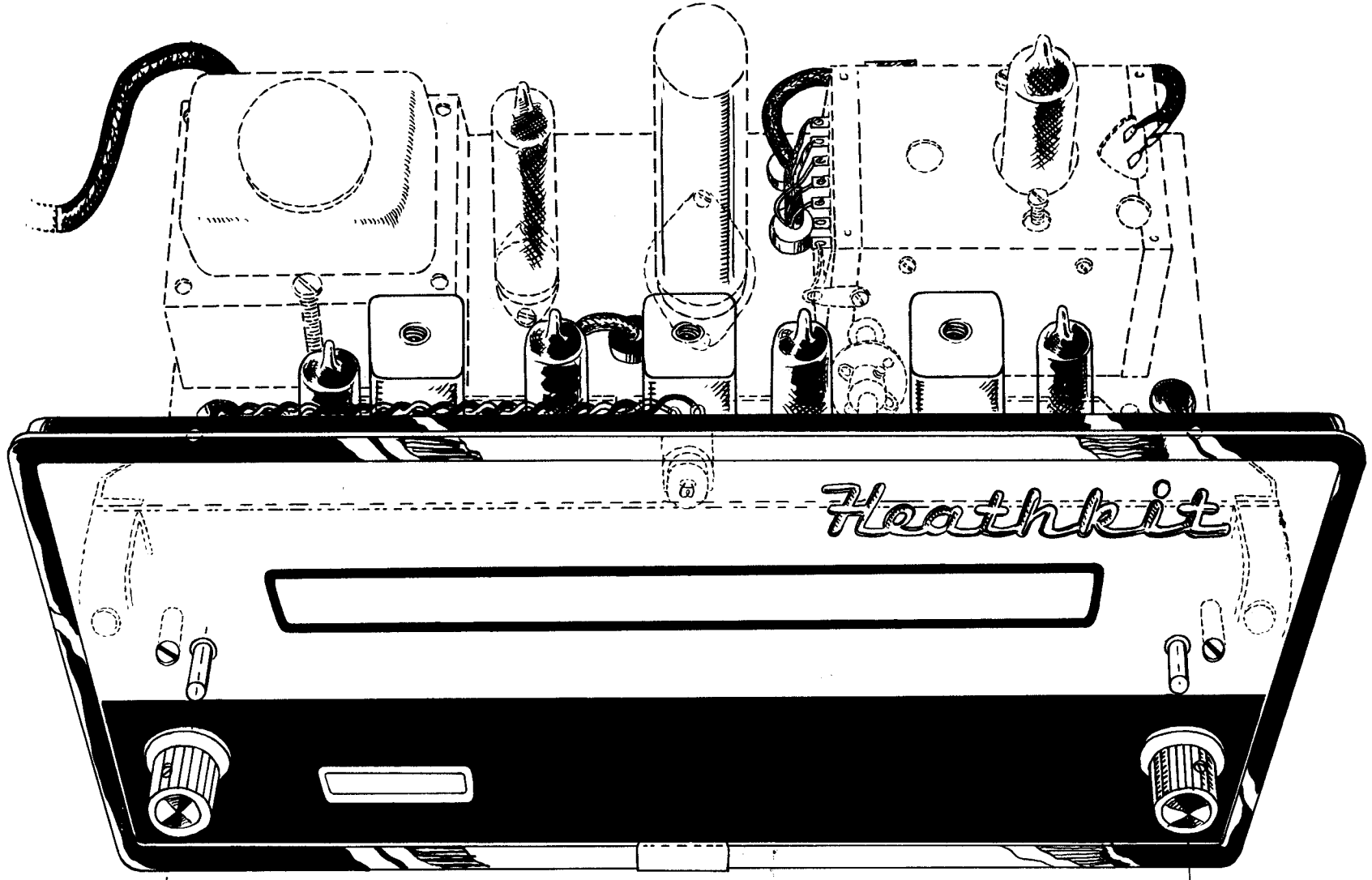
This completes the wiring of your FM Tuner.

**FRONT PANEL ASSEMBLY - PICTORIAL 8**

- (✓) Mount the Heathkit emblem to the front panel, secure with speednuts.
- (✓) Select the four retaining brackets and rubber sleeve. Cut the rubber sleeve into four 1/4" lengths and fit one piece to each retaining bracket as shown in Figure 11.
- (✓) Now secure the front panel and escutcheon using the four retaining brackets. Mount with 6BA x 5/16" countersunk head screws.



Heathkit  
EXPERIENCE



PICTORIAL - 9.



### MOUNTING FRONT PANEL - PICTORIAL 9

- ( ) Slip the front panel assembly through the control spindles on chassis and adjust the tuning indicator so that it aligns with the window in the front panel. Remove front panel and tighten the tuning indicator clip.
- ( ) Replace front panel and secure using 2 - 4BA x 3/8" countersunk head screws.
- ( ) On each spindle, mount a control knob and tighten grub screws.

This completes construction of the tuner. The unit should now be tested before the cover and base plate are fitted.

### TESTING THE COMPLETED TUNER

- ( ) Excepting the EZ80 rectifier valve, plug in all valves in their correct sockets, also insert the fuse in fuseholder.
- ( ) Making sure the mains switch is in the OFF position, check the voltage selector plug on the mains transformer. Set to the nearest voltage of your mains supply.
- ( ) Connect the mains cable to your supply and switch on. The pilot light should light immediately, so should the valves. The EB91 detector may glow very brightly for a few seconds. This is normal.
- ( ) Switch off the tuner and allow the valves to cool. Now insert the EZ80 rectifier and switch on again. This time, after about 1 minute, the EM84 tuning indicator should show two green bars. If so, the tuner should function normally.
- ( ) Connect an aerial to the aerial socket as in Figure 13, and using the prepared audio cable, connect to the radio input on your amplifier. Turn volume control fully clockwise. If the tuner fails to function, refer to the section IN CASE OF DIFFICULTY.
- ( ) If stations are heard normally, you may now proceed to fit the cover and base plate.

### FITTING OF COVER AND BASE PLATE - PICTORIAL 10

- ~~( )~~ Mount rubber feet to base plate using 2BA x 3/4" screws. Mount in pairs.
- ( ) Turn tuner face down on two supporting books and slide on cover. Place the base plate in position and secure together using the four screws for J type speednuts.

### IN CASE OF DIFFICULTY

Recheck the wiring and component values referring to the appropriate Pictorials.

If possible, compare valve socket voltages with those shown in the circuit diagram. The readings should be within 20% of those tabulated if a valve voltmeter is used. Other type meters may give lower readings due to loading effects. If the voltage fails to compare with the ~~valve~~ <sup>VALVE</sup> show, check further into the circuit involved by checking the various components.

Some common types of troubles are listed below along with simple trouble-shooting procedures which are often helpful in locating the source of difficulty.

Tuner completely inoperative: If no sound of any kind is evident when connected to an amplifier and aerial, check the audio cable for short circuits between the shell of the plug and the inner conductor of both ends. An ohmmeter check is recommended.

A screwdriver is a useful tool for making simple disturbance tests. If a stage in the tuner is operating normally, a click will be heard in the speaker when the grid of an operating stage is touched. This procedure should start at the grid of the EF80.

Oscillation: If the tuner operates, but tends to whistle when a station is tuned in, or a very low sensitivity is evident, it is likely that the unit is oscillating. Another indication is that the tuning indicator will be closed whether a station is tuned in or not. Oscillation is usually caused by poor soldered connections on the circuit board.



**Hum and noise:** Under some conditions, hum may be encountered when the tuner is connected to the audio system. This may be caused by improper earthing of the entire installation, unless the hum is tunable in the receiver. In this case the cathode/heater insulation of ECC85, EB91 or EZ80 valves may be faulty.

A rushing or hissing noise is normal when tuning between stations. This noise should disappear on strong stations and be substantially reduced on weaker stations. Failure to quiet properly may be due to a poor aerial if the tuner is operated in fringe areas. Of course, perfect limiting cannot be expected on very weak stations.

To ensure the best possible performance from your tuner, a good Band 2 dipole aerial should be obtained from your radio dealer. An indoor type can be made using two horizontal lengths of wire or rod each 2'6" long with the inner ends joined to standard 75Ω co-axial cable which must be of sufficient length to connect to the tuner aerial socket. As shown in Figure 12, the inner conductor of the cable is connected to one wire and the outer metal braid is joined to the other wire. The other end of the co-axial lead should be terminated by a plug (Part No. 438-504) carefully following the instructions (see Figure 13). The aerial should be placed as high as possible and oriented for best results. All dipole aerials are strongly directional.

Proper tuning is essential if full enjoyment of the F.M. programme is to be obtained. Mistuning will result in excessive distortion and noise. Strong stations will frequently cause a triple tuning response to be evident. Always tune to the strong and clear response, this response being the one which brings the tuning indicator bars closest together.

The pre-set output control should be set in such a position that full output from the amplifier is obtained with the amplifier volume control turned to about 4/5ths of its maximum rotation. If a pre-set input control is fitted to the amplifier, turn the tuner control for maximum output, then adjust the amplifier input control accordingly. The Heathkit tuner may be used with any type of transformer operated amplifier having provision for a radio tuner. **IT MUST NOT BE USED WITH AC-DC UNIVERSAL TYPE AMPLIFIERS UNLESS A MAINS ISOLATING TRANSFORMER IS EMPLOYED.**

When stereo transmissions are available, a suitable stereophonic adaptor will be marketed to suit your tuner. Until such times, the spare audio output socket and 4-way supply socket will not be used.

Heat dissipation in the tuner is adequately taken care of through the ventilating slots in the base plate. The tuner is designed for bookshelf or console cabinet operation. If mounted in a wooden cabinet, the metal cabinet may be removed, as good ventilation is essential.

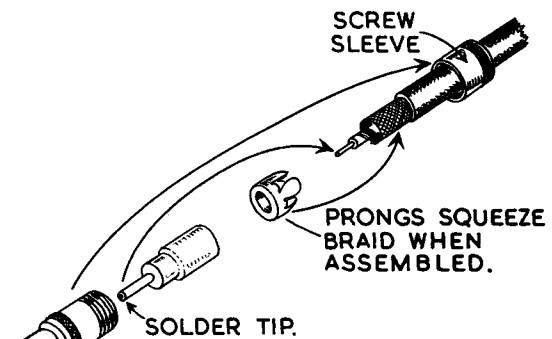
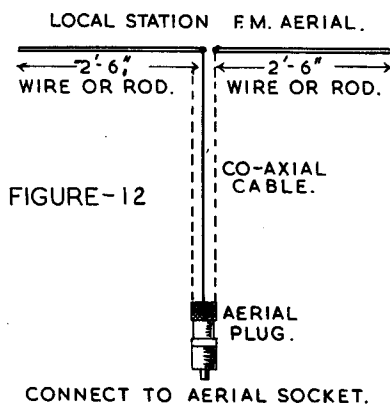


FIGURE - 13.

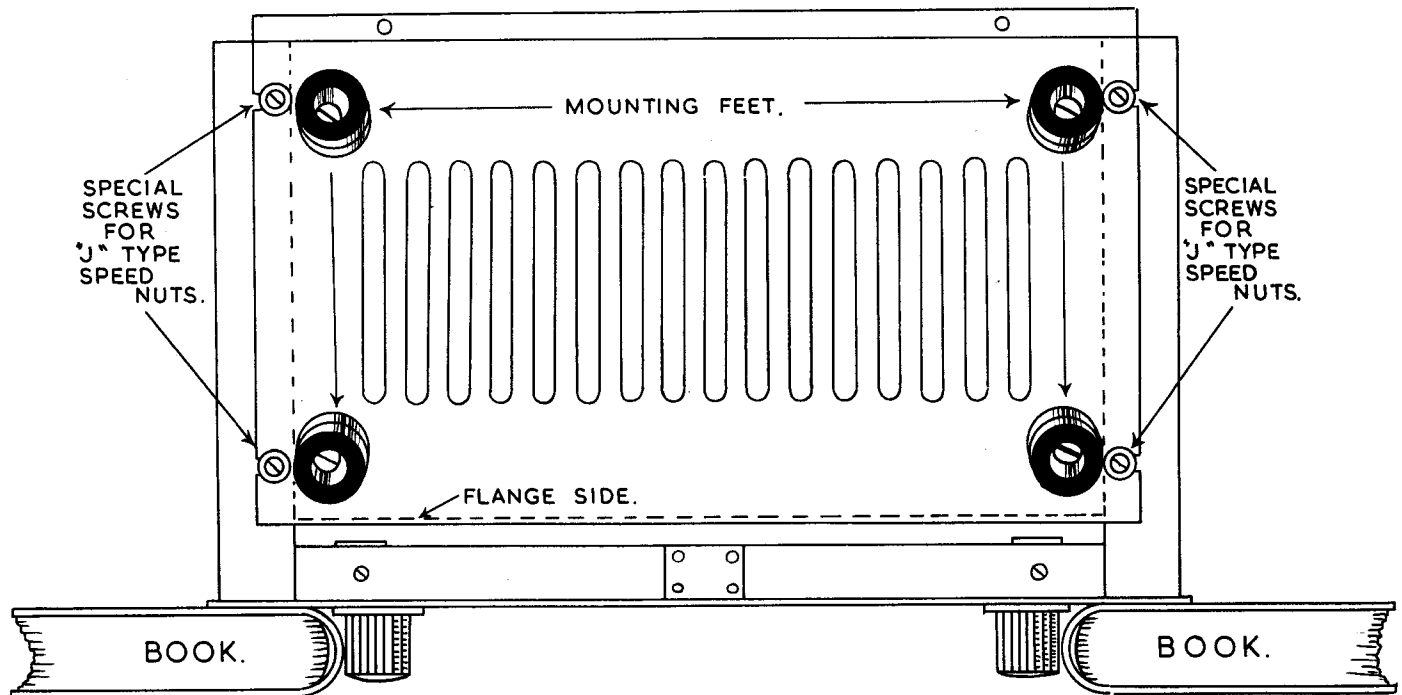
**ALIGNMENT INSTRUCTIONS**

The tuning unit, the I.F. transformers and the ratio detector transformer are pre-aligned at the factory against standards developed during design and testing of the tuner. Because of the use of a sealed R.F. unit and a printed circuit board, divergencies due to stray capacities will be very small but for those who wish to check the alignment and possess the necessary test equipment, the following procedure is recommended:

1. Remove the HT supply lead from tag 4 on the tuner unit.
2. Connect the output or "hot" lead of an accurate signal generator through a .01 μF capacitor to tag 4 of the tuner unit and the earth lead of the generator to chassis.

3. Now connect a high resistance voltmeter, preferably a valve voltmeter across the positive and negative ends of the 10  $\mu$ F capacitor on the circuit board. Set the meter range to 1.5 or 3 volt range DC.
4. Switch the tuner on and allow a few minutes for warmup and then adjust the signal generator input to give an output reading of approximately 1 volt DC. The generator frequency must be set to 10.7 megacycles.  
  
Using a suitable alignment tool (such as a shaped plastic knitting needle) adjust the top core of the ratio detector or transformer for maximum indication of the meter. DO NOT touch the bottom core of the ratio detector at this time.
5. Now adjust the top and bottom cores of the 2nd and 1st I.F. transformers for maximum output, reducing the generator input as the alignment proceeds. An I.F. transformer is situated in the RF unit, fitted with hexagonal shaped cores. File a tool suitable for this and adjust the top and bottom cores for maximum output.
6. I.F. alignment is completed by removing the negative lead of the valve voltmeter and connecting it to chassis, near the EB91 valve, and positive lead to junction of R23 and C39. Now set the valve voltmeter to the highest sensitivity range, 1.5 volt full scale will be suitable. Adjust the bottom core of the ratio detector transformer for zero output. When aligning, make sure that a + and - swing can be obtained.
7. Alignment of the RF unit should **not be attempted** unless there is conclusive evidence of misalignment. Reconnect the HT connection to tag 4.
8. Adjustment of oscillator trimmer: Set scale and signal generator to 94 Mc/s. Reconnect the negative lead of the valve voltmeter to the negative end of 10  $\mu$ F capacitor. Adjust the oscillator trimmer for maximum output.
9. Adjustment of RF trimmer: With signal generator set to 94 Mc/s, adjust RF trimmer for maximum output.
10. Adjustment of aerial coil: With signal generator set to 94 Mc/s, adjust aerial coil for maximum output.
11. Tracking: Tune through complete range and check that the overall gain does not vary by more than  $\pm 2$  dB relative to 98 Mc/s.

NOTE: The overall gain of the RF unit at 98 Mc/s is 48 dB.



PICTORIAL-10.

## REPLACEMENTS

Material supplied with Heathkits has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally, however, improper instrument operation can be traced to a faulty valve or component. Should inspection reveal the necessity for replacement, write to Daystrom Ltd. and please supply all of the following information:-

- A. Thoroughly identify the part in question by using the part number and description found in the Manual parts list.
- B. Identify the type and model number of the kit in which it is used.
- C. Mention the order number and date of purchase.
- D. Describe the nature of defect or reason for requesting replacement.

Daystrom Ltd. will promptly supply the necessary replacements. Please do not return the original component until specifically requested to do so. Do not dismantle the component in question as this will void the guarantee. If valves are to be returned, pack them carefully to prevent breakage in shipment, as broken valves are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit-builder.

## SERVICE

If the completed instrument should fail to function properly and attempts to find and cure the trouble prove ineffective, the facilities of Daystrom's Service Dept. are at your disposal. Your instrument may be returned carriage paid to Daystrom Ltd., Gloucester, and the Company will advise you of the service charge where not covered within the terms of the guarantee (i.e. a faulty component supplied by us). THIS SERVICE POLICY APPLIES ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THIS MANUAL. Instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned not repaired.

Daystrom Ltd. is willing to offer its full co-operation to assist you in obtaining the specified performance level of your instrument. Factory repair service is available or you may contact the Engineering Consultation Department by mail. For information regarding possible modification of existing kits, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. Although Daystrom Ltd. sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit and layout changes for specific purposes. Therefore, such modifications must be made at the discretion of the kit builder according to information which will be much more readily available from some local source.

## SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted.

ATTACH A LABEL TO THE INSTRUMENT GIVING  
NAME, ADDRESS AND TROUBLE EXPERIENCED.

Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper, wood wool or plastic cushioning material on all sides. DO NOT DESPATCH IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

PRICES: All prices are subject to change without notice.

MODIFICATIONS TO SPECIFICATIONS: Daystrom Ltd. reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

\* \* \* \* \*

The Heathkit builder is again strongly urged to follow step-by-step the instructions given in this Manual to ensure successful results. Daystrom Ltd. assumes no responsibility for any damages or injuries sustained in the assembly or handling of any of the parts of this kit or the completed instrument.

## PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION	PART No.	PARTS Per Kit	DESCRIPTION
Resistors, Carbon $\pm$ 10% $\frac{1}{2}$ watt			Dial parts, Knobs, Assemblies (Cont'd.)		
H-680C10	1	68 $\Omega$ (Blue, Grey, Black)	455-501	1	Threaded bush
H-151C10	1	150 $\Omega$ (Brown, Green, Brown)	608-501	1	Flywheel
H-102C10	1	1 K $\Omega$ (Brown, Black, Red)	100-506	1	Guide plate assembly
H-152C10	1	1.5 K $\Omega$ (Brown, Green, Red)	463-503	1	Pointer
H-222C10	2	2.2 K $\Omega$ (Red, Red, Red)	100-504	1	R. F. tuning assembly with valve ECC85
H-682C10	4	6.8 K $\Omega$ (Blue, Grey, Red)	462-501	2	Knob
H-473C10	4	47 K $\Omega$ (Yellow, Violet, Orange)	Valves, Pilot lamp		
H-103C10	1	100 K $\Omega$ (Brown, Black, Yellow)	411-520	2	EF89
H-474C10	1	470 K $\Omega$ (Yellow, Violet, Yellow)	411-521	1	EF80
H-824C10	1	820 K $\Omega$ (Grey, Red, Yellow)	411-40	1	EB91 (6AL5)
Resistors, Carbon $\pm$ 10% 1 watt			411-523	1	EM84
1-222C10	1	2.2 K $\Omega$ (Red, Red, Red)	411-522	1	EZ80
1-333C10	1	33 K $\Omega$ (Orange, Orange, Orange)	412-4	1	MES lamp 6.3 volt 110 m/A
Resistors, wire-wound 5%			Valveholders, Sockets, Plugs, Tagstrips		
5-500W5	2	50 $\Omega$ value marked	434-522	1	Valveholder B7G (printed circuit type)
7-751W5	1	750 $\Omega$ value marked	434-521	3	Valveholder B9A " "
Capacitors, electrolytic			434-502	2	Valveholder B9A (Chassis mounting type)
25-520	1	10 $\mu$ F 50 volt DC	434-524	1	4-way socket
25-507	1	40+40+20 $\mu$ F 275v DC	434-505	1	2-way socket (phono)
Capacitors, silver mica			432-506	1	Socket, co-axial (aerial input)
20-502	4	300 pF	438-501	2	Plug (phono)
20-503	1	680 pF	438-504	1	Plug, co-axial
Capacitors, silver ceramic			431-503	1	6-way tagstrip
21-503	1	100 pF	Wire, Cable, Sleeving		
Capacitors, moulded paper			344-510	1 length	Black covered wire
22-501	1	.04 $\mu$ F 150 volt	344-511	1 length	Brown covered wire
Capacitors, ceramic disc			344-512	1 length	Red covered wire
21-510	4	2000 pF (.002 $\mu$ F) 500 volt	344-514	1 length	Yellow covered wire
21-511	6	10,000 pF (.01 $\mu$ F) 500 volt	343-503	1 length	Co-axial cable
Controls			89-502	1 length	3-core mains cable
63-517	1	Rotary ON/OFF switch	346-501	1 length	1 $\frac{1}{2}$ m.m. sleeving
10-519	1	$\frac{1}{2}$ megohm potentiometer (pre-set volume control)	340-501	1 length	Bare tinned copper wire 22 swg.
Transformers			Mechanical parts		
52-504	2	I. F. transformer 1st & 2nd (Yellow Ring)	200-515	1	Chassis
52-503	1	Ratio detector transformer (Red Ring)	90-510	1	Cabinet shell
54-512	1	Mains transformer	604-501	1	Escutcheon
Dial parts, Knobs, Assemblies			204-517	2	Support bracket
100-505	1	Tuning drum	208-507	1	Tuning indicator clip
349-501	1 length	Dial cord	601-103B	1	Base plate
453-506	1	Drive shaft assembly	320-503	1	Front panel (plastic)
258-503	1	Spring (expansion)	85-505	1	Circuit Board
613-501	1	Sleeve	204-520	1	Pilot lamp bracket
453-507	1	Extension shaft	204-521	2	Buffer bracket
456-503	1	Coupling	204-518	4	Retaining bracket
			Hardware (screws, nuts, washers)		
			250-501	24	6BA x $\frac{1}{4}$ " screws, binderhead
			250-502	4	6BA x 5/16" csk. head
			250-513	4	4BA x $\frac{1}{4}$ " screw, binderhead

PARTS LIST (Cont'd.)

<u>PART No.</u>	<u>PARTS Per Kit</u>	<u>DESCRIPTION</u>	<u>PART No.</u>	<u>PARTS Per Kit</u>	<u>DESCRIPTION</u>
Hardware (screws, nuts, washers) (Cont'd.)			Miscellaneous		
250-9U	12	4BA x 3/8" screw, binderhead	331-501	1 length	Solder 18 swg. (thick)
250-535	2	4BA x 3/8" screw, csk. head	331-502	1 length	Solder 22 swg. (thin)
250-522	4	2BA x 3/4" screw, binderhead	259-505	3	6BA locking solder tag
252-501	25	6BA full-hex nut	73-501	6	Grommet 3/8" (plastic)
252-3U	9	4BA full-hex nut	434-520	1	Lampholder M. E. S.
252-502	4	2BA full-hex nut	423-501	1	Fuseholder
252-501	28	6BA lockwasher	421-501	1	Fuse link 4 amp
254-1U	15	4BA lockwasher	261-501	8	Feet
254-502	6	2BA lockwasher	255-507	2	4BA tapped pillar 1/2" long
253-501	5	3/8" flat washer	255-505	2	4BA tapped pillar 3/4" long
252-505	4	Speednut 'J' type (with screws)	481-501	1	Capacitor mounting plate (insulated)
252-502	2	Speednut, small	391-501	1	Heathkit emblem
			261-1	4	Rubber buffer
			595-516	1	Instruction Manual
			346-503	1	Rubber sleeve
			207-504	1	Cable clamp

G U A R A N T E E

Daystrom Limited guarantee subject to the following terms to repair or replace free of charge any defective parts of this Heathkit (with the exception of cathode ray tubes and valves referred to hereunder) which fail owing to faulty workmanship or material provided the defective parts are returned to Daystrom Limited within 12 months from date of purchase:-

1. This guarantee is given to and for the benefit of the original buyer only, and is and shall be in lieu of, and there is hereby expressly excluded, all other guarantees conditions or warranties, whether express or implied, statutory or otherwise, as to quality or fitness for any purpose of the equipment, and in no event shall Daystrom Limited be liable for any loss of anticipated profits, damages, consequential or otherwise, injury, loss of time or other losses whatsoever incurred or sustained by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof.
2. No replacement will be made of parts damaged by the buyer in the course of handling, assembling, testing or operating Heathkit equipment.
3. The purchaser shall comply with the Replacements Procedure laid down in the relevant Heathkit Manual.
4. Daystrom Limited will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used and in such event this guarantee shall be completely void.

**Note:** The Cathode Ray Tubes and Valves forming part of the equipment are guaranteed by the respective manufacturers. It should be noted that their guarantee is given only in respect of faulty workmanship and/or material and does not cover misuse or consequential damage.



### BRIEF SPECIFICATIONS

Power requirements.... 110 volts, 200-250 volts  
A.C. 40 to 60 cycles. (Both mains  
leads individually fused and switched.)  
Power Output.....8 watts R.M.S. each  
channel, 16 watts total, sinusoidal.  
Distortion.....less than 0.1% at 6 watts  
each channel.  
Frequency response.... within 2dB from 30 to  
20,000 c/s.  
Negative feed-back.... multiple loops; main loop  
20dB.  
Hum and Noise.....-51dB to -69dB accord-  
ing to input. Ref. 8 watts.  
Stability Factor.....better than 10dB.  
Damping Factor..... 20.  
Speaker Output..... 2-4 and 14-16 ohms.

#### Sensitivities:

Radio..... 200 mV, 100K ohm impedance.  
Gram..... from 20 mV, 47K ohm to 1 megohm.  
Tape..... 400 mV, 1 megohm (also suitable for self-equalising crystal pick-ups).  
Tape out..... 500 mV, 500K ohm (monitoring facility if desired).  
Valve Complement..... 2, EF86, 2, ECF80, 4, ECL82, 1, GZ34.  
Pilot Lamp..... 6.3 V., .1A.  
Dimensions..... 13½" x 5½" x 9½" (overall).  
Shipping Weight..... 23 lbs. 8 ozs.

The design of the Heathkit S-88 is such that it can be mounted in a cabinet or simply placed on a bookshelf or room divider. The panel is attractively finished in two tone grey with an elegant brass surround.

### CONTROLS

1. Push-button selector switch - gram., (Equaliser for R.I.A.A., - L.P., or 78), radio and tape; monaural or stereo.
  2. Stereo-monoaural switch (slide type).
  3. Balance control giving 8dB total variation.
  4. Bass lift and cut of 10dB at 40 c/s.
  5. Treble lift and cut of 10dB at 9,000 c/s.
  6. Volume control and on/off switch.
  7. Stereo channel reversal switch.
  8. Filter switch, 4 position, 4kc/s, 8kc/s, 12kc/s and linear.
- A 3 position switch is provided to match a variety of pick-ups and pre-set level controls are fitted to both radio tuner inputs.

## HELPFUL KIT BUILDING INFORMATION

Before attempting actual kit construction read the construction manual thoroughly to familiarise yourself with the general procedure. Note the relative location of pictorial inserts in respect of the progress of the assembly procedure outlined. This information is offered primarily for the convenience of the novice kit builders and will be of definite assistance to those lacking thorough knowledge of good construction practices. Even the advanced electronic enthusiast may benefit by a brief review of this material before proceeding with kit construction. In the majority of cases, failure to observe basic instruction fundamentals is responsible for inability to obtain desired level of performance.

### RECOMMENDED TOOLS

The successful construction of Heathkits does not require the use of specialised equipment and only basic tools are required. A good quality electric soldering iron is essential. The preferred size would be a 25-50 watt iron with a small tip. The use of long nose pliers and a diagonal or side cutting pliers is recommended. A small screw driver will prove adequate and several additional assorted screw drivers will be helpful. Be sure to obtain a good supply of resin core type radio solder. Never use separate fluxes, paste or acid solder in electronic work.

### ASSEMBLY

In the actual mechanical assembly of components to the chassis and panel, it is important that the procedure shown in the manual be carefully followed. Make sure that the valve holders are properly mounted in respect to keyway or pin numbering location. The same applies to transformer mountings so that the correct transformer colour coded wires will be available at the proper chassis opening. Make it a standard practice to use lockwashers under all 4BA and 2BA nuts. The only exception being in the use of soldering tags - the necessary locking feature is already incorporated in the design of the soldering tags. A control lock washer should always be used between the control and the chassis to prevent undesirable rotation in the panel. To improve instrument appearance and to prevent possible panel marring use a control flat nickel washer under each control nut.

When installing terminals that require the use of fibre insulating washers, it is good practice to slip the shouldered washer over the terminal stud before installing the mounting stud in the panel hole provided. Next, install a flat fibre washer and a soldering tag under the mounting nut. Be sure that the shouldered washer is properly centred in the panel to prevent possible shorting of the terminal.

### WIRING

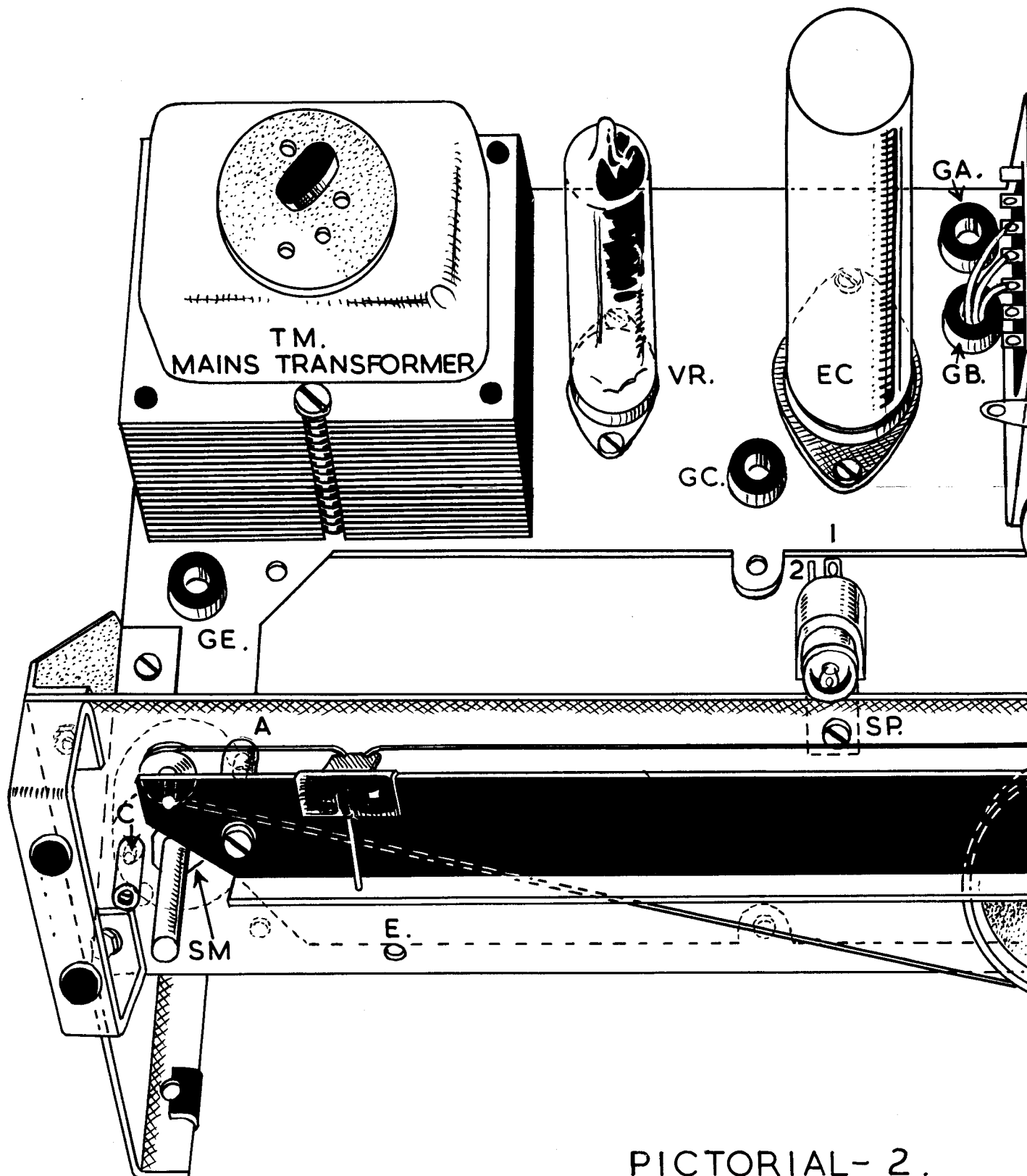
When following the wiring procedure make the leads as short and direct as possible. In filament wiring requiring the use of a twisted pair of wires allow sufficient slack in the wiring that will permit the twisted pair to be pushed against the chassis as closely as possible thereby affording relative isolation from adjacent parts and wiring.

When removing insulation from the end of connecting wire, it is seldom necessary to expose more than a quarter inch of the wire. Excessive insulation removal may cause a short circuit condition in respect of nearby wiring or terminals. In some instances, transformer leads of solid copper will have a brown baked enamel coating. After the transformer leads have been trimmed to a suitable length, it is necessary to scrape the enamel coating in order to expose the bright copper wire before making a terminal or soldered connection. In mounting parts such as resistors or capacitors, trim off all excess lead lengths so that the parts may be installed in a direct point-to-point manner. When necessary use insulated sleeving over exposed wires that might short to nearby wiring. It is urgently recommended that the wiring and parts layout as shown in the construction manual be faithfully followed. In every instance the desirability of this arrangement was carefully determined following the construction of a series of laboratory models.

### SOLDERING

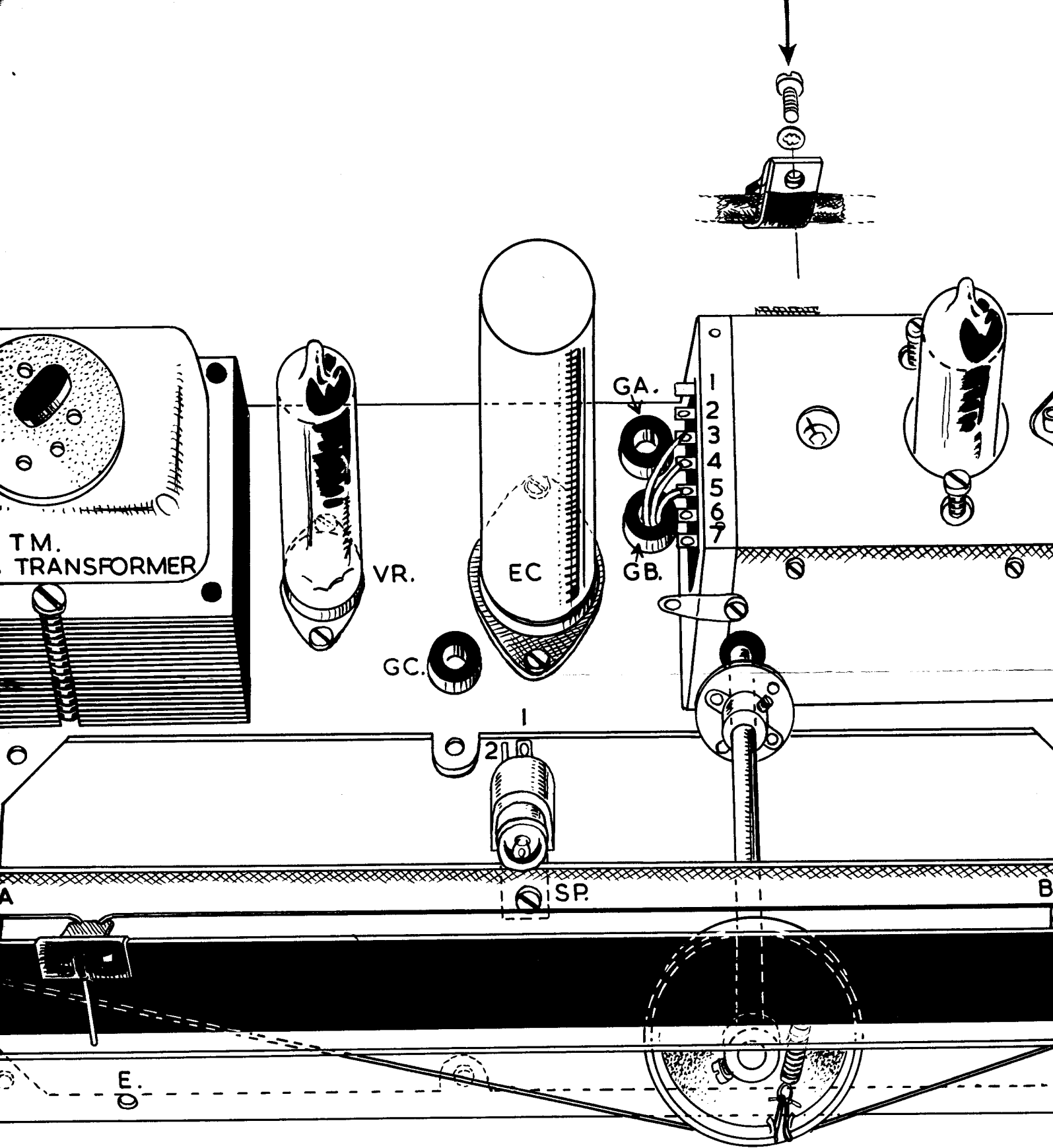
Much of the performance of the kit instrument, particularly in respect of accuracy and stability, depend upon the degree of workmanship used in making soldered connections. Properly soldered connections are not at all difficult to make but it would be advisable to observe a few precautions. First of all before a connection is to be soldered, the connection itself should be clean and mechanically strong. Do not depend on solder alone to hold a connection together. The tip of the soldering iron should be bright, clean and free of excess solder. Use enough heat so that the solder flows thoroughly and smoothly into the joint. Avoid excessive use of solder and do not allow a flux flooding condition to occur which could conceivably cause a leakage path between adjacent terminals on switch assemblies and valve holders. This is particularly important in instruments such as the VVM, oscilloscope and generator kits. Excessive heat will also burn or damage the insulating material used in the manufacture of switch assemblies. Be sure to use only good quality resin core type solder.

AERIAL		CAPACITOR (VARIABLE)		SWITCH — SINGLE POLE (S.P.) SINGLE THROW (S.T.)		BATTERY	
LOOP		RESISTOR		SWITCH — DOUBLE POLE (D.P.) DOUBLE THROW (D.T.)		FUSE	
DIPOLE		RESISTOR (TAPPED)		SWITCH — TRIPLE POLE (T.P.) DOUBLE THROW (D.T.)		CRYSTAL	
EARTH		RESISTOR (VARIABLE)		LOUDSPEAKER		TERMINAL & TERMINAL STRIP	
INDUCTOR (COIL OR R.F. CHOKE)		POTENTIOMETER		RECTIFIER		WIRING BETWEEN LIKE LETTERS IS UNDERSTOOD	
R.F. COIL WITH ADJUSTABLE IRON DUST CORE		JACK (TWO CONDUCTOR)		MICROPHONE		MICRO (X 1/1,000,000) = μ	
L.F. CHOKE (IRON CORE) WITH TAPPINGS		JACK (THREE CONDUCTOR)		TYPICAL TUBE SYMBOL		MILLI (X 1/1000) = m	
R.F. TRANSFORMER (AIR CORE)		WIRES CONNECTED		TRANSISTOR (P.N.P. TYPE)		KILO (X 1000) = K	
TRANSFORMER (R.F. OR ADJUSTABLE L.F. IRON DUST CORE)		WIRES CROSSING BUT NOT CONNECTED		TRANSISTOR (N.P.N. TYPE)		MEGA (X 1,000,000) = M	
TRANSFORMER (MAINS OR L.F.) IRON CORE		A-AMMETER V-VOLTMETER mA-MILLIAMMETER μA-MICROAMMETER ETC.		TRANSISTOR (N.P.N. TYPE)		OMEGA (OHMS) = Ω	
CAPACITOR		NEON LAMP STABILISER VALVE		SOCKET OUTLET — CO AXIAL		MICROFARAD = μF	
CAPACITOR (ELECTROLYTIC)		LAMP PILOT OR ILLUMINATING		TWO PIN SOCKET AND TWO PIN PLUG		PICOFARAD = pF MICRO, MICROFARAD = μμF	

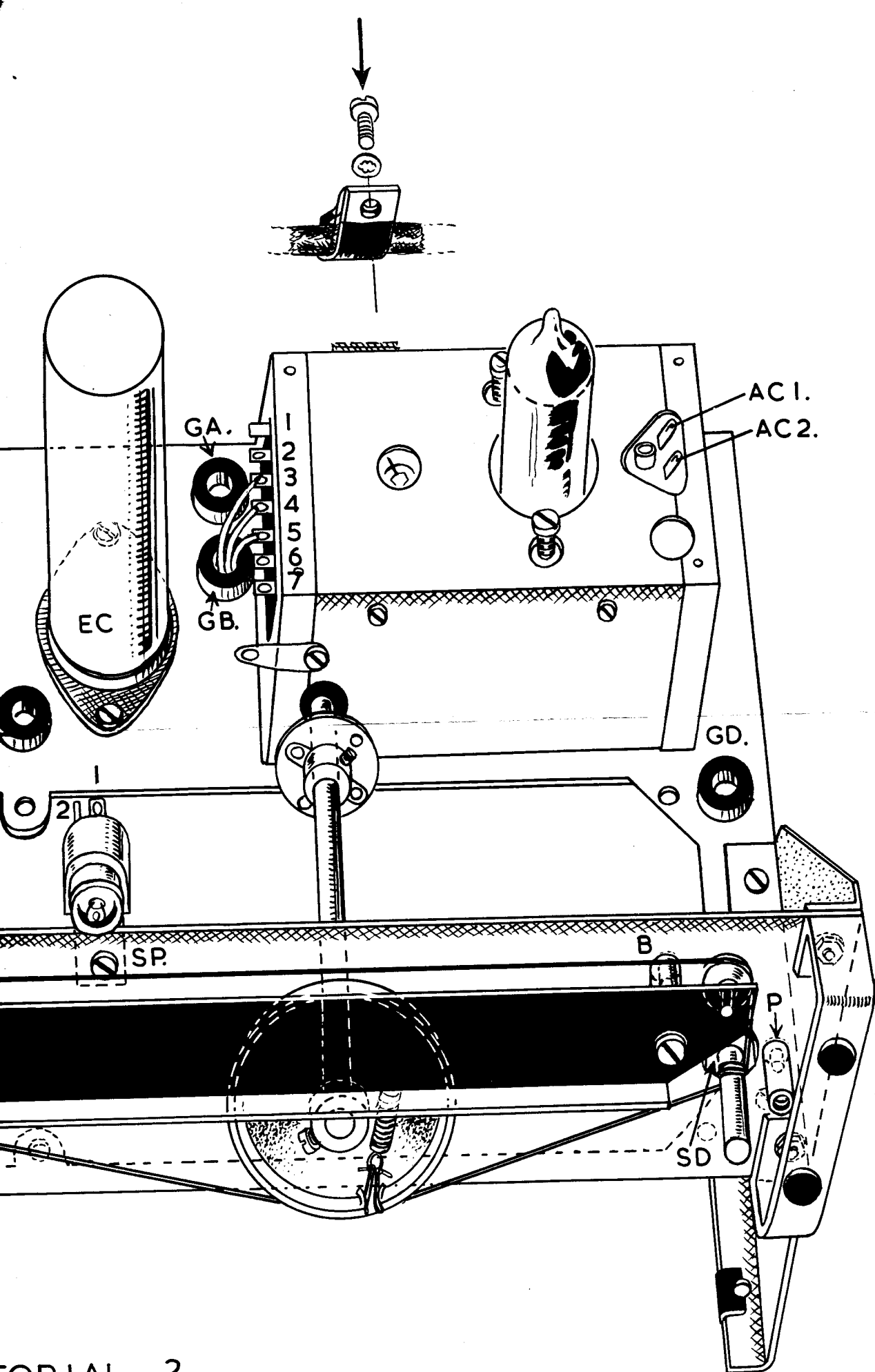


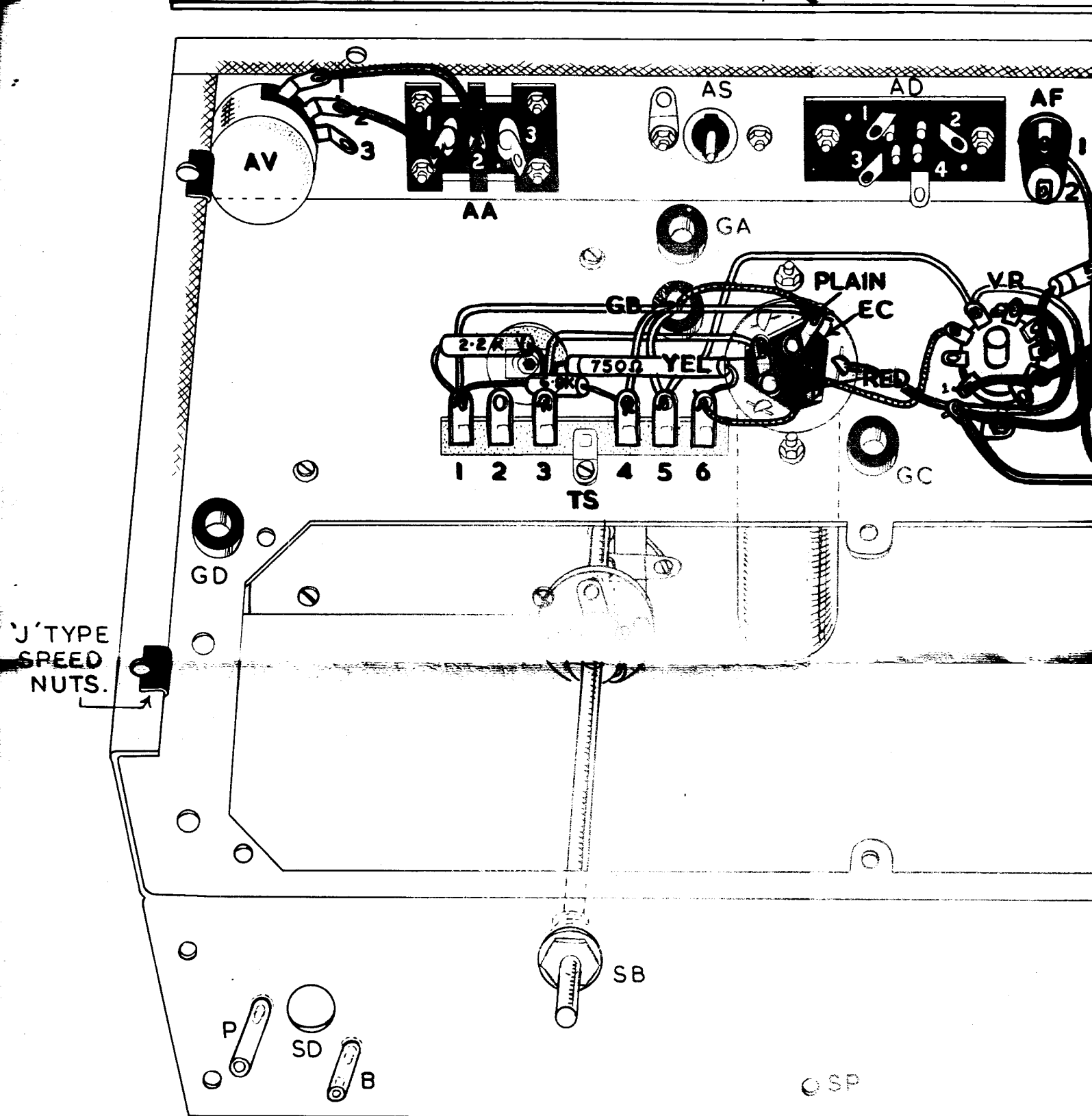
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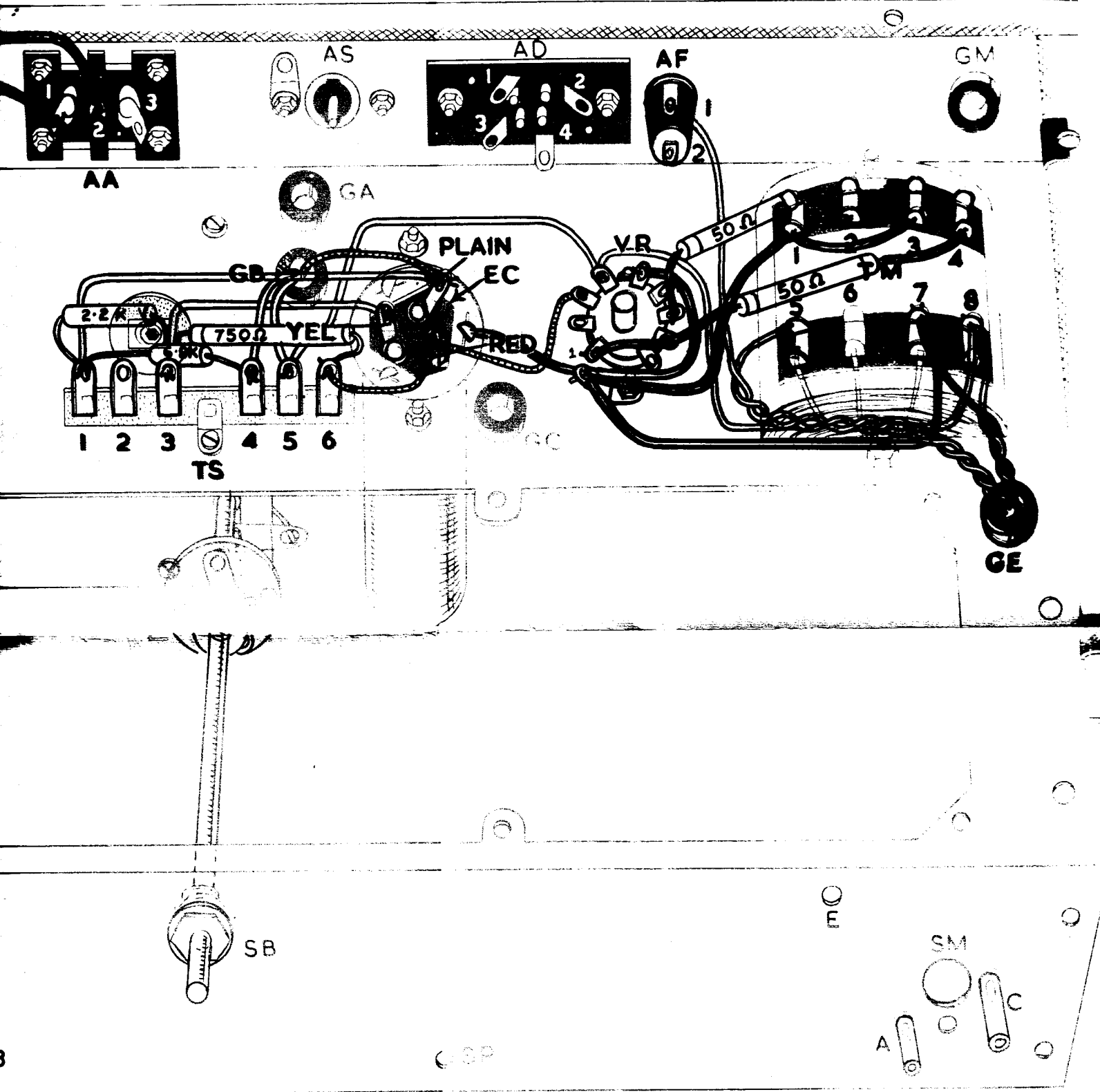


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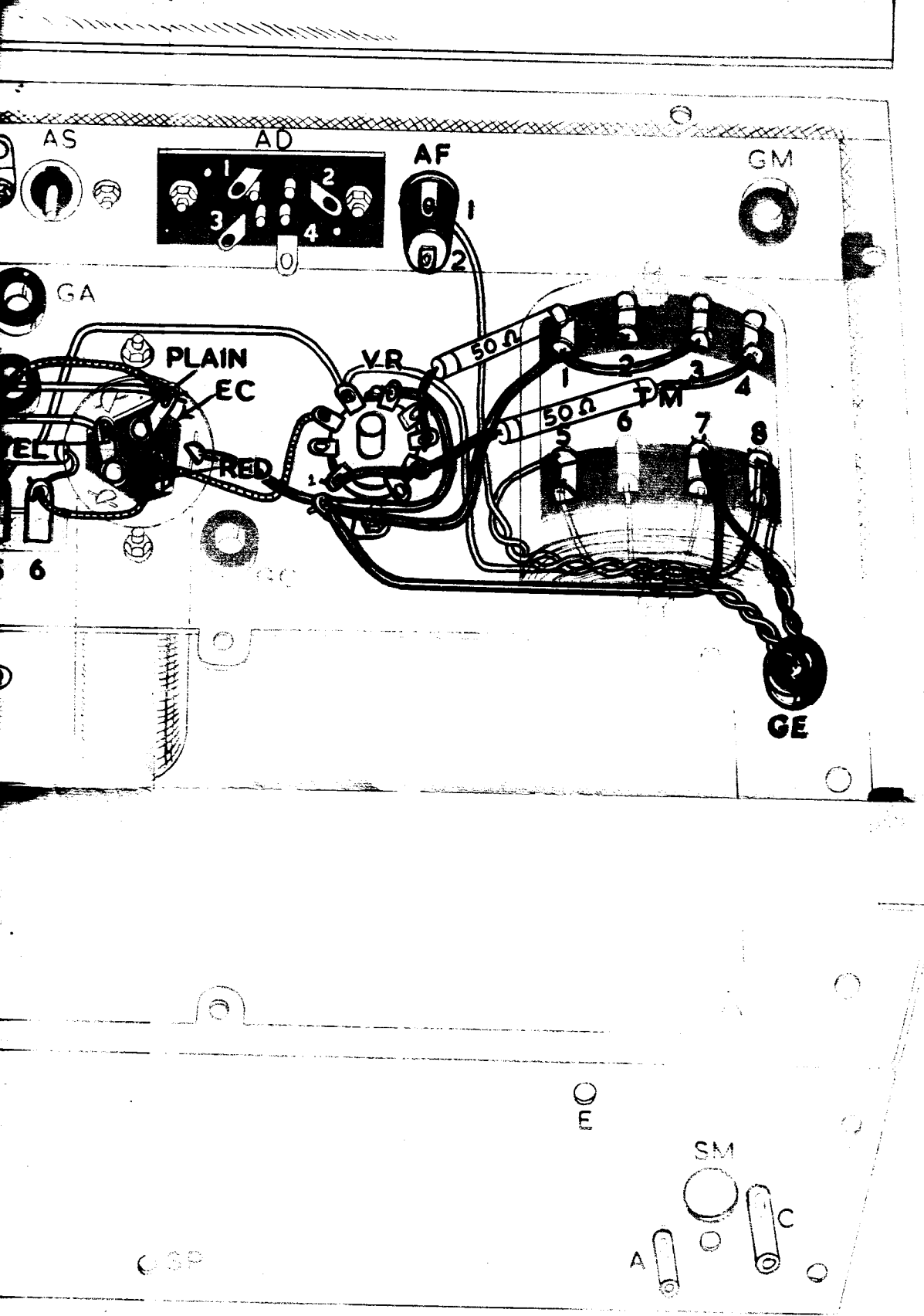




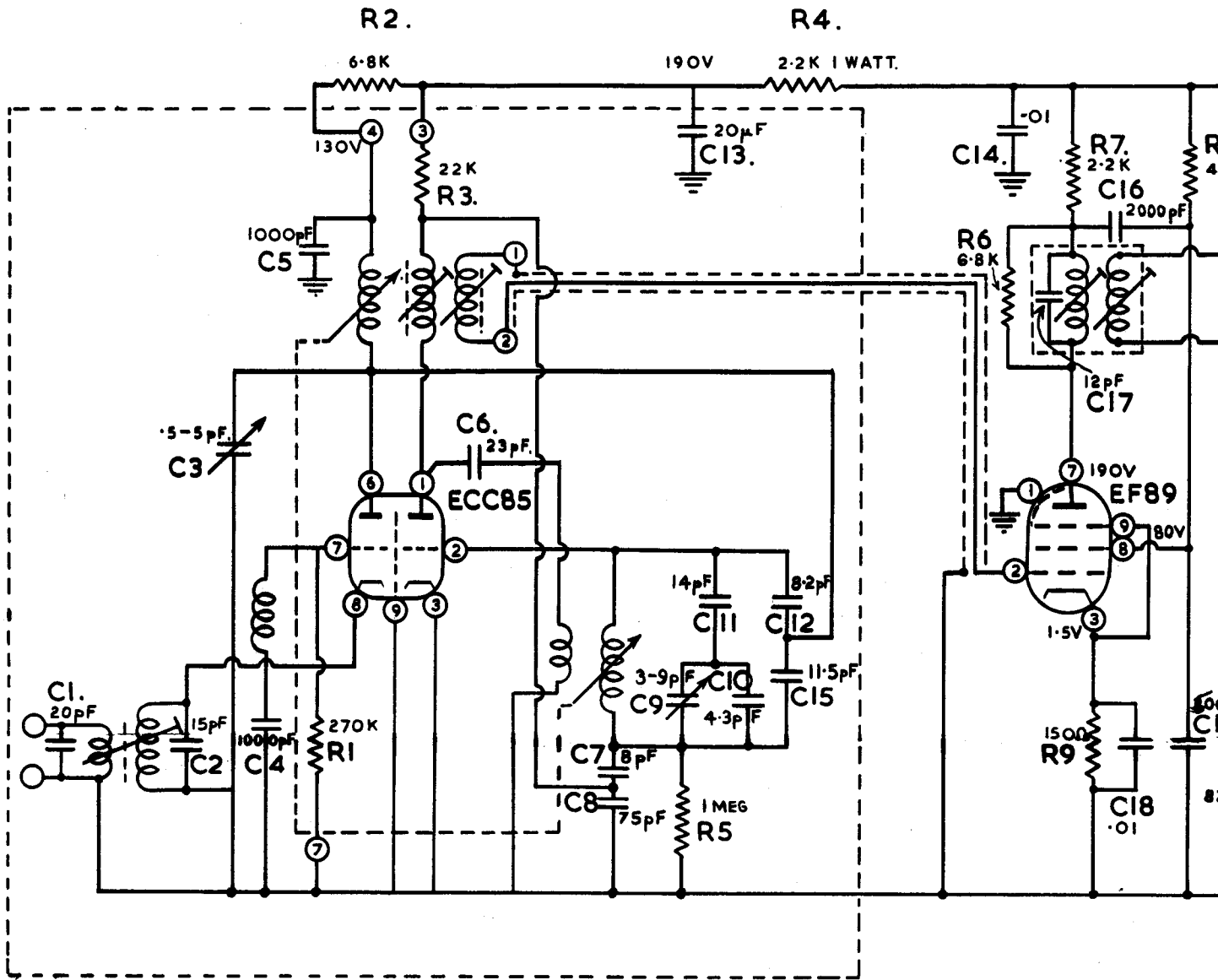
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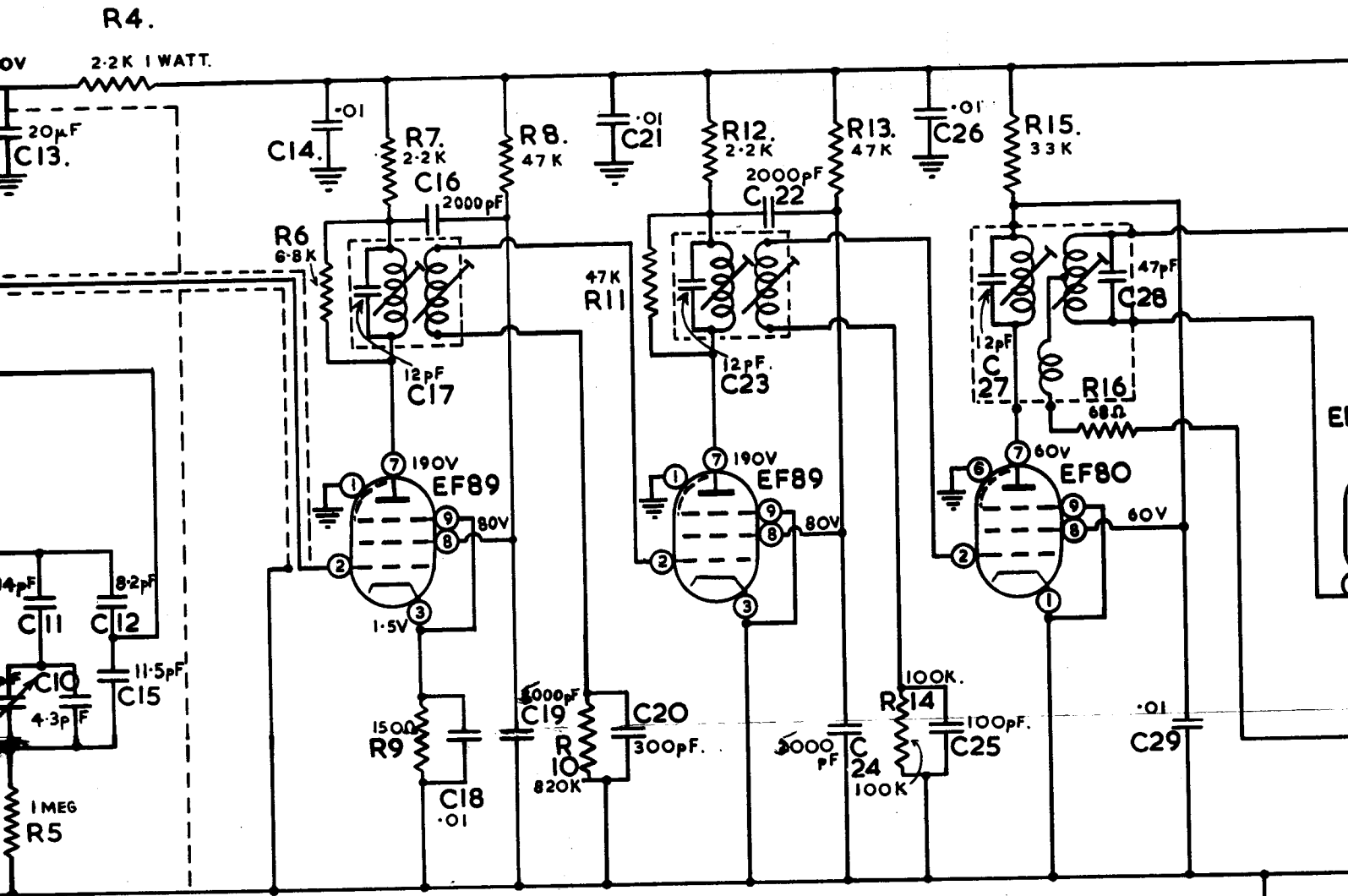
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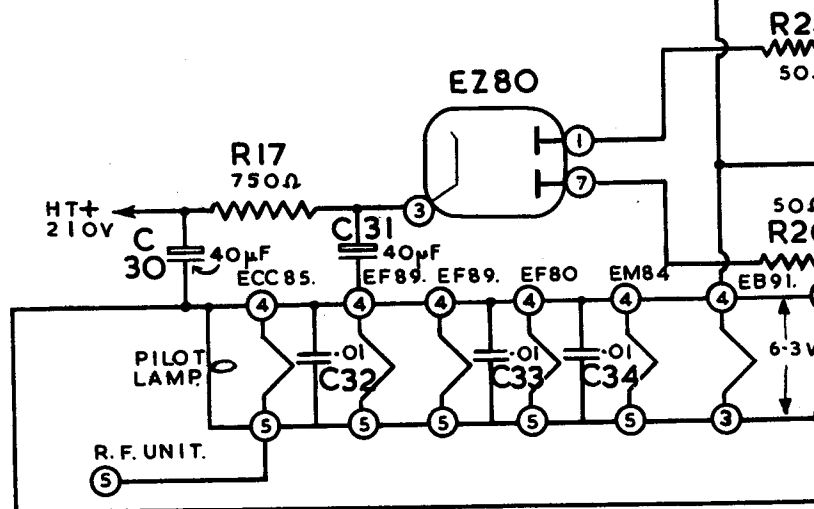
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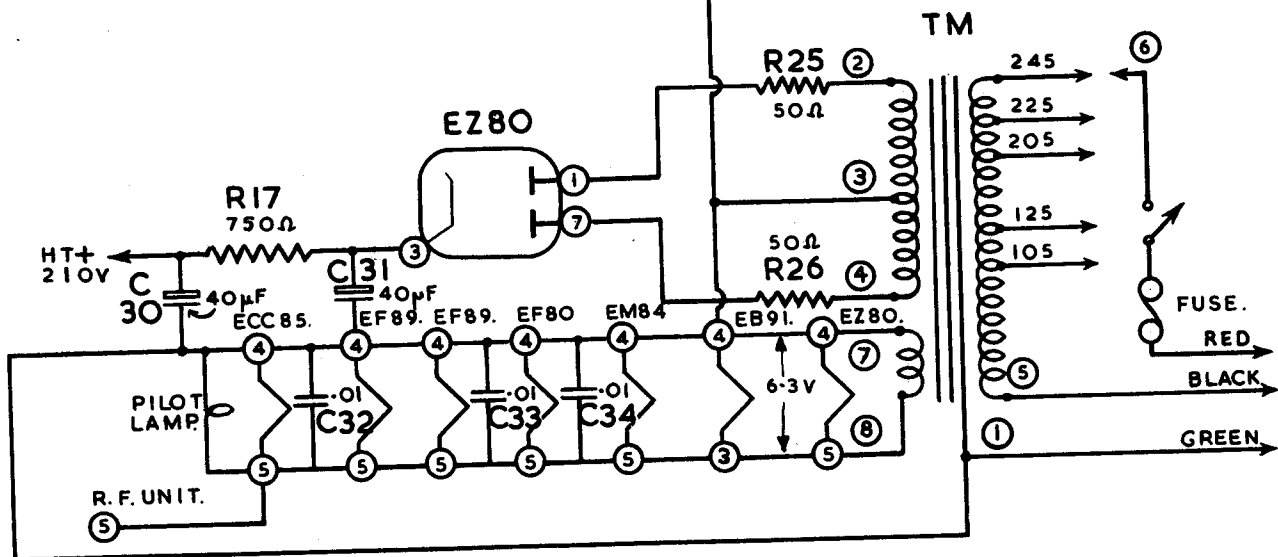
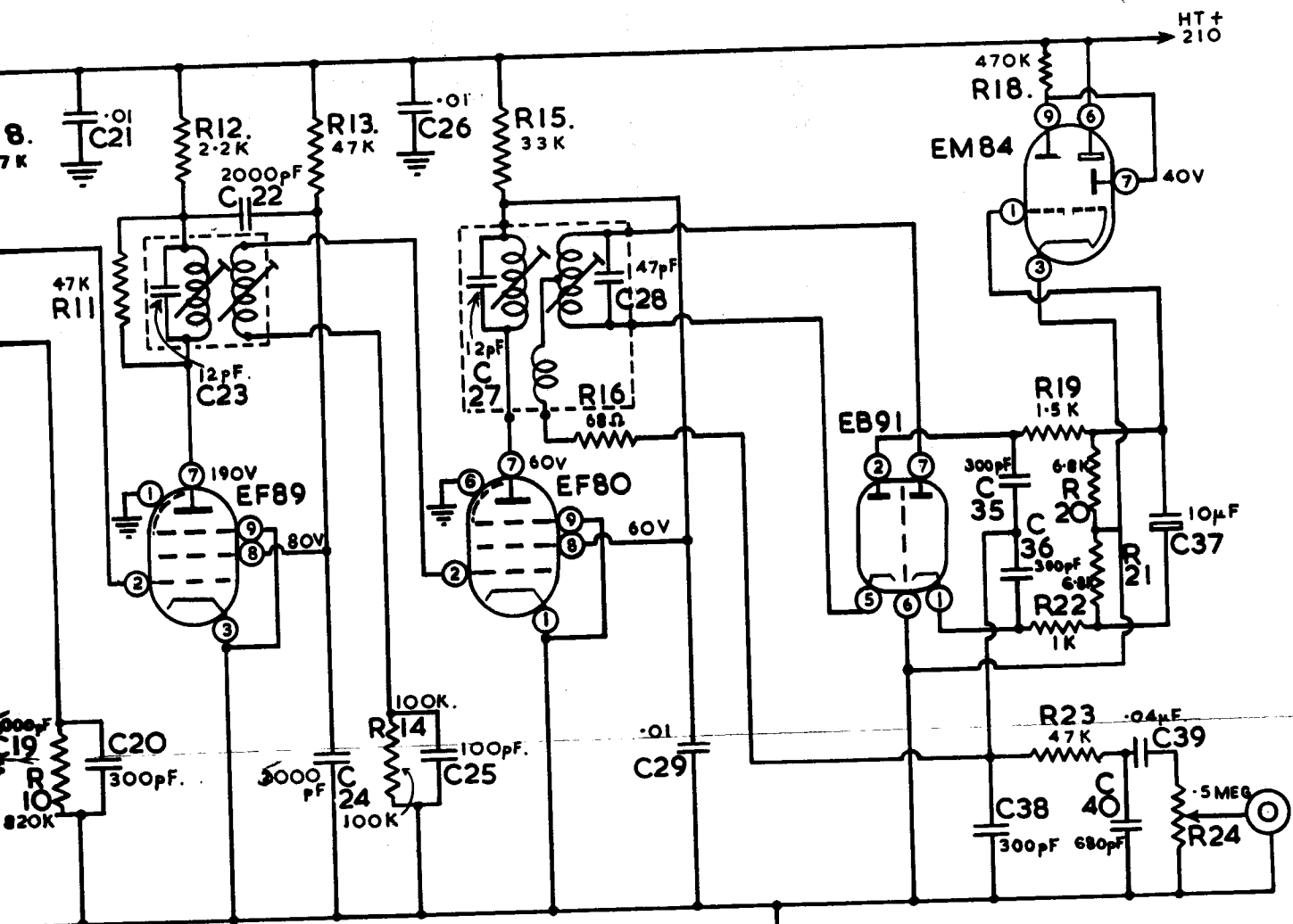


CIRCUIT DIAGRAM FOR  
HEATHKIT F. M. TUNER.  
MODEL FM-4U.

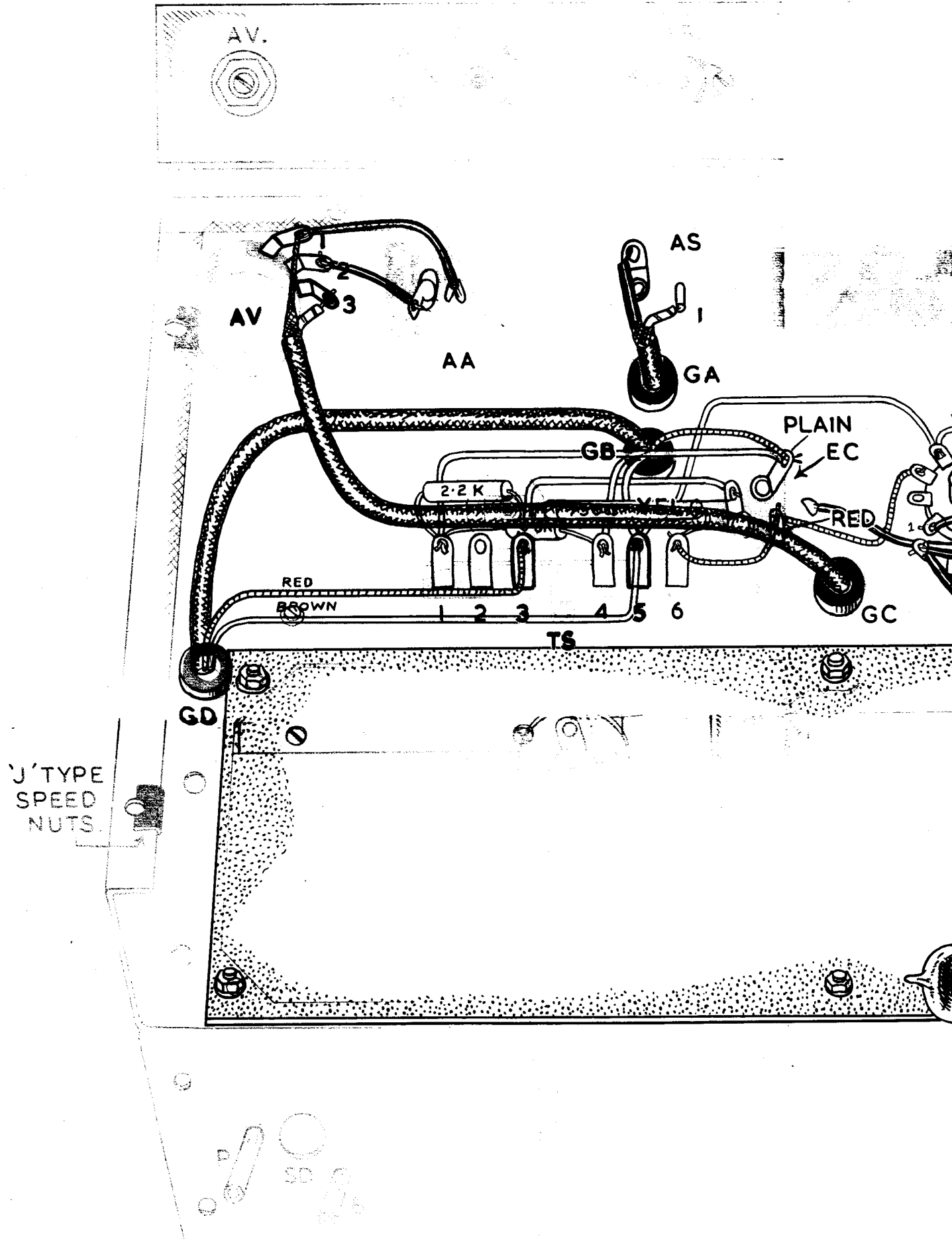


FOR  
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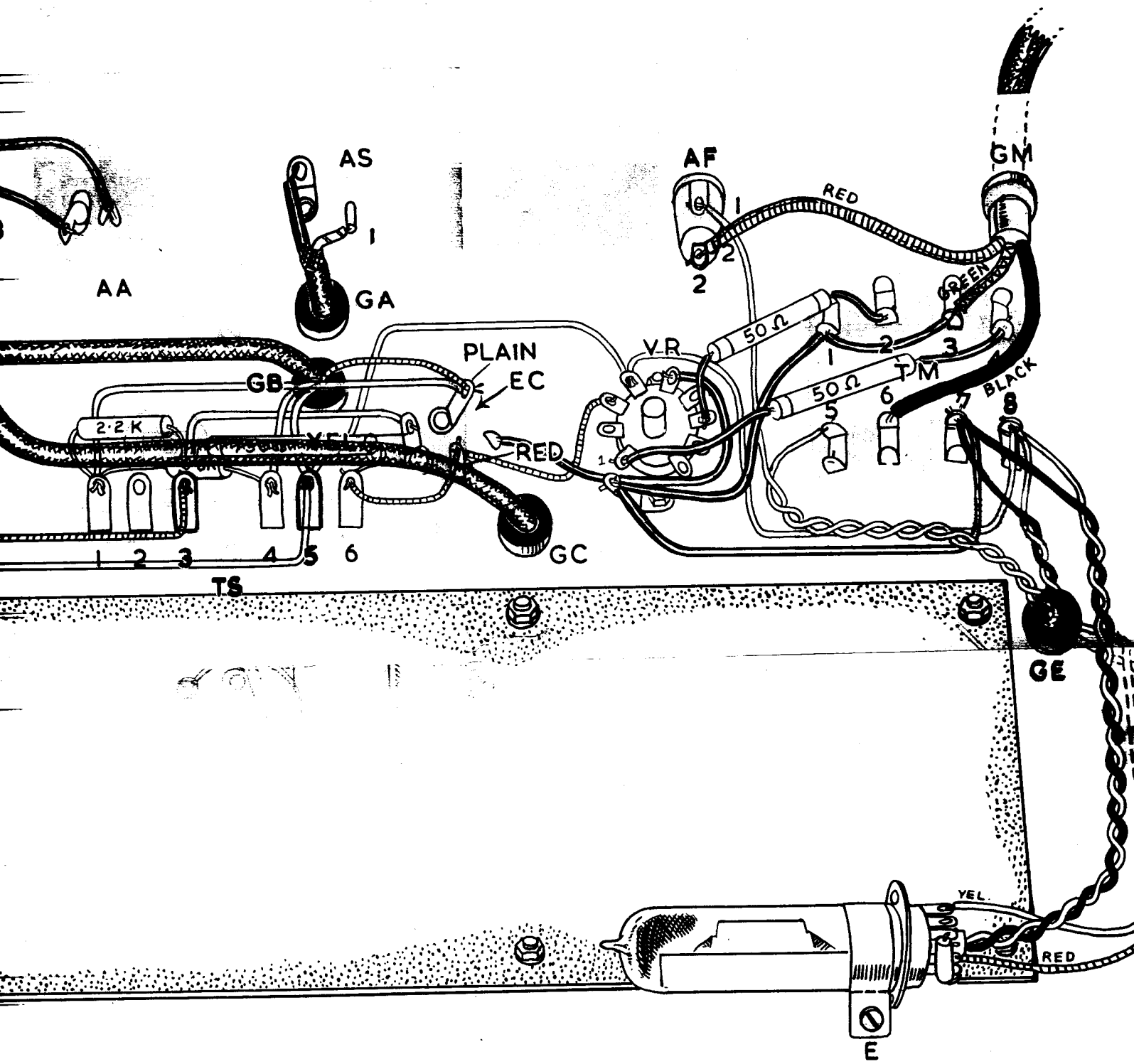




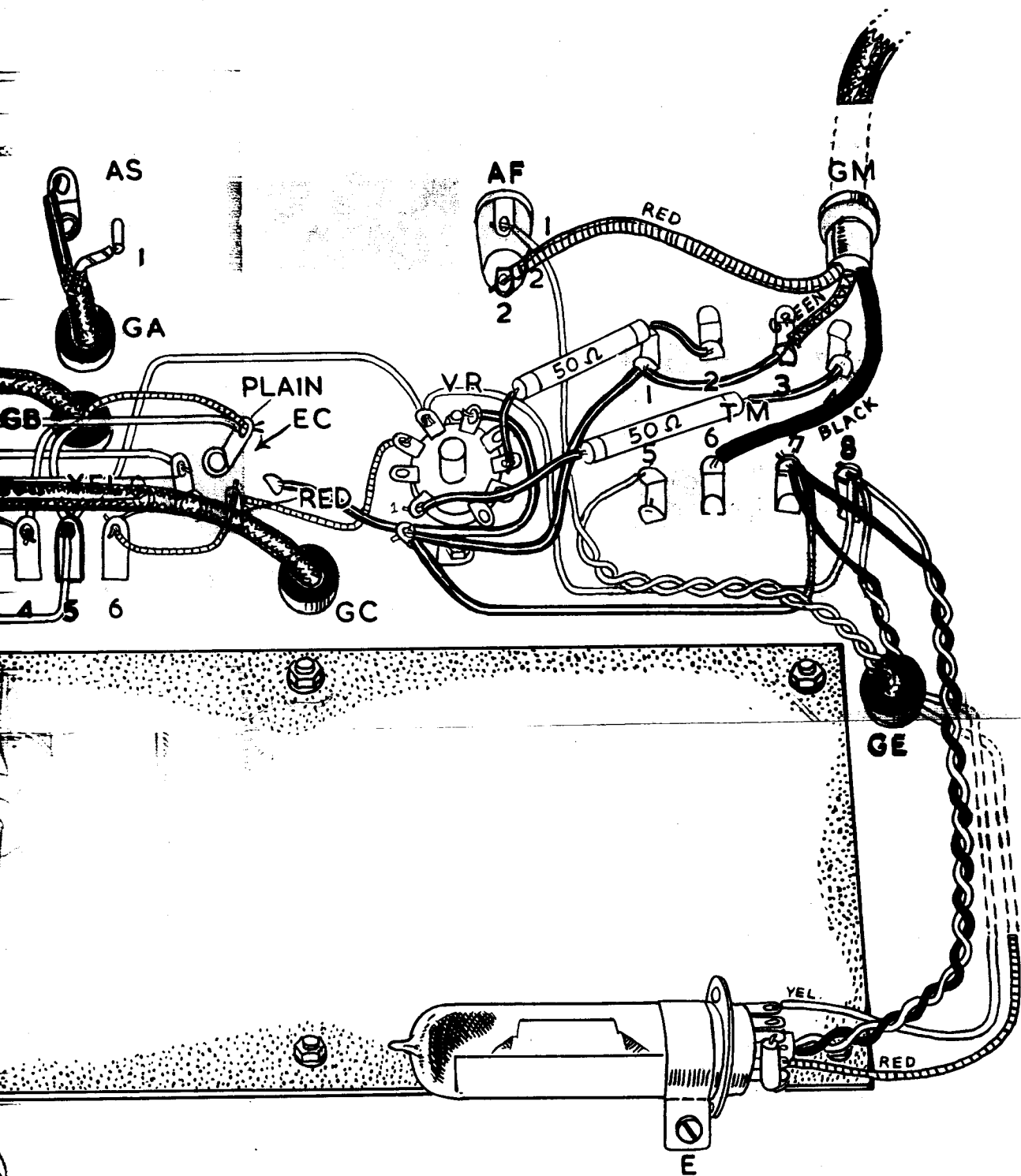




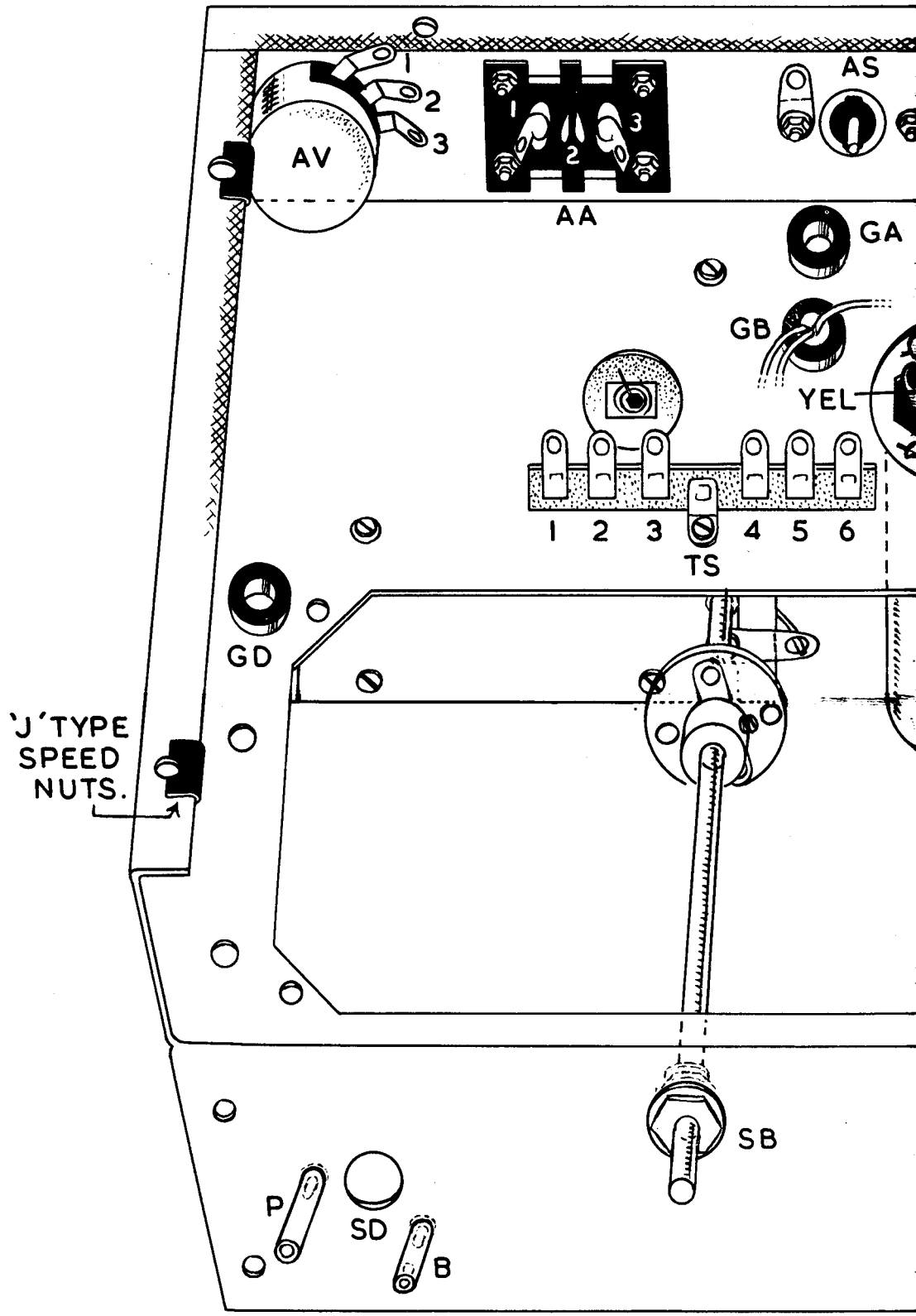
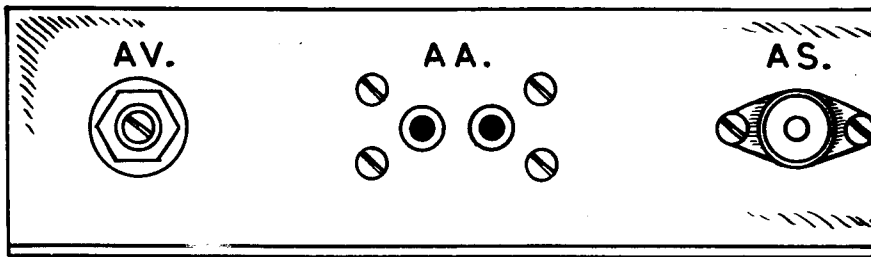
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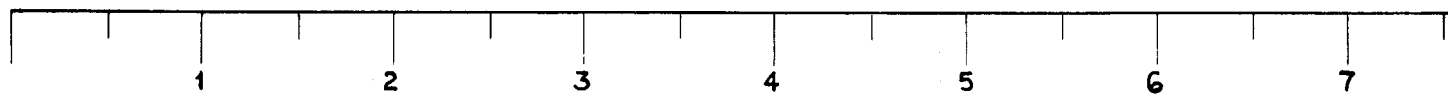
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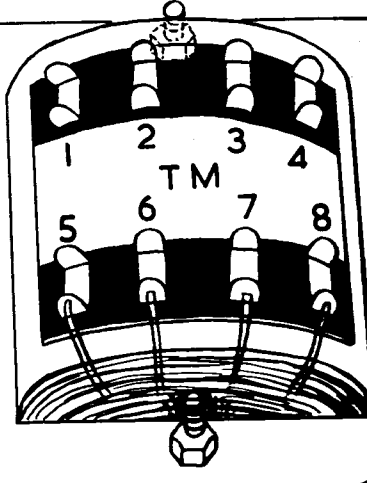
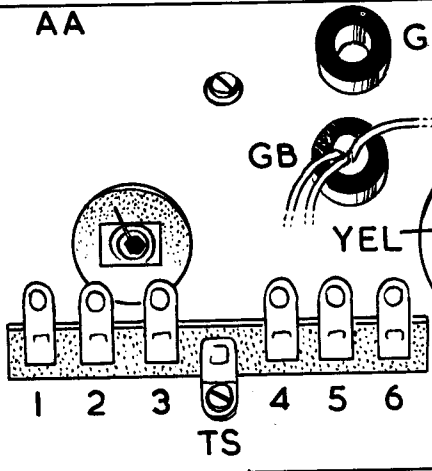
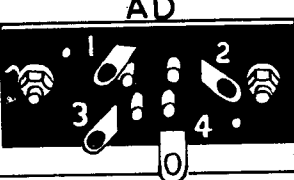
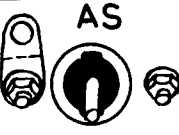
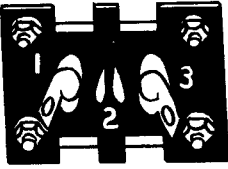
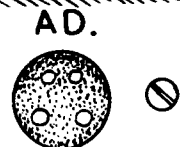
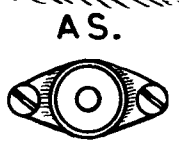
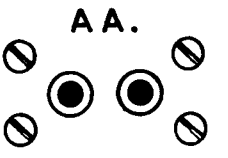
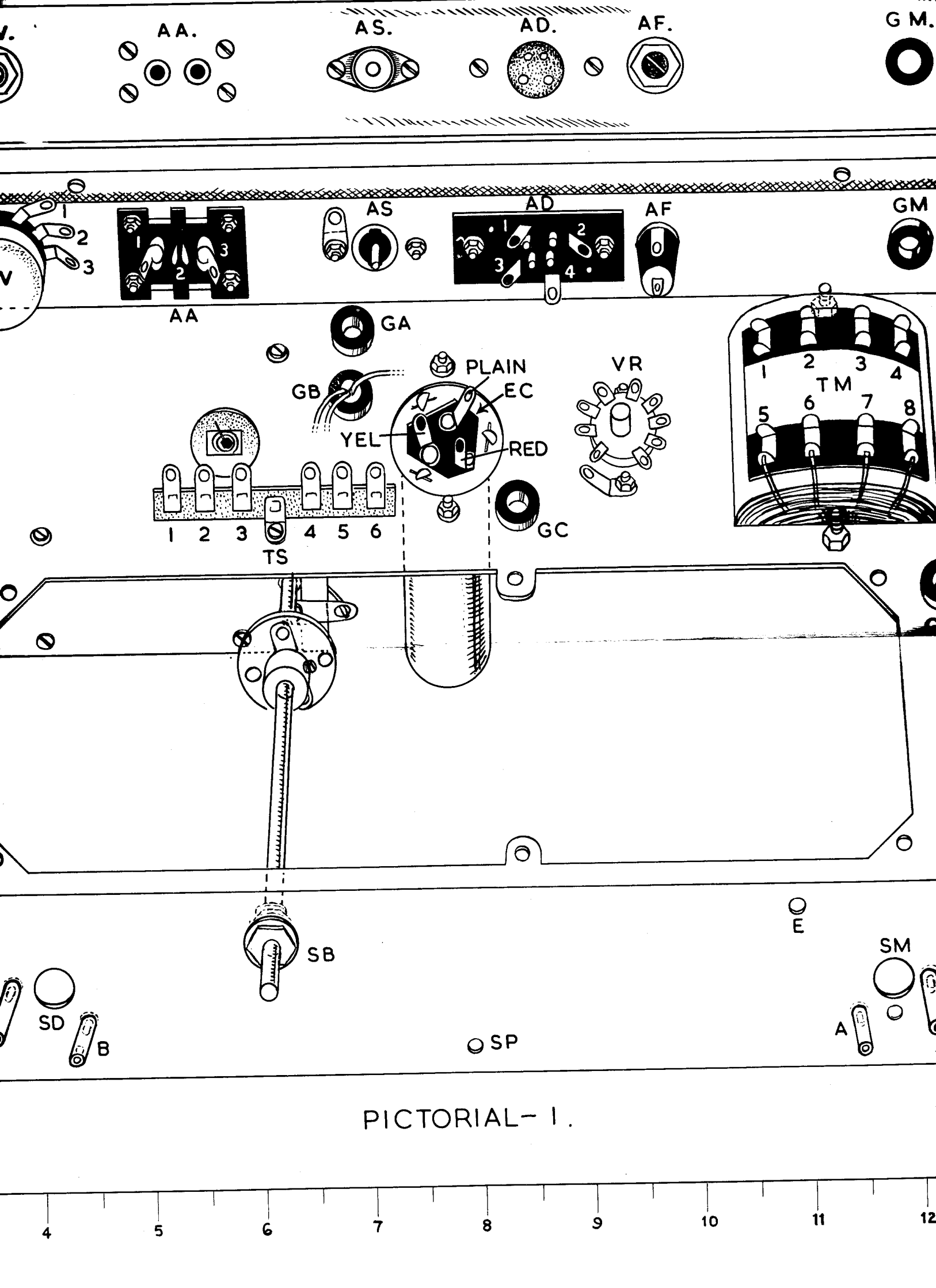


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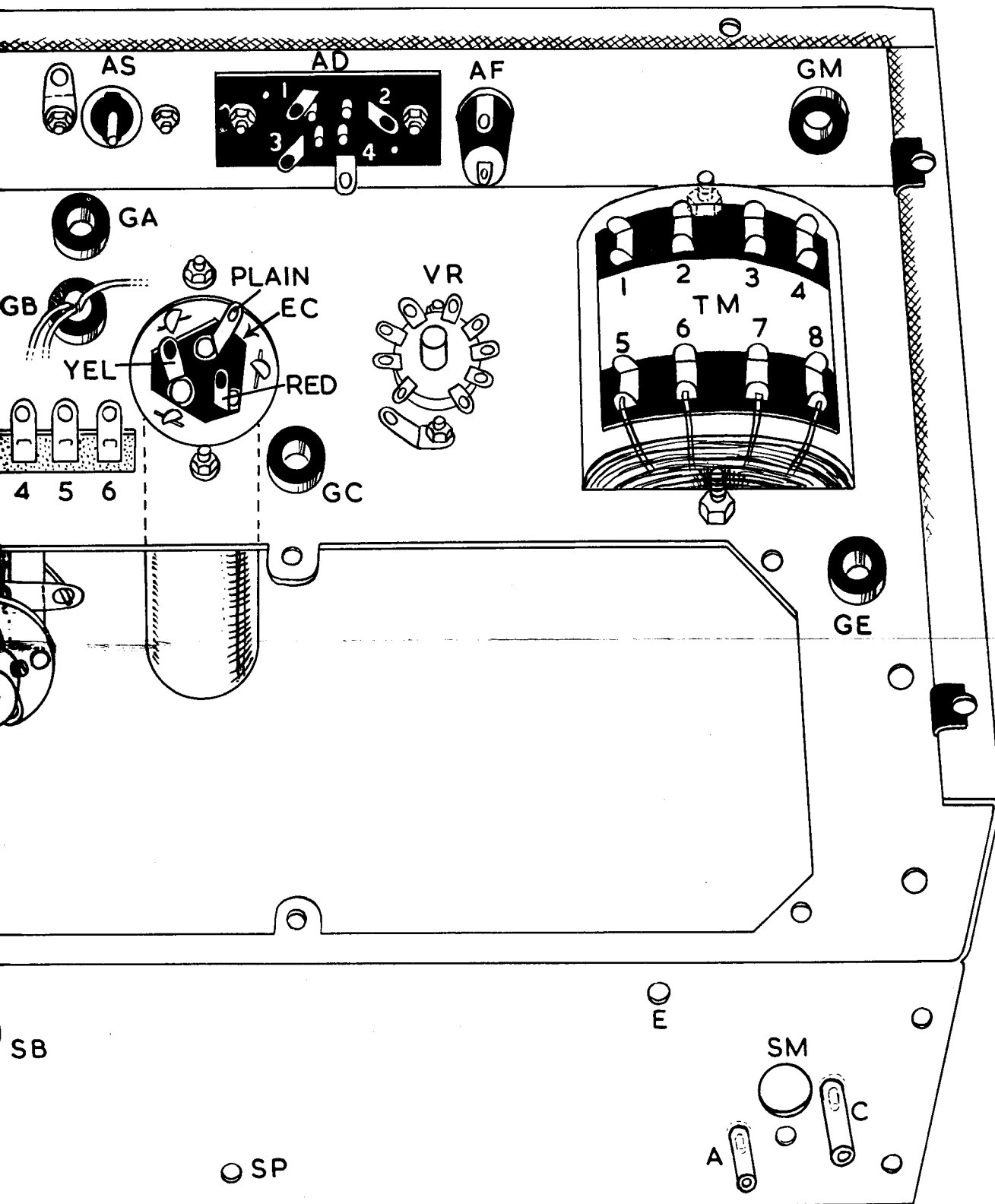
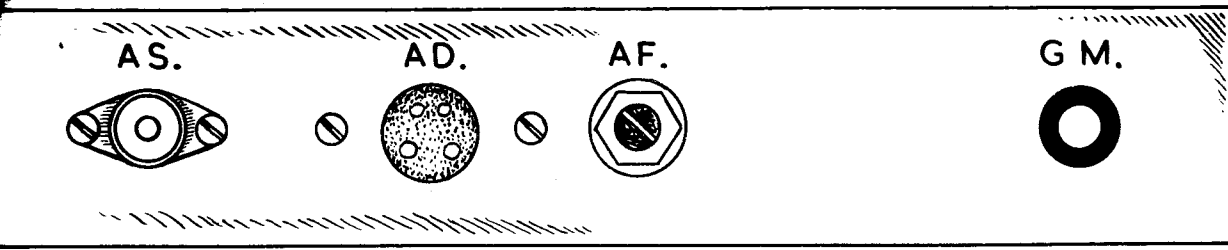


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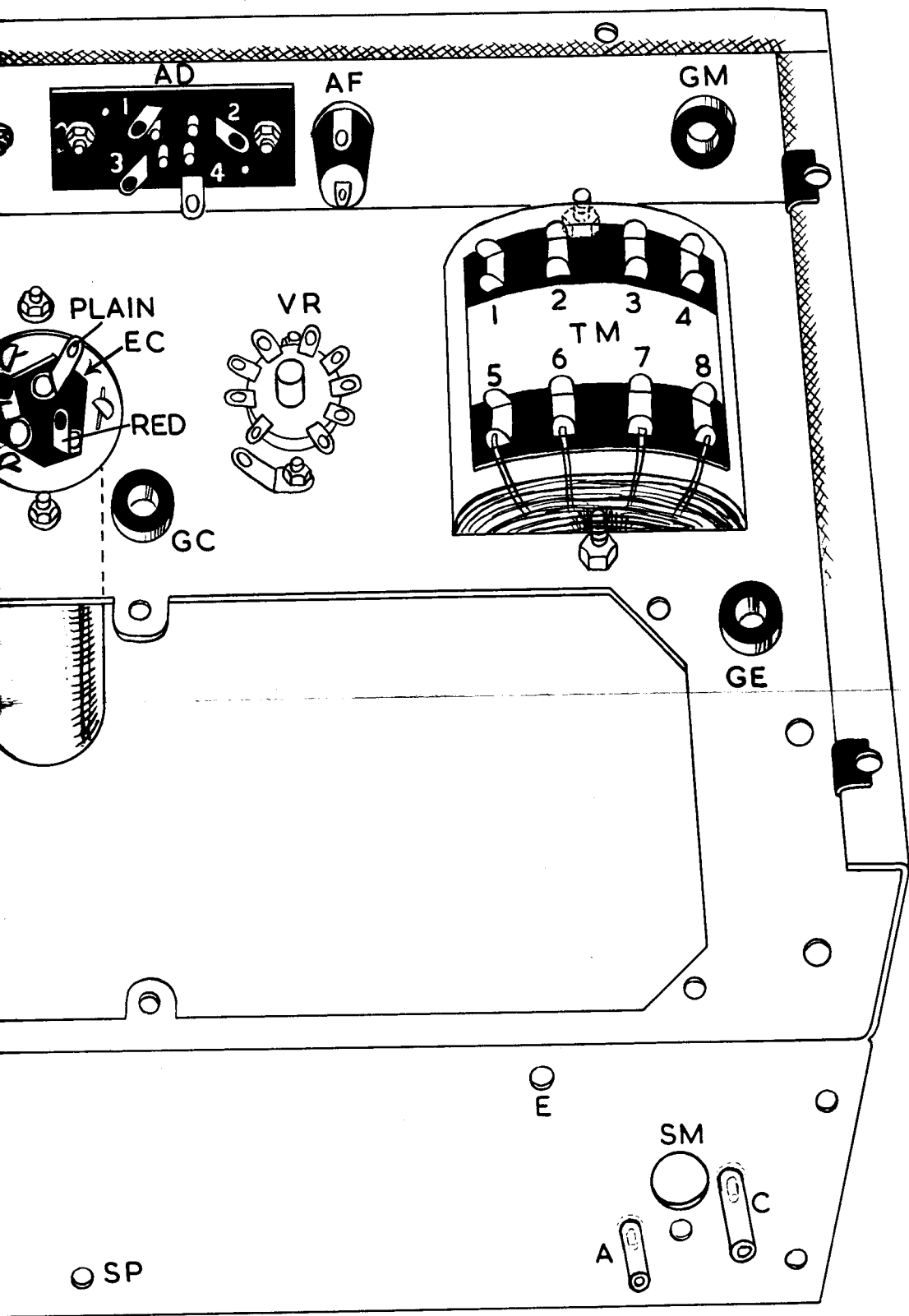
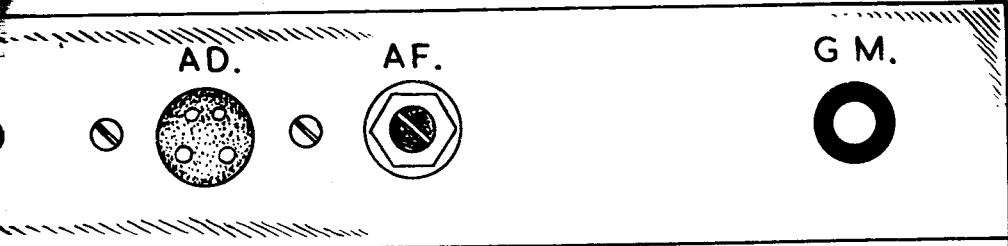




PICTORIAL- I.



PICTORIAL- I.



TUTORIAL- I .

