PRICE 17/6

Assembling and Using Your...

Heathkit

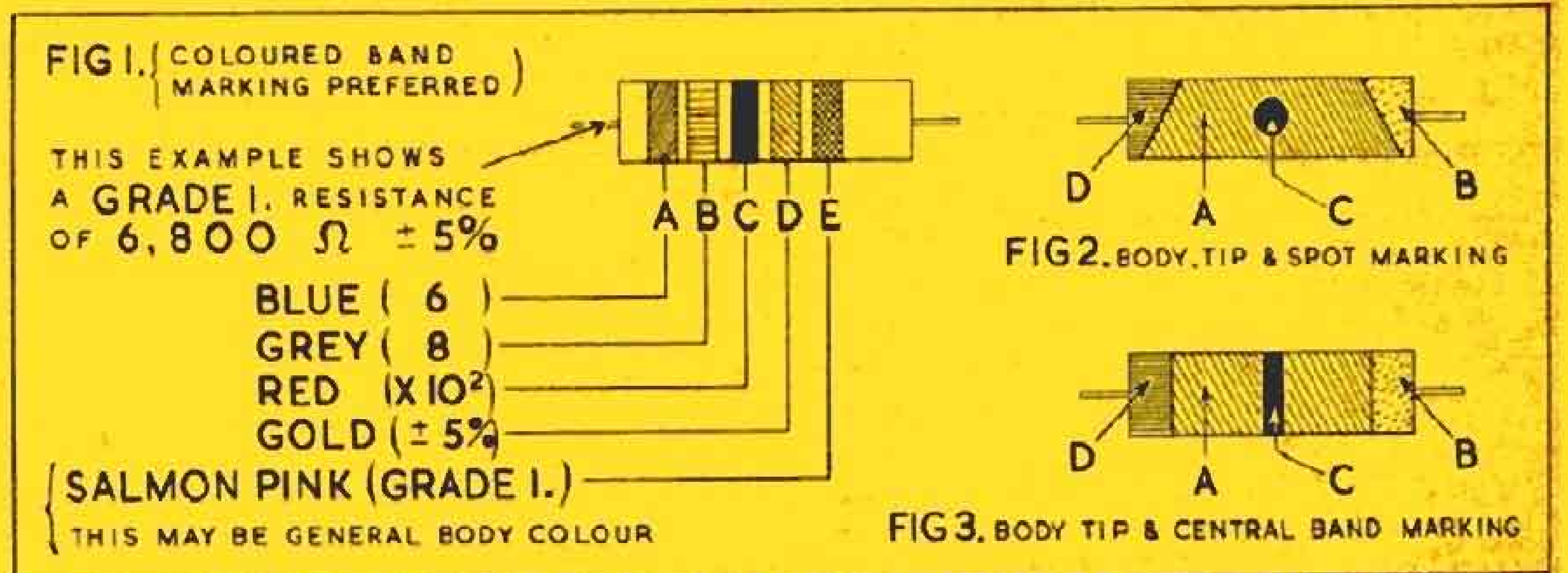
DAYSTROM

TELEVISION ALIGNMENT GENERATOR

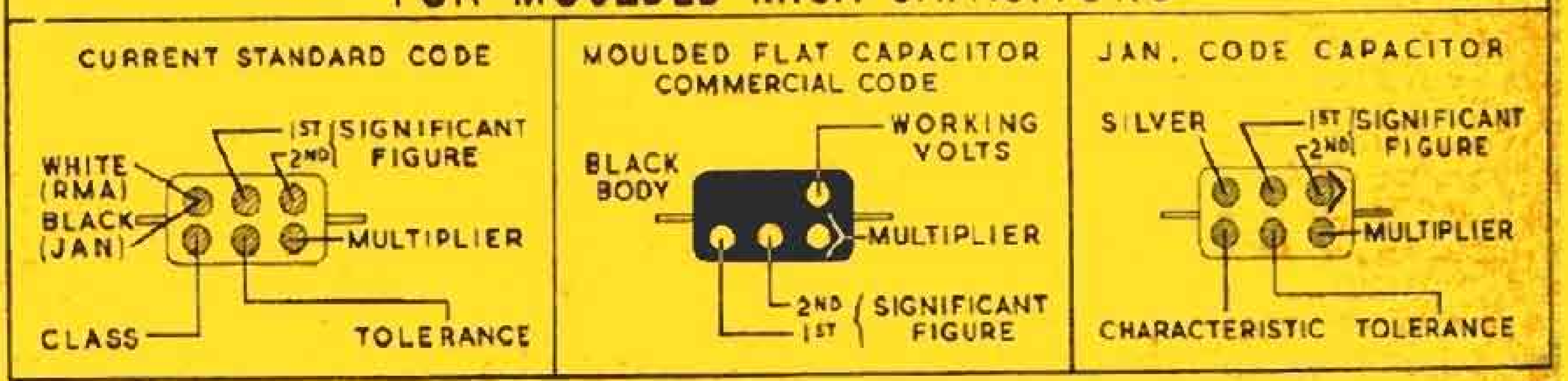
MODEL HFW-1

DAYSTROM LIMITED
A Member of the Schlumberger Group including the Heath Company.
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 of pF for Cols. A, B & C.				COL. D. (TOLERANCE RATING)			CAPACITORS COL. E. TEMP. COEFFICIENT per 10⁶ per °C.
	COL. A.	COL. B.	COL. C. (MULTIPLIER)					
	1st Figure	2nd Figure	Resistors ohms	Capacitors pF	Resistors	Ceramic Capacitors Up to 10 pF	Ceramic Capacitors 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 ± 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.

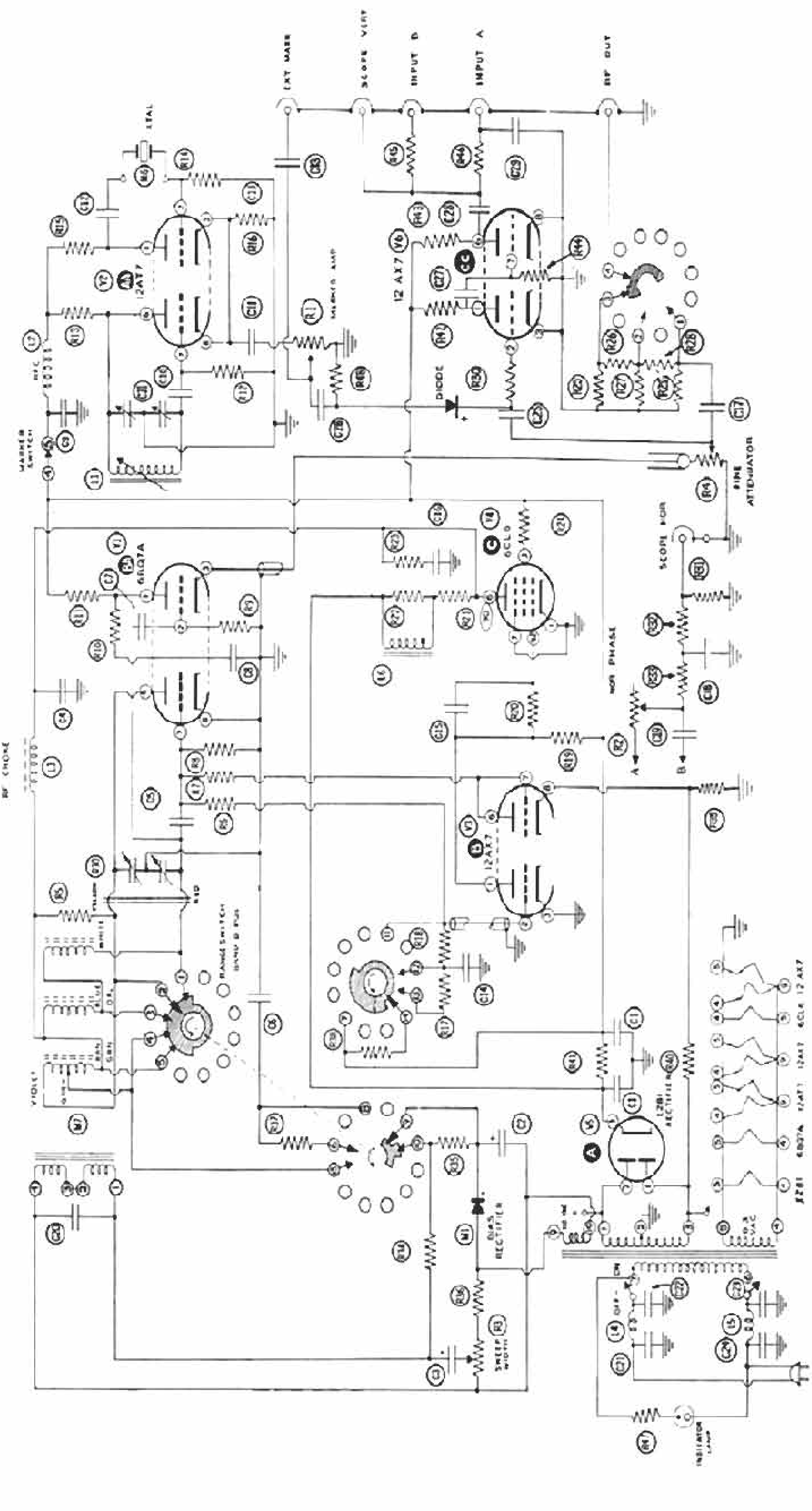
Assembly and Operation of the

Heathkit Television Alignment Generator

MODEL HFW-1

SPECIFICATION

Frequency Range and Output:	Band A. 3.6 Mc/s to 10 Mc/s, output .23 volts RMS $\pm \frac{1}{2}$ dB Band B: 10 Mc/s to 26 Mc/s, output .22 volts RMS $\pm \frac{1}{4}$ dB Band C: 30 Mc/s to 80 Mc/s, output .11 volts RMS $\pm \frac{1}{2}$ dB Band D: 80 Mc/s to 220 Mc/s, output .08 volts RMS $\pm \frac{3}{4}$ dB
Output Impedance:	80Ω, terminated at both ends of output cable
Sweep Deviation:	Continuously variable from 0-4 Mc/s lowest maximum sweep, 0-42 Mc/s highest maximum sweep, depending on frequency
Fixed Frequency Marker:	5.0 Mc/s crystal, included with kit. Other frequency crystals may be quickly substituted if desired
Variable Frequency Marker:	19 Mc/s to 60 Mc/s on fundamentals, 57 Mc/s to 180 Mc/s on calibrated harmonics. Calibrated against furnished crystal which determines marker accuracy
External Marker:	Any RF frequency can be mixed with crystal and variable marker oscillators to provide as many as three marker pips on one trace. Marker energy can be taken out from external connector for separate applications
Attenuators:	Step and 'fine' controls for sweep oscillator, separate control for marker amplitude
Blanking:	2-way blanking incorporated to eliminate return trace
Phasing:	Narrow range phasing control to ensure alignment accuracy

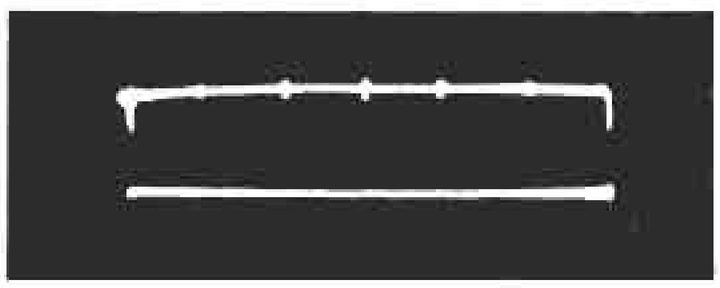


CIRCUIT DIAGRAM OF HEATHKIT TELEVISION ALIGNMENT GENERATOR MODEL HFW-1

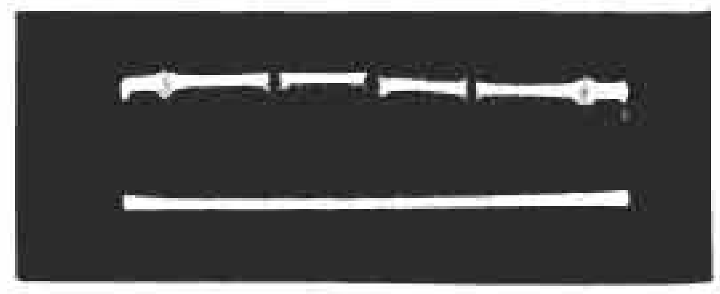
Valve Complement:	6BQ7A - sweep oscillator and buffer 12AT7 - variable and crystal marker oscillator 12AX7 - blanking and AGC amplifier 6CL6 - shunt regulator 12AX7 - mixer-amplifier EZ81 - rectifier GEX13 - mixer diode
Cables:	Output cable, scope horizontal and vertical cables and two signal input cables provided
Power Requirements:	100-125, 200-250 volts a.c., 50-60 c/s, 50 watts
Dimensions:	13" wide x 8½" high x 7" deep
Nett Weight:	11 lb.
Shipping Weight:	16 lb.

FREQUENCY LINEARITY

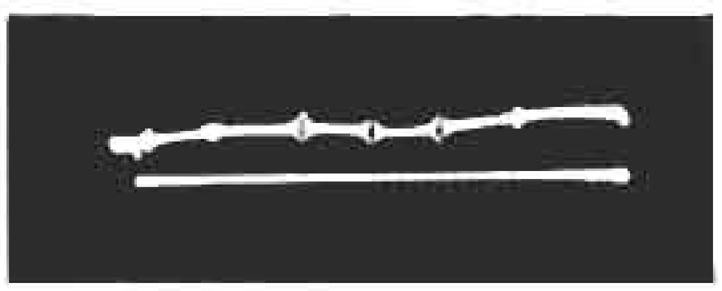
BAND A
Centre frequency 6.5 Mc/s,
side markers 1 Mc/s apart.



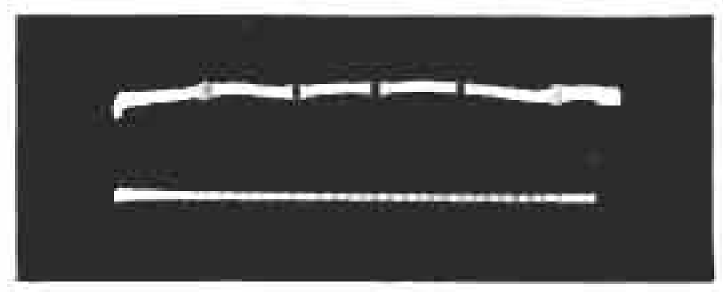
BAND B
Centre frequency 16 Mc/s,
side markers 2 Mc/s apart.



BAND C
Centre frequency 50 Mc/s,
side markers 3 Mc/s apart.



BAND D
Centre frequency 140 Mc/s,
side markers 2 Mc/s apart.



All pictures taken with the oscillator dial approximately at the mid-range position. Sweep width adjusted to show only easily identifiable markers.

RESISTOR AND CAPACITOR IDENTIFICATION CHART (see Circuit Diagram)

C1	20+20 µF	C22	.001 µF	R9	100 KΩ	R30	1 KΩ
C2	40 µF	C23	.001 µF	R10	10Ω	R31	100 KΩ
C3	16 µF	C24	.001 µF	R11	10 KΩ 1W	R32	100 KΩ
C4	.001 µF	C25	47 pF	R12	22 KΩ	R33	1 MΩ
C5	47 pF	C26	47 pF	R13	100 KΩ	R34	10 KΩ 2W
C6	.005 µF	C27	.002 µF	R14	100 KΩ	R35	15 KΩ 1W
C7	47 pF	C28	47 pF	R15	33 KΩ	R36	6.8 KΩ 1W
C8	.01 µF	C29	.001 µF	R16	150Ω	R37	2.2 KΩ
C9	.001 µF	C30	130+130 var.	R17	22 MΩ	R38	220 KΩ
C10	47 pF	C31	130+130 var.	R18	5.6 MΩ	R39	33 KΩ 1W
C11	100 pF			R19	1 MΩ	R40	33 KΩ 1W
C12	.001 µF			R20	1 MΩ	R41	470Ω 1W
C13	100 pF			R21	2 KΩ 8W	R42	220 KΩ
C14	.001 µF	R1	200Ω pot.	R22	150 KΩ	R43	220 KΩ
C15	.25 µF	R2	100 KΩ pot.	R23	220Ω	R44	100 KΩ
C16	.05 µF	R3	10 KΩ pot.	R24	6.8 KΩ 2W	R45	150 KΩ
C17	.001 µF	R4	200Ω pot.	R25	47Ω	R46	47 KΩ
C18	.05 µF	R5	22 KΩ	R26	680Ω	R47	100 KΩ
C19	.01 µF	R6	100 KΩ	R27	47Ω	R48	220Ω
C20	.25 µF	R7	6.8 KΩ	R28	680Ω		
C21	.001 µF	R8	4.7 KΩ	R29	68Ω		

INTRODUCTION

The Heathkit Television Alignment Generator, model HFW-1 is designed to offer the maximum in performance, flexibility and utility at the lowest possible cost. To this end, several outstanding new features have been incorporated which are unusual in instruments in this price range.

A unique non-mechanical sweep oscillator system is used in the Heathkit HFW-1 Generator. The heart of this system is the controllable inductor, which controls oscillator coil inductance as a function of excitation current flow in the primary windings of the unit. The main advantage of this circuit is that a large amount of sweep width can be obtained which is smoothly controllable, very linear and very stable. There is no mechanical vibration or hum and nothing to wear out or fatigue with age. Operation of the instrument is non-critical as the large amount of sweep width available makes it easy to locate the band-pass trace even though the sweep generator or the TV set may be off frequency by a substantial amount. Once the waveform has been located, it is only necessary to adjust the frequency, sweep width and phasing until the pattern fills the desired portion of the 'scope screen.

Additional features found in the sweep generator are an AGC circuit to keep the RF output constant over the sweep range, positive action return trace blanking, an electronically regulated power supply to assure stable operation and a separate marker mixer-amplifier stage.

A multiple marker system is employed to make alignment easier. The built-in variable marker oscillator covers a range from 19 Mc/s to 60 Mc/s on fundamentals and 57 Mc/s to 180 Mc/s on calibrated harmonics. Higher order harmonics are also available when required. The fixed marker is a crystal controlled oscillator, which operates at 5.0 Mc/s with the crystal furnished with the kit. The crystal mounts outside the front panel, making it easy to substitute any other crystal if needed. Both oscillators have a common output, controlled by one knob independently of the sweep circuit output. Since the fixed and variable oscillators have a common output, each frequency will be present, as well as the sum and difference frequencies. Marker pips spaced 5.0 Mc/s apart are obtained by using the mixed outputs. If closer spaced markers are desired, a crystal of lower frequency can be used. Spacing of the markers is determined by the crystal frequency.

Another marker can be fed into the external marker connector for FM alignment or other work requiring frequencies not covered by the internal marker generator. Also, an external generator can be used to beat against the fixed or variable internal oscillators to give three or more simultaneous pips. Marker oscillator signal can be taken out of the external marker connector for separate application if needed.

CIRCUIT DESCRIPTION

The swept oscillator is basically a standard Colpitts oscillator, using half of a 6BQ7A valve. The coils are built into the controllable inductor and are series connected. When the low band is in use, all coils are in the circuit. As the range switch is set to higher bands, the coils are shorted out in succession until the straps and switch which form the high frequency band coil are left. Ferrous material is used for the cores of the coils, which are made so that each core makes contact with the laminated pole pieces of the inductor. When no exciting current is applied to the primary circuit, the coils are operating at their nominal inductance and the oscillator is running at the lowest possible frequency for the particular setting of the tuning capacitor. When current flows in the primary coil, a magnetic field is set up. This field completes itself through the oscillator coil cores, causing the cores to change characteristics to a degree dependent on the amount of excitation current and the subsequent magnetic field strength. In effect the coils lose inductance as the exciting current increases and the frequency of the oscillator increases proportionally. Highest possible deviation of frequency is obtained when the cores are saturated. In order to control the width of the sweep, a control is connected across the 110 volt winding in series with a limiting resistor R36 which prevents overloading of the controllable inductor. The Increductor unit is connected to one end and to the centre of the control through a capacitor. Sweep width can be set to any level by rotating the control until the desired amount of sweep width is obtained.

Centre frequency sweep is obtained by biasing the windings of the controllable inductor with d.c. current. The current is adjusted on each band so that at zero sweep width, the operating frequency is halfway between the no-current and the saturation point of the inductor. When the range switch is turned to a different band, it will change the amount of current, thus assuring good linearity at all frequencies. Bias current is obtained from the small selenium rectifier connected to one side of the 110 volt winding. The circuit is completed through R35, R34 and the primary windings of the Increductor unit. The filter capacitor C2 is used to smooth out the current. Sweep is obtained by coupling a.c. through C3 isolating capacitor, which varies the primary current without changing the static or centre current supplied by the rectifier. Changes in current for different bands are accomplished by switch shunting R35 bleeder resistor. Oscillator operation is entirely on fundamentals, ensuring adequate output on all bands and efficient attenuator action.

The second half of the 6BQ7A sweep oscillator is connected as a cathode follower. RF energy is coupled from the grid circuit of the oscillator to the grid of the cathode follower. A cathode follower is a high impedance input device, so loading effects on the oscillator are negligible. Output from the cathode follower is at low impedance and is connected to the attenuator network.

Blanking is required to eliminate the return trace encountered when the oscillator returns to the starting point. Without blanking, a double trace is present which is difficult to interpret. Elimination of the return trace is accomplished by cutting down the HT voltage to the oscillator valves and at the same time driving the oscillator grid highly negative. HT voltage is reduced due to a portion of the negative grid blanking voltage fed to the regulating amplifier. This causes the shunt regulator valve to conduct heavily during the blanking time. The subsequent large drop across the shunt regulator load resistor and choke effectively cuts off the high voltage to the sweep oscillator valve. Negative voltage at the oscillator grid is applied from one half of the 12AX7 blanking and AGC amplifier. The grid and anode are tied together and to the oscillator grid through R7 isolating resistor. One side of the power transformer high voltage secondary is tied to the cathode of the blanking valve through a voltage dividing network of R39 and R40. When the cathode swings in a positive direction, the anode is negative in respect to the cathode and no current can flow. At this time, the oscillator will be operating with its own grid leak R8 only. During the negative half of the cycle at the cathode of the blanking valve, the grid and anode become effectively positive in respect to the cathode and current will flow. The anode will follow the cathode causing a high negative voltage to be applied to the oscillator grid, cutting the valve off.

Regulation of the RF output voltage is accomplished by feeding a portion of the d.c. voltage developed at the oscillator grid through an isolating resistor to the control grid of the AGC amplifier. Any variations in oscillator output are amplified and fed through a resistor and capacitor to the grid of the 6CL6 shunt regulator. A unique direct coupling system is used at this point, which allows the shunt regulator to handle wide voltage swings without distortion. The oscillator anode is connected through an RF filter to the anode of the 6CL6. A resistor and choke are also connected to this anode. Any variation in current will cause a related increase or decrease of HT voltage at this point and thus the oscillator high voltage is varied. If oscillator output increases, the negative voltage at the grid will also increase. A negative voltage at the grid of the AGC amplifier will be fed to the grid of the 6CL6 as a positive potential, causing an increase in anode current. This in turn is reflected in reduced anode voltage, which is reflected to the oscillator anode causing the output to drop. An opposite reaction occurs if the output of the oscillator should decrease.

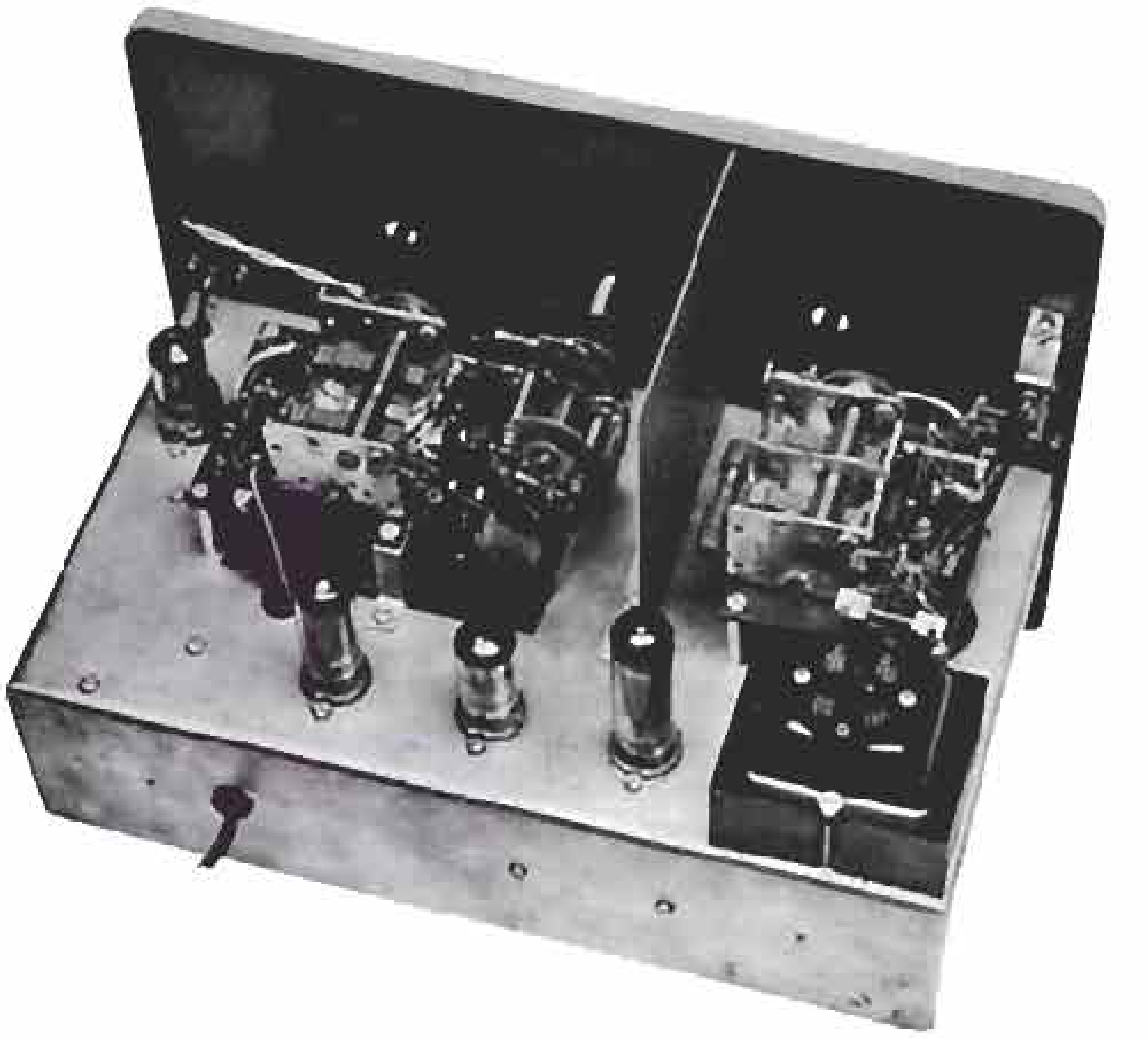
Changes of oscillator efficiency on different bands are compensated for by switching bias voltage to the grid of the AGC amplifier. Efficiency on band D is low and the voltage from the oscillator grid is fed straight through without compensation. Better efficiency is evident on band C and a slight amount of positive voltage is added through the switch to keep the amplifier operating in its optimum range. Highest operating efficiency is obtained on bands A and B and the same higher positive potential is applied for both.

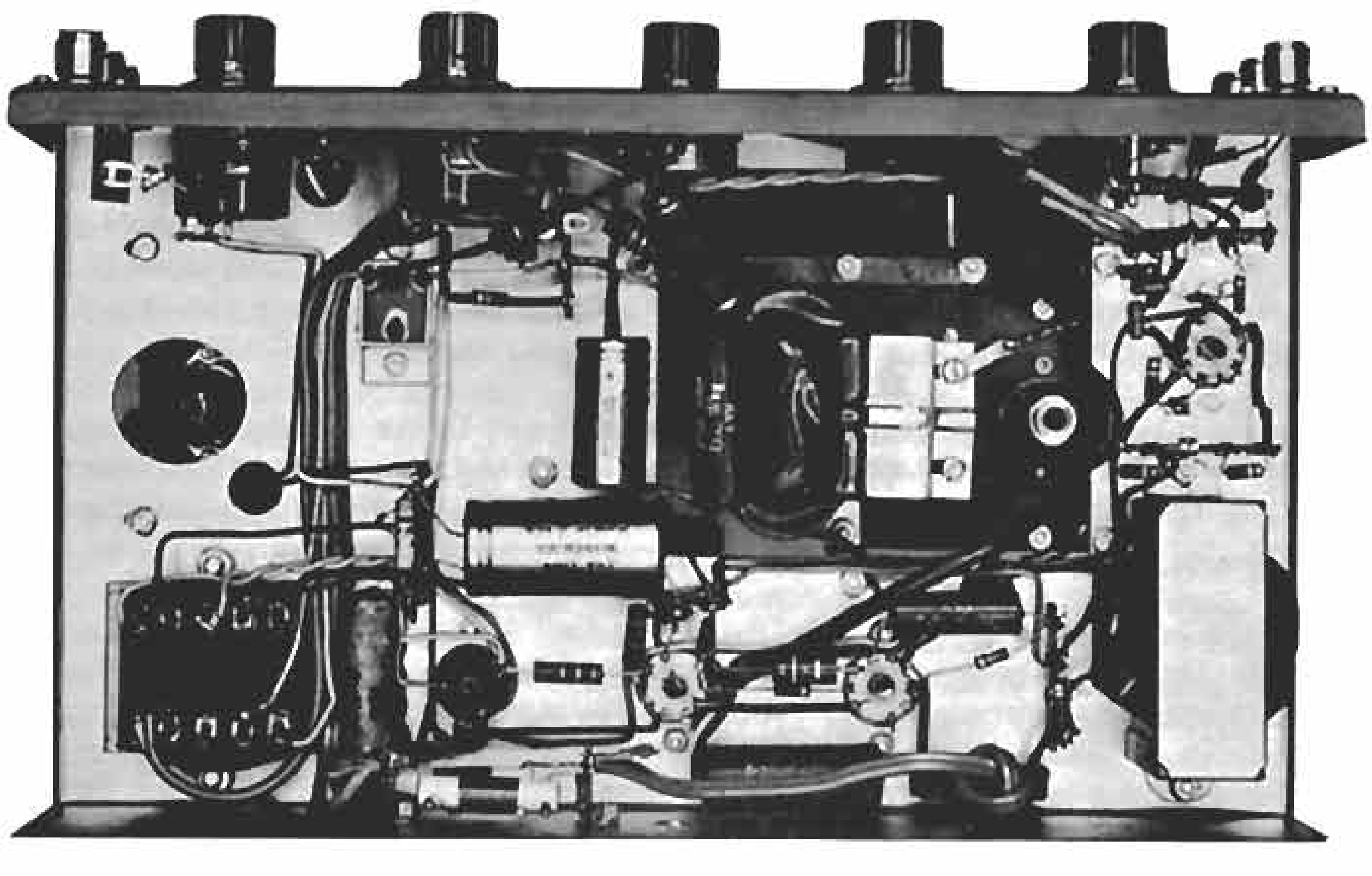
A 12AT7 dual triode valve is used in the multiple marker system. One half of the valve is employed as a Colpitts variable frequency oscillator, covering a fundamental range from 19 Mc/s to 60 Mc/s. Core tuning is used in the coil so the oscillator can be trimmed and padded for perfect tracking over the entire frequency range. Output from the oscillator is taken from the cathode circuit at low impedance so that changes of control settings and loading will not affect stability. The second half of the 12AT7 is a Pierce crystal oscillator and the output of this section is taken from the same cathode load as the first. Mixing the output of the two oscillators in a common load causes the frequencies of both generators to be present, as well as the sum and difference of the frequencies and their harmonics. Therefore, a 5.0 Mc/s crystal mixed with the variable oscillator at an example frequency of 25 Mc/s will give markers at 25 Mc/s, 30 Mc/s, 20 Mc/s, 35 Mc/s, 15 Mc/s etc. Other frequency crystals can be substituted to obtain markers that are closer or further spaced, or to give direct frequency check points. Additional markers are obtained by connecting a signal generator to the EXT. MARK. connector.

The outputs from the marker and sweep generators are heterodyned in the crystal diode mixer to develop beats that are amplified by a 12AX7 and superimposed on the receivers response curve as markers. The amplitude of the markers is controlled by the marker amplifier control which also permits the internal marker oscillator to be switched off.

The power supply employs an EZ81 full wave rectifier with well filtered d.c. output. Anode voltage for the rectifier and filament voltage for all valves is furnished by the power transformer, as well as voltage for the phasing and blanking circuits. Phasing is accomplished by connecting a capacitor C19 and variable resistor R2 across the high voltage anode windings. Changing the amount of resistance changes the phase shift in the network, which is connected to the horizontal output terminals.

Calibration of the HFW-1 Television Alignment Generator is easily accomplished, as an accurate reference is furnished with the kit, (the 5.0 Mc/s crystal). Harmonics of the 5.0 Mc/s crystal are used to calibrate the variable frequency marker oscillator at several points on the dial. Adjustment of pointer setting and core tuning effectively trims and pads the oscillator so that it tracks over the entire dial range. The sweep oscillator dial needs only to be indexed with the capacitor plates fully meshed as accuracy is not required from the sweep portion of the instrument. The marker system is always considered to be the accurate reference, not the sweep system. Frequency markings on the sweep dial are for reference only.





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. You will find it helpful to refer to the component identification sheet and also to the general details printed on the inside covers of the manual. If a shortage is found, attach the inspection slip to your claim and notify us promptly.

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.

Unless otherwise stated, use lockwashers under all nuts, and also between controls and the chassis. When shake-proof solder tags are mounted under nuts, the use of lockwashers is unnecessary.

Resistors and capacitors have a tolerance rating of ± 10% unless otherwise stated. Therefore a 100 KΩ resistor may test anywhere between 90 and 110 KΩ. 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, tagstrips, 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 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 tagstrips, 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.

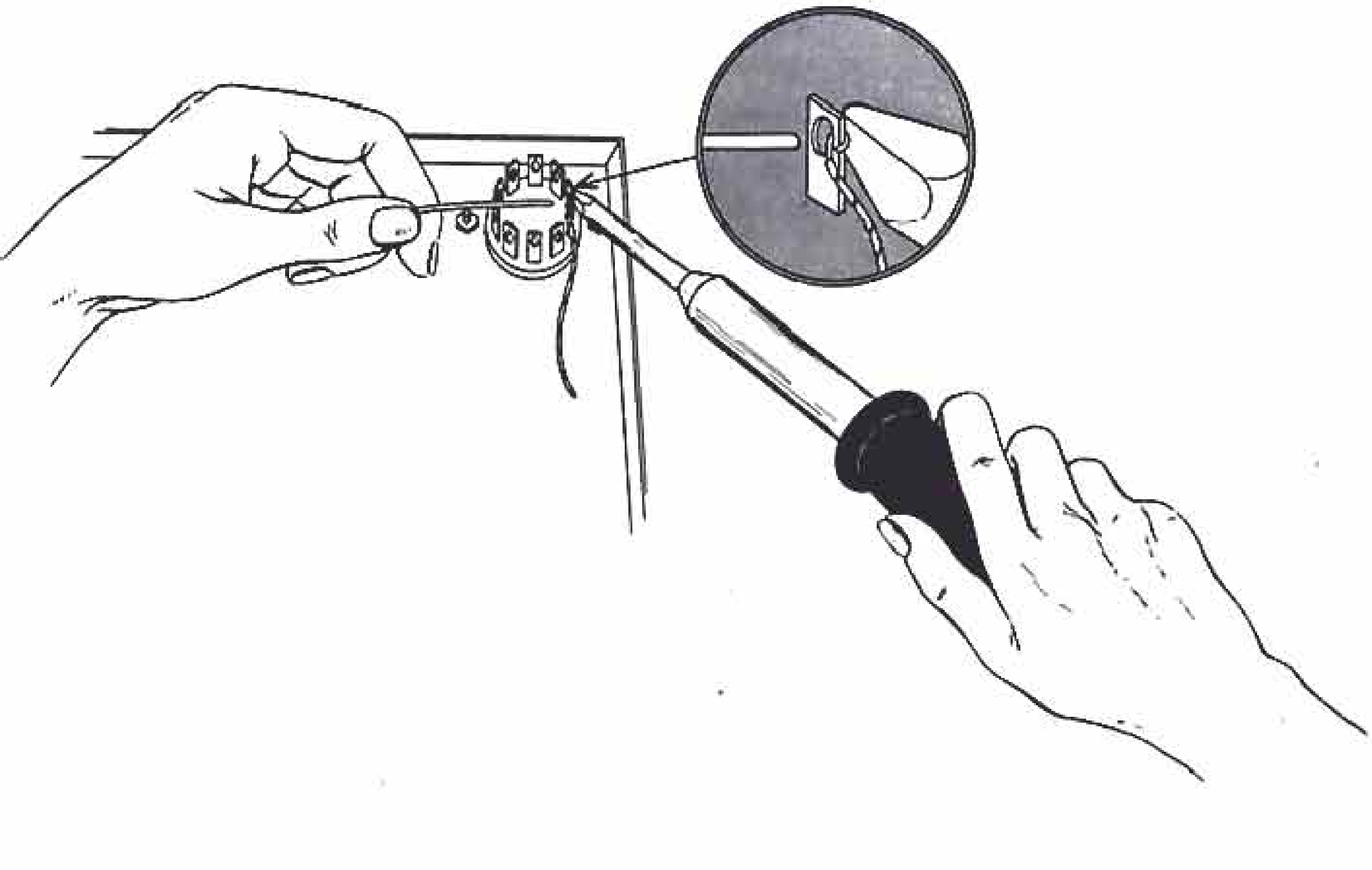
NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes or liquids. Such compounds, although not corrosive at room temperature, will form residues when heated. These residues are deposited on surrounding surfaces and attract moisture. 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

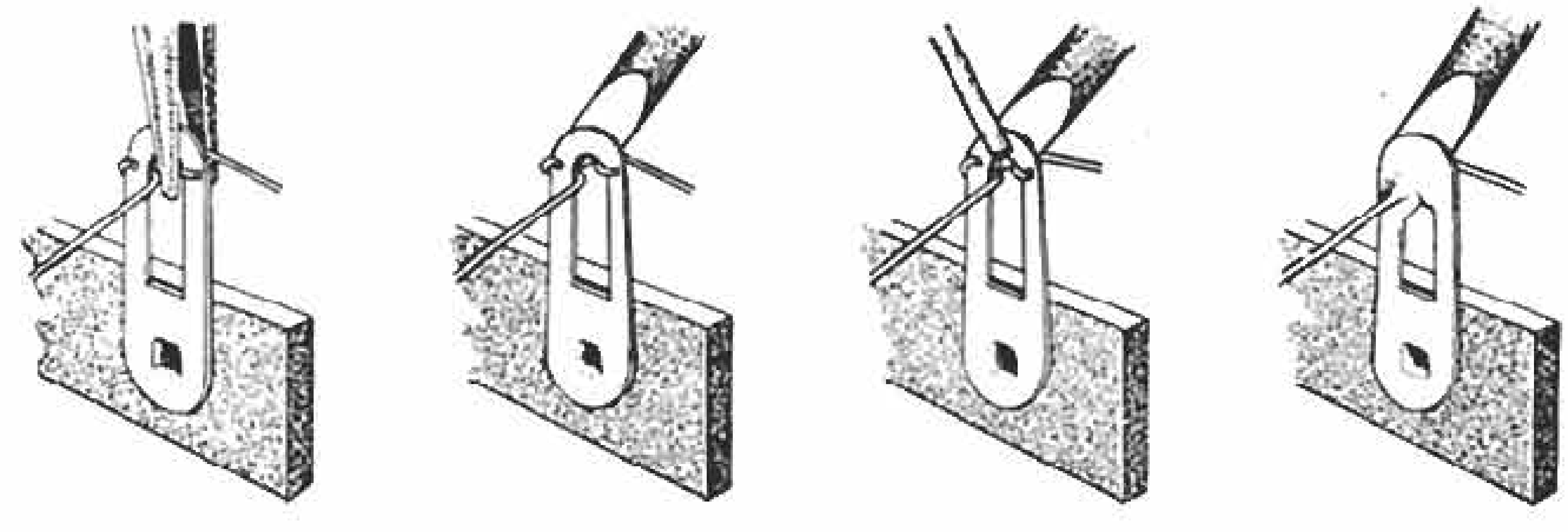
IN THE "STEP-BY-STEP" PROCEDURE the abbreviation "NS" indicates that the connection should not yet be soldered, for other wires will be added. At a later stage the letter "S" indicates that the connection must now be soldered. Note that a number appears after each solder (S) instruction. This number indicates the number of leads connected to the terminal in question. For example, if the instructions read, "Connect one lead of a 47 KΩ 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.

SPECIAL NOTE: Where a wire is passed through a tag to other parts of the circuit, this will be regarded as two connections (S-2).

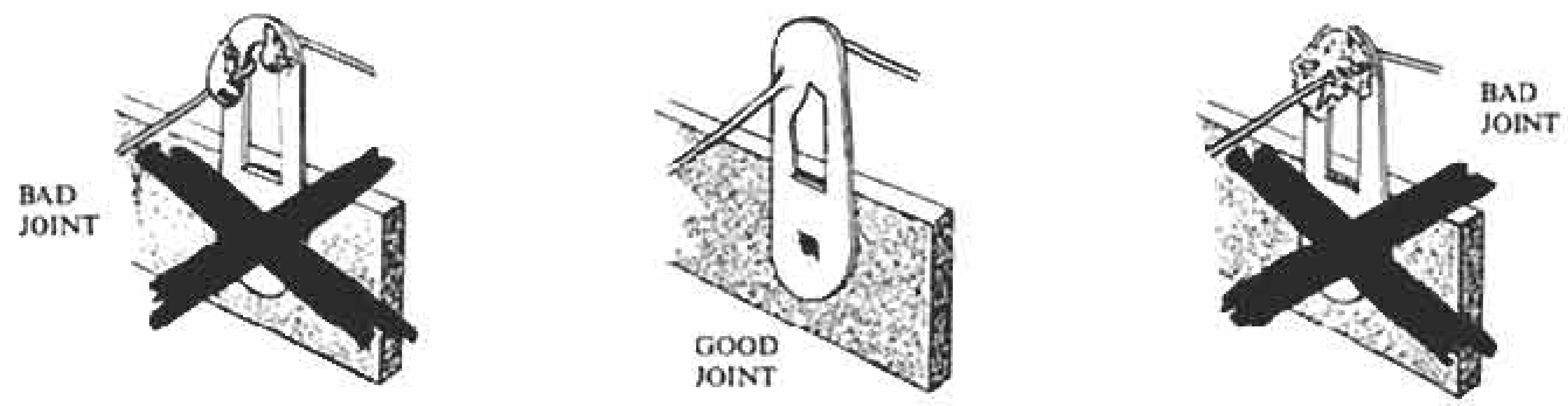
When two or more connections are made to the same solder tag a common mistake is to neglect to solder the connections on the bottom. Make sure all the wires are soldered.



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.



CRIMP WIRES | HEAT CONNECTION | APPLY SOLDER | ALLOW SOLDER TO FLOW



COLD SOLDER JOINT CONNECTION INSUFFICIENTLY HEATED | PROPER SOLDERED CONNECTION | COLD SOLDER JOINT CONNECTION MOVED WHILE COOLING

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. Do not 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. Do not 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 be means of a rag or steel wool.

Do not apply too much solder to the soldered joint. Do not 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.

Do not 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.

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

CAUTION: The controllable inductor, the variable capacitors and the crystal are quite delicate and should be handled with care. The variable capacitors should be kept fully meshed until construction is completed, to avoid bending the plates. The crystal can be damaged by a sharp blow of any kind, so it should be placed where it will not be disturbed or accidentally dropped. Many short leads come out of the controllable inductor unit which may be broken off if the unit is handled excessively. It is recommended that the unit be placed in a safe location until it is ready to be installed in the instrument.

The Heathkit HFW-1 Television Alignment Generator is a complex instrument containing several sub-assemblies. We very strongly urge that the step-by-step instructions be followed exactly, rather than wiring from the Pictorials and Circuit Diagram exclusively. Special instructions regarding the sequence of assembly and lead lengths are given to make construction of the kit as easy as possible. Wiring and mounting of parts in improper order may result in the necessity of re-doing work previously accomplished.

- If there is an amendment sheet to this manual, make sure that you have made the alterations at the appropriate places.

- Place the chassis upside down on the bench. Note that one apron of the chassis has five identical holes and angled edges. Place this side away from you. The chassis will then be orientated correctly with the bottom chassis diagram Figure 1.

NOTE: Included in the hardware are twelve 6BA x $\frac{1}{4}$" chrome binderhead screws. These are required for mounting the co-axial sockets to the front panel at a later stage.

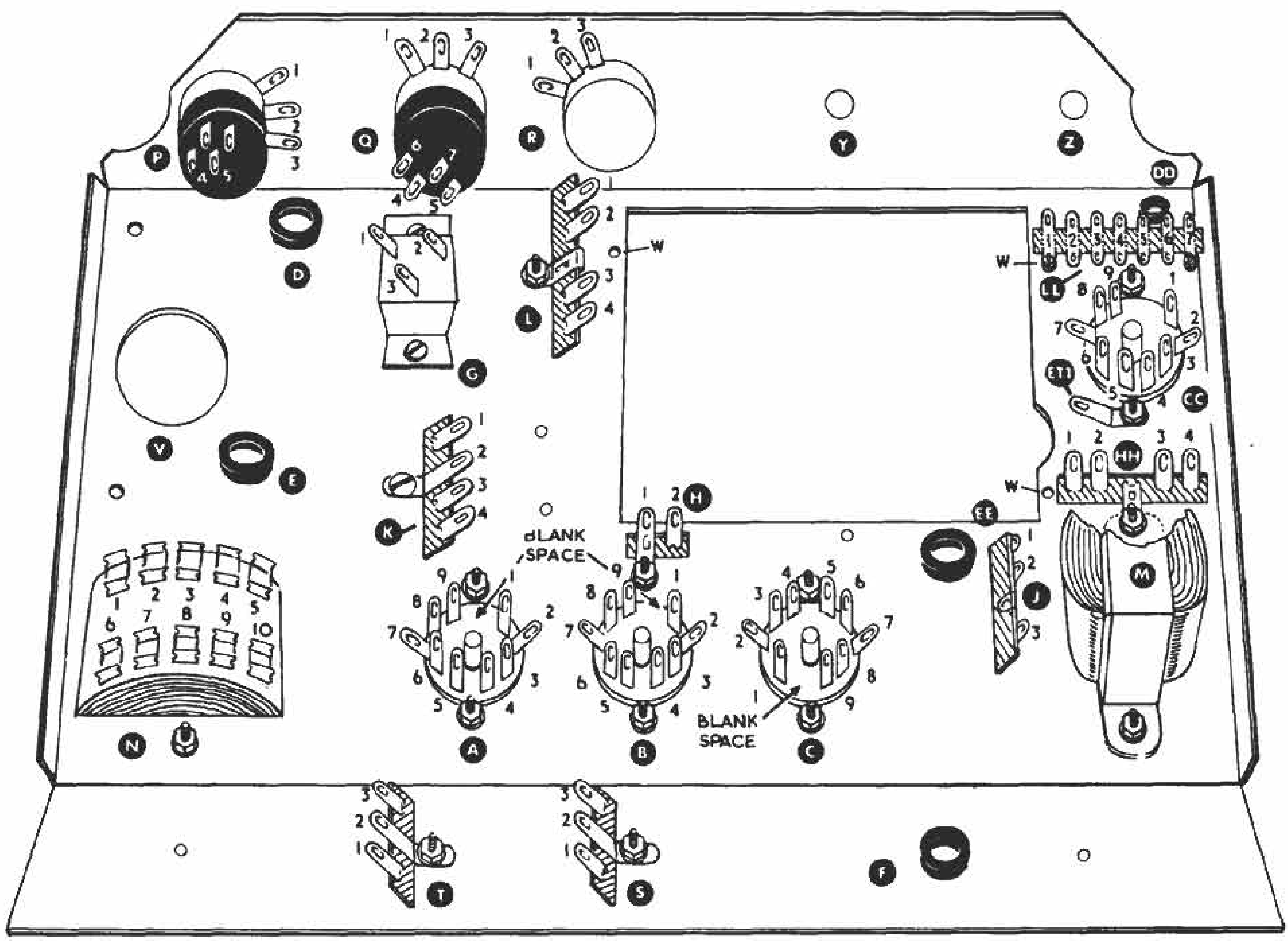


FIGURE — 1

( ) Refer to Figure 2 and note that the pins on the valveholder are numbered consecutively in a clockwise sequence when viewed from the bottom. Mount a 9-pin ceramic valveholder with blank space positioned as shown at location CC together with a 6BA solder tag at ET1. Secure with 6BA x ¼" screws, nuts and lockwasher.

( ) Mount a 9-pin ceramic valveholder with blank space positioned as shown at location A. Secure with 6BA x ¼" screws, nuts and lockwashers.

( ) Mount 9-pin ceramic valveholders with blank spaces positioned as shown at locations B and C together with a 2-way tagstrip at H. Secure using 6BA x ¼" screws, nuts and lockwashers.

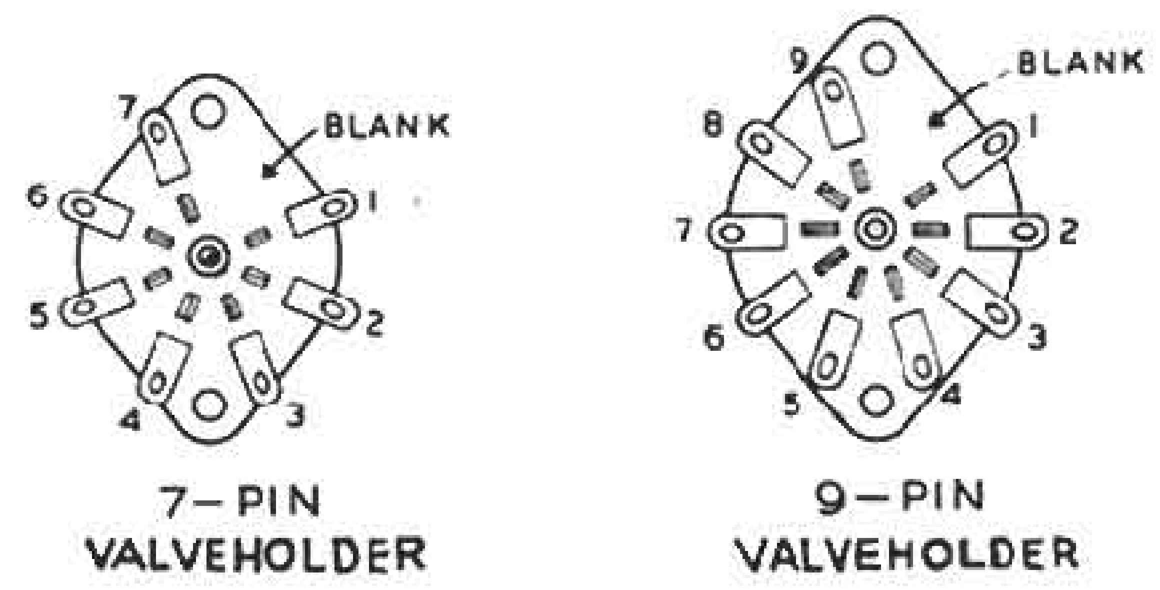


FIGURE-2

( ) Fit a 3/8" rubber grommet at E, EE, D and F.

( ) Fit a ¼" rubber grommet at DD.

( ) Mount the metal rectifier and temporarily secure at location G only, using a 4BA x ¼" screw, nut and lockwasher in the rear hole.

( ) Mount a 4-way (one earth) tagstrip at J and secure using a 4BA x ¼" screw, nut and lockwasher.

( ) Mount a 4-way (one earth) tagstrip at K and temporarily secure using a 4BA x 3/8" screw and nut with a lockwasher under the screwhead.

( ) Mount a 4-way (no earth) tagstrip at L and secure temporarily using a 4BA x ¼" screw, nut and lockwasher.

( ) Mount a 7-way (two earth) miniature tagstrip at LL using a 4BA x ¼" screw, nut and lockwasher at right-hand mounting lug only.

( ) Mount 3-way (one earth) tagstrips at T and S and secure using 4BA countersunk head screws, nuts and lockwashers.

( ) With leads toward centre of the chassis, install the 30H LF choke at M together with a 4-way (no earth) tagstrip at front fixing hole. Secure with 4BA x ¼" screws, nuts and lockwashers.

( ) Select the mains transformer and remove the nuts from the fixing screws. Locate at N with terminations as shown. Secure with 2BA nuts and bolts provided, fitting 2BA lockwashers under the nuts.

( ) Temporarily mount a 200Ω potentiometer with switch at location P. See Figure 3 for mounting details.

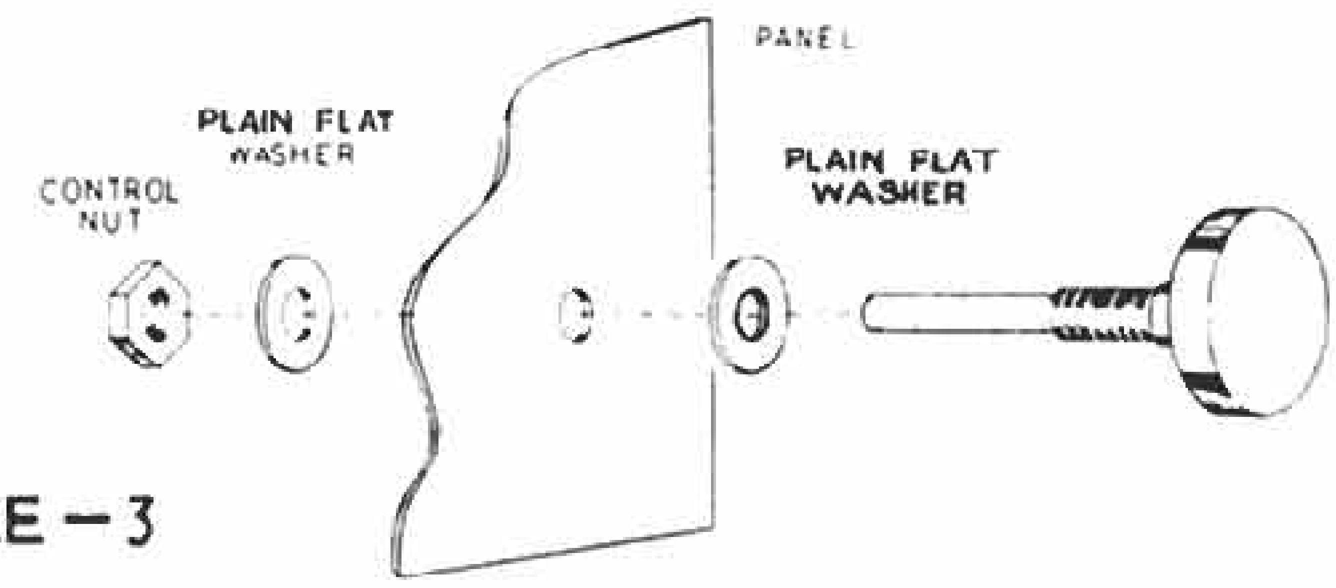


FIGURE - 3

HOW TO MOUNT CONTROLS TO FRONT PANEL

- In a similar manner, mount a 100 KΩ potentiometer with switch at Q.
- Instal a 10 KΩ potentiometer at R in a similar fashion.

The chassis is now ready for initial wiring.

PRELIMINARY WIRING OF THE HFW-1

The Pictorial on Page 13 is a pictorial representation of the completed main chassis wiring. All remaining connections will be made after the sub-chassis is wired and mounted. It is again suggested that you use the larger pictorials for reference as the work progresses. They are duplicates of the pictorials in the Manual.

Unless otherwise indicated, all wire used is insulated. Wherever there is a possibility of the bare leads on resistors and capacitors shorting to other parts or to the chassis, the leads should be covered with insulated sleeving. Bare wire is used where lead lengths are short and the possibility of short circuits non-existent.

Leads on resistors, capacitors and transformers are generally much longer than they need to be to make the indicated connections. In these cases, the excess leads should be cut off before the part is added to the chassis. In general, the leads should be just long enough to reach their terminating points. Not only does this make the wiring much neater, but in many instances the excessively long leads will actually interfere with proper operation of the equipment.

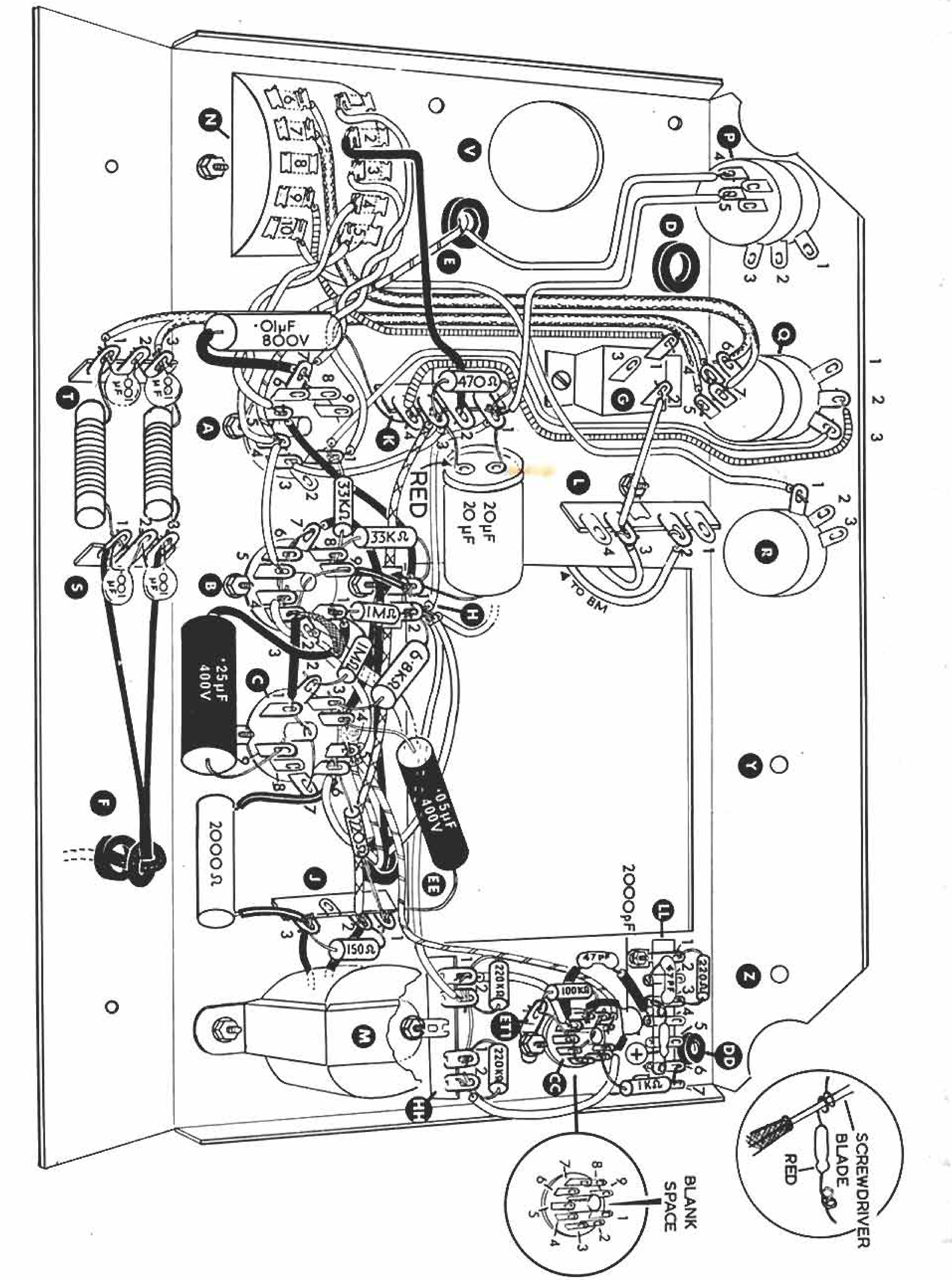
The Pictorials indicate actual chassis wiring, designate values of the component parts and show colour coding of leads where pertinent. We very strongly urge that the chassis layout, lead placement and earthing connections as shown, be followed exactly. While the arrangement shown is probably not the only satisfactory layout, it is the result of considerable experimentation and trial. The photographs on Page 6 should be of assistance.

Please note particularly that the marker and sweep oscillators make no connection to chassis except near the output terminals. The use of insulated earth return is common practice in high frequency equipment and is very important. Improper earthing will result in instability and high radiation leakage from the cabinet.

Unless otherwise stated use BLACK connecting wire. When making connections with insulated wire, strip ends $\frac{1}{4}$" long for connections to tagstrips and 3/16" long for connections to valveholder tags.

Refer to Pictorial 1 for the following steps:

- Connect a filter choke (a ceramic former wound with fine wire) from T1 (NS) to S1 (NS).
- Connect a similar choke from T3 (NS) to S3 (NS).
- Cut a 9" length of GREY twin mains lead. Separate the leads for approximately 1" long at each end. Connect one lead at one end to Q4 (S-1) and connect the other lead at the same end to Q5 (S-1).
- Route the lead along the chassis and connect one lead at the free end to T1 (NS) and connect the other lead to T3 (NS).
- Cut and prepare a similar $8\frac{1}{2}$" length of twin lead. Connect one lead at one end to Q6 (NS) and connect the other lead at the same end to Q7 (NS).
- Route the lead along the chassis and connect one lead at the free end to N6 (S-1) and connect the other lead to N7 (S-1).
- ( ) Select four .001 μF (1000 pF) disc ceramic capacitors. Connect them as follows:
  - First capacitor from S1 (NS) to S2 (NS).
  - Second capacitor from S2 (S-2) to S3 (NS).
  - ( ) Third capacitor from T1 (S-3) to T2 (NS).
  - ( ) Fourth capacitor from T2 (S-2) to T3 (S-3).
- Cut two $3\frac{1}{2}$" lengths of BROWN connecting wire and twist together. Connect either of the leads at one end to N4 (S-1) and the other lead at the same end to N5 (S-1). Route wire as shown and connect one lead at the free end to valveholder A tag 4 (NS). Connect the other lead at the same end to A5 (NS).
- Connect a $7\frac{3}{4}$" length of BROWN connecting wire at one end to A4 (NS). Route the wire along the chassis and pass the free end through grommet E to be connected later.
- Connect a 3" length of BROWN connecting wire from A4 (S-3) through B5 to B4 (NS). Now solder B5 only.
- ( ) Connect a $3\frac{1}{2}$" length of BROWN connecting wire from B4 (S-2) to C5 (NS).
- ( ) Connect a $5\frac{3}{4}$" length of BROWN connecting wire from C5 (NS) to CC9 (S-1).
- Cut a 6" length of BROWN connecting wire and connect one end to C5 (S-3). Pass the free end through grommet EE to be connected later.
- Connect one end of a $6\frac{1}{4}$" length of wire through B7 (S-2) to B6 (S-1). Route the other end through grommet EE to be connected later.
- Using sleeving, connect bare wire from N2 (S-1) to K2 (S-1).


·01μF 800V
470Ω
20μF 20μF
RED
33KΩ
33KΩ
1MΩ
1MΩ
6·8KΩ
·25μF 400V
·05μF 400V
2000Ω
150Ω
220Ω
2000pF
47pF
220KΩ
220KΩ
100KΩ
1KΩ
220Ω
TO BM
SCREWDRIVER BLADE
RED
BLANK SPACE

PICTORIAL — I

( ) Using sleeving, connect bare wire from A5 (S-2) to H1 (NS).

( ) Using sleeving, connect bare wire from H1 (NS) through B9 (S-2) and centre screen (S-2) to B3 (NS).

( ) Using sleeving, connect bare wire from B3 (NS) through C1 (S-2) and centre screen (S-2) to C7 (S-1).

( ) Using sleeving, connect bare wire from C4 (NS) to H1 (NS).

( ) Cut two $5\frac{1}{2}$" lengths of connecting wire, twist together except for 1" at each end. Connect one lead at one end to N1 (S-1) and the other lead at the same end to N3 (S-1). Route wire as shown and connect one lead at free end to A1 (NS) and the other lead at the same end to A7 (NS).

( ) Connect a $3\frac{1}{2}$" length of wire from A3 (S-1) to K3 (NS).

( ) Connect an 8" length of wire from K3 (NS) to J2 (NS).

( ) Connect a 5" length of wire from K1 (NS) to H2 (NS).

( ) Connect a 4" length of wire from K1 (NS) to P5 (S-1).

( ) Connect one end of a $7\frac{1}{4}$" length of wire to P4 (S-1). Route the other end through E to be connected later.

( ) Connect a 470Ω 1 watt resistor (YELLOW, VIOLET, BROWN) from K1 (NS) to K3 (NS).

( ) Select the 20 μF + 20 μF electrolytic capacitor. Connect the single lead at one end to H1 (NS). At the other end connect the lead (RED spot) to K3 (S-4) and the remaining lead to K1 (S-4).

( ) Using sleeving, connect a .01 μF 800V paper capacitor from K4 (NS) to A7 (S-2).

( ) Connect a 33 KΩ 1 watt resistor (ORANGE, ORANGE, ORANGE) from A1 (NS) to B8 (NS).

( ) Connect a 33 KΩ 1 watt resistor (ORANGE, ORANGE, ORANGE) from B8 (S-2) to H1 (S-5).

( ) Connect a 10" length of wire from A1 (S-3) to Q3 (S-1).

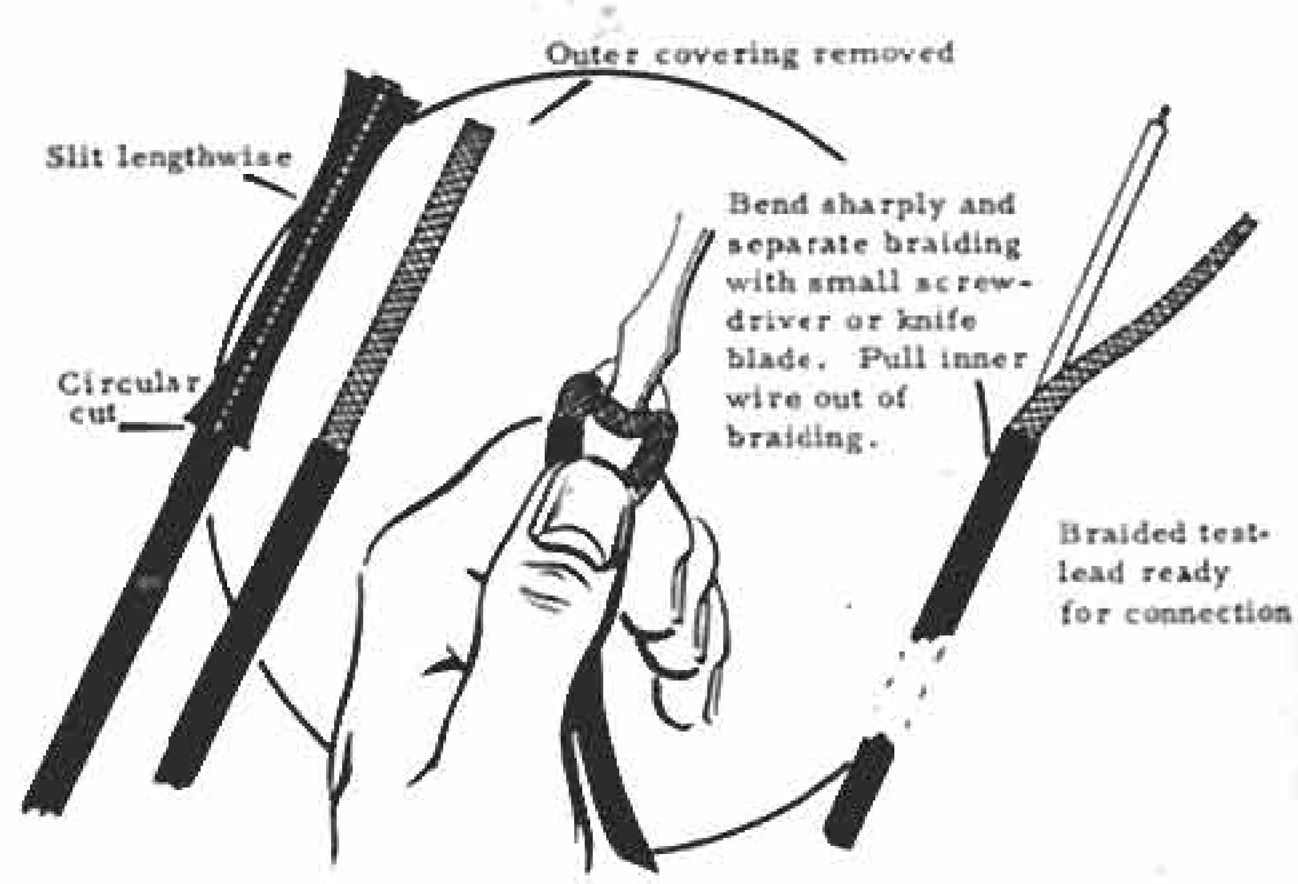
( ) Connect a 9" length of wire from K4 (S-2) to Q2 (NS).

( ) Connect a 6" length of wire from N9 (S-1) to G1 (-NEG) (NS).

( ) Connect a 2" length of wire from G2 (+POS) (S-1) to L3 (NS).

( ) Connect a 10" length of wire from N10 (S-1) to R1 (NS).

( ) Prepare an 8" length of co-axial cable as shown in Figure 4. Connect the inner conductor to B2 (S-1) and the outer braid to B3 (S-3). Leave the other end free to be connected later.



METHOD OF PREPARING BRAIDED LEAD

FIGURE - 4

( ) Connect a 1 megohm $\frac{1}{2}$ watt resistor (BROWN, BLACK, GREEN) from H2 (NS) to B1 (NS).

( ) Connect a 1 megohm $\frac{1}{2}$ watt resistor (BROWN, BLACK, GREEN) from B1 (NS) to C2 (S-1).

( ) Connect a 6.8 KΩ 2 watt resistor (BLUE, GREY, RED) from H2 (NS) to C3 (S-1).

( ) Using sleeving, connect a .25 μF 400V paper capacitor from B1 (S-3) to C9 (S-1).

( ) Connect a .05 μF 400V paper capacitor from C4 (S-2) to J1 (NS).

( ) Connect a 220Ω $\frac{1}{2}$ watt resistor (RED, RED, BROWN) from C6 (NS) to J1 (S-2).

( ) Using sleeving, connect a 2000Ω 8 watt resistor (value marked on body) from C6 (NS) to J3 (NS).

( ) Connect one end of a 5" length of wire to C6 (S-3) and pass the other end through grommet EE to be connected later.

( ) Connect a 150 KΩ ½ watt resistor (BROWN, GREEN, YELLOW) from J2 (NS) to J3 (NS). NOTE: Bend earth tag on strip toward valveholder C. This tag is not used.

( ) Cut the BLUE and RED leads from choke M to length and connect the BLUE lead to J2 (S-3) and the RED lead to J3 (S-3).

( ) Connect a 6" length of wire from H2 (NS) to HH2 (NS).

( ) Connect one end of a 6¼" length of wire to H2 (NS). Route the free end along chassis and pass through grommet EE to be connected later.

( ) Connect one end of a 7" length of wire to H2 (S-6). Route through the large aperture to be connected later.

( ) Connect a short bare wire link between HH2 (NS) and HH3 (NS).

( ) Connect a 220 KΩ ½ watt resistor (RED, RED, YELLOW) from HH1 (NS) to HH2 (S-3).

( ) Connect a 220 KΩ ½ watt resistor (RED, RED, YELLOW) from HH3 (S-2) to HH4 (NS).

( ) Connect a 2" length of wire from HH4 (S-2) to CC1 (NS).

( ) Connect a bare wire from CC8 (S-1) through centre screen (S-2) to CC4 (NS).

( ) Connect a bare wire from CC3 (S-1) through CC4 (S-3) and CC5 (S-2) to ET1 (NS).

( ) Connect a 100 KΩ ½ watt resistor (BROWN, BLACK, YELLOW) from CC7 (NS) to ET1 (S-2).

( ) Using ½" of sleeving, connect a 2000 pF (.002 μF) disc ceramic capacitor from CC1 (S-2) to CC7 (S-2).

( ) Connect a short wire from HH1 (S-2) to CC6 (NS).

( ) Using ¾" of sleeving on each lead, connect a 47 pF tubular ceramic capacitor from LL4 lower tag (S-1) to CC6 (S-2).

( ) Connect a similar 47 pF capacitor from LL2 lower tag (S-1) to LL3 lower tag (NS).

( ) Form leads on the diode as shown in the inset on Pictorial 1 and using a heat shunt, connect the (+) RED end to LL6 lower tag (S-1) and the other end to LL3 lower tag (S-2).

( ) Connect a 1 KΩ ½ watt resistor (BROWN, BLACK, RED) to LL6 upper tag (NS) to CC2 (S-1).

( ) Connect a 220Ω ½ watt resistor (RED, RED, BROWN) from upper tag LL1 (S-1) to upper tag LL3 (S-1).

ASSEMBLY OF THE MARKER OSCILLATOR

Wiring of the main chassis is now complete. The marker and sweep oscillator circuits will be wired next. It is extremely important that all resistors, capacitors, chokes and wires be mounted so that the leads are just long enough to reach their terminating points. Excessive lead length will contribute to difficulty in calibration and stability.

( ) Place an insulated panel so that the large hole is to the right as shown in Figure 5. The edge with the three small irregularly spaced holes should be nearest you. Make sure the panel is properly orientated as it will be impossible to complete the assembly of the instrument if the parts are improperly mounted on the board.

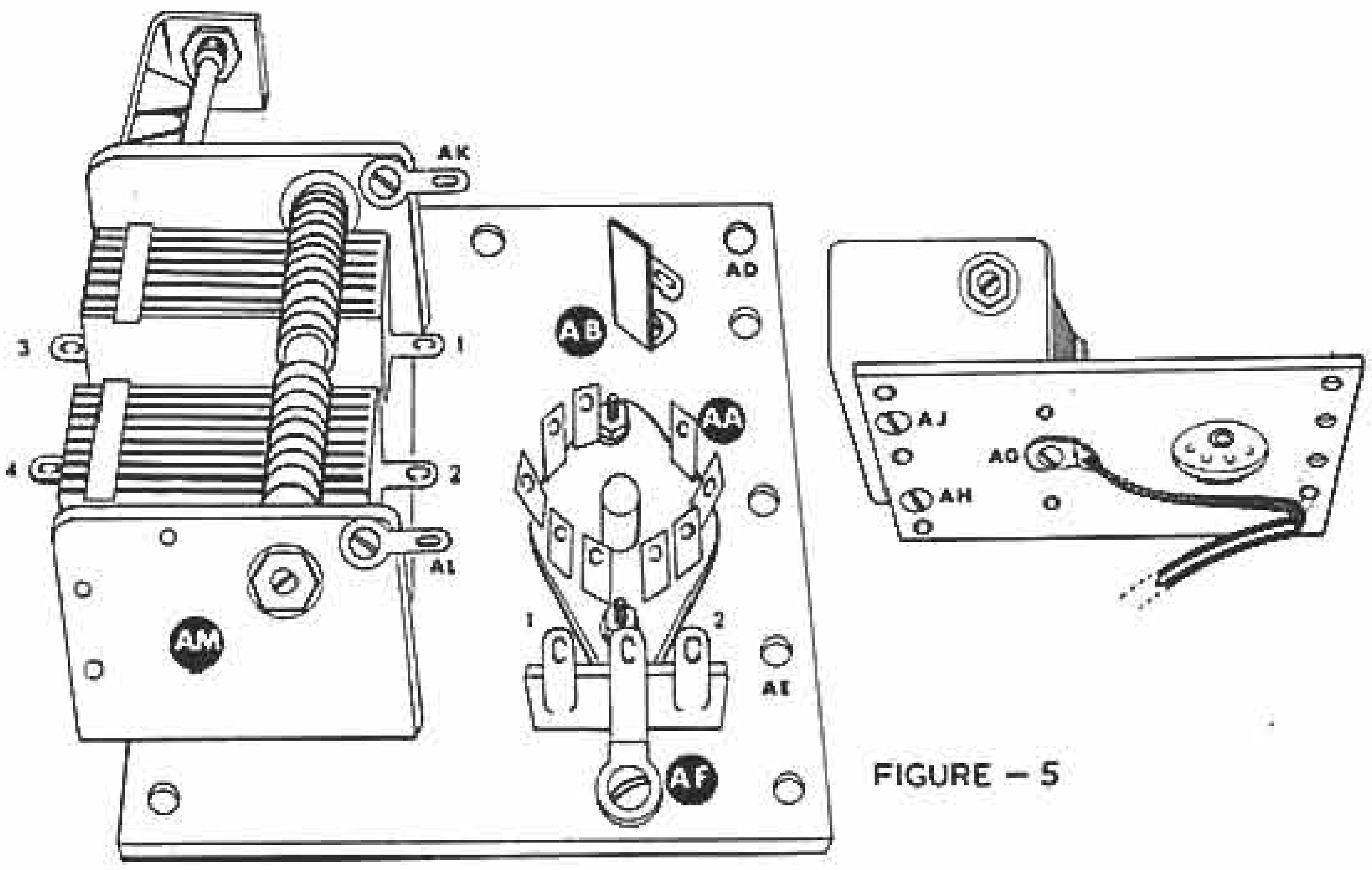


FIGURE – 5

( ) Mount a 9-pin paxolin valveholder at hole AA with the blank space between pins 1 and 9 toward hole AB. Use 6BA x 5/16" screws and nuts only.

( ) Mount an offset 1-way tagstrip at location AB using a 4BA x 3/8" screw, nut and lockwasher.

( ) Instal a 3-way miniature tagstrip at location AF using a 4BA x 3/8" screw, nut and lockwasher.

( ) Mount a 130+130 pF twin-gang variable capacitor with 4BA x $\frac{1}{4}$" screws through holes AG, AH and AJ. Use lockwashers under the screwheads at AH and AJ and a 4BA solder tag under AG. The solder tag should point towards hole AD. Keep the capacitor plates fully meshed to avoid possible damage to unit.

( ) Instal a 4BA solder tag on the variable capacitor frame at AK. Secure with a 4BA x 1/8" cheesehead screw with a lockwasher under the head of the screw.

( ) In a similar manner, instal a 4BA solder tag on the variable capacitor frame at AL. Use a 4BA x 1/8" cheesehead screw.

( ) Cut off the wire braid attached to this variable capacitor frame between the two stators. NOTE: DO NOT cut off the braid on the other variable capacitor.

WIRING THE MARKER OSCILLATOR

Refer to Pictorial 2 for the following steps:

( ) Connect a short piece of bare wire from AA4 (NS) to AA5 (S-1).

( ) Using $\frac{3}{4}$" sleeving, run a bare wire from AA3 (NS) to AA8 (NS).

( ) Connect a bare wire from AA9 (NS) to solder tag AK (NS).

( ) Cut the leads of a 22 KΩ resistor (RED, RED, ORANGE) to a length sufficient to reach and connect the resistor from AA7 (NS) to AA9 (NS).

( ) Prepare a 47 pF tubular ceramic capacitor and instal it from AA7 (S-2) to variable capacitor AM tag 1 (S-1).

( ) Trim the leads of a 150Ω resistor (BROWN, GREEN, BROWN) and connect it from socket AA8 (S-2) to solder tag AK (S-2).

( ) Prepare a 100 KΩ resistor (BROWN, BLACK, YELLOW) as before and instal it from socket AA2 (NS) to AA8 (S-3).

( ) Using sleeving, connect a 100 pF tubular ceramic capacitor from AA3 (S-2) to tagstrip AB (NS).

( ) Connect a 100 KΩ resistor (BROWN, BLACK, YELLOW) from AF2 (NS) to AA6 (NS).

( ) Connect a bare wire from AM2 (S-1) to AA6 (S-2).

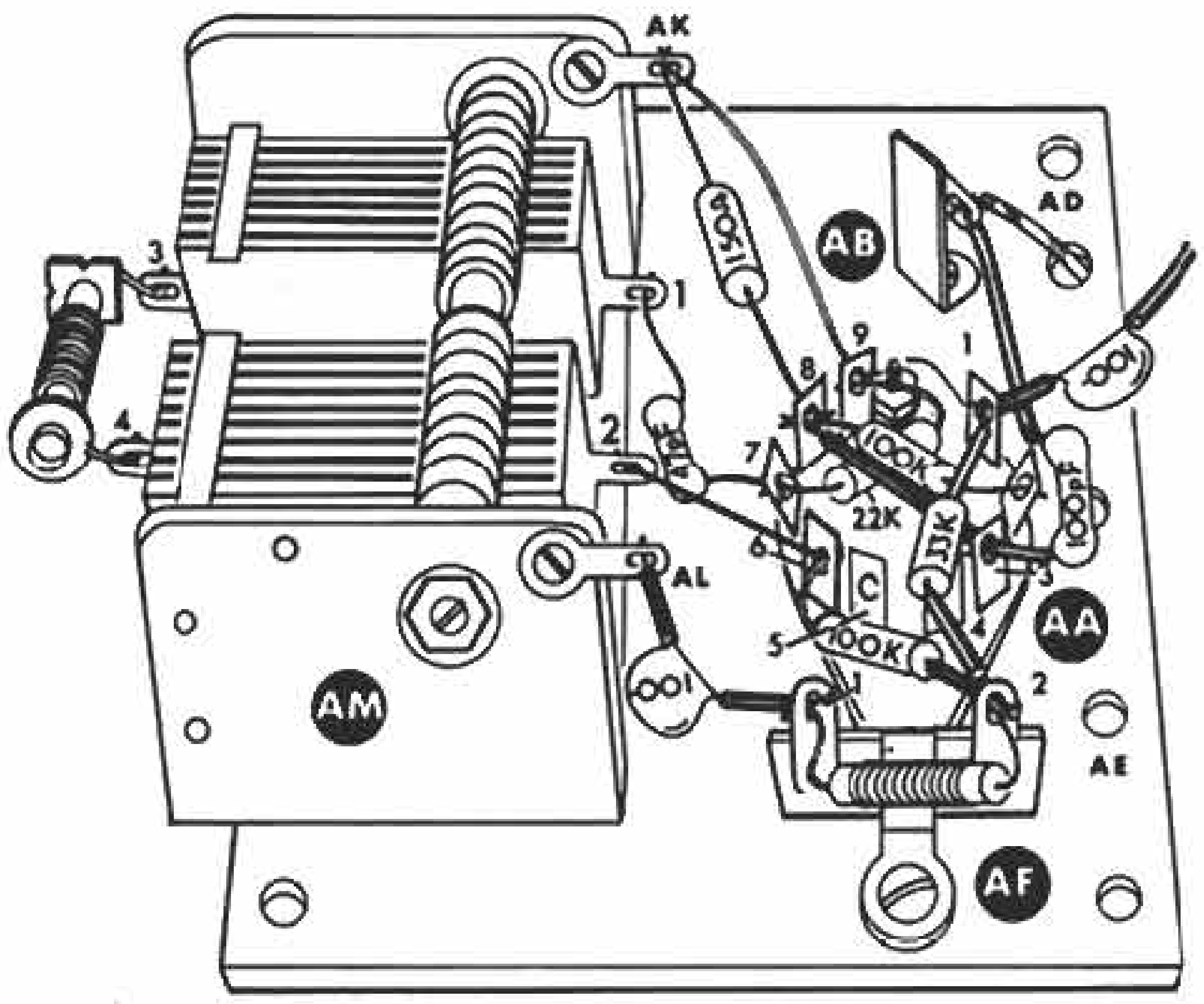
( ) Using sleeving, connect one end of a .001 μF (1000 pF) disc ceramic capacitor to socket AA1 (NS). Do not cut off any wire on this component as the other end must reach the panel when installed. Leave the other end free to be connected later.

( ) Using sleeving, connect a 33 KΩ resistor (ORANGE, ORANGE, ORANGE) from tagstrip AF2 (NS) to AA1 (S-2).

( ) Instal a filter choke (a ceramic former wound with fine wire) from tagstrip AF1 (NS) to AF2 (S-3). NOTE: The centre (earth) tag of AF2 is not used and may be cut off.

( ) Using a $\frac{1}{4}$" of sleeving on each lead, connect a .001 μF (1000 pF) capacitor from tagstrip AF1 (NS) to solder tag AL (S-1).

( ) Identify the marker oscillator coil and hold the coil tags underneath the variable capacitor stator tags AM3 and AM4. Heat a stator tag with the soldering iron until the solder flows smoothly over the connection. Allow to cool and repeat the operation at the opposite end of the coil. Make sure the coil is mounted as shown in the Pictorial.



PICTORIAL — 2

( ) Cut a piece of co-axial cable to a length of $6\frac{1}{4}$" and cut away $1\frac{1}{2}$" of outside insulation as shown in Figure 4. Prepare as illustrated, pulling the centre conductor through a hole made in the braid close to the end of the insulation.

( ) At the opposite end of the cable, cut away 1.1/8" of outside insulation and prepare as before.

( ) Place the long exposed inner wire through hole AD from the bottom, pulling the wire up until the end of the shielded portion of the wire rests against the bottom of the chassis. Strip and tin the inner wire and connect it to AB (S-2). Make sure the braid points toward solder tag AG underneath.

( ) Connect the braid to solder tag AG (S-1) beneath the chassis as shown in Figure 5.

This completes the wiring of the marker oscillator. Set it aside temporarily.

ASSEMBLY OF THE SWEEP OSCILLATOR

Refer to Figure 6 for the following steps:

( ) Orientate the insulated panel so that the valveholder hole is at the left with the three small irregularly spaced holes nearest you. Check with Figure 6.

( ) Mount a 9-pin paxolin valveholder at location BA with the blank space between pins 1 and 9 toward hole BC. Use 6BA x 5/16" screws and nuts.

( ) Instal a 3-way miniature tagstrip as shown in location BB using a 4BA x 3/8" screw, nut and lockwasher.

( ) Instal a 3-way miniature tagstrip at location BC using a 4BA x 3/8" screw, nut and lockwasher.

( ) Instal the switch mounting bracket using 4BA x 3/8" screws, nuts and lockwashers through holes BG and BH. Ensure that the lip of the bracket is placed under the board.

( ) Instal the 130+130 pF twin-gang variable capacitor securing it with a 4BA x $\frac{1}{4}$" screw through hole BD. Use a lockwasher under the screwhead. Do not place screws through BE and BF yet.

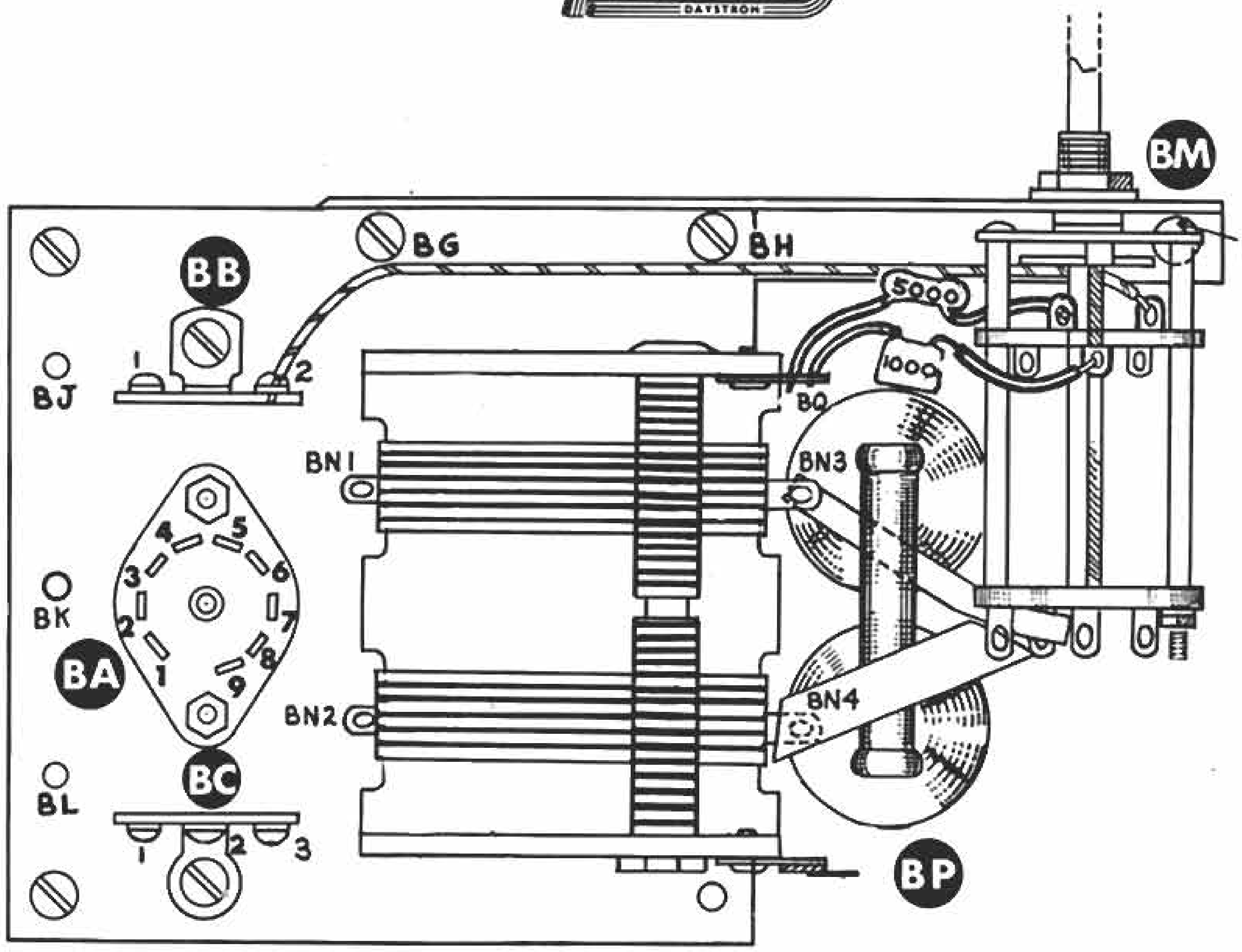


FIGURE – 6

Instal a 4BA solder tag on variable capacitor frame at BQ using a 4BA x 1/8" cheesehead screw with a lockwasher under the head of the screw.

The front section of the 4-position range switch should be wired before the switch is mounted. Refer to Figure 7 and note that tag 6 is the first long clip to the right of the switch wafer mounting post looking at the switch from the rear. Connect a 2200Ω resistor (RED, RED, RED) between switch tag 6 (S-1) and tag 8 (NS).

Cut one lead of a .005 μF (5000 pF) tubular ceramic capacitor to a length of ¾" and, using sleeving, connect this end to tag 8 (S-2). Leave the other end free.

Instal a 5.6 megohm resistor (GREEN, BLUE, GREEN) from tag 11 (NS) to tag 12 (NS). These tags are on the front side of the front wafer.

Cut a wire to a length of 5¼". Strip both ends and connect one end to tag 11 (S-2). Leave the other end free.

Connect a 22 megohm resistor (RED, RED, BLUE) from tag 12 (NS) to tag 13 (S-1).

Using sleeving, connect one lead of a 1000 pF silver mica capacitor to tag 12 (S-3). Leave the other end free.

Instal a 220 KΩ resistor (RED, RED, YELLOW) from tag 14 (S-1) to tag 7 (NS). Place the insulated body of the resistor against the wafer mounting post as shown.

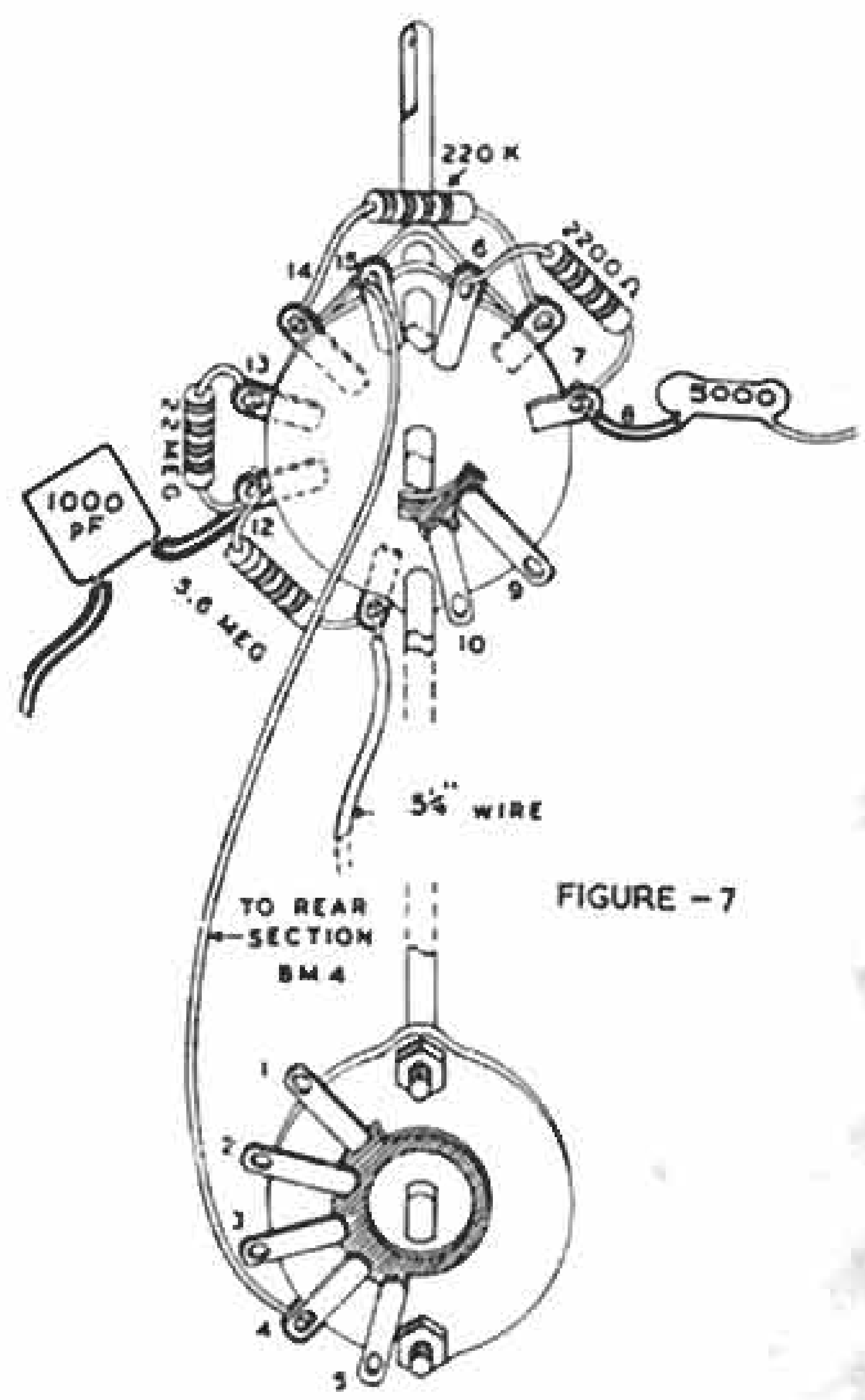


FIGURE – 7

REAR VIEW OF SWITCH BM

( ) Connect a bare wire from switch tag 15 (S-1) across to the rear wafer tag 4 (NS).

( ) Temporarily place a 4BA x 3/8" screw and lockwasher through bracket hole BR which is beneath the switch mounting hole BM.

( ) Mount the 4-position range switch through hole BM in the bracket with a 3/8" lockwasher between the switch and the bracket. Secure using a 3/8" flat washer and 3/8" nut. Orientate the switch with tag 1 pointing toward the variable capacitor as in Figure 8. Leave the switch loosely mounted and place the wire and two capacitors connected to the front section of the switch toward the variable capacitor and the switch bracket. Ensure that switch tags 11 and 12 are clear of the bracket.

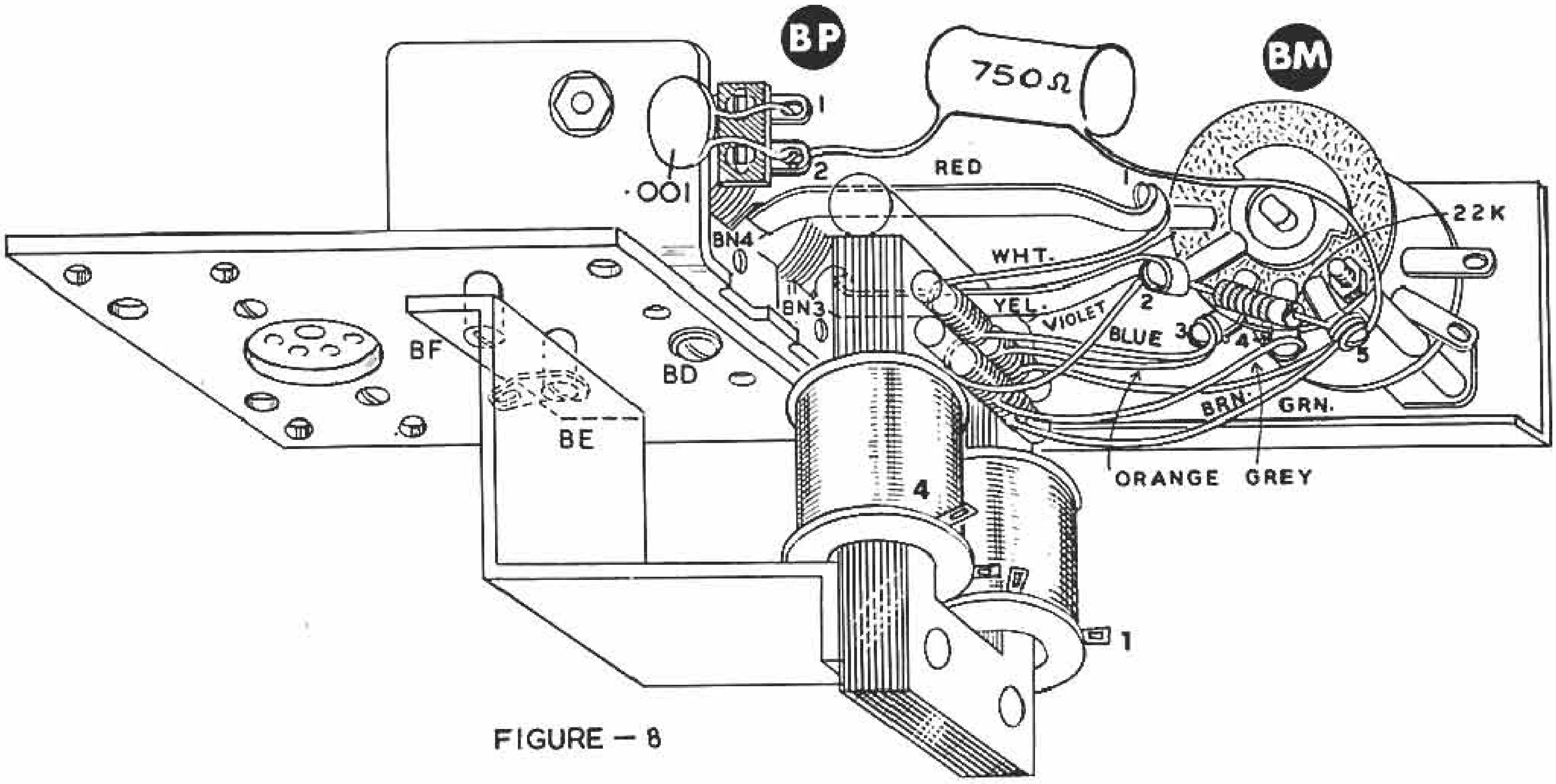


FIGURE — 8

( ) Tin the tuning capacitor stator tags BN3 and BN4.

NOTE: The controllable inductor is quite fragile and should be handled with care. Do not handle the coil leads any more than necessary to connect them to the switch. Daystrom Limited do not guarantee parts that have been damaged due to neglect or abuse. We strongly urge that the unit be checked carefully with an ohmmeter before it is installed as it is extremely difficult to remove the unit once it is wired into the instrument. All coils except the high band straps should show continuity. It may be necessary to scrape the terminations in order to check continuity of the primary coils. Low resistance continuity or high resistance will be encountered frequently but will not affect the performance. Do not bend or exert excessive force on coil tags 1, 2, 3 and 4 when handling or wiring in the unit. Any abuse of these tags may open the primary windings, making it inoperative.

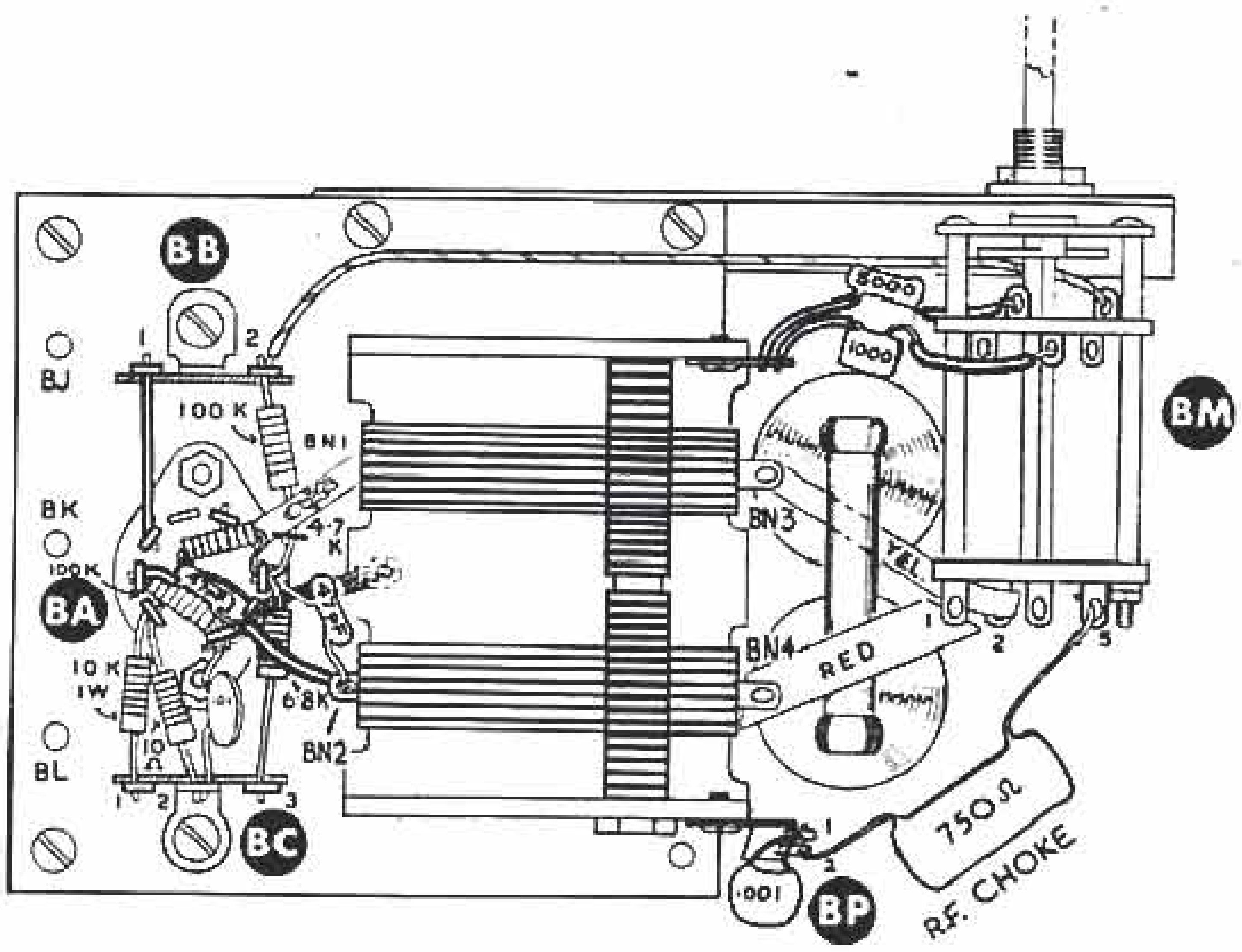
( ) Instal the controllable inductor, checking Figures 6 and 8. The ends of the RED and YELLOW high frequency flat straps that are close together should fit between tags 1 and 2 on switch BM. The opposite ends of the straps should be over stator tags BN3 and BN4 on the variable capacitor. When everything is properly lined up, secure the unit in place with 4BA x 3/8" screws through the inductor mounting bracket and holes BE and BF using 7/32" x 4BA spacers between the inductor and the board as shown in Figure 8. These same screws hold the variable capacitor. Use a lockwasher under the head of screw BF and a 4BA solder tag under the head of screw BE. The solder tag should be toward hole BJ.

( ) Tighten the nut holding the range switch BM to the bracket.

( ) Mount a 2-way (one earth) tagstrip on the variable capacitor at location BP. It will be necessary to straighten the mounting foot before fitting. Use a 4BA x 1/8" cheesehead screw with a lockwasher under the head.

WIRING OF THE SWEEP OSCILLATOR

Lead dress of wires and components is even more critical in the sweep oscillator than in the marker oscillator due to the wider range of frequencies covered. Extreme care should be exercised to keep all leads as short as possible. Painstaking work will be rewarded with reliable performance.



PICTORIAL—3

- To begin wiring, bend tags 1 to 5 on range switch BM until they point back at 45° to the wafer. Connect a WHITE coded wire to the top left tag BM1 (NS) on the range switch. See Pictorial 3 and Figure 8.
- Wrap the RED coded strap end nearest the range switch around switch tag BM1 (S-2). Make sure solder flows smoothly over the entire connection.
- Connect a 22 KΩ resistor (RED, RED, ORANGE) from tag BM2 (NS) to tag BM5 (NS). The resistor leads should be straight back from the contacts so that it will be possible to wrap the YELLOW coded strap around BM2 without interference. Keep leads short.
- Using 1" sleeving, connect the VIOLET lead from the bottom coil to switch BM2 (NS).
- Wrap the nearby end of the YELLOW high frequency strap around switch BM2 (S-3). Make sure that the connection is secure.
- Connect the BLUE lead of the middle coil to switch BM3 (NS).
- Connect the ORANGE lead of the ~~middle~~ Bottom coil to switch BM3 (S-2). Do not confuse with the BROWN lead.
- Connect the GREY lead of the bottom coil to BM4 (S-2).
- Using 1¼" sleeving, connect the BROWN lead of the middle coil to switch BM5 (NS).
- Connect the GREEN lead of the bottom coil to switch BM5 (NS).
- Instal an RF choke (the 750Ω 10 watt tubular resistor with a ferrite core cemented through the centre) from tagstrip BP2 (NS) to range switch BM5 (S-4). Check all wires to the switch to be sure that no short circuits exist. Re-dress the leads slightly if necessary.
- Mount a .001 μF (1000 pF) disc ceramic capacitor between tagstrip BP2 (NS) and earth tag BP1 (S-1).
- Place the end of the RED strap on the adjacent capacitor stator tag BN4 (S-1).
- In the same manner, connect the YELLOW strap to capacitor stator tag BN3 (S-1).

Refer to Pictorial 3 and, using sleeving, connect a short piece of bare wire from valveholder BA5 (S-1) to BA9 (NS) (use lower holes).

Locate the wire braid, one end attached to the variable capacitor frame between the two stators near valveholder BA7. Dress the free end along BA8 (NS) to BA9 (NS). The flat edge should rest against these pins near the valveholder, exposing the top holes. Keep these connections short and cut off surplus braid.

Connect a 100 KΩ resistor (BROWN, BLACK, YELLOW) from valveholder BA2 (NS) across the valveholder to BA9 (NS). Keep the leads as short as possible (use upper holes).

Mount a .01 µF (10,000 pF) disc ceramic capacitor from tagstrip BC2 (NS) to BA9 (S-4). When soldering BA9, make sure that the braid is securely connected.

Connect a 4700Ω resistor (YELLOW, VIOLET, RED) from BA7 (NS) to BA8 (S-2). Again make sure that BA8 and the braid is securely bonded together (use lower holes).

Instal a 100 KΩ resistor (BROWN, BLACK, YELLOW) from BA7 (NS) to tagstrip BB2 (NS). Dress clear from capacitor frame.

Connect a 6800Ω resistor (BLUE, GREY, RED) from BA7 (NS) (use upper hole) to tagstrip BC3 (NS).

Connect a 47 pF tubular ceramic capacitor from BA7 (upper hole) (S-4) to capacitor stator tag BN2 (NS).

Connect the free end of the wire attached to range switch BM11 to tagstrip BB2 (NS). Dress the wire along the sub-chassis and switch bracket.

Using 1" sleeving, connect the free end of the .005 µF capacitor, connected to switch BM8, to solder tag BQ (NS) on the variable capacitor frame.

Using ½" sleeving, connect the free end of the 1000 pF silver mica capacitor attached to switch BM12 to solder tag BQ (S-2).

Connect a short length of bare wire from capacitor stator tag BN1 (S-1) to BA6 (S-1).

Using ½" sleeving, connect a 47 pF tubular ceramic capacitor from capacitor stator tag BN2 (S-2) to valveholder BA2 (S-2).

Place a 10 KΩ 1 watt resistor (BROWN, BLACK, ORANGE) from BA1 (upper hole) (NS) to tagstrip BC1 (NS).

Connect a 10Ω resistor (BROWN, BLACK, BLACK) from BA1 (upper hole) (S-2) to BC tag 2 (S-2).

Connect a bare wire from BA3 (S-1) to tagstrip BB1 (NS).

This completes the wiring of the sweep oscillator chassis.

ASSEMBLY OF SUB-CHASSIS TO MAIN CHASSIS

Refer to Figure 9 and Pictorial 5 for the following steps:

Select the sweep oscillator sub-chassis, the support bracket and three 1.1/16" tapped pillars.

Refer to Figure 9 and, using 4BA x 3/8" screws and lockwashers, mount the pillars at the points indicated.

Mount the support bracket at BS using a 4BA x 3/8" screw, nut and lockwasher.

Locate the sub-assembly over the large aperture and secure to main chassis using 4BA x 3/8" screws, nut and lockwashers.

Select the marker oscillator sub-chassis and four 1.1/16" tapped pillars.

Refer to Pictorial 5 and, using 4BA x 3/8" screws with lockwashers under the screwheads and a 1-way offset tagstrip at AC, mount the pillars to the board. NOTE: To gain access to the screw located under the variable capacitor spindle, remove and replace the small pressure clip.

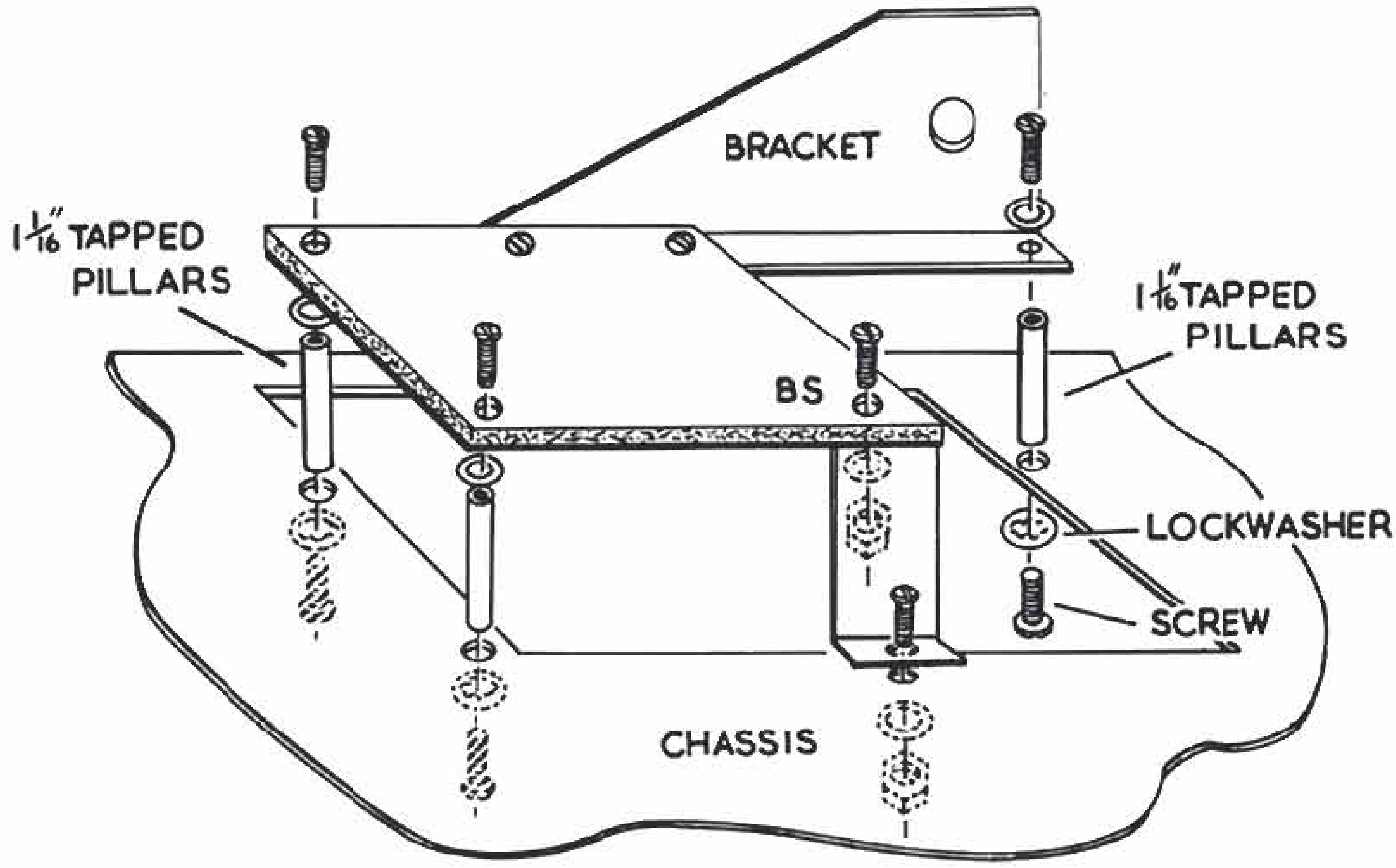


FIGURE — 9

- Temporarily remove the screw and nut securing tagstrip K.

- Position the sub-assembly over the corresponding holes in the main chassis and secure with 4BA x 3/8" screws and lockwashers. NOTE: One screw will secure tagstrip K and another will secure the rectifier G through the front hole.

WIRING OF CHASSIS ASSEMBLY

Refer to Pictorials 1 and 5 for the following steps:

- Run the BLACK wire, from control switch P4 coming through grommet E, up through hole AE in the marker chassis and connect it to tagstrip AF1 (S-3).

- Run the BROWN wire appearing through grommet E (from valveholder A4) up through hole AE and connect it to valveholder AA4 (S-2).

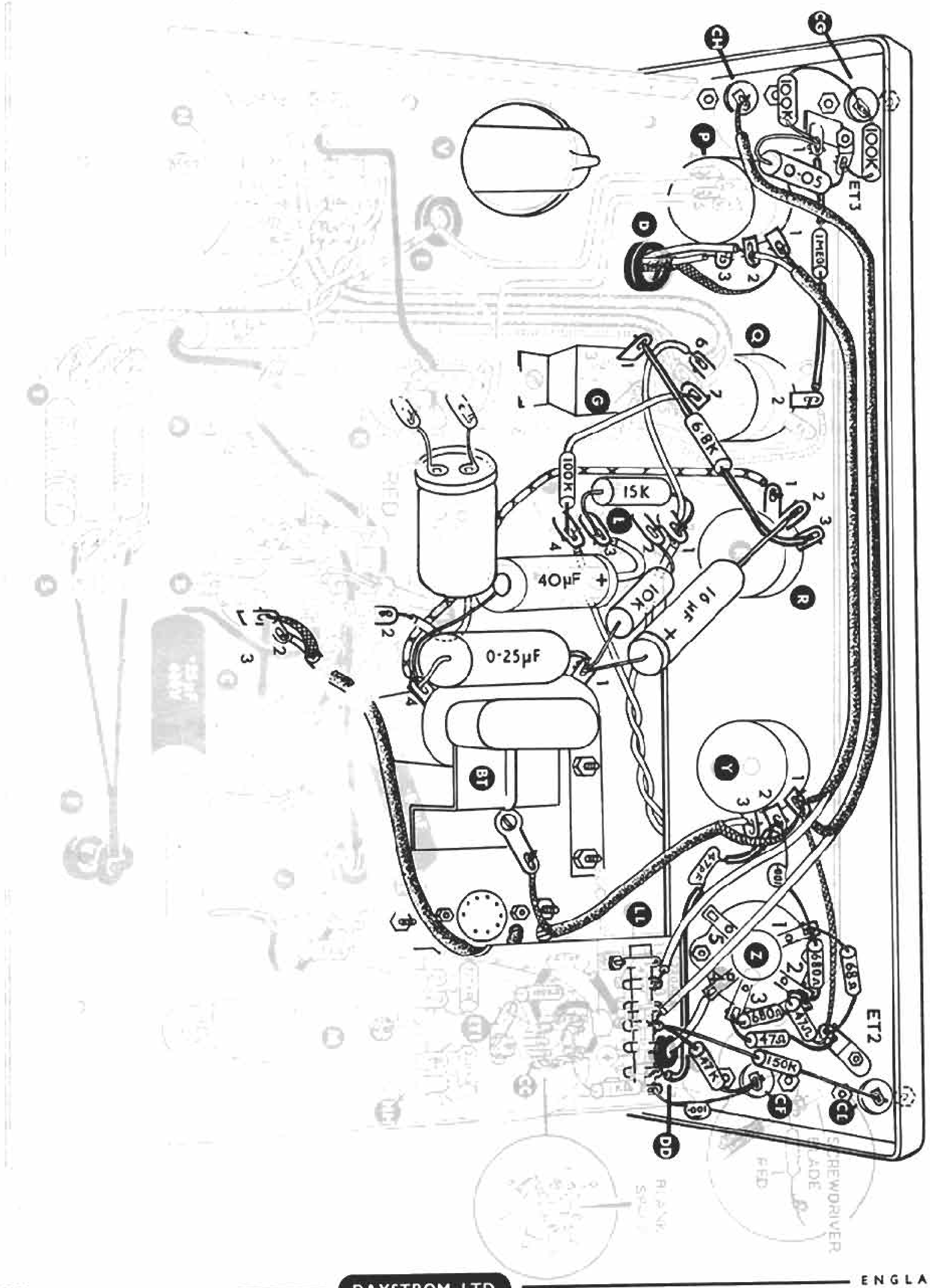
- On the sweep oscillator chassis, run the BROWN wire from grommet EE up through hole BL and connect it to BA4 (S-2). Curve the wire around so it will clear the valve when installed.

- Connect the wire, from valveholder C6 appearing through grommet EE, to tagstrip BP2 (S-3) near the range switch.

- Identify the wire previously connected to valveholder B6 and routed through grommet EE and connect to tagstrip BC3 (S-2).

- Identify the wire previously connected to tagstrip H2, routed through grommet EE, and connect to tagstrip BC1 (S-2).

- Connect the other lead from tagstrip H2 to range switch front wafer tag BM7 (S-2). Dress the wire along the chassis cut-out edge and up to the switch tag. A 220 KΩ resistor (RED, RED, YELLOW) is already connected to BM7.


CH
CG
100K
100K
0·05
ET3
P
D
1MEG
Q
G
6·8K
100K
15K
40µF
10K
16 µF
R
0·25µF
BT
Y
Z
ET2
47Ω
680Ω
150K
DD

PICTORIAL — 4

( ) Place the inner wire of the co-axial cable connected to valveholder B2 up through hole BK and connect to tag-strip BB2 (S-3). Dress the lead so it will clear the valve when installed. NOTE: The centre (earth) tag of BB is not used and may be cut off.

( ) Connect a $4\frac{1}{2}$" length of wire from tagstrip L2 (NS) to range switch BM10 (S-1).

( ) Connect a $4\frac{1}{2}$" length of wire from tagstrip L3 (NS) to range switch BM9 (S-1).

( ) Refer to Pictorial 4 and connect a 15 KΩ 1 watt resistor (BROWN, GREEN, ORANGE) from tagstrip L2 (NS) to L3 (NS).

NOTE: Some controllable inductors will have two primary tags while others will have four. These units are electrically identical and the performance will be the same regardless of the type used. If the two-tag type is supplied, disregard the following step and number the tags 1 and 4, the number 1 tag being nearest to the front of the chassis. The described jumper connection is made internally. DO NOT bend or exert excessive force on tags BT1, BT2, BT3 and BT4 when connecting wires or soldering. A heavy strain will break the wire inside the primary coil.

( ) Connect a bare wire link from controllable inductor BT2 (S-1) to BT3 (S-1).

( ) Instal a .25 μF 400 volt paper capacitor from inductor BT1 (NS) to BT4 (NS).

( ) Mount a 40 μF 150 volt electrolytic capacitor with the (+) end connected to tagstrip L3 (S-4) and the other end connected to inductor BT4 (NS).

( ) Connect a $6\frac{1}{4}$" length of wire from potentiometer R1 (S-2) to inductor BT4 (S-3).

( ) Connect a 10 KΩ 2 watt resistor (BROWN, BLACK, ORANGE) from tagstrip L2 (S-3) to inductor BT1 (NS).

( ) Instal a 16 μF 150 volt electrolytic capacitor from potentiometer R2 (S-1) to inductor BT1 (S-3). The positive (+) end must be connected to BT1.

( ) Using $1\frac{1}{4}$" sleeving on each lead, connect a 6.8 KΩ 1 watt resistor (BLUE, GREY, RED) from G1 (S-2) to R3 (S-1).

ASSEMBLY OF FRONT PANEL

Refer to Pictorials 4 and 5 for the following steps:

( ) Assemble the crystal holder to the crystal bracket using the special 6BA x $\frac{1}{2}$" nylon screw and a 6BA nut only. Do not overtighten.

( ) Mount the sub-assembly to the front panel at CB using 6BA x $\frac{1}{4}$" chrome instrument head screws, nuts and lock-washers.

( ) Remove the nuts and flat washers from the potentiometers P, Q and R, previously mounted to the main chassis.

( ) Locate the front panel to the main chassis and replace the washers and nuts on the potentiometers, but do not finally tighten.

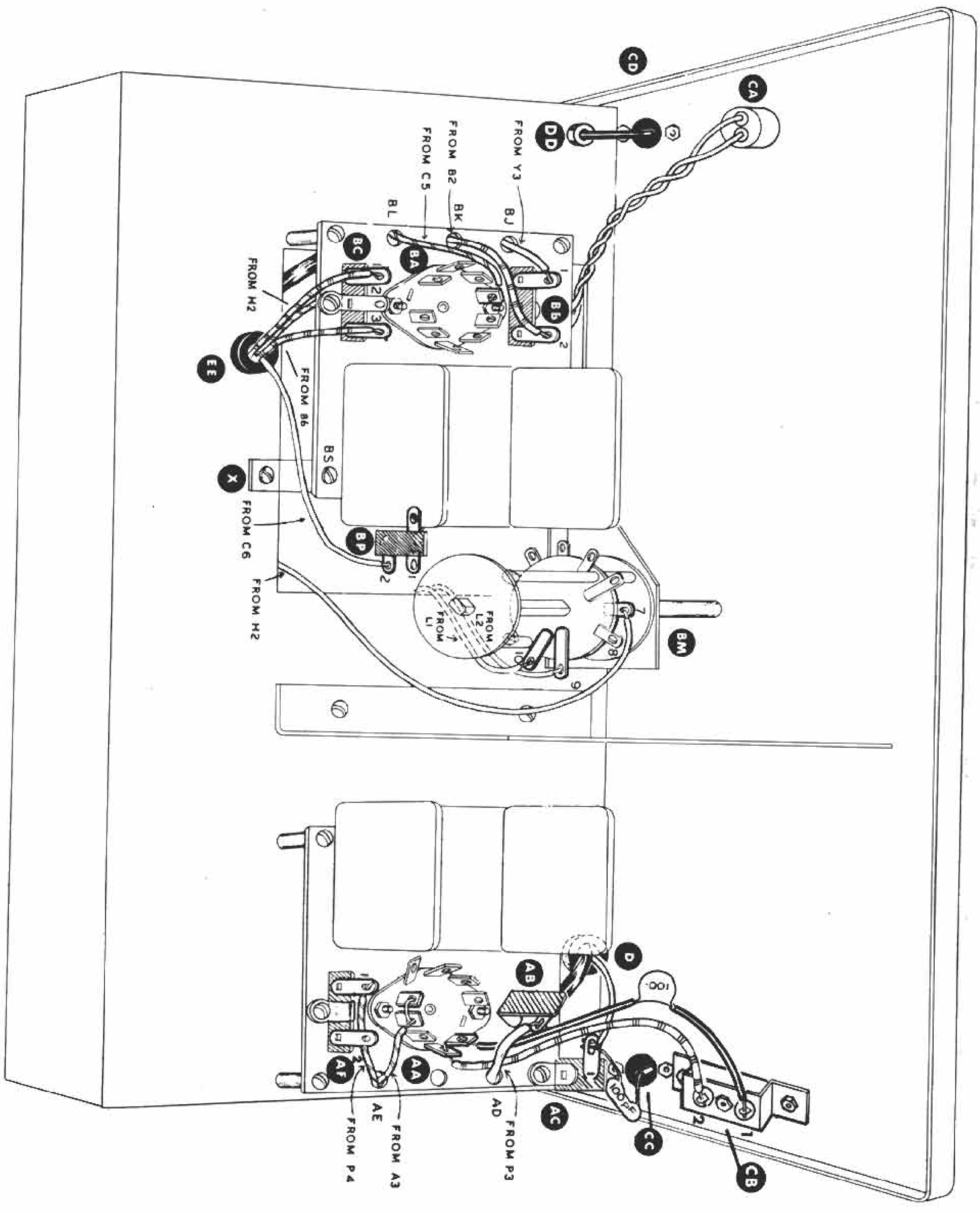
( ) Temporarily instal a 200Ω potentiometer at location Y using flat washers (see Figure 3).

( ) In a similar manner, instal the 3-position attenuator switch at Z. Position the switch as shown in Pictorial 4 with the switch clamp screws vertical. Now tighten nuts on the five controls.

( ) Unscrew the front of the neon indicator, mount at CA and pass the leads down toward tagstrip L located on underside of chassis.

( ) Mount four co-axial sockets at locations CC, CD, CF and CH using 6BA x $\frac{1}{4}$" chrome screws, nuts and lock-washers.

( ) Mount a co-axial socket at CE with a 6BA solder tag ET2 as shown using 6BA x $\frac{1}{4}$" chrome screws, nuts and lockwashers.


CA
CB
CC
CD
DD
D
BA
BB
BC
BJ
BK
BL
BM
BP
BS
EE
X
AA
AB
AC
AD
AE
AF
FROM Y3
FROM B2
FROM C5
FROM H2
FROM B6
FROM C6
FROM H2
FROM L2
FROM L1
FROM P3
FROM A3
FROM P4
.001
100PF

PICTORIAL – 5

( ) Mount a co-axial socket at CG with a 6BA solder tag ET3 between the panel and a 1-way offset tagstrip CJ using 6BA x ¼" chrome screws, nuts and lockwashers.

( ) Set both variable capacitors to the fully meshed position. Instal a cursor with the boss toward the panel on each shaft, positioned to read at the low frequency ends of the scales. Allow 1/16" clearance between the cursors and the front panel and then temporarily tighten the grub screws. Check that an equal amount of clearance exists around the cursor boss and the holes in the front panel. It may be necessary to slacken the nuts securing the controls to achieve this condition. After adjustment, finally tighten the nuts.

( ) Remove the screw securing tagstrip L to chassis. Place the large L shaped screen in position on the chassis and secure with 4BA x ¼" screws, nuts and lockwashers.

FINAL WIRING

Refer to Pictorials 4 and 5 for the following steps:

( ) Connect a 3½" length of wire between Q6 (S-2) and L1 (NS).

( ) Using sleeving, connect a 100 KΩ resistor (BROWN, BLACK, YELLOW) from Q7 (S-2) to L4 (NS).

( ) Connect the leads from the neon indicator CA to L1 (S-2) and L4 (S-2).

( ) Connect a 100 KΩ resistor (BROWN, BLACK, YELLOW) from ET3 (NS) to CG (NS).

( ) Connect a .05 μF 250V paper capacitor from ET3 (S-2) to CJ (NS).

( ) Connect a 100 KΩ resistor (BROWN, BLACK, YELLOW) from CJ (NS) to CG (S-2).

( ) Using sleeving, connect a 1 megohm resistor (BROWN, BLACK, GREEN) from CJ (S-3) to Q2 (S-2).

( ) Prepare and connect a 680Ω resistor (BLUE, GREY, BROWN) from attenuator switch Z1 (NS) to Z2 (NS).

( ) Connect a similar 680Ω resistor (BLUE, GREY, BROWN) from Z2 (NS) to Z3 (NS).

( ) Prepare and connect a 68Ω resistor (BLUE, GREY, BLACK) from Z1 (NS) to ET2 (NS).

( ) Connect a 47Ω resistor (YELLOW, VIOLET, BLACK) from Z2 (S-3) to ET2 (NS).

( ) Connect a similar 47Ω resistor (YELLOW, VIOLET, BLACK) from Z3 (S-2) to ET2 (NS).

( ) Cut the leads to 1" and connect a .001 μF (1000 pF) disc ceramic capacitor from Z1 (S-3) to Y2 (NS).

( ) Using 1½" sleeving on both leads, connect a 47 pF tubular ceramic capacitor between Y2 (S-2) and LL6 (upper tag) (S-2).

( ) Connect a 2½" length of wire from CD (S-1) through grommet DD to Z4 (S-1).

NOTE: Tag Z5 on attenuator switch is not used.

( ) Cut both leads of a .001 μF (1000 pF) disc ceramic capacitor to ¾" and connect from CF (NS) to LL7 (S-1).

( ) Connect a 47 KΩ resistor (YELLOW, VIOLET, ORANGE) from CF (S-2) to LL4 (upper tag) (NS).

( ) Using 1" sleeving on both leads, connect a 150 KΩ resistor (BROWN, GREEN, YELLOW) from CE (S-1) to LL4 (upper tag) (NS).

( ) Connect a 4" length of wire between ET2 (S-4) and Y1 (NS).

( ) Cut a piece of co-axial cable 5¾" long. Remove 1.5/8" of outside insulation at one end, refer to Figure 4 and pull the centre conductor through the braid. At the other end, cut away 1" of outer insulation and pull inner conductor through the braid.

( ) Place the 1.5/8" long exposed inner conductor up through hole BJ in the sweep sub-chassis until the braid is level with the surface of the board. Cut the inner conductor to length, strip the end $\frac{1}{4}$" and connect to BB1 (S-2).

( ) Refer to Figure 8 and connect the braid at this end to solder tag BE (S-1).

( ) At the other end, connect the inner conductor to Y3 (S-1).

( ) Connect the braid at this end to Y1 (NS).

( ) Cut two pieces of co-axial cable, one to 13" long and one to 10" long.

( ) At one end of each cable, remove the outer insulation for a length of 3". Pull the centre conductor through the braid.

( ) At the other end of the 13" length, carefully remove both outer insulation and braiding for 1" long. Strip inner conductor $\frac{1}{4}$" and connect to CG (S-1). Route the cable as shown in Pictorial 4 and connect braiding at the other end to Y1 (NS). Connect inner conductor to LL4 (upper tag) (S-3).

( ) At the unprepared end of the 10" cable, remove $1\frac{1}{2}$" of outer insulation. Pull the inner conductor through the braid. Strip inner conductor at this end and connect to P2 (NS). Connect the braid to P1 (NS).

( ) Route the cable as shown in Pictorial 4 and connect the braid to Y1 (S-4). Connect the inner conductor to LL2 (upper tag) (S-1).

( ) Pass the free end of the co-axial lead (previously connected to tagstrip AB of marker sub-chassis) up through grommet D. Connect the inner wire to P3 (S-1) and the braid to P1 (S-2).

( ) Connect a $4\frac{1}{2}$" length of wire from P2 (S-2) up through grommet D to tagstrip AC (NS).

( ) Connect a 100 pF tubular ceramic capacitor from tagstrip AC (S-2) to CC (S-1).

( ) Using 1" of sleeving, connect the .001 μF (1000 pF) disc ceramic capacitor previously connected to valveholder AA1 to crystal socket CB1 (S-1).

( ) Connect a $2\frac{1}{2}$" length of wire from CB2 (S-1) to AA2 (S-2).

( ) Select the twin mains leaa ana separate the lead for a distance of $2\frac{1}{2}$", pass the lead through grommet F and tie a knot approximately 5" from the end. Strip both leads $\frac{1}{4}$" and connect one wire to S1 (S-3) and the other wire to S3 (S-3).

This completes the wiring of your Heathkit model HFW-1 Television Alignment Generator. Carefully recheck each operation for accuracy. Remove any solder splashes, wire clippings or other foreign material. Inspect the wiring to be sure all components and wires are dressed to avoid shorts to each other or to chassis. Once sure that everything is correct, the group of wires running from back to front of the chassis, past the metal rectifier, may be cabled together with string or insulating tape if desired. Doing this will reinforce the wiring and improve the appearance of the unit.

( ) Fit the two large plain BLACK knobs to the MARKER and OSCILLATOR control shafts and tighten the grub screws.

( ) Turn all other control shafts to a maximum anti-clockwise position.

( ) Fit six small pointer knobs to these controls with the pointer set to the furthest anti-clockwise marks and tighten the grub screws.

( ) Carefully insert valves into their respective sockets:-

12AX7 (ECC83)	at B
6CL6	at C
6BQ7A	at BA
12AT7 (ECC81)	at AA
12AX7 (ECC83)	at CC

Do not fit the EZ81 rectifier at A at this time.

(✓) Instal the handle on the instrument cabinet using the nuts provided.

(✓) Mount the rubber feet in the bottom of the cabinet by pushing the small end through the hole in the cabinet and rotating until they lock in place.

PREPARATION OF LEADS

(✓) Divide and cut the remaining co-axial cable into six equal lengths (approximately 3 ft. each).

(✓) On one cable, fit a co-axial plug at each end as shown in Figure 10.

(✓) Fit a co-axial plug at one end only of the remaining five cables.

(✓) Refer to Figure 4 and remove 3" of outer insulation from the other ends of the five cables and pull inner conductor through the braid.

( ) Fit crocodile clips at this end of three of the cables.

( ) Fit BLACK plugs to the braid of the remaining two cables and RED plugs to the inner conductors.

The cables will normally be used in the following manner:-

1. Co-ax to Co-ax - RF OUT to TV aerial socket.
2. Co-ax to clips - INPUT 1 from video detector or test points.
3. Co-ax to clips - INPUT 2 from sound detector or test points.
4. Co-ax to clips - RF OUT to TV IF input test point.
5. Co-ax to plugs - HOR. out to scope HOR input.
6. Co-ax to plugs - VERT out to scope VERT input.

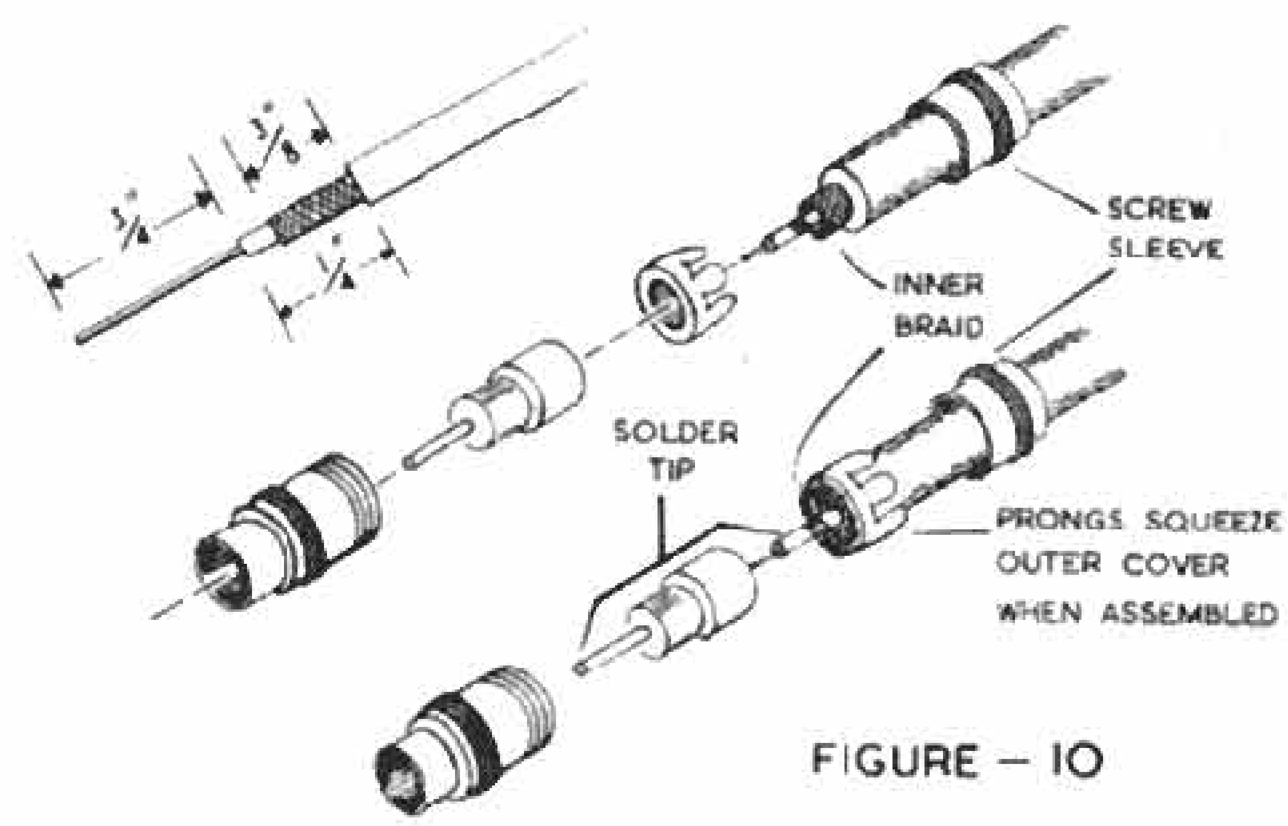


FIGURE – 10

TESTING THE COMPLETED INSTRUMENT

If an ohmmeter is available, check the d.c. resistance between pin 3 of EZ81 valveholder A and earth. The resistance should be at least 20,000 ohms after one minute. If however, a lower resistance is measured, then carefully recheck wiring for an error. Give special attention to the connections around the EZ81 valveholder, the filter capacitor, tagstrips H and BP and 6CL6 valveholder C.

Insert the voltage selector plug in the top of the transformer in the correct tap to suit your mains supply voltage. This plug incorporates a 0.5A fuse.
Make sure that the mains switch is off by rotating the HOR. PHASE control to its full anti-clockwise position. Connect the mains cable to a 105-250 volt 50/60 cycle a.c. outlet. DO NOT CONNECT THIS INSTRUMENT TO A D.C. (DIRECT CURRENT) LINE. SERIOUS DAMAGE TO THE POWER TRANSFORMER WILL RESULT. Do not attempt to use this instrument on a 25 cycle a.c. source as it will not operate and the transformer may be damaged.

Turn the instrument on by rotating the HOR. PHASE control clockwise until a click is heard. The heaters of all valves should light. Now switch off and insert the EZ81 rectifier valve in its valveholder. Switch on again and the heaters should light. Observe the metal elements in the valve to make sure that they remain dark coloured. A red glow from the plates of the rectifier indicates the existence of a short circuit somewhere in the HT+ circuit. Switch off immediately and refer to the section IN CASE OF DIFFICULTY.

ALIGNMENT OF THE INSTRUMENT

Calibration of the marker generator is easily accomplished as an accurate calibration reference is furnished with the kit. Connect the output lead to the EXT. MARKER socket on the front panel. The opposite end of this cable should be connected to the RF probe of a signal tracer or the demodulator probe of an oscilloscope. If neither of these is available, any amplifier or oscilloscope can be used with a crystal diode in series with the input lead. Plug 5.0 Mc/s (5000 kc/s) crystal into XTAL socket. NOTE: The MARKER oscillator coil has been preset and very little adjustment will be required. Turn the instrument on and rotate MARKER AMP. control fully clockwise. Set the indicator to 20.0 Mc/s (the fourth harmonic of the crystal) and using the hexagon trimmer, adjust the marker oscillator coil core until a beat note or squeal is heard, or a fuzzy trace appears on the oscilloscope with the 'scope gain at maximum if an oscilloscope is used. Next, set the dial to 25 Mc/s (the fifth harmonic). A beat note should again be evident. The next check points should be at 35 Mc/s and 40 Mc/s. If the beat notes occur at frequencies other than those indicated, slip the pointer slightly on the shaft and again adjust the marker coil core. This effectively trims and pads the oscillator to get it to track with the dial markings. It may be necessary to repeat this operation several times to obtain the desired degree of accuracy. If the error should become worse, slip the indicator on the shaft in the opposite direction a small amount at a time until the marker tracks properly. If it is impossible to obtain satisfactory tracking, there is a chance that the oscillator is beating against the wrong harmonic of the crystal. To correct this condition, set the indicator to 20 Mc/s once again. Adjust the oscillator coil core until a beat is heard that is a different one than originally obtained. Then, repeat the operations described above. Once the beats occur at the proper places, the oscillator is correctly calibrated. In general, the core will be fairly well into the coil when proper calibration is obtained.

In some rare instances, it may be difficult or impossible to properly calibrate the marker oscillator due to a shift of variable capacitor calibration, which may have been caused by handling in transit. Usually the errors will be rather minor, but then they can be cleared up entirely by making a very simple adjustment of the variable capacitor itself.

If it is impossible to obtain good tracking over the entire marker range, it would be advisable to set the dial to 55 Mc/s and adjust the core slightly until the beat note is evident. The dial should then be rotated to 60 to make sure that the right beat is being used. Once sure that the correct frequency has been obtained, move the dial lower in frequency until a discrepancy shows up. When an error does appear, it should be noted whether the dial reads high or low in frequency. If the dial reads high, it will be necessary to rotate the capacitor outward a little and bend the outside serrated plate outward slightly at the point where the frequency error was evident. Reset the capacitor to the original setting to see whether or not the error is still present. By very gently pushing the outside plates outward, the gang can be effectively adjusted until good accuracy is obtained. Of course, if the frequency reads low, it will be necessary to push the plates inward gently to get the same effect. After this discrepancy has been cleared up, the accuracy should be checked once again at the high end of the dial. When sure that everything is all right, the variable capacitor should be set to a lower frequency until the next discrepancy, if any, appears. Again, a very minor adjustment of the plates will allow this point to be brought in tolerance. Continuing this procedure until the bottom frequency of 20 Mc/s is calibrated will ensure that a degree of accuracy better than 1% can be obtained over the entire range of the marker oscillator. MARKER dial calibration may be checked, when the instrument is in use, by beating against a known accurate source, such as a separate generator or a known transmission.

Fine calibration of the sweep oscillator dial is not necessary. This portion of the instrument is calibrated by indexing the pointer to the line to the left of range identification letters A, B, C and D with the variable capacitor plates fully meshed. Proper identification of the sweep frequency is accomplished by use of the marker generator.

Similarly, the SWEEP WIDTH control is not calibrated as the markers will quickly reveal the bandwidth of any circuit being aligned.

Instal the instrument in the cabinet, securing with self-tapping screws through the holes in the back.

OPERATION OF THE HFW-1 TELEVISION ALIGNMENT GENERATOR
MARKER OSCILLATOR

An extremely versatile marker circuit is employed in the Heathkit Television Alignment Generator. It is capable of providing single, dual or multiple markers, depending upon the desire of the operator. The high output level of the variable marker oscillator makes it possible to use harmonics as well as fundamentals, thus greatly extending the usefulness of this section of the instrument.

The primary function of the marker oscillator is to give an accurate single frequency which can be used to identify portions of a bandpass waveform. This is accomplished by beating a portion of the marker oscillator output against the sweep oscillator output within the instrument. When the frequencies of the two oscillators approach the same point, the difference between the two frequencies will be within the audio range and will show up on the trace as a fuzzy line. If a wide band oscilloscope is used, this line will extend practically the full length of the trace, since most modern oscilloscopes are capable of reproducing frequencies up into the RF spectrum.

To identify bandwidth of a tuned circuit, the marker pip is set to a point 30% down the slope of one side of the waveform and the frequency on the marker dial noted. The pip is then set to a point 30% down the opposite side and the frequency noted again. The difference between the two frequencies will be the bandwidth of the circuit under test.

When adjusting the bandpass waveform of a circuit, the marker is set to the high or low side of the waveform, depending on which is to be adjusted. The RF or IF transformer adjustment is then made until the waveform conforms to the manufacturers' specifications.

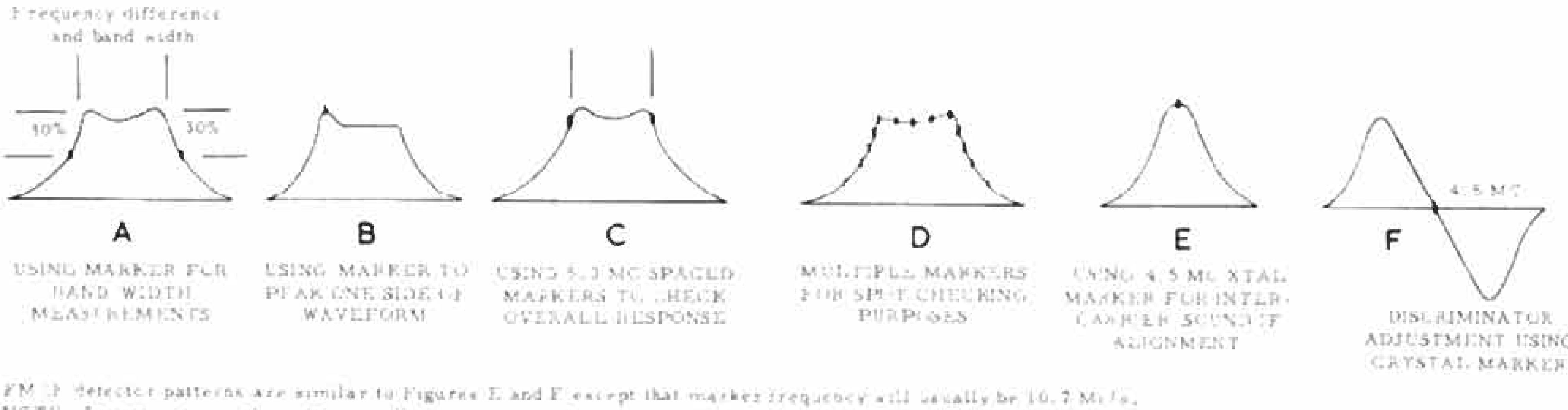
The crystal oscillator is designed so that the output of the crystal oscillator is mixed with the output of the variable marker oscillator in a common cathode resistor. This causes the crystal frequency and its harmonics to be present at the output also, as well as the mixed frequencies, which are the sum and difference of the crystal and variable oscillator outputs. Thus, if the variable marker is operating at 25 Mc/s and the crystal is in its socket, the output frequencies will be 25 Mc/s, 30 Mc/s and 20 Mc/s. Therefore, if the variable marker is set to the high or low side of a wide band IF or RF waveform, another marker will appear at a point 5.0 Mc/s away on the opposite side of the waveform. Markers spaced farther apart or closer together can be obtained by substituting crystals of higher or lower frequency, respectively.

It must be remembered that the crystal operates on harmonics at these higher frequencies and so the 5.0 Mc/s spaced markers will be much lower in amplitude than will the fundamental marker provided by the variable oscillator. Usually a good check can be obtained by moving the variable oscillator marker pip well down one side of the trace so that the marker gain can be turned up without distorting the trace. The other bandwidth marker will then show up clearly on the opposite side. sometimes the bandwidth marker amplitude can be effectively increased by simply moving the variable marker to the opposite side of the trace. In some cases, the plus beat may be more evident than the minus beat or vice versa.

Many additional uses for the crystal marker exist. Direct crystal markers can be obtained by use of a crystal operating directly at the desired frequency or at a harmonically related lower frequency. A 4.5 Mc/s crystal is very useful as a signal generator for the alignment of the 4.5 Mc/s sound IF encountered in intercarrier TV sets. For FM alignment purposes, a 10.7 Mc/s or a 5.35 Mc/s crystal can be used to give a highly accurate marker. Harmonics of a crystal of this frequency can also be used for FM RF alignment. The ninth and tenth harmonics of a 10.7 Mc/s crystal both fall in the 88-108 Mc/s FM spectrum. The 18th, 19th and 20th harmonics of a 5.35 Mc/s crystal could be used in the same manner. Similarly, crystals having harmonics in the TV IF or RF regions can be used if needed.

Multiple markers can be achieved by feeding the output of an external generator into the EXT. MARK. connector. Output of the external generator can be used to give direct marker indication at any frequency within the range of the generator. The MARKER AMP. control will also control the level of any signal fed into the EXT. MARK. connector. Multiple markers are obtained by beating the external generator against either the variable or crystal oscillator at a frequency difference designed to give markers spaced at the required frequency intervals. For example, if 100 kc/s spaced markers are needed, the external generator should be set to 4.9 Mc/s or 5.1 Mc/s, beat against the crystal oscillator, or to a frequency 100 kc/s above or below the variable oscillator, if this method should be more convenient. When this is done, the sum, the difference and main frequencies will all be present, as well as the harmonics, causing marker pips to be evident all of the way across the trace.

Markers are easily identified, due to the quick disconnect features of the crystal socket and the EXT. MARK. connector. If in doubt as to which marker is the main one, remove the crystal from its socket and disconnect or turn off the external generator if used. The single pip remaining will be that generated by the variable oscillator. Re-establishing the other marker frequencies one at a time will readily identify all other markers. If a fixed marker remains, regardless of whether the marker generator is operating or not, it can be assumed that the marker is generated by the local oscillator of the set under test. A pip of this type can be eliminated if necessary, either by removing the oscillator valve from its socket or disconnecting HT+ from the oscillator.



FM IF detector patterns are similar to Figures E and F except that marker frequency will usually be 10.7 Mc/s.
NOTE: In many cases, the patterns will appear inverted on the oscilloscope screen. Pattern polarity depends upon the type of detector employed in the set under test. Inverted patterns are just as easy to interpret and should not cause difficulty in alignment.

FIGURE — 11

Another feature of the marker generator is that the output of the fixed and variable oscillators can be taken out directly for fixed alignment purposes if required. If a relatively low level signal is required, the output can be taken directly from the RF OUT socket with the FINE ATTEN. control turned fully anti-clockwise and the MARKER AMP. and ATTENUATOR controls set to the desired level. (The marker signal is attenuated by both controls but not by the FINE ATTEN.)

Should higher level output be required, the output cable should be connected to the EXT. MARK. connector and the energy taken directly from the oscillators. When this is done, it must be remembered that the attenuator is ineffective and it may be necessary to attenuate the signal by means of a resistor in series with the 'hot' output lead. The value of this resistor will depend upon the amount of attenuation required. When the marker generator is used in this manner, unmodulated signal from the variable or fixed oscillators can be used to align traps, RF and IF tuned amplifiers and discriminators. Traps etc. are adjusted by setting the variable oscillator to the required frequency and adjust for a null on a VTVM or oscilloscope. The crystal oscillator can be used as a fixed frequency generator for many additional purposes by substituting crystals of the correct frequency for the application. The crystal oscillator was designed to operate with high frequency crystals, operating at frequencies of 1 Mc/s or more and so reliable operation with lower frequency crystals cannot be obtained. When purchasing crystals at a fundamental frequency near 1 Mc/s, make sure that it is a high sensitivity type, for many 1 Mc/s crystals will not function in this type of circuit.

MARKER AMPLITUDE CONTROL

Attenuation of the marker oscillator output is accomplished by use of the MARKER AMP. control. This control should always be set to a point where the markers are easily seen but no higher. Excessive marker amplitude will result in severe distortion of the trace. If distortion is noted when the marker frequency is varied, reduce the control setting until the undesirable condition disappears. It may be difficult to achieve adequate attenuation of marker amplitude when working with extremely high gain circuits. When this occurs, improvement of control can be obtained by utilising the harmonic of a lower frequency i.e. for 60 Mc/s use 30 Mc/s.

SWEEP OSCILLATOR

The sweep oscillator uses the centre frequency sweep system, providing excellent frequency and amplitude linearity at all frequencies. Blanking occurs for 180 degrees of the line cycle, which gives an excellent straight reference line to help alignment. To set up the sweep generator, it is only necessary to set the sweep dial to the centre frequency of the tuned stage to be aligned and turn up the SWEEP WIDTH control until a satisfactory trace is obtained. If the left-hand edge (the low frequency side) of the trace is square instead of coming down to a point with the base reference line, set the sweep dial to a slightly lower frequency until the beginning of the trace comes down to the reference line. See Figure 12. If the right-hand edge of the trace is squared off, increase the frequency setting of the OSCILLATOR dial. When both ends are clipped increase the SWEEP WIDTH control setting. Centre the trace by adjusting the HOR. PHASE and OSCILLATOR controls as necessary.

FIGURE — 12

High fundamental output from the sweep oscillator makes it possible to align single or multiple stages of a receiver as required. The output is more than sufficient to give a very readable trace on a 'scope connected to the video detector when the generator is connected to the grid of the last video IF stage. Careful design of the attenuator circuit gives adequate control of this high output level, allowing easy operation of the instrument into multiple stage high gain amplifiers as well as single stages of the same RF or IF strip. An additional advantage of the high output is that the fourth and fifth harmonics of the high band (band D) are strong enough to give readable traces on UHF channels, if the oscilloscope is connected to the video detector. To identify these frequencies, however, harmonics of a VHF signal generator or output of a UHF generator should be used as markers.

Another feature of the sweep generator is the extremely wide band sweep width available. For normal applications the SWEEP WIDTH control will not be advanced very far. If desired, however, the SWEEP WIDTH can be advanced to a point where all traps as well as the IF and RF bandpass waveforms can be seen. As the operator becomes more familiar with the unusual characteristics of the instrument, additional uses will be found for this large reserve of sweep width, as this feature can frequently save a considerable amount of time in trap alignment or used for display of superimposed traces using inputs A and B simultaneously.

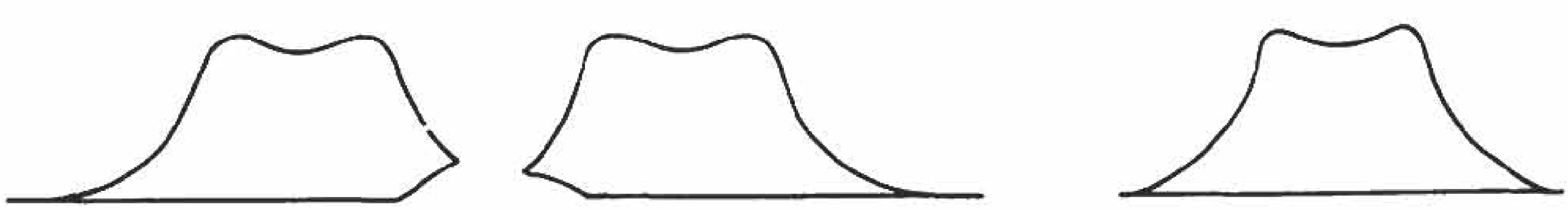
RANGE CONTROL

The RANGE control switch is used to select the range of frequencies covered by the sweep oscillator. Proper bands can be identified by noting the corresponding letters below the sweep oscillator dial. Band A is the low band covering a range of 3.6 Mc/s to 10 Mc/s; band B, 10 Mc/s to 26 Mc/s; band C, 30 Mc/s to 80 Mc/s and band D, 80 Mc/s to 220 Mc/s. The figures on the OSCILLATOR dial refer to the frequency at the centre of the sweep. A point to remember is that the upper frequency of the sweep oscillator is not limited by the highest indicated frequency on the OSCILLATOR dial for the unit is capable of sweeping across bands. Another point worth considering is that the maximum available sweep width on each band is generally achieved with the sweep frequency indicator set near the high frequency side of any given band. In other words, more sweep width will be available at the high end of band B than at the same frequency at the low end of band C, etc.

HORIZONTAL PHASE

Compensation for phase shift in the receiver under test is accomplished by proper use of the HOR. PHASE control. Before setting the OSCILLATOR and SWEEP WIDTH controls to produce a bandpass waveform, the phasing control should be set to approximately 12 o'clock. Once the desired waveform is obtained, the phase control should be adjusted until the trace is centred or shows no foldover at the right or left-hand edges. Adjustment is completed by careful touch-up of the OSCILLATOR, SWEEP WIDTH and HOR. PHASE controls. Figure 13 clearly illustrates proper adjustment of the phasing control.

Frequency linearity is dependent on phase control settings to a certain extent. If non-linearity becomes evident, reset the phase control and centre the trace, using the OSCILLATOR dial.



INCORRECT PHASING CORRECT PHASING

FIGURE—13

SWEEP WIDTH

The SWEEP WIDTH control is used to control the amount of sweep deviation of the sweep oscillator. The OSCILLATOR dial is set to the centre frequency of the IF or RF stage to be aligned as described previously and the SWEEP WIDTH control advanced until the trace is completed. This control should be set just high enough to give complete coverage of the bandpass waveform when IF or RF adjustments are to be made. If trap settings are to be observed also, the setting may be increased as required.

FINE ATTENUATOR AND ATTENUATOR

Output of the sweep generator is controlled by the FINE ATTEN. and ATTENUATOR controls. Alignment should usually be stated with the ATTENUATOR in the X1 position and the FINE ATTEN. at approximately 5. As soon as a response is obtained, the settings should be increased or decreased as required. Good alignment practice requires that the output be kept as low as possible, consistent with good indication on the oscilloscope screen. Too much output will result in serious distortion of the trace and misalignment. To make sure that the response is not distorted, back the FINE ATTEN. control off, observing the waveform. If a point is found where the waveshape changes, the IF or RF strip of the receiver was overloaded. Final attenuator settings should be made at a point below that at which distortion occurred. If it becomes necessary to set the FINE ATTEN. control to a point near 1 on the dial, the ATTENUATOR switch should be backed off a position and the other control reset. The FINE ATTEN.

control affects the sweep oscillator only, while the ATTENUATOR switch attenuates the sweep and marker output at the same time, helping to prevent marker overloading.

GENERAL ALIGNMENT PROCEDURES USING THE HEATHKIT SWEEP GENERATOR

Most television receivers will fall into one of four general patterns of alignment, which will be described later. However, each different set will have one or more special procedures involved in relation to special circuits in the set, so it is very desirable that the manufacturer's instructions be available and used. In addition to the time saved, better results will undoubtedly be obtained.

For all alignment except RF, it is necessary to render the local oscillator of the TV receiver inoperative. This is done by temporarily removing the HT+ lead to its anode circuits. Also, the AGC circuit should be made ineffective be earthing the AGC line or applying fixed d.c. potential from a battery or potentiometer, as required by the manufacturer.

Alignment of any television receiver should not be attempted unless there is evidence of misalignment. By connecting an oscilloscope and the Heathkit Television Alignment Generator to the receiver as outlined below and checking the gain of each stage before any adjustments are made, an excellent idea of stage gain is obtained and any stage not showing gain can be checked. A check of valves and other circuit elements is recommended before changing tuned circuits.

Generally, alignment is started with the trap circuits. The sound traps which keep the audio from modulating the picture and the traps to prevent adjacent channels from interfering are almost always aligned before the balance of the receiver. The 4.5 Mc/s trap in most intercarrier type sets should be aligned after the sound and video IF strips have been adjusted in most cases. Sound IF sections are aligned with conventional FM procedure. The TV tuner oscillator and RF sections are aligned only if defective indication is observed showing that misalignment has taken place.

SOUND AND ADJACENT CHANNEL TRAP ALIGNMENT

A d.c. valve voltmeter is generally used as the indicator for trap adjustment. The indicator is connected across the second detector load resistance. CW (unmodulated) signal from the marker generator is coupled into the grid of an IF stage ahead of the trap circuit through a .001 µF or larger capacitor. The marker generator is tuned to the trap circuit frequency and its output increased until an indication is observed. Adjust the trap for minimum indication. Locate the other traps and resetting the generator to the proper frequency, adjust each for minimum indication. Energy from the marker oscillator can be taken from the RF OUT connector by setting the FINE ATTEN. and ATTENUATOR to 0 and X1 respectively and placing the RANGE switch at position D, so that the sweep oscillator will not cause interference. Should the output be too low when signal is taken from this point, connect the output cable to the EXT. MARK connector instead and attenuate the signal as necessary by installing a suitable value of resistance in series with the 'hot' lead. In cases where the manufacturer specifies a modulated signal for trap alignment, refer to the section headed SPECIAL PROCEDURES.

INTERMEDIATE FREQUENCY (IF) ALIGNMENT
STAGGER TUNED TYPE

To align stagger tuned type IF stages, the output of the generator is either fed to the grid of the mixer valve through a capacitor or the grid of each individual stage as it is aligned, in sequence, beginning at the stage before the video detector. Manufacturer's instructions regarding this should be followed in all cases. The oscilloscope is connected across the load resistance of the video detector. Connect the horizontal input of the 'scope to the HOR. socket of the sweep generator. Render the TV receiver oscillator valve inoperative by using the previously described method. Set the OSCILLATOR dial to the frequency of the IF strip and advance the SWEEP WIDTH control until a large, easily seen trace appears. If the horizontal line at each end of the trace is too long, the sweep width should be reduced and the sweep oscillator frequency adjusted slightly if necessary to properly centre the trace. If the trace does not return to the horizontal line, the sweep width should be increased. Regardless of the amount of sweep used, the width of the bandpass trace will be limited by the band width of the IF amplifiers under test and a more accurate trace will be obtained by using all of the trace for the amplified portion.

The MARKER AMP. control is advanced and the MARKER control adjusted to the frequency of the first IF stage as outlined in the manufacturer's instructions and this stage adjusted for maximum indication. If recommended, the primary of the IF transformer preceding the stage under alignment should be shorted. The marker pip is then moved to the frequency of the next stage and this stage adjusted. Be sure to reduce the output of the generator as alignment proceeds. Use maximum gain of the oscilloscope vertical amplifier during entire alignment always reducing output of the generator rather than that of the 'scope. Each IF stage is aligned in the above manner. The overall response is then compared with the recommended curve in the manufacturer's instructions. The locations of the sound and video sections can be checked with the dual markers and compared with proper positions. Slight readjustment of individual stages may be necessary to properly match manufacturer's recommended trace. The overall response check is usually made by feeding the output of the generator to the mixer grid through a capacitor of suitable size.

In some cases, the IF stages will be pre-aligned using fixed frequency procedure with a VTVM used as an output indicator at the video detector stage. When this type of alignment is called for, the marker oscillator can be used as a signal generator by turning the FINE ATTEN. to its maximum anti-clockwise position and the ATTENUATOR and MARKER AMP. controls to a point that will give adequate output. If it should be impossible to obtain sufficient output in this manner, the signal can be taken directly for the EXT. MARK. connector and attenuation accomplished by use of a suitable value of resistance in series with the 'hot' output lead.

OVERCOUPLED IF TYPE

Connections are made with the 'scope as outlined under stagger tuned types. The output of the alignment generator is fed into the grid of the final IF stage (nearest video detector) through a coupling capacitor (.001 μF). Proceed to align the last IF transformer in the manner outlined in the manufacturer's instructions. Manufacturers usually supply a pattern to be obtained for each stage and these should be followed. It is sometimes necessary to short out the primary of the IF transformer preceding the stage under alignment and this should be done when recommended. Alignment proceeds stage by stage from the stage nearest the video detector to the mixer valve. After alignment of the final stage, the trace should appear similar to the typical TV IF response curve shown in the instructions. The markers are again used to locate sound and video carriers to check shape and width of the trace.

Fixed frequency pre-alignment procedures may be used for this type of IF system. When this is the case, observe the instructions under STAGGER TUNED TYPES.

SOUND IF ALIGNMENT (OTHER THAN A.M.)

Discriminator, ratio detector and beam gated circuits are commonly encountered as detectors in TV sound IF systems. Except for the gated beam detector, alignment procedures are much the same, the only difference being the point to which the oscilloscope is connected. In almost all cases, the output of the sweep generator will be connected to the grid of the first sound IF amplifier through a suitable capacitor.

To observe the bandpass waveform in a circuit employing a discriminator, the 'scope should be connected to the grid return of the last limiter valve and the output of the generator increased to give a satisfactory trace. The marker is set to the centre frequency of the sound IF strip and adjustments are made keeping the waveform symmetrical on each side of the marker. When this adjustment is completed, the 'scope is connected at the volume control or at the opposite side of the isolating resistor running to the control and the discriminator transformer adjusted for maximum amplitude and straightness of the slanted detecting curve. Adjustment is complete when the marker is in the centre of the curve. (NOTE: The crystal oscillator will furnish the marker for 4.5 Mc/s intercarrier type sound systems.)

When a ratio detector is employed, the 'scope should be connected to the anode of the detector or diode which is in turn connected to the negative terminal of an electrolytic stabilising capacitor. This capacitor should be disconnected to make IF transformer adjustment. After the IF stages are properly adjusted, the capacitor is reconnected and the oscilloscope vertical test lead connected to the 'hot' terminal of the volume control. Final adjustments are made as in the preceding paragraph.

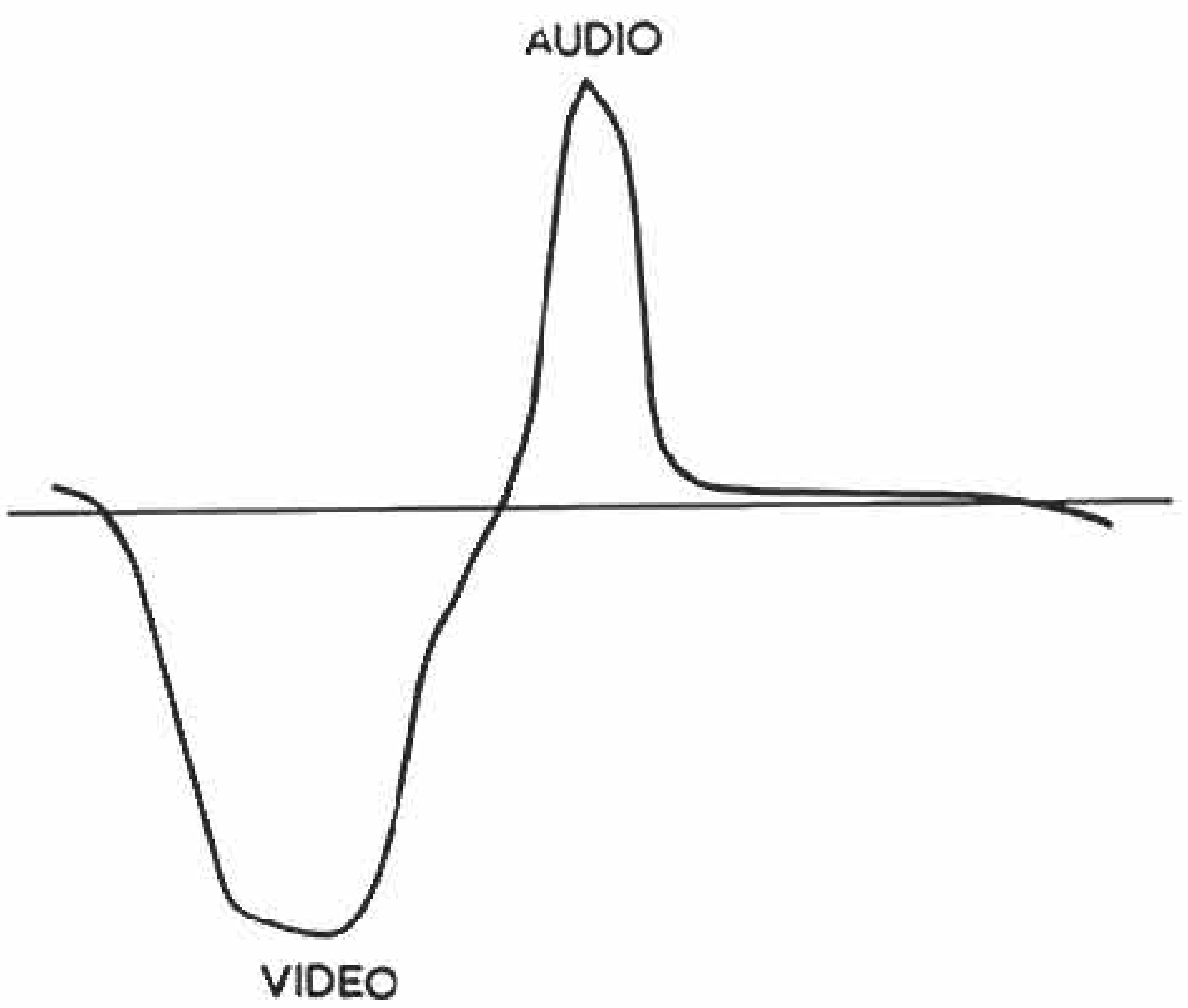
Adjustments of beam gated stages are generally made on actual signal from a television broadcasting station and alignment methods described by the manufacturer should be used. Where modulated fixed frequency signal sources are required, refer to the section under SPECIAL PROCEDURES.

OSCILLATOR AND RF ALIGNMENT

Alignment of the tuner section of a TV receiver should not be attempted unless the performance of the set indicates the necessity of doing so. When necessary, alignment is usually started by adjusting the oscillator frequency, after the oscillator is restored to operation. To accomplish this, the alignment generator is connected to the aerial terminals of the set through suitable impedance matching resistors (usually 120Ω) in series with the earth and hot lead of the output cable. The oscilloscope is connected to the video detector as before. Alignment is begun starting at the highest frequency (channel 13) and finishing at the lowest frequency (channel 1) unless otherwise specified.

Oscillator tuning is adjusted to place the sound and video markers at the manufacturer's specified points on the response curve. Where marker frequencies higher than those marked on the MARKER dial are called for, the fourth harmonic of the variable oscillator can be used. The specified marker frequency is divided by four and the marker dial set to the resulting frequency. 5.0 Mc/s spacing of markers for identification of the other carrier will be generated by the crystal oscillator.

When fixed frequency alignment procedures are recommended, harmonic or fundamental output of the variable marker oscillator can be used, taken from the appropriate output connector. A valve voltmeter will be used as an indicator when this method of alignment is undertaken. The VTVM is usually connected to the load for the sound detector and the oscillator adjustment made for zero reading (a null). Other connection points for the VTVM may be recommended and these should be used as specified by the manufacturer.



TYPICAL SUPERIMPOSED DISPLAY

FIGURE – 14

After oscillator alignment is completed, RF and mixer alignment is done. The sweep generator remains connected to the aerial terminals through matching resistors and the oscilloscope is usually connected to the grid return of the mixer valve at a point specially provided for this purpose. Alignment is again started at the highest frequency channel and the response waveform adjusted to conform to the recommended shape. NOTE: The output level at the signal takeoff point in the tuner is usually quite low and most oscilloscopes have insufficient vertical gain to give an easily readable pattern. When this condition is encountered, a single stage pentode pre-amplifier such as a microphone pre-amp should be used ahead of the 'scope to increase the gain to a satisfactory level. Sometimes a demodulator probe connected at the recommended point will give better results without a pre-amplifier. This situation will not develop when alignment instructions specify that the 'scope be connected to the video detector.

INTERCARRIER TYPE SETS

Intercarrier alignment procedures are much the same as those previously specified. Usually the video IF strip is aligned using fixed frequency procedure with a VTVM as a detector. The VTVM is usually connected to the video detector load and IF adjustments made for maximum indication. Again, direct output from the variable or fixed marker oscillator can be used. If sweep techniques are called for, the previously described methods can be used.

After alignment is completed using fixed frequency methods, the overall response is checked with the sweep generator and 'scope. This is accomplished with the generator connected to the mixer stage and the 'scope to the video detector. If necessary, the IF adjustment cores are touched up to get the waveform to conform to the recommended pattern.

Sound IF alignment is accomplished as before, except that a 4.5 Mc/s crystal should be used exclusively as the signal source or marker, depending upon the alignment method employed. After the sound strip is correctly aligned, the 4.5 Mc/s trap (if any) is adjusted using the 4.5 Mc/s output of the marker and a VTVM with an RF probe at the cathode or grid of the c.r.t. In some cases, the d.c. probe of the VTVM will be connected instead to a point in the sound detector circuit. In all cases, the manufacturer's instructions should be followed.

Alignment procedures for the tuner of intercarrier type sets will follow the same general course outlined under OSCILLATOR AND RF ALIGNMENT, mentioned previously.

FM RECEIVER ALIGNMENT

The alignment of FM receivers is similar to the outline under SOUND IF ALIGNMENT of television receivers. The normal FM IF frequency is 10.7 Mc/s and as nearly every signal generator covers this frequency, markers can easily be obtained from external generators and fed into the EXT. MARK. connector of the alignment generator. If extremely accurate alignment is required a 10.7 Mc/s or 5.35 Mc/s crystal can be plugged into the XTAL socket.

Extra bandwidth identification markers may be achieved by use of an external signal generator tuned to a frequency 100 kc/s above or below the frequency of the crystal oscillator. In some cases a satisfactory 10.7 Mc/s marker can be obtained by setting the marker oscillator dial to the second harmonic of the receiver IF frequency, or 21.4 Mc/s. This does not always provide a satisfactory marker, but it may work out well with a large percentage of FM sets encountered.

SPECIAL PROCEDURES

In some cases, a modulated RF signal is required for adjustment of traps, detectors, etc. If the operator is thoroughly familiar with the type of circuits involved, other methods of alignment can sometimes be used, employing the output of the marker generator. When methods other than those recommended are not feasible, certain steps should be taken to ensure alignment accuracy consistent with that of the alignment generator. Observance of the following instructions will help to improve the performance of the receiver after alignment is completed.

When a modulated signal for trap alignment is called for, an unmodulated signal can sometimes be used in conjunction with a d.c. VTVM connected to the video or audio detector, depending on the location of the trap in the circuit. The usual procedure is to connect an a.c. meter or an oscilloscope to the grid or cathode of the c.r.t. when a modulated signal is used. Regardless of which method is employed, the trap will be tuned for minimum indication. If it is essential that a modulated source be used, a separate signal generator must be employed. Before using the external generator to make adjustments, it should be zero beat against the crystal or variable marker generator, depending upon the frequencies involved. This can be accomplished by feeding the output of both generators to the RF probe of a signal tracer or to the input of a receiver tuned to the frequency in question. This method of instrument calibration should always be used to keep alignment consistent with the original aligning instrument. While errors in any given instrument may be small, they may be in opposite directions and the resultant error may be sufficient to cause the set under alignment to perform at less than optimum level.

Occasionally, a modulated signal is required to adjust the detector of the sound strip on TV or FM sets. The procedure outlined under SOUND IF ALIGNMENT can sometimes be substituted with very good results. However, if any doubt as to the efficiency of this method exists, the recommended procedure should be observed. Again the external generator should be calibrated against the marker generator to ensure best performance.

Too many different procedures exist for aligning of beam gated detectors to outline all of them within this manual. Generally, these detectors are aligned on station with attenuation in the aerial circuit to keep the signal level below the limiting level of the detector. The IF transformers are adjusted for maximum indication, using an oscilloscope or a.c. meter across the volume control and keeping the input attenuated below the limiting level of the detector. After these adjustments are made, the input is increased beyond the limiting point and the AM rejection control in the cathode circuit and the quadrature coil adjusted for minimum intercarrier buzz. When a modulated signal source is used to align this type of circuit, the external generator should be calibrated against the marker generator.

ACCESSORY INSTRUMENTS

A stable, high sensitivity, wide band oscilloscope is a must if satisfactory alignment is to be accomplished with a minimum of difficulty. Although wide band response is not required for sweep alignment purposes, it is desirable for observance of synchronising pulses, etc. encountered when doing routine service work on television receivers. The Heathkit IO-12U oscilloscope meets these requirements and incorporates other refinements very useful in general service work. High intensity levels along with excellent focusing characteristics make it easy to operate this oscilloscope even in brilliantly illuminated rooms.

Two probe kits are available which add to the usefulness of the oscilloscope. One is the PK-1 Low Capacitance Probe which allows accurate measurement of sync waveforms etc. in high impedance circuits. Normally, distortion occurs when a 'scope is connected to a high impedance point where complex waveforms are present, due to capacitive loading by the 'scope input. The PK-1 probe effectively cancels this capacity, thus preventing distortion.

Signal tracing and waveform checks in the RF sections of receivers can be made using the 337C Demodulator Probe. This probe is also useful for making stage gain measurements in low impedance RF circuits.

Another instrument that is absolutely necessary for alignment purposes is a high impedance valve voltmeter. The Heathkit IM-13U (or V-7A) VTVM has an input resistance of 11 megohms on all d.c. ranges. This is sufficiently high to make loading effects negligible and all readings will be true indications of potential existing in the circuit under investigation. An additional advantage of this type of VTVM is that a variety of probes can be used, greatly extending the usefulness of the instrument. A high voltage probe and an RF probe are available as accessories.

Although not essential, a grid dip oscillator (G.D.O.) such as the Heathkit GD-1U is very useful for television and general service work. Every serviceman is familiar with the occasional set that comes into the shop with all of the alignment screws tightened down. It is extremely difficult to put sets in this condition back into alignment, as it is almost impossible to force an alignment signal through the set. A G.D.O. can be used to make rough adjustments of the tuned circuits and traps with the set 'cold'. Finishing touch-up of alignment is then easy. Another use of the G.D.O. employs the instrument as a marker generator. The G.D.O. operates over a very wide range of frequencies, all on fundamentals, making it especially useful for tuner alignment work. To be used as a marker, the G.D.O. is merely placed near the set under alignment, no direct connections are needed. Many additional uses of the instrument have been listed in various magazines and even more may become apparent as the operator becomes more familiar with the characteristics of the unit.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in coloured pencil on the pictorial and circuit diagram as it is followed in the instrument. Most cases of difficulty result from wrong connections. Often having a friend check the wiring will reveal a mistake consistently overlooked.

2. If possible, compare valve socket voltages with those shown on Page 39. The readings should be within 20% of those tabulated if a VTVM is used. Other type meters may give lower readings due to loading effects. If the voltage fails to compare with the value shown, check further into the circuit involved by checking the various components (resistors, capacitors, valves, etc.).

3. Carefully recheck the colour codes on resistors and polarity on all electrolytic capacitors.

Some common troubles are listed below along with trouble shooting procedures which may be helpful in locating the source of difficulty.

INSTRUMENT COMPLETELY INOPERATIVE: If the instrument fails to operate, check the valves to see if the filaments are lit. If there is no evidence of heating, measure across the end of the a.c. line at the tagstrip next to the grommet on the back of the chassis. Lack of a.c. energy at this point indicates either an open mains lead or imperfect connection at the outlet. The a.c. cable can be checked quickly with an ohmmeter. When voltage is obtained at this point on the tagstrip, the voltmeter should be moved to the strip at the opposite end of the mains chokes.

No voltage at this point indicates an open choke. Finally, check with the meter connected across tags 6 and 7 of the mains transformer. No voltage at this point indicates a defective switch on the back of the phase control or a wiring error.

Should voltage be present at all points in the a.c. circuit, a short in the heater or rectifier anode or cathode circuits can be suspected. Careful visual inspection will usually reveal the source of trouble. If not, all valves should be removed and the power transformer disconnected from the circuit. Ohmmeter checks for wiring shorts can then be made and power transformer checked for open windings.

NO SWEEP OSCILLATOR OUTPUT: Lack of RF output can be traced to either failure of the oscillator to function or a defect in the attenuator and output network. Check components and connections in the attenuator network to make sure that everything is wired properly and no shorts exist. Once sure that everything is all right at this point, pins 1 and 6 of the 6BQ7A sweep oscillator should be checked to see if HT+ is present. Special attention should be given to the four stator tags on the variable capacitor. HT+ should be present at all four terminals. If not, carefully check the stator tag connections for a break. If a break is present, it can be repaired quickly by resoldering the connections.

Failure of the sweep oscillator to function due to voltages far out of line with those shown on the voltage chart might be caused by a defect somewhere in the power supply or by improper connection of the wires running from the main chassis to the sweep sub-chassis. Once sure that the interconnecting wires are connected properly, check under POWER SUPPLY MALFUNCTION.

Valves can always be suspected of causing trouble, especially at higher frequencies. It might be worthwhile to substitute valves to see if performance can be improved. While a certain valve might not operate well in one circuit, it may be perfectly good in another and so exchanging identical types is often advantageous.

NO MARKER OSCILLATOR OUTPUT: The same procedure as outlined above should be observed. Again, special attention should be given to the four stator tags on the variable capacitor. Lack of high voltage on the anodes (pins 1 and 6) of the 12AT7 will indicate either an open RF choke or a defective switch on the MARKER AMP. control. If the choke is open, repairs can usually be made by soldering the choke leads carefully close to the body of the choke. Checks should also be made for short circuits in the wiring, the valve and the variable capacitor.

POWER SUPPLY MALFUNCTION: To locate trouble in the power supply, voltage checks should be made in a definite sequence. First, pins 1 and 7 of the EZ81 should be checked for a.c. voltage. Next, check all heaters to make sure that they are alight. If not, check for a short, open circuit or wrong connection at one of the valveholders. If everything is all right at these points, the potential at pin 3 of the EZ81 should be checked. If no HT+ exists, look for a short in the HT+ line and in the filter capacitor. Also, check the EZ81 for open circuits and low emission. When sure that everything is correct at these points, check voltage at pin 1 of the 12AX7 and pins 3 and 6 of the 6CL6. Discrepancies at these points should be straightened out before going further. Possible sources of trouble are the .25 μF capacitor (C15) connecting between pin 1 of the 12AX7 and pin 2 of the 6CL6, the .05 μF capacitor (C16) between earth and the 220Ω resistor (R23) to pin 6 of the 6CL6, leakage to earth in the 30 henry anode choke, short circuits at tagstrips K, H and BP, and defective parts or wiring around the front wafer of switch BM. Short circuits are easily located by disconnecting wires one at a time from the point where the short is found. A follow up of the wire which remains shorted will reveal the fault.

The final power supply check point is at pin 6 of the 6CL6. If no voltage or low voltage is present at this point regardless of whether or not the valve is in its socket, the sweep oscillator chassis should be checked for short circuits and wiring errors.

NO HORIZONTAL OUTPUT FOR 'SCOPE: If it should be impossible to obtain a horizontal line on the 'scope, the lead running between the two instruments should be checked for open or short circuits. Also, the 1 megohm (R33), the two 100 KΩ resistors (R31, R32) and the 100 KΩ potentiometer should be checked as well as the .01 μF (C19) and the .05 μF capacitor (C18) used in the phasing circuit.

If sweep can be obtained but the phasing control is ineffective, there is a possibility that the wires from the EZ81 valveholder and tagstrip K have been accidentally exchanged. Reversal of the wires will correct this condition. If the wiring is all right, make sure that the 1 megohm resistor (R33) is connected to the proper point on the phase control and that the .01 μF high voltage capacitor (C19) is not shorted.

NO FREQUENCY SWEEP: Lack of sweep or sweep width will be caused by some defect in the 110 volt circuit leading to the controllable inductor. The 10 KΩ sweep width control should be checked for continuity as well as the 6800Ω resistor (R36) connected to it. A shorted .25 μF capacitor (C20) across the primary of the inductor or an open 16 μF (C3) between the control and the inductor will cause lack of sweep. Voltage at the small selenium rectifier (M1) should be checked since this provides bias for the Increductor unit. Connections to the front wafer of the range switch should be inspected and the switch itself checked against the schematic to be sure that everything is correct.

POOR FREQUENCY LINEARITY AND CALIBRATION: Poor linearity and calibration will most likely be caused by improper biasing of the controllable inductor. The steps outlined under NO FREQUENCY SWEEP should be observed and the 15 KΩ (R35) and 10 KΩ (R34) resistors which make up the load for the biasing circuit checked out. Very high or low mains voltage will have some effect on linearity and frequency, but the error will not be serious. A substantial deviation from recommended value of these resistances could cause poor operation.

POOR AMPLITUDE LINEARITY: A non-linear trace indicates improper biasing on either the 12AX7 AGC amplifier (V3) or the 6CL6 regulator (V4). The 220 KΩ (R38), 22 megohm (R17) and 5.6 megohm (R18) resistors on the front wafer of the range switch should be checked for value and connection. These resistors control the bias on the 12AX7 AGC amplifier (V3). If the trouble shows up only on the low end of band D, the 1 megohm resistor (R20) between pin 1 of the 12AX7 and pin 2 of the 6CL6 should be checked. If the value is approximately correct, it may be necessary to reduce it slightly until the regulation is perfect. Decreasing the value of this resistor will also decrease the output of the sweep generator, however, so care should be exercised.

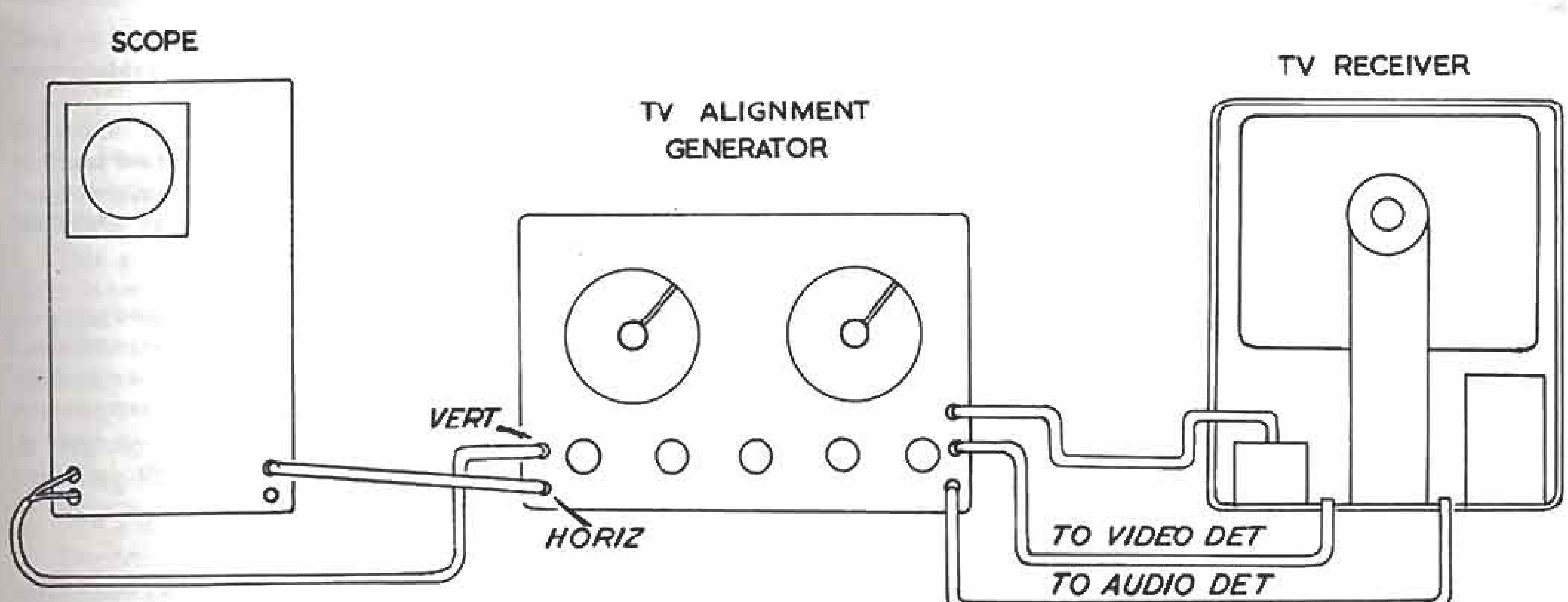
Poor regulation on the lower frequency bands or all bands will most likely be due to some fault around the resistors or switch previously mentioned.

Amplitude or output variations can be expected as sweep frequency settings or band settings are changed. This is not important, since these adjustments will not be made during any alignment procedure. The important thing is that the output be flat over any given sweep width with the centre frequency set at a common reference.

VOLTAGE CHART

VALVE TYPE	REF.	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
EZ81	A	215V a.c.	NC	220	6.3V a.c.	0	NC	215V a.c.	NC	NC
12AX7	B	70	-8	0	6.3V a.c.	6.3V a.c.	-22	-22	70V a.c.	0
6CL6	C	0	-2.1	150	0	6.3V a.c.	100	0	NC	-2.1
12AT7	AA	129	-10 to -30	.9	6.3V a.c.	6.3V a.c.	60	-5 to -20	.7	0
6BQ7A	BA	136	N	1.55	6.3V a.c.	0	92	-9	0	0
12AX7	CC	44	N	0	0	0	52	-.4	0	6.3V a.c.

N - not significant
NC - no connection
Mains voltage: 240 volt a.c.
Unless otherwise indicated, all voltages positive and measured to chassis.
Voltages taken with a Heathkit 11 megohm valve voltmeter.
Bias voltage across inductor primary terminals: 6 volts on bands A, B and C, 15 volts on band D
Readings taken with RANGE switch at C, MARKER and OSCILLATOR dials fully clockwise.
MARKER AMP. and HOR. PHASE about ½ open and all other controls fully anti-clockwise.



A TYPICAL ALIGNMENT SET-UP
FIGURE - 15

SERVICE INFORMATION

SERVICE

If, after applying the information contained in this manual, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which we make available to our customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under In Case of Difficulty. Possibly one of these will solve your problem.

2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units and anything else that might help to isolate the cause of trouble.

3. Report fully on the results obtained when testing the unit initially and when following the suggestions under In Case of Difficulty. Be as specific as possible and include voltage readings if test equipment is available.

4. Identify the kit model number, invoice number and date of purchase, if available.

5. Print or type your name and address, preferably at the head of the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like him to do for you and the difficulty you wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was sent to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be sent to you, subject to the terms of the Guarantee.

HEATHKIT equipment purchased locally and returned to Daystrom Limited for service must be accompanied by your copy of the dated sales receipt from your authorised HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Guarantee.

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 Department are at your disposal. Your instrument may be returned carriage paid to Daystrom Limited, 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).

For information regarding modification of HEATHKIT equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although Daystrom Ltd. sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than Daystrom Limited.

REPLACEMENTS

Material supplied with HEATHKIT products has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty component. Should inspection reveal the necessity for replacement, write to Daystrom Limited and 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 kit in which it is used.
C. Mention date of purchase.
D. Describe the nature of defect or reason for requesting replacement.

Daystrom Limited will promptly supply the necessary replacement. 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. 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.

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 Limited 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 instructions given in this Manual to ensure successful results. Daystrom Limited 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.

GUARANTEE

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:—

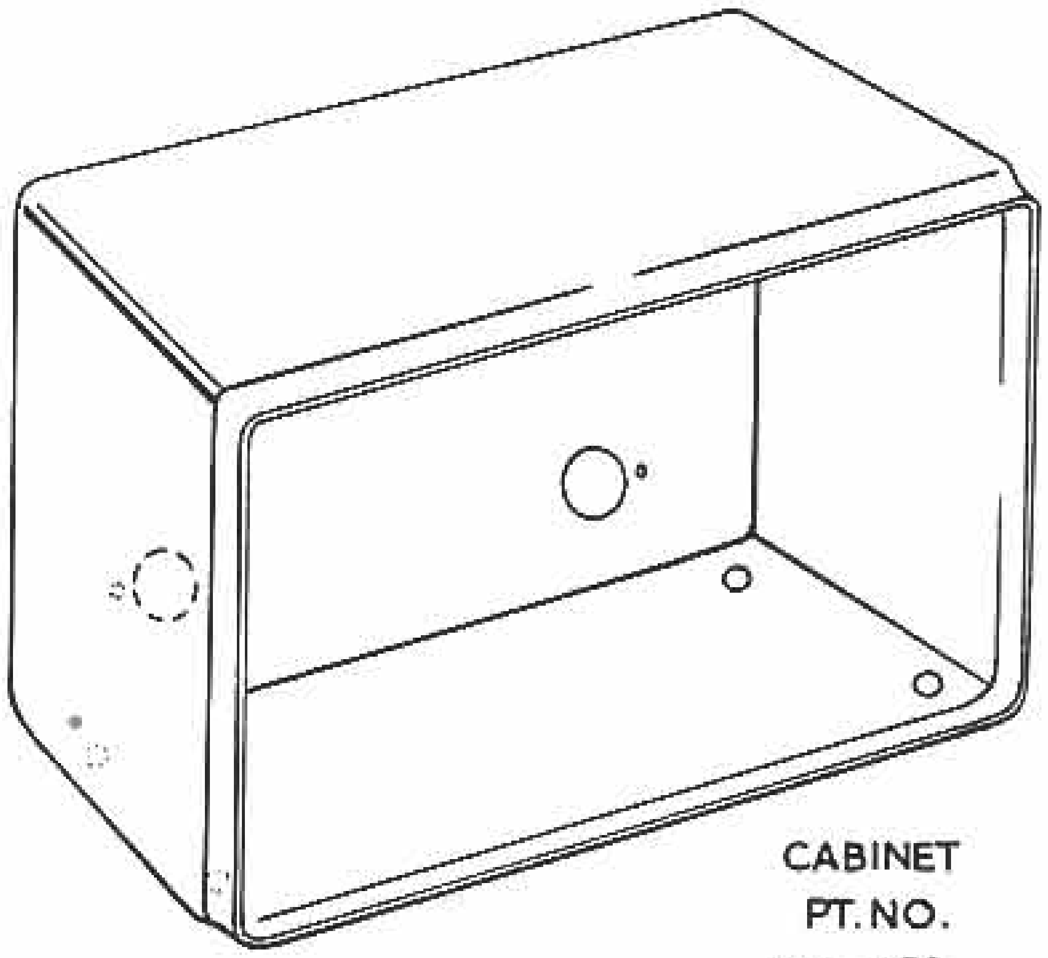
1. This guarantee is given to and for the benefit of the original buyer only, and is and shall be in lieu of, and there is hereby expressly excluded, all other guarantees conditions or warranties, whether express or implied, statutory or otherwise, as to quality or fitness for any purpose of the equipment, 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.

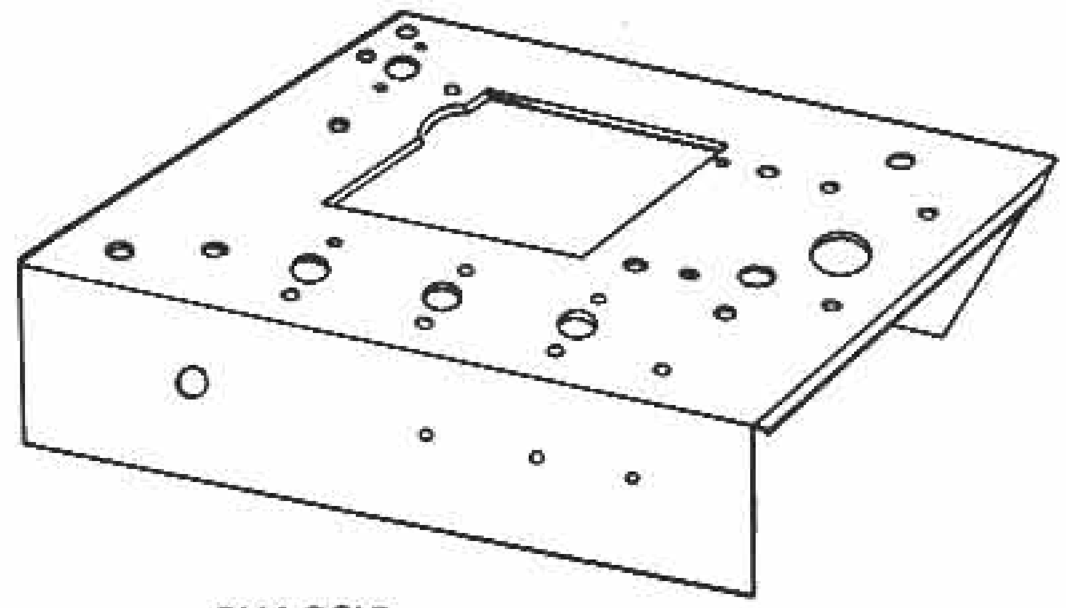
3. The purchaser shall comply with the Replacements Procedure laid down in the relevant Heathkit Manual.

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.

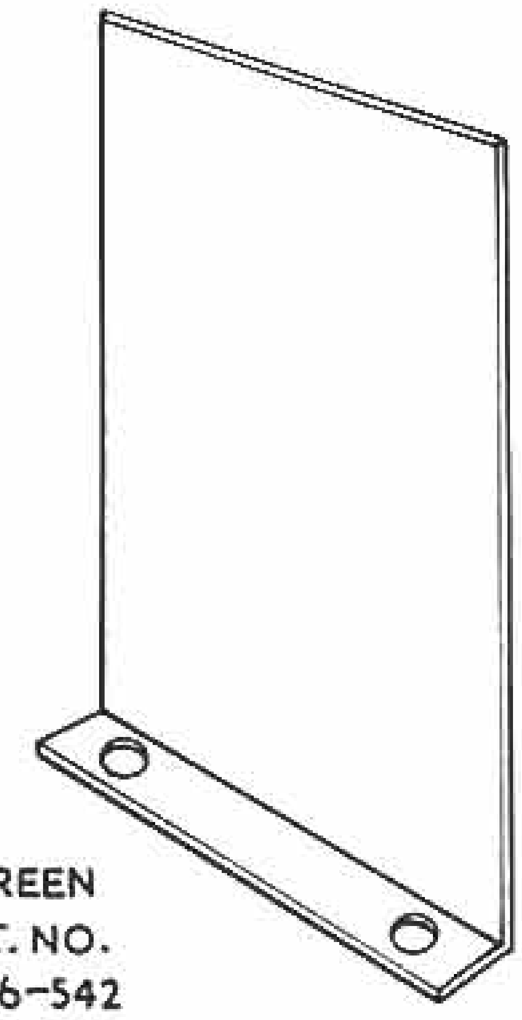
Note: The Cathode Ray Tubes and Valves forming part of the equipment are guaranteed by the respective manufacturers. It should be noted that their guarantee is given only in respect of faulty workmanship and/or material and does not cover misuse or consequential damage.



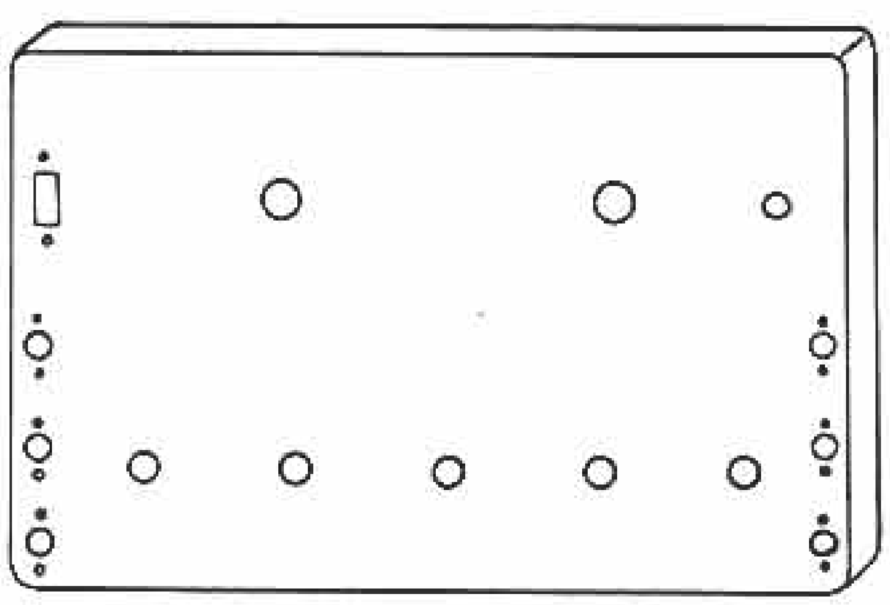
CABINET
PT. NO.
90- 532



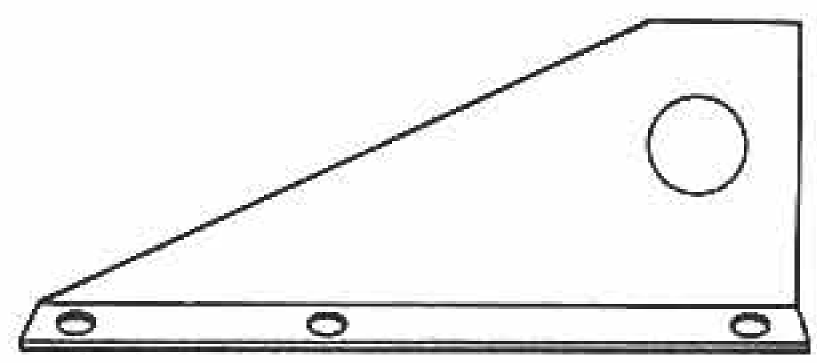
CHASSIS
PT. NO.
200-553



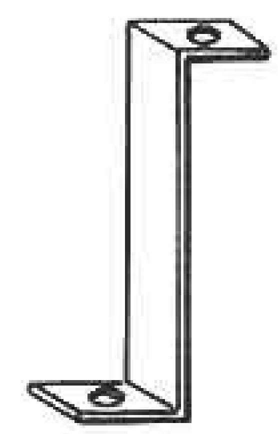
SCREEN
PT. NO.
206-542



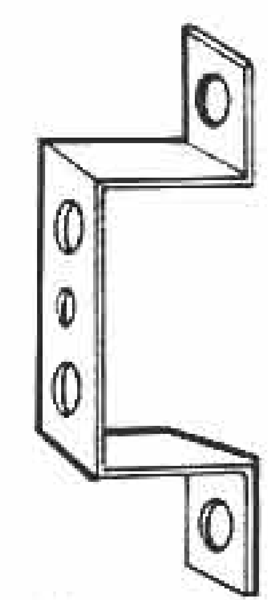
FRONT PANEL
PT. NO. 203-545



SWITCH MOUNTING BRACKET
PT. NO. 204-585



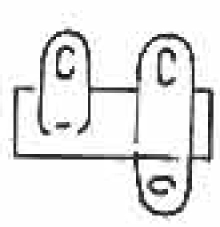
SUPPORT BRACKET
PT. NO. 204-584



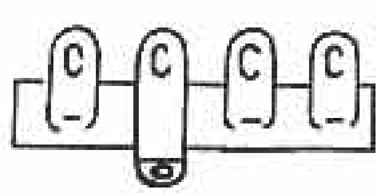
CRYSTAL
BRACKET
PT. NO. 204-583

HEXAGON TRIMMER TOOL
PT. NO. 490-503

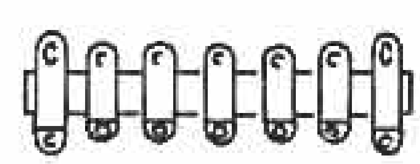
1-WAY OFFSET
PT. NO. 431-501



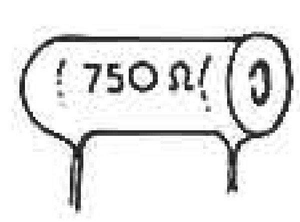
2-WAY ONE EARTH
PT. NO. 431-511



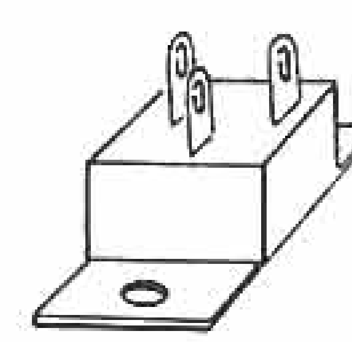
4-WAY ONE EARTH
PT. NO. 431-502



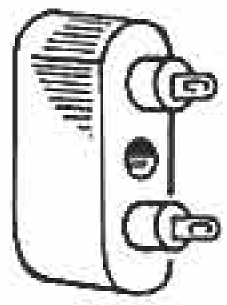
7-WAY MINIATURE
PT. NO. 431-514



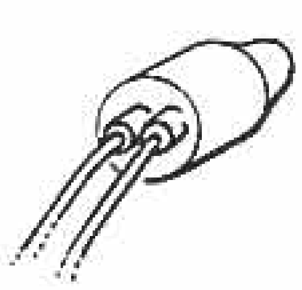
RF CHOKE
PT. NO. 100-557



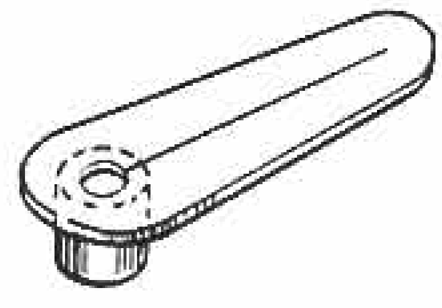
METAL RECTIFIER
PT. NO. 57-503



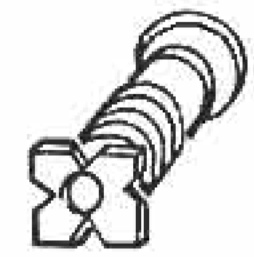
CRYSTAL HOLDER
PT. NO. 434-544



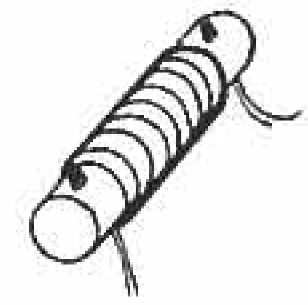
NEON INDICATOR
PT NO 412-519



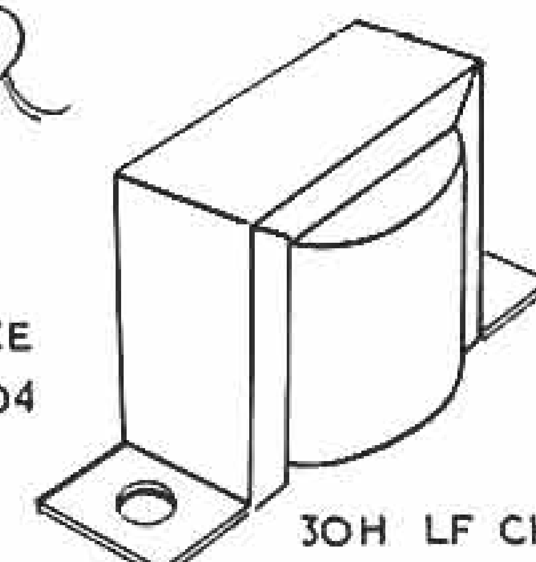
CURSOR
PT. NO. 463-513



MARKER
OSCILLATOR
COIL
PT. NO. 40-595



FILTER CHOKE
PT. NO. 45-504



30H LF CHOKE
PT. NO. 46-512

PARTS LIST

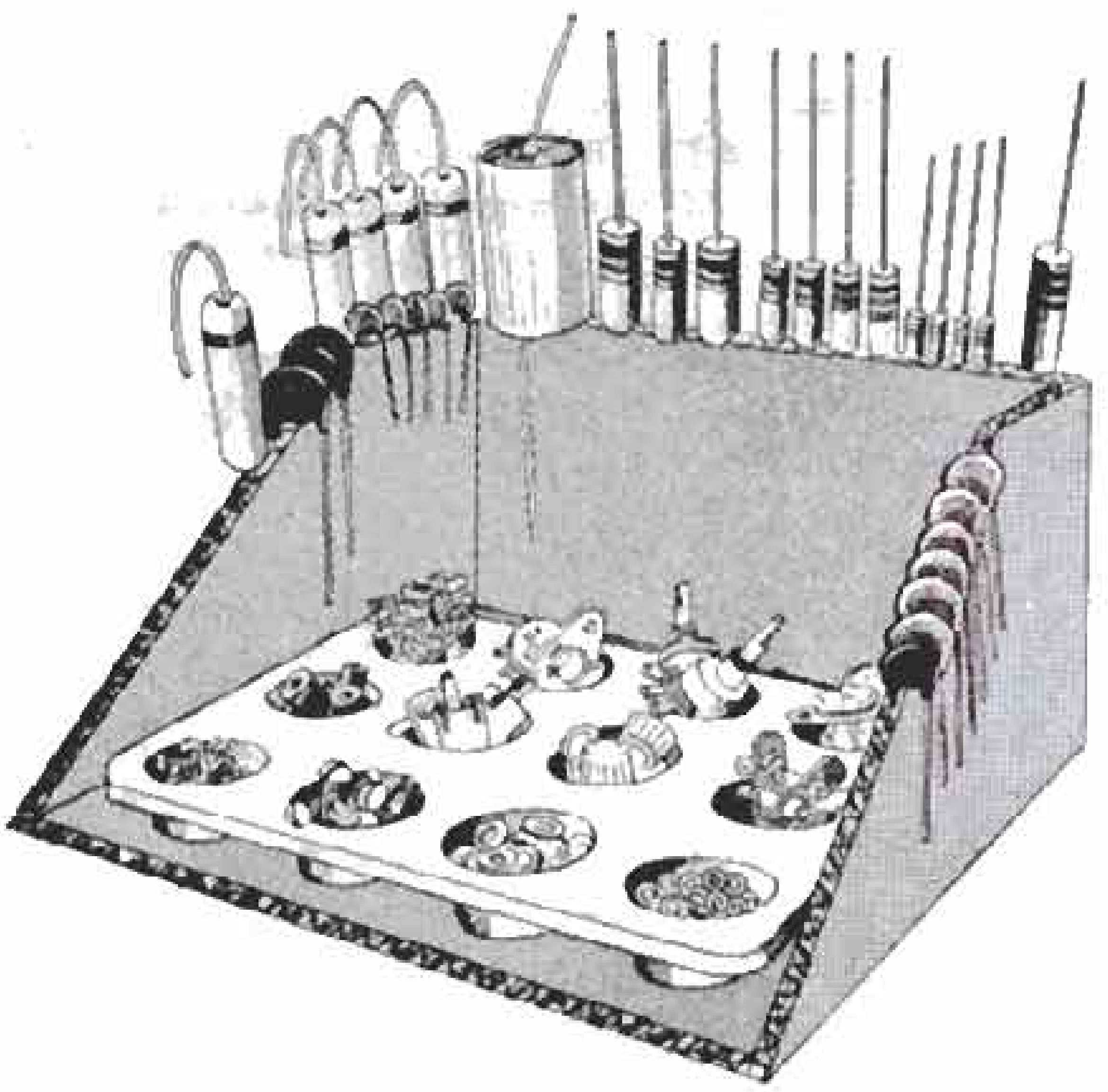
PART No.	PARTS Per Kit	DESCRIPTION
Resistors (carbon, $\frac{1}{2}$ watt, ± 10%)		
H-100C10	1	10Ω (Brown, Black, Black)
H-470C10	2	47Ω (Yellow, Violet, Black)
H-680C10	1	68Ω (Blue, Grey, Black)
H-151C10	1	150Ω (Brown, Green, Brown)
H-221C10	2	220Ω (Red, Red, Brown)
H-681C10	2	680Ω (Blue, Grey, Brown)
H-102C10	1	1 KΩ (Brown, Black, Red)
H-222C10	1	2.2 KΩ (Red, Red, Red)
H-472C10	1	4.7 KΩ (Yellow, Violet, Red)
H-682C10	1	6.8 KΩ (Blue, Grey, Red)
H-223C10	2	22 KΩ (Red, Red, Orange)
H-333C10	1	33 KΩ (Orange, Orange, Orange)
H-473C10	1	47 KΩ (Yellow, Violet, Orange)
H-104C10	8	100 KΩ (Brown, Black, Yellow)
H-154C10	2	150 KΩ (Brown, Green, Yellow)
H-224C10	3	220 KΩ (Red, Red, Yellow)
H-105C10	3	1 megohm (Brown, Black, Green)
H-565C10	1	5.6 megohm (Green, Blue, Green)
H-226C10	1	22 megohm (Red, Red, Blue)
Resistors (carbon, 1 watt, ± 10%)		
1-471C10	1	470Ω (Yellow, Violet, Brown)
1-682C10	1	6.8 KΩ (Blue, Grey, Red)
1-103C10	1	10 KΩ (Brown, Black, Orange)
1-153C10	1	15 KΩ (Brown, Green, Orange)
1-333C10	2	33 KΩ (Orange, Orange, Orange)
Resistors (carbon, 2 watt, ± 10%)		
2-682C10	1	6.8 KΩ (Blue, Grey, Red)
2-103C10	1	10 KΩ (Brown, Black, Orange)
Resistors (wire-wound)		
8-202W5	1	2 KΩ (value marked)
Capacitors (all types)		
20-504	1	1000 pF silver mica
21-501	6	47 pF tubular ceramic
21-502	2	100 pF tubular ceramic
21-509	9	.001 µF (1000 pF) disc ceramic
21-519	1	.002 µF (2000 pF) disc ceramic
21-503	1	.005 µF (5000 pF) tubular ceramic
21-514	1	.01 µF (10,000 pF) disc ceramic
23-60	1	.01 µF paper, 800V
23-504	1	.05 µF paper, 250V
23-501	1	.05 µF paper, 400V
23-63	2	.25 µF paper, 400V
25-514	1	20+20 µF electrolytic, 250V
25-20	1	40 µF electrolytic, 150V
25-5	1	16 µF electrolytic, 150V
26-528	2	130+130 pF twin-gang variable
Diode, Rectifier, Valves		
56-502	1	Diode GEX13 (or equiv.)
57-503	1	Metal rectifier C2D
411-24	1	Valve 12AT7 (ECC81)
411-507	2	Valve 12AX7 (ECC83)
411-512	1	Valve EZ81

PART No.	PARTS Per Kit	DESCRIPTION
Diode, Rectifier, Valves (cont'd.)		
411-535	1	Valve 6BQ7A
411-536	1	Valve 6CL6
Metal Parts		
90-532	1	Cabinet
200-553	1	Chassis
203-545	1	Front panel
204-583	1	Crystal bracket
204-584	1	Support bracket
204-585	1	Switch mounting bracket
206-542	1	Screen
Potentiometers, Switches, Tagstrips		
19-521	1	200Ω linear potentiometer with switch
10-553	1	200Ω linear potentiometer
10-546	1	10 KΩ linear potentiometer
19-514	1	100 KΩ linear potentiometer with switch
63-553	1	3-position attenuator switch
63-554	1	4-position range switch
431-501	3	1-way offset tagstrip
431-511	2	2-way (one earth) tagstrip
431-10	2	3-way (one earth) tagstrip
431-531	3	3-way miniature (one earth) tagstrip
431-12	2	4-way (one earth) tagstrip
431-502	2	4-way (no earth) tagstrip
431-514	1	7-way miniature (two earth) tagstrip
Hardware (screws, nuts, washers etc.)		
250-501	10	6BA x $\frac{1}{4}$" binderhead screw
250-502	4	6BA x 5/16" binderhead screw
250-519	12	6BA x $\frac{1}{4}$" chrome binderhead screw
250-527	1	6BA x 3/8" cheesehead nylon screw
250-531	2	6BA x $\frac{1}{4}$" inst. hd. chrome screw
252-501	27	6BA nut
254-501	20	6BA lockwasher
259-505	3	6BA shakeproof solder tag
250-513	11	4BA x $\frac{1}{4}$" binderhead screw
250-9	20	4BA x 3/8" binderhead screw
250-533	4	4BA x 5/8" binderhead screw
250-530	4	4BA x 1/8" cheesehead screw
250-529	2	4BA x $\frac{1}{4}$" c'sk head screw
252-3U	17	4BA nut
254-1	37	4BA lockwasher
259-504	4	4BA shakeproof solder tag
253-501	5	3/8" flat washer
254-502	2	2BA shakeproof washer
250-8	2	No. 6 x 3/8" self-tapping screw
Wire, Cable etc.		
89-1	1 length	Mains lead
333-501	1 length	18 swg. solder
340-501	1 length	22 swg. bare copper wire
343-503	1 length	Co-axial cable

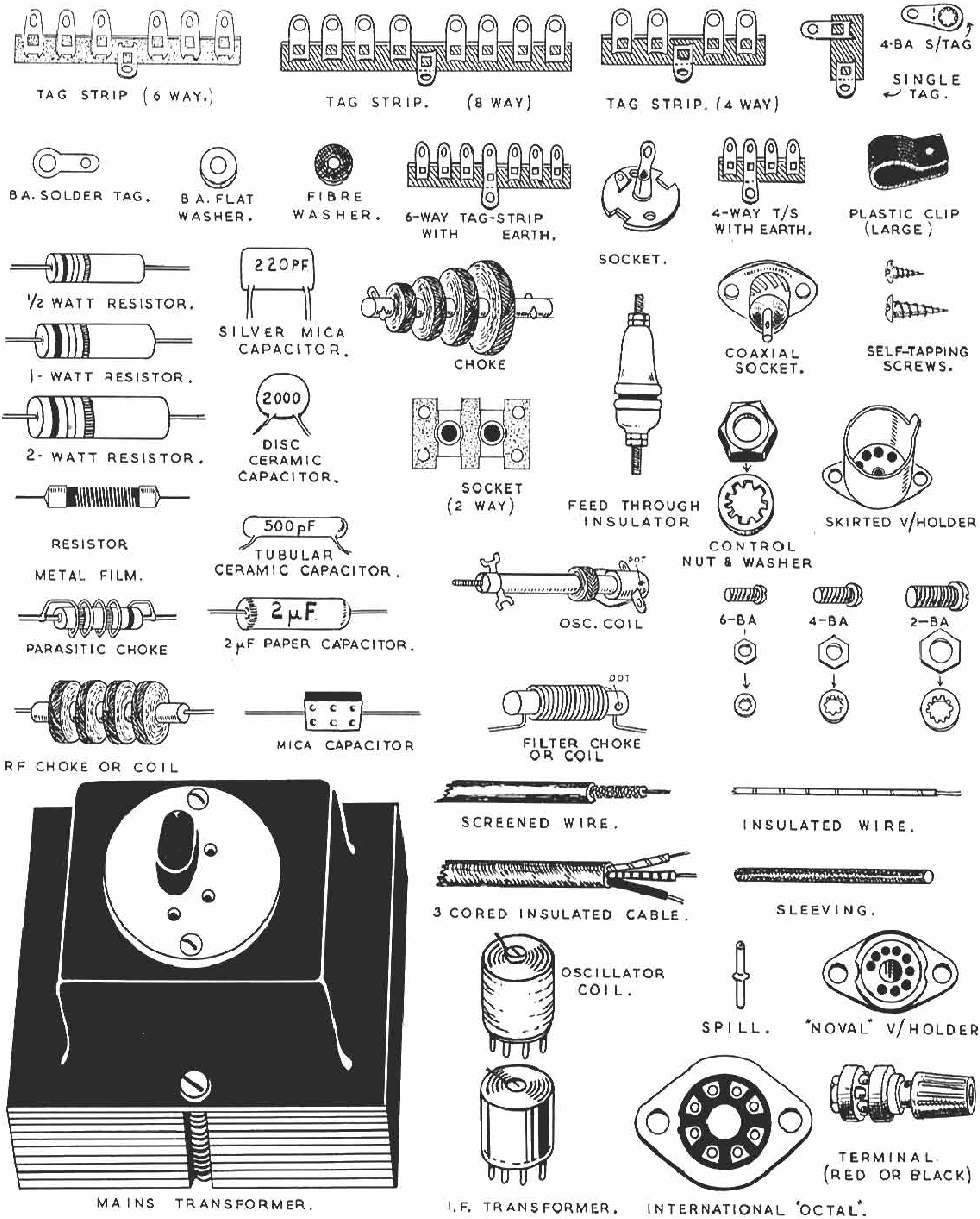
PARTS LIST (cont'd.)

PART No.	PARTS Per Kit	DESCRIPTION
Wire, Cable etc. (cont'd.)		
346-1	1 length	1 mm. sleeving
344-500	1 length	Black connecting wire
344-501	1 length	Brown connecting wire
Plugs, Sockets, Valveholders		
70-501	2	4 mm. plug, black
70-502	2	4 mm. plug, red
432-506	6	Co-axial socket
434-502	4	9-pin ceramic valveholder
434-544	1	Crystal holder
434-549	2	9-pin paxolin valveholder
438-504	7	Co-axial plug
438-505	1	Fused plug, 0.5 A
Transformers, Chokes, Coils		
40-595	1	Marker oscillator coil
45-504	3	Filter choke
46-512	1	30H LF choke
54-534	1	Mains transformer
100-557	1	RF choke (750Ω resistor with ferrite core)
403-2	1	Controllable inductor

PART No.	PARTS Per Kit	DESCRIPTION
Miscellaneous		
73-501	4	3/8" rubber grommet
73-504	1	¼" rubber grommet
75-505	2	Insulating panel
211-501	1	Handle with end plates
255-504	7	1.1/16" tapped pillar
255-511	2	4BA x 7/32" spacer
260-1	6	Crocodile clip
261-502	4	Rubber feet
404-505	1	Crystal, 5 Mc/s
412-519	1	Neon indicator
462-525	6	Black knob with pointer skirt
462-527	2	Black knob, large, plain
463-513	2	Cursor
490-503	1	Hexagon trimmer
630-501	1	Nut starter
595-577(8)	1	Manual

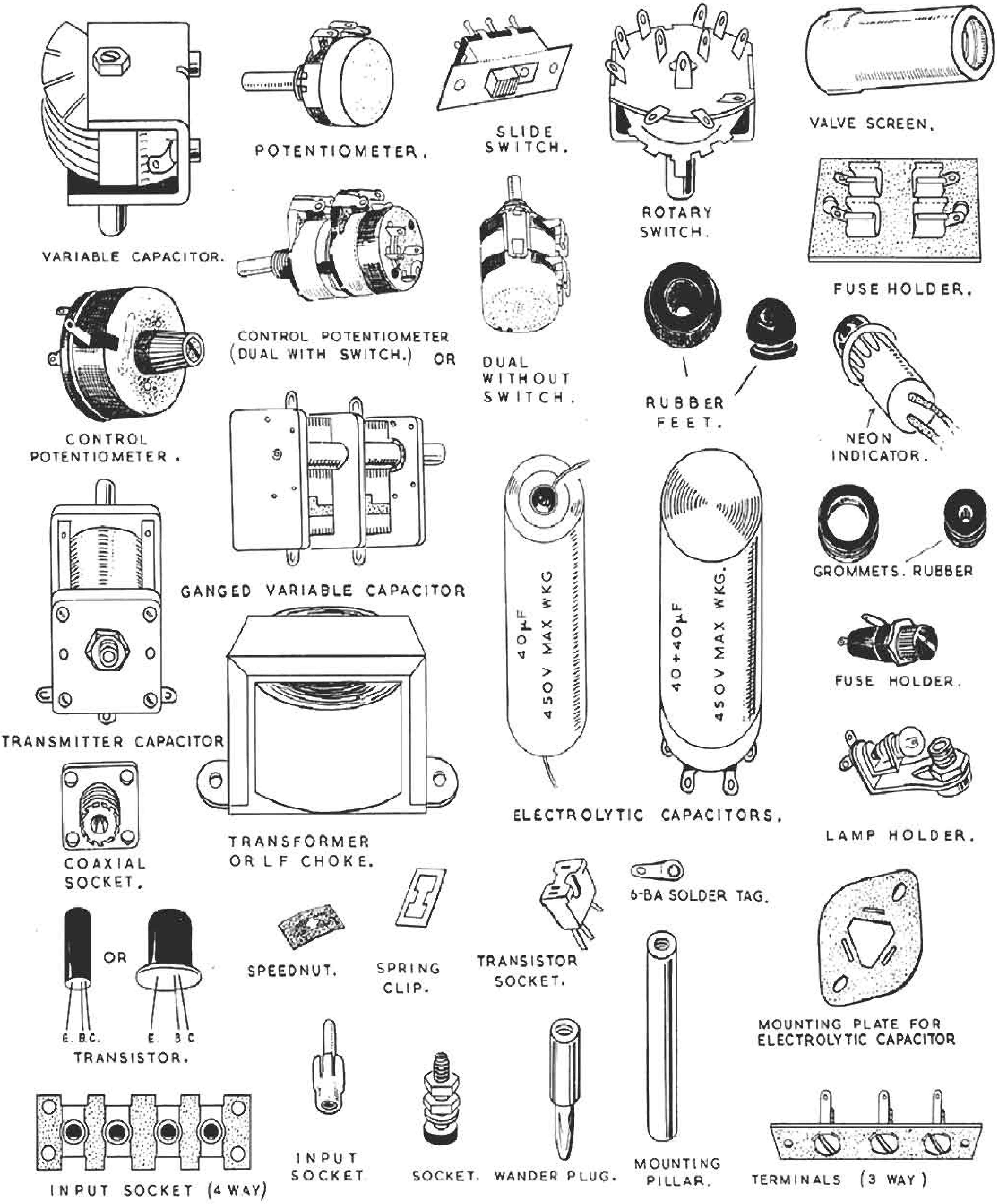


This illustration shows how resistors and capacitors may be placed in the cut edge of a corrugated cardboard carton until they are needed. Their values can be written on the cardboard next to each component.


TAG STRIP (6 WAY.)
TAG STRIP. (8 WAY)
TAG STRIP. (4 WAY)
4·BA S/TAG
SINGLE TAG.
B.A. SOLDER TAG.
B A. FLAT WASHER.
FIBRE WASHER.
6-WAY TAG-STRIP WITH EARTH.
4-WAY T/S WITH EARTH.
PLASTIC CLIP (LARGE)
SOCKET.
½ WATT RESISTOR.
220PF
SILVER MICA CAPACITOR.
CHOKE
COAXIAL SOCKET.
SELF-TAPPING SCREWS.
1- WATT RESISTOR.
2000
2- WATT RESISTOR.
DISC CERAMIC CAPACITOR.
SOCKET (2 WAY)
FEED THROUGH INSULATOR
CONTROL NUT & WASHER
SKIRTED V/HOLDER
RESISTOR METAL FILM.
500pF
TUBULAR CERAMIC CAPACITOR.
DOT
OSC. COIL
6-BA
4-BA
2-BA
2μF
PARASITIC CHOKE
2μF PAPER CAPACITOR.
RF CHOKE OR COIL
MICA CAPACITOR
DOT
FILTER CHOKE OR COIL
SCREENED WIRE.
INSULATED WIRE.
3 CORED INSULATED CABLE.
SLEEVING.
OSCILLATOR COIL.
SPILL.
"NOVAL" V/HOLDER.
TERMINAL. (RED OR BLACK)
MAINS TRANSFORMER.
I.F. TRANSFORMER.
INTERNATIONAL 'OCTAL'.

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.



HELPFUL KIT BUILDING INFORMATION

Before attempting actual kit construction read the construction manual thoroughly to familiarize 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

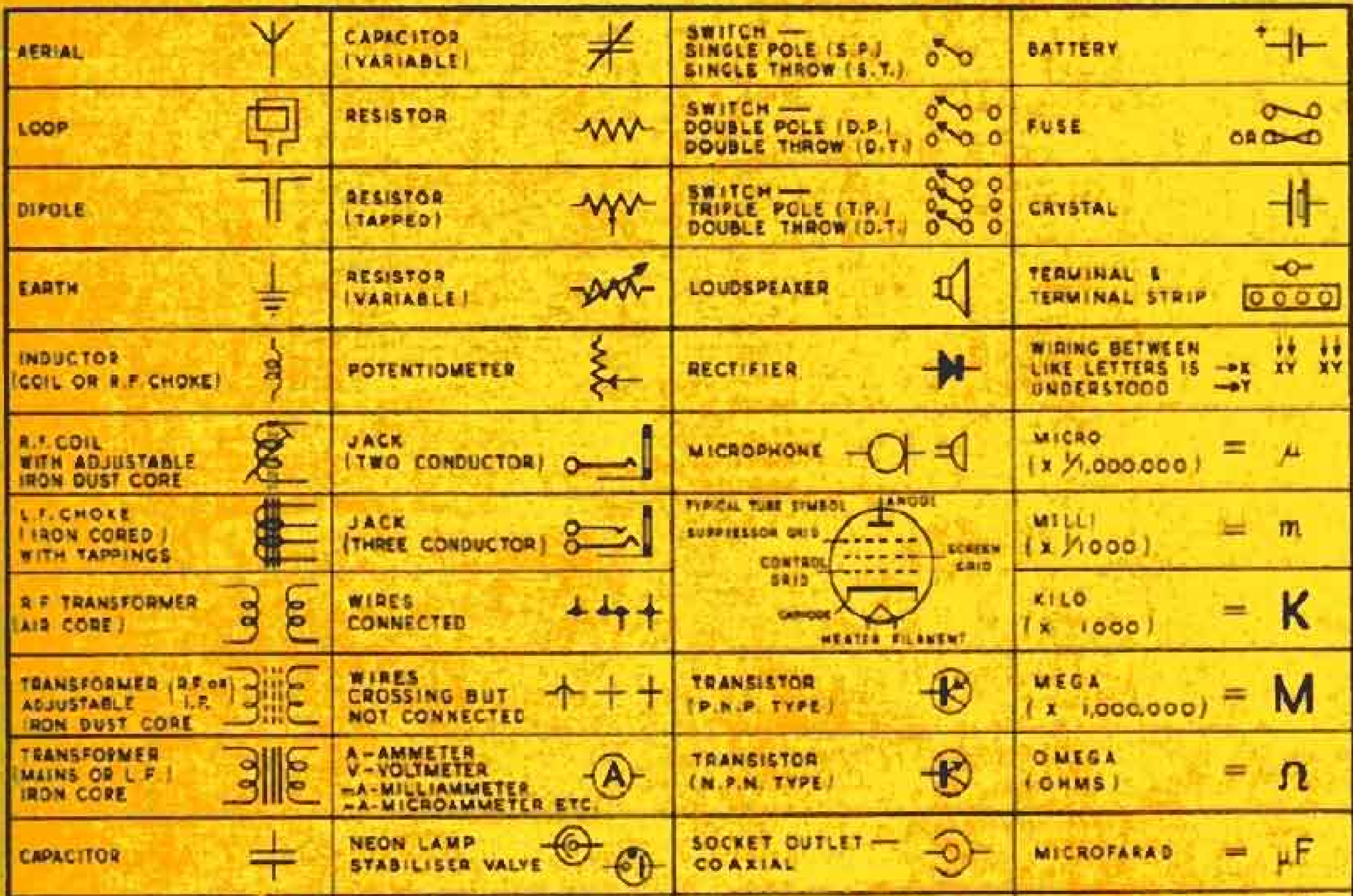
When following the wiring procedure make the leads as short and direct as possible. In filament wiring requiring the use of a twisted pair of wires allow sufficient slack in the wiring that will permit the twisted pair to be pushed against the chassis as closely as possible thereby affording relative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



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