PRICE $2.00

Assembling and Using Your...

Heathkit

F M TUNER

MODEL FM-4

HEATH COMPANY

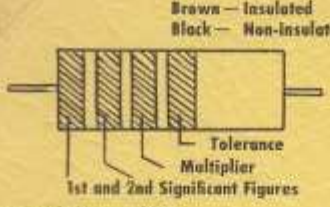
A Subsidiary of Daystrom Inc

BENTON HARBOR, MICHIGAN

STANDARD COLOR CODE — RESISTORS AND CAPACITORS

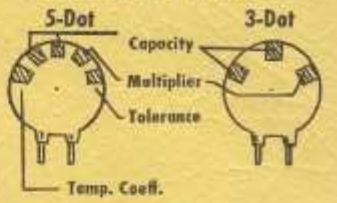
INSULATED UNINSULATED Color	FIRST RING BODY COLOR First Figure	SECOND RING END COLOR Second Figure	THIRD RING DOT COLOR Multiplier
BLACK	0	0	None
BROWN	1	1	0
RED	2	2	00
ORANGE	3	3	,000
YELLOW	4	4	0,000
GREEN	5	5	00,000
BLUE	6	6	000,000
VIOLET	7	7	0,000,000
GRAY	8	8	00,000,000
WHITE	9	9	000,000,000

AXIAL LEAD RESISTOR

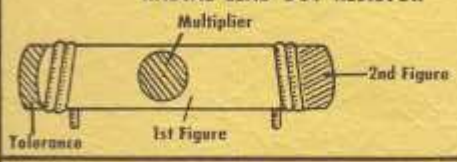


Wire wound resistors have 1st digit band double width

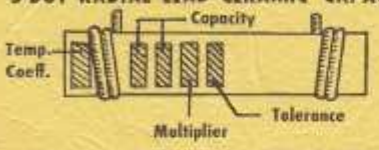
DISC CERAMIC RMA CODE



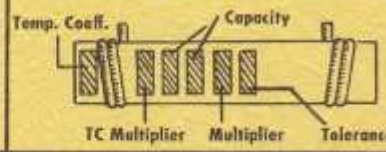
RADIAL LEAD DOT RESISTOR



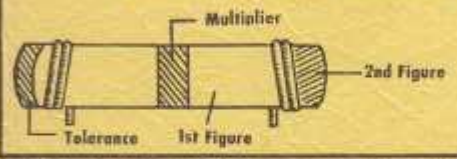
5-DOT RADIAL LEAD CERAMIC CAPACITOR



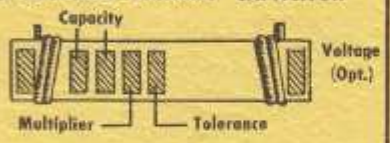
EXTENDED RANGE TC CERAMIC HICAP



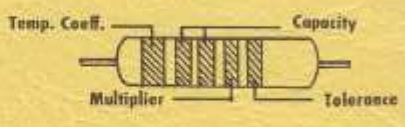
RADIAL LEAD (BAND) RESISTOR



BY-PASS COUPLING CERAMIC CAPACITOR



AXIAL LEAD CERAMIC CAPACITOR

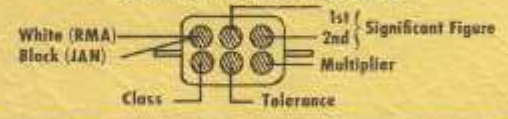


The standard color code provides all necessary information required to properly identify color coded resistors and capacitors. Refer to the color code for numerical values and the zeroes or multipliers assigned to the colors used. A fourth color band on resistors determines tolerance rating as follows: Gold = 5%, silver = 10%. Absence of the fourth band indicates a 20% tolerance rating.

The physical size of carbon resistors is determined by their wattage rating. Carbon resistors most commonly used in Heathkits are ½ watt. Higher wattage rated resistors when specified are progressively larger in physical size. Small wire wound resistors ½ watt, 1 or 2 watt may be color coded but the first band will be double width.

MOLDED MICA TYPE CAPACITORS

CURRENT STANDARD CODE

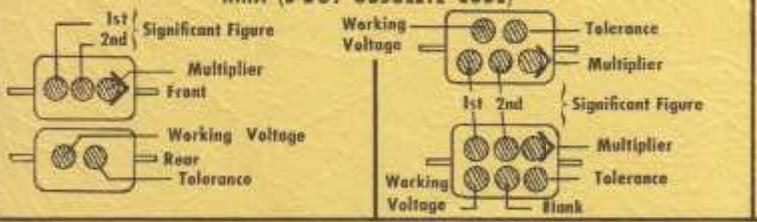


JAN & 1948 RMA CODE

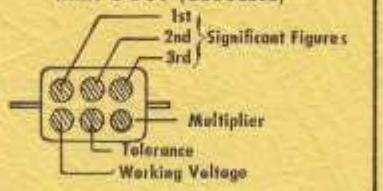
RMA 3-DOT (OBSOLETE) RATED 500 W.V.D.C. ± 20% TOL.

BUTTON SILVER MICA CAPACITOR

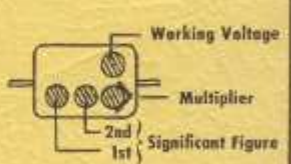
RMA (5-DOT OBSOLETE CODE)



RMA 6-DOT (OBSOLETE)

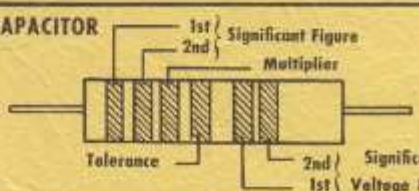


RMA 4-DOT (OBSOLETE)



MOLDED PAPER TYPE CAPACITORS

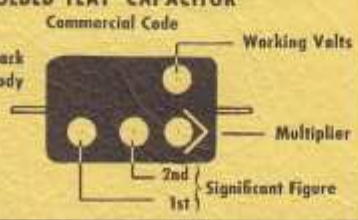
TUBULAR CAPACITOR



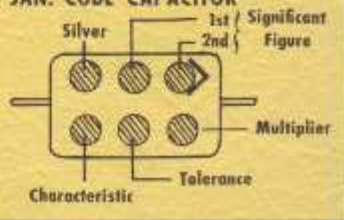
Normally stamped for value

A 2 digit voltage rating indicates more than 900 V. Add 2 zeros to end of 2 digit number.

MOLDED FLAT CAPACITOR



JAN. CODE CAPACITOR



The tolerance rating of capacitors is determined by the color code. For example: red = 2%, green = 5%, etc. The voltage rating of capacitors is obtained by multiplying the color value by 100. For example: orange = 3 × 100 or 300 volts. Blue = 6 × 100 or 600 volts.

In the design of Heathkits, the temperature coefficient of ceramic or mica capacitors is not generally a critical factor and therefore Heathkit manuals avoid reference to temperature coefficient specifications.

Courtesy of Centralab

ASSEMBLY AND OPERATION OF THE HEATHKIT F M TUNER
MODEL FM-4

Tuning Range:	88 mc to 108 mc.
IF Frequency:	10.7 mc.
Antenna:	300 Ω unbalanced.
Output Impedance (Cathode Follower):	600 Ω.
Output Voltage:	Nominal .5 volt, (with 30% modulation, 20 μv).

6/29/59

INTRODUCTION

The Heathkit FM-4 is a wide band FM Tuner employing five tubes, a silicon rectifier and their associated circuitry. It is designed to obtain a maximum sensitivity concurrent with the other specifications necessary to obtain good high fidelity FM broadcasts. Another feature of the FM-4 is automatic frequency control, variable to fit the needs of your individual location. Unbalanced input, and cathode follower and multiplex outputs are included in the design. Small physical size and an attractively styled exterior complete the picture. We trust the FM-4 will give you many pleasant hours of easy listening.

GENERAL CONCEPTS OF SPECIFICATIONS

The proper scientific way of measuring the quality of a piece of electronic equipment is by means of the specifications. To say that a tuner is good or bad is hardly enough, since with different people, conditions, and areas, its real or apparent operating characteristics could vary widely. Therefore, we present the following test results for the FM-4 Tuner and we shall attempt to explain a little of what each test means as we present it to you. We hope that this will make these values a little more useful and interesting to you, and possibly enable you to compare it with other tuners with which you may come in contact. We think the results will please you.

Before we can begin with test results, we will have to give a very abbreviated explanation of some of the terms that must be used. Further explanations may be found in the books listed in the Bibliography on Page 45.

AM-FM. AM (Amplitude Modulation) and FM (Frequency Modulation) refer to the manner in which the intelligence (music, talk, ball game, etc.) is carried by the radio waves.

> In Amplitude Modulation, you can say that the intelligence is carried by varying the size (amplitude) of the radio waves.
>
> In Frequency Modulation, the intelligence is carried by varying the frequency of the radio waves. If this frequency were to vary widely enough, the location of the station on your dial would actually move back and forth (very quickly, of course). In practice, though, it does not vary widely enough to be seen on the dial.

DEVIATION. On a transmitted FM signal, the intelligence is carried by varying the stations output frequency (98.6 megacycles, for example) at the audio rate of the intelligence. Deviation is the amount (or distance in kilocycles) that the signal varies from its center frequency.

SENSITIVITY. Generally, sensitivity means "how small a usable signal can this tuner receive at the antenna terminals." It is measured in microvolts (millionths of a volt).

PERCENTAGE OF MODULATION. This represents the amount of intelligence impressed on the FM signal. It is limited to a maximum deviation of plus or minus 75 kc (see "Deviation"). This "amount of deviation" is usually expressed as a percent of modulation. For example, 22.5 kc would be 30% modulation:

$$\frac{22.5}{75} = .30 \text{ or } 30\%$$

QUIETING. The application of an input signal, even though it may not be carrying any intelligence, causes a change of operating conditions in the tuner. This makes the noise from the tuner decrease to where it almost disappears completely and is referred to as "quieting". This is demonstrated when you hear the loud hissing (this is White Noise) between stations. Note that it disappears when you come to a station, even if there is no sound on the station at the time.

SPECIFICATIONS

Quieting Sensitivity...	2.5 μv for 20 db quieting..... 3.5 μv for 30 db quieting 25 μv for full quieting (45 db)	Sensitivity by itself is quite useless if the sound is so noisy that it isn't listenable. This test is a measurement (specified in units of sound, "db") of how much difference there is between the program and the noise. Tests are made for 20 db, 30 db and maximum db (full) difference.
Image Ratio.....	45 db.....	Since most radios are of a superheterodyne design, there is always one other frequency besides the one you are tuned to that could enter the tuner, mix with the oscillator signal and create a signal that would be amplified by the IF amplifiers. It is the function of a good tuner to keep this "other frequency" (known as the "Image") from entering the IF amplifiers. This test tells us how much the "image" would be held back if it were to arrive at your antenna the same size as the signal to which you are tuned.
AFC Correction..... Factor	75 kc per volt.....	If the tuner tends to drift away from the frequency you are tuned to, it will take one volt DC feedback to the tuning unit to correct the oscillator for each 75 kc that it drifts.
AM Suppression.....	25 db.....	Since this is an FM tuner, it is highly desirable that any AM signals present at the antenna not be present in its output, where they would appear badly distorted. If an AM signal and an FM signal, each of the same magnitude, is present at the antenna, the AM signal would be 25 db smaller at the output.
Frequency Response..	±2 db from 20-20,000 cps.....	This tells us how equally all of the audio frequencies, 20-20,000 cycles, are amplified through the complete tuner. It insures that low notes will not be amplified less than high notes or vice versa.
Harmonic Distortion..	Less than 1.5%..... 1100 μv, 400 cycles, 100% modulation	This tells us that an incoming (modulated) waveform will not be distorted by being misshapen by any more than 1.5%.
Intermodulation..... Distortion	Less than 1%.....	This states that an incoming (modulated) waveform will not be distorted more than 1% due to the action of other waveforms present.

CIRCUIT DESCRIPTION

Refer to Fold-out Schematic on Page 47.

The tuning unit of the Heathkit FM-4 Tuner consists of a single dual triode: the first half is used as a grounded grid amplifier and the other half as an autodyne converter. The tuning is done inductively by varying the position of the cores of the RF plate coil and the osc-mixer coil.

The 300 Ω, unbalanced antenna input is connected to the cathode of the RF amplifier V1-A through a band-pass filter (L7-L8-C15). This filter attenuates all but the FM band and matches the impedance of the tuner input to the impedance of V1-A's cathode. The grounded grid provides isolation between the input and output of the RF amplifier, and the 56 Ω (R1) resistor provides cathode bias for the stage. In the plate circuit, L1 and the two adjacent 30 $\mu\mu$f capacitors (C2 and C3) form a resonant circuit which is tunable through the FM band. A single, shorted, grounded, turn of wire (L10) is connected near L1. This is used to trim the low frequency end of the FM band by slightly altering the value of L1.

The autodyne converter is essentially a tickler and feedback-tuned grid oscillator. The oscillator tuned circuit consists of L2, with two 15 $\mu\mu$f capacitors (C4 and C6) in series across it, and associated circuit capacities. Coil L4, in the plate circuit, provides the feedback necessary to sustain oscillation. As in coil L1, there is a single shorted, grounded, turn of wire (L9) that trims the low end of the oscillator range.

The input signal from the RF amplifier is coupled to the grid of V1-B through a 15 $\mu\mu$f capacitor (C6). Here it mixes with the oscillator signal, and a 10.7 mc IF frequency is produced at the plate, where it is coupled through transformer T1 to the first IF amplifiers.

Automatic frequency control is provided by the action of the AFC control voltage on special diode X-1. As its applied voltage changes, the capacity across the diode changes, causing a slight change in the capacity across oscillator coil L2. (This capacity appears across L2, due to the following capacitors being in series: 8.2 $\mu\mu$f (C5), capacity of X-1, .001 μfd feed-through capacitor C17, and the grid capacity of V1-B.) A change in capacity across L2 changes the oscillator frequency. Whether the frequency increases or decreases depends on the change in the voltage applied to X-1. This voltage is supplied by the detector circuit and is of such a polarity and magnitude as to correct any frequency drift.

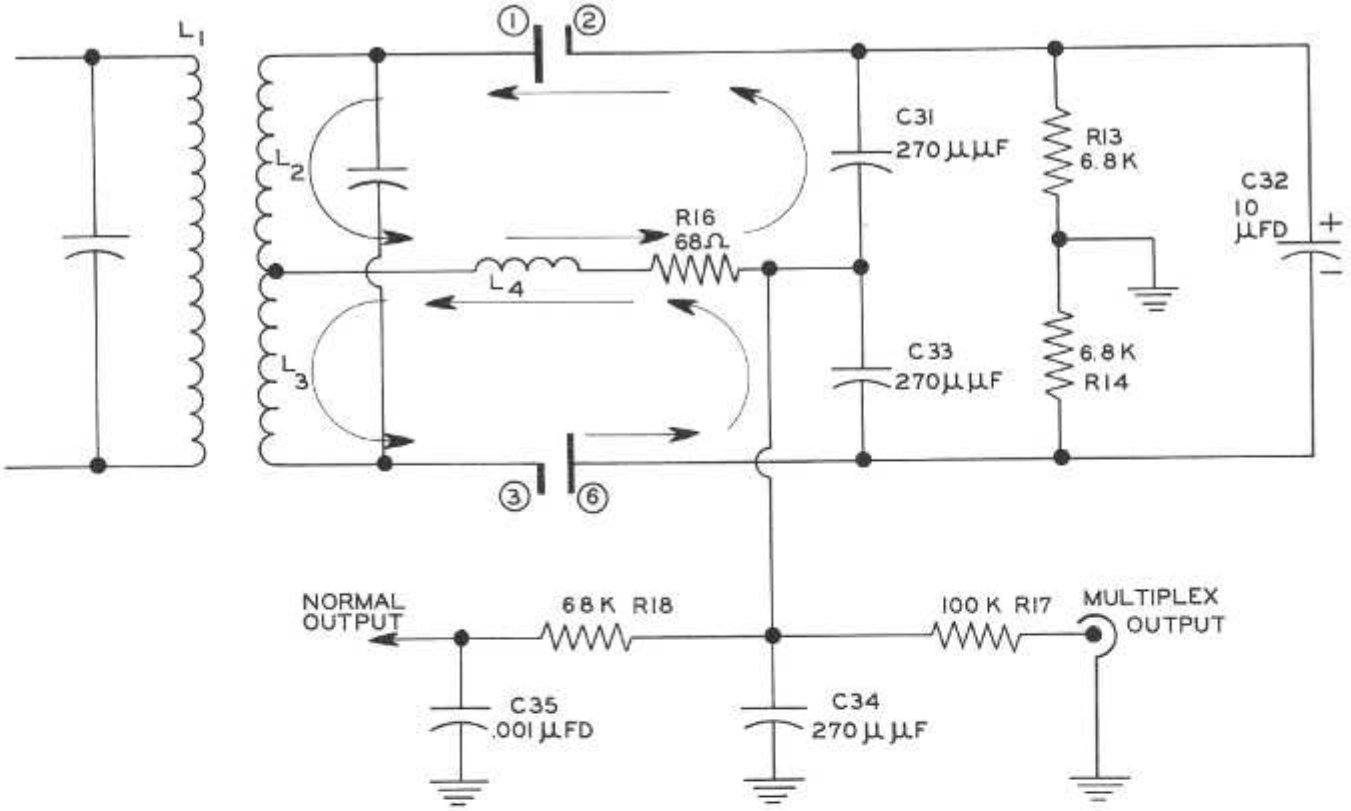
Connected just above X-1 are the 220 KΩ (R6) and 4.7 megohm (R3) resistors which bias the diode to keep it from conducting and loading down the oscillator.

From transformer T1 (in the tuning unit), the 10.7 mc IF signal is amplified by the circuits of V2 and V3, the IF amplifiers. Transformers T2 and T3 are band-pass transformers. That is, as the 10.7 mc IF frequency deviates plus or minus 75 kc or less, each frequency it deviates to will receive equal amplifcation through the transformers.

V4 is the limiter stage. Since this is a frequency modulation tuner, it is desired that all amplitude changes in the signal (amplitude modulation) be removed so that they cannot cause distortion in the output signal. Due to the action of the resistor-capacitor combinations in the grid return and plate return, the limiter stage acts as a valve and removes all of the amplitude changes.

The 820 KΩ resistor (R10) and 270 $\mu\mu$f capacitor (C23) in the grid return of V3 aid in limiting on the higher level signals only.

The ratio detector circuit is the circuit that converts the frequency modulated IF signal (10.7 mc) into an audio signal 20-20,000 cycles.



Its operation may be very briefly described as follows: L_1 represents the transformer primary, L_2 and L_3 represent the secondary, and L_4 is just a few turns of wire, tightly wrapped around the bottom of the primary L_1. Consider a separate voltage to be induced by the primary into each of the windings, L_2, L_3 and L_4. L_4, since it is closely coupled to the primary, introduces a voltage (in series with both halves of the secondary) that is relatively constant in amplitude (as long as the voltage on L_1 does not change). This winding, L_4, is usually known as the "Tertiary Winding", the word tertiary coming from the Latin word for "third".

Notice that each diode has its own separate loop in which its current flows (indicated by the arrows). The current flowing in the top diode is controlled by the voltage induced in L_2 and L_4 which charges the top 270 $\mu\mu$f capacitor. The current flowing in the bottom diode is controlled by the voltage induced in L_3 and L_4 which charges up the bottom 270 $\mu\mu$f capacitor (C31). The two 270 $\mu\mu$f capacitors (C31 and C33) are charged up in the same direction and the 10 μfd capacitor (C32) keeps the sum of these two voltages from being able to change at an audio rate.

Note that the diode currents through L_4 and the 68 Ω resistor (R16) are going in opposite directions. At the center frequency, 10.7 mc, the diode currents are equal, producing equal charges on the two 270 $\mu\mu$f capacitors. As the frequency deviates from 10.7 mc, the change in frequency causes the current of one diode to increase while the current in the other diode decreases. These changes are caused by a change in phase relationships between the coils. As the diode currents become different, the charges on the 270 $\mu\mu$f capacitors become different. Hence, as the incoming frequency varies at an audio rate, the charges on these individual capacitors also change at an audio rate. The sum of the two voltages remains essentially constant (therefore amplitude modulation changes are minimized), while the ratio of one voltage to the other varies at an audio rate. Hence the name, "ratio detector".

The output is taken from the circuit at the junction of the two capacitors. At this point we find a 100 KΩ isolating resistor (R17) to the multiplex output, a 270 μμf capacitor (C34) to ground to short out any remaining IF frequencies, and the normal output which goes through the 68 KΩ resistor (R18) and .001 μfd de-emphasis network (C35).

To make the receiver more noise-free, the higher audio frequencies are transmitted more strongly from the station. The de-emphasis circuit merely corrects for these emphasized higher frequencies, and rebalances the high and low frequencies back to their original condition. From this point, the audio signal is applied to the cathode follower output stage through the volume control (R22). A cathode follower output is desirable to lower the impedance of the output signal, thereby making it less sensitive to hum and other distorting influences. The bias on this cathode follower is developed across the 1 KΩ resistor (R20) in the cathode. From here the audio signal goes to your amplifier and speaker system.

CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. While the arrangement shown is probably not the only satisfactory arrangement, nevertheless it is the result of extensive experimentation and trial. If followed carefully, it will result in a stable instrument, operating at a high degree of accuracy and dependability. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the charts and other information shown on the inside covers of your manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the REPLACEMENT section and supply the information called for therein, and include all inspection slips in your letter to us. Hardware items are counted by weight and there may be a few more or less than the quantity specified. If a few are missing, please obtain them locally if at all possible.

In order to expedite delivery to you, we are occasionally forced to make minor substitution of parts. Such substitutions are carefully checked before they are approved and parts supplied will work satisfactorily. In checking the Parts List for resistors, for example, you may find that a resistor with a 5% tolerance has been substituted for a resistor with a 10% tolerance, as shown on the Parts List. These changes are self-evident and are mentioned here only to prevent confusion in checking the contents of your kit.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -50% are common for electrolytic capacitors.

PROPER SOLDERING TECHNIQUES

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

If terminals are bright and clean and free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Correctly soldered connections are essential if the performance engineered into a kit is to be fully realized. If you are a beginner with no experience in soldering, a half hour's practice with some odd lengths of wire may be a worthwhile investment.

For most wiring, a 30 to 100 watt iron or its equivalent in a soldering gun is very satisfactory. A lower wattage iron than this may not heat the connection enough to flow the solder smoothly over the joint. Keep the iron tip clean and bright by wiping it from time to time with a cloth.

CHASSIS WIRING AND SOLDERING

1. Unless otherwise indicated, all wire used is the type with the colored insulation (hookup wire); the size of the conductor is the same for all colors of hookup wires furnished with your kit. If the wire with a specific color of insulation is to be used, it will be stated in the step. In the case that bare wire is to be covered with insulating sleeving, the phrase "use sleeving" will be used.

2. 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. Wherever there is a possibility of bare leads shorting to other parts or to the chassis, the leads should be covered with insulating sleeving. This will be indicated by the phrase, "Use sleeving".

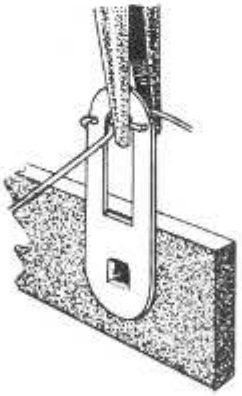
3. Crimp or bend the lead (or leads) around the terminal to form a good joint without relying on solder for physical strength. If the wire is too large to allow bending, position the wire so that a good solder connection can still be made.

4. Position the work, if possible, so that gravity will help to keep the solder where you want it.

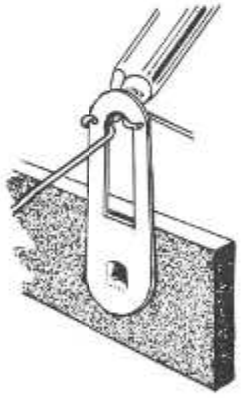
5. Place a flat side of the soldering iron tip against the joint to be soldered until it is heated sufficiently to melt the solder.

6. Then place the solder against the heated terminal and it will immediately flow over the joint; use only enough solder to thoroughly wet the junction. It is usually not necessary to fill the entire hole in the terminal with solder.

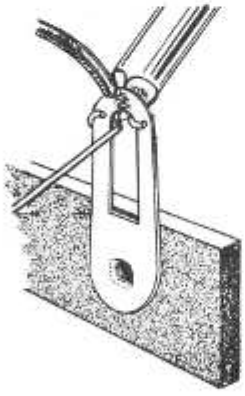
7. Remove the solder and then the iron from the completed junction. Use care not to move the leads until the solder is solidified.



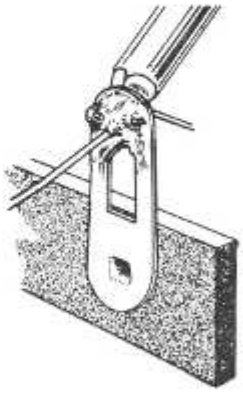
CRIMP WIRES



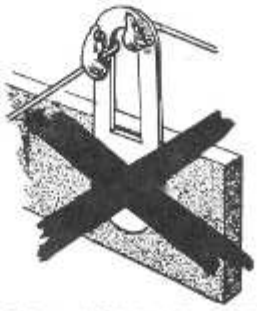
HEAT CONNECTION



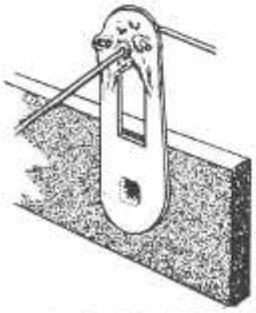
APPLY SOLDER



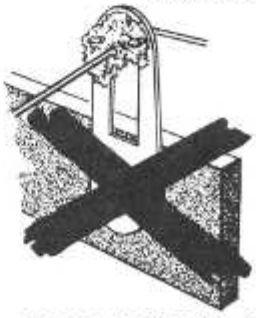
ALLOW SOLDER TO FLOW



COLD SOLDER JOINT CONNECTION INSUFFICIENTLY HEATED



PROPER SOLDER CONNECTION



COLD SOLDER JOINT CONNECTION MOVED WHILE COOLING

A poor or cold solder joint will usually look crystalline and have a grainy texture, or will stand up in a blob and will not have adhered to the joint. Such joints should be reheated until the solder flows smoothly over the entire junction. In some cases, it may be necessary to add a little more solder to achieve a smooth, bright appearance.

NOTE: 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 A NEW ROLL PLAINLY MARKED "ROSIN CORE RADIO SOLDER" BE PURCHASED.

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

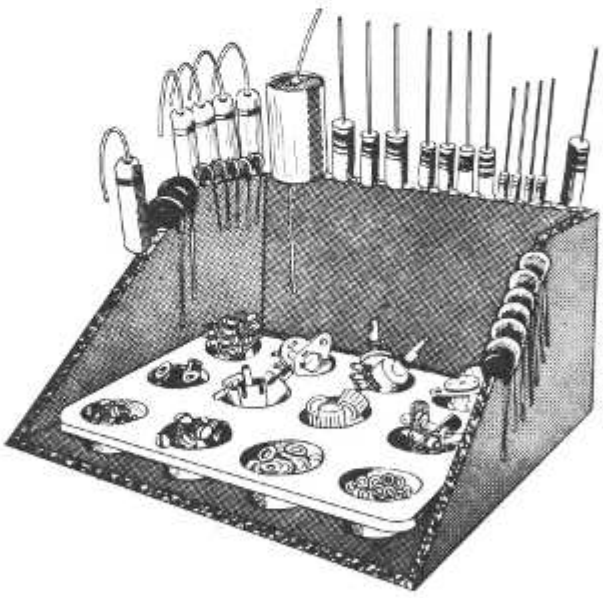
1. Attach the large fold-in pictorials to the wall above your work bench.

2. Read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations.

3. Lay out all parts so that they are readily available.

4. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screwdriver with a 1/8" blade; long-nose pliers; wire cutters, preferably separate diagonal cutters; a pen knife or a tool for stripping insulation from wires; a solder iron (or gun) and rosin core solder. A soldering aid, a set of nut drivers and a nut starter, while not necessary, will aid extensively in construction of the kit.

Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.



STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted. Some kit builders have also found it helpful to mark each lead in colored pencil on the pictorial as it is added.

The abbreviation "NS" indicates that a connection should not be soldered as yet for other wires may need to be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this. Note that a number will appear after each solder instruction. This number indicates the number of leads that are supposed to be connected to the terminal in question before it is soldered. For example, if the instruction reads, "Connect one lead of a 47 KΩ resistor to lug 1 (S-2)", it will be understood that there will be two leads connected to the terminal at the time it is soldered. This additional check will help avoid errors.

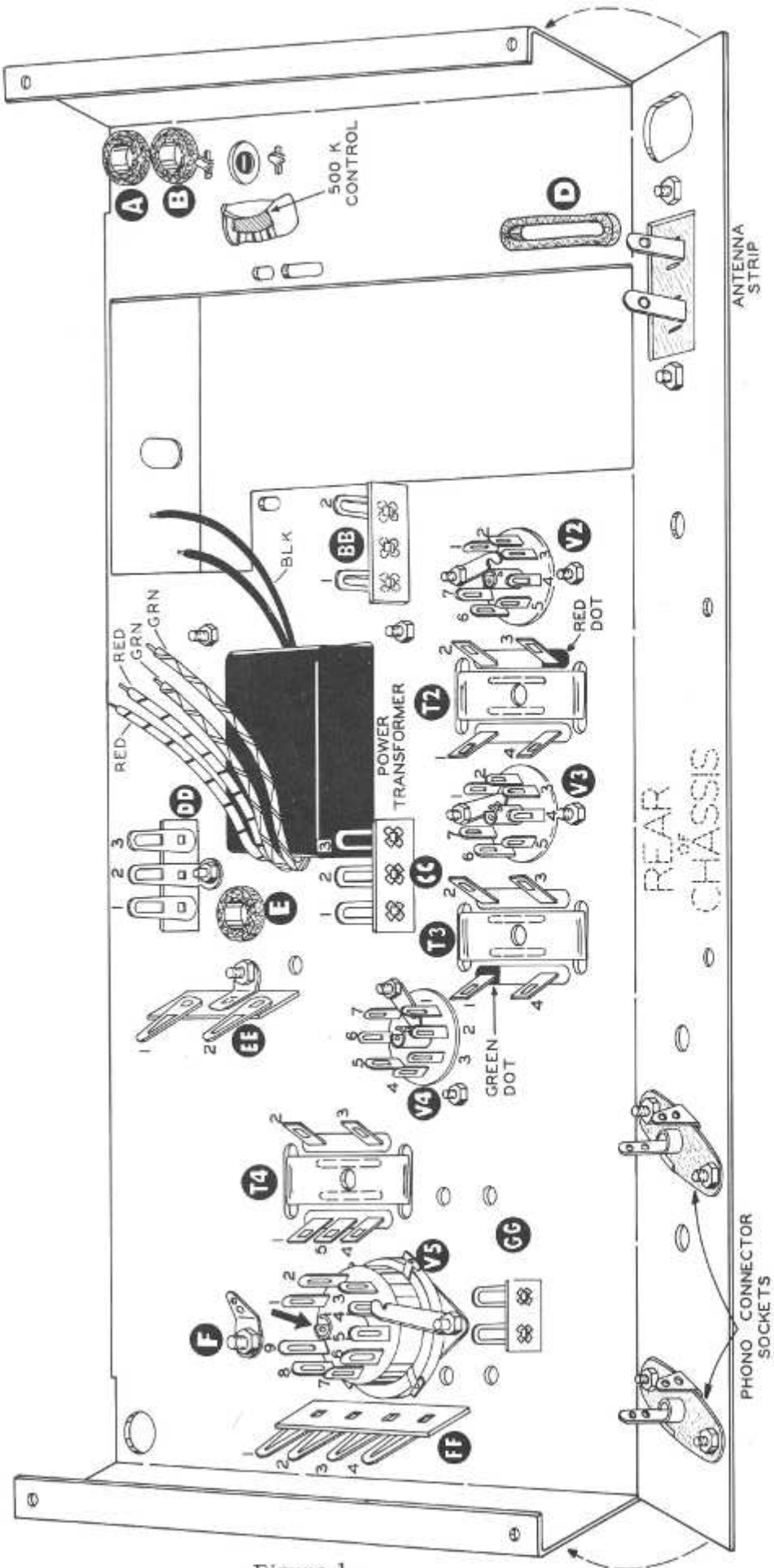

A
B
C
500 K CONTROL
D
ANTENNA STRIP
BB
BLK
RED
GRN
GRN
RED
POWER TRANSFORMER
V2
RED DOT
T2
V3
DD
E
CC
T3
EE
GREEN DOT
V4
T4
GG
V5
F
FF
REAR OF CHASSIS
PHONO CONNECTOR SOCKETS

Figure 1

STEP-BY-STEP

Refer to Figure 1 on Page 9 for the following steps.

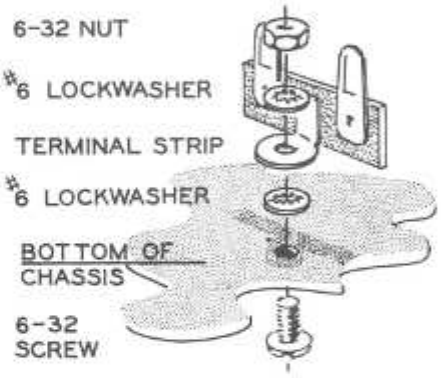
( ) Place the chassis on your work surface in front of you, in the manner shown in Figure 1.

( ) Mount the 3/4" grommet in oblong hole D.

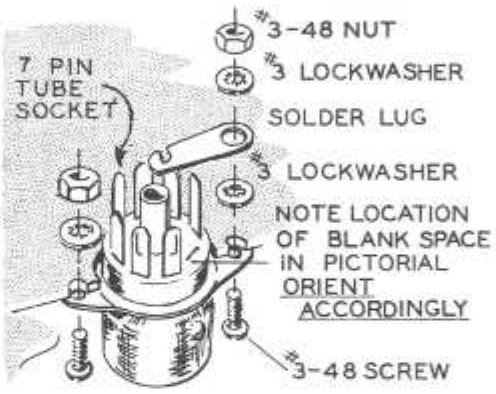
NOTE: Use 6-32 x 1/4" screws, lockwashers and nuts for mounting parts, unless directed otherwise.

( ) Mount the antenna terminal strip in the square hole near D, using 6-32 screws, nuts and lockwashers. This should be mounted from the outside of the chassis. Mount a large solder lug on the centermost 6-32 screw between the terminal strip and the chassis. Temporarily position the lug parallel to the top of the chassis as it appears in Figure 5 on Page 23.

( ) Mount the 2-lug terminal strip BB, using 6-32 hardware, as shown in Detail 1A.



Detail 1A



Detail 1B

( ) Mount a 7-pin tube socket V2 with 3-48 screws, lockwashers and nuts. On the mounting screw nearest the center of the chassis, install a small solder lug. Tighten the screw, holding solder lug between pin 1 and the center post, as shown. See Detail 1B.

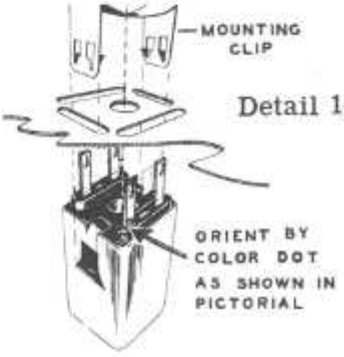
( ) In the same way, mount tube sockets V3 and V4. In each case, mount a solder lug in the same manner as in V2.

NOTE: To make the IF (intermediate frequency) transformer mounting clips seat properly, it may be necessary to press on the clips from the bottom with a screwdriver while holding the transformer in place.

( ) Mount transformer T2 (#52-26) with the red dot nearest pin 5 of V2. Hold the transformer in place with one hand and push the mounting clip through from the bottom until each side engages. See Detail 1C.

( ) In the same manner, mount transformer T3 (#52-27) with the green dot nearest pin 1 of V4.

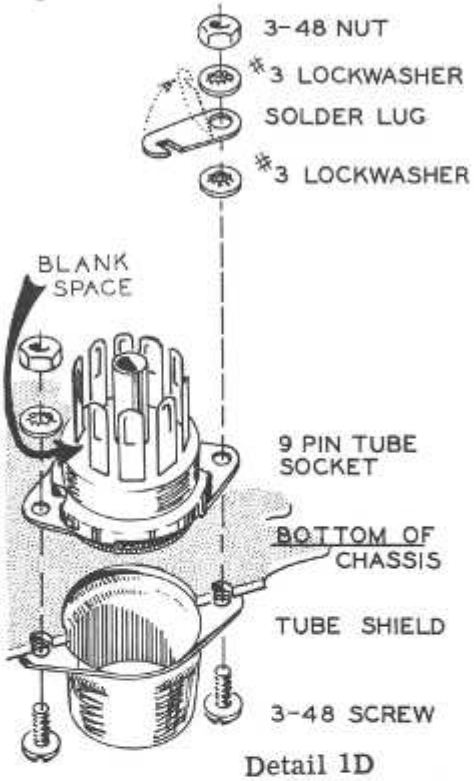
( ) Using 6-32 hardware, mount the two phono sockets on the rear panel near V5.



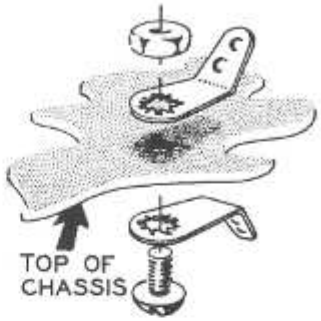
Detail 1C

( ) Mount the 9-pin tube socket V5 and its shield base, using 3-48 hardware, as shown in Detail 1D. Keep the open space toward the front of the chassis. On the 3-48 screw closest to the rear of the chassis, place a small #6 solder lug. If the solder lug is placed flat against the chassis, and bent up later, it will be easier to start the nut. While tightening down this same screw, hold the small solder lug in an upright position near pin 4.

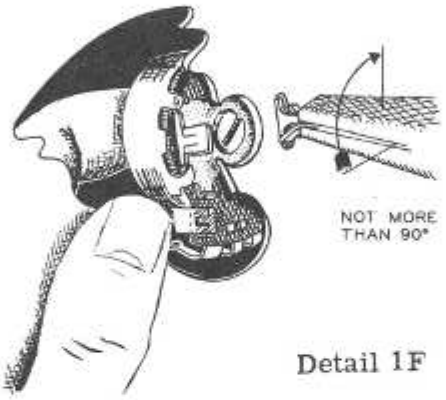
( ) Using 6-32 hardware, mount terminal strip GG.



Detail 1D



Detail 1E



Detail 1F

( ) Mount 4-lug terminal strip FF, using 6-32 hardware (see Detail 1A). Temporarily bend out the foot of the terminal strip to start the nut, and then return it to its straight up position.

( ) Mount ratio detector transformer T4 (#53-4) with the side having three lugs near tube socket V5.

( ) Using 6-32 hardware, mount two large #6 solder lugs at location F. Mount one on each side of the chassis and face both toward the power transformer cutout. See Detail 1E.

( ) Mount 2-lug terminal strip EE, using 6-32 hardware (see Detail 1A).

( ) Mount grommet E.

NOTE: Before mounting the power transformer, check to make sure that all four of its bolts are tight.

( ) Mount the power transformer from the top of the chassis with the leads extending in the directions indicated in Figure 1. (Make certain that leads are not pinched between the transformer and chassis.) At the same time, mount terminals CC and DD on the transformer mounting lugs and secure them with #6 lockwashers and nuts (see Detail 1A).

( ) Install grommets A and B.

( ) Place the tabs of the 500 KΩ control through the chassis slots from the top. Direct the three solder lugs toward the power transformer. Hold the control firmly in place and twist each lug about 45°. See Detail 1F.

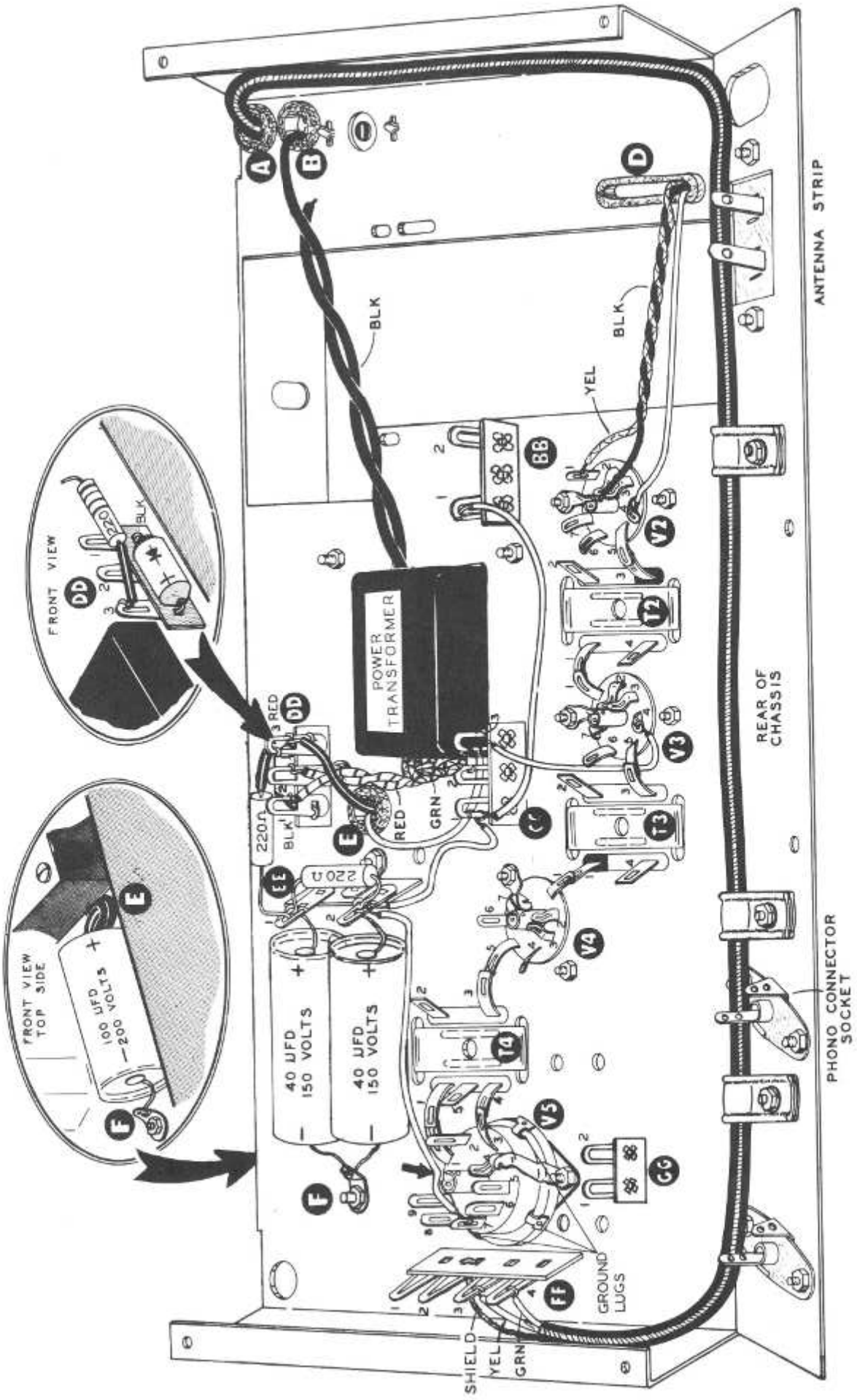

ANTENNA STRIP
REAR OF CHASSIS
PHONO CONNECTOR SOCKET
POWER TRANSFORMER
BLK
YEL
RED
GRN
220Ω
40 UFD 150 VOLTS
100 UFD —200 VOLTS
FRONT VIEW
FRONT VIEW TOP SIDE
GROUND LUGS
SHIELD
YEL
GRN

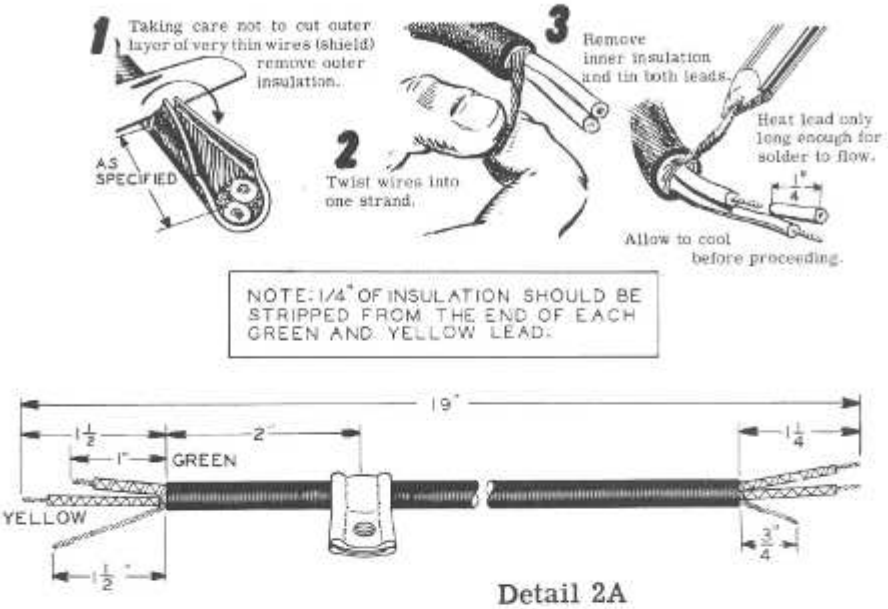
Figure 2

Refer to Figure 2 for the following steps.

( ) Prepare the 2-conductor shielded cable by first removing 1 1/2" of outer insulation from one end of the cable, and 1 1/4" from the other end. Next prepare the four wire ends as shown in Detail 2A.

( ) Mount a cable clamp, as shown, 2" from the end of the outer insulation, at the end from which 1 1/2" of outer insulation was removed. See Detail 2A.

( ) Using one of the long (3/8") 6-32 screws, nut and lockwasher, mount the cable clamp with its flat side toward the inside of the chassis in the mounting hole between the phono connectors.



Detail 2A

( ) Mount the other two cable clamps in the same manner, taking care that the cable is snug against the rear panel between the clamps before tightening down the screws.

( ) Continue guiding the cable down the rear corner of the chassis, up the side of the chassis, and through grommet A.

NOTE: When soldering connections to the bottom hole of a terminal, it is much easier when the iron is applied to one side of the terminal and the solder is applied to the opposite side.

( ) At the end of the 2-conductor cable near tube socket V5, connect the shielding through the bottom hole of terminal FF2 (NS). Before inserting, clip 1/4" from the end of the tinned shielding. You will find that this will make it easier to insert the shielding. Solder this bottom hole only.

NOTE: You will find your long-nose pliers to be almost a necessity for the next two connections.

( ) Connect the yellow lead to terminal FF3 (NS).

( ) Connect the green lead to terminal FF4 (NS).

( ) At the power transformer, twist the two red leads together and connect one lead to DD1 (NS) and the other lead to DD2 (S-1).

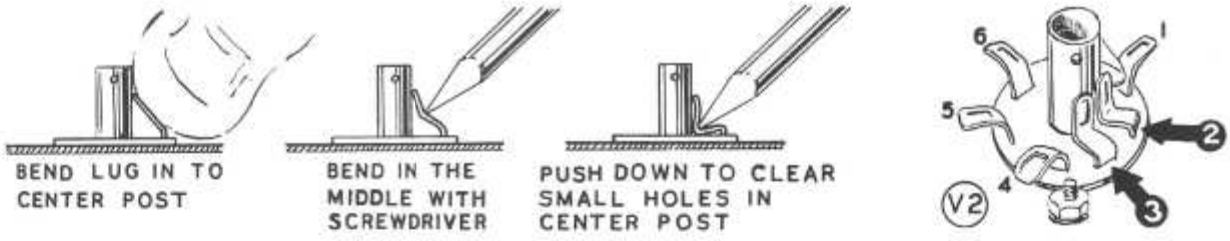
( ) Twist the two green leads from the power transformer together and connect one lead to CC2 (S-1) and the other lead to CC3 (NS).

( ) Twist the two black power transformer leads together and temporarily push the longer of the two down through grommet B.

( ) On tube socket V2, in the manner shown in Detail 2B, bend out pins 1, 4, 5, 6 and 7.

( ) In the same manner, on tube sockets V3 and V4, bend out pins 1, 4, 5 and 6.

Detail 2B

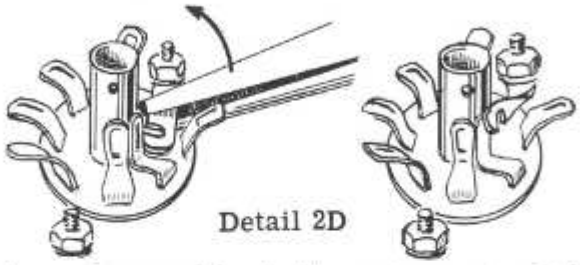


Detail 2C

(✓) In the manner shown in Detail 2C, on V2 bend in pins 2 and 3 to the center post.

(✓) In like manner on tube sockets V3 and V4, bend in pins 2, 3 and 7 to the center post.

(✓) Bend the small #6 solder lugs on V2, V3 and V4 up to rest against the center post of each tube, as shown in Detail 2D. In the case of V2, make certain that the small #6 solder lug does not touch pin 7. This would short pin 7 to the chassis (ground).



Detail 2D

(✓) Using the minimum of solder required to make a good connection, solder the bent over pins and ground lug to the center post of V2. Keep the small holes in the center post open so that wires may also be connected in later steps.

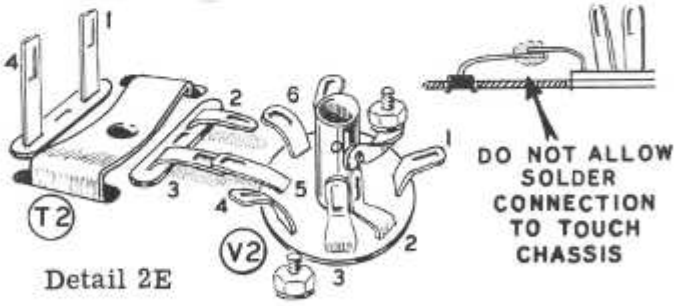
(✓) In the same manner, solder the bent over pins and ground lugs to the center posts of V3 and V4.

(✓) Bend pin 4 of V5 down to touch the center post (see Detail 2C).

(✓) Using a screwdriver, bend the small #6 solder lug on V5 down to touch pin 4 (NS). Be sure that this does not also ground out pin 5 of V5.

(✓) Bend down the four ground lugs which are part of the outside base of V5.

(✓) Bend over lug 3 of IF transformer T2 to meet pin 5 on tube socket V2, as depicted in Detail 2E. Solder this connection.



Detail 2E

NOTE: When soldering lugs together, if you notice that the lugs do not seem to be joined tightly together after the joint has been soldered, merely reheat the solder joint while applying a slight bit of pressure with a screwdriver to the top of the top lug. Do not remove the pressure until the solder has solidifed. It is important that these two lugs be touching mechanically, rather than merely held together by a "blob" of solder.

(✓) Bend over lug 1 of IF transformer T2 to touch pin 1 of tube socket V3. Solder this connection.

(✓) Bend down lug 3 of IF transformer T3 to touch pin 5 of tube socket V3 and solder the two together.

(✓) Bend down lug 1 of IF transformer T3 to touch pin 1 of tube socket V4. Solder the connection.

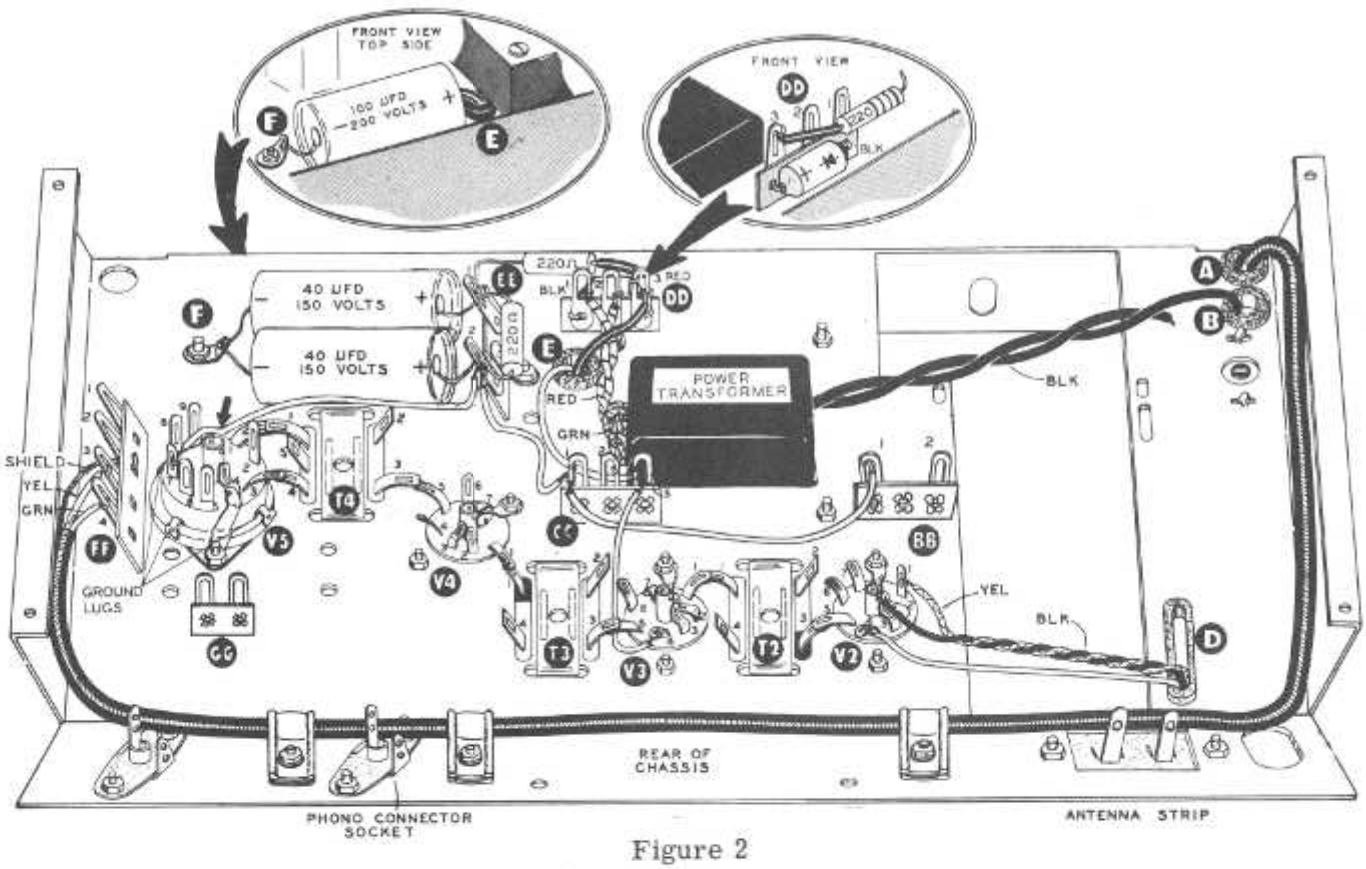


Figure 2

( ) Slightly twist lug 3 of IF transformer T4 and bend it down to touch pin 5 of V4. Solder the connection.

( ) Bend out lugs 1 and 4 of IF transformer T4 to meet pins 1 and 3 of tube socket V5. Solder both of these connections. Now solder bent over pin 4 to both the ground lug and the center post, as shown. Be sure that the ground lug does not touch pin 5.

NOTE: When soldering connections to the bottom hole of a terminal, it is much easier when the iron is applied to one side of the terminal and the solder is applied to the opposite side.

( ) Connect the lead from the black end of the silicon rectifier through the bottom hole of terminal DD1, keeping the body of the rectifier close to the terminal strip. Solder both connections to DD1, starting with the bottom hole.

( ) Connect the lead from the red end of the rectifier through the bottom hole of terminal DD3. Solder this connection at the bottom hole only.

( ) Connect a 220 Ω 1 watt (large size) resistor (red-red-brown) from DD3 (NS) to EE1 (NS). Position it as shown in Figure 2. Use sleeving.

( ) Connect the remaining 220 Ω 1 watt (large size) resistor (red-red-brown) to EE1 (NS).
( ) Connect the other lead of the resistor to terminal EE2 (NS).
( ) Slide a 1 1/2" length of insulated sleeving over the positive (+) lead of the 100 μfd, 200 volt capacitor. Run this lead from the top of the chassis down through grommet E.
NOTE: The pilot lamp socket will be mounted later, in the hole to the rear of grommet E. Allow enough lead to be able to mount it easily.

NOTE: Grommet E is partially hidden underneath the edge of the transformer. This is done purposely to minimize the shock hazard on the end of this capacitor. The B+ voltage is present at this point and by keeping the capacitor as close as possible to the transformer, it is impossible for a person to get his fingers to the front of this capacitor and get shocked.

( ) Connect the negative (-) lead of the 100 μfd, 200 V DC capacitor to the ground lug at F on the top of the chassis (S-1). This lug will be located just behind this capacitor lead, just forward of the tube socket V5.

( ) Connect the positive (+) lead of this capacitor to terminal DD3 (S-2).

NOTE: All hookup wire used should be black unless otherwise indicated. Also, all hookup wire should have 1/4" of insulation stripped from the ends, unless otherwise directed.

( ) Connect a length of hookup wire from EE2 (NS) to pin 7 of V5 (S-1).

NOTE: Position the capacitors in the following two steps so that the capacitor closest to the front of the chassis will be at least 1/2" from the front edge.

( ) Position a 40 μfd, 150 volt electrolytic capacitor between terminal EE2 and ground lug F. Connect the positive (+) end of the capacitor to EE2 (NS).

( ) Connect the negative (-) end of the capacitor to terminal F (NS).

( ) Position the other 40 μfd 150 volt electrolytic capacitor between terminal F and EE1. Connect the negative (-) end of the capacitor to terminal F (S-2) and connect the positive (+) end of the capacitor to terminal EE1 (S-3).

( ) Connect a length of hookup wire close to the chassis from terminal EE2 (S-4) to terminal CC1 (NS).

( ) Connect a length of hookup wire close to the chassis from terminal CC1 (NS) to terminal BB1 (NS).

( ) Cut a piece of hookup wire to a length of 2 1/2" and strip both ends. Connect it from terminal CC3 (NS) to pin 4 of V3 (NS). Route this lead along the chassis underneath the solder connection on pin 5 of V3.

( ) Cut a piece of hookup wire 5" in length and strip both ends. Connect one end to pin 4 of V2 (NS). Pass the other end down through grommet D temporarily.

( ) Cut a piece of black hookup wire 5" in length. Twist this hookup wire together with a 5" length of yellow hookup wire.

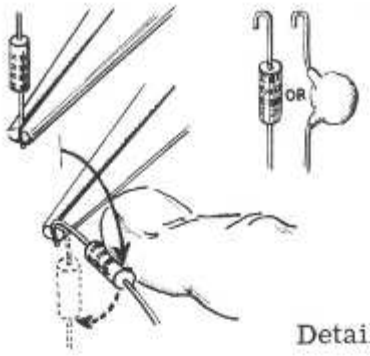
( ) At one end of this pair, cut 1/2" from the end of the yellow wire and strip 1/4" of insulation from both the yellow and black wires at each end.

( ) Connect the short yellow lead to pin 1 of V2 (NS). Connect the black lead to the center post of V2 (NS).

NOTE: In the center post of V2 there are a number of holes. Connections to the center post may be made relatively easily by passing the lead to be connected through one of these holes.

( ) Guide the other end of this twisted pair through grommet D.

( ) Cut a piece of hookup wire 5" in length. Strip both ends. Connect one end to terminal CC3 (S-3) and push the other end down through grommet E.



Detail 2F

Refer to Figure 3 for the following steps.

NOTE: Component leads in this kit should be as short as possible. The 1/2" length indicated in the steps is intended as an aid for novices at wiring, but it is always best to keep leads as short as possible.

Detail 2F illustrates a means of preparing components for easier installation in congested areas.

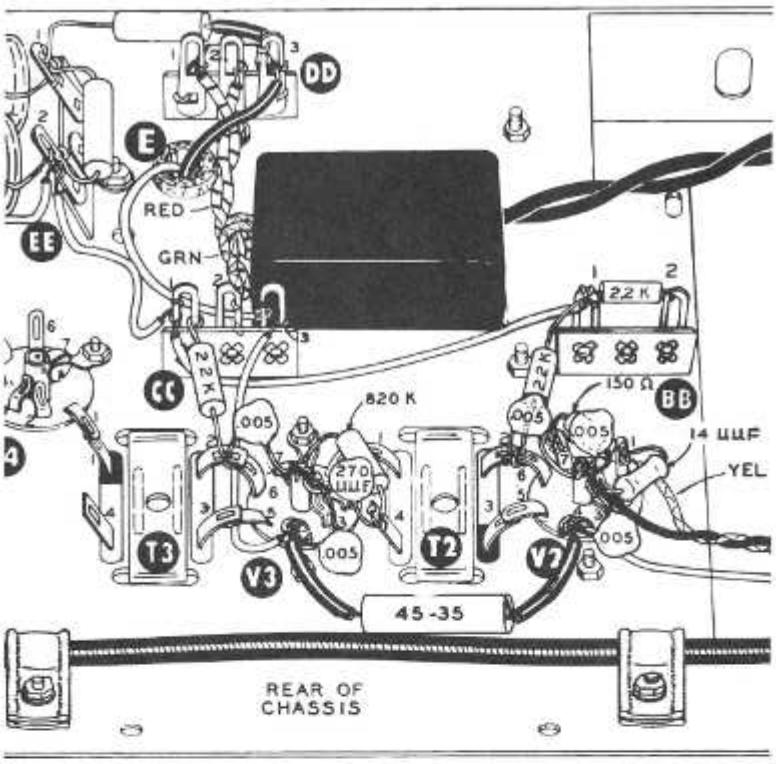


Figure 3

( ) Using sleeving to insulate the leads, connect a filament RF choke (#45-35) from pin 4 of V2 (NS) to pin 4 of V3 (NS). Place the body of the choke against the back panel above the cable.

( ) Clip both leads of a .005 µfd capacitor to approximately 1/2" in length.

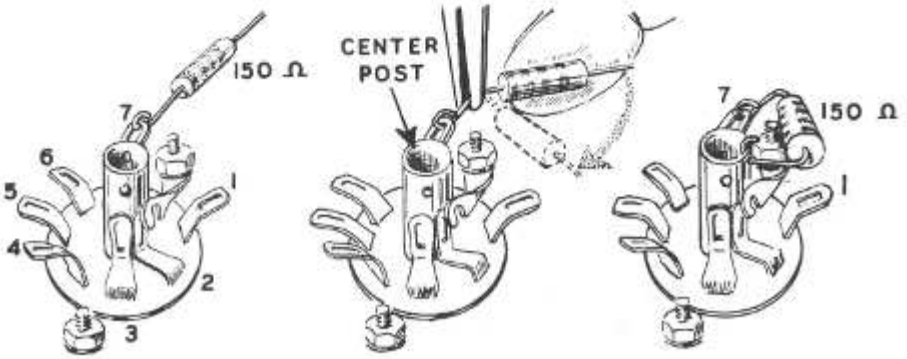
( ) Connect this capacitor between pin 4 of V2 (S-3) and the center post (NS). Your long-nose pliers may be handy for inserting these capacitor leads into the two holes, one in the pin and the other in the center post.

( ) Clip both leads of the 14 µµf capacitor to 1/2" in length (this may be either the disc type or the tubular type). Positioning the capacitor up from the tube socket V2, connect one lead to pin 1 (S-2), and the other lead through one of the holes in the center post (NS).

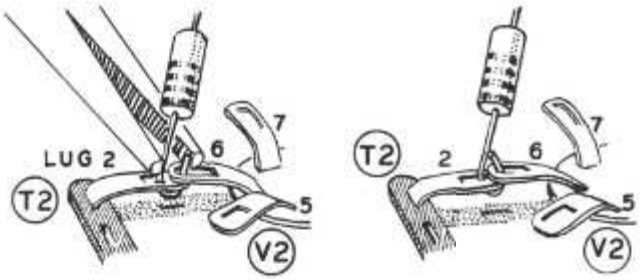
( ) Clip each lead of the 150 Ω resistor (brown-green-brown) to 1/2" in length. With your long-nose pliers, form a hook at the end of one of the 1/2" leads. Hook this lead onto pin 7 of V2 (NS) and squeeze the hook tight around pin 7. Refer to Detail 2F.

( ) Bend the other lead of the resistor around and insert it through one of the holes in the center post of V2 (NS), as shown in Detail 3A.

( ) Bend lug 2 of transformer T2 to meet pin 6 of V2 (NS).



Detail 3A



Detail 3B

(✓) Clip each lead of a 2.2 KΩ resistor (red-red-red) to 1/2" in length. Hook one lead up through pin 6 of V2 and also through lug 2 of IF transformer T2 (see Detail 3B). Squeeze down the hook to make a tight mechanical connection (NS).

(✓) Connect the other end of the resistor to terminal BB1 (NS).

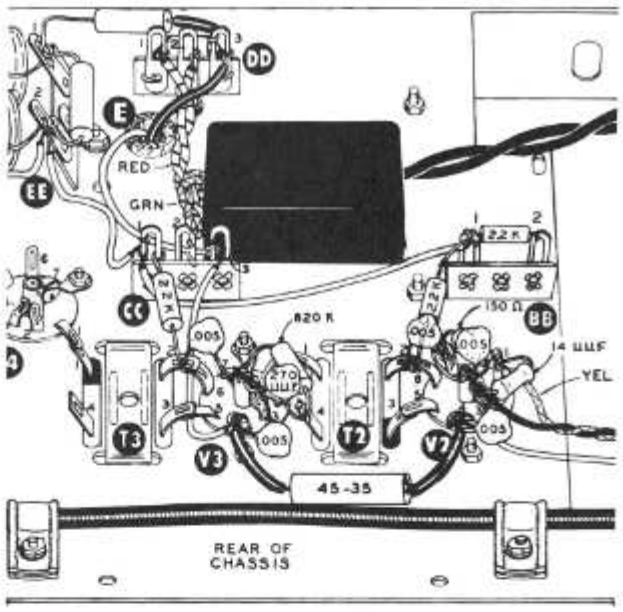


Figure 3

NOTE: Before forming a hook on a component, first examine the pictorial to see in which direction a hook should be formed to place the component as it is shown.

(✓) Clip each lead of a .005 μfd capacitor to 1/2" in length. Connect one lead to pin 7 of V2 (S-2). Connect the other lead through one of the holes in the center post (NS).

(✓) Clip both leads of a .005 μfd capacitor to 1/2" in length. Connect one lead to lug 2 of transformer T2 (S-2). See that enough solder reaches the joint so that the two lugs and the two leads are soldered together.

(✓) Connect the other lead of the .005 μfd capacitor through one of the holes in the center post of V2.

(✓) At this point, solder the connections (6 leads) to the center post.

NOTE: At this point a double check might be in order. Carefully examine pins 1, 4 and 7 and the leads connected to each pin to make sure that none of these leads touch the chassis or any pin to which they are not connected. Make sure that no leads connected to the center post are inadvertently touching pin 1 or pin 7.

(✓) Clip the leads of a 2.2 KΩ resistor (red-red-red), each to 1/2" in length.

(✓) Connect this resistor between terminals 1 (S-3) and 2 (NS) of terminal strip BB.

(✓) Clip each lead of a .005 μfd capacitor to 1/2" in length. Connect one lead to pin 4 of V3 (NS).

(✓) Connect the other end of the capacitor through one of the holes in the center post (NS). Orient the body of the capacitor to lie close to the chassis.

(✓) Carefully check the connections to pin 4 of V3 to make sure that the leads connected do not short out to the chassis or to the 3-48 mounting screw or nut. A short circuit at this point could seriously damage several components.

(✓) Clip each lead of a 270 μμf capacitor to 1/2" in length. Connect this capacitor between lug 4 of T2 (NS) and the center post of V3 (NS).

(✓) In the same manner, connect an 820 KΩ resistor (gray-red-yellow) between the same points, lug 4 of T2 (S-2) and the center post of V3 (NS).

(✓) Bend lug 2 of T3 over to pin 6 of V3 (NS).

( ) Clip each lead of a 2.2 KΩ resistor (red-red-red) to 5/8" in length. Hook one lead up through pin 6 of V3 and lug 2 of transformer T3. Close the hook to make a tight connection between the two lugs (NS).

( ) Connect the other end of this resistor to terminal CC1 (NS). Clip off any excess lead if it seems to be too long.

( ) Clip both leads of a .005 μfd capacitor to 1/2" in length. Connect one lead to pin 6 of V3 (S-2). Connect the other end of the capacitor through one of the holes in the center post of V3 (NS).

( ) At this point solder the center post (4 leads).

NOTE: Once again, double check for any spot where a lead or a resistor might touch the chassis around this particular socket. Especially check pins 1, 4, 5 and 6 to make sure that no leads connected to them touch the chassis or each other.

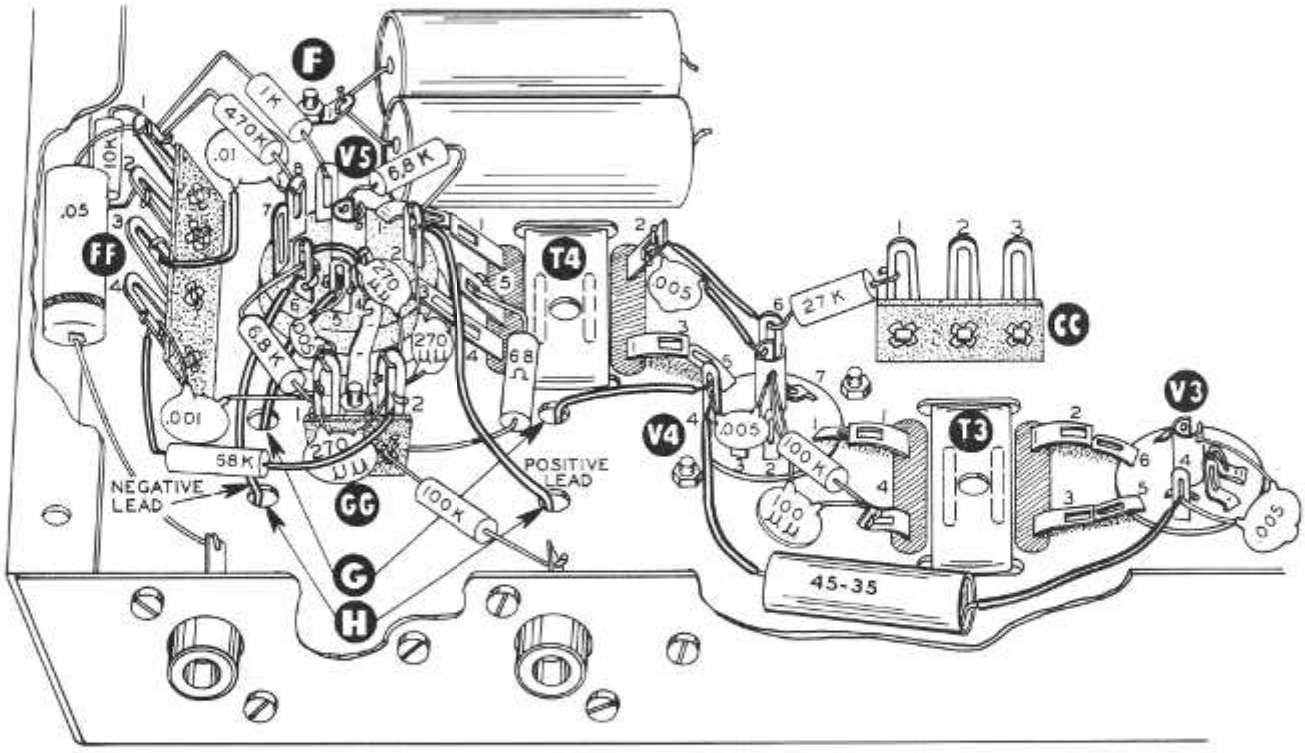


Figure 4

Refer to Figure 4 for the following steps.

( ) Bend lug 4 of transformer T3 over and twist it so that it faces toward tube socket V4, as shown in Figure 4.

( ) Clip both leads of the 100 μμf capacitor to 1/2" in length. Connect one lead to lug 4 of transformer T3 (NS).

( ) Connect the other end of this capacitor to the center post of tube socket V4 (NS). Orient the body of the capacitor to lie flat on the chassis.

( ) Clip each lead of a 100 KΩ resistor (brown-black-yellow) to 1/2" in length.

( ) Connect one end of this resistor to lug 4 of transformer T3 (S-2), and the other end to the center post of tube socket V4 (NS). Check to make sure that neither of these leads connected to the center post touch the connection on pin 1 of this same tube socket V4.

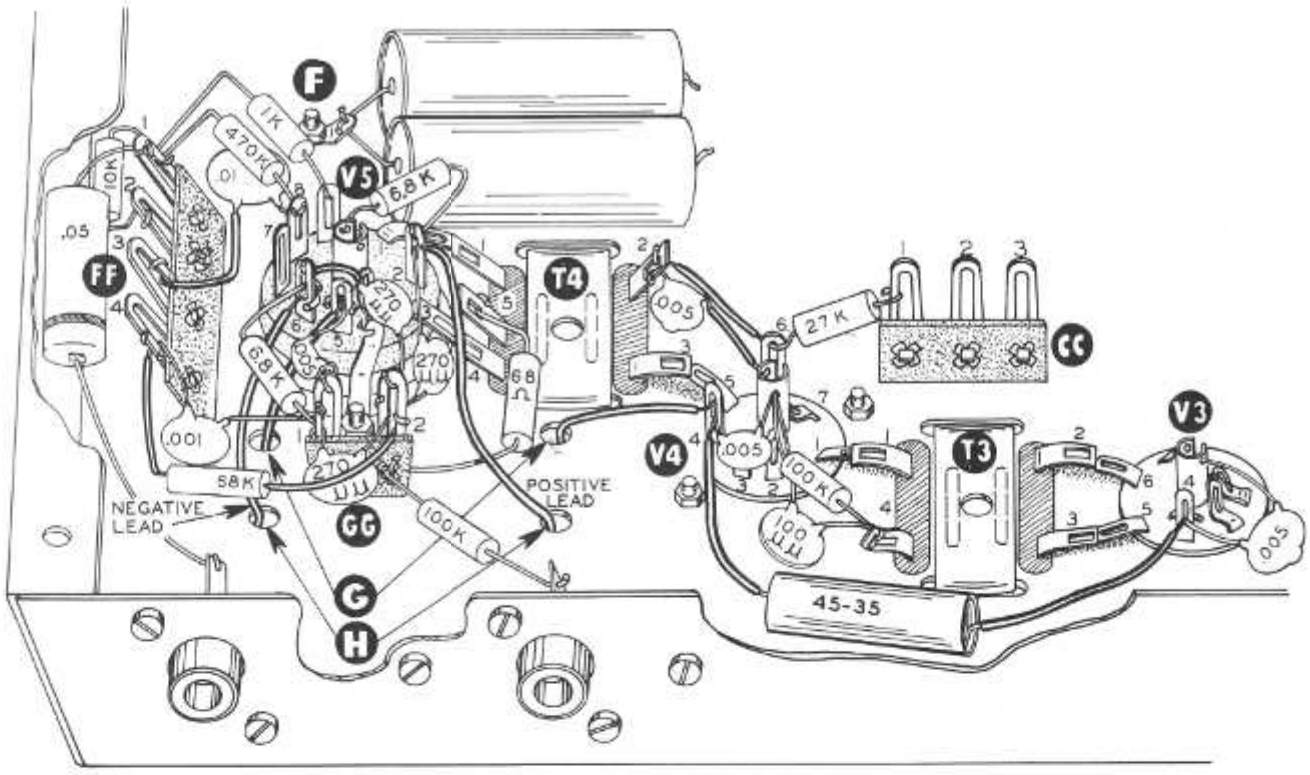


Figure 4

(✓) Connect an RF choke (#45-35) between pin 4 of V3 (S-4) and pin 4 of V4 (NS). Use sleeving.

(✓) Clip both leads of a .005 µfd capacitor to 1/2" in length. Connect one lead to pin 4 of V4 (NS).

(✓) Connect the other end of this capacitor through one of the holes in the center post of V4 (NS).

(✓) Clip each lead of a .005 µfd capacitor to 3/4" in length. Connect one lead to lug 2 of transformer T4 (NS) and shorten the lead as much as possible. Orient the capacitor body close to the lug and chassis, as shown in Figure 4.

(✓) Place sleeving over the other lead of the capacitor and connect this lead to the center post of V4 (NS).

(✓) Run one lead of a 27 KΩ resistor (red-violet-orange) through pin 6 of V4 (NS), to lug 2 of transformer T4 (S-2). Use sleeving over the segment between V4 and T4. Now solder pin 6 (S-1).

(✓) Connect the other end of this resistor to terminal CC1 (S-4).

(✓) Solder the connections to the center post of V4 (4 leads).

NOTE: Once again, double check for the areas where a lead or a resistor might touch the chassis around this particular socket. Especially check pins 1, 4, 5 and 6 to make sure that no leads connected to them touch the chassis or each other.

(✓) Slip about 3/4" of sleeving over each lead of the remaining filament choke. Place the body of the choke on the top of the chassis and run a lead through each of the holes G.

(✓) Connect the lead that comes out closest to pin 4 of V4 (S-3).

(✓) Connect the other lead that comes up near tube socket V5 to pin 5 of V5 (NS).

( ) Clip one lead of the 68 Ω resistor (blue-gray-black) to 1/2" in length, and connect it to lug 5 of transformer T4 (S-1).

( ) Insert the lead from the other end of this resistor through the hole in the bottom of lug GG2 (NS). Orient the body of the resistor as shown in Figure 4, away from lug 4 of the transformer to insure against possible short to lug 4 and to make sure that neither lead touches the chassis or any other component.

( ) Locate the 10 μfd, 25 volt electrolytic capacitor. Note that one end of it is marked with a plus sign (+) and the other end is either not marked at all or is marked with a negative (-) sign. Clip the lead at the negative end to approximately 1 1/2".

( ) Placing this capacitor on top of the chassis alongside the filament choke, insert the negative lead (using sleeving over it) up through the left hand hole of pair H, that is, the hole closest to pin 6 of V5. Connect this lead to pin 6 of V5 (NS).

( ) Clip the positive lead to 2" in length. Place insulating sleeving over the lead. Push it up through the other hole of pair H and connect it to pin 2 of V5 (NS). Take care that this lead, when connecting it to pin 2, does not touch pin 3 or lug 5 of T4, or any component connected to lug 5.

NOTE: At this point it might be well to check and make sure that all leads passing through each pair of holes G and H are not touching the chassis at all as they go through the holes. The portion of the lead that goes through the holes should be well insulated with sleeving.

( ) Connect a 100 KΩ resistor (brown-black-yellow) from the hole at the base of lug GG2 (NS) to the phono socket nearest transformer T3 (be sure to connect it to the longest of the two lugs). Solder the connection to the phono socket (S-1) and make sure that neither lead touches ground or the chassis anywhere along the way.

( ) Apply your soldering iron to one side of this hole at the base of terminal GG2. Apply solder to the other side until this lower hole only is filled. Make sure that a large "blob" of solder does not form here and short out to the chassis.

( ) Clip both leads of a .005 μfd capacitor to 1/2" in length. Connect this capacitor between pin 5 of V5 (S-2) and GG1 (NS).

( ) Clip one lead of a 6.8 KΩ resistor (blue-gray-red) to a length of 3/4" and the other lead to a length of 1/2". Connect the 3/4" lead to pin 2 of V5 (NS).

( ) Connect the 1/2" lead to the center post of tube socket V5 (S-1). Position as shown.

( ) Clip both leads of the other 6.8 KΩ resistor (blue-gray-red) to 1/2" in length. Connect this resistor from pin 6 of V5 (NS) to lug GG1 (NS).

( ) Clip each lead of a 270 μμf capacitor to 1/2" in length. Connect one lead to pin 2 of V5 (S-3). Make sure this lead does not short out to pin 3 of V5.

( ) Connect the other lead from the capacitor to terminal GG2 (NS). Orient the body of the capacitor toward the chassis.

( ) Clip one lead of a 270 μμf capacitor to 1/2" in length and the other to 3/4" in length. Place a 1/4" length of insulating sleeving over the 1/2" lead.

( ) Connect this 1/2" lead to pin 6 of V5. Solder this connection before attaching the other end of the capacitor (S-3). In this manner you insure that there is no short to pin 5.

( ) Connect the other lead of this capacitor to terminal GG2 (NS).

( ) Connect a 270 $\mu\mu$f capacitor between terminals GG1 (NS) and GG2 (NS).

( ) Clip one lead of a .001 μfd capacitor to a length of 1/2" and connect it to lug FF4 (NS).

( ) Connect the other lead of this capacitor to terminal GG1 (S-4).

( ) Clip each lead of a 68 KΩ resistor (blue-gray-orange) to a length of 1". Place sleeving over each lead and connect the resistor between terminals FF4 (S-3) and GG2 (S-4).

( ) Clip each lead of a 10 KΩ resistor (brown-black-orange) to 1/2" in length. Connect one lead to terminal FF2 (S-1).

( ) Connect the other lead of the resistor to terminal FF1 (NS). Position the body of the resistor between terminals FF1 and FF2.

( ) Clip one lead of a .01 μfd, 50 volt capacitor to a length of 1/2". Connect this 1/2" lead to pin 8 of V5 (NS). Shorten this lead, if possible, and cut off any excess length. Hook this lead to pin 8 so that the capacitor will be as close as possible to pin 8. Make sure when this is done that the lead is not long enough to touch the chassis. Place the body of the capacitor against the chassis.

( ) Slip 3/4" of insulated sleeving over the other lead of this .01 μfd capacitor and connect it to terminal FF3 (S-2).

( ) Clip each lead of a 470 KΩ resistor (yellow-purple-yellow) to 1/2" in length. Connect one lead to pin 8 of V5 (S-2). It may be helpful, when soldering this connection, to place the other lead of the resistor over toward solder lug F. By soldering with the lead in this direction, the most space is made available in this area.

( ) Connect the other end of the 470 KΩ resistor to terminal FF1 (NS).

( ) Connect a 1 KΩ resistor (brown-black-red) from pin 9 of V5 (S-1) to terminal FF1 (NS).

( ) Insert a .05 μfd 200 V capacitor between terminal strip FF and side of the chassis, by sliding it back along the underside of the chassis lip. (The 10 KΩ resistor may have to be pushed down to accommodate the capacitor.)

( ) Connect one lead of the capacitor to FF1 (S-4) and connect the other lead to the long lug of the phono socket in the corner of the chassis (S-1). Be careful to avoid routing this lead directly under the small hole in the chassis lip. The hole will be used later by the screw which fastens the bottom plate.

This completes wiring of the ratio detector circuit.

At this point, since there are many connections to the tube in this area, it might be a very good idea to return and check your work. Especially check each and every connection and lead to make sure the leads do not touch each other or the chassis. Once again we might repeat-check to make sure that no wire touches another wire or the chassis.

( ) Perform the steps in boxes around Figures 5 and 6 before proceeding with the following steps.

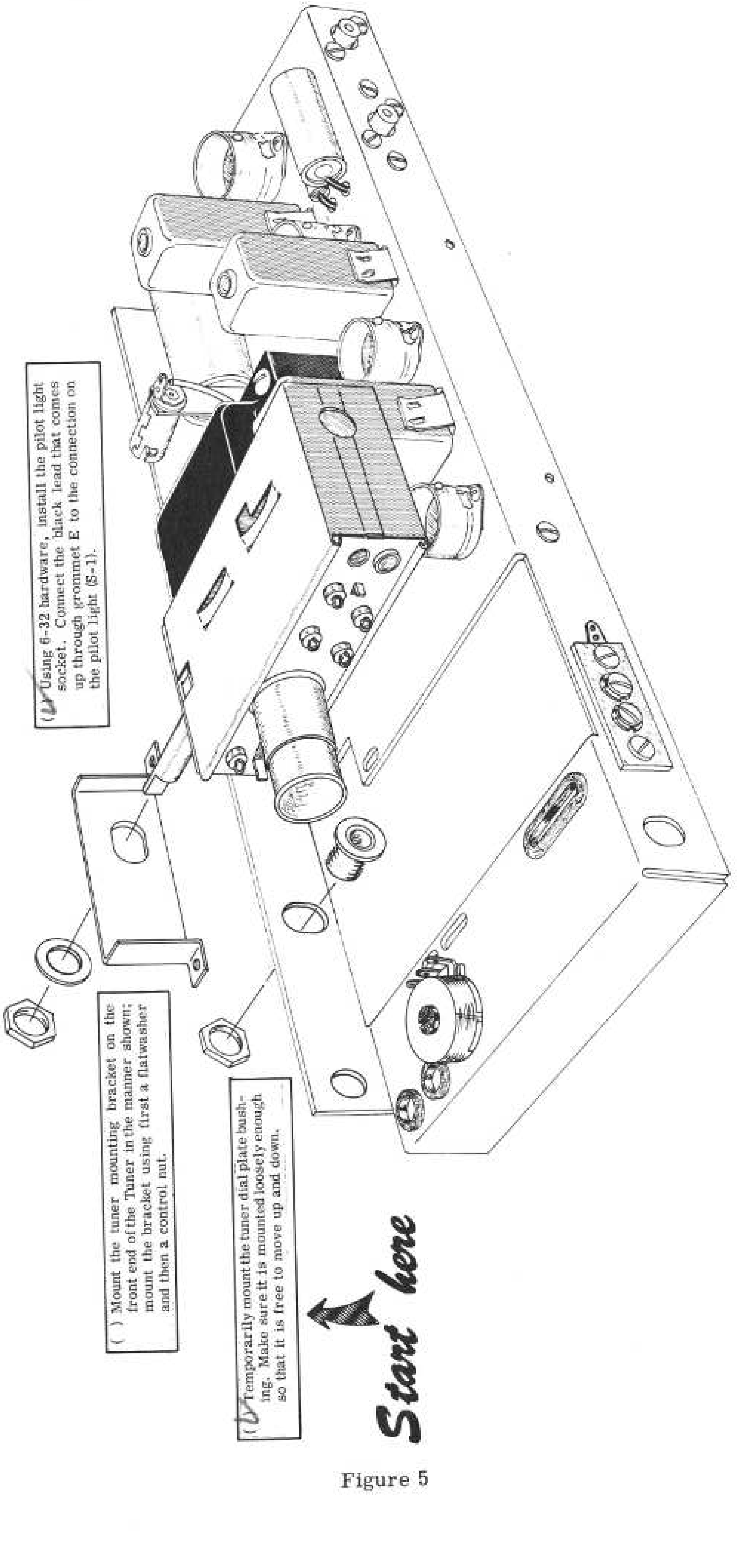
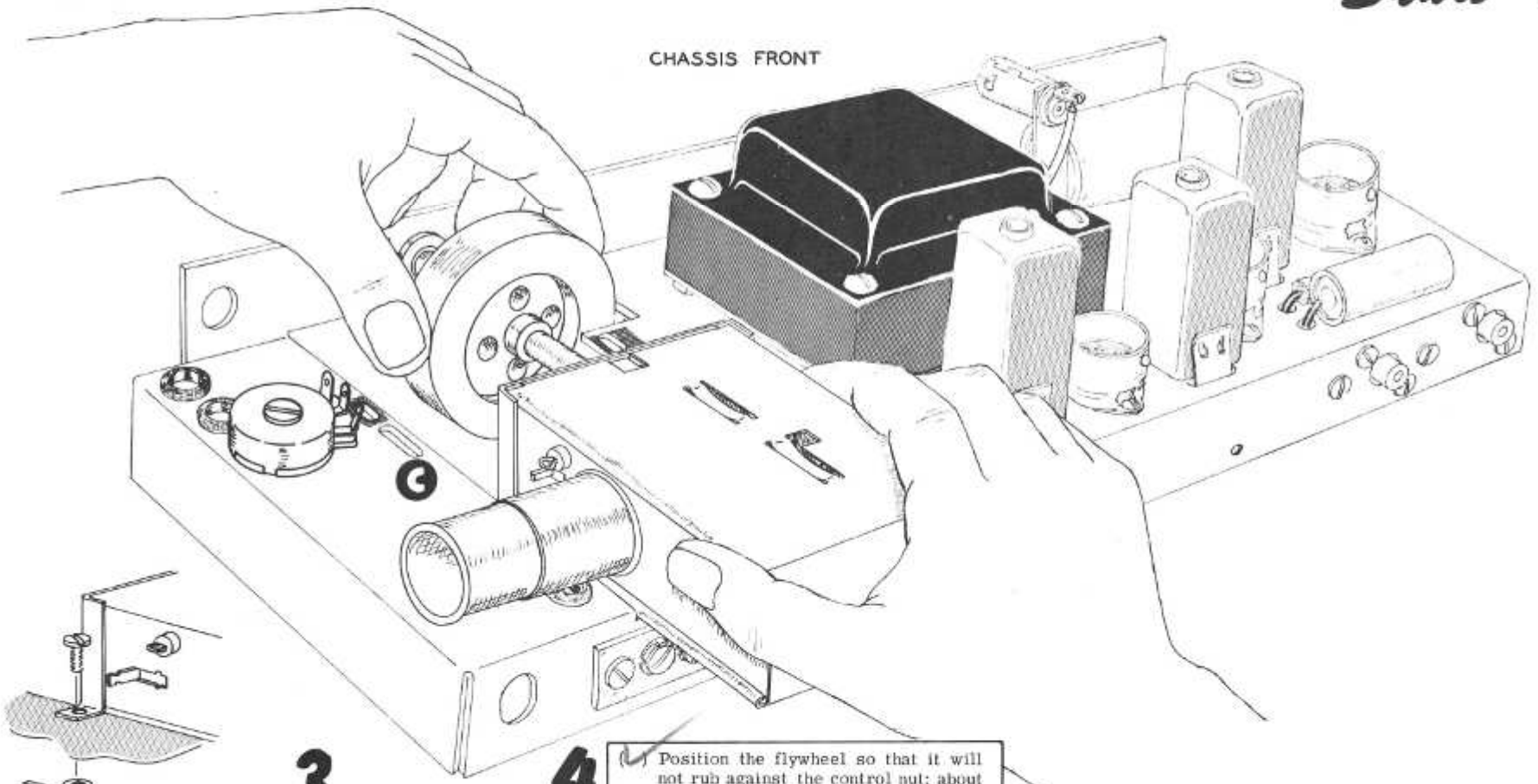

( ) Using 6-32 hardware, install the pilot light socket. Connect the black lead that comes up through grommet E to the connection on the pilot light (S-1).
( ) Mount the tuner mounting bracket on the front end of the Tuner in the manner shown; mount the bracket using first a flatwasher and then a control nut.
( ) Temporarily mount the tuner dial plate bushing. Make sure it is mounted loosely enough so that it is free to move up and down.
Start here

Figure 5

2 Position the chassis in front of you. Hold the flywheel with your left hand, with the setscrews facing the chassis front. Slide the tuner shaft through the flywheel and through the bushing in front of it until the rear of the tuner is essentially flush with the rear of the chassis. NOTE: The screw holes in the tuner mounting bracket should be centered over the oval holes (shaded in Figure 6) prepared for them in the chassis. If they are not centered, loosen the control nut holding the tuner mounting bracket (the tuner will have to be slid back to accomplish this). Move the tuner mounting bracket over enough so that when it is back in position, it will be centered over the oval holes.

1 Install the two setscrews in the flywheel.

Start here



3 Fasten the tuner mounting bracket to the chassis, using 3-48 screws, nuts and lockwashers. On the screw near hole C, mount a 4-lug terminal strip under the chassis (see Figure 10).

4 Position the flywheel so that it will not rub against the control nut; about 1/32" gap would be fine. A simple way of setting this gap is to take a piece of paper, fold it double, and place it between the tuner control nut and the surface bearing against it on the flywheel. Hold the flywheel against the piece of paper and tighten the set-screws. When the paper is removed, the gap will be just about right.

Figure 6

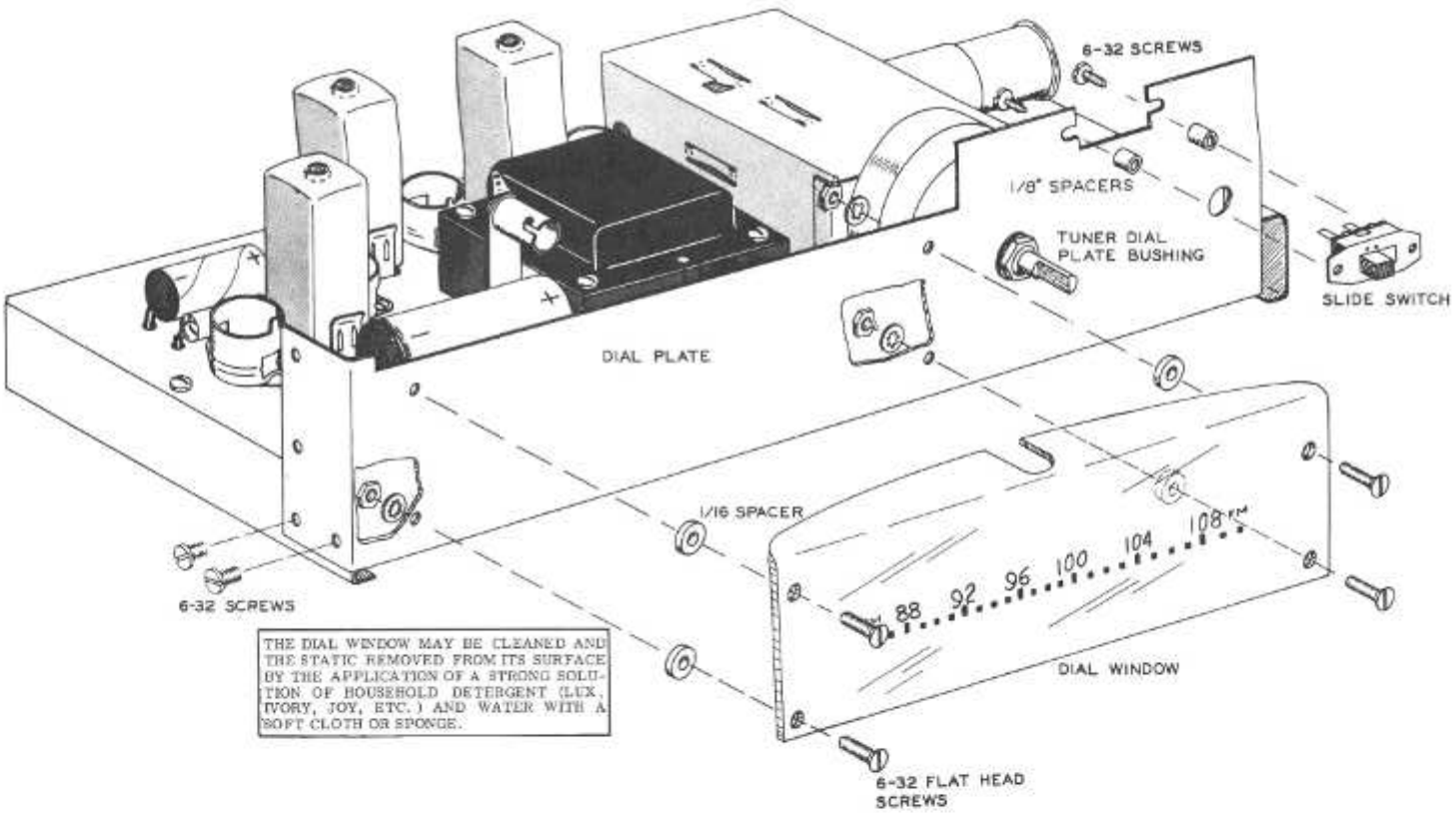


Figure 7

( ) Place the tuner on your work surface, front toward you, in the manner shown in Figure 7.

( ) Using four 6-32 flat head screws, mount the dial window on the dial plate, as shown in Figure 7. (The dial plate will be mounted to the tuner in a later step.) Place a 1/16" spacer between the window and dial plate. A #6 lockwasher and a 6-32 nut should be placed on each screw, on the back of the dial plate. When tightening each of these four screws, tighten them to be just snug. Any excess tightening could break the dial window.

( ) Install the slide switch in the dial plate. This can be seen in Figure 7. The 6-32 x 1/4" screws should be inserted from the rear of the dial plate. One of the 1/8" spacers should be placed between the switch and the dial plate on each side. The switch should be installed so that the lugs of the switch are closest to the center of the dial plate.

( ) Remove the control nut that was previously placed temporarily on the tuner dial plate bushing. This will be the nut at the outer end of the shaft of the tuning unit.

( ) Position the dial plate, making sure that the two lower holes at the bent-over end of the dial plate line up with the corresponding holes in the chassis. The two larger holes on the tuner end of the dial plate should line up with the comparable holes in the chassis lip.

( ) Secure the dial plate to the chassis by placing a flat control washer and a control nut on the tuner dial plate bushing. Before tightening this nut securely, check the alignment of the dial plate by checking through the large hole to the right of this tuning control. The round dial plate hole should be centered in front of the chassis hole. The holes in which the bushing is mounted are elongated. This is done to make this bushing adjustable vertically so that the shaft will not bind in any way and impede the flywheel action.

( ) Carefully tighten the tuner bushing nut only enough so that the bushing does not seem to be binding on the shaft that passes through it. Too much tightening could make it bind.

( ) Place a drop or two of lubricating oil on a piece of scrap paper. Dip the tip of your screwdriver blade into this drop of oil; then apply the oiled tip to only the outside (front) of the tuner dial plate bushing.

( ) Temporarily place a knob on the end of the shaft and check to see that the flywheel appears to move freely, then return the control to the maximum counterclockwise position.

( ) Fasten the left hand end of the dial plate to the chassis by inserting a 6-32 self-tapping screw in each of the two holes at the lower left hand end of the dial plate, as it appears in Figure 7. Do not run these 6-32 self-tapping screws in all the way, since they will be removed. Run them in to about half way along their length, and then remove them. This has prepared threads in the chassis to receive regular 6-32 x 1/4" binder head machine screws.

( ) Having removed the self-tapping screws, install a regular 6-32 x 1/4" screw in each hole.

NOTE: The self-tapping screws are removed because the one closest to the front panel is too long and could impede the action of the pulley directly in back of it. Two extra nuts and lock-washers have been provided with the kit for these screws, just in case the threads in the chassis should be stripped.

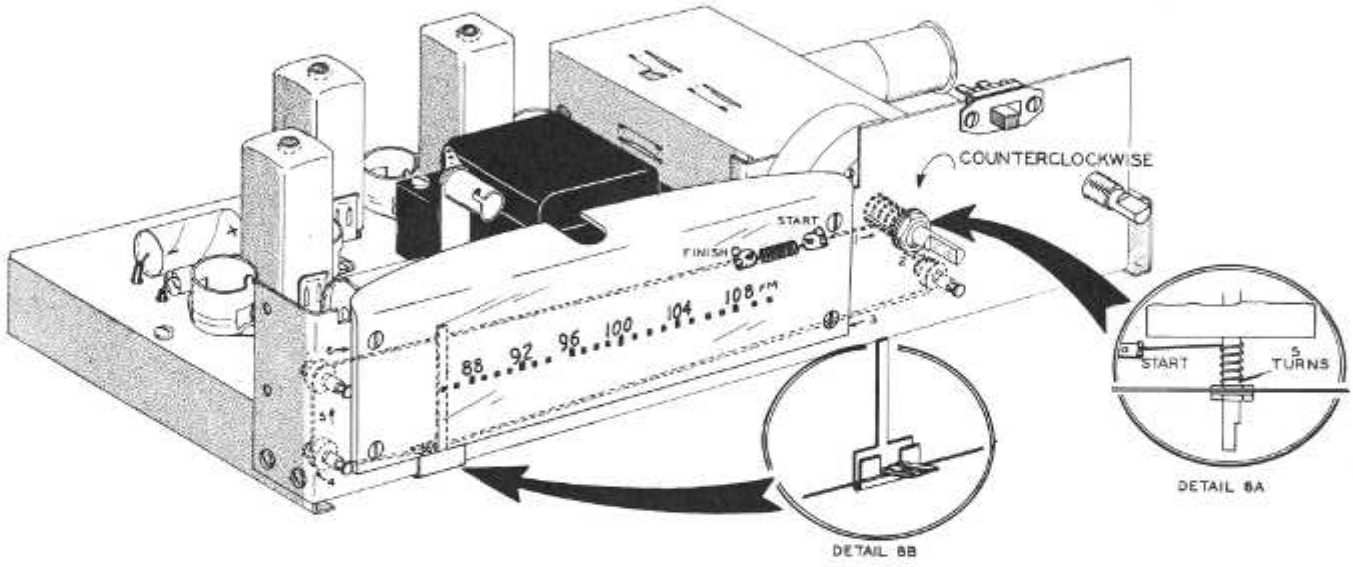


Figure 8

( ) Refer to Figure 8 and place the chassis on your work surface, as shown. Dial stringing always seems to be a rather confusing business but we shall try to make it as painless as possible.

( ) Start the stringing by wrapping the dial cord around the shaft in front of the tuner five turns counterclockwise. As a reference point in counting the turns, you can Scotch Tape the short end of the dial cord to the front of the power transformer; see Figure 8 for the point labeled "Start". As the other end of the dial cord passes this point for the first time, it will be one complete turn. As it passes it for the fifth time, it will be five complete turns. At this point there should be one lead, rather long in length, extending in a downward position.

( ) Run this lead around the outside of the pulley just below and to the right of the shaft (arrow 2).

( ) At this point, run this lead down the length of the chassis to the pulley on the far corner (arrow 3), around this pulley (arrow 4), up around the pulley on top of the chassis (arrows 5 and 6), and back across the chassis to the "Finish" point.

( ) Slip the dial string off one or more of the pulleys to give a little extra length. Hook the dial cord spring between the two eyelets and replace the string over each of the three pulleys.

( ) At this point you may find that the five turns that you wrapped around the shaft are all doubled up on top of each other. If this is the case, they should be straightened out to appear in an even line as is seen from the top in Detail 8A. This can be accomplished in either one of two ways: The first method is to remove the string from one of the pulleys and straighten the turns out with some sharp instrument, such as an ice pick or a soldering aid. The other method is to leave the string on all the pulleys and put the turns in their proper sequence while rotating the dial back and forth. Check to see that the string stays straightened when the dial is turned back and forth.

( ) Next, place the spring and the two eyelets in their proper position, which is over rather close to the flywheel. Tune the control shaft to its maximum counterclockwise position. Grasp the eyelet that is closest to the tuning shaft with long-nose pliers and slide it over to the right until it is 1/2" from the shaft. When this is done, you should be able to turn the dial all the way from one end to the other without the eyelets touching the pulley on one end or the shaft on the other.

( ) Check to make sure the tuning shaft remains in its counterclockwise position. Install the dial pointer up from the bottom of the dial plate behind the dot that represents 86 on the dial. Spread the three prongs and place the dial cord between them, as shown.

( ) Once the dial cord is in this position, temporarily pinch the three prongs together to secure the pointer in place.

This completes the assembly and adjustment of the dial cord assembly.

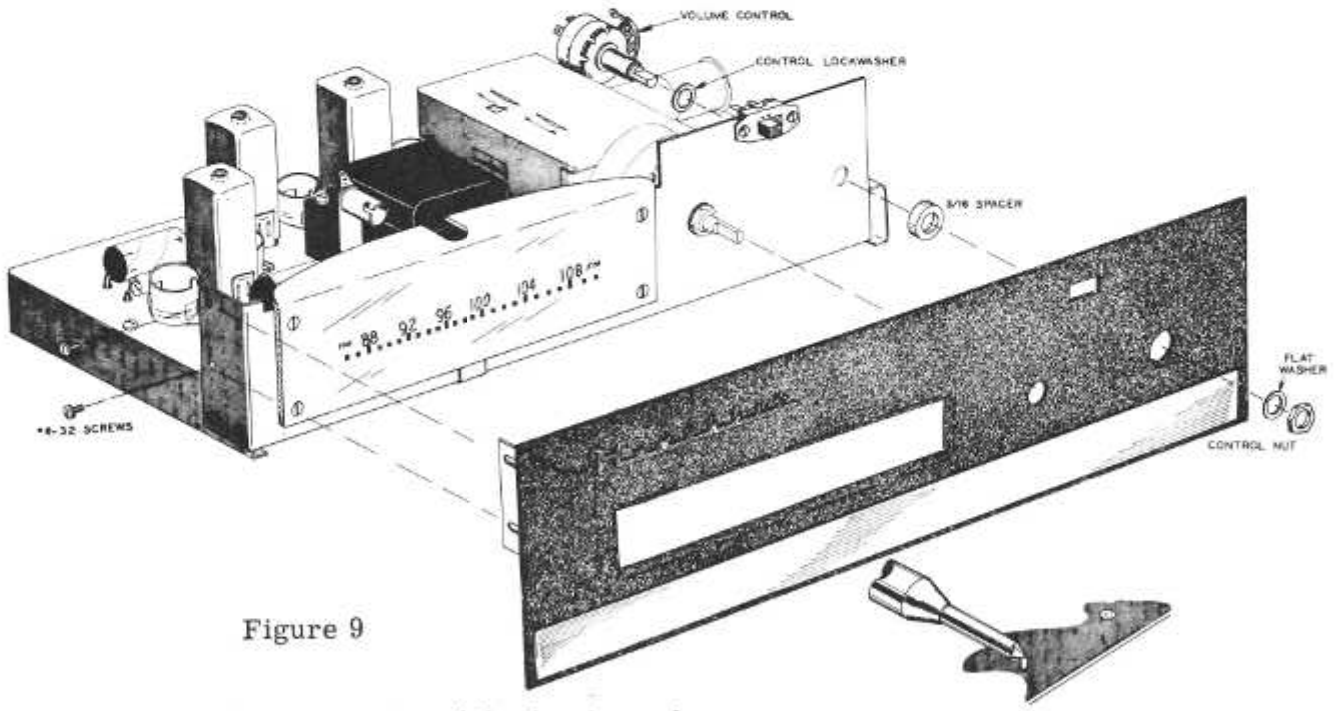


Figure 9

Refer to Figure 9 for mounting of the front panel.

( ) Mount the Heathkit nameplate by melting down the studs to hold it firmly in place.

( ) Put a lockwasher on the VOLUME control and place it through its hole, as shown. Face the three solder lugs away from the center of the chassis.

( ) Next, place the 3/16" thick spacer over the volume control bushing.

( ) Mount the front panel on the chassis. Place a flat washer over the volume control bushing and secure the panel to the chassis assembly by screwing the control nut on the VOLUME control.

( ) Secure the bracket at the left side with two 6-32 screws, nuts and lockwashers.

Refer to Figure 10 for the following steps.

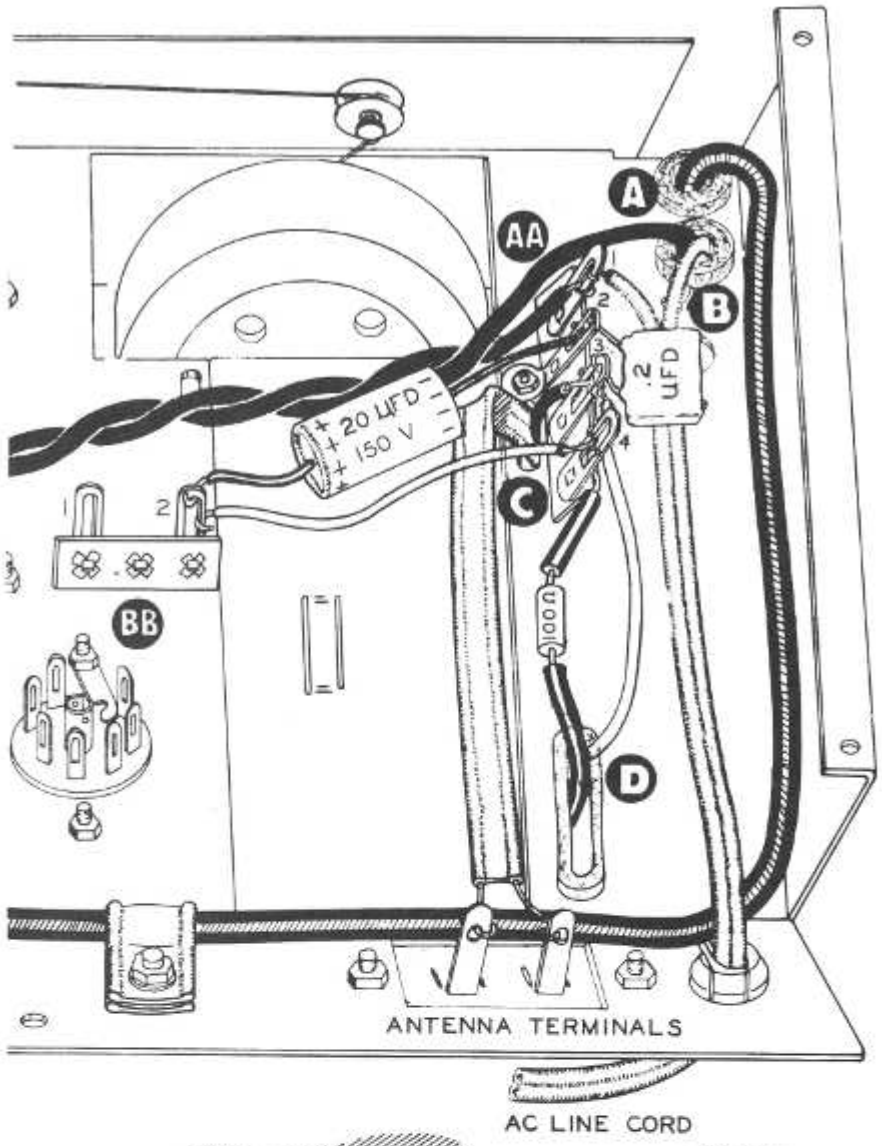
( ) Connect the shorter of the two black power transformer leads to terminal AA1 (NS).

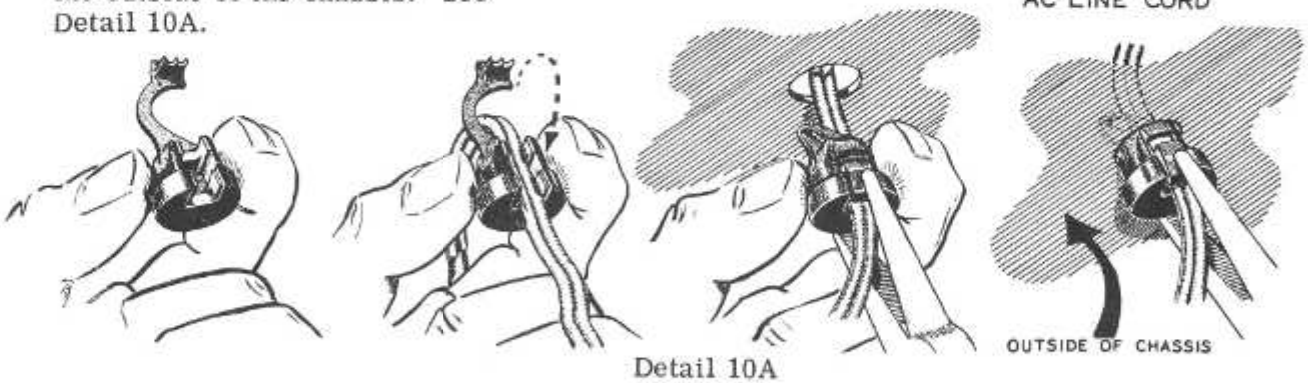
( ) Route the longer of the two black power transformer leads up through grommet B to one of the two lugs at the rear of the VOLUME control (S-1).

( ) Run the AC line cord through the hole in the rear of the chassis. Connect one of the leads up through grommet B to the remaining terminal for the ON-OFF switch (S-1).

( ) Connect the other line cord lead to terminal AA1 (S-2).

( ) Pull the line cord taut, and place the line cord strain relief insulator on it just outside the chassis. Squeeze the two segments of the strain insulator together with long-nose pliers and insert it through the chassis hole from the outside of the chassis. See Detail 10A.





Detail 10A

( ) Clip the positive (+) lead of the 20 μfd, 150 volt capacitor to 1 1/4" in length. Place a 3/4" length of insulated sleeving over this lead.

( ) Connect the lead to terminal BB2 (NS), placing the body of the capacitor in the position shown in Figure 10.

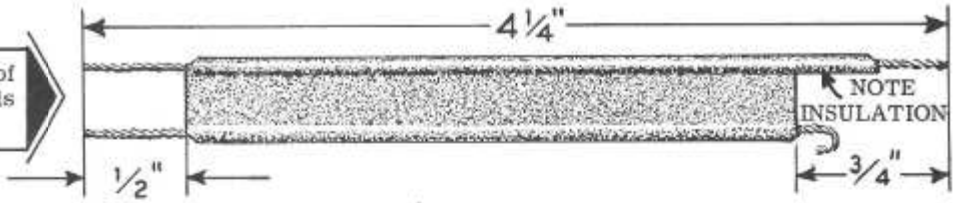
( ) Clip the negative (-) end of this capacitor to 1 1/4" in length, and place 3/4" of sleeving over the lead. Connect this lead to terminal AA2 (NS).

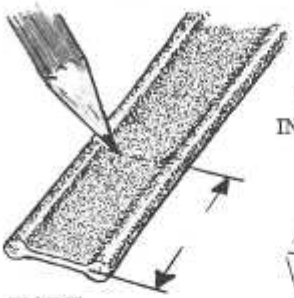
( ) Cut a length of hookup wire to 4" and strip both ends. Connect this wire from terminal BB2 (S-3) to terminal AA4 (NS).

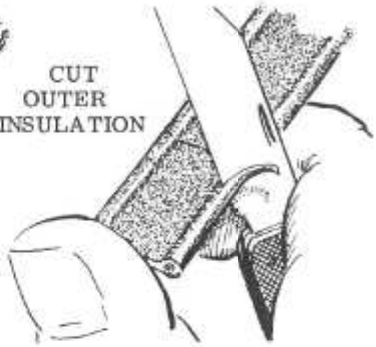
( ) Using sleeving, connect a 100 Ω 1/2 watt resistor (brown-black-brown) from terminal AA4 (S-2), up through grommet D to lug 4 (S-1) of the tuning unit. See Figure 11.

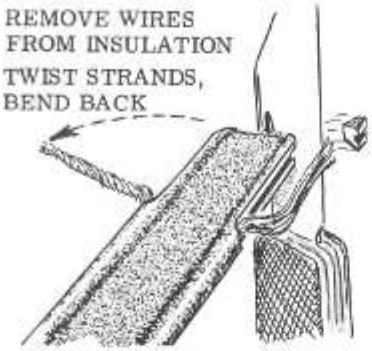
( ) Prepare the short section of twin lead, following the steps in Detail 10B. Observe that you have received almost three times the amount of twin lead that you shall require in the kit. This is provided to enable you to have an extra length in case the first one should be spoiled. Also it allows a little bit of room, should you desire to practice stripping the lead.

( ) Cut a piece of twin lead to a length of 4 1/4". Prepare each of the four ends in the manner shown




MARK DIMENSION

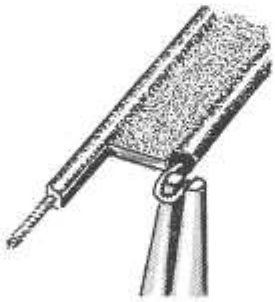

CUT OUTER INSULATION

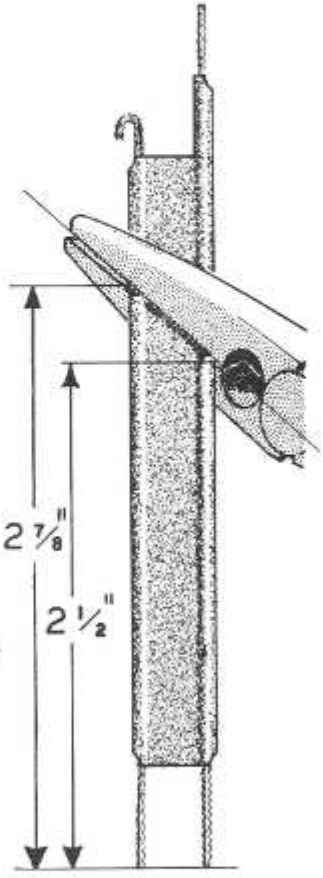

REMOVE WIRES FROM INSULATION
TWIST STRANDS, BEND BACK


CUT OFF CENTER STUB


SOLDER

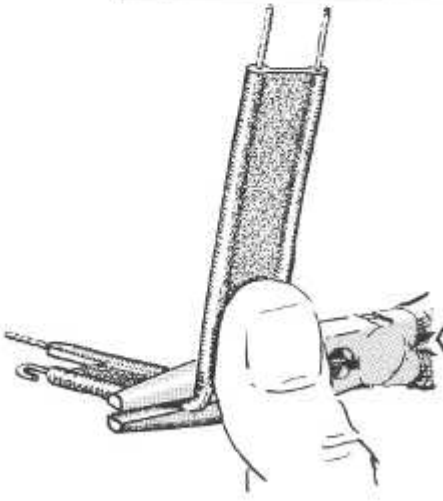
( ) Tin all four leads. This prevents the strands of wire from separating. After you tin each wire, apply heat to it and slap it sharply against a firm surface. This will shake off all the excess solder.





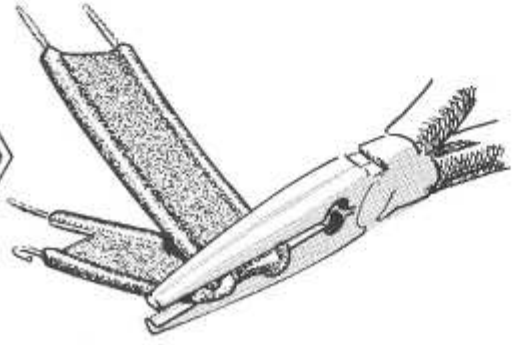
( ) Form a hook on the short lead with your long-nose pliers.

( ) Make a mark with a sharp pencil (or fingernail) at 2 1/2" and 2 7/8". With your right hand, hold your long-nose pliers across these two points.



( ) With your left thumb, push up firmly on the long end so that a crease is formed.

( ) Fold over at this crease and squeeze tightly with your long-nose pliers. It is to be expected that this will spring open somewhat afterwards.



Detail 10B

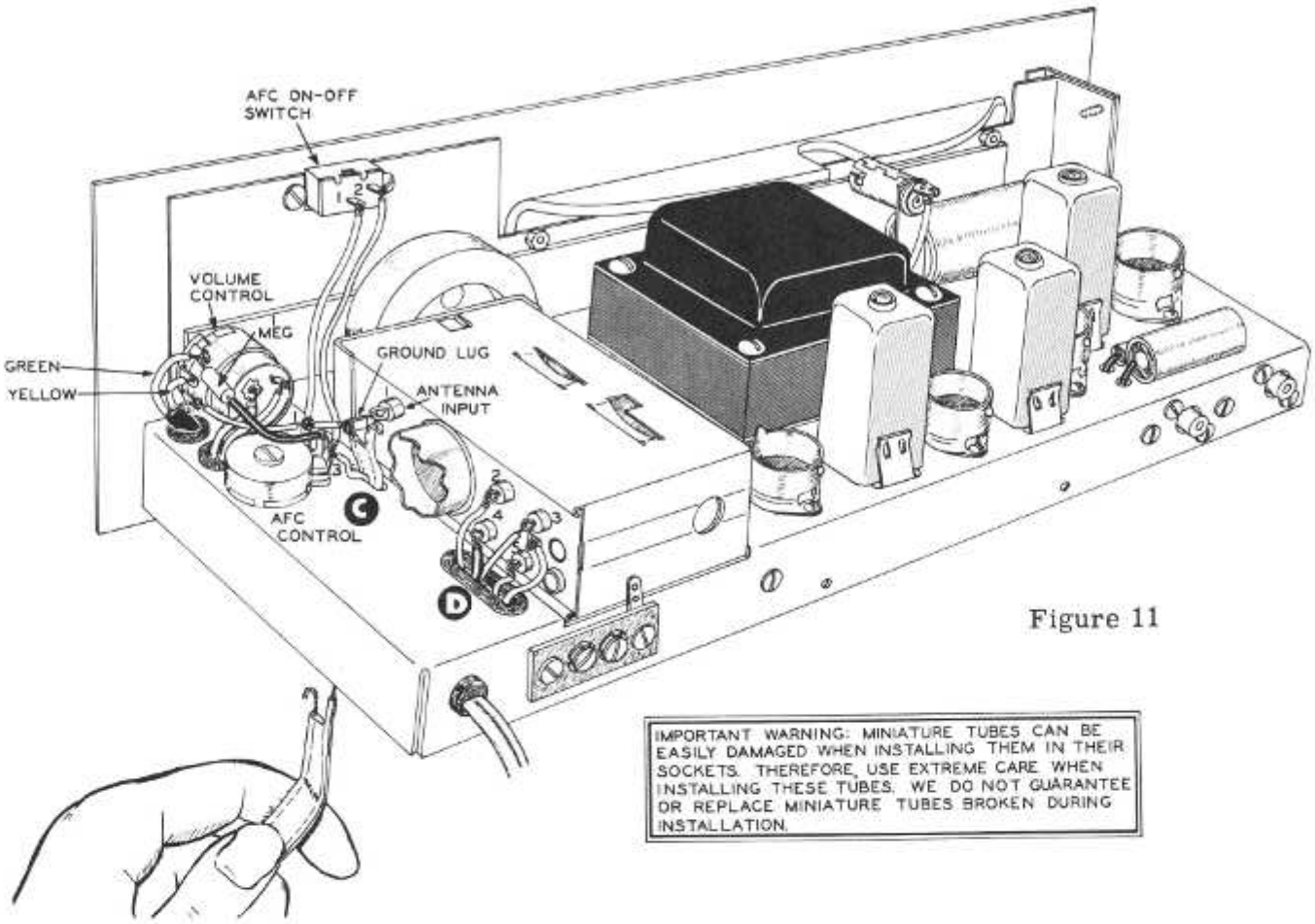


Figure 11

Refer to Figure 11 for the next steps.

( ) Place the chassis on your work surface in the position shown in Figure 11. Holding this prepared segment of twin lead in your left hand, as shown, insert it up from the bottom of the chassis through hole C. The hook you prepared will come up adjacent to the ground lug on the tuning unit. Clamp the hook around the ground lug and solder it (S-1).

( ) Insert the longer straight lead through the eyelet for the antenna input (S-1).

Connect the leads that come up from the bottom of the chassis through the long grommet D in the following manner:

( ) Connect the lead that comes from pin 4 of tube V2 to lug 2 (S-1). You will find these connections much easier to make mechanically by using your long-nose pliers and possibly forming a hook at the end of the wire as before.

( ) Referring to the two wires in the twisted pair, connect the yellow wire to lug 5 of the tuning unit (S-1).

( ) Connect the black lead to the ground post which is just above lug 5 of the tuning unit (S-1).

( ) Going back to Figure 10 temporarily, solder each lead of the free end of the twin lead to one of the lugs of the 2-lug screw type terminal strip.

( ) Cut a 3 1/2" length of hookup wire and strip both ends. Connect one end to terminal AA3 (NS).

( ) Insert the other end up through grommet D, and attach it to lug 3 of the tuning unit (S-1).

(✓) Connect a 1 1/2" length of hookup wire from terminal AA3 (NS) up through slotted hole C to terminal 3 of the AFC control (NS).

(✓) Clip each lead of the .2 μfd 50 volt disc capacitor to 1/2" in length. Connect one of these leads to terminal AA3 (S-3).

(✓) Connect the other lead of this capacitor to terminal AA2 (S-2).

(✓) Refer to Figure 11 and connect a length of hookup wire from the bottom lug of the VOLUME control (NS) to lug 1 of the AFC control (NS).

Connect the cable that comes up through grommet A as follows:

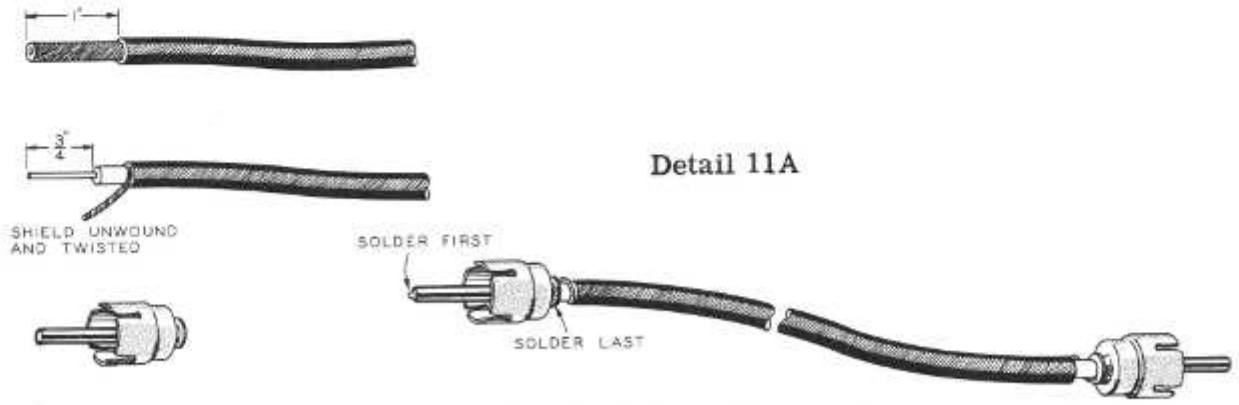
(✓) Connect the ground shield to the bottom lug of the VOLUME control (S-2).
(✓) Connect the yellow lead to the center connection of the VOLUME control (S-1).
(✓) Connect the green lead to the top lug of the VOLUME control (NS).

(✓) Slip approximately 3/4" of sleeving over one lead of the 1 megohm resistor (brown-black-green). Connect this lead through lug 2 (NS) to lug 3 (NS) of the AFC control. Now solder lug 2 (S-1).
(✓) Connect the other end of this 1 megohm resistor to the top lug of the VOLUME control (S-2).
(✓) Connect a length of hookup wire from lug 1 (NS) of the AFC control to the ground lug (near the antenna input) of the tuning unit. Solder the ground lug connection next to the already soldered antenna connection.
(✓) Cut a length of hookup wire to 2 1/2" and strip both ends. Connect it from lug 1 of the AFC control (S-3) to lug 1 of the AFC ON-OFF switch (S-1).
( ) Cut a length of hookup wire to 3" and strip both ends. Connect it from lug 3 (S-3) of the AFC control to lug 2 of the AFC ON-OFF switch (S-1).

This completes the wiring of the FM-4 Tuner.

NOTE: 6' of audio cable has been furnished with this kit and should suffice for the average installation. In preparing this audio cable, use whatever portion of this 6' you may need for your particular installation. If your requirements are for a 1' cable, prepare a cable 1' long; but if your requirements are for a 6' cable, then, of course, prepare the whole 6'.

(✓) Prepare the audio cable. Strip approximately 1" of the outer rubber insulation from each end of the cable. Unwrap the outer shielding from this last 1" of cable and twist it to form a lead. Strip approximately 3/4" of insulation from the inner conductor. See Detail 11A.



Detail 11A

(✓) Install phono connectors on each end of the cable, as shown. Insert the inner conductor through the back of the connector until it will go no further. A small amount of wire should show at the tip of the connector. Solder the wire to the connector at this point.

(✓) Wrap the outer conductor lead around the plug shell and solder securely.
(✓) Repeat this entire operation for the opposite end of the cable.

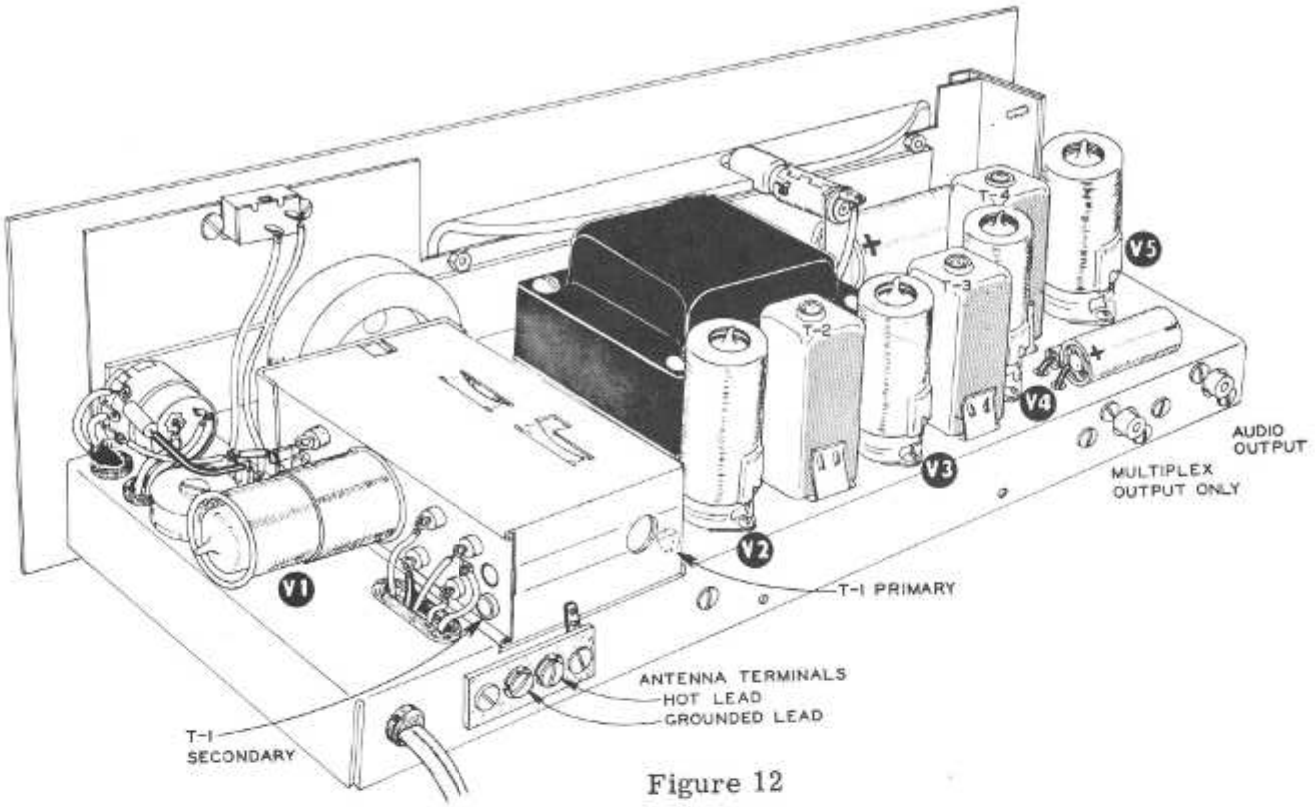


Figure 12

( ) Refer to Figure 12 and insert the #47 pilot lamp in the pilot lamp socket. The pilot lamp should just about touch the opening in the window in front of the bulb. The element of the lamp should be just about centered in this opening for maximum light conduction into the dial window. If it is not centered, loosen the mounting screw for the pilot lamp socket and slide the bracket forward or back, as necessary. The pilot lamp bracket can also be bent slightly in case the bulb needs to be centered vertically.

( ) Install one of the 7-pin tubes (6AU6) in each of the 7-pin tube sockets and install the 9-pin tube (6BN8) in the 9-pin tube socket.

( ) Place a tube shield over each one of these tube sockets, locking them in place with a half twist to the right.

( ) Install the two knobs on the front panel. Adjust the slotted AFC control to just about the center of its travel, using a screwdriver. The tuner is now complete, except for the installation of the bottom plate and the top cover. Before being so bold as to turn the tuner on, let us once again check for any possible errors in the wiring or construction stages.

( ) If the two knobs are not an equal distance out from the front panel, loosen the two tuner mounting bracket screws (3-48) slightly, and gently adjust the tuning unit forward or backward, as needed.

( ) Move the solder lug that was mounted with the antenna terminal strip to a straight up position. Solder this lug to the rear cover of the tuning unit.

NOTE: We cannot stress too strongly the importance of thoroughly checking your wiring and all solder connections. At no point should any of the leads touch the chassis unless soldered to a post that is connected to the chassis directly. At no point should any lead touch another lead or the chassis, unless those leads are soldered together.

> In working on high frequency circuits, such as are found in these FM-4 circuits, proper grounding is exceedingly important. Recheck all tube socket screws and terminal strip mounting screws and make sure that they are snug.

( ) Connect the line cord to a 117 volt, 50-60 cycle AC outlet. Do not connect the plug to a DC line, as serious damage will result; the same would be true for a 25 cycle AC line.

( ) Turn the receiver on and observe the filaments of each tube. A small red glow should be seen, indicating that the filament is lit. A bright red indication over a large area inside the tube would indicate a short circuit of some sort and would mean that you should turn the set off immediately, rechecking for possible short circuits. Observe the bottom of the chassis to make sure that no part appears to be overheating. If some part should overheat, it would probably become discolored and may even smoke slightly. Once again, this would indicate a short circuit and the power should be immediately removed from the set.

( ) Connect your audio cable between the amplifier or preamplifier to be used and the output jack on the rear of the tuner that is closest to the outside edge. Upon turning up the VOLUME control, a hiss should be heard in your speaker.

( ) Connect one of your antenna leads to each of the antenna terminals at the rear of the tuner. By tuning through the band, you should hear all of your local stations. Now reverse the connections you just made to the antenna terminals; tune through the band again, and determine which connection produced the most clear stations. The difference that you may find would be an effect of the unbalanced input of the tuner. It can change the manner in which signals are received at the tuner.

( ) Although your tuner should now operate within its stated specifications, its sensitivity may be increased still further by a slight adjustment of the secondary (only) of transformer T1. The complex behavior of wires and components at the frequencies present in the tuner, cause the amount of capacity at the output of the tuning unit to vary unavoidably.

Tune a weak station as clear as possible with the AFC off; it should be weak enough so that some hissing is heard along with the program. If necessary, a weak signal can be created on a local station by unhooking the antenna from its terminals and just laying it near the terminals.

With the alignment tool furnished, adjust only the secondary of T1 for the loudest and clearest signal. This is the slug adjustment at the rear of the tuning unit (Figure 12), near the wired connections. Do not touch any other IF adjustment unless you should go through a regular alignment procedure.

( ) If the tuner seems to be operating normally, proceed with the remaining construction; if not, turn to the IN CASE OF DIFFICULTY section before proceeding.

NOTE: The dial pointer has been set to approximately the correct position in a previous step. In most cases it will be off one way or another from the proper location with reference to the dial markings. The following measures should be taken to correct its position.

( ) Tune in your local station which is closest to 98 mc, the center of the FM dial. If the frequency of this station is not known to you, it is generally listed on the radio page of your local newspaper.

( ) Hold the string so that the tuning will not be changed and slip the dial pointer behind the exact spot on the dial where the frequency of this local station is listed.

Example: If the frequency of your local station is 99.3 mc, move the dial pointer to a position between the dial indications that indicate "99" and "100" to the approximate location of 99.3.

( ) Refer to Figure 13 on Page 35 and mount the four plastic feet to the bottom plate, using in each case a 6-32 screw, nut and lockwasher. Observe in each corner that the innermost hole is the one that is used for the 6-32 screw. At an angle toward the corner from this hole is a smaller hole. This one is used for the guide pin on each foot.

( ) Fasten the bottom plate to the chassis by first fastening the small lip at the rear of the chassis, using #6 sheet metal screws. Be sure to install all six of the bottom cover screws, or your tuner could be noisy on weaker stations.

( ) Fasten each corner of the bottom plate to the chassis with #6 sheet metal screws through the holes just adjacent to the foot in each corner.

( ) Finally, slide the cover over the tuner so that the flanges are under the bottom plate.

( ) Fasten the cover to the bottom plate by inserting a #6 sheet metal screw through each one of the four holes.

Upon completion of the kit, if a gap should be present between the top of the front panel and the cover: remove the four sheet metal screws holding the cover to the bottom plate and insert a flat washer (#253-27) on each screw, between the bottom plate and the cover.

This completes the assembly of your FM-4 FM Tuner.

INSTALLATION AND OPERATION

The AFC control should be adjusted to approximately the center of its range for normal signal conditions. You may check the setting of this adjustment by tuning in one or two of your strongest local stations. If you have this control set so there is too much AFC, the tuner will seem to hold on to these local stations over a relatively wide part of the band. If properly adjusted, you should be able to tune through a local station and out of it again within just about the width of the dial pointer itself. By having an adjustment such as this on the tuner, the person in a large city with a large number of strong local stations can set this adjustment so none of these will hold on too strongly. The person who has a tuner out in a remote rural area where there is no station very close, could adjust this for more AFC and thus hold on much more strongly to the relatively weak stations that he receives.

The reason for being able to turn the AFC off with the AFC ON-OFF switch is for those occasions when you should desire the utmost in selectivity. If you should have one station immediately alongside another such that the two would interact inside the tuner itself, then by turning the AFC off with the switch they can be much more easily separated. It is desirable that the holding action of the stronger station doesn't influence the tuning to the weaker station in such a case as this.

The antenna is a very important part of your hi-fi FM installation, especially if good reception of weak signals is desired. Since the FM broadcast frequencies are right in the middle of the television broadcast frequencies, it is always possible to use a TV antenna of any type. It is best not to hook the lead-in from your television antenna to your FM antenna at the same time, as this could cause a mismatch which would be detrimental to both signals. It is possible to take about 1 foot of an FM lead-in from your FM antenna post, and couple this over to the lead-in to your television set. Lay about 12" or 18" of your lead-in from your FM antenna tightly against

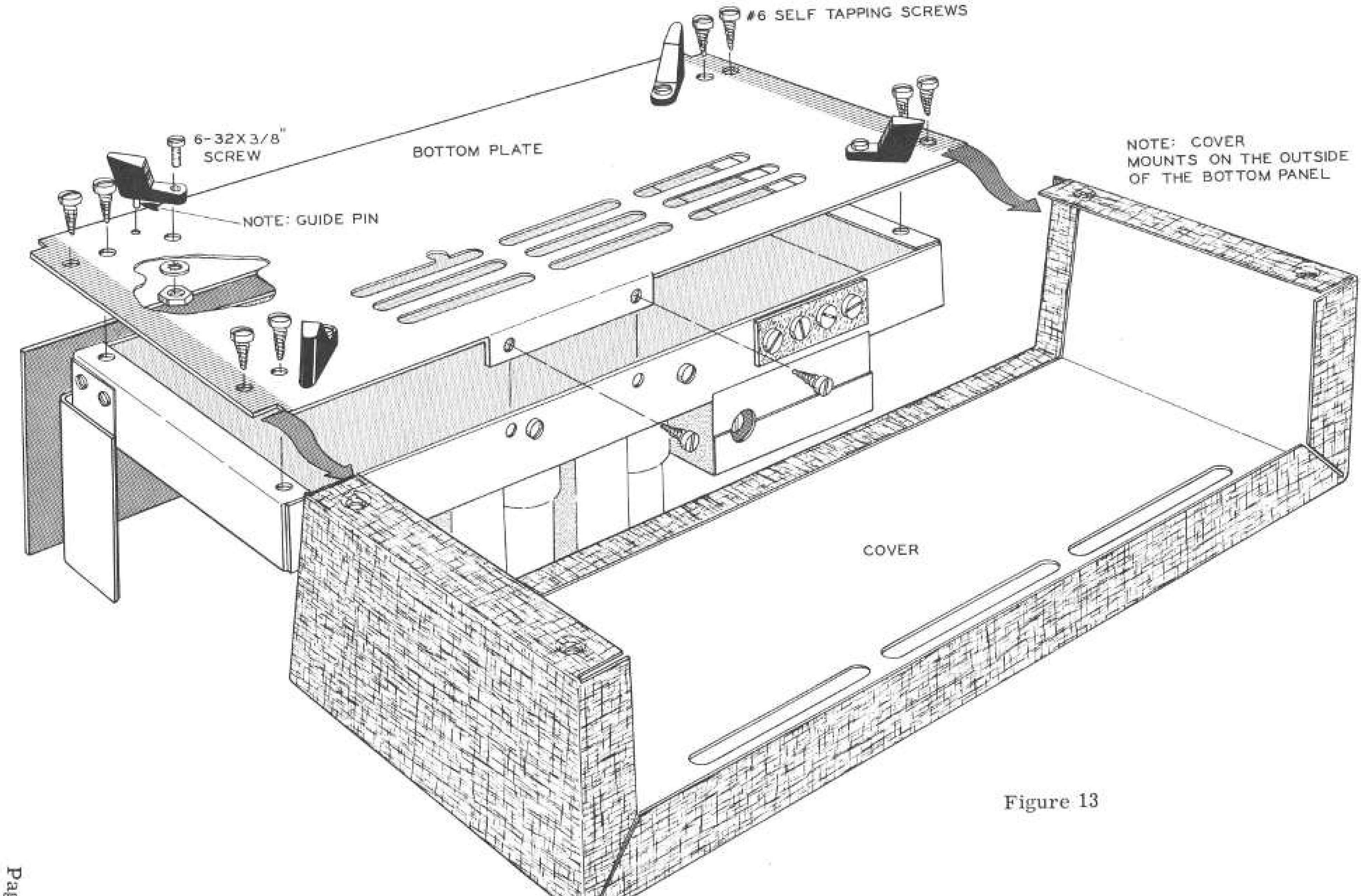
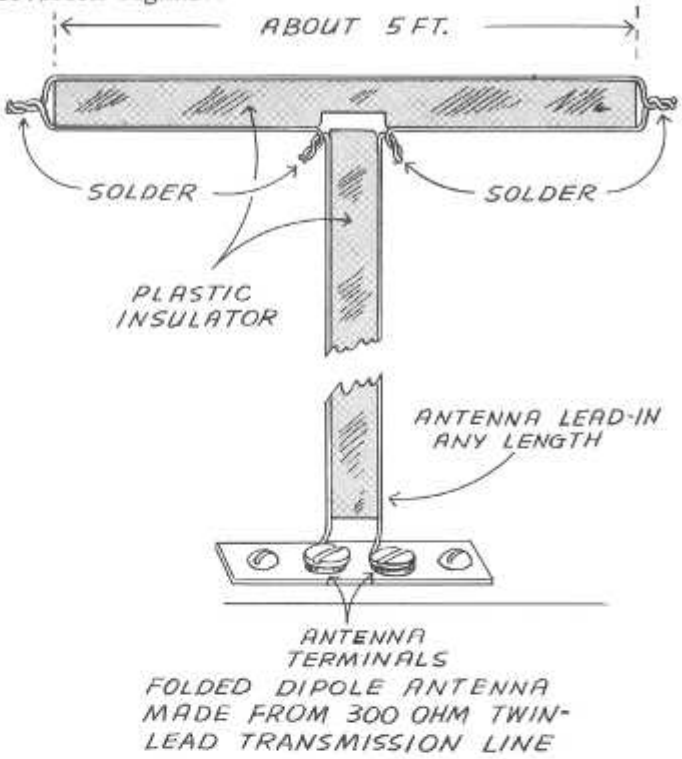

#6 SELF TAPPING SCREWS
6-32X3/8"
SCREW
BOTTOM PLATE
NOTE: GUIDE PIN
NOTE: COVER
MOUNTS ON THE OUTSIDE
OF THE BOTTOM PANEL
COVER

Figure 13

the lead-in from your TV antenna and tape the two together. This gives a reasonably good signal with a minimum of loss or distortion in your television signals.

The simplest and least expensive antenna you can use is a simple folded dipole made of 300 Ω twin lead, as indicated in the accompanying diagram. The 5' upper portion of this antenna should be hung so that it is as straight as possible with no twist in the lead. This lead can be stapled, nailed or taped to a piece of wood or heavy cardboard to reinforce it. This type of antenna is directional and will receive the stations which are directly in front of it or in back of it most strongly. The final test, of course, is to try it in your own particular location and see which direction gives you the best results.



FOLDED DIPOLE ANTENNA MADE FROM 300 OHM TWIN-LEAD TRANSMISSION LINE

Mouting the FM-4 Tuner

The FM-4 Tuner can easily be flush mounted in the Heathkit Chairside Enclosure or in your own custom installation. By merely removing the cabinet, you will note there is sufficient space around the edges to flush mount the Tuner in the opening provided in the enclosure. It is recommended that the bottom plate be left on in a custom enclosure, since the stray capacities of the top or metal parts of any other unit on which it may be resting could cause instability of operation. It may be necessary in some cases, such as the Heathkit Chairside Enclosure, to remove the four legs before installing.

Observe the gasket material included with your kit. When flush mounting the Tuner in the Chairside Enclosure or in your installation, it is suggested that you line the inside edges of the front panel with this material to prevent the metal panel from marring the finish of your enclosure. Merely cut four strips to the proper length, remove the paper backing from the adhesive of each strip, and place them firmly against the inside edges of the panel that will come in contact with the mounting surface.

( ) Note that the notches in the bottom plate of the tuner may seem too wide to seat snugly in the side of your Heathkit Chairside Enclosure. This is due to unavoidable variations due to the various characteristics of wood. Wooden or cardboard wedges may be added in the notches, to properly center the tuner in your enclosure.

IN CASE OF DIFFICULTY
TROUBLESHOOTING

The TROUBLESHOOTING section of this manual is presented in two parts: a generalized procedure, and a chart of specific difficulties which is shown on Page 37. While the chart indicates some of the troubles that may be encountered, it is impossible to list all of the difficulties that could occur.

Observance of a few basic procedures found in the generalized section will aid you in correcting the troubles not shown on the chart. While service instruments are of value, they are not entirely necessary when performing these basic procedures.

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.
2. It is interesting to note that about 90% of the kits that are returned for repair are defective due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as illustrated in the Figures found in the SOLDERING TECHNIQUES section of this manual.

3. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagram and as called out in the wiring instructions.

4. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring beneath the chassis.

5. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram. NOTE: All voltage readings were taken with a Heathkit Vacuum Tube Voltmeter. Voltages may vary 10% due to line voltage variations.

6. A review of the circuit description will prove helpful in indicating where to look for trouble.

CAUTION: To avoid any shock hazard when making the following tests, make sure that only the pins that are mentioned in the text are touched with the screwdriver, and that the other hand or any other part of the body is not in contact with the chassis or any conductor that may provide a return path to ground.

7. If the tuner is still not cured, turn the volume control of the amplifier up and touch pin 9 or the audio output jack with a screwdriver. You should hear a loud sound out of your speaker. If you don't, either your amplifier is at fault or the audio cable has an open or short circuit in it.

If you hear a sound here, proceed back to pin 8 of V5. If you don't hear a sound at this point, this means that this cathode follower circuit is at fault. If you hear a sound, proceed back further.

Next, scratch pin 1 of V4. You should hear a scratching noise in your speaker. No sound at this point means that you have trouble between the cathode follower and this limiter stage.

In a like manner, you can check V3 and V2 to find out in which area your trouble lies. Once you have found the general area, the trouble should be located by using a voltmeter and checking the voltage readings on the Schematic.

NOTE: If the trouble should seem to be in the tuning unit, it is inadvisable to probe around inside it as it is an extremely delicate piece of equipment. Just moving a lead can throw the tuning unit completely out of alignment.

If the receiver operates but sensitivity seems to be low or the stations do not seem to be tuning properly, this may be due to a defective tube or improper alignment. The tuner is designed to be aligned as perfectly as possible, but minute differences in wiring from one builder to another can make quite a bit of difference. The tuner may be misaligned to a greater or lesser extent by wiring arrangements other than those shown in the pictorials, or by using longer leads than necessary. Also, your FM antenna, like a television antenna, is directional and should be oriented for the best possible signal conditions.

If, after applying all of these procedures, your difficulties are not resolved, check the SERVICE section of this manual for some of the facilities that the Heath Company makes available.

TROUBLESHOOTING CHART

TYPE OF DIFFICULTY	POSSIBLE CAUSE
Poor flywheel action, flywheel seems to rub.	Dip the end of a pencil or a wire into some light lubricating oil and apply it to the tuner-dial plate bushing. If the flywheel action still seems poor, check the alignment of the tuner shaft with regard to the tuner-dial plate bushing. If this is the trouble, the flywheel will turn freely when the nut of this bushing is loosened. The tuner mounting nut may also have to be loosened to aid in the realignment. A horizontal adjustment can be made on the tuner mounting bracket and a vertical adjustment can be made with the dial plate bushing.
Dead tuner, filaments not lit.	AC line cord, open AC switch, defective wall outlet, power transformer.
Dead tuner, filaments lit.	Open or shorted output cable, volume control defective, no B+ voltage.
No B+ voltage.	Open power transformer plate winding, defective silicon rectifier, filter capacitor, filter resistors, or shorted circuit in B+ line.
Hum.	Reverse line cord in wall outlet, open filter capacitors, heater to cathode leakage in tubes, open ground in output cable.
Noise, but no audio.	Defective antenna, front end tube (V1) defective.
Noisy, low audio out.	Poor grounds (tighten tube sockets and all nuts and screws), defective tube, ratio detector transformer misaligned.
Distorted output.	Ratio detector secondary (top adjustment) misaligned, defective filter, check B+ voltage at supply, plates and screen grids.

ALIGNMENT

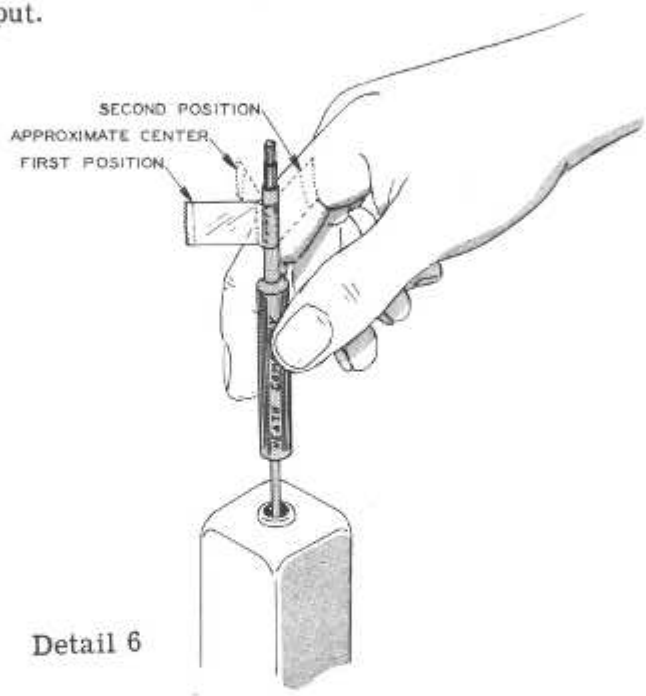
The alignment of an FM tuner, like a television tuner, is a very involved and difficult thing when done properly. Because of this, we have tried to divide the alignment up into two sections. In the first section we have tried to break the alignment down into its least common denominator, trying to align the set as simply as possible and still do a good job. The second part of this alignment section is the normal type of alignment chart which you would find in any television set or FM set alignment procedure.

NOTE: Alignment should not be attempted unless the following two conditions have been fulfilled: (1) When all other possibilities have been exhausted and you are sure that alignment is the difficulty with your set; (2) It is strongly recommended that you do not attempt alignment at all unless you have at least some experience in electronics work. Just a few simple mistakes can put your tuner very badly out of adjustment.

SECTION 1 - A short simple alignment procedure. Equipment required: An RF signal generator tunable from 98 to 100 megacycles with little drift, and a DC vacuum tube voltmeter.

Remove the cabinet shell of the FM-4, but keep the bottom cover on. Set the VOLUME control of the FM-4 to maximum clockwise position and the AFC switch to the OFF position. Allow the FM-4 and the generator to warm up for 15 to 30 minutes. Set the generator to about 98 megacycles, unmodulated (if a local station is close enough to 98 megacycles to interfere, choose another frequency in the vicinity). Connect the generator output to the antenna terminals of the tuner. Connect the DC voltmeter to the multiplex output of the tuner. This is the output jack on the rear that is closest to the center of the tuner. Tune your tuner to the same frequency as is indicated on the generator. Insert your alignment tool in the top slug of the ratio detector transformer, T4. Detune this slug by turning it counterclockwise approximately one turn. Switch your DC voltmeter to the 10 volt DC range, and by careful tuning of your tuner you should be able to see an output on the meter. Tune the tuner for the maximum point on this meter. You are now ready to begin the IF alignment procedure.

Begin the alignment procedure with T4, the ratio detector transformer. Keep the generator output at the lowest usable level. Adjust the bottom slug of T4 for a maximum reading on the meter. This being done, proceed to T3. Align each slug of T3 for a maximum reading on the meter and in like manner, align transformers T2 and T1 (in the tuning unit). When this is done, you will have the IF's peaked for the maximum output.



Detail 6

Since the response characteristic of an FM IF strip is relatively flat-topped, you will have to go from this peaked characteristic to a flat-topped characteristic. To do this, put a flag with a piece of tape on your alignment tool, as shown in the accompanying Detail. The purpose of this flag is to indicate the approximate center of the flat-topped response of each winding that you adjust. As an example, suppose your meter reading the peak for a particular adjustment had read 5 volts. As you continuously turn the adjustment slug in a clockwise manner, you will note that the meter will read gradually more and go up through, for example, 4.7 volts, read 5, seem to stay rather flat around 5 for a few moments and then proceed back down through 4.7 volts again and decrease from that point still further. The portion where it stays relatively flat around the 5 volt area would be the point where it is properly peaked. What we desire to do is to adjust each coil in this manner and adjust the tool so that the slug will be positioned exactly in the center of this rather flat portion of the response. In this particular case, you would notice the direction in which the flag was pointed when the meter was reading 4.7 volts the first time, you would continue on through 5 volts until the meter came back down to 4.7 volts again, and you would notice the position of the flag. The correct setting for this particular slug would be the halfway point in between these two flag positions.

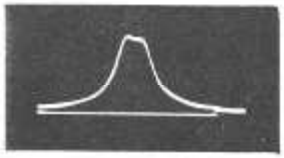
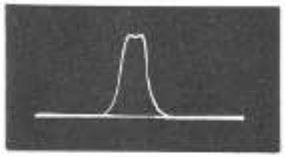
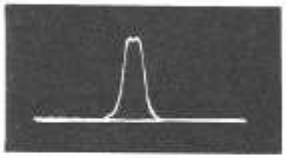
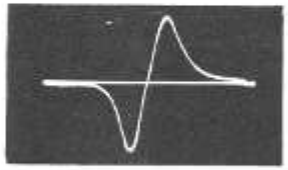
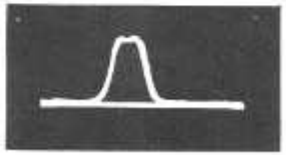
In the same manner, adjust each of the slugs that you adjusted previously for the center portion of this relatively flat response. Each one of these slugs should be quite close to the maximum response that was obtained previously when you peaked them all to maximum.

When these adjustments are all made properly, your IF strip should be quite close to proper alignment. It remains now to return the secondary of the ratio detector transformer back to its proper position. This should be done by turning the top slug of the ratio detector transformer T4 in a clockwise direction. The proper voltage (zero volts) is indicated when the output voltage changes very rapidly; it will go from a positive voltage through zero to a negative voltage of the same magnitude. The center of this, or zero volts, is the proper setting for this adjustment and the maximum plus and minus voltages should be about equal. A voltmeter with a zero-center range is very handy for this adjustment.

This completes the quick alignment procedure.

COMPLETE ALIGNMENT PROCEDURE
USING A SWEEP GENERATOR, MARKER GENERATOR AND OSCILLOSCOPE

Tuning Control - off station position
Volume Control - full clockwise
AFC Switch - off

PREPARATION	SWEEP GENERATOR: Connect sweep generator	SWEEP GENERATOR: Sweep generator and marker generator frequency	OSCILLOSCOPE: To be connected	ADJUST: for maximum gain and bandwidth	ADJUST: for approximate response
Disconnect positive (+) lead of C32 from pin 2 of V5.	Through .01 μfd capacitor to Pin 1 of V4	10.7 mc	Across 6.8 KΩ resistor (R13) to center post (ground)	Bottom slug of T4	
	Through .01 μfd capacitor to Pin 1 of V3	10.7 mc		Top and bottom slugs of T3	
	Through .01 μfd capacitor to Pin 1 of V2	10.7 mc		Top and bottom slugs of T2	
	Through .01 μfd capacitor to Pin 1 of V4	10.7 mc	To audio output jack	Top slug of T4 for straightest center portion of curve and balanced plus (+) and minus (-) swing	
Reconnect (+) lead of C32. Tune the dial pointer to 98 mc.	To Antenna input, with 240 Ω in series with hot lead (for 50 Ω generator Z)	Sweep generator - 98 mc Marker generator - 10.7 mc	To pin 1 of V4 through 100 KΩ resistor. Ground lead to V4 center post	Top and bottom slugs of T1	

The tuning unit of the FM-4 Tuner is a completely prealigned unit, designed so that it should need no further adjustment during its useful lifetime. In the event that a component, such as a resistor or capacitor, should ever be replaced in the Tuner and the leads are disturbed so that alignment is necessary, we present the following information.

Since our customers range from complete novices to receiver design engineers, we feel it necessary to give this information. We strongly urge that only those familiar with tuner and VHF alignment procedures make any attempt whatsoever to adjust the tracking of the tuning unit.

Slide the cover from the tuning unit by pulling it off to the rear. Observe the two slugs on the threaded plastic shaft, and note that in front of each slug is a single shorted grounded turn, made similar to a flat washer. The cement holding each of these two slugs can be removed by painting the cemented area with carbon tetrachloride. When these are loose, replace the cover and proceed to make the necessary adjustments through the holes in the side of the cover.

Set the dial indicator at its proper position in the center area of the dial by using an accurate generator or a local station. Tune the dial indicator to 104 mc and adjust the rear slug (L2 oscillator) for the proper frequency. Tune the dial indicator to 92 mc and adjust the position of the adjacent shorted turn (L2-A) for the proper frequency.

Tune the dial back to 104 mc and adjust slug L1 (RF coil), the front slug, for maximum gain and bandwidth. Tune to 92 mc and adjust the adjacent shorted turn (L1-A) for maximum gain and bandwidth. Repeat both the oscillator and RF coil adjustments.

C46 is a factory adjustment for uniformity in tuning units and should not be adjusted.

SERVICE

If, after applying the information contained in this manual and your best efforts on the unit, you are still unable to obtain proper performance from the instrument, it is suggested that you take advantage of the technical facilities which the Heath Company makes available to its customers.

The Technical Consultation Department is maintained for the purpose of providing Heath customers with a personalized technical consultation service; this service is available to you without charge. The technical consultants are thoroughly familiar with all details of the instrument and can usually localize the trouble from a suitable description of the difficulty encountered. It is, of course, necessary that you provide full and complete information concerning your problem when writing to the Technical Consultation Department for assistance. For instance, clearly identify the kit involved, giving the purchase date and, if possible, the invoice number; describe in detail the difficulty that you have encountered; state what you have attempted to do to rectify the trouble, what results have been achieved, and include any information or clues that you feel could possibly be of value to the consultant who handles your problem. Failure to provide complete descriptive details may lead to incorrect assumptions on the part of the consultant and needless delay in the solution to your problem. Quite frequently, when the information given the consultants is complete, concise and reliable, a diagnosis of the difficulty can be made with confidence and specific instructions given for its correction. If replacement of a component is involved in the correction, the component will be shipped to you, subject to the terms and conditions of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the completed instrument to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a fixed fee of $6.00, plus the price of any additional parts or material required. However, if the instrument is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase and give invoice number, if possible.

Local Service by Authorized Heathkit Dealers is also available and often will be your fastest, most efficient method of obtaining service for your Heathkits. Although you may find charges for local service somewhat higher than those listed in Heathkit manuals (for factory service), the amount of increase is usually offset by the transportation charges you will pay if you elect to return your kit to the Heath Company.

Heathkit dealers will honor the regular 90 day Heathkit Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company. It will be necessary that you verify the purchase date of your kit by presenting your copy of the Heath Company invoice to the authorized dealer involved.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if your local dealer assists you in locating a defective part (or parts) in your Heathkit, or installs a replacement part for you, he may charge you for this service.

Heathkits purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized Heathkit dealer in order to be eligible for parts replacement under the terms of the Warranty.

THESE SERVICE POLICIES APPLY ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned NOT repaired.

For information regarding modifications of Heathkits 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 the Heath Company welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for specific purposes. Therefore, such modifications must be made at the discretion of the kit builder, according to information which will be much more readily available from some local source.

REPLACEMENTS

Material supplied with Heathkits 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 tube or component. Should inspection reveal the necessity for replacement, write to the Heath Company 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 the order number and date of purchase.
D. Describe the nature of defect or reason for requesting replacement.

The Heath Company 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. If tubes are to be returned, pack them carefully to prevent breakage in shipment as broken tubes are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SHIPPING INSTRUCTIONS

In the event that your Instrument must be returned for service, these instructions should be carefully followed.

ATTACH A TAG TO THE INSTRUMENT BEARING YOUR NAME, COMPLETE ADDRESS, INVOICE NUMBER ON WHICH THE INSTRUMENT WAS PURCHASED, AND A BRIEF DESCRIPTION OF THE DIFFICULTY ENCOUNTERED. Wrap the Instrument in heavy paper, exercising care to prevent damage. Place the wrapped Instrument in a stout carton of such size that at least three inches of shredded paper, excelsior, or other resilient packing material can be placed between all sides of the Instrument and the carton. Close and seal the carton with gummed paper tape, or alternately, tie securely with stout cord. Clearly print the address on the carton as follows:

To: HEATH COMPANY
Benton Harbor, Mich.

Include your name and return address on the outside of the carton. Preferably affix one or more "Fragile" or "Handle With Care" labels to the carton, or otherwise so mark with a crayon of bright color. Ship by parcel post or prepaid express; note that a carrier cannot be held responsible for damage in transit, if in HIS OPINION, the article is inadequately packed for shipment. Your Instrument will be returned by express collect.

SPECIFICATION CHANGES

All prices are subject to change without notice. The Heath Company 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.

WARRANTY

Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

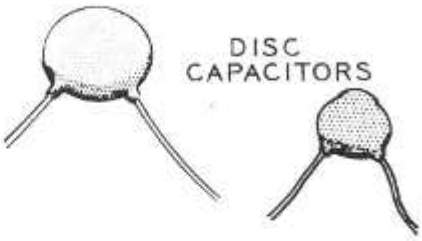
NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

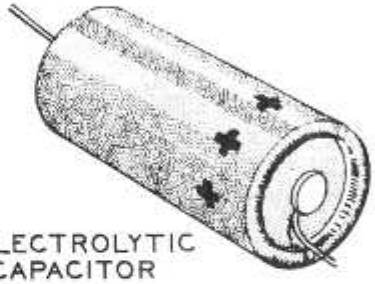
HEATH COMPANY

PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
1-2	1	68 Ω 1/2 watt (blue-gray-black)
1-3	1	100 Ω 1/2 watt (brown-black-brown)
1-9	1	1 KΩ 1/2 watt (brown-black-red)
1-19	2	6.8 KΩ 1/2 watt (blue-gray-red)
1-20	1	10 KΩ 1/2 watt (brown-black-orange)
1-23	1	27 KΩ 1/2 watt (red-violet-orange)
1-26	2	100 KΩ 1/2 watt (brown-black-yellow)
1-33	1	470 KΩ 1/2 watt (yellow-violet-yellow)
1-35	1	1 megohm 1/2 watt (brown-black-green)
1-44	3	2.2 KΩ 1/2 watt (red-red-red)
1-60	1	68 KΩ 1/2 watt (blue-gray-orange)
1-66	1	150 Ω 1/2 watt (brown-green-brown)
1-68	1	820 KΩ 1/2 watt (gray-red-yellow)
1A-19	2	220 Ω 1 watt 10% (red-red-brown)
Capacitors		
A21-9	1	100 μμf ±10% 500 V N750 disc ceramic
B21-14	1	.001 μfd ±20% 500 V disc ceramic
B21-17	4	270 μμf ±10% 500 V disc ceramic
B21-27	8	.005 μfd +80 -20 or GMV 500 V disc ceramic
21-41	1	14 μμf ±5% 500 V N750 tubular ceramic
21-47	1	.01 μfd ±10% 50 V disc ceramic
23-59	1	.05 μfd 200 V ±20%
C25-4	1	10 μfd 25 V electrolytic
C25-20	2	40 μfd 150 V electrolytic
C25-19	1	20 μfd 150 V electrolytic
C25-57	1	100 μfd 200 V tubular electrolytic
27-4	1	.2 μfd ±20% 50 V Mylar
Controls-Transformers-Tubes		
E10-60	1	500 KΩ linear tab mounting control
A19-44	1	1 megohm audio taper control w/SPST switch
52-26	1	IF transformer (1st stage)
52-27	1	IF transformer (2nd stage)
53-4	1	Ratio detector transformer
54-81	1	Power transformer
411-11	3	6AU6 tube
411-128	1	6BN8 tube
Sheet Metal Parts		
90-M105	1	Cabinet shell
100-M220	1	Dial plate assembly
100-M221	1	Dial cord assembly
100-M222	1	Front panel assembly
200-M208	1	Chassis
204-M238	1	Tuner mounting bracket
205-M151	1	Bottom cover plate


1/2 WATT RESISTER


1 WATT RESISTER


DISC CAPACITORS


ELECTROLYTIC CAPACITOR


AUDIO CONTROL SWITCH


TAB MOUNTING CONTROL


TUBULAR CERAMIC CAPACITOR 14 uuF

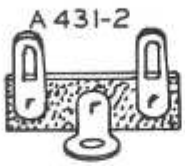

IF TRANSFORMER

PART No.	PARTS Per Kit	DESCRIPTION
Shields-terminal Strips-Sockets		
B206-3	1	9-pin miniature tube shield
B206-25	3	7-pin miniature tube shield
206-55	1	Tube socket shield base
207-5	3	3/16" plastic cable clamp
A431-2	2	2-lug terminal strip
B431-6	1	2-lug terminal strip (screw type)
A431-10	2	3-lug terminal strip, one grounded
A431-12	2	4-lug terminal strip, one grounded
A431-14	1	2-lug terminal strip, one grounded
434-42	2	Phono socket
434-56	1	9-pin miniature socket
B434-90	1	Pilot lamp socket
434-91	3	7-pin miniature tube socket
Shielded Wire-Sleeving		
343-3	1	Length shielded cable
344-1	2	Length hookup wire (1 black, 1 yellow)
346-1	1	Length sleeving
347-2	1	Length twin lead
347-3	1	Length 2-conductor shielded cable
Hardware		
250-8	10	#6 x 3/8" binder head sheet metal screw
250-32	4	6-32 x 3/8" flat head machine screw
250-49	10	3-48 x 1/4" binder head machine screw
250-56	19	6-32 x 1/4" binder head machine screw
250-89	7	6-32 x 3/8" binder head machine screw
250-100	2	#6 x 5/16" setscrew
250-106	2	#6 self-tapping screw
252-1	10	3-48 x 7/32" nut
252-3	31	6-32 x 1/4" nut
252-7	3	3/8-32 x 1/8" control nut
253-10	3	Flat control washer
253-27	8	5/32" ID x 5/16" OD flat steel washer
254-1	32	#6 lockwasher
254-4	1	Control lockwasher
254-7	16	#3 lockwasher
255-1	2	1/8" spacer
255-30	1	3/8" x 5/8" x 3/16" spacer
259-1	3	#6 solder lug
259-6	4	#6 small solder lug
455-10	1	Tuner dial plate bushing


SHIELD BASE


CABLE CLAMP


TUBE SHIELD

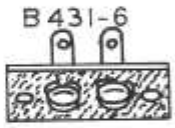


2 LUG

3 LUG

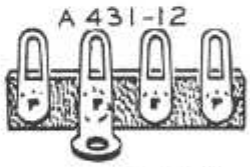
TERMINAL STRIPS


PHONO SOCKET



SCREW TYPE TERM. STRIP

2 LUG



4 LUG

TERMINAL STRIPS


1/8 SPACER


TUNER BUSHING


#6 SOLDER LUG


SMALL #6 SOLDER LUG

#6 SETSCREW


#3 LOCKWASHER


3-48 NUT


STEEL WASHER


#6 LOCKWASHER


6-32 NUT


CONTROL WASHER


CONTROL LOCKWASHER


CONTROL NUT


6-32 x 3/8 FHMS


#6 SELF-TAPPING

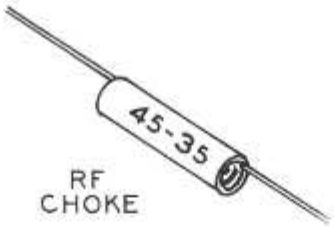

6-32 x 1/4 BHMS


6-32 x 3/8 BHMS

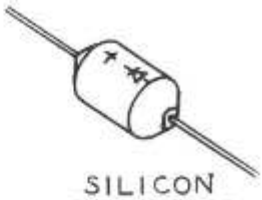

3-48 x 1/4 BHMS


6 x 3/8 BHS

PART No.	PARTS Per Kit	DESCRIPTION
Miscellaneous		
C45-35	3	1.7 μh filament RF choke
57-23	1	200 ma silicon rectifier
60-1	1	SPST slide switch
73-1	3	7/16" rubber grommet
73-2	1	3/4" rubber grommet
73-19	1	Length gasket material
A75-24	1	Insulator, line cord strain relief
89-1	1	Line cord
110-1	1	Preassembled tuning unit with 6DT8 (or 6AQ8) tube installed
258-1	1	Dial cord spring
260-7	3	IF transformer mounting clip
261-13	4	Plastic feet
391-6	1	"Heathkit" nameplate
412-1	1	#47 pilot lamp
438-4	2	Phono plug
446-16F266	1	Dial window
454-2	1	Flywheel
462-78	2	Knob
463-11	1	Dial pointer
490-1	1	Alignment tool
595-260	1	Manual

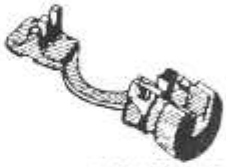


RF CHOKE


SILICON RECTIFIER


RUBBER GROMMET


DIAL CORD SPRING


LINE CORD STRAIN RELIEF


DIAL POINTER


PHONO PLUG


PLASTIC FOOT


TRANSFORMER MOUNTING CLIP

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HELPFUL KIT BUILDING INFORMATION

Before attempting actual kit construction read the construction manual through thoroughly to familiarize yourself with the general procedure. Note the relative location of pictorials and pictorial inserts in respect to the progress of the assembly procedure outlined.

This information is offered primarily for the convenience of novice kit builders and will be of definite assistance to those lacking thorough knowledge of good construction practices. Even the advanced electronics 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 specialized equipment and only basic tools are required. A good quality electric soldering iron is essential. The preferred size would be a 100 watt iron with a small tip. The use of long nose pliers and 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 rosin 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 tube sockets are properly mounted in respect to keyway or pin numbering location. The same applies to transformer mountings so that the correct transformer color coded wires will be available at the proper chassis opening.

Make it a standard practice to use lock washers under all 6-32 and 8-32 nuts. The only exception being in the use of solder lugs—the necessary locking feature is already incorporated in the design of the solder lugs. 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 binding posts that require the use of fiber insulating washers, it is good practice to slip the shoulder washer over the binding post mounting stud before installing the mounting stud in the panel hole provided. Next, install a flat fiber washer and a solder lug under the mounting nut. Be sure that the shoulder washer is properly centered in the panel to prevent possible shorting of the binding post.

WIRING

When following 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.

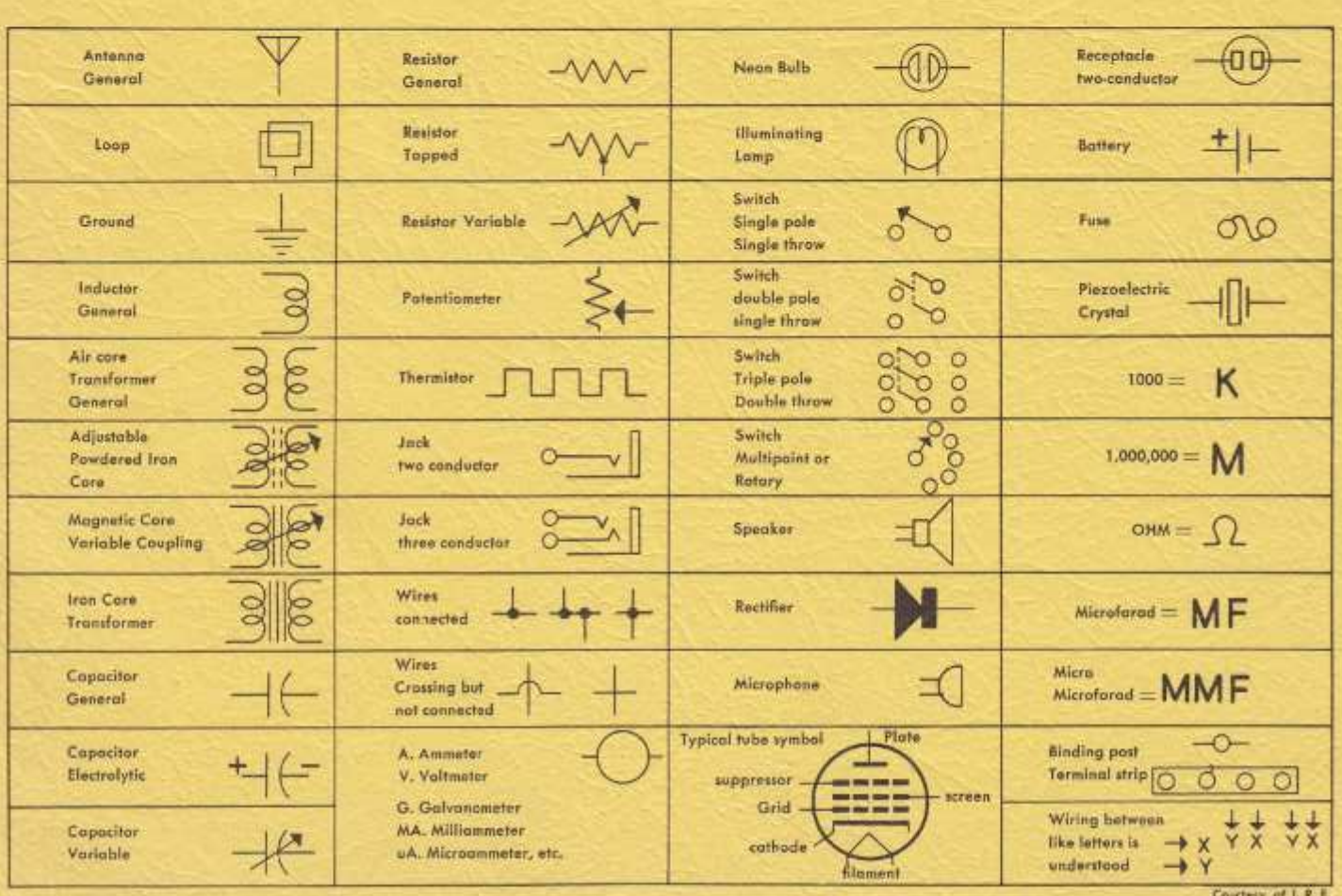
When removing insulation from the end of hookup wire, it is seldom necessary to expose more than a quarter inch of the wire. Excessive insulation removal may cause a short circuit condition in respect to nearby wiring or terminals. In some instances, transformer leads of solid copper will have a brown 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 condensers, trim off all excess lead lengths so that the parts may be installed in a direct point-to-point manner. When necessary use spaghetti or insulated sleeving over exposed wires that might short to nearby wiring.

It is urgently recommended that the wiring dress and parts layout as shown in the construction manual be faithfully followed. In every instance, the desirability of this arrangement was carefully determined through the construction of a series of laboratory models.

SOLDERING

Much of the performance of the kit instrument, particularly in respect to accuracy and stability, depends upon the degree of workmanship used in making soldered connections. Proper 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 to thoroughly flow the solder 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 tube sockets. This is particularly important in instruments such as the VTVM, 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 rosin core radio type solder.



Courtesy of I. R. E.

HEATH COMPANY

A Subsidiary of Daystrom Inc.

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

BENTON HARBOR, MICHIGAN

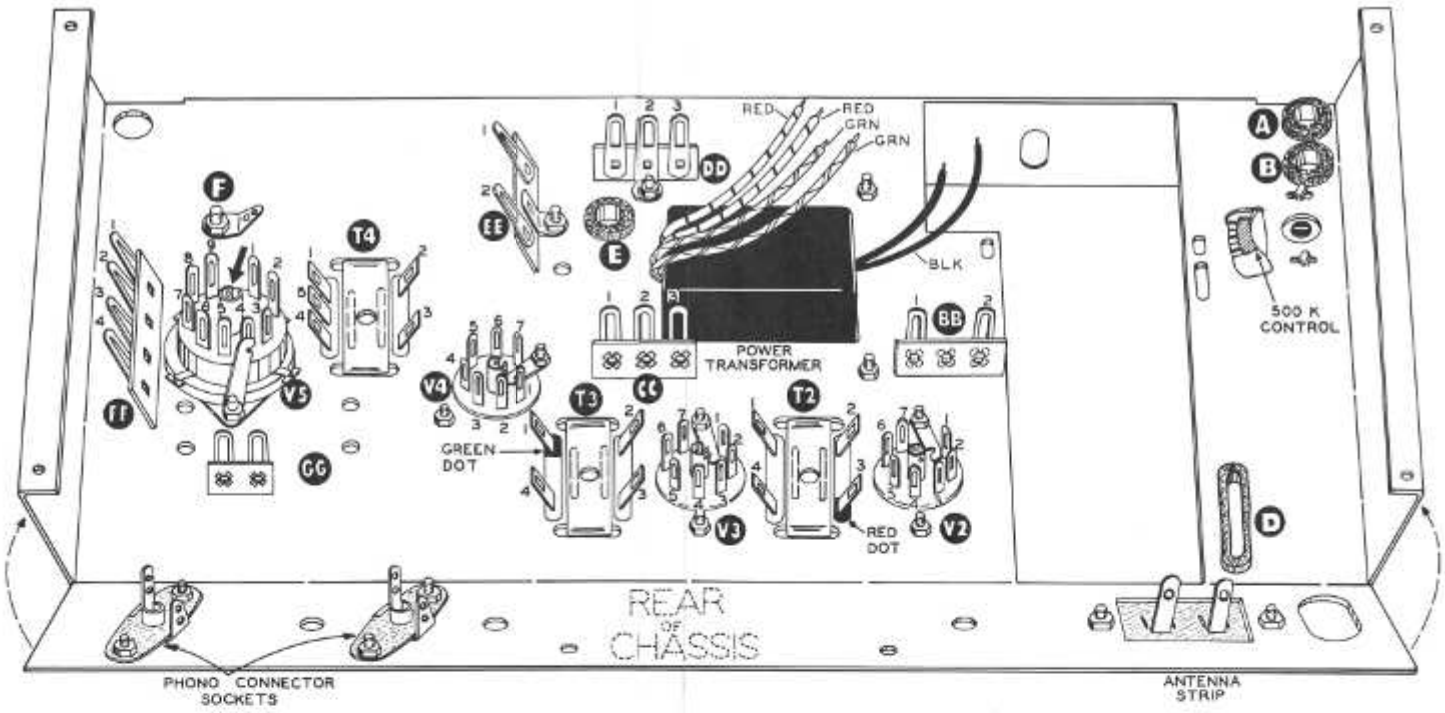


Figure 1

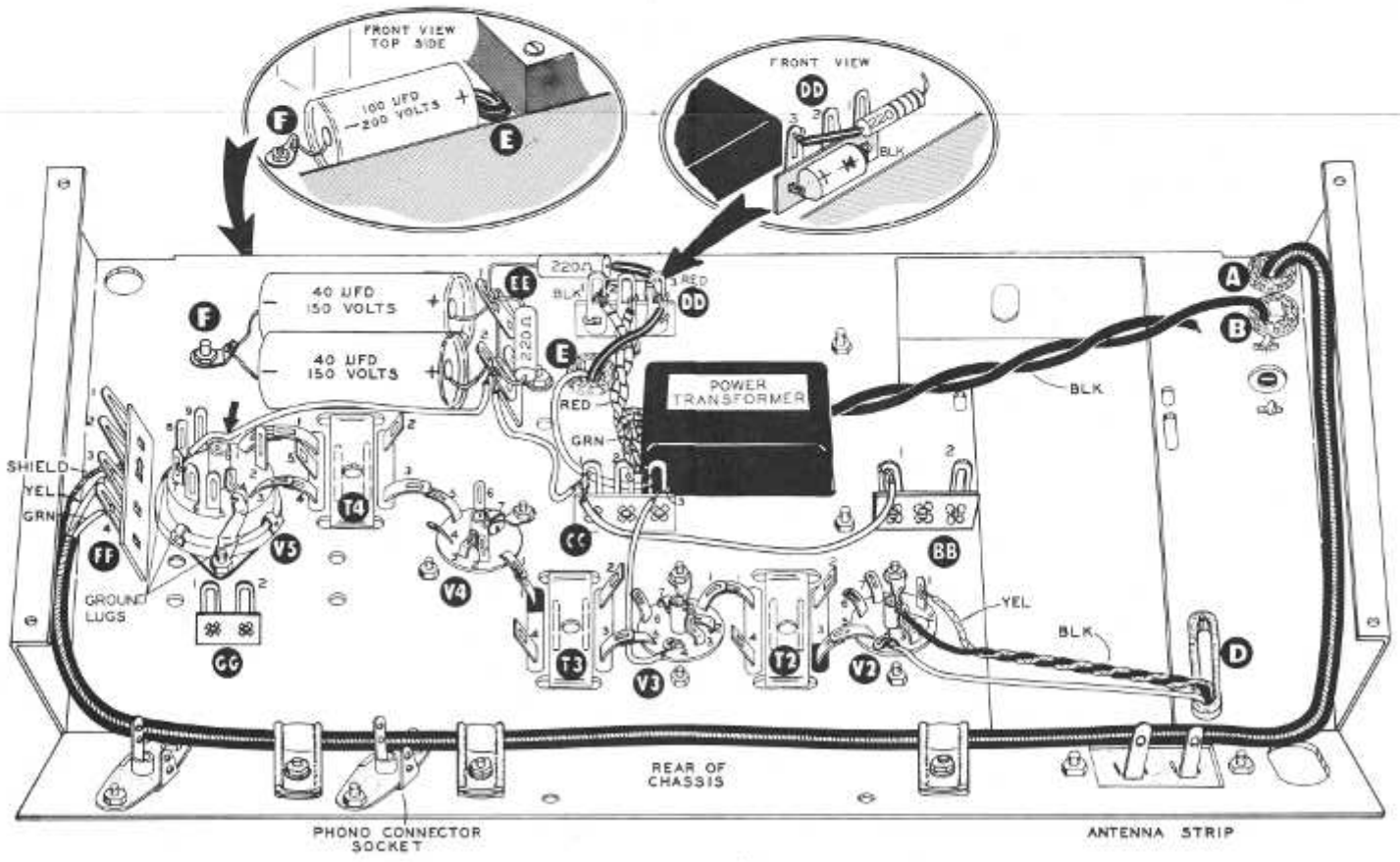
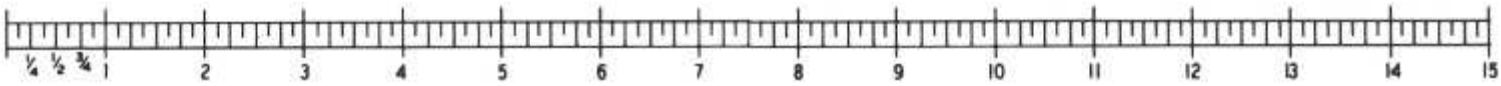


Figure 2



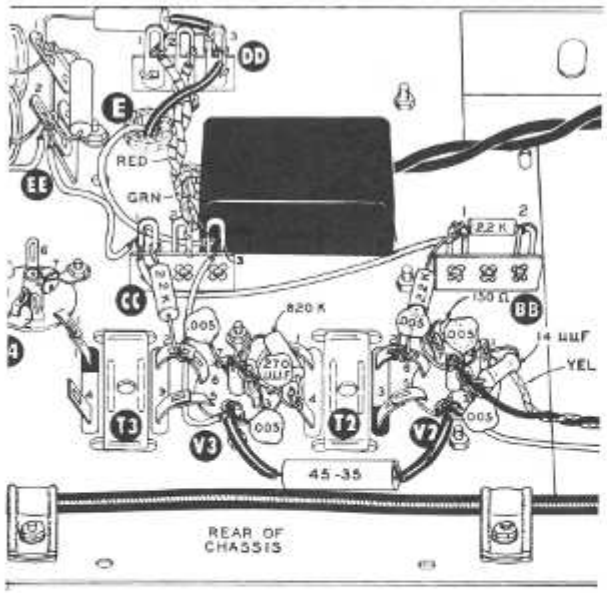


Figure 3

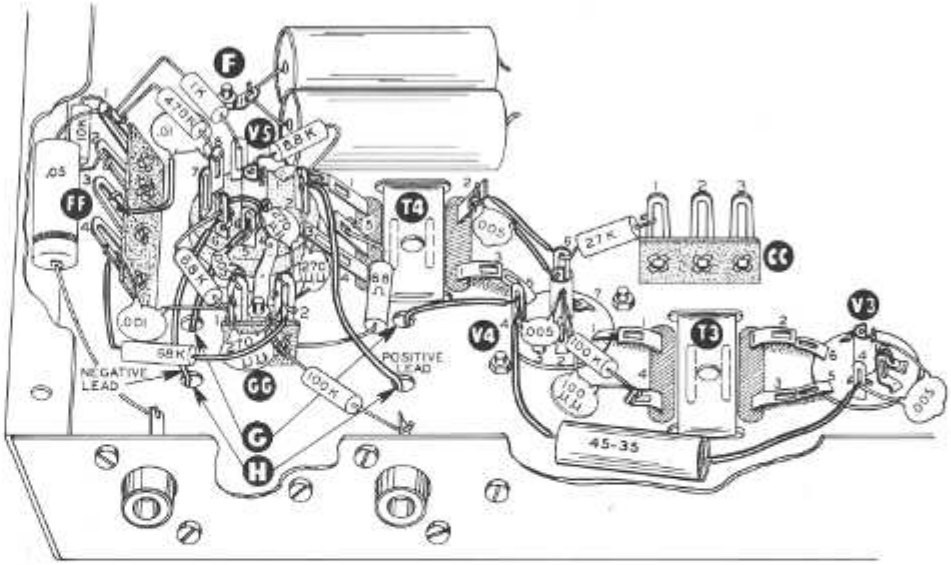


Figure 4

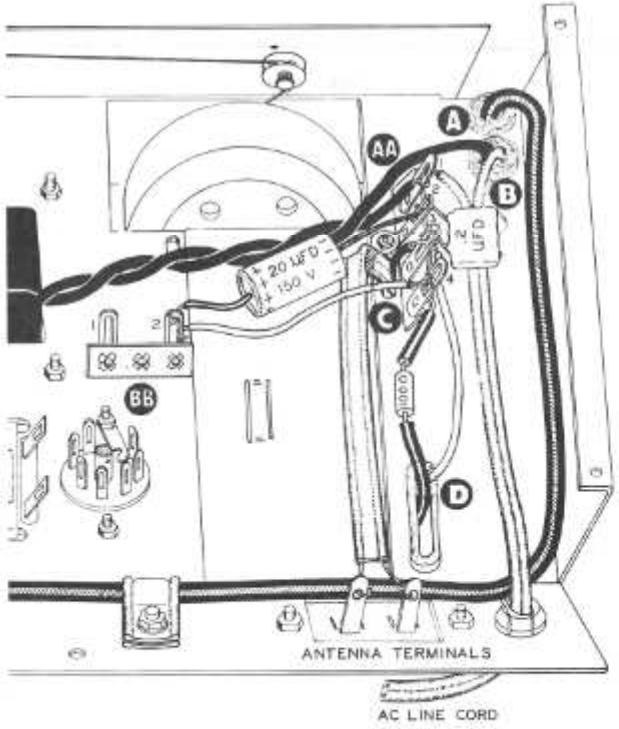


Figure 10

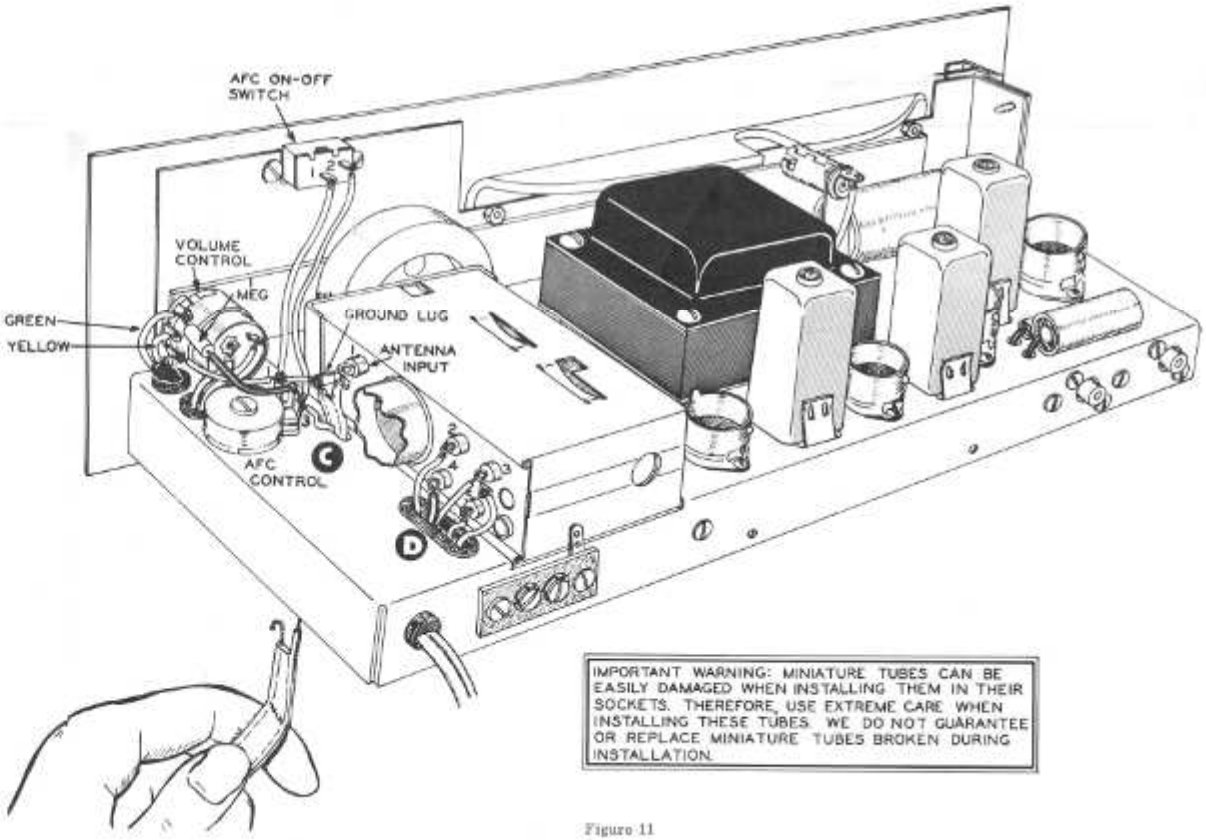
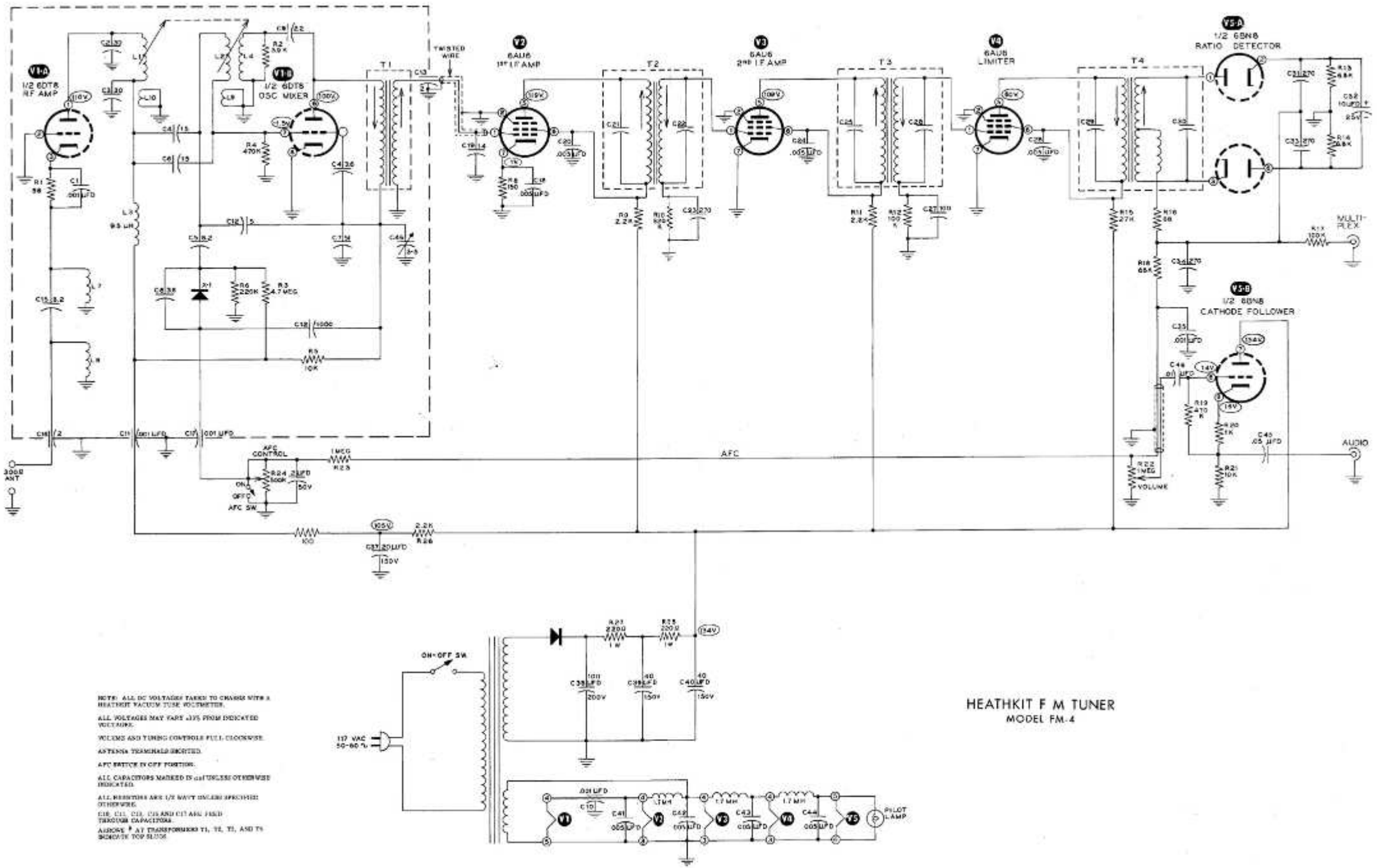


Figure 11



NOTE: ALL DC VOLTAGES TAKEN TO CHASSIS WITH A HEATHKIT VACUUM TUBE VOLTMETER.

ALL VOLTAGES MAY VARY ±15% FROM INDICATED VOLTAGES.

VOLUME AND TUNING CONTROLS FULL CLOCKWISE.

ANTENNA TERMINALS SHORTED.

AFC SWITCH IN OFF POSITION.

ALL CAPACITORS MARKED IN μf UNLESS OTHERWISE INDICATED.

ALL RESISTORS ARE 1/2 WATT UNLESS SPECIFIED OTHERWISE.

C18, C19, C20, C21 AND C37 ARE FEED THROUGH CAPACITORS.

ARROWS ↑ AT TRANSFORMERS T1, T2, T3, AND T4 INDICATE TOP SLUGS.

HEATHKIT F M TUNER
MODEL FM-4