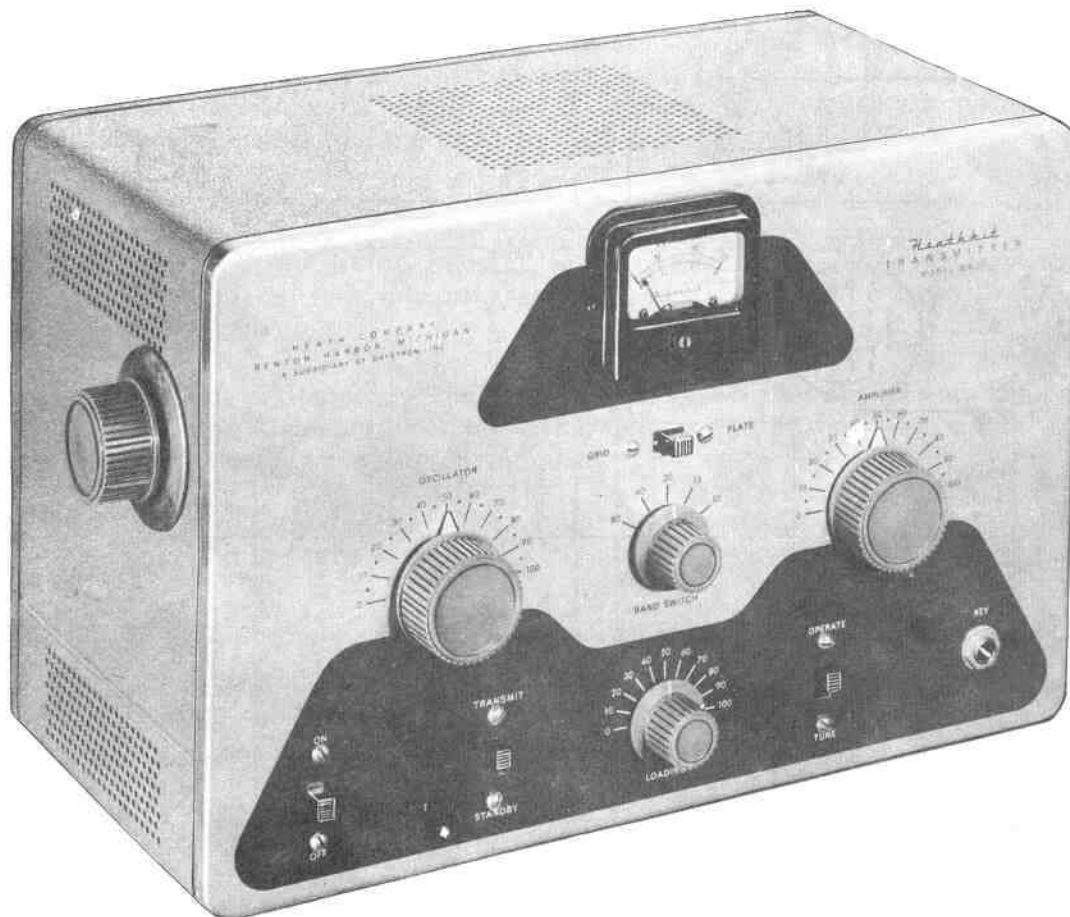


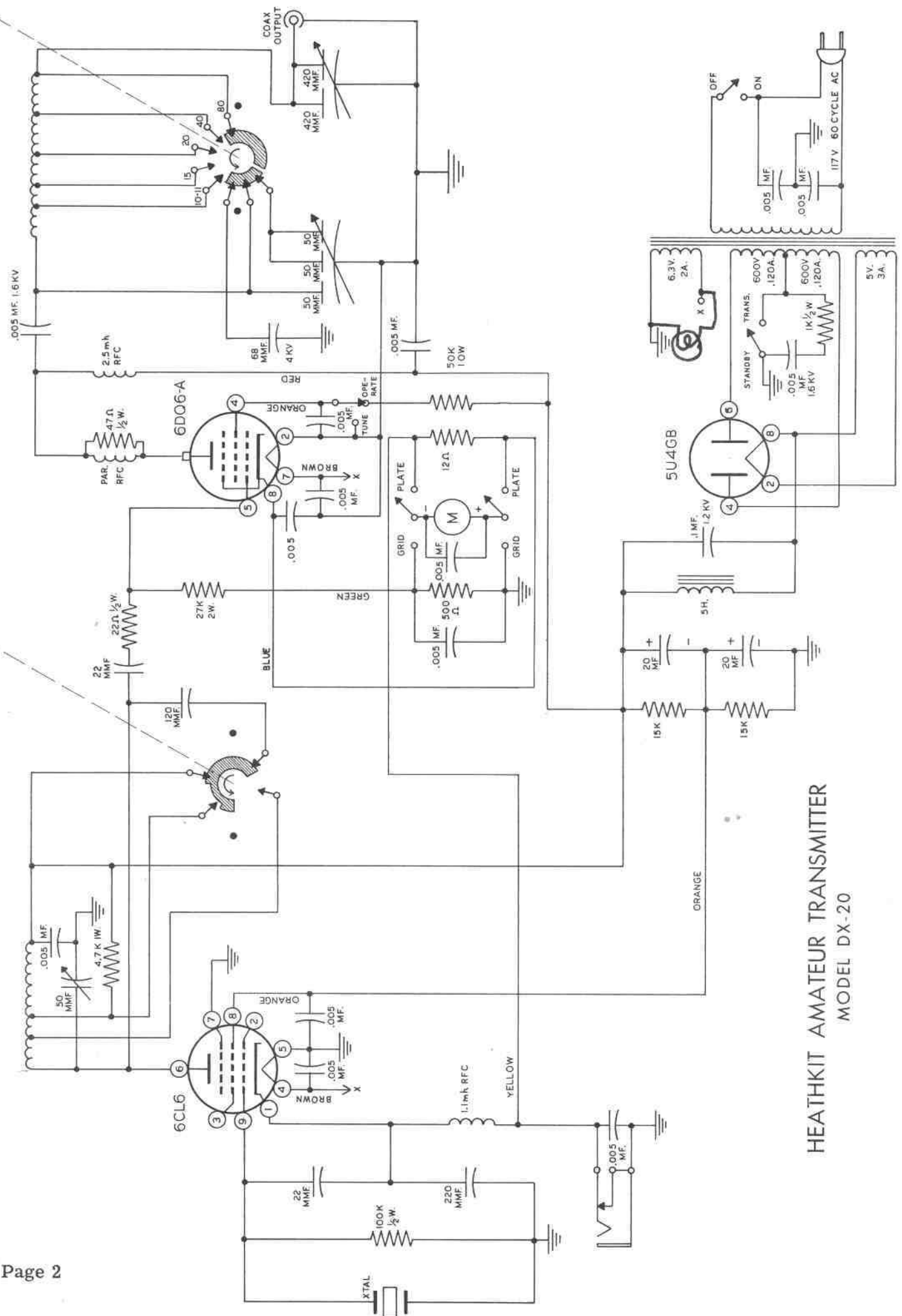
# ASSEMBLY AND OPERATION OF THE HEATHKIT AMATEUR TRANSMITTER MODEL DX-20



## SPECIFICATIONS

RF Power Input:.....	50 watts CW
Output Impedance:.....	50-1000 ohms
Output Coupling:.....	Pi network (coaxial)
Operation:.....	Crystal - external VFO
Band Coverage:.....	80-40-20-15-11-10
Tube Complement:.....	5U4GB rectifier 6CL6 oscillator 6DQ6A final amplifier
Power Requirements:.....	117 volts AC, 60 cycle, 160 watts
Cabinet Size:.....	13" wide x 8 1/2" high x 7" deep
Net Weight:.....	16 lbs.
Shipping Weight:.....	18 lbs.

SWITCH SHOWN IN 80 METER POSITION



HEATHKIT AMATEUR TRANSMITTER  
MODEL DX-20

## INTRODUCTION

The Heathkit model DX-20 Transmitter is especially designed for easy assembly which will appeal to the old timer as well as the beginning amateur. It contains no trick circuitry to confuse the beginner and the carefully engineered circuit layout coupled with good quality components results in high operating efficiency. The power, portability and 6-band design are ideal for emergency operation as well as for amateur field day use.

There are a number of natural crystalline substances which have the ability to transform a mechanical strain to an electrical charge. Likewise, they are also able to change an electrical charge into a mechanical strain. This property or reaction is called piezoelectricity. For example, if we were to cut a small plate or bar of this crystal substance and place it between two conducting electrodes and then connect these electrodes to a voltage source, the crystal would become mechanically strained. Conversely, if you were to squeeze the crystal between two electrodes, a voltage would develop between the electrodes.

One may visualize what does happen in a conventional oscillator circuit where our crystal holders exert pressure and a voltage is caused to exist across the electrodes on each side of the quartz wafer. It may be said that the crystal, when placed in the grid circuit of an oscillator and upon application of power to the circuit, is shocked into oscillation and vibrates at the frequency for which it is ground.

A grid current is caused to flow in the tube where it is greatly amplified and caused to appear across a tuned plate coil and capacitor combination tuned either to the fundamental frequency of the crystal or to one of its multiples or harmonics.

This increased radio frequency energy is then coupled to the grid circuit of the final stage where it is further amplified and appears in the plate circuit where the pi network matches it into the antenna.

## CIRCUIT DESCRIPTION

Oscillator: A 6CL6, which is the miniature counterpart of the popular 6AG7, is utilized in an efficient and proven Colpitts circuit. This type of oscillator and tube combination produces full grid drive on fundamental and harmonic frequencies allowing the final amplifier to operate at maximum output efficiencies.

The crystal has been enclosed inside the metal cabinet to insure confining all radiation, thus lessening the chances of television interference.

A VFO may be used with a suitable adaptor and plugged into the crystal socket. The VFO should be powered from another source.

The crystal oscillator tube and circuit have been conveniently located to provide a short lead from the plate of the 6CL6 to the grid of the 6DQ6A final amplifier.

Several functions of note are provided by the shield partition. It serves effectively in isolating the grid and plate circuits to prevent feedback, while providing a mounting position for the 6DQ6A final amplifier. It also shields the oscillator circuit from the output stage and supports the band switch and front panel.

Recent developments in the tube industry have resulted in the 6DQ6A, a heavy-duty tube designed for continuous service in the television field. Borrowing a page from their book, and after exhaustive tests, it was found that this tube was sufficiently rugged to be used as the final amplifier for this transmitter.

The power supply delivers a full 500 volts at a current of 100 milliamperes to the final amplifier which is according to ohm's law,  $E \times I = 50$  watts. It is designed with choke input along with two 20  $\mu$ f capacitors in series to increase the voltage rating and allow a larger safety factor. Along with this idea, each filter has a 15 K 10 watt resistor connected both as a bleeder and a voltage divider for the filter capacitors as well as a voltage tap point for the screen of the oscillator. To further improve regulation, the choke is tuned with a .1  $\mu$ f 1200 volt capacitor which limits the surge voltage under key-up conditions. A heavy duty type 5U4GB rectifier tube is used well within its current capabilities, rounding out an efficient power source.

#### NOTES ON ASSEMBLY AND WIRING

In presenting the Step-By-Step instructions, the following procedure has been worked out in a logical sequence, giving the kit builder a carefully planned method for constructing this transmitter. We would advise, therefore, that the builder follow the instructions as they are outlined in this manual.

There is a considerable similarity between the screws and nuts of the 3-48 and 4-40 hardware supplied. Before using these pieces, examine them closely to determine that you have the part called for in the instructions. This is particularly true of the small size 4-40 nuts which resemble 3-48 nuts in physical size. These nuts may even hold on a 3-48 screw but will feel loose. If any doubt exists, try the nut on a 4-40 screw to check it. There is only one 4-40 screw and one 4-40 nut in this kit and they are used to mount the crystal socket. A washer is not required.

In designing the DX-20 little was spared in time and effort along with excellent quality components to promote an ideal circuit and arrangement. By the same token, the kit builder should exercise a great deal of care during assembly and wiring. Only by putting the best possible workmanship into the kit can best results be obtained from it. There is also a great deal of personal satisfaction in a neat, professional looking transmitter, which invariably results from careful assembly and wiring. This manual is supplied to assist you in every way to complete the DX-20 with the least possible chance for error.

It is suggested at this time that the builder take the time to read the entire manual, omitting the Step-By-Step instructions, before beginning assembly. This will enable him to proceed with the work much faster when construction is begun. Fastening the large pictorials to the wall above the work space will be found very handy. Their use will greatly simplify the construction of the kit. These diagrams are repeated in smaller size within the manual.

The manual should be retained in your files for future reference in regard to operating and maintaining the DX-20. During initial testing of this transmitter, satisfactory operation should be noted before mounting it in the cabinet.

Remember that voltage dangerous to life is present at several points of the chassis and the builder is cautioned especially in regard to children coming in contact with any parts of the exposed chassis.

During the building an awkward situation may come up, such as holding a nut while trying to center the screw. A pair of pliers is used to squeeze a piece of solder across the nut, securing it sufficiently to use as a handle in orienting over the screw end.

A soft rag or cloth spread over the work surface will prevent marring the cabinet and component finish. Some of the resistors and capacitors have longer than necessary lead lengths. These leads should be cut to the length specified in the instructions.

In some cases the wire length specified to run from one place to another may seem long. However, these leads, when dressed according to instructions, give a neat appearance as well as efficient operation and should be adhered to. Otherwise, excessive lead length should be avoided.

Marking the letters of the tube sockets, terminal strips and wire clamps on the bottom of the chassis will facilitate wiring.



In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. Such substitutions are carefully checked before they are approved and the parts supplied will work satisfactorily. By checking the parts list for resistors. You may find, for example, that a 1.2 K $\Omega$  resistor has been supplied in place of a 1 K $\Omega$  as shown in the parts list. These changes are self-evident and are mentioned here only to prevent confusion in checking the contents of your kit. We strongly urge that you follow the wiring and parts layout shown in the manual. The position of wires and components is extremely critical in a stable transmitter and changes may seriously affect the characteristics of the circuit. Resistors and condensers generally have a tolerance rating of  $\pm 10\%$  unless otherwise stated in the parts list. Therefore, a 100 K $\Omega$  resistor may test anywhere from 90 K $\Omega$  to 110 K $\Omega$ . The letter K is commonly used to designate a multiplier of 1000.

#### PROPER SOLDERING PROCEDURE

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

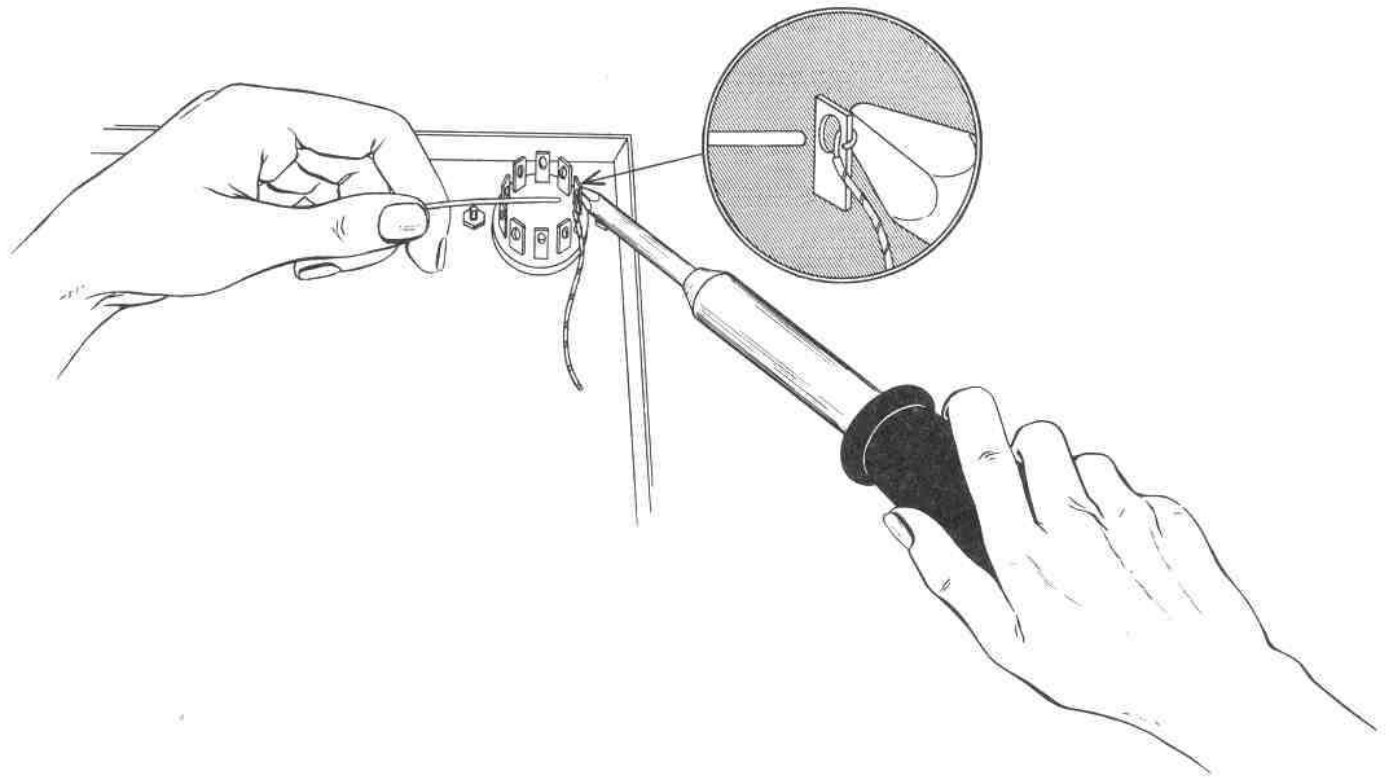
Correct soldering technique is extremely important. Good solder joints are essential if the performance engineered into the kit is to be fully realized. If you are a beginner with no experience in soldering, a half-hour's practice with odd lengths of wire and a tube socket will be a worthwhile investment.

High quality solder of the proper grade is most important. There are several different brands of solder on the market, each clearly marked "Rosin Core Radio Solder." Such solders consist of an alloy of tin and lead, usually in the proportion of 50:50. Minor variations exist in the mixture such as 40:60, 45:55, etc. with the first figure indicating the tin content. Radio solders are formed with one or more tubular holes through the center. These holes are filled with a rosin compound which acts as a flux or cleaning agent during the soldering operation.

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

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.

If terminals are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so a good joint is made without relying on solder for physical strength. To make a good solder joint, the clean tip of the soldering iron should be placed against the joint to be soldered so that the terminal is heated sufficiently to melt solder. The solder is then placed against both the terminal and the tip of the iron and will immediately flow out over the joint. Refer to the sketch below. Use only enough solder to cover wires at the junction; it is not necessary to fill the entire hole in the terminal with solder. Excess solder may flow into tube socket contacts, ruining the socket, or it may creep into switch contacts and destroy their spring action. Position the work so that gravity tends to keep the solder where you want it.



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



A good, clean, well-tinned soldering iron is also important to obtain consistently perfect connections. For most wiring, a 60 or 100 watt iron, or the equivalent in a soldering gun, is very satisfactory. Smaller irons generally will not heat the connections enough to flow the solder smoothly over the joint and are recommended only for light work, such as on etched circuit boards, etc. Keep the iron tip clean and bright. A pad of steel wool may be used to wipe the tip occasionally during use.

Take these precautions and use reasonable care during assembly of the kit. This will insure the wonderful satisfaction of having the instrument operate perfectly the first time it is turned on.

## STEP-BY-STEP ASSEMBLY INSTRUCTIONS

The following instructions are presented in a simple, logical step-by-step sequence to enable you to complete your kit with the least possible confusion. There are those who would rather bypass the step-by-step assembly as a supposedly arduous process and just follow the circuit diagram in wiring. This method could more than likely lead to disaster, besides not coinciding with the proper wire lead length, color coding and lead dress.

In most kits the parts are assembled in a sequence, one part being mounted over or under another and wiring being in a likewise relationship. So it is obvious that adhering to the progressive steps would be more advisable.

Be sure to read each step all the way through before beginning. When a step is completed, check it off the space provided. This makes it easy to resume construction after your work has been interrupted.

NOTE: We suggest that you do the following before any work is begun.

1. Select the large pictorial that is included in the manual that pertains to the particular phase of assembly involved.
2. After identifying the part or parts listed, place them in a shallow box so that they are readily accessible. This will assist in saving time and confusion.
3. The assembly and wiring instructions on the inside rear cover of the manual should be thoroughly read, and refer to the general information on both inside covers of the manual to identify the parts.
4. In assembly, use lockwashers under all nuts unless a solder lug is used or otherwise specified.

When the instructions call for soldering, the abbreviation (S) is used. When other wires are to be included in a connection before making a solid union, the abbreviation (NS) is used, meaning do not solder.

NOTE: Much time can be saved by sorting out all the hardware and small parts, and especially isolating the various sizes of nuts and bolts, etc. into little partitioned boxes similar to papier mache' egg containers. Consult your parts list and pictorials for further description.

For the following steps the chassis is viewed from the underside facing the rear apron. (See Pictorial 1 on Page 8.)

- (✓) Select the four  $3/8 \times 9/32$  rubber grommets. Insert one in the line cord hole at position E. This is best done with the aid of a small screw driver or similar tool by forcing the grommet into and sideways against the edge of the  $25/64$ " hole, then releasing it.
- (✓) Install the other three rubber grommets in positions A, B and C in the same manner.
- (✓) The  $3/16 \times 5/16$  small rubber grommet is next installed at position D.
- (✓) Mount the 5U4GB octal socket at position G using 6 -  $32 \times 1/4$ " machine screws and #6 lockwashers under the 6 - 32 nuts. Orient the socket so the keyway faces the transformer position. See Figure 1 and Pictorials 1 and 2.

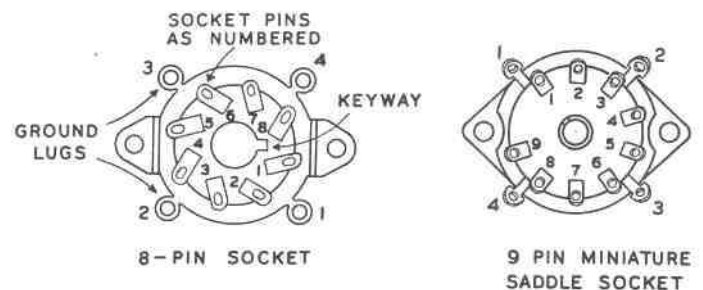
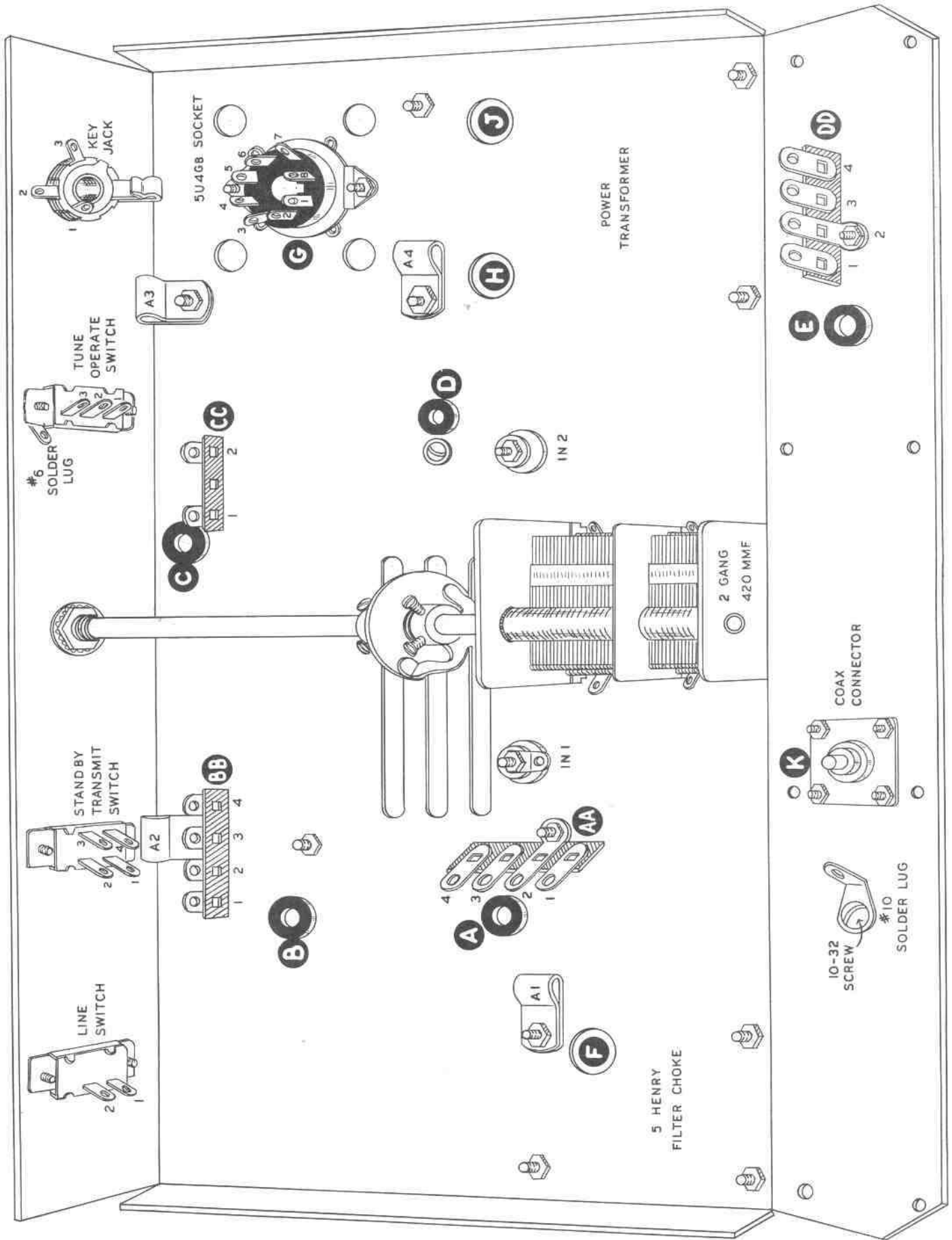


Figure 1



PICTORIAL 1



- (✓) The female coax connector is mounted on the rear chassis apron at position K using four 3 - 48 x 1/4" screws. These are four of the six noted in your parts list. Mount the connector so that the open solder end is exposed.
- (✓) Mount the one large #10 solder lug on the inside rear apron of the chassis under the 10 - 32 x 5/8" screw next to the coax connector with the #10 lockwasher under the two 10 - 32 nuts. Leave the second nut loose for connecting the ground wire.
- (✓) Mount a 4-point tie strip as shown in Pictorial 1 at position DD. Use a 6 - 32 x 1/4" screw with a #6 lockwasher on top and one under the mounting foot.
- (✓) Select the one 6 - 32 x 1/2" screw and at position A2 mount a plastic wire clamp over the mounting foot of a 4-point tie strip BB, using one of the two #8 flat metal washers first over the clamp, then a #6 lockwasher and 6 - 32 nut. Mount it with the loop end snug into the corner of the chassis. See Pictorial 1.
- (✓) Another plastic wire clamp is mounted at position A3 to the right of the grommet C using a 6 - 32 x 3/8" screw, the remaining #8 flat metal washer, a #6 lockwasher and secure with a 6 - 32 nut.
- (✓) The oscillator coil single point tie lug is mounted on top of the chassis at position EE. See Pictorial 2. Use a 6 - 32 x 1/4" screw, a #6 lockwasher under the foot and one under the 6 - 32 nut.
- (✓) Note the position in Pictorial 1 and mount the 2-gang 420  $\mu\mu\text{f}$  variable capacitor using three 6 - 32 x 1/4" screws, two with #6 lockwashers under the screws and one with a #6 solder lug in the position shown under the screw as in Pictorial 2.

(✓) Install the flexible 1/4" shaft connector. Tighten the two screws after observing the shaft end beginning to come through the hub.

(✓) The two final tank coil feed-through insulators are mounted in the 5/16" holes on each side of the 2-gang 420  $\mu\mu\text{f}$  capacitor. See Pictorial 1. Be sure to mount them with fiber compression washers on each side of the chassis to avoid breaking. See Figure 2. Put the long end of the insulator on top of the chassis. Place the flat metal washers next to the ceramic instead of between the nuts as supplied. Do not overtighten.

#### OSCILLATOR CIRCUIT ASSEMBLY

(✓) Straighten the leads out on the oscillator coil and note the positions for the taps. See Figure 3. Counting the first, or end turn as #1, the 15 meter tap is on the sixth turn down, next to the first indented turn.

(✓) Cut a piece of tinned #20 wire 2" long. Form a small hook at one end with small needle nose pliers. This is the small diameter bare wire.

(✓) Place the wire hook around the sixth turn down. Pinch the loop together around the tap point (S). Be careful not to use too much heat for too long or the plastic spacers may

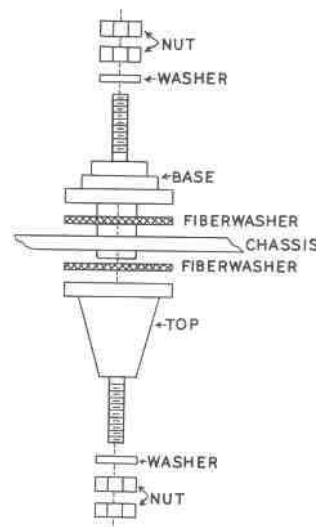


Figure 2

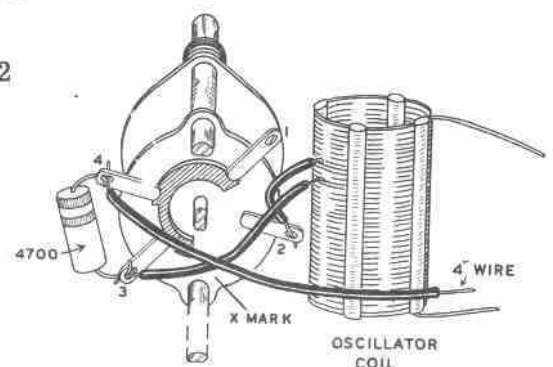
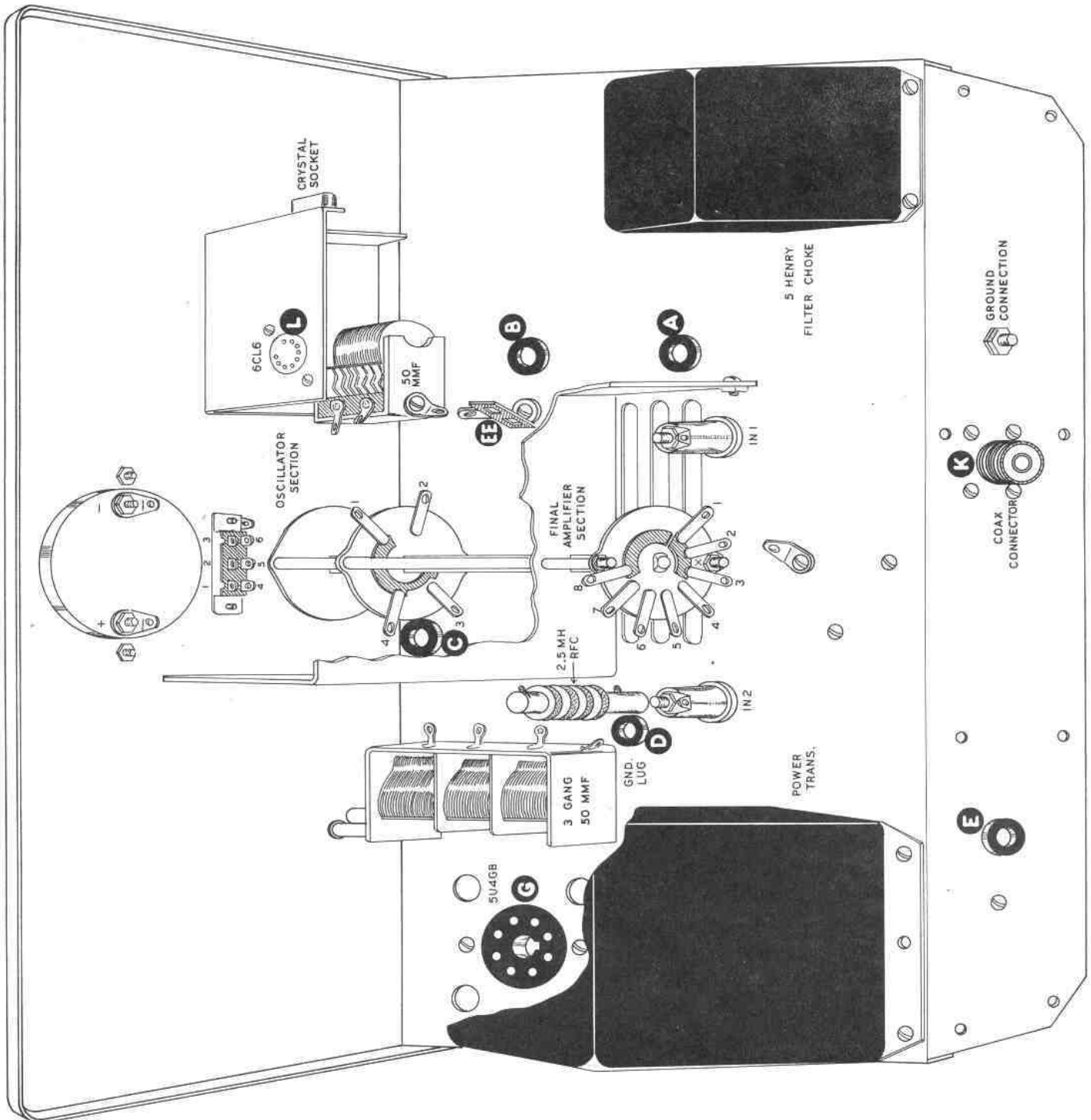


Figure 3



PICTORIAL 2

melt. Avoid solder running over and shorting other turns.

- (✓) Cut a piece of #20 tinned wire 2 5/8" long.
  - (✓) Form a small hook as before and place it around the #10 turn which is the 20 meter tap point. Pinch the hook together around the tap (S).
  - (✓) Cut a piece of insulated sleeving 1 1/2" long and slip it over the shorter 15 meter tap lead.
  - (✓) Cut a piece of insulated sleeving 2 1/8" long and slip it over the longer 20 meter tap lead.
- NOTE: For the following bandswitch wiring sequence, use identifying (x) mark on the bottom end of the wafers to avoid wiring to the wrong switch terminals. See Figure 3.
- (✓) Select the 4700  $\Omega$  1 watt resistor (yellow-violet-red). Cut both leads to a length of 1/2".
  - (✓) Bend both leads at right angles and on the oscillator section of the bandswitch connect one lead to #3 terminal (NS). Connect the other lead to #4 terminal (NS). Bend the resistor leads inward slightly at the ends to maintain resistor position.
  - (✓) Run the longer insulated 20 meter coil tap lead under the bandswitch center shaft and through the #3 terminal of the oscillator bandswitch (S). See Figure 3.
  - (✓) Bend the 15 meter insulated tap lead down and connect it to the #2 terminal on the oscillator bandswitch (S).
  - (✓) Cut a piece of #20 tinned wire 4" long. Pass it under the center shaft and connect one end to oscillator switch terminal #4 (S).
  - (✓) Cut a piece of insulated sleeving 3 1/2" long and slip it over the 4" wire.
  - ( ) Take special note of the wafer position and identifying (x) mark. Disassemble the rear wafer from the bandswitch back to the stop nuts. (Do not loosen these nuts.) See Figure 4.

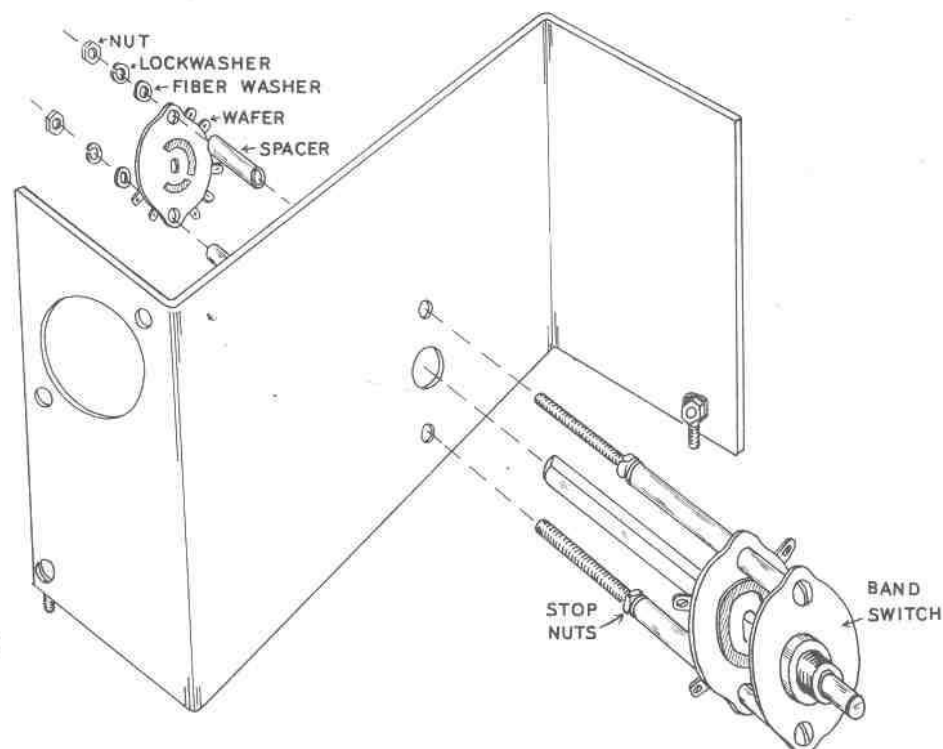


Figure 4

(✓) Reassemble the switch through the 6DQ6A tube mounting shield plate. Maintain the shield against the stop nuts. Replace the 5/8" spacers, switch wafer, insulating washers, lock-washers and nuts in their original order. Maintain the identifying (x) on the bottom or next to the chassis end of both wafers.

(✓) Mount the two 6 - 32 spade screws on the shield plate as shown in Figures 5 and 6 using a 6 - 32 x 1/4" screw through the shield, the spade screw, a #6 lockwasher and secure with a 6 - 32 nut.

(✓) Mount this shield, band-switch and coil assembly on the chassis. Thread the 4" sleeving covered lead along with the bottom coil lead through the hole on the oscillator tie strip as shown in Figure 6. (These leads are later bent flat towards the end of the lug before soldering.)

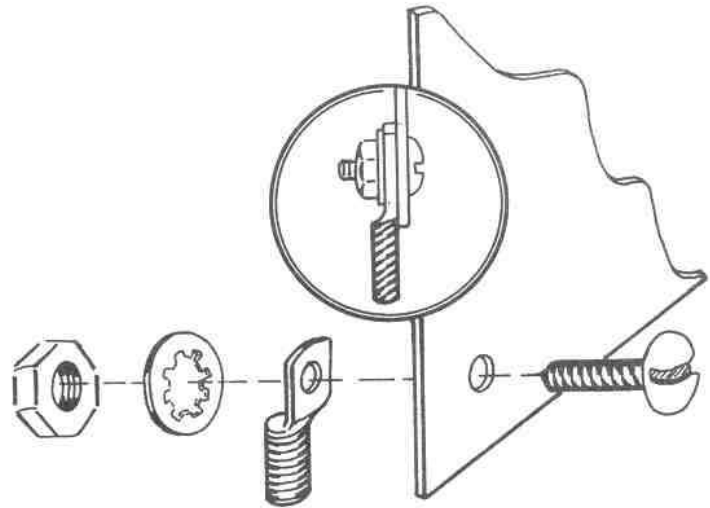


Figure 5

(✓) While holding the shield and assembly on, turn the chassis over. On the under side at position AA (see Pictorial 1) on the end of one 6 - 32 spade screw, mount a 4-point tie strip, using a #6 lockwasher under the foot and one under the nut. (Do not overtighten or you will shear off the spade screw.)

(✓) At position CC mount a 2-point tie strip on the other spade screw using a #6 lockwasher under the foot and one under the nut. (Do not overtighten.) This secures the tube mount shield plate as well as the bandswitch to the chassis.

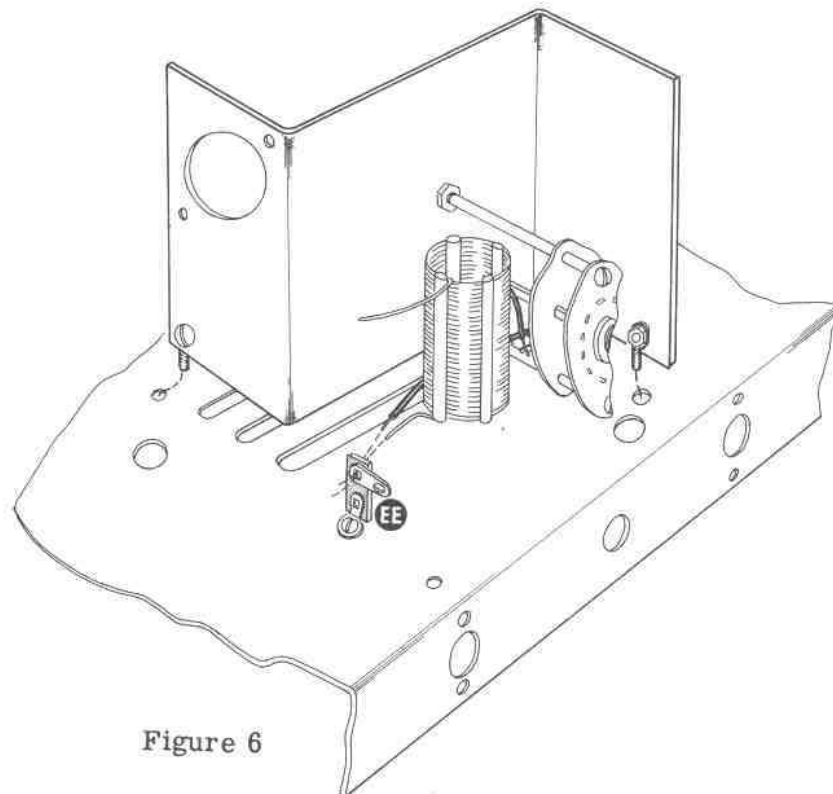
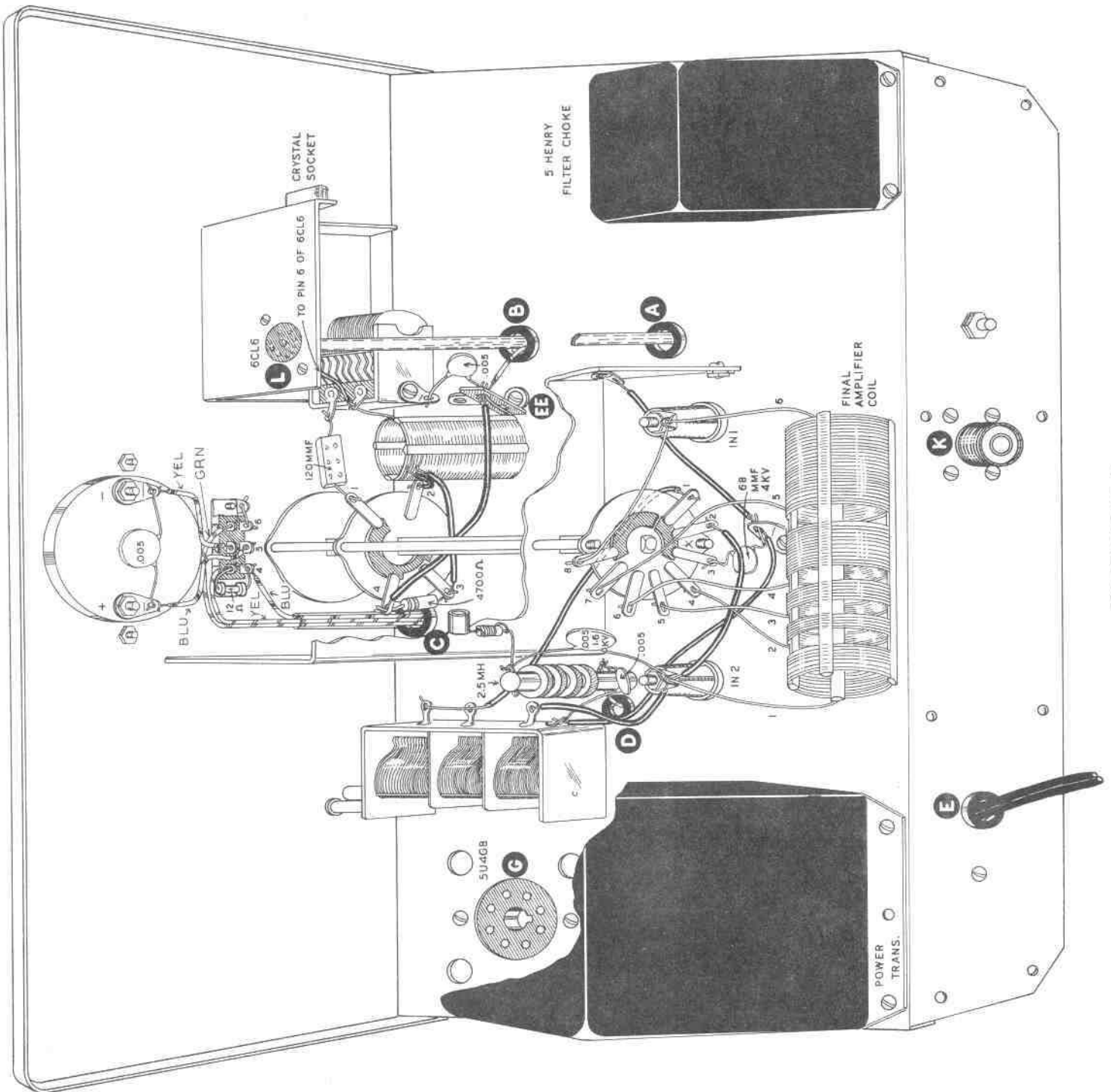


Figure 6



PICTORIAL 3



## PARTIAL PANEL ASSEMBLY

- (✓) Mount a DPDT slide switch directly under the meter hole, using 6-32 x 1/4" screws. Use a #6 lockwasher as a spacer between the switch and the panel on one side and mount the #6 solder lug between the switch and panel on the other side in the position shown in Pictorial 2 or 3.
- (✓) Note the position in Pictorial 2 and mount the 3-gang variable capacitor on the panel using the three 1" flathead machine screws. See Figure 7. Insert the screw through the panel, then through a 1/16" washer, then through a 3/4" spacer into the capacitor frame. Bend up the three solder lugs to face horizontally toward the center of the panel.
- (✓) Mount the meter using the small screws, lockwashers and nuts supplied with the meter.
- (✓) Put two #6 solder lugs under the nuts and washers on the meter connections. Face the lugs toward the switch and tighten. See Pictorial 2.
- (✓) Connect a .005  $\mu$ f disc ceramic capacitor directly across the meter solder lugs (NS) as shown in Pictorial 3.
- (✓) Cut a piece of blue wire 2 1/2" long. Trim the insulation 1/4" off each end.
- (✓) Connect one end to the solder lug on the meter marked + (S).
- (✓) Dress the lead toward the center of the meter switch and run it between the #1 and #2 terminals. Connect it to #5 (S).
- (✓) Cut a piece of yellow wire 2" long and trim the insulation 1/4" off each end.
- (✓) Connect one end to the remaining meter terminal (S). Dress toward the center of the switch and connect it to #2 (S).
- (✓) Cut a piece of tinned #20 wire 3/4" long.
- (✓) Slide the bare wire through switch terminal #6 and on through the grounded solder lug. Solder both ends. See Pictorial 3.
- (✓) Cut a piece of yellow wire 8 1/2" long. Trim the insulation 1/4" off each end.
- (✓) Connect one end to meter switch terminal #1 (NS). Leave the other end free.
- (✓) Cut a piece of blue wire 18" long. Trim the insulation 1/4" off each end.
- (✓) Connect one end to meter switch terminal #4 (NS). Leave the other end free.
- (✓) Select the 12  $\Omega$  precision resistor and trim the leads to 5/8" in length.
- (✓) Connect the resistor to meter switch terminals #1 (S) and #4 (S). Keep the resistor bent up and away from the switch mounting screw and nut to avoid shorts. See Pictorial 3.
- (✓) Cut a piece of green wire 16" long and trim the insulation 1/4" off both ends.

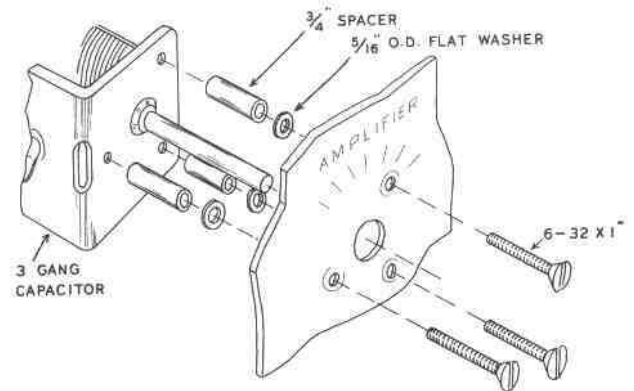


Figure 7

(✓) Pass one end under the yellow and blue wires from the meter and connect to switch terminal #3 (S). Form the lead back toward the panel and around behind the 12 Ω precision resistor. Maintain all three wires (the yellow, blue and green) together and toward the bottom edge of the panel. See Pictorial 3.

(✓) Cut a piece of the large, clear plastic tubing to 2 1/2" and slip it over these leads.

This completes your panel partial assembly.

#### PANEL AND CHASSIS ASSEMBLY

(✓) Place a large 3/8" control lockwasher over the bandswitch shaft end.

(✓) Pass all three meter switch wires through grommet C. At the same time allow the bandswitch shaft to come through the bandswitch hole.

(✓) Secure with a 3/8" flat control washer and a 3/8 - 32 control nut. Tighten lightly to allow aligning of other panel holes with those in the chassis.

NOTE: In case of difficulty in lining up the panel with the bandswitch assembly and chassis, some free play is provided by loosening the nuts on the rear deck of the bandswitch and also the shield plate mounting nuts on the underside of the chassis.

(✓) Select the 1/4" shaft bushing and insert it from the front through the hole in the panel marked (loading).

(✓) Secure with a 3/8 lockwasher and a 3/8 - 32 nut. Tighten lightly.

(✓) Mount the key jack as shown in Pictorial 1 and Figure 8, using only a 3/8 flat control washer and a 3/8 - 32 nut on the panel side. Tighten lightly.

(✓) Line up the slide switch mounting holes visually with the holes in the chassis, then tighten the bushing, key jack and bandswitch nuts.

(✓) Mount the SPST line switch with both contacts toward ON position. Use two 6-32 x 3/8" screws with the #6 lockwashers between the panel and the switch. The 3/8" screws are used instead of the 1/4" to provide easy assembly.

(✓) The DPST switch is mounted in the TRANSMIT-STANDBY location. Mount with the four contacts toward TRANSMIT position. This insures that all switches in the upward position are "ON", and in the downward position are "OFF". Use two 6-32 x 3/8" screws with the #6 lockwashers between the panel and the tapped end of the switch.

(✓) Place the SPDT switch in the TUNE-OPERATE location. Insert a 6-32 x 3/8" screw first in the OPERATE hole, then through a #6 lockwasher, and into the tapped end of the switch.

(✓) Insert a 6-32 x 3/8" screw in the TUNE hole, then through a #6 solder lug, and into the tapped end of the switch. Face the solder lug toward the terminal side of the switch.

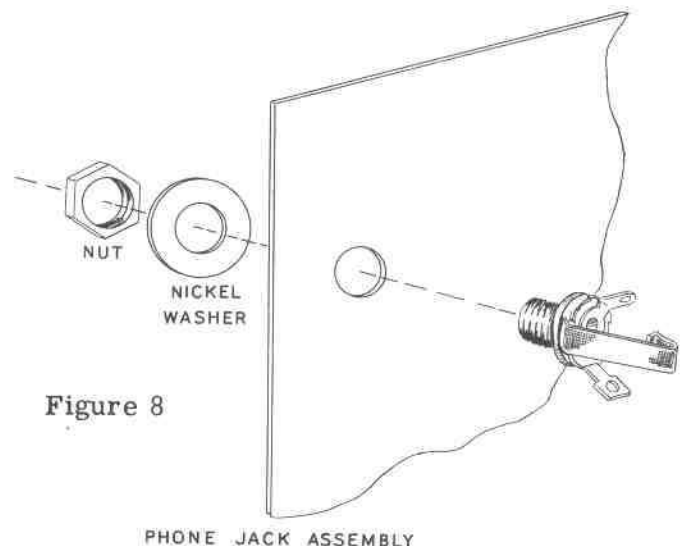


Figure 8

PHONE JACK ASSEMBLY

#### CHASSIS ASSEMBLY

( ) The 2.5 mh radio frequency choke is mounted on top of the chassis next to the 3/16 x 5/16 grommet D. See Pictorial 2. Use a 6 - 32 x 3/8" screw with a #6 lockwasher under it. Thread the screw with the lockwasher through the chassis, then through the #6 fiber washer and into the choke. To avoid fracturing the ceramic, do not overtighten.

- ( ) Mount the octal socket for the 6DQ6A final amplifier at position Z and the single tie point strip at position ZZ. Use 6 - 32 x 3/8" screws. Orient the keyway to face downward. Hold the socket against the outside of the shield plate and at the upper socket mounting hole insert the screw through the shield, then through the tube socket, then through the foot of the tie strip ZZ, a #6 lockwasher and secure with a 6 - 32 nut. NOTE: With some tube sockets it may be necessary to clip or file a piece off the foot of the tie strip to mount it properly. See Figure 9.
- ( ) On the lower socket mounting hole use a 6 - 32 x 3/8" screw through a #6 solder lug, then insert it through the shield plate, then the tube socket, a #6 lockwasher and a 6 - 32 nut. Face the solder lug downward before tightening. See Pictorial 3.

### OSCILLATOR "L" BRACKET ASSEMBLY

- ( ) Select the oscillator tube mount "L" bracket, the 9-pin tube socket and the crystal socket.
- ( ) Mount the crystal socket on the "L" bracket as shown in Figure 10. Use the one 4 - 40 x 1/2" machine screw and allow the flat sides of the 4 - 40 nut to recess between the socket pillars. A lockwasher is not used. Tighten with a small screwdriver. NOTE: If none of the remaining small nuts fit the 4 - 40 x 1/2" screw, then the 4 - 40 nut must have been used on one of the 3 - 48 screws to mount the coax socket.
- ( ) Mount the 6CL6 socket at position L. Orient the 9-pin socket so that pins 8 and 9 face toward the crystal socket. Secure the one end of the socket at the extreme corner of the bracket using a 3 - 48 x 1/4" machine screw, a #3 lockwasher and a 3 - 48 nut.

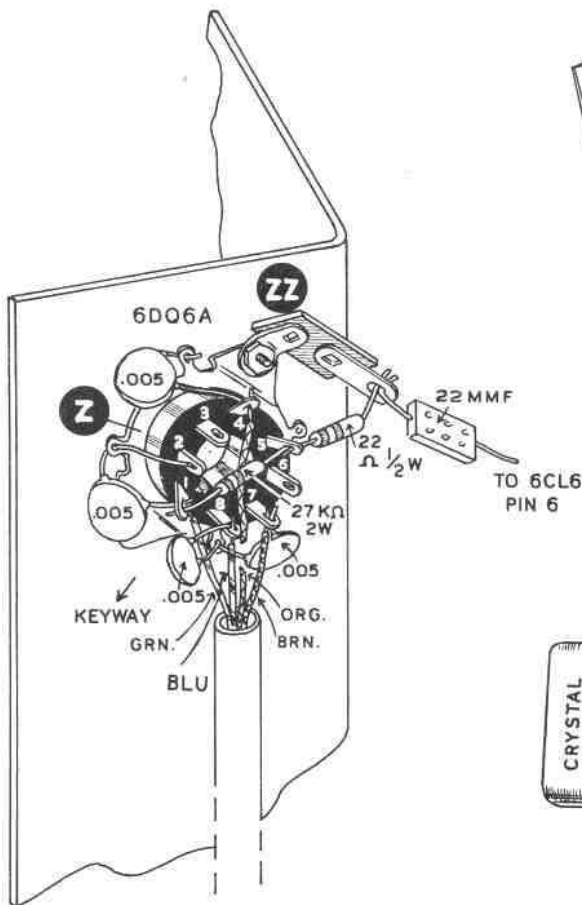


Figure 9

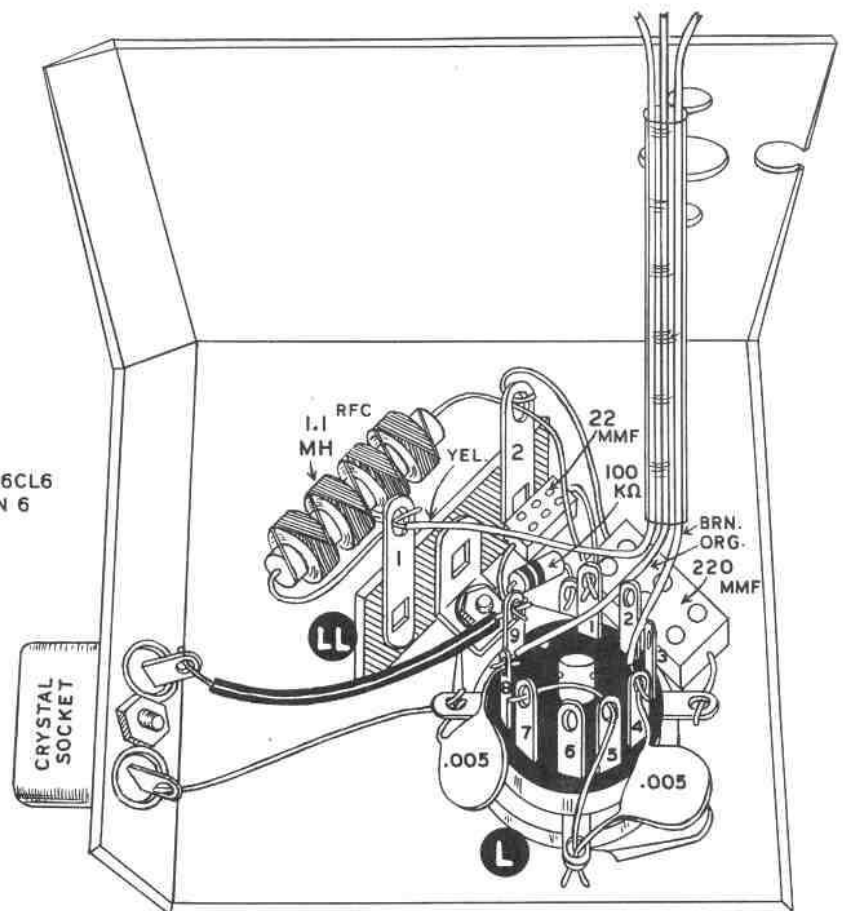


Figure 10

- (✓) The inside end of the socket is secured, using a 3 - 48 x 1/4" machine screw through the bracket, then the socket, then the mounting foot of the 2-point tie strip LL, with a #3 lock-washer and a 3 - 48 nut. It may be necessary to clip or file a piece off the foot of the 2-point tie strip LL in order to mount it.
- (✓) Bend all nine tube connection tabs outward slightly. NOTE pin numbers molded in the tube socket. See Figure 1.
- (✓) Bend down horizontally all four grounding tabs on the 6CL6 socket which will be numbered 1-2-3-4 going clockwise from pin 1. Mark these numbers next to the ground tabs to facilitate wiring. NOTE: In wiring to small socket connections and other terminals, form bared ends of wires through lugs and then back in a small loop to maintain their position until soldered. Trim excess wire off. However, in some cases the wire is provided only long enough to push through the lug, in which case the connection should be carefully but thoroughly soldered.
- (✓) Cut a piece of #20 tinned wire 1 1/8" long and thread it through the #3 ground lug and up through pin 5 and bend it over and connect to pin 7. Solder pins 5 and 7.
- (✓) Select the 100 K 1/2 watt resistor (brown-black-yellow). Cut both leads to 1/2" and bend at right angles.
- (✓) Connect one lead to ground lug 1 (S) and the other lead to pin 9 (NS).
- (✓) Select the 22  $\mu\mu\text{f}$  silver mica capacitor (red-red-black). See Figure 11. Cut both leads to 1/2".
- (✓) With the capacitor lying flat, bend both leads to a right angle edge-wise. Mount on top of the 100 K resistor and connect to pin 1 (NS) and pin 9 (NS). Refer to Figure 10.
- (✓) Cut one lead of the 1.1 MH radio frequency choke to 7/8" and the other to 1 1/4".
- (✓) Thread the 1 1/4" lead through LL2 (NS) and continue to pin 1 on the 6CL6 socket L (S).
- (✓) Connect the 7/8" lead to LL1 (NS).
- (✓) Select the 220  $\mu\mu\text{f}$  silver mica capacitor (red-red-brown). See Figure 11. This capacitor may be marked .00022  $\mu\text{f}$ . Cut one lead to 5/8" and the other to 1".
- (✓) Position the capacitor flat against the bracket in the position shown in Figure 10. Connect the 5/8" lead to ground lug 2 (S).
- (✓) The 1" lead is formed up and through LL2 (S). See Figure 10.
- (✓) Cut a piece of #20 tinned wire 1 1/4" long.
- (✓) Connect one end to ground lug #4 (NS).
- (✓) Connect the other end to the outside crystal socket terminal (S).
- (✓) Cut both leads on a .005  $\mu\text{f}$  disc ceramic capacitor to 3/8".
- (✓) Connect one end to the #4 ground lug (S).
- (✓) Connect the other end to pin 8 on the 6CL6 socket (NS).
- (✓) Cut a piece of #20 tinned wire 1 1/2" long and cover with a piece of insulated sleeving 1" long.

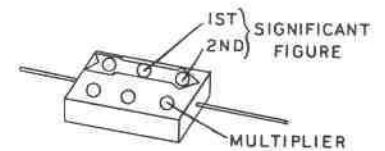


Figure 11

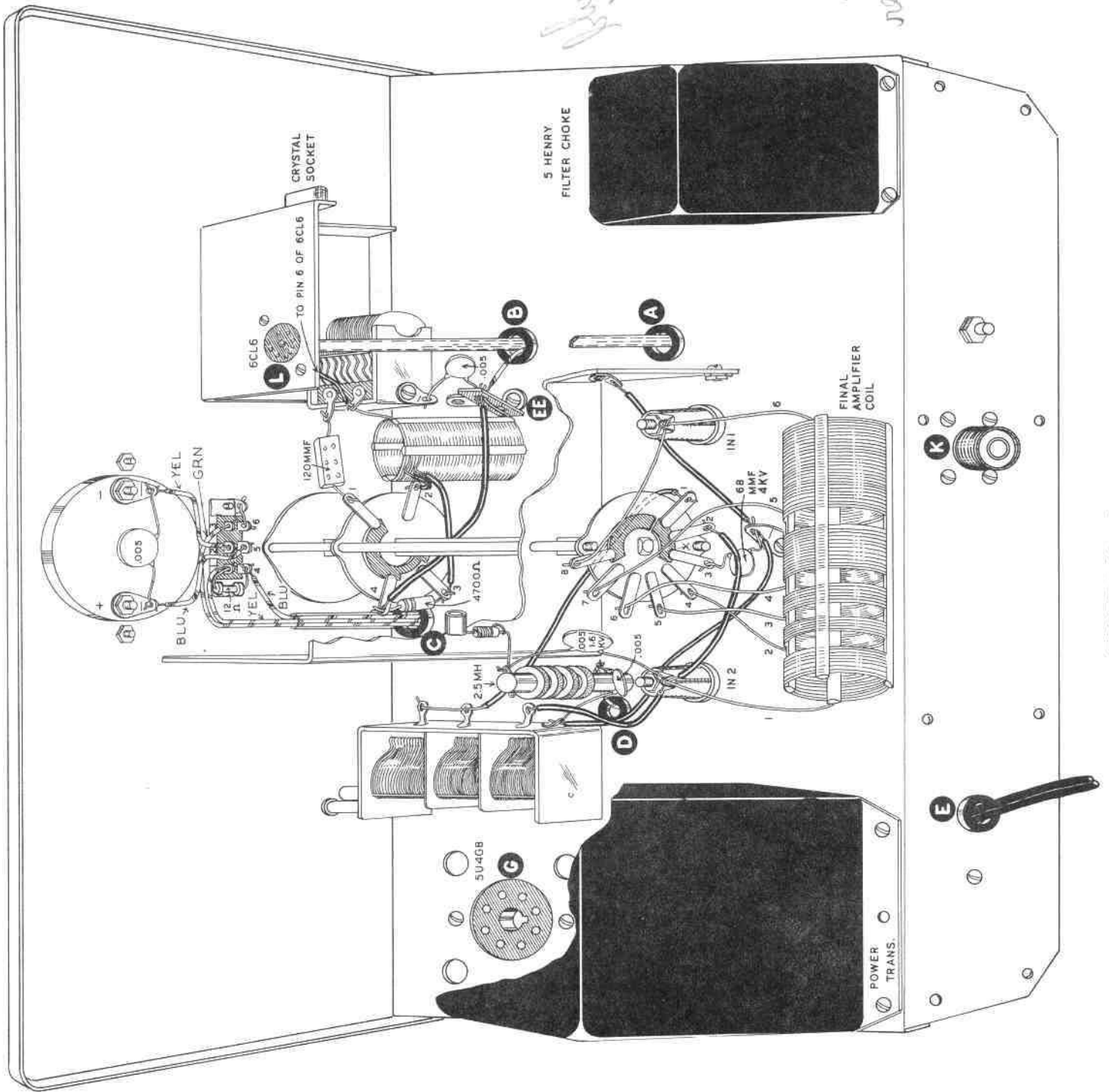
- (↪) Connect one end to pin 9 (S).
- (↪) Connect the other end to the crystal socket connection nearest to the RFC (S). See Figure 10.
- (↪) Cut both leads of a .005 disc ceramic capacitor to 3/8".
- (↪) Connect one end to the #3 ground lug (S).
- (↪) Connect the other end to pin 4 (NS).
- (↪) Cut a piece of yellow wire 5 1/2" long. Strip the insulation off both ends 1/4".
- (↪) Connect one end to tie point LL1 (S). Leave the other end free.
- (↪) Cut a piece of orange wire 9" long. Strip the insulation off both ends 1/4".
- (↪) Connect one end to pin 8 (S). Leave the other end free.
- (↪) Cut a piece of brown wire 8 1/2" long. Strip the insulation off both ends 1/4".
- (↪) Connect one end to pin 4 (S). Leave the other end free.
- (↪) Cut a piece of large clear plastic tubing to 2 1/2".
- ( ) Form the yellow, orange and brown leads together toward the center of the 6CL6 socket and then straight out from it. Slip the clear plastic tubing over them.

This completes your oscillator "L" bracket assembly.

#### OSCILLATOR CIRCUIT COMPLETION

- (↪) Cut a piece of red wire 2 1/2" long. Strip the insulation 1/4" off each end.
- (↪) Insert one end from the chassis underside up through grommet B and 1/8" into tie point lug hole EE (NS). See Pictorial 3. Leave the other end free.
- (↪) Select a .005 disc ceramic capacitor and cut both leads to 1/4".
- (↪) Push 1/8" of one lead into the tie point hole EE along with the other three leads (S). Leave the other end free. Bend leads flat towards end of lug and solder.
- (↪) Select the one 6 - 32 x 3/16" RH screw.
- (↪) Mount a #6 solder lug at the tapped hole position on the rear frame of the oscillator variable capacitor. Use a #6 lockwasher under the head of the 6 - 32 x 3/16" screw for extra clearance, with the solder lug next to the frame. Offset the solder lug toward the near corner of the capacitor frame. See Pictorial 3. Tighten securely.
- (↪) Bend the outside (stator) solder lug on the oscillator capacitor up and clip a slot in it sufficient to pass the oscillator coil lead. See Pictorial 3.
- (↪) The oscillator "L" bracket assembly is placed in position against the panel. Pass the yellow, orange and brown wires through grommet B next to the coil and allow the 3" oscillator coil lead to pass under the "L" bracket assembly.





PICTORIAL 3

(✓) While holding the "L" bracket in position, place the single section variable capacitor up against it and align with dimpled holes in the panel. See Pictorial 3. Select the 6 - 32 x 3/16" flat head screws and secure the assembly to the panel. It may be advisable to wriggle the "L" bracket slightly while tightening to allow it to align itself over the dimples.

(✓) Maintain the coil in the aligned vertical position and equidistant between the shield partition and the panel. See Figure 12.

(✓) Dress the top coil lead down into the slot in the oscillator tuning capacitor. Maintain the coil position and avoid shorting out the top turn (S). Do not clip off remaining lead.

(✓) Shorten this same lead to 2" measuring out from the point just soldered.

(✓) Cut a piece of insulated sleeving 1 3/4" and slip over the bare lead.

(✓) Form the coil lead up under the yellow and orange leads and connect it to pin 6 on the 6CL6 tube socket (NS). See Pictorial 3.

(✓) Connect the remaining end of the .005  $\mu$ f disc ceramic capacitor leading from the coil tie strip EE to the ground lug on the variable capacitor frame (S). See Pictorial 3.

(✓) Select the 120  $\mu$ f mica capacitor (brown-red-brown) and cut both leads to 5/8". See Figure 11.

(✓) Connect one end to the variable capacitor solder lug nearest to the panel as in Pictorial 3 (S).

(✓) Connect the other end to bandswitch terminal #1 (S).

This completes the oscillator assembly.

#### FINAL AMPLIFIER ASSEMBLY

For the next step the chassis is viewed as shown in Pictorial 4.

(✓) Run the yellow wire from grommet C through plastic clamp A2, then back over to #4 on BB (NS).

(✓) Cut a piece of red wire 4 1/2" long. Trim the insulation 1/4" off each end. Connect one end up through grommet D to the bottom RF choke terminal (NS). Connect the other end to #2 on CC (NS).

(✓) Cut the leads on a .005 disc ceramic capacitor to 3/4". Insert 1/8" of one lead down through the bottom solder lug hole on the 2.5 mh RFC (S). See Pictorial 3.

(✓) Connect the other end to the ground lug on the 3-gang capacitor (NS).

(✓) Cut a piece of #14 tinned copper wire 7" long.

(✓) Run 3 1/2" of one end through the bottom hole in the grounded solder lug positioned between the feed-through insulators on the top side of the chassis (NS). See Pictorial 3.

(✓) Cut two pieces of insulated sleeving 2 7/8" long and slip over each end.

(✓) Form one end over and connect to the ground solder lug on the 3-gang capacitor frame (NS).

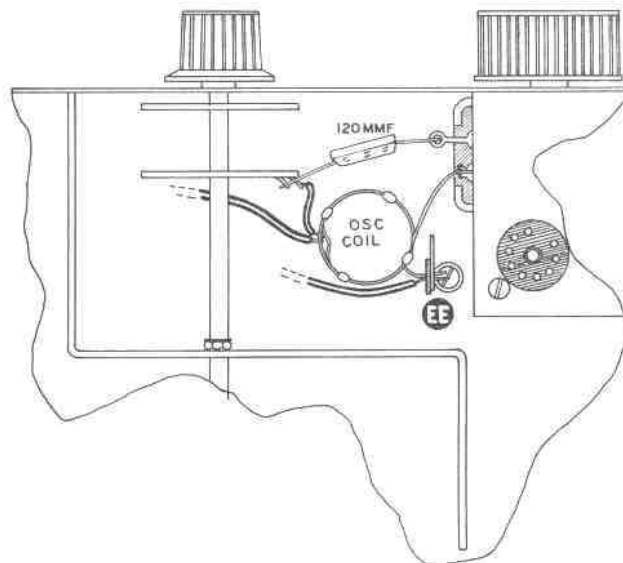


Figure 12

- (✓) Bend the other end of the #14 wire toward the shield bracket, then up through the grounded lug on the final amplifier tube socket (NS). See Pictorial 3.
- (✓) Allow extra lead length if required either way by slipping it through the ground lug in the center of the wire (NS). When all leads are in proper place, solder the ground at the 6DQ6A tube socket and the ground on the tuning capacitor frame. Dress the ground lead away from the top of the insulator.
- (✓) Mount a #6 solder lug on both feed-through insulators. Face both lugs toward the rear of the chassis and tighten between the two 6 - 32 nuts supplied with the insulators.

NOTE: For the following, Figure 13 may be used directly as a form.

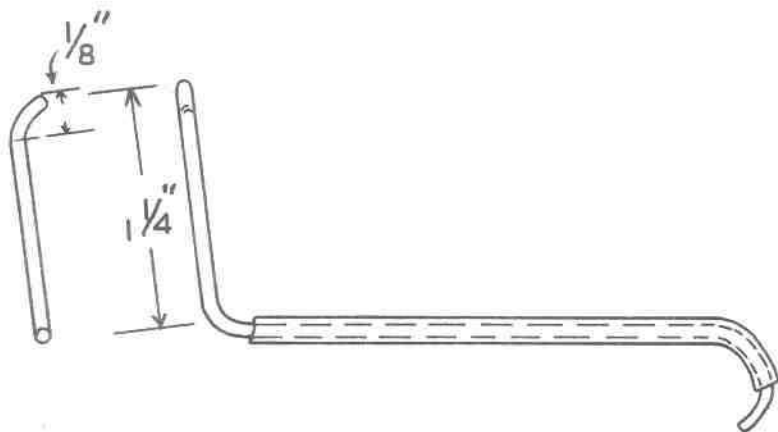


Figure 13

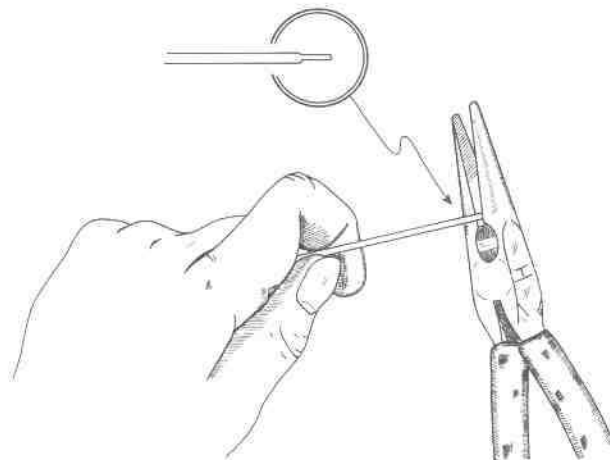


Figure 14

- (✓) Cut a piece of #14 tinned copper wire 4 3/4" long.
- (✓) Measure from one end 1 1/4" and bend the wire to a near right angle.
- (✓) At the 1 1/4" end of wire, bend 1/8" of the end down slightly.
- (✓) At the opposite end slip a piece of insulated sleeving 3" long on up to the bend point.
- (✓) Form another bend 1/2" in from the end, back towards itself in a half circle. Flatten the end slightly so it will go through the switch terminal. See Figure 14.
- (✓) Push the long hooked end of the #14 wire under the bandswitch center shaft and insert 1/8" of the flattened end into bandswitch terminal #1 (S). See Pictorial 3.
- (✓) The end with the 1/8" bent end connects to the solder lug nearest the panel on the 3-gang variable capacitor. Allow the bare wire to lie across the center lug also. Solder both connections.
- (✓) Cut a piece of #14 tinned wire to a length of 5". Bend 1/8" of one end down to a near right angle.
- (✓) Cut a piece of insulated sleeving to 1 1/2" and slip on up to the bent end.
- ( ) Insert the bare lead down through the inside hole on the solder lug on IN-2 and out towards the rear of the chassis until the 1/8" bent end comes even with the remaining end solder terminal on the 3-gang capacitor. Push the end down in the terminal hole (S). See Pictorial 3.

- (✓) Cut a piece of insulated sleeving 2 1/2" long.
- (✓) Slip the insulation over the #14 wire up to 1/4" from the solder lug.
- (✓) Flatten the end 1/4" by squeezing with pliers (see Figure 14). Align flat to pass through the #2 terminal on the bandswitch (S).
- (✓) Select the 68  $\mu\mu\text{f}$  4 kv disc ceramic capacitor and cut both leads to 3/4". This capacitor may be marked .000068  $\mu\text{f}$ , 4 kv.
- (✓) Maintain the capacitor tight against the chassis with one end even with the vent slot. Form one end to fit up into bandswitch terminal #3 (NS). See Pictorial 3.
- (✓) Bend the other lead around and through the remaining hole on the ground lug. When both ends are fitted neatly in place, solder both connections.
- (✓) Cut a piece of #14 tinned wire 2 7/8" long. Flatten 1/4" of one end slightly. See Figure 14.
- (✓) Insert the unflattened end through the inside hole on the solder lug on the feed-through insulator IN-1 below the 6DQ6A socket (NS).
- (✓) Form the flattened end over and connect it to the #8 terminal on the bandswitch (S). Avoid shorting to the nut on the bandswitch.
- (✓) Select the final amplifier coil and pull the end leads out and into place. Align all leads straight out from the coil.
- ( ) Shorten the longer leads to no more than 2 1/2" long.

NOTE: In mounting the amplifier coil, considerable care should be exercised to avoid breaking the bandswitch. Do not force the leads or exert pressure on the switch terminals. It is best to form the wires into place using small pliers and making slight bends where required to allow leads to slip through the bandswitch terminals until all are in place. Do not clip the leads or solder until then.

- (✓) Hold the coil in your left hand and use small pliers (preferably needlenose) to bend and help insert the leads into place. Allow the two outside coil leads to go through the outside hole in the lugs on the feed-through insulators IN-1 and IN-2. See Pictorial 3.
- (✓) The first coil tap, lead #2, connects to the #4 bandswitch terminal (NS). See Pictorial 3.
- (✓) The next tap lead, #3, goes to the #5 terminal (NS).
- (✓) Coil lead #4 goes to bandswitch terminal #6 (NS).
- (✓) Coil lead #5 goes to bandswitch terminal #7 (NS).
- (✓) Work the leads through the terminals until the coil is about 1/4" in from the chassis rear edge, maintaining the coil position on a plane with the edge and lying down on the chassis. (The coil is bent upward later into operating position.)
- (✓) Where the coil leads extend through and beyond the bandswitch terminals, trim off the excess lead length.
- (✓) Twist excess lead length from the ends of the coil around the lugs on the feed-through insulators (NS).
- (✓) Make certain all leads are properly placed and then solder all leads to the bandswitch plus the connection on IN-1 under the 6DQ6A socket.

- (✓) Trim the leads on a .005  $\mu$ f 1.6 kv large disc capacitor to 1".
- (✓) Insert one lead 1/8" down through the top 2.5 mh R. F. choke solder lug (NS). Bend the capacitor down and insert the other lead through the hole in the solder lug on the feed-through insulator IN2 (S). See Pictorial 3.
- (✓) Bend the final amplifier coil up and align it with the edge of the chassis. Allow approximately 1 1/8" space between the chassis and the under part of the coil.
- (✓) Select the 47  $\Omega$  1/2 watt resistor (yellow-violet-black) and trim both leads to 1/2".
- (✓) Cut a piece of #20 tinned wire 5" long.
- (✓) Secure one end of the #20 wire 1/8" next to the resistor body by forming a small hook around one lead and pinching it together(S). See Figure 15.
- (✓) While holding the resistor by the wire lead next to the connection with pliers, wind seven turns of #20 tinned wire close together. Secure the end by pinching a small loop around the resistor lead. Trim off the excess wire (S).
- (✓) Space out the turns on the parasitic choke by the thickness of a thumb nail. Avoid turns shorting together. Refer to Figure 15.
- (✓) Select the small plate cap that fits on the 6DQ6A tube.
- (✓) Insert the choke coil lead through the plate cap and bend over the hold down tabs onto the resistor lead right next to the coil and resistor connection. Allow the solder to flow between this connection and the plate cap.
- (✓) Insert the 6DQ6A tube in the socket to establish the parasitic choke position. Allow the choke to hang straight down from the tube. Bend the bottom lead of the parasitic choke to form a right angle and connect it upwards through the solder terminal on top of the 2.5 mh plate choke (S). See Pictorial 3.

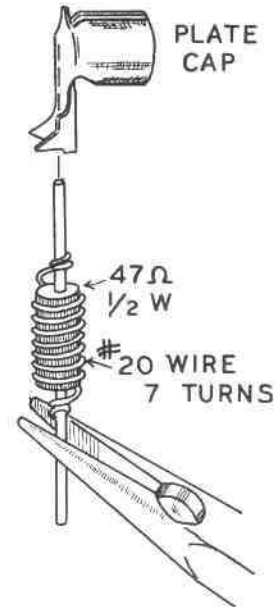


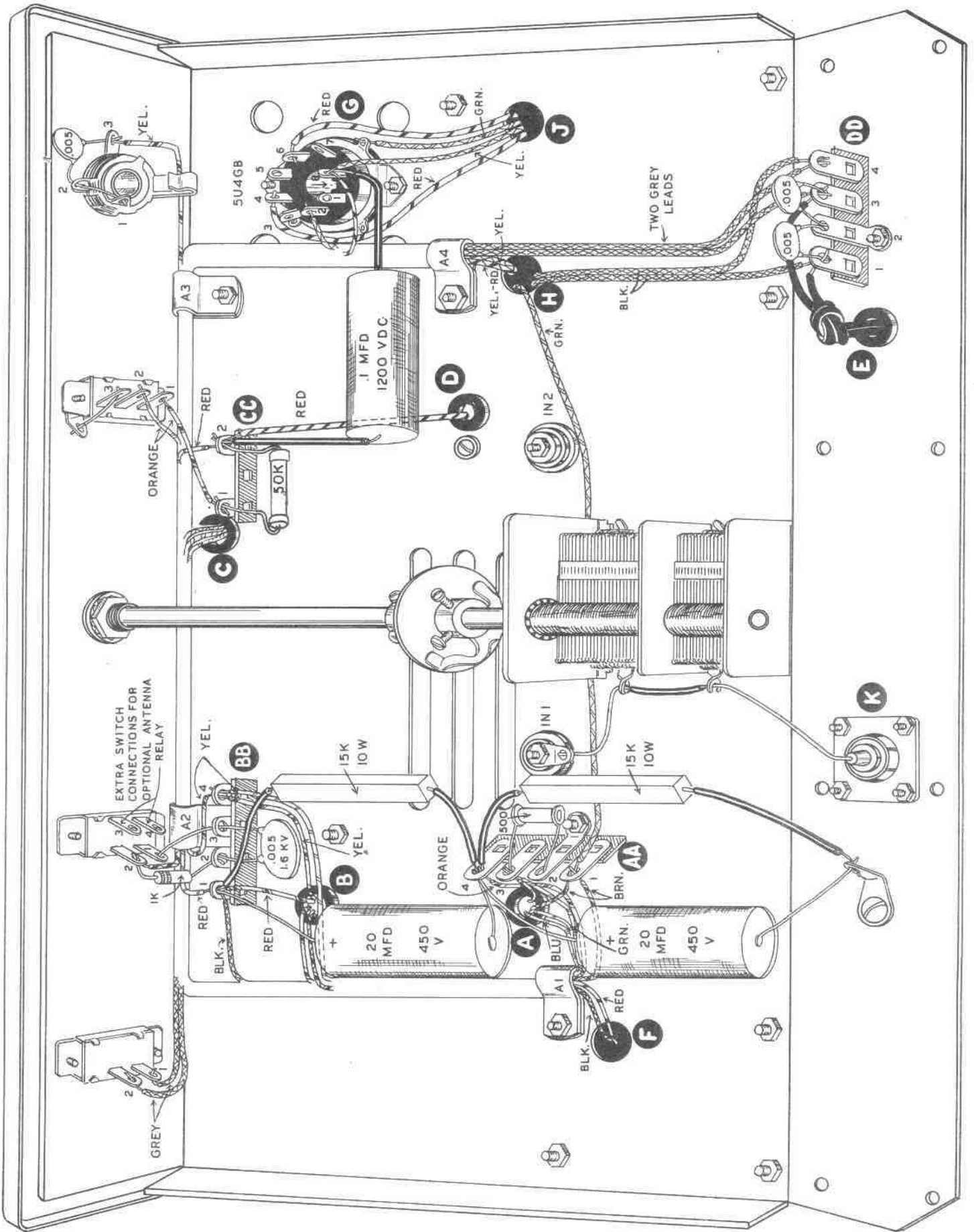
Figure 15

This completes the final amplifier assembly.

#### CHASSIS ASSEMBLY AND WIRING

- (✓) The 5-henry filter choke is mounted using four 8 - 32 x 3/8" screws. Use the screw through the flange of the choke, then through the chassis, a #8 lockwasher and secure with an 8 - 32 nut. On the 8 - 32 screw near hole F under the lockwasher and nut, mount a plastic wire clamp at A1. Face the loop end toward the 4-point tie strip AA and tighten. See Pictorials 1 and 2.
- (✓) Mount the power transformer using 8 - 32 x 3/8" screws, #8 lockwashers and 8 - 32 nuts. A plastic wire clamp is mounted at position A4 under the lockwasher and nut. Face the plastic loop toward the outside folded chassis edge as shown in Pictorials 1 and 2.
- (✓) Run the green wire from grommet C along the chassis corner, through plastic clamp A2. Form a right angle bend 1 1/4" past A2 and continue down through clamp A1. Bend the lead to a right angle from the clamp and over toward AA2 but connect it to AA3 (NS). See Pictorial 4. Form all leads from A1 over toward AA2, then to connection points to maintain square wiring neatness.





PICTORIAL 4

- (✓) Run the blue wire from grommet C in a similar course through A2 and A1 except, go through grommet A, then through a 2 1/2" piece of the clear plastic tubing to pin 8 on the 6DQ6A socket (NS).
- (✓) Run the brown wire from the oscillator at grommet B together with the green and blue wires and down through plastic clamp A1, and with a right angle bend, connect it to AA1 (NS).
- (✓) Run the yellow lead from the oscillator assembly over to tie point BB4 (NS). Form the lead close to the chassis with a right angle bend to maintain neatness.
- (✓) Form the orange lead from the oscillator assembly together with the other wires and down through plastic clamp A1, and with a right angle bend toward AA2 but connect to AA4 (NS). See Pictorial 4.
- (✓) Run the red and yellow tracer wire from transformer hole H through plastic clamps A4, A3, A2 and up to the standby switch lug 2 (NS).
- (✓) At transformer hole J measure straight out from the chassis and cut the green power transformer lead to 1 3/4". Trim the insulation 3/8" off the end.
- (✓) Dress the lead close to the chassis and up through ground lug 4 on the 5U4GB socket (S).
- (✓) At the opposite transformer hole H, place the rule against the chassis and stretch the green lead straight out along the rule. Cut it to a length of 7".
- (✓) Trim the insulation 3/8" off the end of the green lead and dress it close to the chassis and tuck it under the 420  $\mu\mu\text{f}$  variable capacitor frame as shown in Pictorial 4. Connect the lead to tie point AA1 (NS).
- (✓) At the transformer hole H, measure out from the chassis and cut the yellow transformer lead 3" long. Trim the insulation 3/8" off the end.
- (✓) Run the yellow lead through plastic clamp A4 until opposite pin 2. With a right angle bend connect it to pin 2 on the 5U4GB socket (S).
- (✓) At transformer hole J, cut the other yellow lead to a length of 2 1/4". Trim the insulation 3/8" off the end.
- (✓) Form the lead close to the chassis and on the left side of the green wire and connect it to pin 8 on the 5U4GB socket (NS).
- (✓) Select one red lead from transformer hole J and cut it to 3 3/8" from the chassis. Trim the insulation 3/8" off the end.
- (✓) Form the lead close to the chassis under the yellow lead and up to pin 4 on the 5U4GB socket (S).
- (✓) Cut the other red lead from hole J to a length of 3". Trim the insulation 3/8" off the end.
- (✓) Form the lead close to the chassis, to the right of the green lead and up to pin 6 on the 5U4GB socket (S).
- (✓) At hole H cut the one black lead nearest to the green to 3 3/4". Measure from the chassis straight out. Trim the insulation 3/8" off the end.

- (✓) Form the lead against the chassis toward the rear apron and up. Connect it to tie point DD1 (NS).
- (✓) Measure out from the chassis and cut the remaining black lead to 4 1/4". Trim the insulation 3/8" off the end.
- (✓) Form alongside the other black wire to the rear apron and to a right angle over to tie point DD4 (NS).
- (✓) Run the long red choke lead through plastic wire clamp A1 up toward the front of the chassis then make a right angle bend and go through plastic clamp A2. Continue on through A3 and down. Make a right angle bend opposite pin 8 on the 5U4GB socket. Connect to pin 8 (NS).
- (✓) Measure straight out from the chassis and cut the black choke lead to 5 1/2". Trim the insulation 3/8" off the end.
- (✓) Run the black choke lead through plastic clamp A1 and up toward the front apron. Make a right angle bend at, and connect to tie point BB1 (NS).
- (✓) Cut a piece of gray wire to 18". Trim the insulation 3/8" off each end. Connect one end to tie point DD4 (S).
- (✓) Dress the gray lead from DD4 close to the chassis rear apron and next to the black leads. Go through plastic clamp A4. Continue on up to clamp A3 and to a right angle along the chassis edge beyond clamp A2 to beneath the line switch. Bend to a right angle and connect to switch terminal 1 (S).
- (✓) Cut another piece of gray wire 18" in length. Trim the insulation 3/8" off each end.
- (✓) Connect one end to tie point DD3 (NS) and follow the same route as the previous gray lead and connect it to line switch terminal 2 (S).
- (✓) Insert the line cord through grommet E on the rear apron. Pull through sufficient wire and tie a knot in it. Position the knot so it leaves 2" leads to connect to tie strip DD. (This knot is provided to relieve any possible strain on the connections when the cord is pulled.)
- (✓) Connect one line cord lead to tie point DD1 (NS) and the other to DD3 (NS).
- (✓) Select two .005 disc ceramic capacitors. Cut the leads on both to 3/8".
- (✓) Refer to Pictorial 4 and connect one lead from each capacitor to the grounded tie point connection DD2 (S).
- (✓) Connect one of the two extra leads to tie point connection DD1 (S) and the other to DD3 (S).
- (✓) On the underside of the chassis, on feed-through insulator IN-1, mount a #6 solder lug between the two nuts. Face the lug toward the coax connector. See Pictorial 4.
- (✓) With long nose pliers, bend the two solder lug connectors on the 2-gang variable capacitor to a near right angle to provide a path for inserting a wire. These are the two lugs facing the coax connector.
- (✓) With small diagonal (cutting) pliers, cut a small slot in the capacitor lugs sufficient to pass a #14 wire.
- (✓) Cut a piece of tinned #14 wire to 4 1/4".
- (✓) Slip a piece of insulated sleeving 3/4" long onto the mid point of the wire.

- (✓) Bend the #14 wire to conform with the shape in Figure 16. Use the illustration for the template.
- (✓) Refer to Pictorial 4. Slip the wire "U" into the two solder connections on the 2-gang capacitor through the cut slots in the lugs. The lead with the short bend goes to the coax connector and the long bend goes through the solder lug on the IN-1 feed-through insulator.
- (✓) Make certain all connections are snug in place. Avoid solder drips shorting to the chassis from the 2-gang capacitor lugs. Solder all four connections.

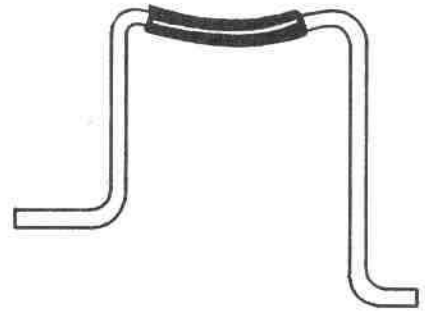


Figure 16

- (✓) Select the .1  $\mu$ f 1.2 kv paper capacitor and cut one lead to 1 5/8". Slip a piece of insulated sleeving 1 3/8" long over the lead. Bend this lead sharply to a right angle as shown in Pictorial 4.
- (✓) Shorten the other end of the capacitor to 1 3/4". Slip a piece of insulated sleeving 1 1/2" long over the lead and form a right angle bend 3/8" from the end.
- (✓) Consult Pictorial 4 and mount the capacitor to allow the 1 5/8" lead to pass 1/8" through tie point CC2 (NS).
- (✓) Snug the capacitor up against the wires passing through plastic clamp A4 and allow 1/8" of the bent end to pass through the 5U4GB rectifier pin 8 connection. Dress the capacitor against the chassis in aligned position as in Pictorial 4 and solder pin 8.
- (✓) Select the .005  $\mu$ f 1.6 kv large disc ceramic capacitor and cut one lead to 1" and the other to 3/8".
- (✓) Refer to Pictorial 4 and insert the 1" end through grounded tie point BB3 and on up to switch lug #1 on the standby switch. Solder both connections.
- (✓) Insert the 3/8" capacitor lead through tie point BB2 (NS).
- (✓) Select the 1000  $\Omega$  1/2 watt resistor (brown-black-red) and cut both leads to 1/2".
- (✓) Bend both leads to a right angle and connect one end to BB2 (S). The other end connects to switch lug #2 (S).
- (✓) Select the 500  $\Omega$  precision resistor and cut both leads to 1/2".
- (✓) Compress both leads together sufficiently to pass through tie points AA2 (S) and AA3 (NS). Keep the resistor body away from the chassis to avoid a short.
- (✓) Select the 50 K 10-watt, wire-wound resistor and cut both leads to 1". Bend both leads to a right angle.
- (✓) Compress both leads together sufficiently to pass through tie points CC1 (NS) and CC2 (NS). Position the resistor against the chassis.
- (✓) Cut a piece of red wire 7" long and trim the insulation 3/8" off each end.
- (✓) Slip one end through plastic clamp A2. Make a right angle bend at, and connect it to tie point BB1 (NS).
- (✓) Recess the lead along with the other wires in the corner of the chassis until opposite tie point CC2. Make a right angle bend and connect it to CC2 (S).

- (✓) Connect the short red lead from the oscillator at grommet B to BB1 (NS).
- (✓) Cut a piece of #20 tinned wire 3/4" long and slip one end through the #3 connection on the (TUNE-OPERATE) switch and on through the grounded #6 solder lug. Solder both connections.
- (✓) Cut a piece of orange wire 3" long. Trim the insulation 1/4" off each end.
- (✓) Connect one end to tie point CC1 (S).
- (✓) Form the other end toward the inside corner of the chassis and combine with the other wires toward the (TUNE-OPERATE) switch. Bend to a right angle and connect it to switch lug #1 (S).
- (✓) Cut one lead on a .005  $\mu$ f disc ceramic capacitor to 1" and the other to 3/8".
- (✓) Thread the 1" lead through the key jack terminals #2 and #1. Solder both connections.
- (✓) Connect the 3/8" end to the key jack terminal #3 (NS).
- (✓) Cut a piece of yellow wire 11" long. Trim the insulation 3/8" off each end.
- (✓) Run the lead through plastic clamp A2. Form close to the corner of the chassis along with the other leads and on through clamp A3 to a point opposite terminal #3 on the key jack. Make a right angle bend up and connect it to #3 (S).
- (✓) The opposite end of the yellow wire is formed back from plastic clamp A2 to tie point BB4 (NS).

#### FINAL AMPLIFIER SOCKET WIRING

- (✓) Bend out slightly all pin connections on the 6DQ6A socket to facilitate wiring.

NOTE: The grounding lugs on the socket mounting ring are numbered 1 to 4 clockwise from pin #1. See Figure 1.

- (✓) Cut one lead on a .005  $\mu$ f disc ceramic capacitor to 1" and the other to 3/8".
- (✓) Thread the 1" lead through ground lug #1 then up through socket pin #2. Solder both connections.
- (✓) Connect the 3/8" end to the inside hole on socket pin #1 (NS).

NOTE: Maintain solder connections 1/8" from the body of the capacitor where possible to provide minimum lead inductance. Trim off any excess lead lengths after soldering in proper position.

- (✓) Cut the leads of a .005  $\mu$ f disc capacitor to 3/8". Connect one end to ground lug #2 (S) and the other end to pin connection #4 (NS).
- (✓) Cut the leads of a .005  $\mu$ f disc capacitor to 3/8". Connect one end to ground lug #4 on the socket (NS). The other end connects to the inside hole on pin #8 (NS).
- (✓) Cut the leads of a .005  $\mu$ f disc capacitor to 3/8". Connect one end to ground lug #4 on the socket (S). The other end connects to the inside hole on pin #7 (NS).
- (✓) Cut a piece of the large clear plastic tubing to 2 1/2" long.



- (✓) Cut a piece of green wire 4" long. Trim the insulation 3/8" off each end.
- (✓) Run one end up through grommet A, go through the piece of plastic tubing to pin #1 on the 6DQ6A socket (NS). Connect the remaining end to AA3 (S).
- (✓) Cut a piece of brown wire 4 1/2" long. Trim the insulation 3/8" off each end.
- (✓) Run one end up through grommet A, go through the plastic tubing to pin #7 (S). Connect the remaining end to AA1 (S).
- (✓) Cut a piece of orange wire 20 1/4" long. Trim the insulation 3/8" off each end.
- (✓) Run the orange lead up through grommet A, go through the plastic tubing, between pins #7 and #8 and connect it to pin #4 (S). Form the remaining end neatly around through A1, and with the other wires, go through A2 and A3. Bend the lead back on itself and connect to #2 (middle terminal) on the TUNE-OPERATE switch (S).
- (✓) Turn the chassis right side up with the pin connections of the 6DQ6A toward you.
- (✓) Select the 27 K 2 watt resistor (red-violet-orange) and cut both leads to 3/8" and bend to a right angle.
- (✓) Connect one end of the resistor to pin #1 on the 6DQ6A socket (S). Connect the other end to pin #5 (NS). See Figure 9.
- (✓) Select the 22  $\Omega$  1/2 watt resistor (red-red-black) and trim both leads to 3/8".
- (✓) Connect one end to the inside hole of pin #5 (S) and the other end straight out and through the insulated tie point ZZ (NS).
- (✓) Select a 22  $\mu\mu\text{f}$  mica capacitor and trim both leads to 3/8". This capacitor may be marked .000022  $\mu\text{f}$  or color coded (red-red-black). Bend both leads at right angles toward the flat side.
- (✓) Connect one end to the insulated tie point (S) and the other end to plate pin #6 on the 6CL6 socket along with the oscillator coil lead (S).

This completes your 6DQ6A socket wiring.

- (✓) Select one 20  $\mu\text{f}$  filter capacitor and cut both leads to 1 1/2".
- (✓) Run the negative (outside shell) lead through the #10 ground lug on the rear apron (NS). Then run the positive (red insulated end) lead through tie point AA4 (NS). Refer to Pictorial 4.

- (✓) Select the other 20  $\mu\text{f}$  filter capacitor and cut both leads to 1 1/4".
- (✓) Insert the positive (red insulated end) lead through tie point BB1 (NS), and the negative (outside shell) lead through tie point AA4 (NS).
- (✓) Form the first capacitor tight against the chassis and snug up against the wires between A1 and AA. The second capacitor is aligned neatly with the first and tight against the chassis in the space between grommets A and B. Trim off any excess lead lengths.
- (✓) Slip a 1 1/8" piece of insulated sleeving over each lead of a 15 K 10 watt resistor and insert one end through the #10 ground lug from the coax connector side together with the filter capacitor lead (S). Refer to Pictorial 4.
- (✓) Run the other end through tie point AA4 (NS).
- (✓) Mount the other 15 K 10 watt resistor as shown in Pictorial 4. Slip a 1 1/8" piece of insulated sleeving over both leads and insert one end through tie point AA4 (S). The other end of the resistor goes through tie point BB1 (S).

NOTE: Dress both resistors neatly in a line with the coax connector and out away from the filter capacitors as shown in Pictorial 4.

- (✓) Insert the 4 1/4" long 1/4" shaft from the front panel through the bushing marked (loading) and on through the first hub on the flexible drive. You may have to back out the set screws to allow the shaft through. Tighten the set screws.

- (✓) The small threaded 1/4" stud is inserted through the large 2" plug button and secured with a #6 lockwasher and a 6 x 32 nut. See Figure 17.

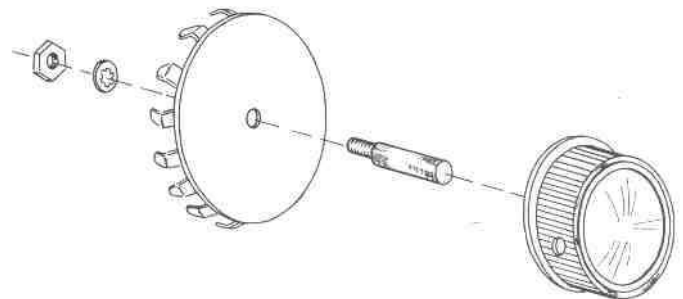


Figure 17

- (✓) The large (pointerless) knob is mounted on the 1/4" stud. Be sure the set screw is unscrewed sufficiently to allow the stud to go in.

- ( ) Mount the four rubber feet in the holes on the bottom of the cabinet. Moistening them with soapy water will allow easier insertion. See Figure 18.

- ( ) Try the plug button in the hole on the cabinet. If it is too tight, bend the spring tabs inward slightly to allow easier insertion and removal. Maintain a snug fit to prevent radio frequency leakage and possible television interference.

- ( ) Mount the two small knobs at positions (bandswitch) and (loading). At the indicated (O) position on the loading control the 2-gang capacitor should be closed. The bandswitch knob, when turned full left (counterclockwise), should indicate 80 meters.

- ( ) The two remaining large pointer knobs are mounted at (oscillator) and (amplifier) positions.

- ( ) With their pointers at the (O) mark, both the variable capacitors should be closed.

- ( ) Plug in the 5U4GB rectifier and the 6CL6 oscillator tubes. Seat the 6DQ6A firmly in its socket and dress the parasitic choke straight down from the tube cap.

Figure 18



This completes the construction of your DX-20. "Congratulations."

#### PRELIMINARY OPERATION CHECKS

Before plugging in the line cord, some precautionary checks should be exercised.

A short in the high voltage is a good point to check. This could be indicated by testing from the 6DQ6A plate cap to ground. A resistance check of approximately 30 K $\Omega$  is normal. Any resistance reading very much lower than that should institute an immediate check for the cause.

Reversed filter capacitors can cause much trouble and a recheck at this point would certainly be in order.

A shorted capacitor is possible, but not likely. However, this possibility should be looked into with the aid of an ohmmeter. A thorough check should be made across all capacitors associated with the high voltage.

The entire circuit should be examined for faults in wiring or possible shorts, such as tube pin connections touching together, wire ends shorting across where they should have been clipped off, or resistor or capacitor leads contacting the chassis or shields. Also be sure to remove all wire clippings and solder drops from the chassis.

If there are any short circuits, serious damage will result to the tubes or components when power is applied.

Check all solder connections to be sure none has been missed.

For the following tune-up sequence the transmitter should be left out of its cabinet until proper operation is noted.

#### TUNING INSTRUCTIONS

The DX-20 tune up is very simple; but at the same time, unless proper procedure is exercised poor output along with high current with consequent shortening of tube life and overheating of the power transformer will result.

Always be sure a crystal of proper frequency is plugged in, the fact being that one at an odd frequency out of the tuning range of the oscillator circuit would result in little or no drive to the final stage. This would cause both the oscillator and the amplifier tubes to overheat and possibly damage them.

Before turning the transmitter on at any time, the switch positions should be noted.

First, be sure that the (transmit-standby) switch is on (standby). The (tune-operate) switch should be on (tune). For the following adjustments an 80 meter crystal in the range of 3500 to 4000 kilocycles would be ideal. A 40 meter 7000 to 7300 kilocycles would also suffice. Put the (grid-plate) switch on (grid) position to read grid current or drive to the 6DQ6A final. Bear in mind that a 40 meter crystal will not work on the 80 meter bandswitch position.

If a key is plugged in, it should be depressed or put on (closed circuit) position. Otherwise, with no key plugged in, the key jack provides the (closed circuit) and you may go on with the tune-up.

It should also be noted at this time that unless the key circuit is closed, no grid current will be indicated. Upon noting the preceeding, turn the (on-off) switch to (on). Allow about one minute for the tubes to come up to operating temperature. There is no high voltage flowing to the tubes until the (transmit-standby) switch is put on (transmit).

When the high voltage is applied, the oscillator tuning should be rotated through its range to a point indicating approximately two milliamperes for all bands except 10 and 11 meters, which requires as much drive as possible to insure good output, due to the final amplifier doubling on these bands. This is generally in the order of 4 - 5 milliamperes, with a 40 meter crystal recommended.

NOTE: A common erroneous practice is to use the highest reading possible of grid current on all bands, believing at the same time that this results in higher output. However, in this case, just the opposite is true (except, of course, when the final is doubling). Therefore, it is recommended that the grid drive instructions be followed, as these are the readings for maximum output. It has also been noted that excessive drive is more conducive to television interference.

Upon obtaining the required drive reading, the grid-plate switch should be moved to (PLATE) position and the (TUNE-OPERATE) switch moved to (OPERATE). For initial tune up on all bands, the loading capacitor should be closed or at (O) position.

If the key circuit is closed, the final amplifier capacitor should be immediately tuned to the minimum reading on the meter. This should be in the vicinity of 15 to 20 milliamperes with no antenna or load attached to the transmitter.

For tuning up exercises and to gain some familiarity with the operation of this transmitter, a dummy load is recommended. This would also prevent much interference being created on the band during these checks.

A 40 watt 120 volt light bulb would be a good size to use as a dummy load. Connect one side of the bulb to the ground lug and the other side to the coax connector inner conductor. It may be advisable to alternately open and close the key circuit during these tests to prevent any lengthy overloads of high current to the final amplifier.

With the loading control turned fully to the left, or to (O) position, close the key and immediately tune the amplifier to indicate the lowest reading of plate current. NOTE: The loading control has a direct effect on the tuning of the amplifier stage so that the amplifier control will require resetting to minimum plate current each time the loading is changed.

Now, gradually turn the loading control to the right. A good sequence would be, first to 10 on the loading dial, then dip the amplifier control to read minimum plate milliamperes again. Disregard the "amplifier" scale readings for the moment. Once the final amplifier is dipped to minimum, then increase the loading to 20. Close the key and dip the final again to minimum. Increase the loading to 30. Dip the final again. At this point the plate current should be close to 120 milliamperes (cathode current) after dipping, which is the recommended value to maintain approximately 50 watts input, with the plate voltage being 500 volts.

NOTE: These are readings obtained with an 80 meter (test) crystal on a frequency of 3700 kilocycles. The bandswitch was tuned to 80 meters and the oscillator dial control indicated approximately 73. The amplifier dial control indicated approximately 40 on the scale. (Do not be alarmed if your readings do not coincide exactly.)

Under different conditions of loading, the grid current or (drive) varies and should be rechecked by switching the meter to grid position and retuning the oscillator to maintain 2 milliamperes on 80-40-20-15 meter bands. On the 10 and 11 meter bands, the final doubles and requires maximum drive.

With the use of a 7000 kilocycle (test) crystal, the bandswitch was switched to 40 meters. The oscillator tuning dial reading was approximately 55 to 65. The amplifier dial reading was 45 - 50. With the same 40 watt bulb dummy load, the load reading was 40 - 50 on the dial.

A good point in question would be to familiarize oneself with tuning up procedures for the different bands, using a dummy load at all times.

The procedure with the antenna connected to the transmitter would be similar to that with the dummy load, although the dial readings may vary widely.

Increase the load a little at a time and then successively redip the final amplifier for minimum plate current. Each time the loading is increased, the minimum current value becomes higher until 120 milliamperes is indicated. This is the recommended value and it would be well not to exceed it if long tube and component service life is expected.

#### MODE OF OPERATION

In the DX-20 the oscillator operates straight through on 80 meters or it can double with a 160 meter crystal.

On 40 meters an 80 meter crystal may be used and the frequency doubled in the oscillator plate circuit or a 40 meter crystal used straight through.

For 20 meters an 80 meter crystal may be employed utilizing the fourth harmonic, or a 40 meter crystal doubling.

A 40 meter crystal is used for 15 meters, taking the third harmonic from the plate circuit of the oscillator.

On 11 meters a crystal of approximately 6.75 megacycles may be used. The oscillator and amplifier both double. For 10 meters the final amplifier doubles, with the oscillator supplying excitation from a 40 meter crystal and its plate circuit on 20 meters.

A word of caution should be in order at this time. The frequency of the crystal when multiplied, should not fall outside of amateur frequency allocations.

An external variable frequency oscillator such as the Heathkit model VF-1 may be used providing an external or separate power supply is employed for it. This supply should provide 250 to 350 volts DC at 15-20 milliamperes and 6.3 volts at .45 ampere.

When using a VFO a jumper must be connected across the radio frequency choke in the cathode circuit of the 6CL6 oscillator stage. To key the VFO with the transmitter, the cathode of the VFO tube should be connected to key jack terminal #3 and the chassis of the VFO grounded to the transmitter chassis. A plug to connect the VFO to the crystal socket of the DX-20 can be made from an old crystal holder or a Mosley type 301 twin lead connector. Note: The grounded side of the crystal socket which is the left side should be connected to the ground side of the coax cable.

#### IN CASE OF DIFFICULTY

Wiring mistakes are a very common cause of difficulty. However, before any circuit checking is done, be sure to remove the line cord from the power source. Recheck all wiring with the pictorials and schematic diagrams. Often times there is a miscount on tube socket pins with consequent wiring to the wrong pin connection. Also, the possibility of wiring to the wrong tie strip point should not be overlooked. Wire ends protruding past a connection point and shorting to another will cause considerable trouble.

All solder connections should be checked visually and mechanically. Moving or bending a wire or soldered component slightly will often show up a faulty rosin joint or mechanically insecure connection.

These conditions can be remedied with the careful application of needed solder and a sufficiently heated iron.

Trouble in the transformer primary circuit would be evidenced by checking across the line cord plug with an ohmmeter, with the line switch on the transmitter switched on ON position. Caution: Be sure the cord is removed from the line voltage source. With the ohmmeter indicating low ohms, the reading should be very close to 5 ohms.



If trouble is experienced in localizing the difficulty, perhaps a friend (preferably another amateur) could check the circuit and wiring and locate an error consistently overlooked.

If the key circuit is closed and all switches are on proper positions and no grid current is indicated on the meter, then the crystal could be suspected and another one should be tried.

A point well worth mentioning here is that some key click filters that use any inductance or radio frequency chokes in series with the key can cause a reactance in the cathode circuit such as to render the oscillator inoperative.

Proper key leads need be merely two flexible wires twisted together or a piece of the smaller size coax with the coax shield connected to the ground side of the key plug. The body or base of the key should also be connected to the grounded side. Keep the key leads short to prevent radiation and possible television interference.

If the transmitter is evidently working satisfactorily into a dummy load but when connected to the antenna does not tune up properly, then the antenna impedance could be too high or too low. Refer to the article on antennas on Page 35.

#### INSTALLATION AND OPERATION

NOTE: It should be noted that an Amateur Radio Operator and Station License is required to place this transmitter on the air. Information regarding licensing and amateur frequency allocations may be had from publications of the Federal Communications Commission or the American Radio Relay League. This transmitter can be used for novice operation only if the following two requirements are met: (a) CW operation only. (b) Crystal control only, on assigned novice frequencies.

GROUNDING: The importance of a good ground that presents low impedance at all frequencies cannot be emphasized too strongly. What may be a perfectly satisfactory ground at 80 meters could place the transmitter considerably above ground at the higher RF frequencies. As an example, the length of the ground wire is sometimes critical. An 8 foot wire from the transmitter to ground would be a direct short at 80 meters but becomes one-quarter wave length at 10 meters and therefore places the chassis at a high RF potential. Some hints that will be of assistance in obtaining a good ground are:

1. Connection for the ground should be made to cold water or well pipes and/or multiple pipes or rods driven approximately eight or more feet into moist earth. A salt solution poured around the ground rods will further increase the conductivity to ground. A more elaborate installation might include a system of wires approximately one-quarter wave length long laid a few inches under the surface of the earth in a grid or radial pattern. The use of one or all of these grounding systems may be combined to form a good ground reference.
2. The electrical connection to the ground point should consist of a short heavy conductor (#12 wire or heavier, or copper braid). If a short ground wire is difficult to obtain because of transmitter location, several leads of random length may be used. The use of random leads lessens the possibility that all leads should become one-quarter wave length at the frequency of operation. If the transmitter becomes hot at one particular frequency, the addition of a ground wire cut to one-half wave length at this frequency may clear up the difficulty.

Some of the symptoms of inadequate grounding are manifested in the form of:

1. Inability to load the antenna properly.
2. High RF potentials on the chassis or case of the transmitter.
3. Undue voltage strain on output circuit components.
4. Final plate current reading affected by touching the panel or case.

LOCATION: The transmitter should be located where free circulation of air is possible and objects should not be placed on the case as this might restrict the circulation of air. Good ven-

tilation is essential to insure maximum component life. The considerations mentioned with regard to grounding will also affect the selection of a good location, as will the point of entry of the antenna feeder.

**OPERATION:** The tuning procedure outlined previously will also apply when loading an actual antenna. Some special cases involving particular antenna types will require special consideration and will be covered under antennas.

**ANTENNAS:** The pi network output circuit of the model DX-20 will match pure resistive loads from approximately 50 to 1000  $\Omega$ . The loading adjustment will match all impedances within these limits. Therefore the transmitter will match antennas and unbalanced lines within these limits, also, provided such antennas or lines are nonreactive. Reactive antennas or lines present a somewhat different problem, however, since the reactance takes the form of impedance which may raise or lower the antennas impedance beyond the matching range of the transmitter output circuit. A half wave end fed antenna for a given band presents too high an impedance and is not recommended without an antenna tuner.

Balanced antenna systems should be fed through an antenna coupler so that neither leg of the line nor the antenna will be at ground potential. Normally the output of the transmitter is unbalanced since one side of the output circuit is grounded.

When loading to either a balanced or an unbalanced system, the maximum loading point of 100 milliamperes in the final stage should not be exceeded. In many instances, the transmitter will load to a higher level, but the harmonic suppression of the pi network is better if the output coupling capacitor is not reduced to absolute minimum value. Then too, the extra 5 or 10 watts which would be gained by maximum loading would not make any appreciable difference at the receiving end of the transmission.

#### END-FED HERTZ AND MARCONI ANTENNAS

This type of antenna consists merely of a single wire of from one-fourth wave length long to any even multiple thereof. One end of the wire is coupled to the transmitter and the other end supported in space. If this antenna is operated against ground, it is known as a Marconi antenna, while if the length is one-half wave length or more, it is known as a Hertz antenna. The greatest disadvantage of feeding a single wire is the necessity of bringing part of the radiating element into the radio room where its proximity to nearby objects increases losses. The greatest advantage of such an antenna is the simplicity with which it may be constructed and its compact size where space is at a premium. Providing the reactance of such antennas is not excessive, they may be loaded satisfactorily with the pi network output circuit of the DX-20. If it is desired to operate into an end fed half wave antenna, an antenna coupler should be used between the transmitter and antenna.

The length of such antennas should be calculated from the information given in the Radio Handbook or the ARRL Antenna Manual. Random lengths may also be used effectively except for some critical antenna length where the antenna impedance becomes too high or too low to be matched satisfactorily at the output of the transmitter. When such a situation is encountered it can usually be recognized by the action of the loading controls on the transmitter. Should it be found that increasing the loading (reducing the output coupling capacitor value) does not raise the final amplifier plate current reading on the meter and yet the final amplifier has not become fully loaded, it is very likely that the antenna being used has a higher than normal reactance at the frequency of operation, resulting in the transmitter looking into a higher overall impedance.

If it is found that a change in loading capacitor value has little effect on the final amplifier current and does not affect the final amplifier tuning in the normal fashion, the antenna in use is probably presenting lower than normal impedance to the transmitter.

When the antenna impedance is too high or too low for satisfactory loading, the situation can usually be remedied by changing the length of the feedline to the antenna, the length of the antenna itself or the point at which the feedline is connected to the antenna. Small changes, not to exceed one-quarter wave length should be effective in correcting the impedance mismatch.

Another cure for such difficulty would be to introduce inductance or capacitance in series with the antenna and feeder to cancel out the undesirable reactance in the antenna. Of course, a more elaborate method would be the use of an antenna tuner if some element in the situation made it impractical to employ the methods outlined.

### BALANCED ANTENNA FEEDERS AND SYSTEMS

In the average station it will be found expedient to have the radiating portion of the antenna some distance from the transmitter. This statement assumes that the amateur will have his antenna up high and clear of nearby objects, whereas the actual transmitter may be in the basement or any other room in the home. In such a case, some form of transmission line must be used to efficiently connect the transmitter to the antenna. In many instances, the transmission line is of the "balanced" type in which neither leg of the line is grounded. Such transmission lines may be either tuned or untuned, but in either case, a balanced line must be fed through an antenna coupler or "balun" coils. The coupler also provides the means for matching the impedance of the antenna, which will vary depending upon the type of antenna employed. A typical antenna coupler circuit is shown in Figure 19 on Page 36.

Basically the antenna coupler is an impedance transformer, transforming the impedance of the transmitter to the impedance of the transmission line and antenna system.

Referring to Figure 19, coil L1 should match the impedance of the coaxial cable as closely as possible at the frequency of operation. The circuit consisting of L2, C1 and C2 must tune to the transmitter frequency. If it is desired to series tune the antenna, the shorting bar between 3 and 4 is opened and the transmission line connected at these points. For parallel tuning, 3 is shorted to 4 and the transmission line connected to 1 and 2. Taps are provided on the coil L2 to facilitate matching the transmission line.

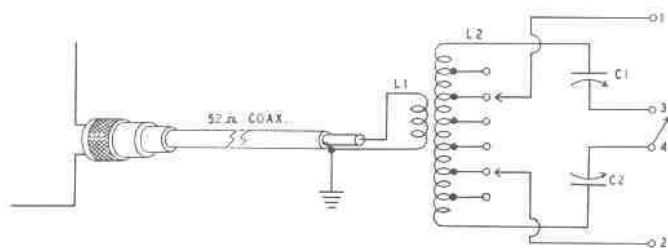


Figure 19

Such a unit can be built up from this or other suggested circuits or may be purchased commercially as a completed unit. In any case, feeding folded dipoles, end-fed "Zepps" and similar antenna types will require an antenna coupler or balun coils since the normal output of the DX-20 is designed for single-ended, unbalanced operation.

**LOW PASS FILTERS:** The harmonic rejection of the pi network output circuit of the DX-20 is excellent and will attenuate harmonics considerably when the transmitter is properly grounded and carefully tuned. However, additional harmonic attenuation may be had with the use of a low-pass filter between the output of the transmitter and the feed line or antenna. Such a filter should be designed to handle the maximum power output of the transmitter and must be operated into its nominal impedance.

Needless to say, no attempt has been made here to cover the theory of antennas, as such, since much has been written on this subject. The possibilities in different antenna types and different feed systems are many and the factors mentioned herein only scratch the surface of the subject. Each operator will need to do his own investigation into the advantages and disadvantages of the various systems to determine just which one will best suit his needs. Basic data is available through the Radio Amateur Handbooks and other technical publications.

Some formulas that should prove helpful are listed as follows:

$$1 \text{ wave length in space} = \frac{300,000 \text{ meters}}{\text{Freq. (kc)}}$$

$$\text{Center-fed dipole one-half wave long (length in feet)} = \frac{468}{\text{Freq. (mc)}}$$



Folded dipole one-half wave long (length in feet) =  $\frac{462}{\text{Freq. (mc)}}$

Zepp antenna one-half wave long (length in feet) =  $\frac{492}{\text{Freq. (mc)}}$

#### BIBLIOGRAPHY

THE RADIO AMATEUR'S HANDBOOK, The American Radio Relay League; 33rd Edition, 1956.

#### 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.

#### 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 Transmitter, 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 Transmitter 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 Transmitter 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 Transmitter 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 would pay if you elected 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 outlet 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.

#### SHIPPING INSTRUCTIONS

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

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

Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

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.

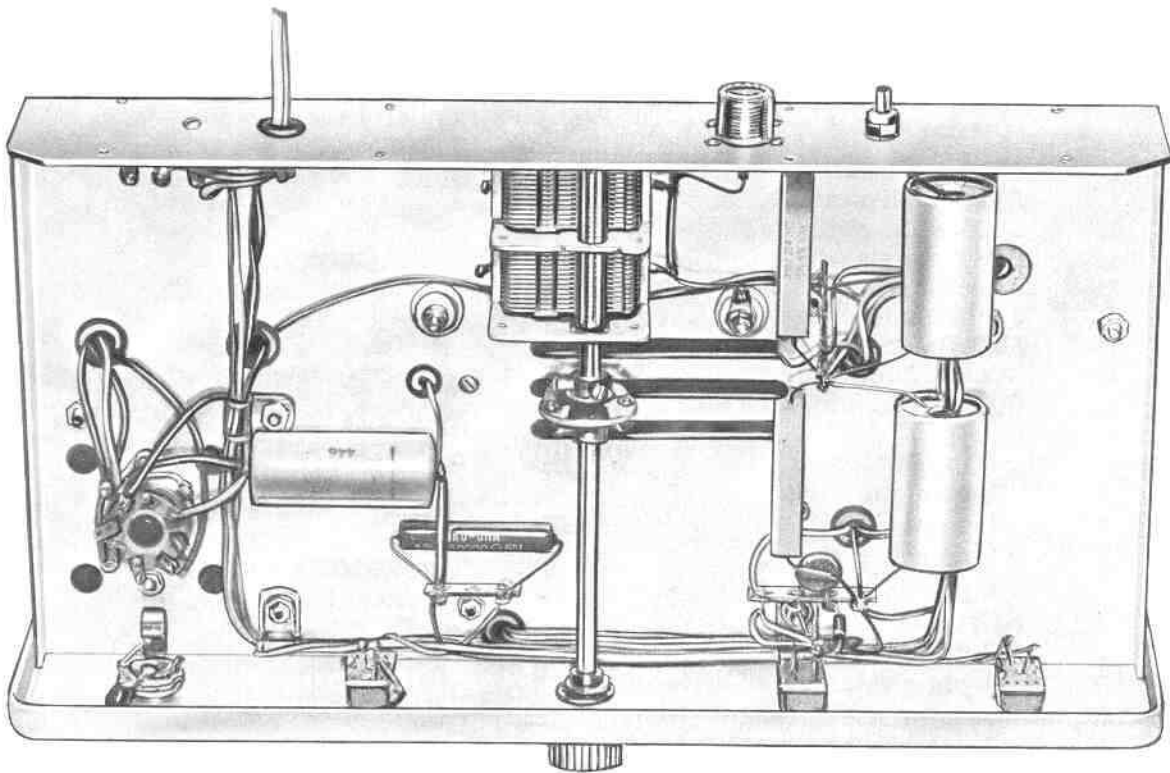


## WARRANTY

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.

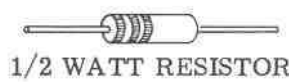
NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

HEATH COMPANY

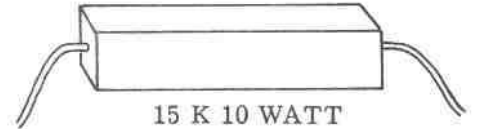
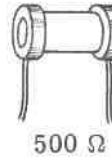
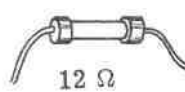


PARTS LIST

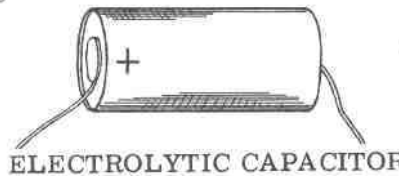
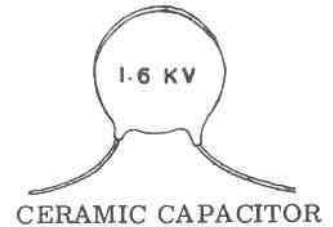
PART No.	PARTS Per Kit	DESCRIPTION
<b>Resistors</b>		
-1-1	1	47 Ω 1/2 watt
-1-9	1	1000 Ω 1/2 watt
-1-26	1	100 K 1/2 watt
-1-49	1	22 Ω 1/2 watt
-1-24A	1	4.7 KΩ 1 watt
-1-6B	1	27 KΩ 2 watt
-2-100	1	12 Ω precision
-2-101	1	500 Ω precision
-3-8J	2	15 KΩ 10 watt
-3-10J	1	50 KΩ 10 watt



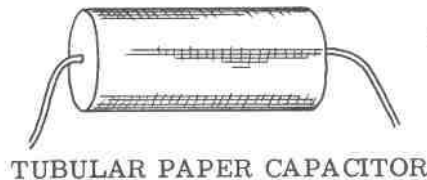
PRECISION RESISTORS



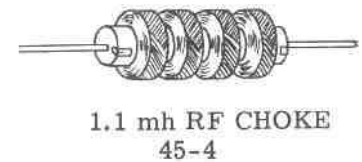
PART No.	PARTS Per Kit	DESCRIPTION
<b>Capacitors</b>		
-20-39	1	220 μmf silver mica
-20-41	2	22 μmf silver mica
-20-64	1	120 μmf mica
-21-27	12	.005 μfd 600 v. disc ceramic
-21-35	2	.005 μfd 1.6 kv disc ceramic
-21-49	1	68 μmf 4 kv disc ceramic
-23-29	1	.1 μfd 1.2 kv paper
-25-33	2	20 μfd 450 v. electrolytic
-26-9	1	2-gang 420 μmf per section
-26-35	1	50 μmf variable
-26-36	1	3-gang 50 μmf per section



PART No.	PARTS Per Kit	DESCRIPTION
<b>Coils-Chokes-Transformers</b>		
40-86	1	Final tank coil
40-93	1	Oscillator tank coil
45-4	1	1.1 MH RF choke
45-14	1	2.5 MH RF choke
46-17	1	Filter choke
-54-54	1	Power transformer

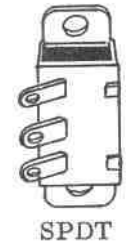
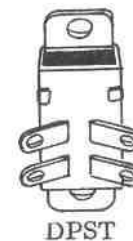


CERAMIC CAPACITOR



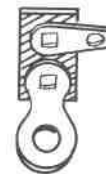
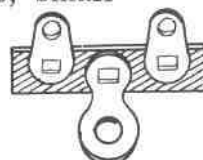
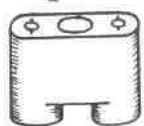
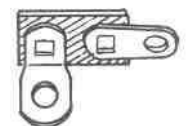
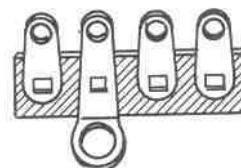
PART No.	PARTS Per Kit	DESCRIPTION
<b>Switches-Meters-Tubes</b>		
-60-1	1	SPST slide switch
-60-2	1	DPDT slide switch
-60-4	1	SPDT slide switch
-60-5	1	DPST slide switch
-63-128	1	2 deck 5 position bandswitch
-407-33	1	3 milliamper meter
-411-2	1	5U4GB rectifier tube
-411-63	1	6CL6 oscillator tube
-411-97	1	6DQ6A final amplifier tube

SWITCHES



TERMINAL STRIPS

PART No.	PARTS Per Kit	DESCRIPTION
<b>Sockets-Terminal Strips-Knobs</b>		
-431-2	2	2-point tie strip
-431-12	3	4-point tie strip
-431-15	1	1-point tie strip
-431-26	1	1-point tie strip
-434-38	1	Crystal socket
-434-39	2	Octal socket
-434-56	1	9-pin miniature socket
-100-M54	2	Pointer knob, large
-462-19	2	Pointer knob, small
-462-44	1	Large knob



PART No. PARTS Per Kit DESCRIPTION

SCREWS

Metal Parts

-90-54	1	Steel cabinet
- 200-M111	1	Aluminum chassis
- 203-103F140	1	Steel front panel
- 204-M128	1	Shield and tube mount
- 204-M129	1	Tube mount L bracket



Hardware

250-7	1	6-32 x 3/16" RH machine screw
250-8	8	#6 sheet metal screw
250-9	12	6-32 x 3/8" RH machine screw
250-18	8	8-32 x 3/8" RH machine screw
250-31	12	6-32 x 1/4" RH machine screw
250-34	1	4-40 x 1/2" RH machine screw
250-48	1	6-32 x 1/2" RH machine screw
250-49	6	3-48 x 1/4" BH machine screw
250-54	1	10-32 x 5/8" RH machine screw
250-70	3	6-32 x 3/16" FH machine screw
250-71	3	6-32 x 1" FH machine screw
251-1	2	6-32 spade screw
252-2	6	3-48 nut
252-3	12	6-32 nut
252-4	8	8-32 nut
252-5	2	10-32 nut
252-7	3	3/8" x 32 control
252-15	1	4-40 nut
253-1	1	#6 fiber washer
253-9	2	#8 flat washer
253-10	2	3/8" x 5/8" control washer
253-27	3	5/32" x 5/16" washer
254-1	28	#6 lockwasher
254-2	8	#8 lockwasher
254-3	1	#10 lockwasher
254-4	2	3/8" x 11/16" control lockwasher
254-7	6	#3 lockwasher
255-5	3	#6 3/4" spacer
259-1	10	#6 solder lug
259-5	1	#10 solder lug
260-2	1	Plate cap



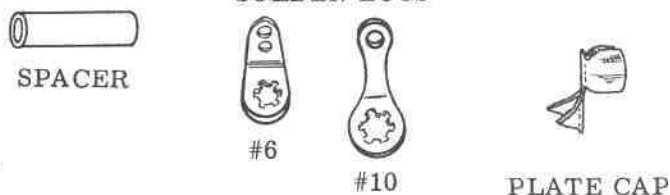
WASHERS



LOCKWASHERS



SOLDER LUGS



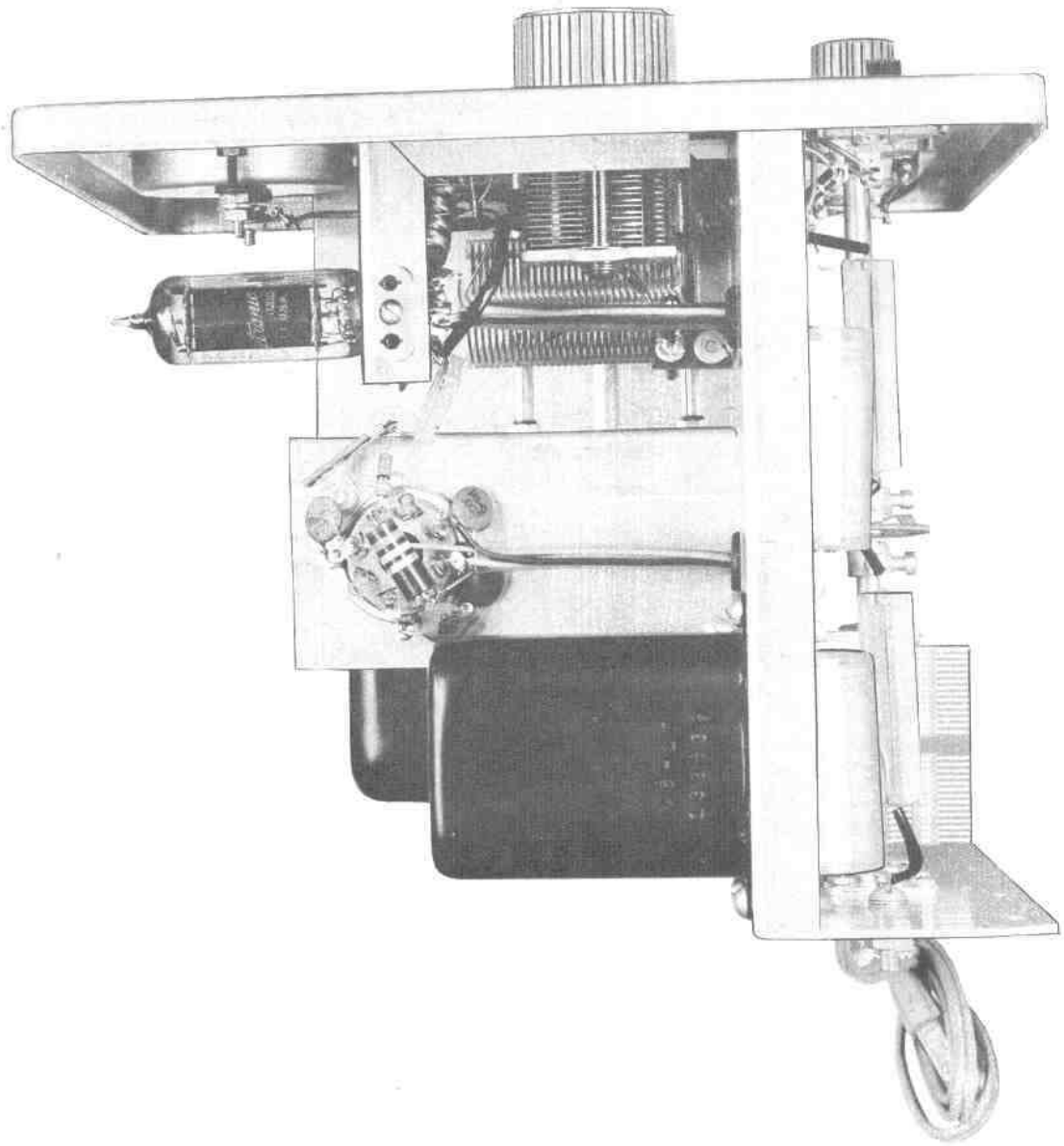
GROMMETS

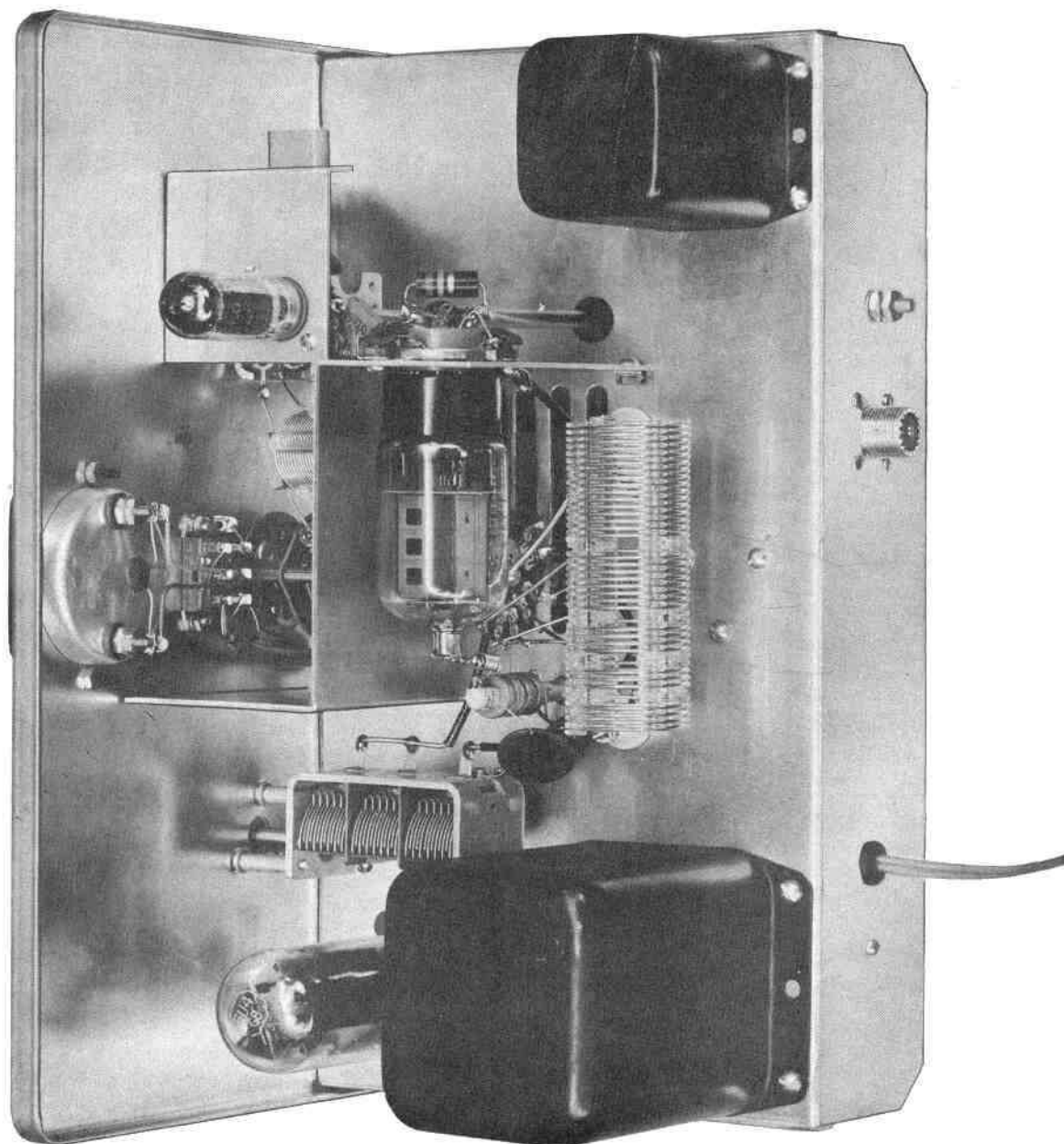


Miscellaneous

71-2	2	Feed-through insulator
73-1	4	3/8" x 9/32" rubber grommet
73-4	1	3/16" x 5/16" rubber grommet
89-1	1	Line cord and plug
207-4	4	Plastic wire clamp
261-4	4	Rubber feet
340-1	1	Length #14 tinned bare wire
340-2	1	Length #20 tinned bare wire
344-1	7	Length colored hookup wire
346-1	1	Length insulated sleeving
346-7	1	Length clear plastic tubing
436-4	1	Key jack
452-1	1	Coaxial connector
453-21	1	1/4" threaded stud
455-9	1	4 1/4" steel extension shaft
456-1	1	1/4" brass bushing
485-M4	1	1/4" flexible coupling
595-144	1	2" plug button
		Instruction manual









# STANDARD COLOR CODE — RESISTORS AND CAPACITORS

### AXIAL LEAD RESISTOR

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

### 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 1/2 watt. Higher wattage rated resistors when specified are progressively larger in physical size. Small wire wound resistors 1/2 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 8 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

### MOLDED FLAT CAPACITOR

Commercial Code

### 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.



# **HEATH COMPANY**

*A Subsidiary of Daystrom Inc.*

**THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM**

**BENTON HARBOR, MICHIGAN**