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Assembling  
and Using

# Heat Kit

AMATEUR  
TRANSMITTER

MODE CQX-25

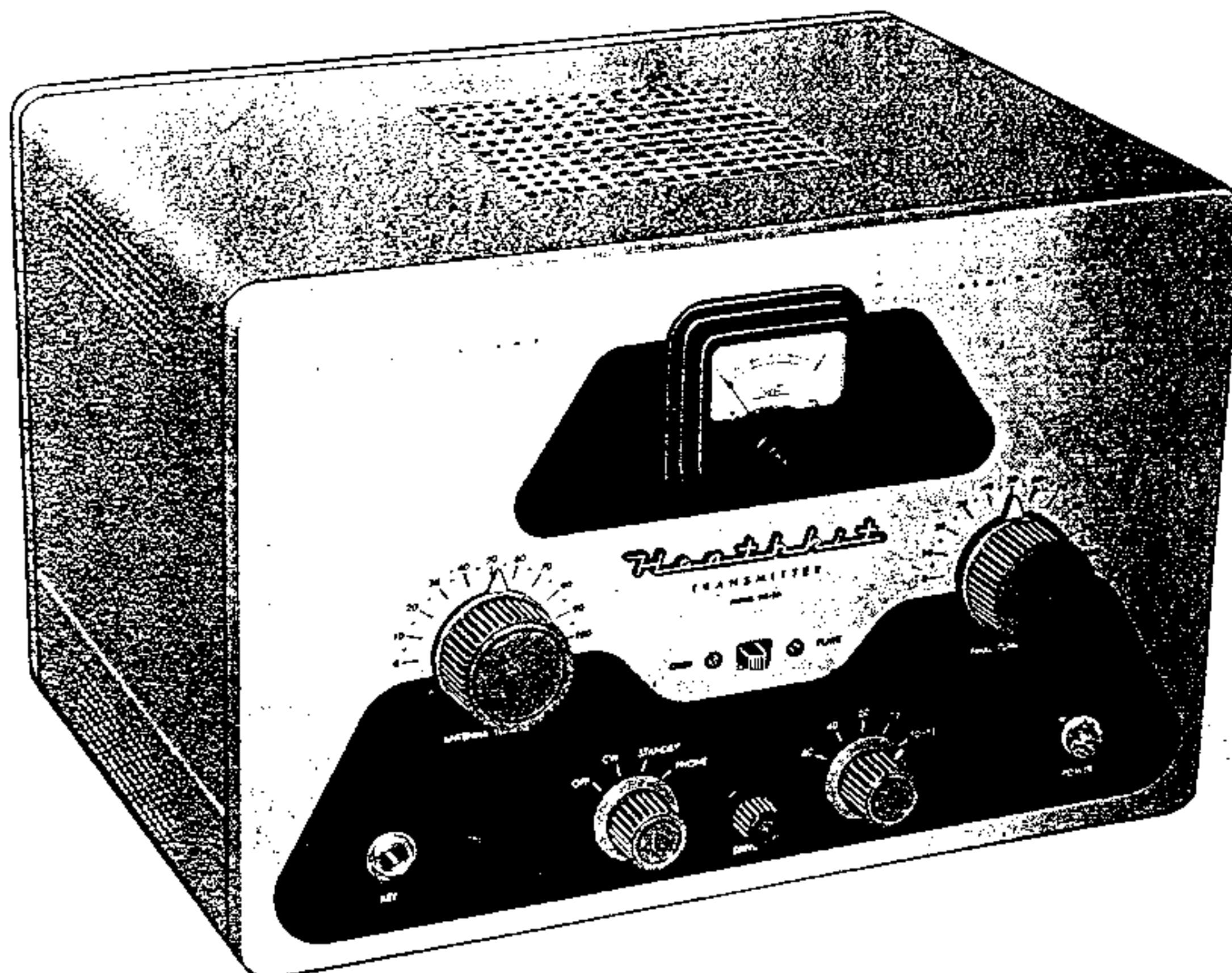
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# ASSEMBLY AND OPERATION OF THE HEATHKIT AMATEUR TRANSMITTER MODEL DX-35



## SPECIFICATIONS

Power Input:.....	65 watt CW, 50 watt peak controlled carrier phone
Output Impedance:.....	50-1000 $\Omega$
Output Coupling:.....	Pi network (coaxial)
Operation: .....	Crystal-VFO, CW, Phone
and Coverage:.....	80, 40, 20, 15, 11, 10 meters
Tube Complement:.....	5U4GB Rectifier 12AX7 Speech Amplifier 12AU7 Carrier Control, Modulator 12BY7 Crystal Oscillator 12BY7 Buffer 6146 Final Amplifier
Power Requirements:.....	115 volts AC, 60 cycles, 175 watts
Cabinet Size:.....	13" wide x 8 1/2" high x 9" deep
Net Weight:.....	21 lbs.
Shipping Weight:.....	26 lbs.



## INTRODUCTION

The Heathkit Transmitter model DX-35 was designed to permit maximum versatility at a reasonable price. It features up to 65 watts input with three switch-selected crystal positions for the novice operator. It includes controlled carrier phone operation and provision for VFO excitation for the general class ham. It has sufficient output to drive larger transmitters when the station is expanded, yet is small enough for field day operation.

The DX-35 consists of one power supply, three radio frequency stages and two dual purpose audio stages. Pi network output coupling is used to facilitate antenna matching. The panel controls consist of a key jack, operation switch, band switch, drive control, pilot light, final tuning, meter switch and antenna tuning. The mike connector, crystal switch, output connector, VFO input and auxiliary socket are located on the rear chassis apron.

The following block diagram and circuit description will give the builder a better understanding of the transmitter. This knowledge is an invaluable aid to construction and as such it is well worth reading thoroughly. **LETHAL VOLTAGES ARE PRESENT AT MANY POINTS ABOVE AND BELOW THE CHASSIS. CONSEQUENTLY, GREAT CARE MUST BE EXERCISED WHEN ANY TEST OR ADJUSTMENTS ARE MADE.**

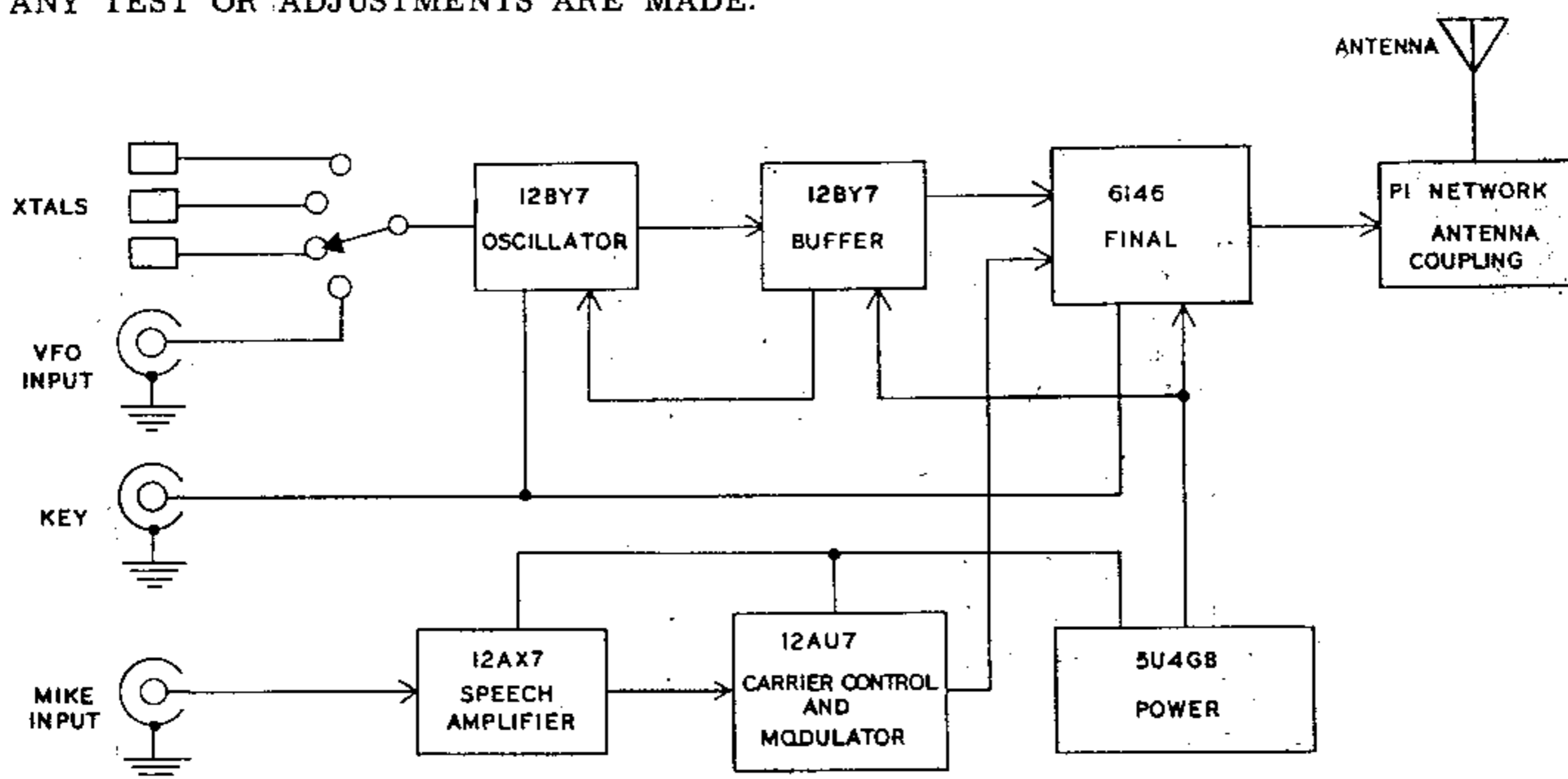


Figure 1

## CIRCUIT DESCRIPTION

**OSCILLATOR:** A 12BY7 tube is operated as a modified Pierce crystal oscillator, with the crystals connected between grid and screen through a blocking condenser. Three crystals may be switched into the circuit by means of a double pole switch which breaks both connections to the crystals to prevent interaction. In the fourth switch position, the 12BY7 grid is connected to a jack for external VFO control and the screen blocking condenser is grounded for screen bypass.

The plate circuit is untuned for operation on 80 and 40 meters, tuned to 40 for operation on 20 and 15 meters and tuned to 20 for operation on 10 meters. The oscillator is capacity coupled to a 12BY7 buffer stage.

Plate and screen voltage for the oscillator stage are derived from the buffer stage cathode. The two 12BY7 tubes are operated in series across the 600 volt supply and receive approximately 300 volts apiece. This eliminates the necessity of power-wasting dropping resistors.

**BUFFER:** The 12BY7 buffer stage has an independent filament supply to prevent heater-to-cathode breakdown as this cathode is 300 volts above the other tubes. The plate of the buffer is shunt-fed directly from the 600 volt supply through a 1.1 mh RF choke. The plate circuit for the buffer stage actually appears in the grid circuit of the 6146 amplifier. The buffer plate is capacity coupled to the amplifier grid coils and is tuned along with the amplifier grid.

**FINAL AMPLIFIER:** By placing the tuned circuit in the grid of the final amplifier, the normal grid RF choke is eliminated. This lessens the possibility of low frequency parasitics due to the grid choke and also the chance of coupling from the final grid choke to the shunt feed choke of the buffer stage. An air trimmer capacitor across the grid coils adjusts the grid drive by tuning the grid for maximum efficiency across the band.

The plate circuit is shunt-fed through a 2.5 mh RF choke and capacity coupled into the pi network tank circuit. For operation at 80 and 40 meters, a 68  $\mu\mu\text{f}$  1000 volt fixed capacitor is automatically paralleled with the plate tuning capacitor by means of the bandswitch. A 900  $\mu\mu\text{f}$  variable capacitor is permanently connected across the output of the pi circuit for antenna loading.

**MODULATOR:** A 12AX7 tube is used as a two-stage resistance coupled speech amplifier. The output of the speech amplifier is split into two channels, one of which feeds one-half of a 12AU7 acting as a control tube. The control tube averages the audio level in its cathode circuit as a DC bias which is applied to the other half of the 12AU7 acting as a cathode follower. The other half of the speech amplifier output is applied to the grid of the cathode follower and appears as a superimposed audio signal on the DC output of the cathode follower. The combined output of the cathode follower is applied to the screen of the 6146 RF amplifier and results in a varying DC screen voltage with an audio component. The net result is a change in both RF output and modulation as the audio level changes.

**POWER SUPPLY:** The power supply consists of a transformer-operated full wave rectifier circuit with a choke input filter. Two filter capacitors are operated in series to withstand the voltage involved. Two identical resistors across the filter capacitors serve a dual purpose of equalizing the filter voltage and acting as a bleeder resistor to stabilize the output under varying load conditions. A 5U4GB tube is used as the full wave rectifier. This tube is a heavy-duty version of the regular 5U4G. Some of the tube ratings have been exceeded while others are operated under the maximum permissible. Tests have indicated that by using the heavy duty tube with choke input and a light current load, no difficulty should be encountered.

#### NOTES ON ASSEMBLY AND WIRING

Many of these kits will probably be constructed by people just starting in the amateur radio field. Consequently, the step-by-step instructions in this manual have been covered in considerable detail. Read each step completely through and be sure it is understood before proceeding with the operation called for. This will assure that a complicated step is performed in the proper sequence in order to complete it with the least possible difficulty.

There is considerable similarity between the screws and nuts of the 3-48 and the 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 are only three of these and they should be used in mounting the crystal sockets.

In the design of the Heathkit DX-35, no effort was spared to obtain the highest quality components and assemble them in the best possible 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, resulting from careful assembly and wiring. A common factor of radio frequency instruments is the critical placement of leads and components. The use of extensive shielding in the DX-35 has eliminated a great deal of this. However, the lead dress shown in the pictorials and bottom chassis photograph should be followed carefully.

This manual is supplied to assist you in every way to complete the DX-35 with the least possible chance for error. We suggest that you take a few minutes now and read the entire manual, omitting the step-by-step instructions, before any work is started. This will enable you to proceed with the work much faster when construction is begun. The large fold-in pictorials are handy to attach to the wall above your work space. Their use will greatly simplify the construction of the kit. These diagrams are repeated in smaller form within the manual. We suggest that you retain the manual in your files for future reference both in the use of the DX-35 and for its maintenance. During the initial testing of the transmitter, it will be out of its cabinet. REMEMBER THAT VOLTAGES DANGEROUS TO LIFE ARE PRESENT AT PRACTICALLY ALL POINTS ON THE CHASSIS.

NOTE: Sometimes the builder may find a place where it is difficult to hold a nut for assembly. Using long-nosed pliers, press a piece of solder across one side of the nut until the solder is forced part way into the threads. This will hold the nut and furnish a narrow handle useful for inserting the nut into tight places.

During the assembly and wiring procedure, a rag or some soft material should be placed over the work bench to prevent marring or scratching the chassis or component finish. Capacitors, resistors and transformers usually have leads longer than necessary to make the indicated connections. In the interest of both efficiency and appearance, the leads should be cut to an appropriate length before the connections are made.

In many cases, the specified wire lengths may seem long. These lengths were chosen so the wire could be run close to the chassis and formed for the best appearance. Marking the letters of the tube sockets and terminal strips on the chassis as they are installed will be a great help during the wiring procedure.

The actual tube markings may differ from the type specified in the parts list by an additional suffix (A, B, GT, etc.). This denotes a minor variation which will not affect the operation of the completed instrument.

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, for example, you may find that a 2 K $\Omega$  resistor has been supplied in place of a 2.2 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 parts 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.

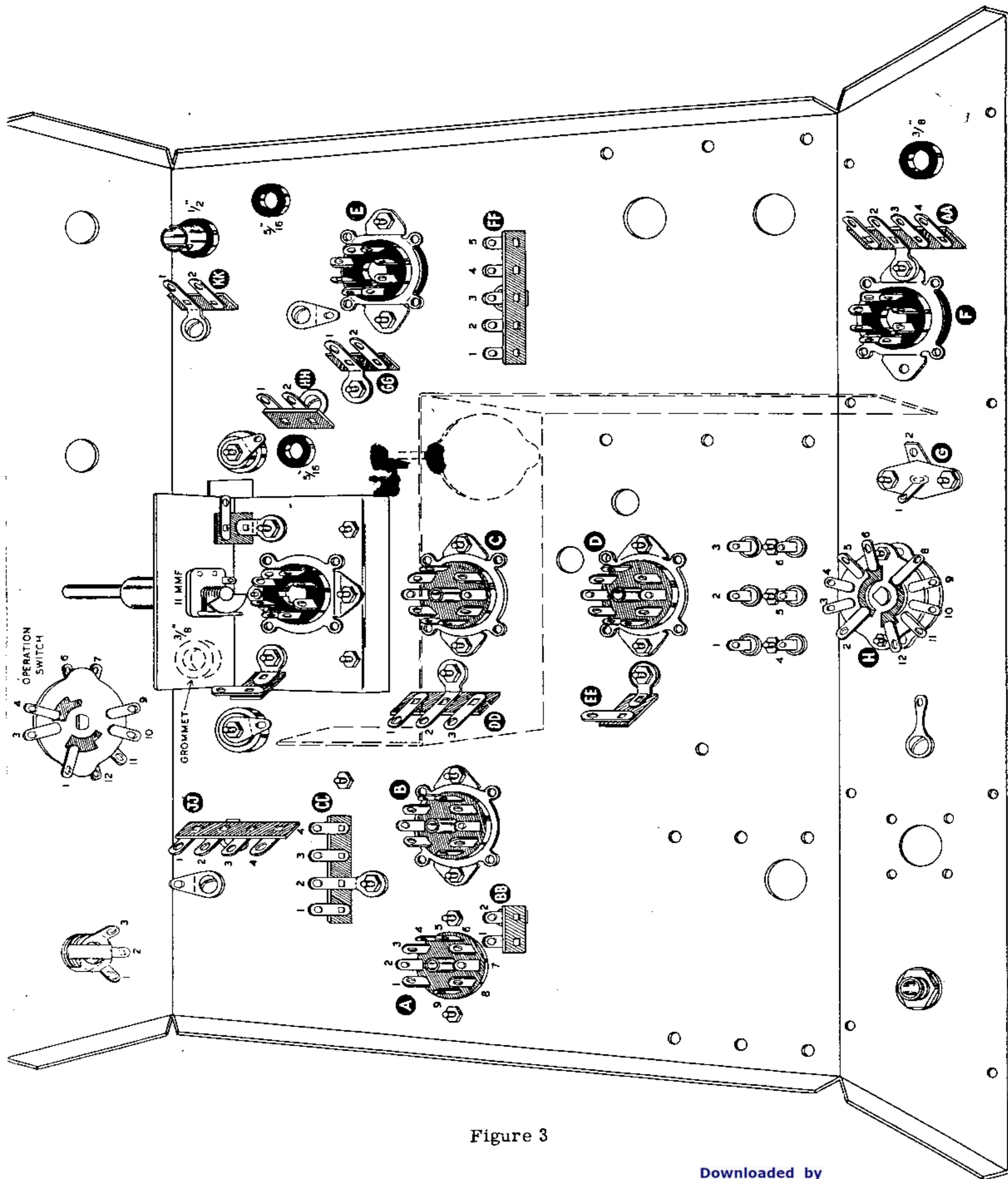
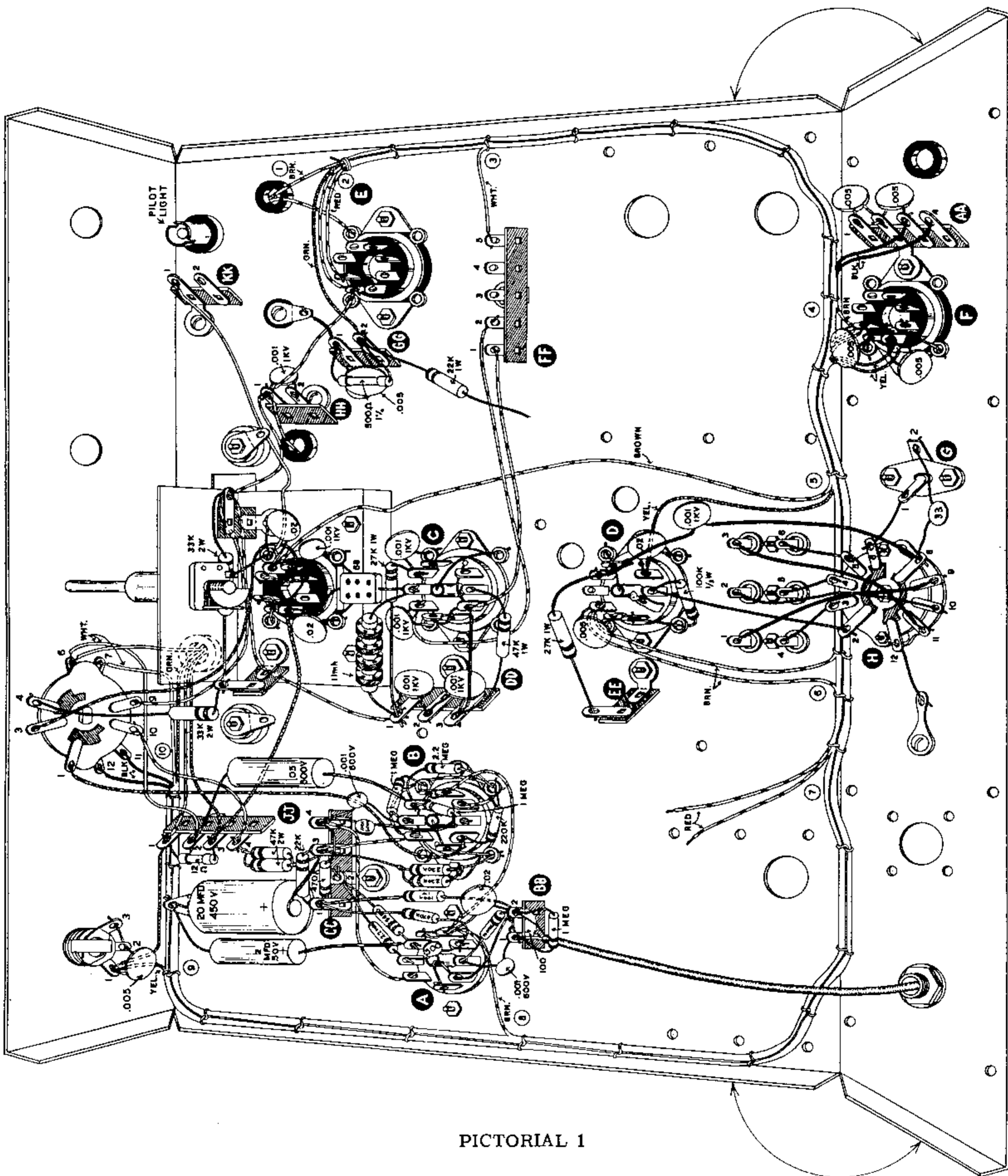
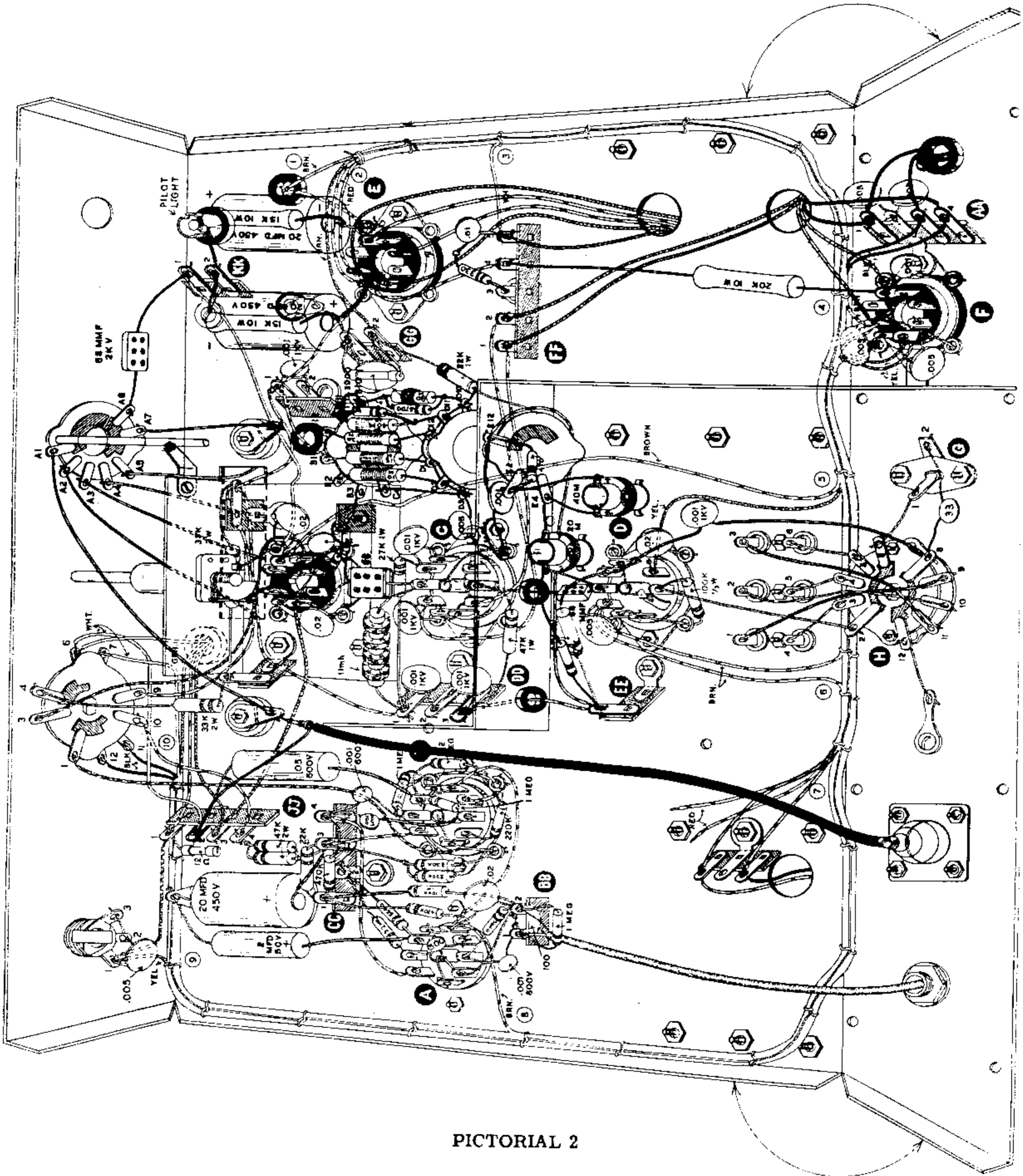


Figure 3

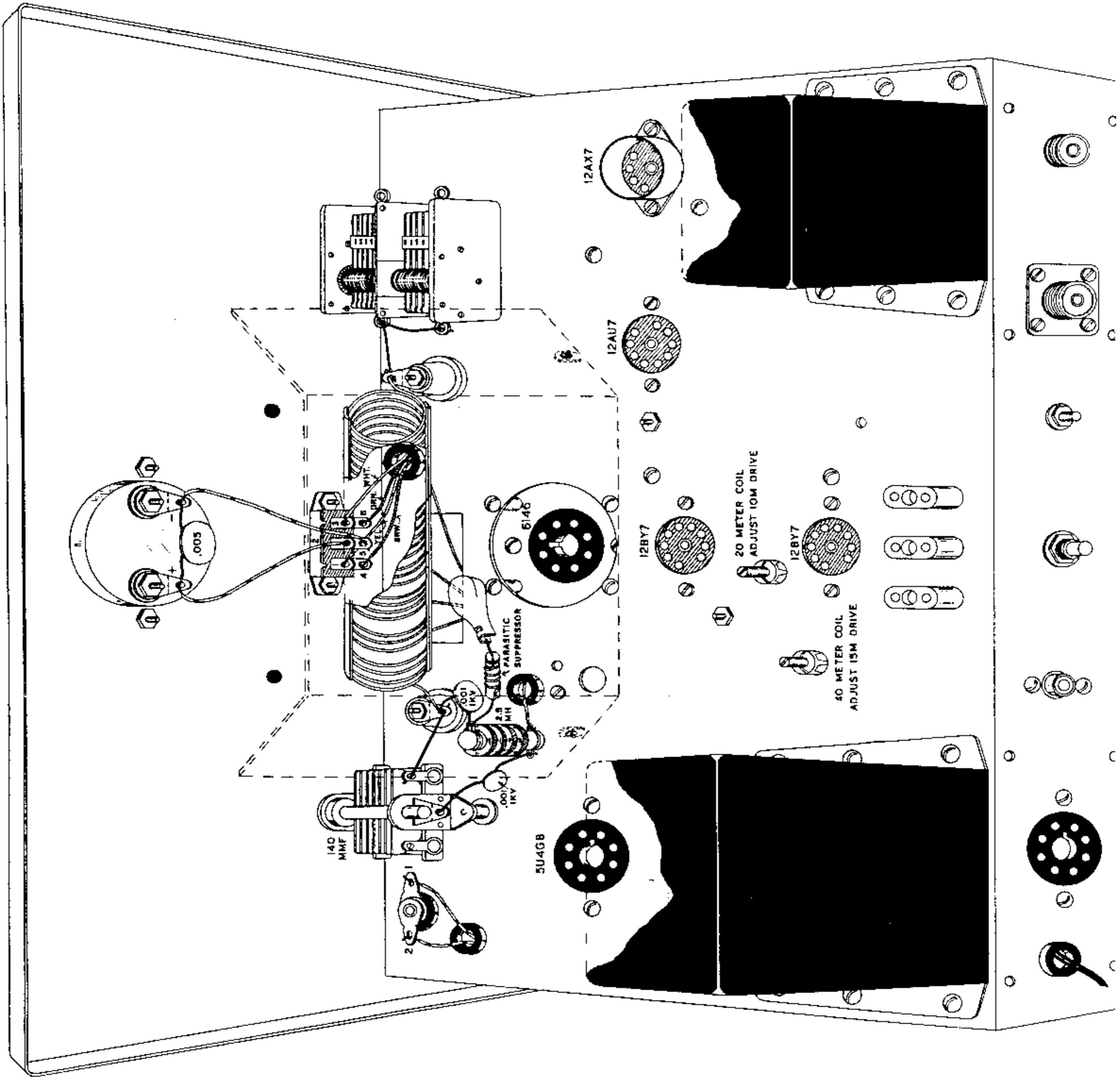


PICTORIAL 1





PICTORIAL 2



PICTORIAL 3

- ( ) Remove the nuts and washers holding the operation switch and the phone jack. Leave the nut on the tuning capacitor in place.
- ( ) Before actually mounting the panel over the controls, bring it close enough to the chassis to mount the double-pole double-throw slide switch using 6-32 hardware. The side of the switch having the yellow and brown wires goes on the side labeled PLATE.
- ( ) Turn the chassis on its back and slip the panel over the control shafts. Replace the flat washers and 3/8" nuts.
- ( ) On the final tuning capacitor, bring the nut on the bushing up until it is against the rear of the panel, with the panel perpendicular to the chassis. Add a flat washer and nut on the front of the panel and tighten.
- ( ) Connect a .005  $\mu$ fd disc ceramic capacitor from the + meter terminal to the - meter terminal (NS). See Pictorial 3.
- ( ) Connect the red wire from the slide switch to the + meter terminal (S).
- ( ) Connect the brown wire from the slide switch to the - meter terminal (S). These wires should lie flat against the panel to clear the coil.
- ( ) Cut both leads of the parasitic choke to 7/8" lengths. Connect one lead to a ceramic plate cap and solder. The other lead will connect to the top terminal of the 2.5 mh RF choke (S).
- ( ) Press the dial light jewel into the panel space marked POWER, and bend the tabs over on the rear of the panel.
- ( ) Install a small red knob on the shaft marked DRIVE.
- ( ) Install round skirt knobs on the band and operation switches and orient with the panel markings. Tighten the set screws.
- ( ) Install a round skirt knob on the crystal switch on the rear chassis apron.
- ( ) Turn both tuning capacitors to full mesh and install pointer knobs with the indicators at "0" on the panel markings.
- ( ) Install the pilot light and the tubes as shown in Pictorials 1 and 3. Place the tube shield over the 12 AX7 tube.

This completes the assembly and wiring of the DX-35 Transmitter.

#### PRELIMINARY OPERATION CHECKS

Before applying power to the transmitter, examine your wiring very carefully for possible shorts, such as tube pins touching, resistor or capacitor leads contacting the chassis or shield plates and switch contacts shorting to the switch frame. Also be sure no wire clippings or solder drops are still in the chassis.

If there are any short circuits, serious damage will result to the tubes and components when power is applied. As an additional check, connect an ohmmeter from tube pin E1 to ground, **WITH THE POWER OFF**. It should read approximately 30 K $\Omega$  in all positions of the operation switch except the phone position where it will read approximately 22 K $\Omega$ . Any abnormal reading must be completely investigated before applying power.

Again, before applying power, check all solder connections. Make sure none have been missed and that all are good electrical connections. Check the coax connector (center) with an ohmmeter for "open", and the mike connector (center) for 1 megohm resistance.

#### TUNING INSTRUCTIONS

If any of the following tests cannot be performed or show abnormal indications, turn to the section of the manual entitled **IN CASE OF DIFFICULTY**. Set the transmitter up as follows: crystal switch in any position (no crystals or VFO plugged in), key plugged in, operation switch OFF, DRIVE control in any position, bandswitch 10-11 meter position, output tuning any position, GRID-PLATE switch in PLATE position, final tuning any position.

Plug the line cord into a 117 volt AC receptacle. Nothing should happen; if anything does, pull the line cord immediately. There is trouble in the AC power circuits which must be corrected before proceeding. If operation is normal so far, switch the operation switch quickly past the **CW** position to the **STANDBY** position.

The pilot light and all tubes should light but there should be no meter or any other indication yet. Switch to PHONE position. There will now be voltage across the key terminals so use caution. Depress the key momentarily. The meter will read between 1/2 and 3/4 scale. Release key. When the crystal knob index is toward the chassis top, it can be adjusted until the index points to the VFO jack or any other of three crystal positions. It will now indicate the crystal in use.

For the following adjustments a 40 meter crystal in the range of 7000 to 7150 should be used. Install the crystal in any of the three sockets and set the crystal switch for this socket. Set the bandswitch to 10 meters and connect a dummy load such as a 40 watt light bulb from the ground bolt to the center of the coax connector.

Plug the power cord into a socket and set the operation switch to STANDBY. Set the loading control to 0 (capacitor fully meshed). After about two minutes time for tube warmup, switch to PHONE position, depress the key and quickly tune the final plate control for a dip.

Now switch the meter to GRID position and adjust the DRIVE control for maximum reading, providing it does not exceed 3 ma. With a fine bladed screwdriver, tune the 20 meter oscillator coil for maximum; this is the screwdriver adjustment on top of the chassis between the two 12BY7 tubes.

Release the key, set the bandswitch to 15 meters and the meter switch to PLATE. Depress the key and tune for dip. Set the meter switch to GRID position and adjust the DRIVE control for maximum, not exceeding 3 ma. Tune the 40 meter oscillator coil (between the oscillator tube and power transformer) for maximum. No further adjustment of these coils is necessary.

Install an 80 meter crystal in one of the remaining crystal sockets and set the crystal switch for this socket. Set the bandswitch for 80 meters, operation switch to PHONE position, and depress key. Adjust the plate for minimum current, and the grid drive for 3 ma. Release the key and set the operation switch to CW position. Depress the key and advance the antenna tuning toward 100 at the same time maintaining the dip in plate current with the final tuning control. The light bulb should reach full brilliance with a plate current of approximately 100 ma. Release the key and set the operation switch to STANDBY. Connect a crystal, ceramic, or hi Z dynamic microphone to the mike connector and remove the key plug. Switch to PHONE position and speak into the microphone. The light should vary in brilliance. Now monitor the signal on a receiver with its antenna removed; the speech should be clear.

The transmitter is now adjusted and ready for installation in the cabinet. Install four rubber feet on the cabinet and slide the transmitter into the cabinet with the line cord coming through the slot in the rear of the cabinet. Secure by installing eight sheet metal screws through the rear of the cabinet into the rear apron of the chassis. Be sure the screws will clear the cable. Crystals may be changed through the door in the back of the cabinet.

#### OPERATION

In practice, 80 meter crystals may be used for operation on the 80-40-20 meter bands, 40 meter crystals can be used for operation on the 40-20-15-10-11 meter bands. 20 meter crystals can be used for operation in the 10 - 11 meter bands. A VFO with output on the 160 and 40 meters, such as the Heathkit VF-1 may be used for operation from 80 through 10 meters.

The auxiliary socket on the rear of the transmitter provides 6.3 volt filament supply between pin 2 and ground pins 7 or 1; 250 volts DC at 20 mills on pin 4 and keying control on pin 8 for operating a VFO. The VF-1 power plug is already wired for this connection.

In tuning up on an antenna, the plate tuning should be set for a dip in the CW position, the grid drive adjusted for 2.5 ma and the loading advanced toward 100 while still maintaining a dip with the FINAL TUNING control. This procedure is continued until the plate current is 100 to 125 mills at resonance. For phone operation, it is only necessary to tune up first in the CW position, connect a microphone to the rear connector and set the operation switch to PHONE. When operating on phone, the plate current will read low (about 40 to 50 mills) and kick up to about 100 mills on modulation.

#### IN CASE OF DIFFICULTY

Mistakes in wiring are the most common cause of difficulty. Consequently, the first step is to recheck all wiring against the pictorials and schematic diagrams. Often having a friend check the wiring will locate an error consistently overlooked.

Also, with miniature sockets there is a possibility of shorts between adjacent socket terminals due to the close spacing. This should be checked and if any doubt exists, the terminals should be pried apart until obvious spacing can be seen between them.

Sometimes apparently good solder connections will have an insulating coating of rosin between the wire, the terminal and the solder. This is often the case when insufficient heat was applied in soldering. An ohmmeter check of any questionable connections will test for this condition. Naturally, all voltages should be "off" for such tests.

Be sure to reread the circuit description on Page 3 so that "cause and effect" reasoning may be employed as the search for trouble progresses. If some difficulty still persists after the steps outlined have been completed, attempt to localize the trouble to a particular stage in the transmitter circuit. Use the tuning procedure as a basis for localization and refer to the block diagram and schematic to visualize circuit relationships. The panel meter and station receiver are extremely valuable tools to use in locating trouble.

NOTE: For the tracing procedures outlined below, use the schematic diagram for reference.

If any activity is noted when the line cord is plugged in and the operation switch is in OFF position the AC circuit should be traced. One side of the line cord is connected directly to one side of the primary of the power transformer. The other side of the line cord is connected to one black cable wire which should connect to either 11 or 12 of the operation switch; the other black cable wire returns from switch terminal 12, if 11 were used before, to the other primary side of the transformer. Contacts 11 and 12 of the switch thus control line power to the transformer. Also check the two .005 disc ceramic capacitors connected across the line for shorts.

If the tubes and pilot light do not light up when the operation switch is set to STANDBY position, again check the AC circuit with power off to determine why the transformer is not receiving power. If the tubes light up and the meter also reads in PLATE position, or some other indication of high voltage being applied is apparent, check the following. Unplug the line cord then with an ohmmeter, check from lug FF5 to ground. It should read an open circuit. This is the power transformer center tap. The white cable wire at FF5 should connect to terminal 7 of the operation switch and through terminal 6 to ground but not be grounded in the STANDBY condition. Check this wiring to be sure it is correct. CAUTION: The following tests are made with power on; use extreme care. With the operation switch in PHONE position, the KEY depressed, and the meter in PLATE position, it should read about 1/2 to 2/3 scale, when not tuned to resonance. If the meter shows little or no indication, check the screen voltage at pin 3 of the 6146 tube with a Volt-Ohm-Millimeter (VOM), using a DC range of at least 150 volts. The screen should read about 40 volts. If less than this, trace back through contact 3 of the operation switch, through contact 1 to pin 8 of the 12AU7 tube; all should read 40 volts. Switch the meter to a higher range, 500 volts, and check pin 6 of the 12AU7. This should read about 400 volts. If the voltages are missing or very far from normal, using the voltmeter on a 750-1000 volt scale and the schematic diagram, trace the voltage back to its source at the rectifier pin 1. No voltage at E1 indicates an open power transformer primary, open power transformer center tap outlined in the steps above, defective rectifier tube 5U4GB or a short circuit. The latter would probably have made itself known by now.

If the oscillator slug tuned coils cannot be adjusted as described, make sure the 40 and 20 meter coils have not been interchanged, that the windings are connected in series (outside lead of 40 meter coil should connect to inside lead of 20 meter coil) and that the coils are connected properly to the switch.

If too little or no grid drive is available, there is the possibility that the final grid coils have been interchanged. A rough check can be made by noting the size of wire and apparent number of turns. Fine wire and more turns are used on the low frequency coils, with progressively larger wire and lesser turns as 10 meters is approached.

No grid drive may be traced back to the oscillator. Turn the power off and remove final tube. Then turn to CW and listen with a receiver for the oscillator. Try different crystals. If no signal is heard, check plate voltage of oscillator at pin 7 and screen voltage at pin 8. Also make sure KEY is closed. There should be about 300 volts on the plate and about 200 on the screen. As the two 12BY7 tubes are in series, no voltage on the oscillator may be due to an open circuit or defective 12BY7 in the buffer stage. Consequently, both stages must be operating properly to obtain grid drive. The plate voltage of the buffer stage will be about 600 volts to ground and its cathode should be about 300 volts to ground. If the voltages differ greatly remove power and completely check the circuit.

Failure to obtain a dip when tuning the final amplifier may be due to lack of grid drive, incorrectly wired tank coil, loading capacitor advanced too far (insufficient capacity, shorted coax line or, on 80 and 40 meters, a short in the padding capacitor (68 mmf 1000 volts).

**NOTE:** When using the DX-35 on CW with the VF-1, the VF-1 operation switch should be placed in the standby position and the key plugged into the DX-35. For best results with either crystal or VFO, the grid should be adjusted to between 2 and 3 milliamperes.

### 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 ventilation 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.

### ACCESSORY SOCKET

The octal accessory socket on the rear of the chassis was provided to furnish power for an external VFO such as the Heathkit V-F-1. Filament power is provided between pins 2 and 7 with 7 being ground for operation of an external unit having one side of the filament at ground potential. Pin 4 supplies B+ voltage through a 20 K $\Omega$  10 watt resistor. This provides approximately 250 volts at 20 milliamperes. Pin 8 is connected to the cathode keying circuit and allows an external VFO to be keyed along with the DX-35. Pin 1 is grounded for the shield cable between the transmitter and VFO. See Figure 8.

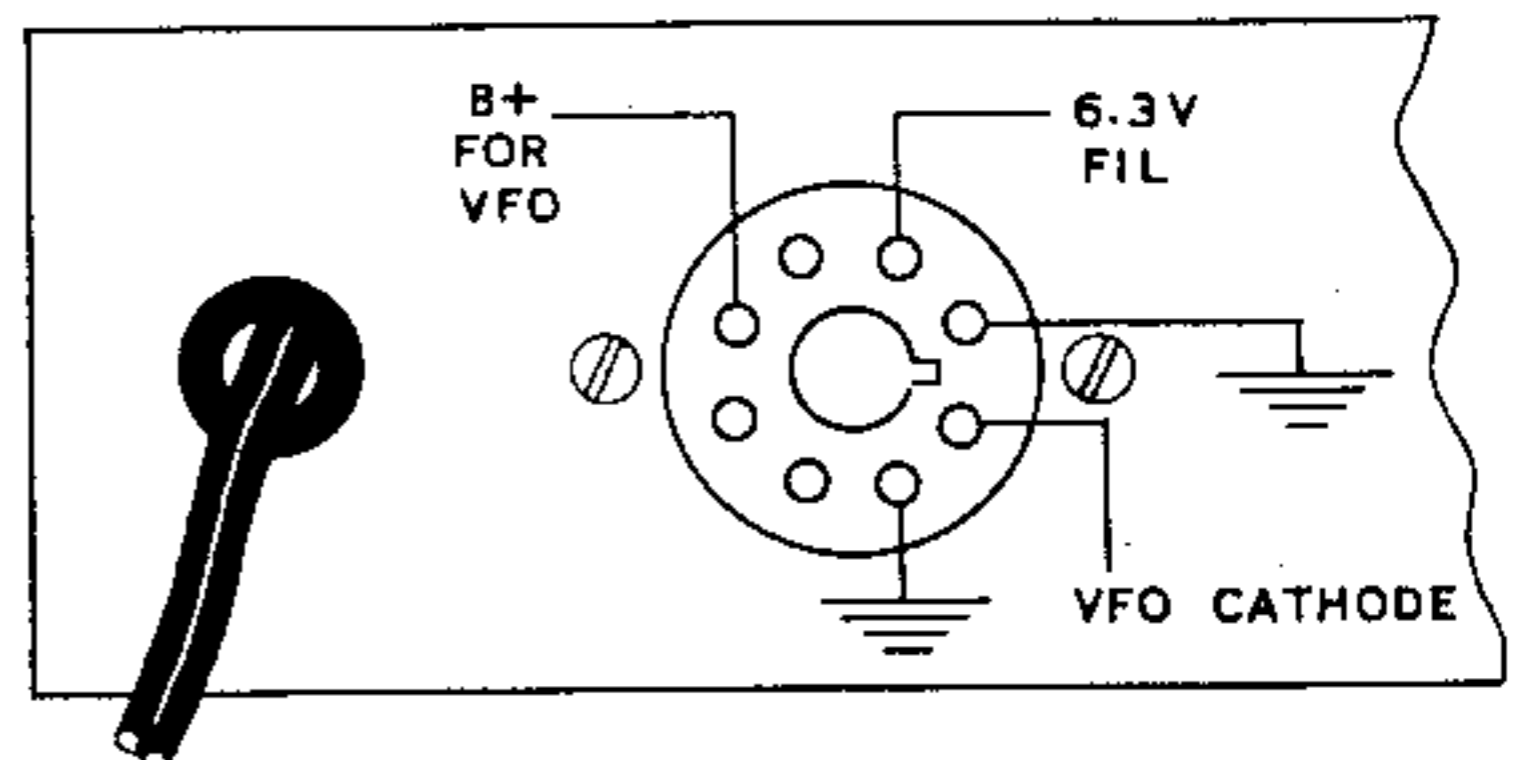


Figure 8

**ANTENNAS:** The pi network output circuit of the model DX-35 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.

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 125 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 10 or 15 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 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-35.

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 lengths 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 coupling capacitor value has little effect on the final amplifier loading 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 above.

#### 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 9 on Page 30.

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 9, 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.

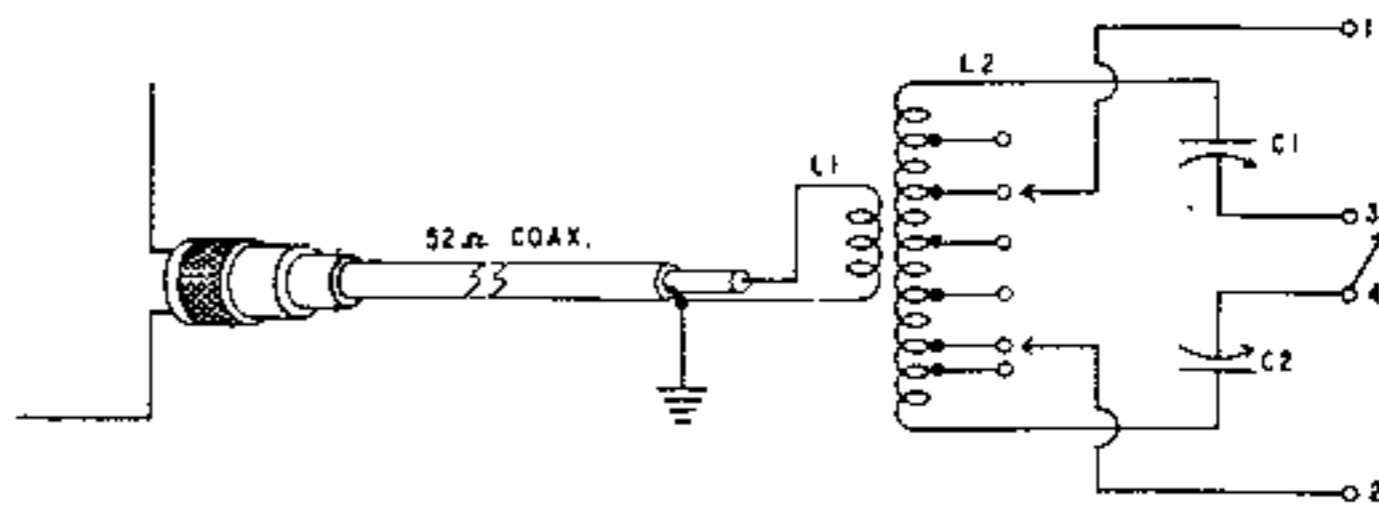


Figure 9

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-35 is designed for single-ended, unbalanced operation.



**LOW PASS FILTERS:** The harmonic rejection of the pi network output circuit of the DX-35 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:

$$1 \text{ wave length in space} = \frac{300,000 \text{ meters}}{F_{kc}}$$

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

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

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

#### 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 warranty. If tubes are to be returned, pack them carefully to prevent breakage in shipment and 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

In event continued operational difficulties of the completed instrument are experienced, the facilities of the Heath Company Service Department are at your disposal. Your instrument may be returned for inspection and repair for a service charge of \$5.00 plus the cost of any additional material that may be required. **THIS SERVICE POLICY APPLIES 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.

The Heath Company is willing to offer its full cooperation to assist you in obtaining the specified performance level in your instrument. Factory repair service is available for a period of one year from the date of purchase or you may contact the Engineering Consultation Department by mail. For information regarding possible modification of existing kits, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at any electronic outlet store. Although the Heath Company sincerely 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.

#### SPECIFICATIONS

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.

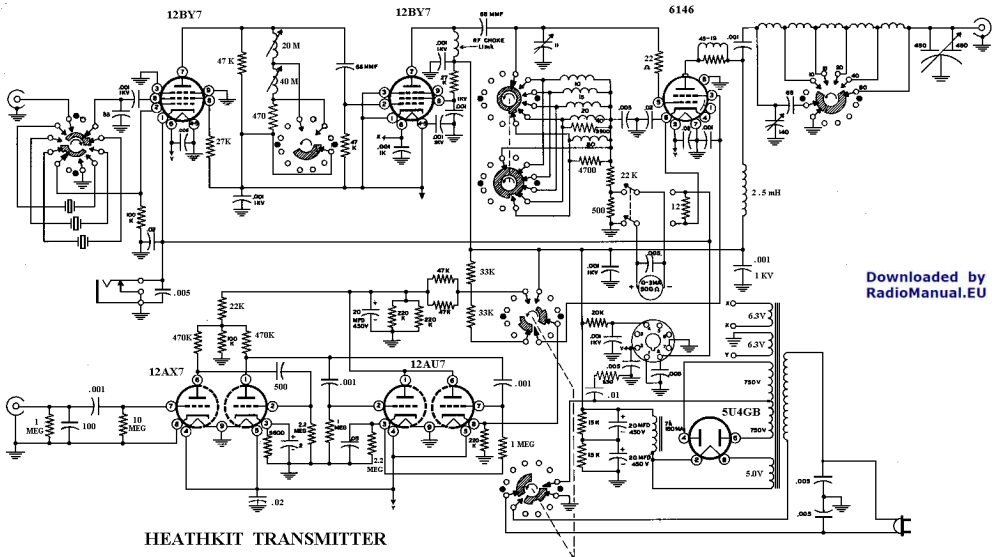
#### WARRANTY

The Heath Company limits its warranty of parts supplied with any kit to a period of three (3) months from the date of purchase. Replacement will be made only when said part is returned postpaid, with prior permission and in the judgment of the Heath Company was defective at the time of sale. This warranty does not extend to any Heathkits which ~~have~~ been subjected to misuse, neglect, accident and improper installation or applications. Material supplied with a kit shall not be considered as defective, even though not in exact accordance with specifications, if it substantially fulfills performance requirements. This warranty ~~is~~ not transferable and applies only to the original purchaser. This warranty is in lieu of ~~all~~ other warranties and the Heath Company neither assumes nor authorizes any other person ~~to~~ assume for them any other liability in connection with the sale of Heathkits.

The assembler is urged to follow the instructions exactly as provided. The Heath Company assumes no responsibility or liability for any damages or injuries sustained in the assembly of the device or in the operation of the complete instrument.

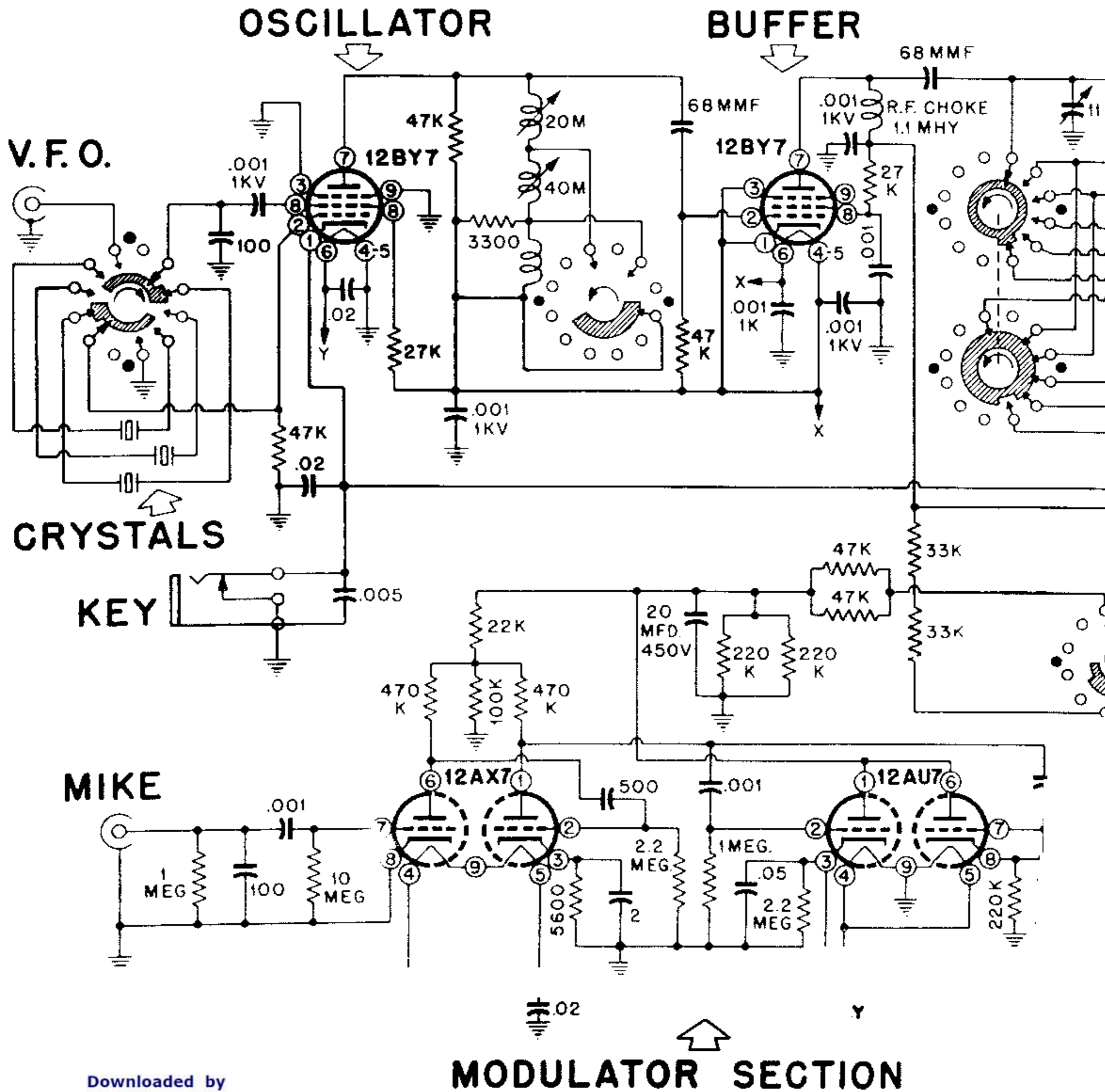
HEATH COMPANY  
Benton Harbor, Michigan

PART No.	PARTS Per Kit	DESCRIPTION	PART No.	PARTS Per Kit	DESCRIPTION
<b>Resistors</b>			<b>Switches-Meters-Tubes</b>		
1-18	1	5600 Ω 1/2 watt	60-2	1	DPDT slide switch
1-25	1	47 KΩ 1/2 watt	63-113	1	Bandswitch
1-26	1	100 KΩ 1/2 watt	63-114	1	Operation switch
1-29	1	220 KΩ 1/2 watt	63-115	1	Crystal switch
1-33	2	470 KΩ 1/2 watt	407-33	1	3 ma meter
1-35	3	1 meg Ω 1/2 watt	411-2	1	5U4GB tube
1-37	2	2.2 meg Ω 1/2 watt	411-25	1	12AU7 tube
1-40	1	10 meg Ω 1/2 watt	411-26	1	12AX7 tube
1-49	1	22 Ω 1/2 watt	411-69	2	12BY7 tube
1-1A	1	470 Ω 1 watt	411-75	1	6146 tube
1-5A	2	22 KΩ 1 watt	412-1	1	#47 pilot light
1-7A	1	47 KΩ 1 watt	413-2	1	Pilot light jewel
1-20A	1	330 Ω 1 watt	<b>Sockets-Terminal Strips-Knobs</b>		
1-24A	1	4700 Ω 1 watt	431-15	4	1-lug terminal strip
1-28A	1	100 KΩ 1 watt	431-10	2	3-lug terminal strip
1-30A	2	220 KΩ 1 watt	431-11	1	5-lug terminal strip
1-46A	2	27 KΩ 1 watt	431-12	3	4-lug terminal strip
1-47A	1	3900 Ω 1 watt	431-16	4	2-lug terminal strip
1-10B	2	47 KΩ 2 watt	432-3	1	Microphone connector
1-18B	2	33 KΩ 2 watt	434-21	1	Pilot light socket
2-100	1	12 Ω 1% precision	434-38	3	Crystal socket
2-101	1	500 Ω 1% precision	434-39	3	Octal socket
3-8J	2	15 KΩ 10 watt	434-42	1	Phono socket
3-9J	1	20 KΩ 10 watt	434-43	1	9-pin miniature shielded socket
<b>Capacitors</b>			434-43	1	9-pin miniature socket
20-31	3	68 μ 1 kv silver mica	434-56	3	Phone jack
21-7	1	33 μ disc ceramic	436-4	1	Phone jack
21-9	1	100 μ 300 v. disc ceramic	436-5	1	Coaxial jack
21-13	1	500 μ 300 v. disc ceramic	436-5	1	Coaxial jack
21-14	3	.001 μ 100 v. disc ceramic	100-M54	2	Pointer knob, large
21-27	9	.005 μf 100 v. disc ceramic	462-19	3	Pointer knob, small
21-31	4	.02 μfd 500 v. disc ceramic	462-36	1	Red knob, small
21-42	1	.01 μfd 1600 volt	<b>Coils-Chokes-Transformers</b>		
21-43	11	.001 μfd 1 kv disc ceramic	40-79	1	40 meter oscillator coil
23-10	1	.05 μfd 600 volt paper	40-80	1	20 meter oscillator coil
25-33	3	20 μfd 450 v. electrolytic	40-81	1	80 meter buffer coil
25-35	1	2 μfd 50 volt electrolytic	40-82	1	40 meter buffer coil
26-9	1	450 μmf variable, dual	40-83	1	20 meter buffer coil
26-31	1	140 μmf variable	40-84	1	15 meter buffer coil
26-32	1	11 μmf variable	40-85	1	10 meter buffer coil
<b>Metal Parts</b>			40-86	1	Amplifier plate coil
90-43	1	Cabinet	45-4	1	1.1 mh RF choke
200-M96	1	Chassis	45-21	1	2.5 mh RF choke, 250 ma.
203-88F119-120	1	Panel	45-19	1	Parasitic choke
204-9	1	Angle bracket	46-12	1	7 henry 150 ma filter choke
204-M100	1	Tube mounting bracket	54-38	1	Power transformer
204-M101	1	Switch mounting bracket			
206-3	1	Tube shield			
206-M40	1	Amplifier shield			
206-M42	1	Oscillator shield			
206-43	1	Coaxial shield			



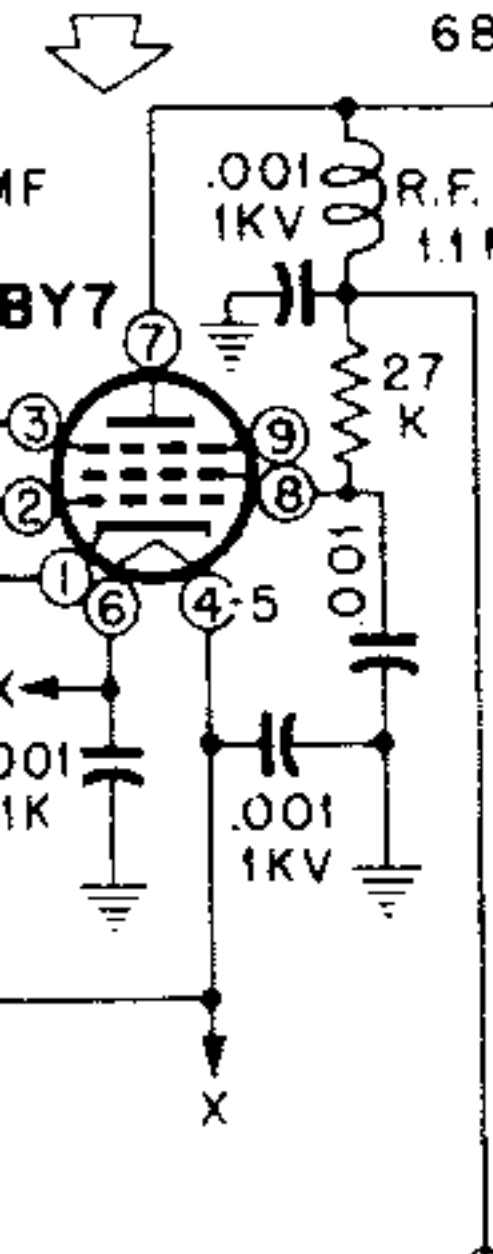
HEATHKIT TRANSMITTER  
MODEL DX - 35

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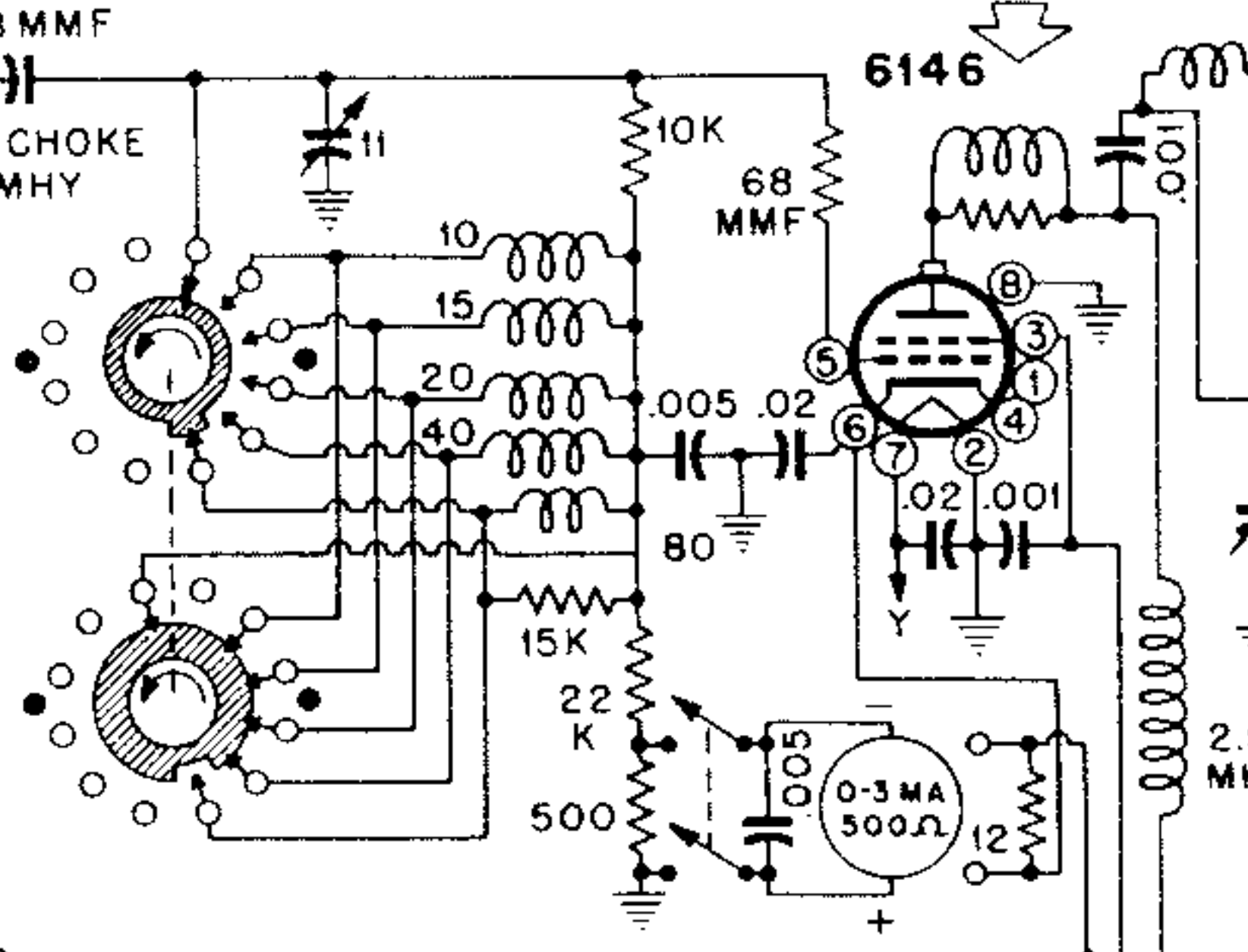


# CHEMATIC DIAGRAM OF THE DX-35 TRANSMITTER

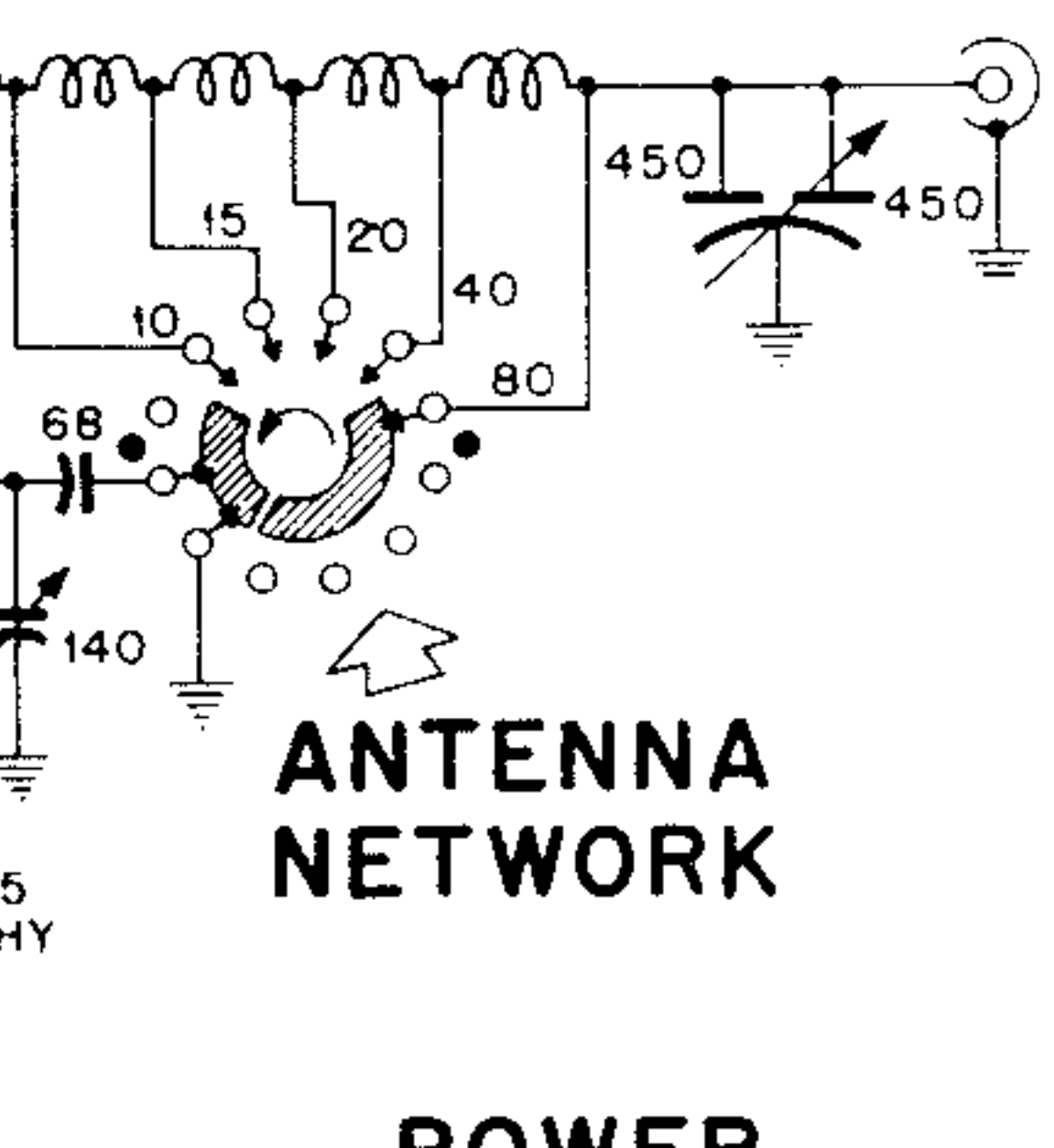
## BUFFER



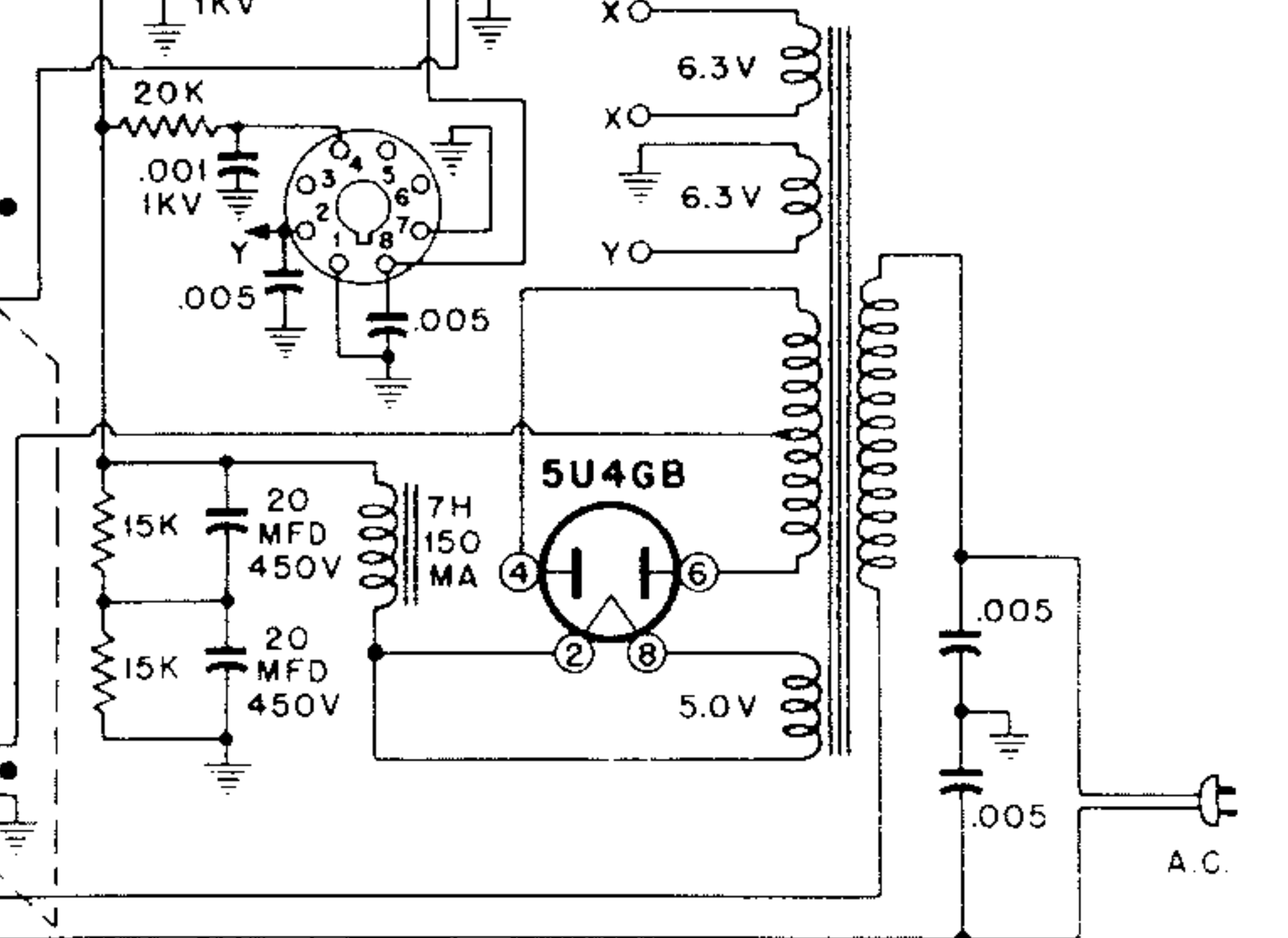
## FINAL AMPLIFIER



## ANTENNA



## POWER TRANSFORMER



## SECTION

