

ASSEMBLY AND OPERATION OF THE HEATHKIT CRYSTAL CALIBRATOR MODEL HD-20



SPECIFICATIONS

| | |
|-----------------------------|---|
| Frequency Coverage. | 100 kc to at least 54 mc, in harmonics of 100 kc. |
| Crystal | |
| Type. | Quartz, fundamental frequency. |
| Frequency. | 100 kc \pm .005%. |
| Pin Spacing. | .486". |
| Pin Size. | .050". |
| Transistor. | 2N409. |
| Battery Voltage. | 9 volts. |
| Battery Life. | 6 months, normal intermittent service. |
| Switch. | OFF-ON |
| Dimensions. | 2 1/2" wide x 4 1/2" high x 2 5/8" deep (overall) |
| Net Weight. | 9 oz. |
| Shipping Weight. | 1 lb. |

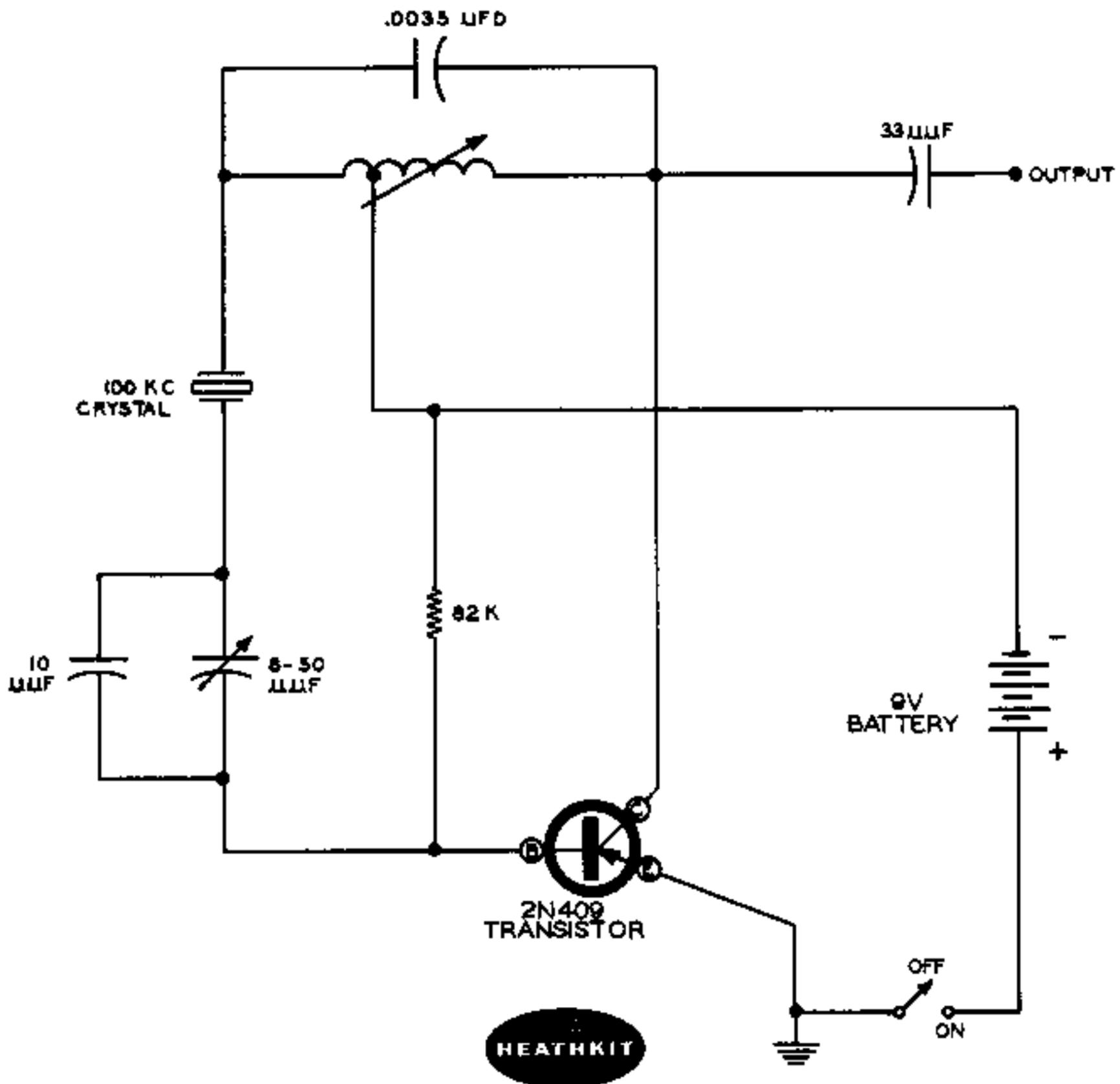
INTRODUCTION

The HEATHKIT® Model HD-20 Crystal Calibrator is an accurate signal source which provides output signals at 100 kc intervals up to 54 megacycles. Amateur Radio operators can use the HD-20 for many purposes such as check-

ing receiver dial calibration, checking band limits, receiver RF alignment, etc.

The HD-20 will also find use in other phases of radio communications which require accurate marker signals at multiples of 100 kc.

SCHEMATIC DIAGRAM



CRYSTAL CALIBRATOR
MODEL HD-20

CIRCUIT DESCRIPTION

The Model HD-20 Crystal Calibrator is basically a transistorized crystal controlled oscillator employing a junction type PNP transistor. The Schematic Diagram shows the HD-20 circuitry with the transistor operating in a grounded emitter configuration.

A 100 kc tank circuit is formed by the .0035 μ f capacitor and the slug-tuned coil. The coil inductance is adjusted to resonate the tank circuit for maximum output signal.

The transistor collector voltage is applied to the tap on the tank coil. This establishes, by providing an RF ground, a point of voltage division on the tank coil for proper positive feedback to the base of the transistor. The exact frequency of the resulting oscillation is controlled by the crystal which is in series with the feedback path. At its 100 kc resonance point, the crystal presents a very low impedance to the feedback voltage, thus sustaining oscillation at this frequency.

The 82 K Ω resistor sets the proper amount of base current for a rich harmonic content in the output signal.

The parallel combination of the 10 μ f capacitor and the 8-50 μ f trimmer, which is in series with the crystal, is used to adjust the oscillator frequency to exactly 100 kc.

The output signal is coupled through the 33 μ f capacitor to a binding post located on top of the HD-20.

Operating power is supplied by a 9-volt battery which is connected through an OFF-ON switch to the oscillator circuit. Due to the amount of current required by the oscillator circuit to provide desirable harmonics, the HD-20 should be turned on only for actual use. This will assure maximum battery life.

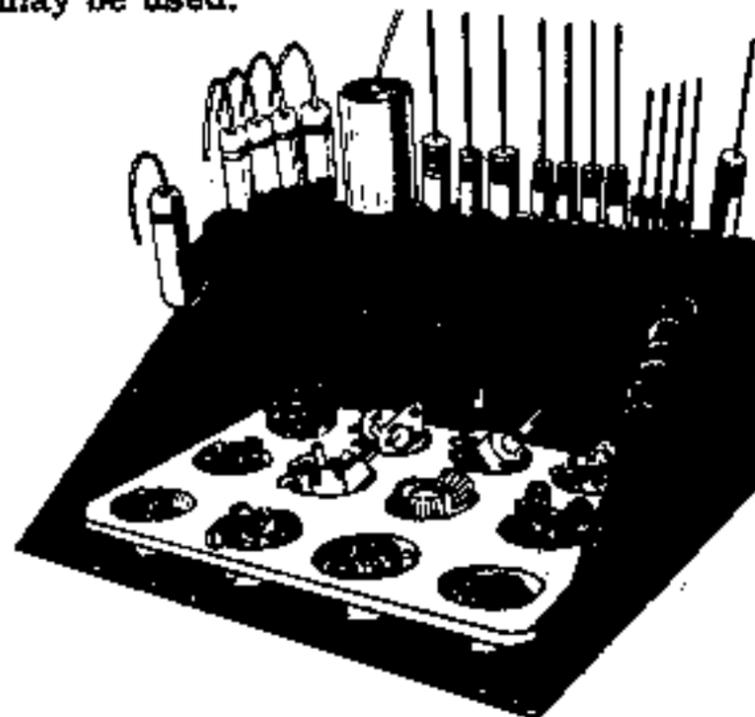
CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be a stable instrument, operating at a high degree of dependability. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the charts and other information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the REPLACEMENT section and supply the information called for therein. Include all inspection slips in your letter to us.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List.

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



PARTS LIST

| <u>PART No.</u> | <u>PARTS Per Kit</u> | <u>DESCRIPTION</u> | <u>PART NO.</u> | <u>PARTS Per Kit</u> | <u>DESCRIPTION</u> |
|---------------------------------|----------------------|---|--|----------------------|--------------------------|
| Resistor-Capacitors-Coil | | | Metal Parts | | |
| 1-102 | 1 | 82 K Ω resistor 1/2 watt (gray-red-orange) | 90-M128F | 1 | Cabinet shell |
| 21-3 | 1 | 10 $\mu\mu\text{f}$ disc ceramic capacitor | 200-M260 | 1 | Chassis |
| 21-7 | 1 | 33 μuf disc ceramic capacitor | 203-M200F352 | 1 | Front panel |
| 21-39 | 1 | .0035 μfd disc ceramic capacitor | Miscellaneous | | |
| 31-27 | 1 | 8-50 μpf trimmer capacitor | 63-195 | 1 | Switch, 2-position |
| 40-77 | 1 | Coil | 73-4 | 1 | 5/16" rubber grommet |
| Hardware | | | 73-M16 | 1 | Length rubber gasket |
| 208-2 | 1 | Battery clip | 75-17 | 2 | Insulator bushing |
| 250-15 | 1 | 8-32 x 1/8" setscrew | 100-M16R | 1 | Binding post cap |
| 250-34 | 1 | 4-40 x 1/2" screw | 260-29 | 1 | Crystal clip |
| 250-49 | 10 | 3-48 x 1/4" screw | 344-1 | 1 | Length hookup wire |
| 250-56 | 1 | 6-32 x 1/4" screw | 404-43 | 1 | 100 kc crystal |
| 252-1 | 10 | 3-48 nut | 417-27 | 1 | 2N409 transistor |
| 252-3 | 2 | 6-32 nut | 427-2 | 1 | Binding post base |
| 252-7 | 1 | 3/8" control nut | 432-14 | 1 | Male battery connector |
| 252-15 | 1 | 4-40 nut | 432-15 | 1 | Female battery connector |
| 253-10 | 1 | 3/8" control flat washer | 434-72 | 1 | Transistor socket |
| 254-1 | 1 | #6 lockwasher | 434-74 | 1 | Crystal socket |
| 254-7 | 8 | #3 lockwasher | 462-129 | 1 | Knob |
| 254-9 | 1 | #4 lockwasher | SS1-6 | | Solder |
| 259-1 | 1 | #6 solder lug | 596-332 | 1 | Manual |
| 259-10 | 1 | 3/8" control solder lug | A 9-volt (NEDA type No. 1600) battery should be purchased at this time for use in the completed kit. | | |

PROPER SOLDERING TECHNIQUES

Only a small percentage of HEATHKIT® equipment purchasers find it necessary to return an instrument for factory service. Of these instruments, by far the largest portion malfunction due to poor or improper soldering.

If terminals are bright and clean and free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Correctly soldered connections are essential if the performance engineered into a kit is to be

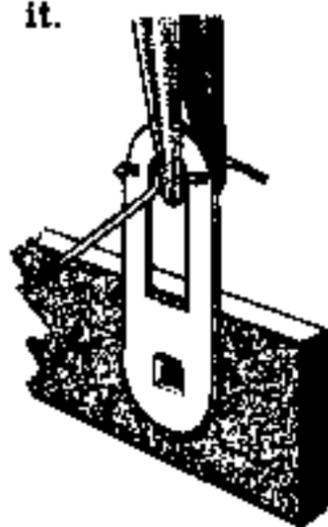
fully realized. If you are a beginner with no experience in soldering, a half hour's practice with some odd lengths of wire may be a worthwhile investment.

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

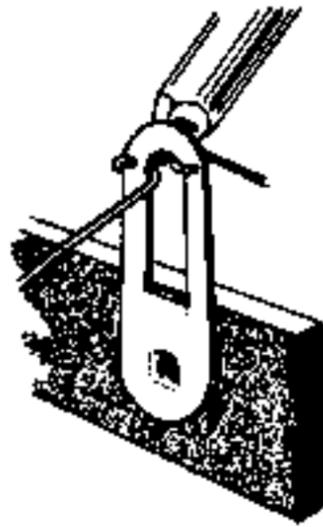
CHASSIS WIRING AND SOLDERING

1. The wire used in the HD-20 is the type with colored insulation (hookup wire). In preparing a length of hookup wire, 1/4" of insulation should be removed from each end unless directed otherwise in the construction step.
2. Leads on resistors, capacitors and similar components are generally much longer than they need to be to make the required connections. In these cases, the leads should be cut to proper length before the parts is added to the chassis. In general, the leads should be just long enough to reach their terminating points.
3. Crimp or bend the lead (or leads) around the terminal to form a good joint without relying on solder for physical strength. If the wire is too large to allow bending or if the step states that the wire is not to be crimped, position the wire so that a good solder connection can still be made.
4. Position the work, if possible, so that gravity will help to keep the solder where you want it.
5. Place a flat side of the soldering iron tip against the joint to be soldered until it is heated sufficiently to melt the solder.
6. Then place the solder against the heated terminal and it will immediately flow over the joint; use only enough solder to thoroughly wet the junction. It is usually not necessary to fill the entire hole in the terminal with solder.
7. Remove the solder and then the iron from the completed junction. Use care not to move the leads until the solder is solidified.

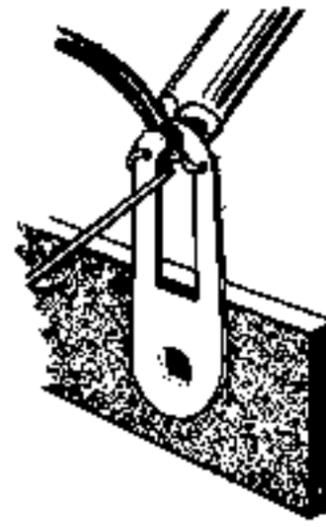
A poor or cold solder joint will usually look crystalline and have a grainy texture, or the solder will stand up in a blob and will not have adhered to the joint. Such joints should be reheated until the solder flows smoothly over the entire junction. In some cases, it may be necessary to add a little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



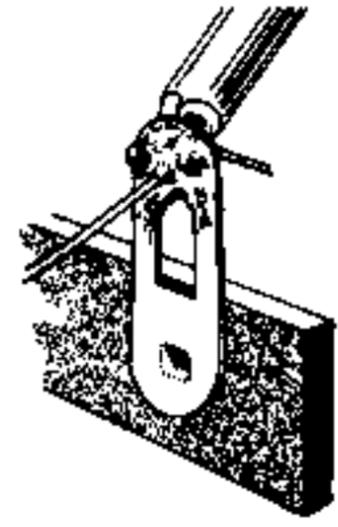
CRIMP WIRES



HEAT CONNECTION



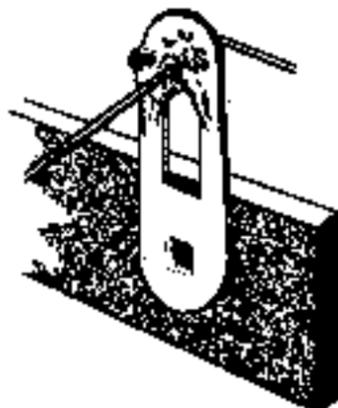
APPLY SOLDER



ALLOW SOLDER TO FLOW



COLD SOLDER JOINT CONNECTION INSUFFICIENTLY HEATED



PROPER SOLDER CONNECTION



COLD SOLDER JOINT CONNECTION MOVED WHILE COOLING



ROSIN CORE SOLDER HAS BEEN SUPPLIED WITH THIS KIT. THIS TYPE OF SOLDER MUST BE USED FOR ALL SOLDERING IN THIS KIT. ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE EQUIPMENT IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. IF ADDITIONAL SOLDER IS NEEDED, BE SURE TO PURCHASE ROSIN CORE (60:40 or 50:50 TIN-LEAD CONTENT) RADIO TYPE SOLDER.

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

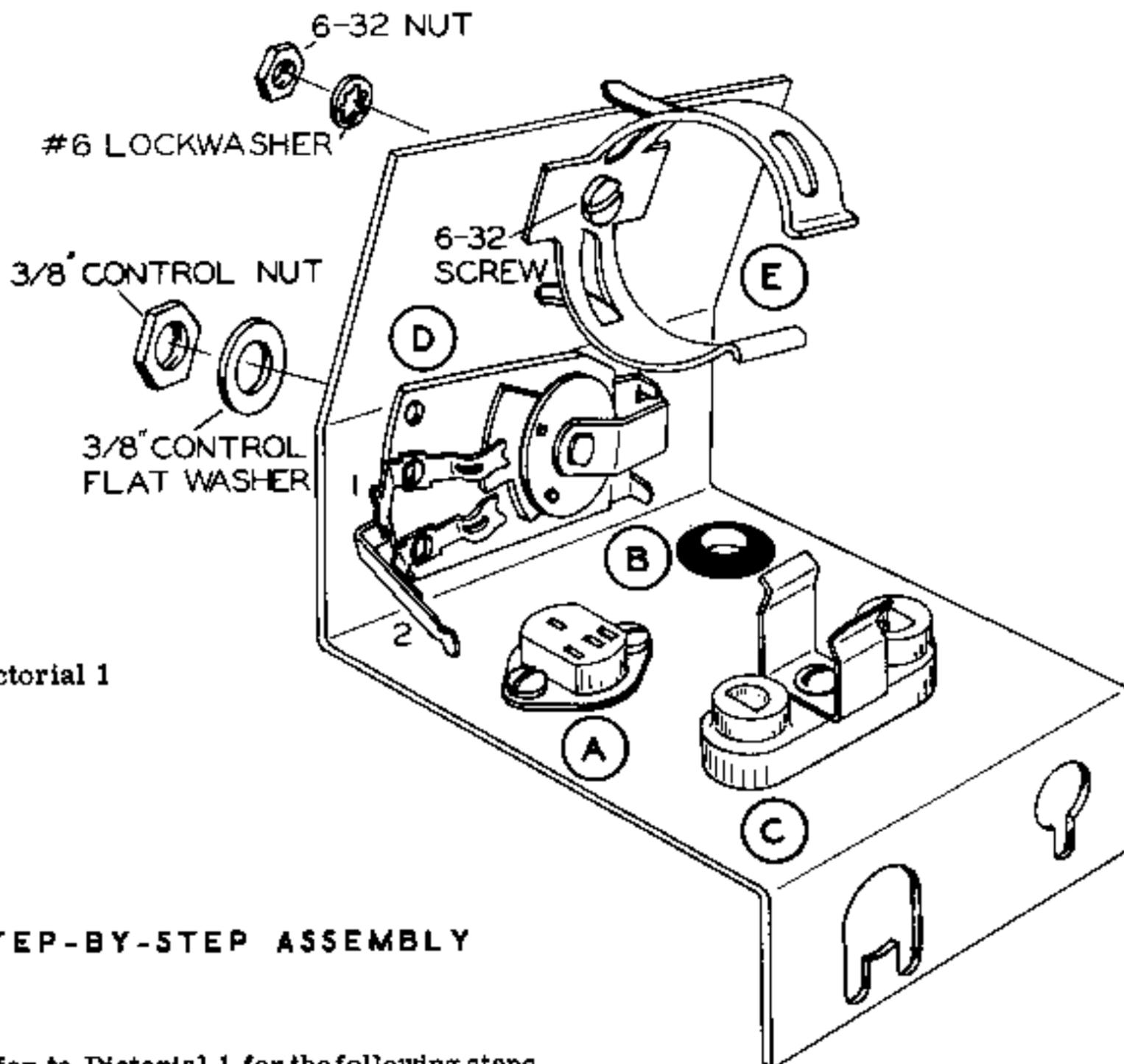
1. Lay out all parts so that they are readily available.
2. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screw

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

STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning the specified operation. Also read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted. Some kit builders have also found it helpful to mark each lead in colored pencil on the Pictorial as it is added.

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

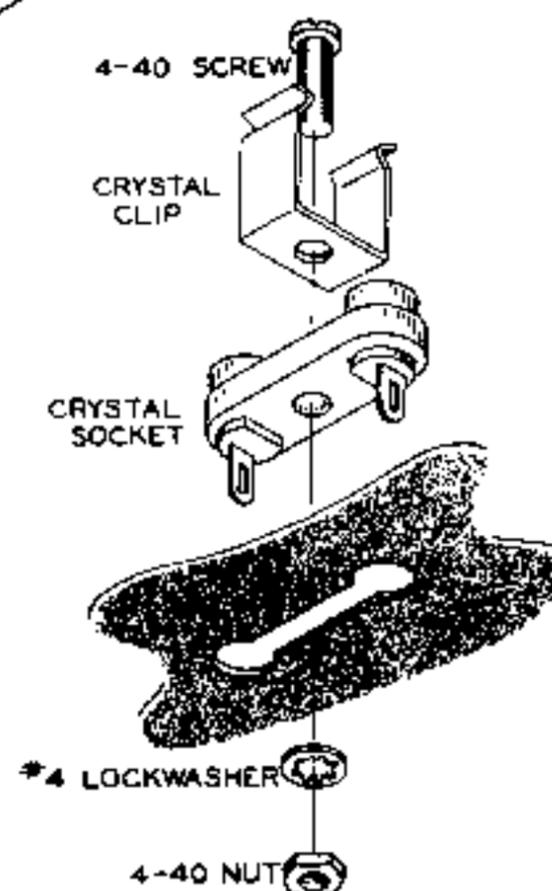


Pictorial 1

STEP-BY-STEP ASSEMBLY

Refer to Pictorial 1 for the following steps.

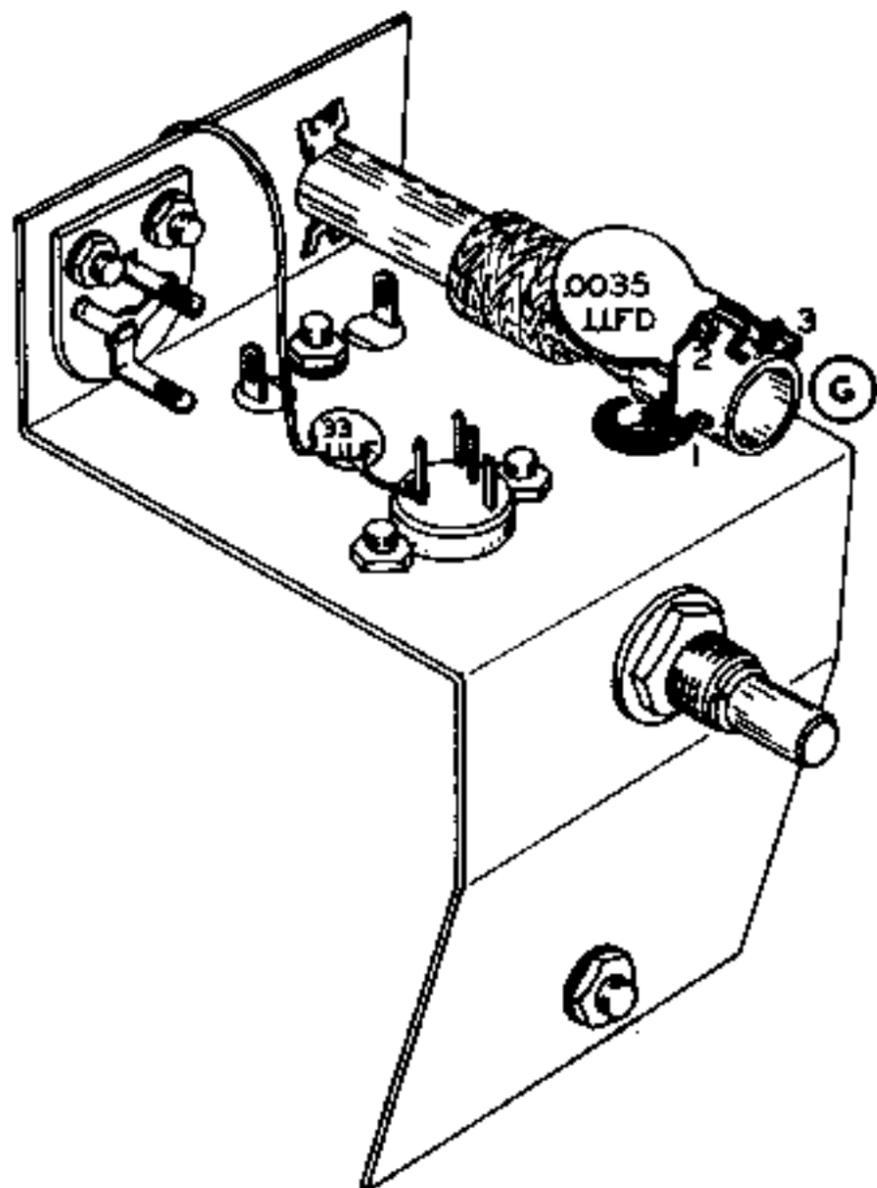
- () Locate the chassis and mount the switch and control solder lug at location D as shown. Position the solder lug so that it contacts lug 2 of the switch, then temporarily secure the switch in place with the control flat washer and control nut.
- () Mount the transistor socket at location A with 3-48 screws and nuts. Make sure that the socket is oriented as shown in Pictorial 1. Lockwashers are not used to mount this socket.
- () Install the rubber grommet in hole B.
- () Mount the crystal clip and crystal socket at location C as shown in Detail 1A. Use the 4-40 screw, #4 lockwasher and 4-40 nut.
- () Mount the battery clip at location E with the 6-32 screw, #6 lockwasher and 6-32 nut.



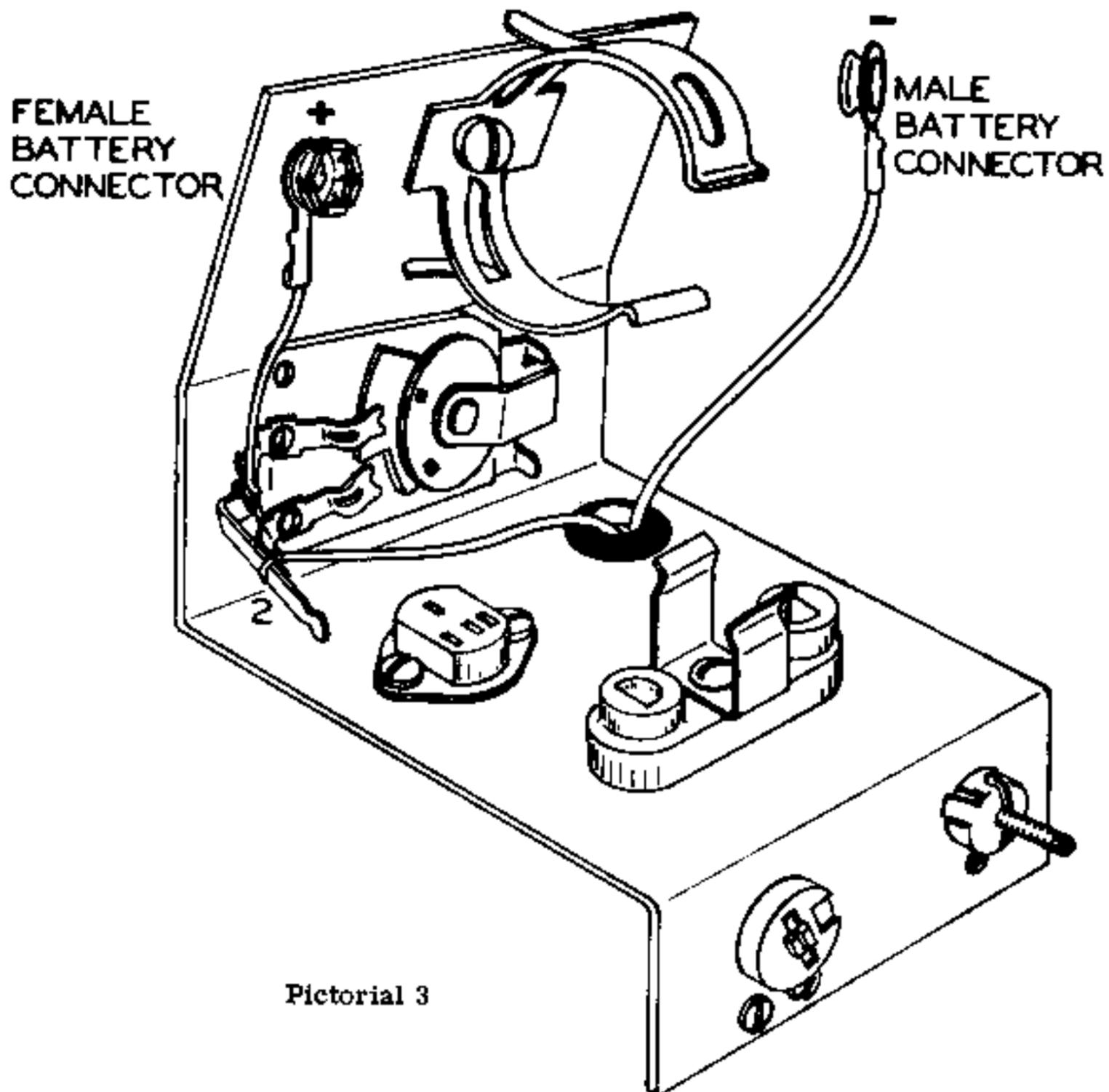
Detail 1A

Refer to Pictorial 2 for the following steps.

- () Mount the trimmer at location F. Use 3-48 screws, #3 lockwashers and 3-48 nuts.
 - () Install the coil in hole G, making sure that the locating tab of the coil fits in the small slot just above hole G. The coil should be gently pushed into hole G until it snaps into place.
- NOTE: When preparing lengths of hookup wire in the following steps, strip 1/4" of insulation from each end. Stripped hookup wire should be used when bare wire is called for in the steps.
- () Connect a short bare wire from lug 1 of the trimmer (NS) to lug 1 of the crystal socket (S-1).
 - () Connect one end of a 1" hookup wire to lug 2 of the trimmer (NS). Connect the other end of this wire to pins 2 and 3 of the transistor socket (NS).
 - () Connect the 10 μf disc capacitor between lugs 1 (S-2) and 2 (S-2) of the trimmer.
 - () Connect a 2 3/8" hookup wire from pin 1 of the transistor socket (NS) to lug 3 of the coil (NS).
 - () Connect a 1 1/2" hookup wire from lug 2 of the crystal socket (S-1) to lug 1 of the coil (NS).
 - () Connect one end of a 3" hookup wire to pin 4 of the transistor socket (S-1). Run the other end of this wire under the coil and through the grommet. Leave this end free.
 - () Connect one end of another 5" hookup wire to lug 2 of the coil (NS). Dress the wire as shown in Pictorial 2 and run the other end through the grommet. Leave this end free.
 - () Cut one lead of the 82 K Ω resistor to 1". Connect this lead to lug 2 of the coil (S-2). Position the resistor as shown, then connect the other lead to pins 2 and 3 of the transistor socket (S-2). Make sure that both pins 2 and 3 are soldered.
 - () Cut both leads of the .0035 μf disc capacitor to 1/2". Connect this capacitor from lug 1 (S-2) to lug 3 (S-2) of the coil as shown in Detail 2A.
 - () Cut one lead of the 33 μf disc capacitor to 3/4". Connect this lead to pin 1 of the transistor socket (S-2). Referring to Detail 2A, temporarily loop the end of the other lead over the chassis flange. This lead will be connected later.



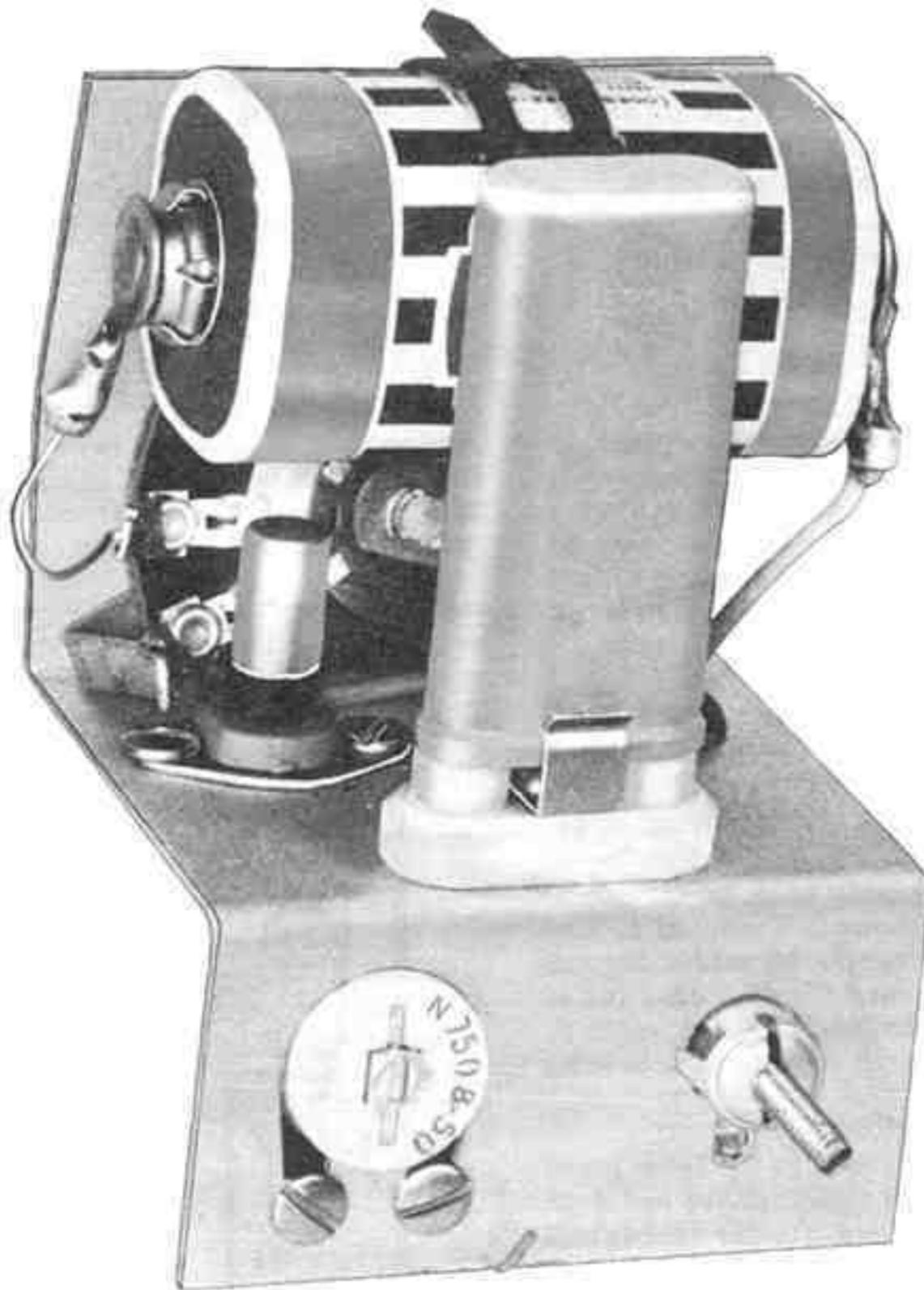
Detail 2A



Pictorial 3

Refer to Pictorial 3 for the following steps.

- () Connect the wire coming through the grommet from the transistor socket to lug 2 of the switch and the control solder lug (S-1). The wire should be soldered to both lug 2 and the solder lug.
- () Install the male (-) battery connector on the end of the remaining wire coming through the grommet (S-1). Crimp this connection before soldering.
- () Connect one end of a 3" hookup wire to lug 1 of the switch (S-1).
- () Install the female (+) battery connector on the other end of this bare wire (S-1). Crimp the connection before soldering.



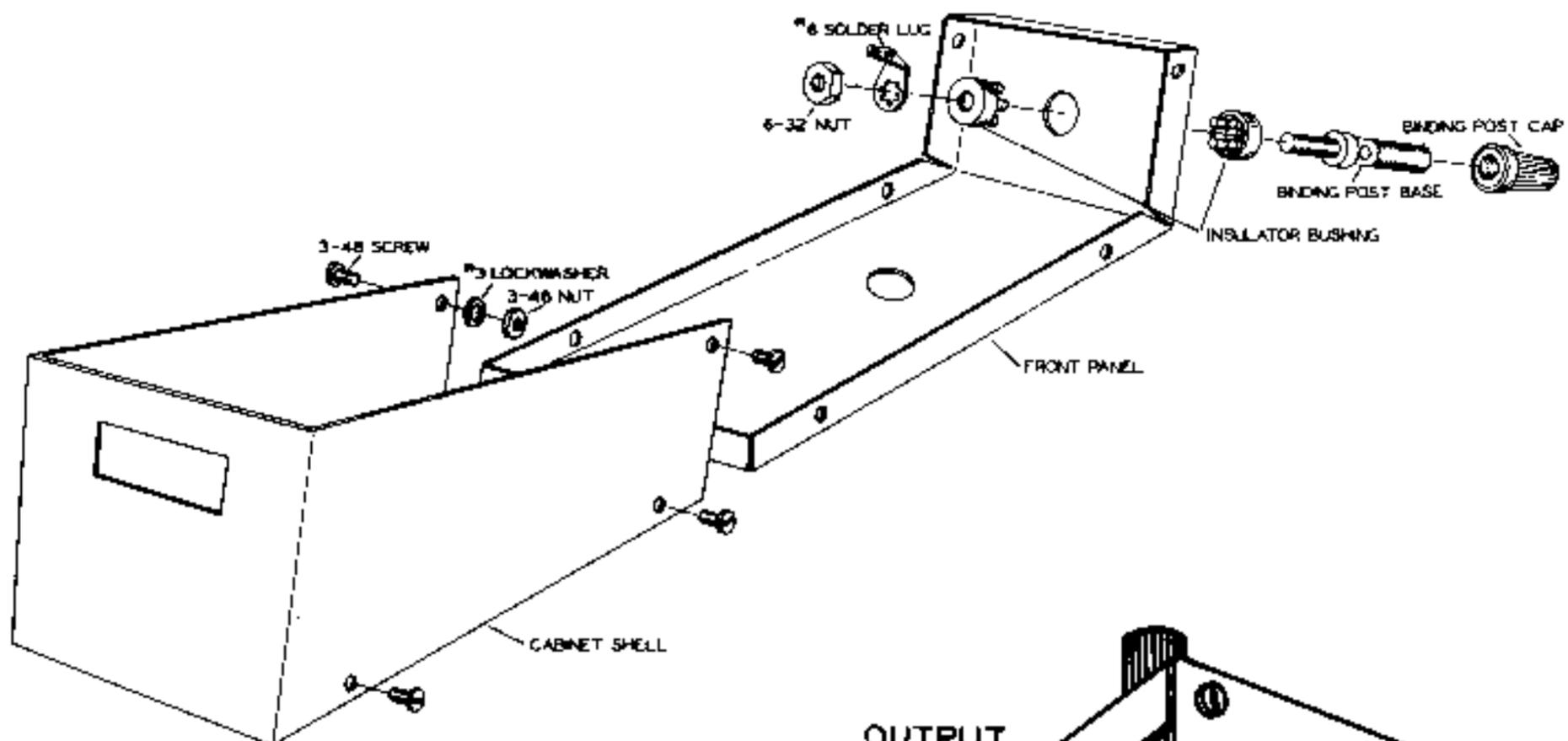
Pictorial 4

Refer to Pictorial 4 for the following steps.

- () Install the 2N409 transistor in the transistor socket. Before pushing the transistor into place, make sure that the pins line up properly with the socket holes.

NOTE: Make sure that the switch shaft is rotated counterclockwise (OFF) before connecting the battery. Damage to the transistor will result if the HD-20 is turned ON without the crystal in place.

- () Install the 9-volt battery in the battery clip oriented with the positive (+) end as shown, then snap the battery connectors onto the battery terminals. Be sure to center the battery in the clip to avoid shorting the terminals when the chassis is installed in the cabinet.
- () Install the crystal in the crystal socket. The bottom of the crystal should snap into the crystal clip.



Pictorial 5

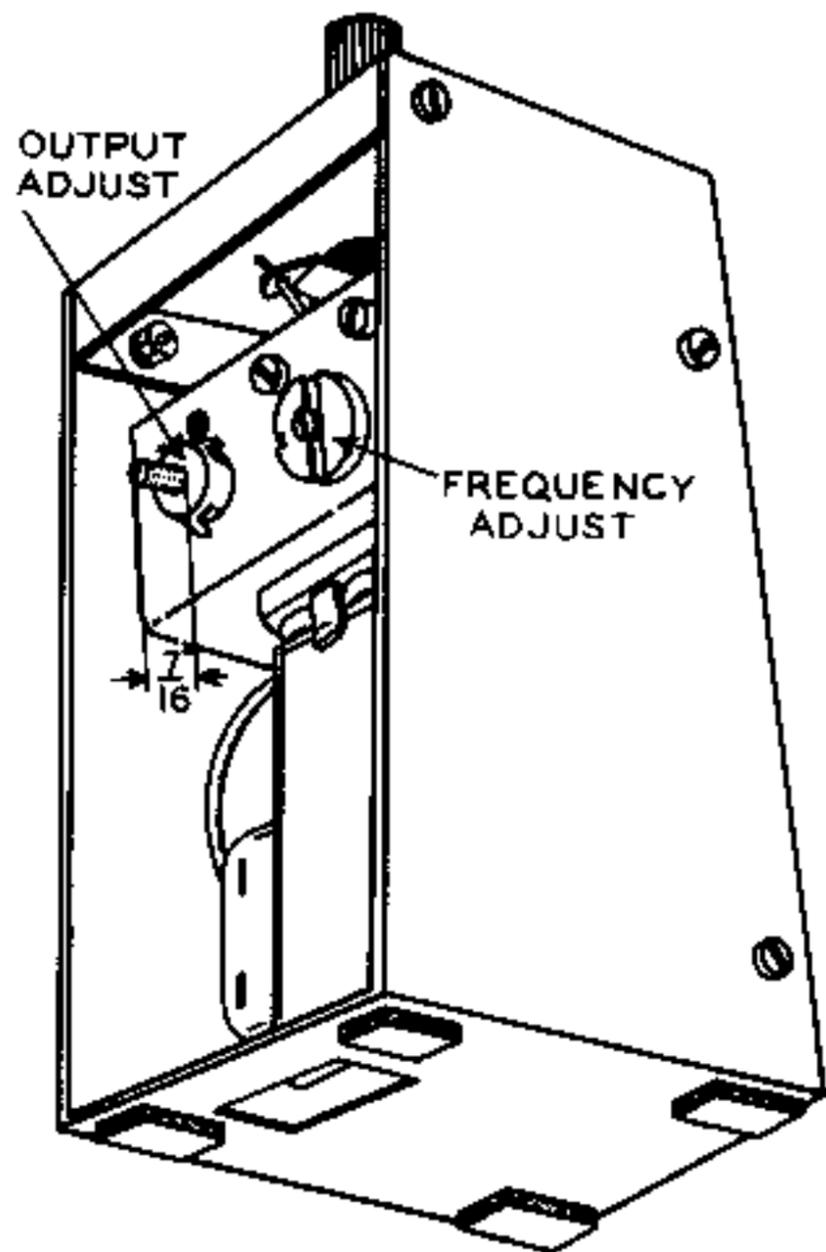
Refer to Pictorial 5 for the following steps.

- () Install the binding post base in the top of the front panel as shown in Pictorial 5. Use two insulator bushings, a #6 solder lug and a 6-32 nut. Make sure the #6 solder lug is oriented toward the back of the cabinet. Screw the binding post cap onto the binding post base.
- () Secure the cabinet shell to the front panel with 3-48 screws, #4 lockwashers and 3-48 nuts. Cut the plastic nut-starter tool in half to aid in starting the #3 nuts on the screws.

Refer to Pictorial 6 for the following steps.

NOTE: It is important that the free lead of the 33 μ f disc capacitor be looped over the chassis flange as shown in Detail 2A so that this lead will be accessible after the chassis is installed in the cabinet shell.

- () Remove the control nut and flat washer from the switch bushing and install the chassis in the cabinet shell. The switch shaft should extend through the hole in the front panel. See that the battery connectors do not short to the sides of the cabinet shell.



Pictorial 6

- () Secure the chassis in place with the control flat washer and nut that were removed in the preceding step. Make sure that the switch does not rotate as the control nut is tightened.

- () Install the 8-32 setscrew in the knob, then place the knob on the switch shaft. Properly orient the knob pointer with respect to the OFF marking on the front panel and tighten the setscrew.
- () Connect the free lead of the 33 μ f disc capacitor to the #6 solder lug mounted on the binding post (S-1). Do not crimp this lead to facilitate chassis removal later.
- () Cut four 1/2" pieces of the rubber gasket. Remove the backing material from one of these pieces and stick it to one of the corners on the bottom surface of the cabinet shell as shown in Pictorial 6.
- () Similarly, stick the other three pieces to the remaining three corners on the bottom of the cabinet shell.

This completes assembly of the HD-20.

ADJUSTMENT

Figure 1 shows several methods of making connections to the HD-20 binding post. Using one of these methods, connect a wire from the HD-20 to the "hot" antenna terminal of a radio receiver.

Referring to Pictorial 6, set the output and frequency adjustments to the approximate positions shown which should be close to the final settings. Turn the HD-20 ON and, with receiver BFO on, tune the receiver slightly off zero beat with any harmonic of the HD-20 signal and adjust the HD-20 output adjust coil slug for the loudest tone from the receiver's speaker or maximum S-meter reading. This resonates the HD-20 output circuit to 100 kc.

If the receiver coverage includes 10 mc, tune in the WWV station at 10 mc. If the receiver does not cover 10 mc, tune in a station that is known to be operating at a frequency which is a multiple of 100 kc. The frequency of the station should be as high as possible, within the upper limit of the HD-20, to provide the most accurate results.

With the receiver BFO off, now rotate the frequency adjust trimmer on the rear of the HD-20 for "zero beat" during the period when no tone modulation is applied to the WWV carrier. (Zero beat will be recognized as the point at which a harmonic of 100 kc corresponds to the frequency of the station that is tuned in, on the receiver. As zero beat is approached, a tone, decreasing in frequency, will be heard from the receiver's speaker. To be sure that the receiver is zeroed to the HD-20 signal and not to a stray signal, try turning the HD-20 OFF and then back ON.) This adjustment sets the HD-20 oscillator exactly to 100 kc. Use either your fingers or an insulated screwdriver to make this adjustment.

To replace the battery, pull the crystal out through the bottom opening. Pry out the battery carefully. Snap the connectors onto the new battery and place it in the holder, taking care that terminals and connectors do not touch the sides of the case. Replace the crystal.

This completes adjustment of the HD-20. If any problem was encountered in making these adjustments, refer to the IN CASE OF DIFFICULTY and SERVICE sections of this manual.

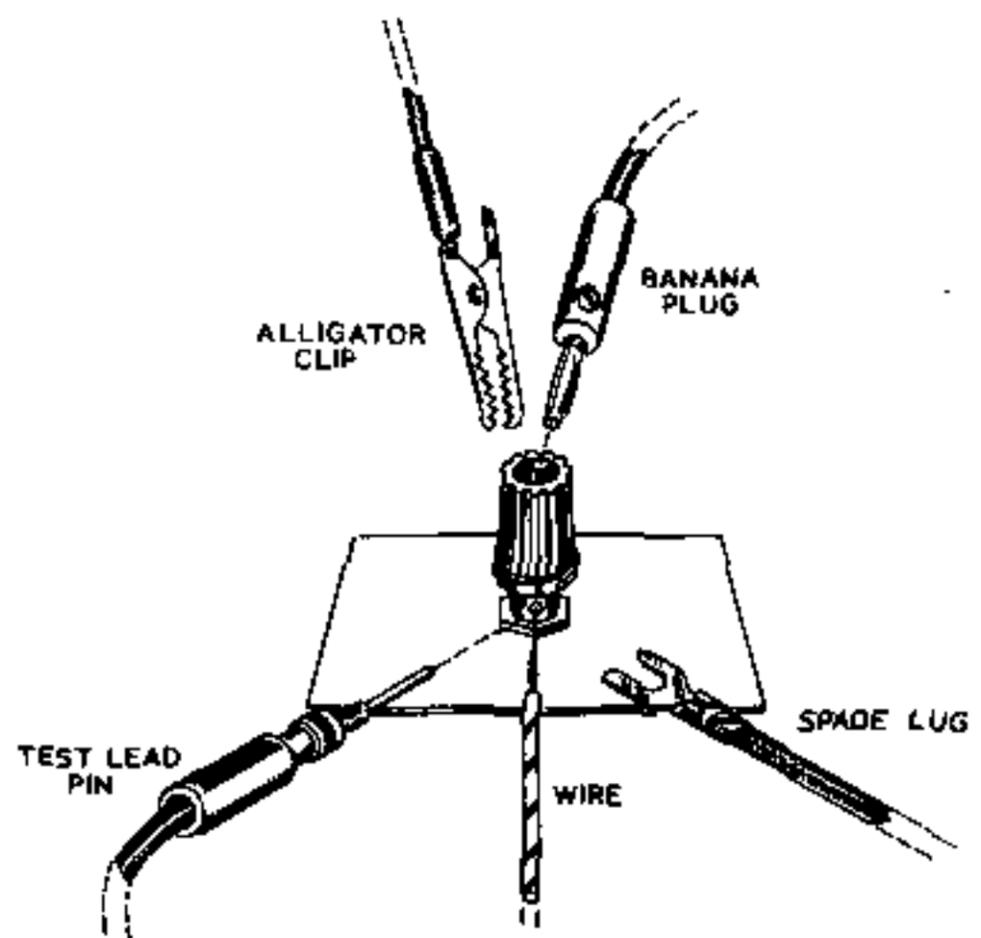


Figure 1

OPERATION

The HD-20 has only one operating control which is the OFF-ON switch. To prolong battery life, this switch should remain in the OFF position when the HD-20 is not in actual use.

It is not considered practical to attempt to describe all of the many possible uses of an accurate signal source such as the HD-20, however a few of the more popular applications are mentioned below.

The Amateur Radio operator will find use for the HD-20 in checking Amateur band limits. This is done by connecting the HD-20 to the receiver antenna terminal and tuning to the

harmonics of 100 kc which correspond to the upper and lower frequencies of the band that is being checked.

Other applications include receiver RF alignment and receiver tracking adjustments.

To prevent errors in identifying the harmonics, the receiver or other equipment that is used with the HD-20 should be accurate to within 30 or 40 kc of the correct frequency. This is especially true at higher frequencies where the 100 kc divisions on a receiver dial are fairly close together.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.
2. It is interesting to note that about 90% of the kits that are returned for repair, malfunction due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as illustrated in the Figures found in the SOLDERING TECHNIQUES section of this manual.
3. Make sure that the positive and negative battery connectors are properly installed. Also make sure that the battery is in good condition.
4. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.
5. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring. Make sure no shorts exist at transistor socket.
6. Check coil continuity with a VOM. If care is not used during construction, the fine wire on the coil could be broken.
7. If HD-20 is oscillating, the battery current will be about 3.5 ma. Check battery current with a VOM and if in excess of 4 ma, adjust the coil slug to restart oscillation.

SERVICE

If, after applying the information contained in this manual and your best efforts, you are still unable to obtain proper performance, 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 your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment. It is not

intended, and is not equipped to function as a general source of technical information involving kit modifications nor anything other than the normal and specified performance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. In a sense, YOU MUST QUALIFY for GOOD technical advice by helping the consultants to help you. Please use this outline: