X-10
CRYSTAL CALIBRATOR

ASSEMBLY MANUAL

A PRODUCT OF ALLIED RADIO · CHICAGO

knight-kit®

SPECIFICATIONS

POWER REQUIREMENTS:	100 to 300 V DC (3 ma @ 150 V DC) 6.3 V AC or DC @ 150 ma.
CRYSTAL:	Hermetically sealed.
FREQUENCY:	100 KC (exactly adjustable).
HARMONICS:	Usable to 35 Mc.
CONTROLS:	On-Off switch and zero adjusting trimmer.
TUBE COMPLEMENT:	6AK6 in an electron-coupled oscillator circuit.
MOUNTING:	Case provided with two sets of holes for universal mounting.
SIZE:	$3 \times 1\frac{7}{16} \times 1\frac{17}{32}$".
NET WEIGHT:	5½ oz.

This CRYSTAL CALIBRATOR is recommended for use only with transformer power supply type receivers.

INTRODUCTION

This unit is a secondary frequency standard producing harmonics every 100 KC, usable to about 35 MC. The 100 KC harmonics give check points in the 80, 40, 20, 15, 11, and 10 meter amateur and international shortwave radio bands. These markers may be used to provide extremely accurate calibration for shortwave receivers.

CHECKING YOUR KIT

Before starting to build your Crystal Calibrator, check each part against the parts list on page 14. This will help you to become acquainted with each part. If you are unable to identify some of the parts by sight, locate them on the pictorial diagrams.

CONSTRUCTION HINTS

The only tools necessary for building your Crystal Calibrator are: A pair of long-nose, side-cutting pliers, a small screwdriver, and a soldering iron. An additional tool that simplifies construction is a pair of diagonal cutters.

Study the pictorial diagrams and note how the parts are mounted. These pictorial diagrams show the actual location of all parts and wires. The schematic diagram shows how the parts are connected electrically and is helpful in understanding how the circuit works.

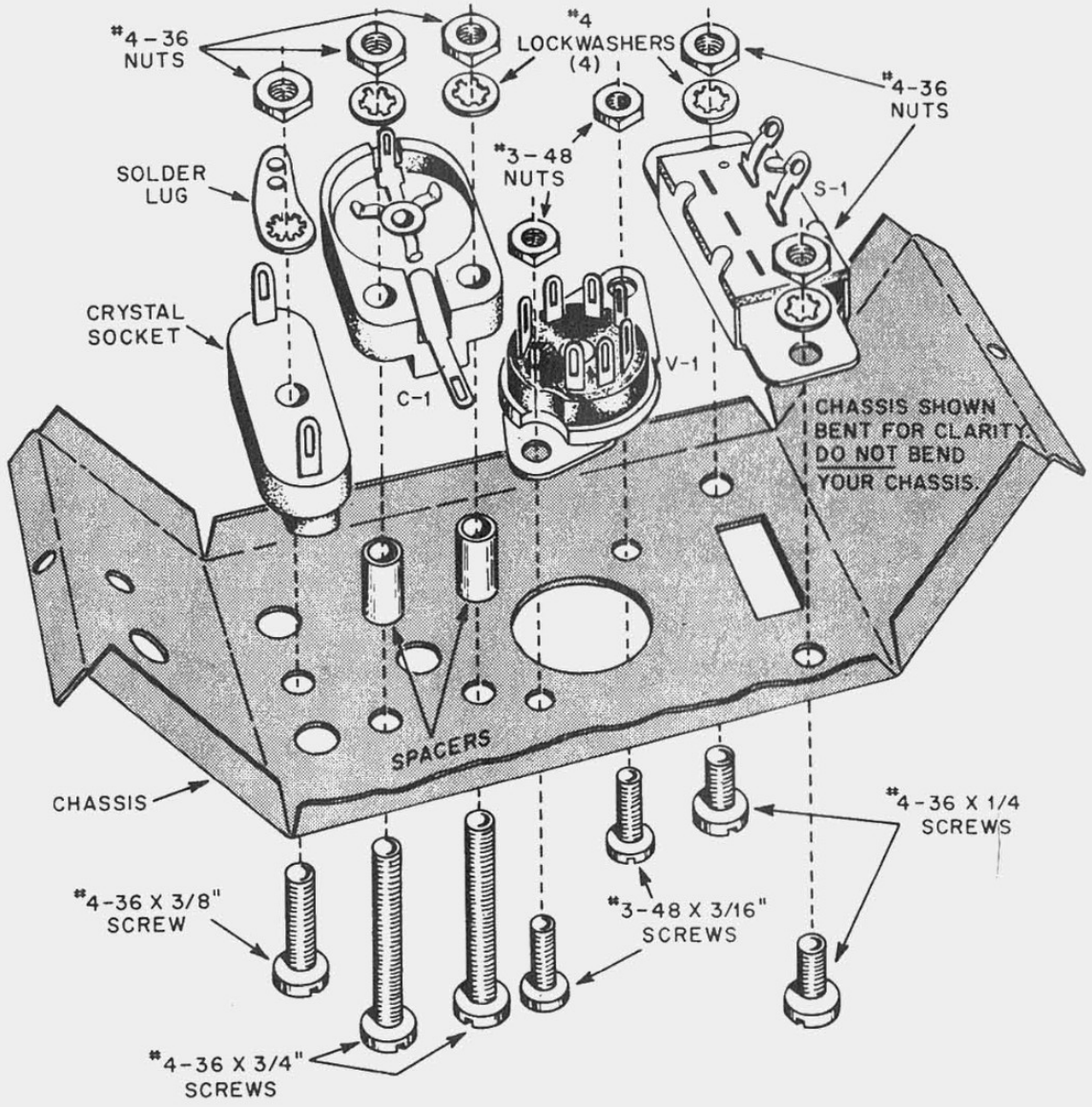

FIGURE 1. MOUNTING PARTS IN THE CHASSIS

THIS KIT MUST BE PROPERLY SOLDERED !

WITHOUT GOOD SOLDERING, AN ELECTRONIC UNIT WILL NOT WORK . . . just as a suit of clothing will fall apart if the stitches are loose . . . no matter how excellent the material.

USE ENOUGH HEAT

This is the main idea of good soldering. The purpose of soldering is to join metal parts, making an UNBROKEN metal path over which electricity can travel. To do this you must apply enough heat to the metal surfaces to make the solder spread freely on them, until the contour (shape) of the connection shows under the solder. If the solder barely melts and forms a rounded ball, *you are not using enough heat.* If you do not use enough heat, there may be no electrical connection, although it appears soldered.

USE A 100-WATT IRON

A 100-watt soldering iron with a clean, chisel-shaped tip will supply the right amount of heat when used correctly. Notice how the iron is held in the picture. Heat the iron for 10 minutes before you start soldering. Keep the tip brightly coated with solder. When necessary, wipe the hot tip clean with a cloth. (If you use a soldering gun, be sure the tip reaches full heat before you solder.)

USE ONLY ROSIN CORE SOLDER

We supply the right kind of solder *(rosin core solder).* Do not use any other kind of solder! USE OF ACID CORE SOLDER, PASTE, OR IRONS CLEANED ON A SAL AMMONIAC BLOCK WILL RUIN ANY ELECTRONIC UNIT AND WILL VOID THE GUARANTEE.

HERE'S HOW TO DO IT . . .

1. Join bare metal to bare metal. Insulation must be removed.
2. Coat the tip of a hot iron with solder.
3. FIRMLY PRESS THE FLAT SIDE OF THE TIP OF A HOT IRON FLAT against the parts to be soldered together. Keep it there while you apply the solder BETWEEN THE IRON TIP AND THE METAL TO BE SOLDERED. Use only enough solder for it to flow over ALL the surfaces of the connection. Remove the iron.
4. DO NOT MOVE PARTS UNTIL THE SOLDER HARDENS. If you accidentally move the wires as the solder is hardening, apply your iron and reheat.

Compare your soldering with the pictures on this page. You have a good connection if your solder has flowed over all surfaces to be connected, following the shape of the surfaces. It should appear smooth and bright.

YOU HAVE NOT USED ENOUGH HEAT: If your connection is rough and flaky-looking, or if the solder has formed a round ball instead of spreading.

The difference between good soldering (enough heat) and poor soldering (not enough heat,) is just a few extra seconds with a hot iron FIRMLY applied. Remember, larger metal surfaces take a longer time to heat.

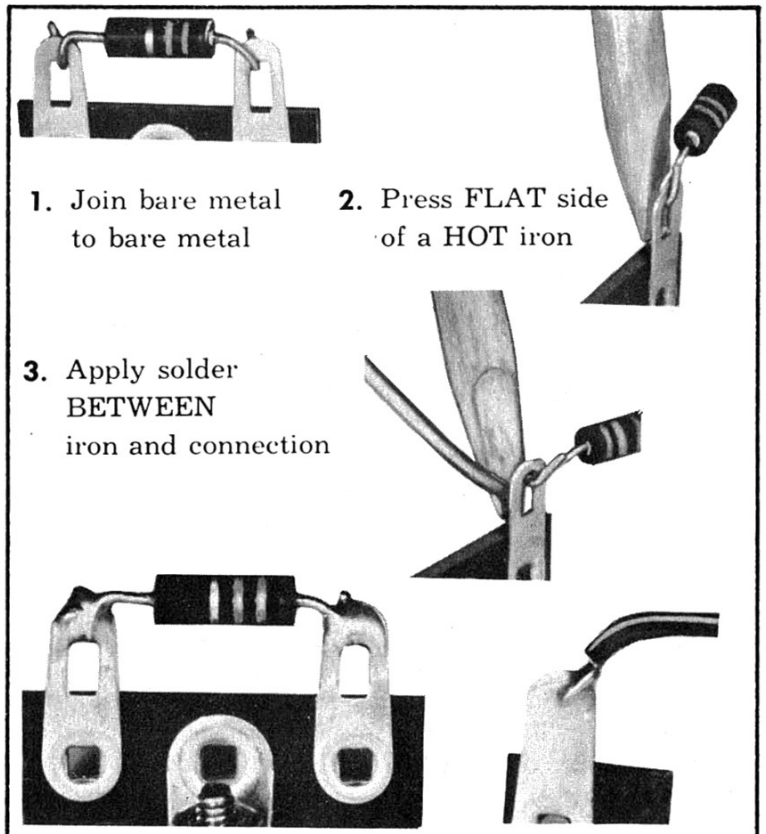

FIGURE 2. THE ONE-TWO-THREE OF GOOD SOLDERING

SEE FIGURE 3:

☐ Install the grommet in the hole in the end of the chassis.

☐ Connect, but do not solder, one lead of C-2, a 3.3 $\mu\mu$fd ceramic tubular capacitor, to pin 1 of V-1. Connect, but do not solder, the other lead of C-2 to pin 6 of V-1. Be sure to keep this capacitor low and close to the socket insulation.

☐ Bend both terminals of C-1, the trimmer capacitor, to the positions shown in Figure 3.

☐ Bend the solder lug so it touches terminal 1 of the crystal socket.

☐ Pass a 2¼" piece of bare wire through terminal 1 of the crystal socket, on through terminal 1 of C-1, on through pin 2 of V-1, and then solder it to pins 2 and 7 of V-1. Connect, but do not solder, the wire at terminal 1 of the crystal socket.

☐ Put a ¾" piece of spaghetti on a 1⅛" piece of bare wire. Solder one end of this wire to pin 1 of V-1. Connect, but do not solder, the other end to terminal 2 of C-1.

☐ Put a ½" piece of spaghetti on a ¾" piece of bare wire. Solder one end to terminal 2 of the crystal socket. Connect, but do not solder, the other end to terminal 2 of C-1.

☐ Solder one lead of R-1, a 4.7 megΩ resistor (with the color stripes yellow, violet, and green), to terminal 1 of C-1. Solder the other lead to terminal 2 of C-1.

☐ Cut one lead of C-3, a .01 μfd (may also be marked 10K) disc capacitor, to within ¼" of the disc. Solder this lead to the solder lug and terminal 1 of the crystal socket. The other lead will be connected later.

☐ Pass one end of the long black wire, brown wire, and the red wire through the grommet. Solder the black wire to pin 3 of V-1.

☐ Solder the brown wire to pin 4 of V-1.

☐ Solder the red wire to terminal 2 of S-1.

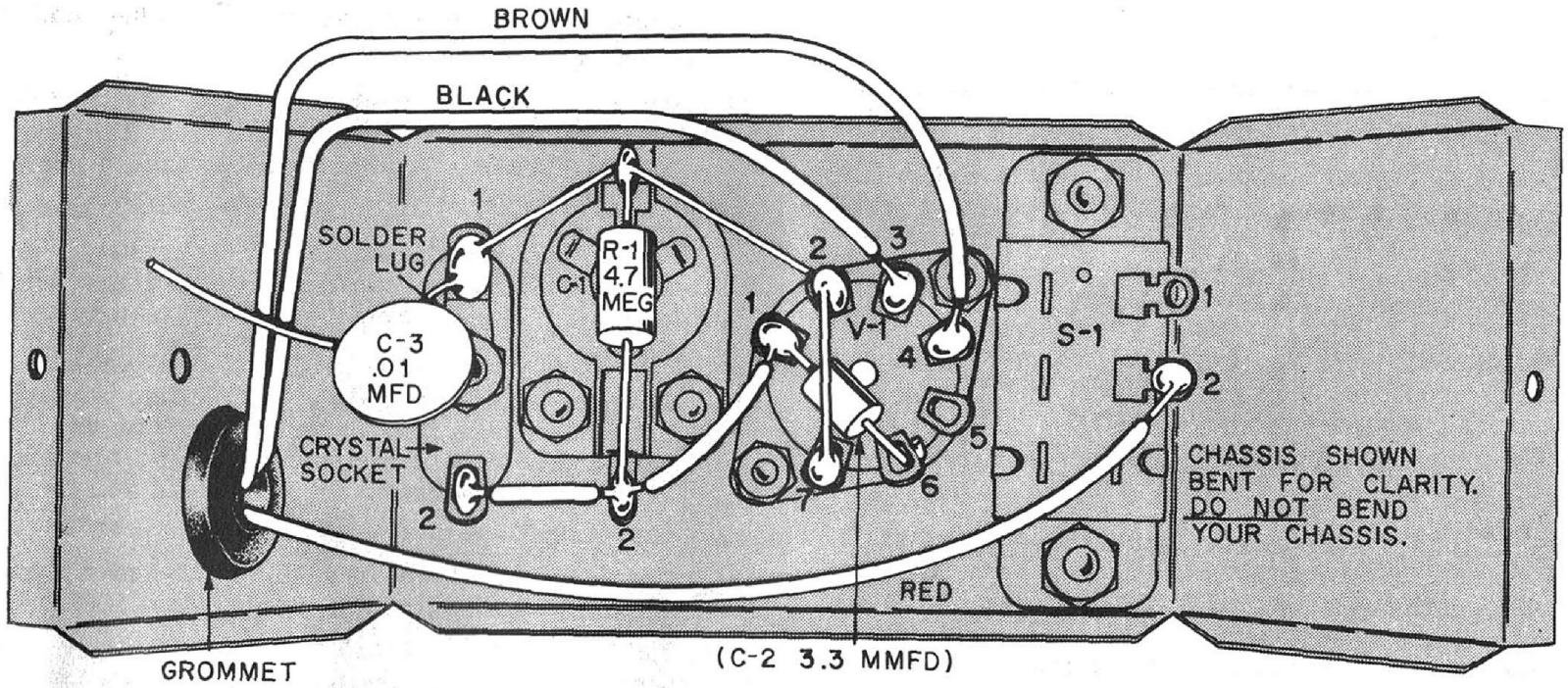

FIGURE 3. FIRST WIRING VIEW

SEE FIGURE 4.

☐ Mount the terminal strip, TS-1, as shown in Figure 4. Use a ¼" screw, a lockwasher, and a matching nut to fasten TS-1, with a lockwasher between the mounting leg and the chassis.

☐ Connect, but do not solder, the loose lead of C-3 to terminal 1 of TS-1.

☐ Solder one lead of R-3, a 22KΩ resistor (red, red, orange) to terminal 1 of S-1. Connect, but do not solder, the other lead of R-3 to terminal 1 of TS-1.

☐ Connect, but do not solder, one lead of R-2, a 470KΩ resistor (yellow, violet, yellow), to pin 5 of V-1. Connect, but do not solder, the other lead to terminal 1 of TS-1.

☐ Put a 1¼" piece of spaghetti on one lead of C-4, a 10 μμfd disc capacitor. Solder this lead to pin 5 of V-1. Connect, but do not solder, the other lead to terminal 2 of TS-1.

☐ Solder one lead of L-1, the powdered-iron core RF choke, to pin 6 of V-1. Solder the other lead to terminal 1 of TS-1.

☐ Solder the green wire to terminal 2 of TS-1. Pass the free end through the grommet.

The wiring of your Crystal Calibrator is finished. Go back and check each wiring step. A wiring error can result in damage to the crystal when the unit is switched on.

FINAL ASSEMBLY

The chassis bottom cover can be fastened outside the chassis in two positions so that the flange with the holes for mounting the unit may be positioned on either side.

☐ Fasten the cover on the chassis with the two sheet metal screws.

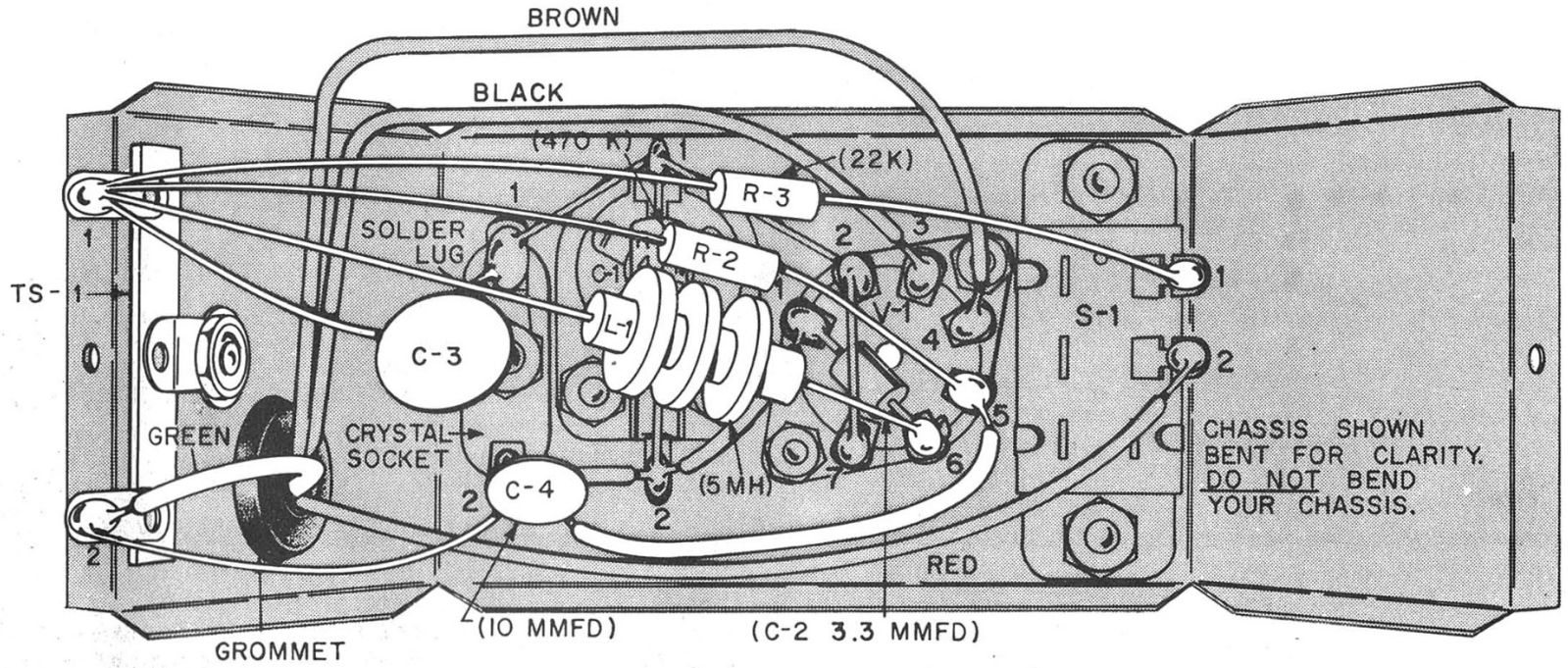

FIGURE 4. FINAL WIRING VIEW

DETERMINING THE MOUNTING POSITION OF THE CRYSTAL CALIBRATOR

These factors should be considered before the Crystal Calibrator is permanently mounted.

1. The Calibrator should be mounted in the coolest position possible. The RF section of a communications receiver is usually one of the coolest spots.

2. The Calibrator should **not** be mounted so that the crystal is in a vertical line with, and above the 6AK6 tube.

3. Accessibility of the off-on switch should be considered. If the receiver has a built-in Calibrator switch on the front panel, then the switch in the Calibrator may remain on and the red B— lead can be connected to the receiver switch. If desired, a calibrator on-off switch can be installed in the front panel of the receiver if it does not already have one. Allied stock number 34B100 which requires a 15/32″ round hole is a good toggle switch for this purpose.

4. The Calibrator can be operated outside of the receiver. But the chassis of the Calibrator must be wired to whatever unit supplies the DC voltage. The B— return of the Calibrator is through the chassis and not through the cable wires.

MOUNTING THE CALIBRATOR

Two #4 self-tapping screws are supplied to fasten the CALIBRATOR permanently in place.

☐ Mark the spots for the screws at the location chosen by using the holes in the chassis cover or chassis as a template. This depends upon which set of mounting holes is to be used.

☐ Using a #47 drill or a 5/64″ drill, make two holes for the screws.

If the holes in the chassis cover are to be used to mount the CALIBRATOR, use the four small flat washers to space the unit away from the mounting surface, thus clearing the cover fastening screw.

☐ Place the CALIBRATOR in position and fasten it with the #4 self-tapping screws.

CONNECTING THE CALIBRATOR

☐ Connect the black and brown wires to a source of 6.3 volts AC or DC. Some receivers may have one side of the 6.3 volt filament supply grounded. If this is the case, either the black or the brown wire may be connected to ground.

☐ Connect the green wire to the antenna terminal of the receiver. This lead may be left permanently connected since it will not significantly load the receiver input.

The B+ supply for the calibrator may be any voltage above 100, but must not exceed the definite maximum of 300 volts. The best voltage is around 150 to 200 volts. Usually the screen grid of the audio output tube is a good source of B+.

A varying B+ voltage will shift the calibrator frequency slightly, so if the receiver has a voltage regulated supply for the local oscillator it is worthwhile to consider using this regulated voltage for the calibrator, if the VR tube can stand the extra drain. The Calibrator will draw 3 ma at 150 volts, most VR circuits can carry this amount of extra load. To determine the ability of a particular receiver VR circuit to operate the Calibrator, connect the red lead to a source of regulated voltage and notice if the VR tube continues to glow. If the VR tube continues to glow, with the Calibrator operating, then the VR circuit can accommodate the additional load. If, however, the VR tube glow extinguishes when the extra load is applied, then the Calibrator cannot be connected to the voltage regulated supply.

☐ Connect the red lead to a source of B+.

☐ Be sure that there is a negative DC return to the chassis of the Calibrator.

☐ Plug the 100 KC crystal and the 6AK6 tube into their respective sockets. (The crystal may be inserted either way.)

HOW TO TEST AND ADJUST THE CRYSTAL CALIBRATOR

☐ With the Calibrator connected as outlined in previous steps and the green output wire connected to the antenna terminal of the receiver, check across a few multiples of 100 KC (3500 KC, 3600 KC, etc.) for signals from the calibrator. If the calibrator cannot be heard, refer to the paragraphs under SERVICE HINTS.

☐ Tune in a radio station, known to be accurate, on a frequency which is an integral multiple of 100 KC.

Any U.S. broadcast station operating on a multiple of 100 KC can be used to zero the Calibrator. However, the National Bureau of Standards stations WWV (in Washington, D.C.) and WWVH (in Hawaii) are the most accurate stations to use when zero setting your Calibrator. Station WWV broadcasts on 2.5, 5, 10, 15, 20, and 25 MC. The radio amateur magazine QST regularly gives up-to-date information about WWV operation.

For final zero adjustment of the CALIBRATOR, allow both the receiver and the CALIBRATOR to warm-up for at least 15 minutes.

If WWV or WWVH is to be used for the zero adjustment, it should be done during the two minutes of each five minute period when the tone modulation is absent. An attempt to adjust the CALIBRATOR while the tone modulation is present may result in zeroing with a sideband which would be inaccurate.

The term "zero beat" refers to the condition of two radio signals being received on exactly the same frequency, and thus producing no audible difference "whistle" in the receiver speaker. When two signals of slightly different frequencies are received, the different frequency will be heard as a "beat note" or heterodyne, providing it is within the audible range. The beat note varies as the difference between the two frequencies changes.

☐ Adjust C-1, the trimmer, through its complete range (one full turn). Two zero beat points should be heard. Carefully adjust the Calibrator trimmer to either of the zero beat points.

The Calibrator will remain on the correct frequency as long as the temperature of the crystal and the 6AK6 plate voltage both remain constant.

USING THE CRYSTAL CALIBRATOR

The main purpose of the Calibrator is to provide check points every 100 KC throughout the spectrum from 100 KC to about 35 MC. Using these check points, the amateur-station operator can adjust the average communications receiver for nearly perfect calibration at the band edges.

The most common type of receiver is one with a main tuning dial and a bandspread dial. The main tuning dials of these receivers are easily adjusted so that the bandspread dials are "right on" at the 100 KC points. Care must be used when the main tuning dial is being adjusted to avoid setting at a point where the bandspread dial is 100 KC wrong.

CIRCUIT DESCRIPTION

The circuit is a 100 KC crystal-controlled, electron-coupled oscillator. The oscillating portion of the circuit is the control grid and screen grid acting as a plate. The output is taken from the plate which is isolated from the oscillating section. Precise calibration at 100 KC is accomplished by varying the trimmer across the crystal.

SERVICE HINTS

In most cases inoperative kits are found to have wiring errors. If your kit does not work, check the wiring step-by-step with the original instructions. Check for wires that accidentally touch each other.

The following list of troubles and possible causes may be helpful.

Trouble	Check
No output heard in receiver	All wiring. B+ switch on? Tube in socket? Crystal in socket? Tube filament continuity. Green wire connection to receiver. B+ voltage. B− return. Filament voltage and wiring.
Low Output	Choke L-1 should be spaced as far as possible from the cover and chassis.

PARTS LIST

Symbol No.	Description	Part No.
	CAPACITORS	
C-1	Ceramic trimmer, 7-45 μμfd	284002
C-2	Ceramic tubular, 3.3 μμfd	276039
C-3	Ceramic disc, .01 μfd	276015
C-4	Ceramic disc, 10 μμfd	276018
	CRYSTAL	
CR-1	100 KC crystal	614000
	RESISTORS	
	When ordering resistors, give part number and description.	
R-1	4.7 megΩ, ½W, 10%	301475
R-2	.47 megΩ, ½W, 10%	301474
R-3	22KΩ, ½W, 10%	301223
	INDUCTOR	
L-1	RF choke, 5 mh, iron-core	161001
	TERMINAL STRIP	
TS-1	2-terminal strip	440201
	SWITCH	
S-1	SPST slide	431005
	TUBE	
V-1	6AK6	610040

Description	Quantity	Stock No.
MISCELLANEOUS		
Chassis	1	461321
Cover, chassis	1	700021
Grommet	1	830100
Manual, instruction	1	750195
Socket, 7-pin miniature	1	501170
Socket, crystal	1	501521

Description	Quantity	Stock No.
HARDWARE		
Lockwasher, #4 internal	6	582200
Nut, 4-36 x 1/4	6	570230
Nut, 3-48 x 3/16	2	570110
Screw, 4-36 x 3/4	2	560237
Screw, 4-36 x 1/4	3	560232
Screw, 4-36 x 3/8	1	560234
Screw, 3-48 x 1/4	2	560112
Screw, #4 self-tapping	4	562292
Solder lug, #6	1	553005
Spacer, 1/8 x 1/4"	2	470070
Washer, flat 1/8 x 1/4"	4	580200
WIRE, SOLDER, AND SPAGHETTI		
#20 Bare tinned copper wire	7"	806007
#22 Str. red	18"	804031
#22 Str. black	18"	804029
#22 Str. brown	18"	804030
#22 Str. green	18"	804032
Rosin Core Solder	12"	930004
Spaghetti for #20 wire	3"	812001

TOOLS YOU MAY NEED

Allied Stock No.	Description	Price*
46N852	Soldering iron (pencil type)	$5.16
50N132	6" long-nose pliers	1.54
50N133	5" diagonal cutting pliers	1.34
45N796	6" screwdriver	.71

*** Subject to change.**

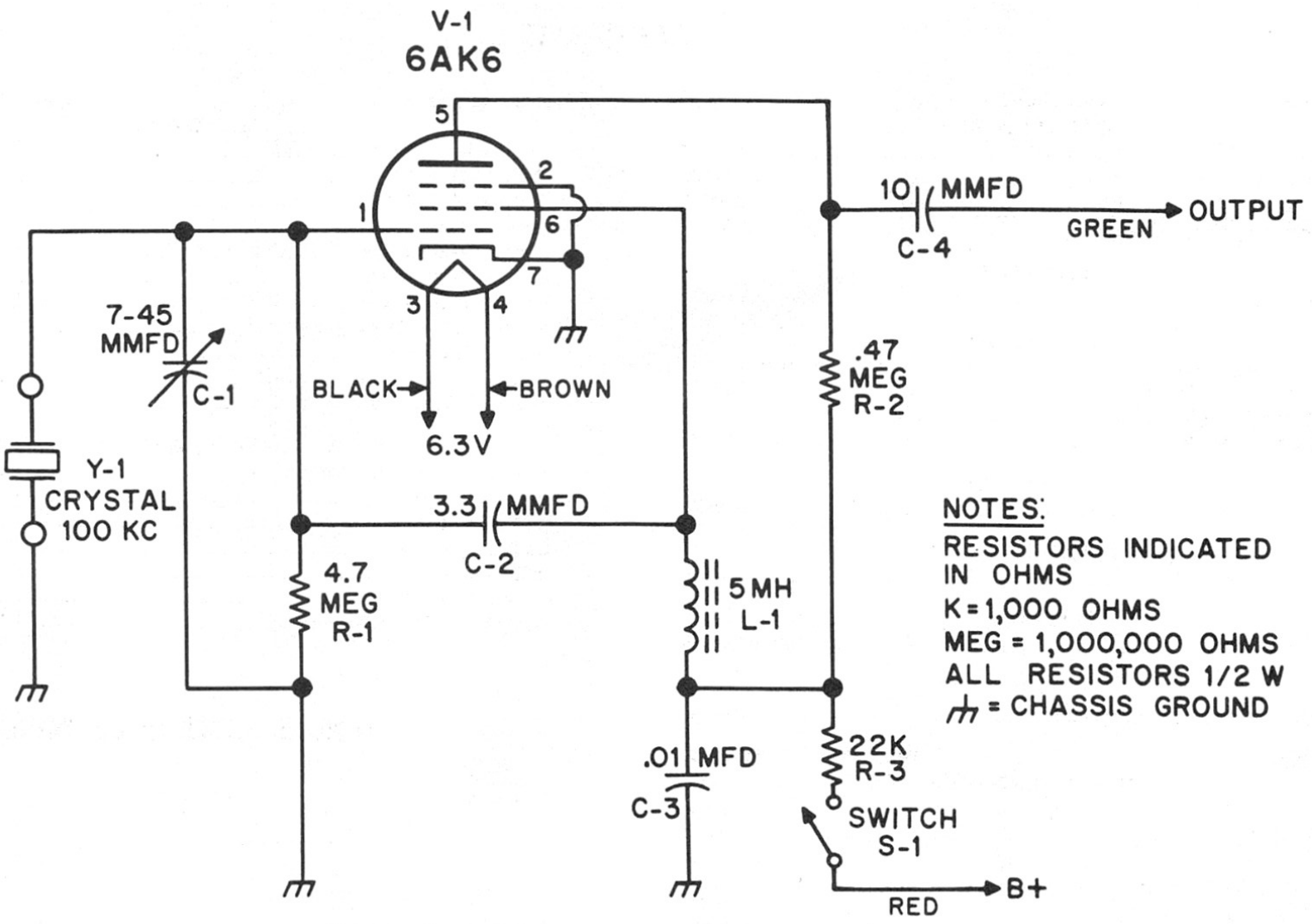

FIGURE 5. SCHEMATIC DIAGRAM

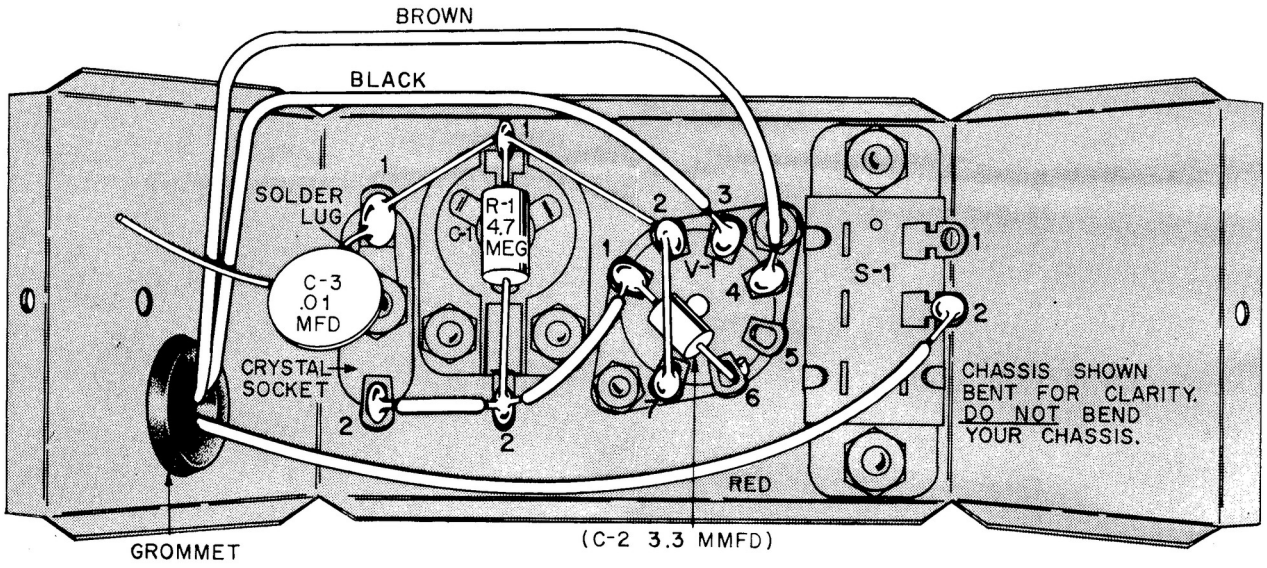

FIGURE 3. FIRST WIRING VIEW

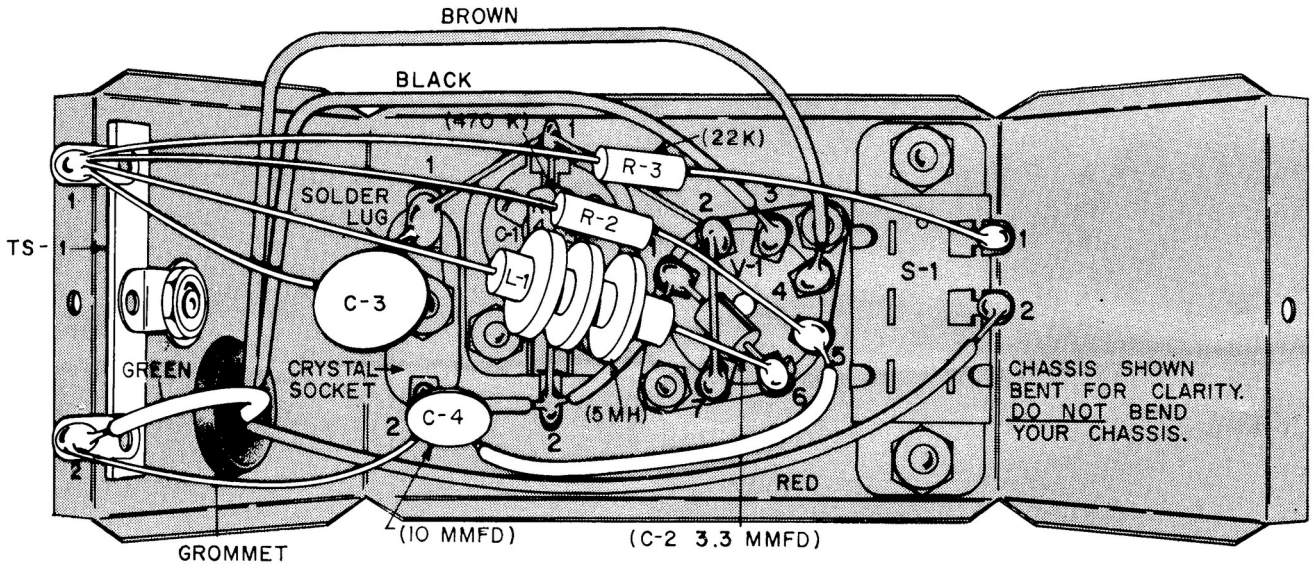

FIGURE 4. FINAL WIRING VIEW

THE knight-kit CRYSTAL CALIBRATOR

ALLIED RADIO
CORPORATION
100 N. WESTERN AVE. CHICAGO 80, ILL.