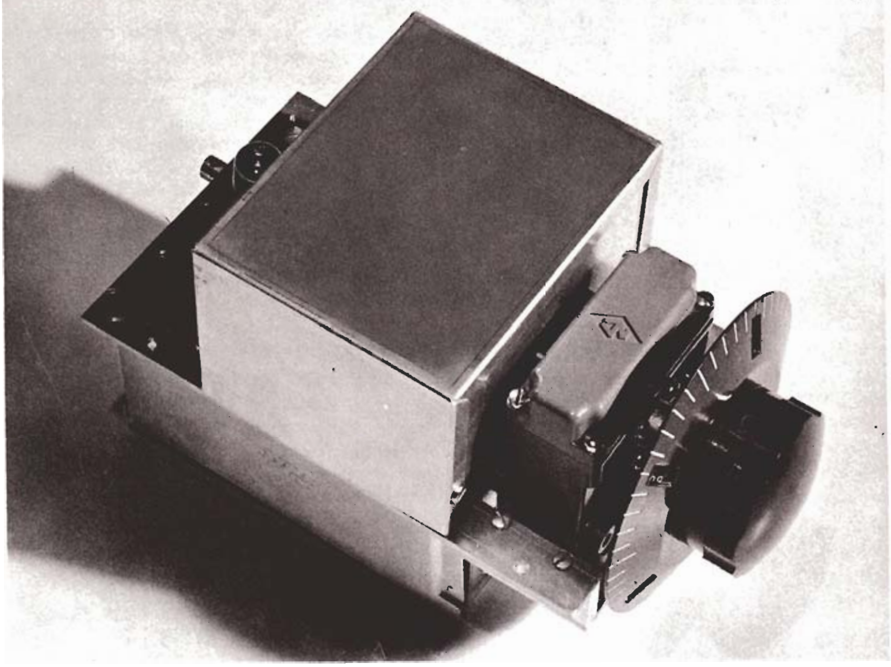
CHAPTER VI—

RF ACCESSORIES FOR SIDEBAND—

Easily Constructed Test Equipment—A Stable VFO, and a T-R Switch

SOLID HIGH-C VFO

For July-August, 1959

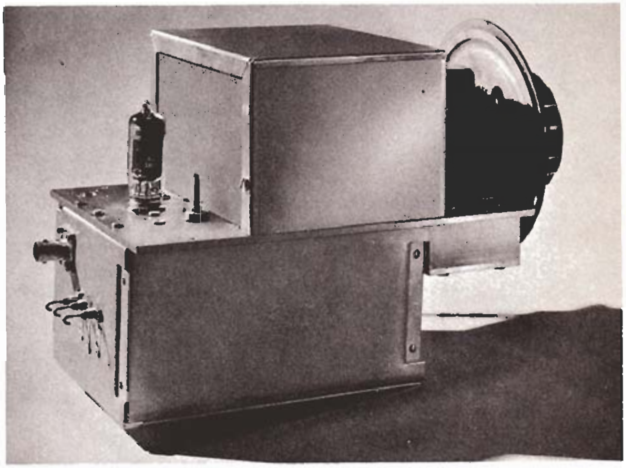


MEET THE DESIGNER . . .

W2FBS—Sam Johnson, needed a stable, tunable oscillator covering a single frequency range for the new heterodyne exciter he was building for his station. Having seen first hand the fine results obtained by ex-W2FZW (now K7BGI) with his high-C oscillator circuits for our 150-watt single band transmitters[1], Sam packaged his high-C circuit like the proverbial battleship. (See the cover photos and description starting on page 3.)

A long-time DX chaser with 230-odd countries confirmed, Sam can be heard almost daily on the CW DX bands, seeking new rare countries. W2FBS, incidentally, provided the technical guidance for our SPECIAL DX LOG ISSUE last year; also the 1959 supplement in this issue.

Vocationally, Sam is a mechanical engineer with General Electric's Gas Turbine Department at our king-sized manufacturing plant in Schenectady, N. Y.



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[1] See G-E HAM NEWS, November-December, 1957 (Vol. 12, No. 6) for details on this oscillator and transmitter.

SOLID HIGH-C VFO

CHOOSE YOUR TUNING RANGE *and build this completely shielded, stable oscillator for your new multiplying type, or heterodyne type, exciter.*

There's a great many possible combinations of frequency-determining components for the high-C oscillator circuit. Several ranges for the popular amateur frequencies are covered here, along with constructional details for variable frequency oscillators with excellent mechanical rigidity. The oscillator shown was designed to be mounted in a hole cut in a larger chassis, with a rubber bushing under each corner.

The basic circuit, shown in the schematic diagram, FIG. 1, is essentially similar to our

(Continued on page 4)

TABLE I: PARTS LIST

C_1 . . . air variable with front and rear rotor bearings; see TABLE II for capacitance values (Bud or Hammarlund "MC" or Johnson "R" series).

C_2, C_3. silvered mica or zero-temperature; see TABLE II, for capacitance values.

C_4 . . . silvered mica; 100 mmf above 5 megacycles in grid circuit; 200 mmf below 5 megacycles.

C_5 . . . 100-mmf silvered mica (use only for capacitive coupled output circuit).

C_5 . . . silvered mica; see TABLE II for values.

J_1 . . . chassis type coaxial cable connector.

L_1 . . . coils 1 inch long, wound on ½-inch diameter ceramic iron-slug tuned coil forms 2½ inches long (CTC LS-7, or PLS7-2C4L); see TABLE II for inductance values and turns.

L_2 . . . CTC LS-3 ready-wound coils; or, wound on same forms as L_1; see TABLE II. Wind 2-turn coil over L_2 for link.

RFC_1 . pi-wound r.f. choke, 2.5 mh below 5 megacycles, 1 mh above 5 megacycles (National R-50, or equivalent).

TABLE II—TUNED CIRCUIT COMPONENT VALUES

FREQUENCY RANGE		CAPACITORS			COILS—WINDING LENGTH = 1 INCH			
"A" (MC)	"B" (MC)	C_1 (mmf)	C_2, C_3 (mfd)	C_6 (mmf)	L_1 (uh)	TURNS	L_2 (uh)	TURNS
1.75—1.88	3.5— 3.76	15—300	0.004	30	3.0	18	30—70	CTC LS-3 5-MC Coil
3.5 —4.0	3.5— 4.0	15—300	0.002	30	1.6	12	30—70	CTC LS-3 5-MC Coil
5.0 —5.5	5.0— 5.5	10—230	0.002	20	0.9	9	30—70	CTC LS-3 5-MC Coil
3.5 —3.75	7.0— 7.5	10—230	0.0025	50	1.3	11	6—13	CTC LS-3 10-MC Coil
3.5 —3.72	7.0— 7.44	15—300	0.004	50	0.9	9	6—13	CTC LS-3 10-MC Coil
6.0 —6.5	6.0— 6.5	10—200	0.002	20	0.6	7	14—20	44 on LS-7 Coil Form
6.0 —6.25	12.0—12.5*	8—140	0.0025	20	0.5	6	5— 9	22 on LS-7 Coil Form
7.0 —7.2	14.0—14.4	8—140	0.002	20	0.5	6	4— 8	19 on LS-7 Coil Form
8.0 —8.22	24.0—24.66	6—100	0.002	60	0.35	5	0.5—1.0	CTC LS-3 30-MC Coil
8.33—8.66	25.0—26.0	6—100	0.002	60	0.35	5	0.5—1.0	CTC LS-3 30-MC Coil

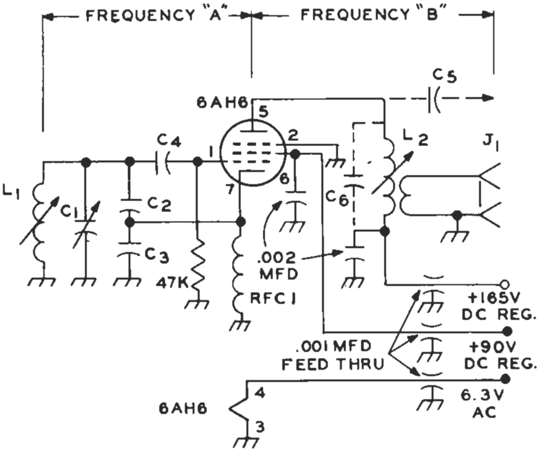
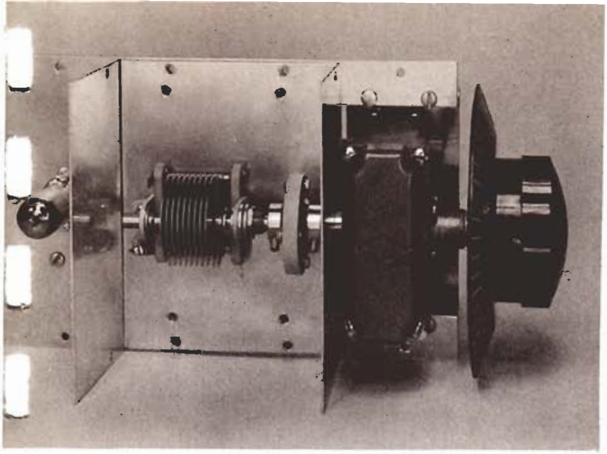
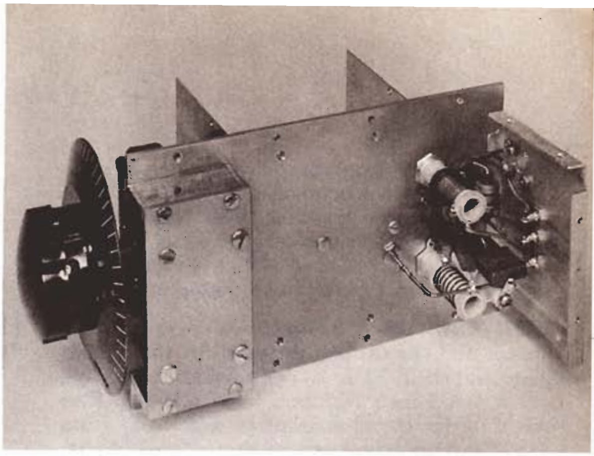


FIG. 1. SCHEMATIC DIAGRAM of the high-C variable frequency oscillator. Components required to cover a given frequency range are listed in TABLE II. All capacitances are in mmf, unless otherwise specified. All resistances are in ohms, ½ watt (K = 1000). Use either link coupling (L_2 and J_1) for the output; or capacitive coupling with C_5, depending on the driving requirements of succeeding stage.



TOP VIEW of the oscillator with shield box over the tuning capacitor removed. Note how gear box on NPW dial fits into step-down shelf on chassis plate, permitting the dial shaft to line up with capacitor shaft. No spacers are used under feet on capacitor.



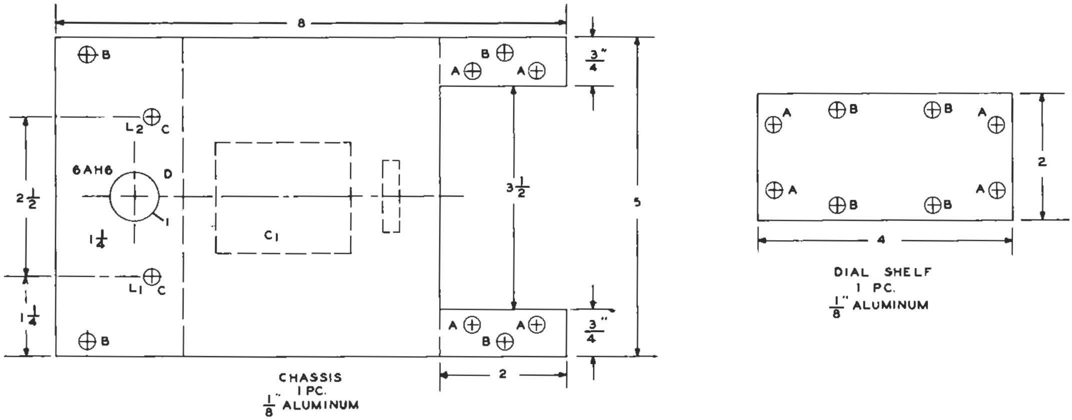
BOTTOM VIEW of the oscillator with bottom plate and side plates removed. The ceramic pillars for mounting C_2 and C_3 (see detail, FIG. 3) are just behind L_1. The 0.001-mfd feedthrough capacitors for power connections are on the rear wall plate.

SOLID HIGH-C VFO

original high-C circuit (See "Technical Tidbits, High-C Oscillators," *G-E HAM NEWS,* November-December, 1957 Vol. 12, No. 6). Capacitors C_2 and C_3 form an r.f. voltage divider for feedback and also are in series across L_1 for determining the frequency of oscillation. The capacitance range of C_1 determines the frequency coverage.

A 6AH6 miniature pentode was chosen as the oscillator tube because of its high transconductance. The plate circuit (C_6—L_2) is usually tuned to the second harmonic of the grid circuit to lessen interaction caused by changes in load on the oscillator output. Details on the critical components are given in TABLE I. A choice of component values for suggested tuning ranges is listed in TABLE II.

This particular oscillator was designed to cover an output tuning range of from 12.0 to 12.5 megacycles, a range of 500 kilocycles. With the National type NPW dial calibrated from 0 to 500, a tuning rate of about 1 kilocycle per dial division was achieved. However, the tuning rate was not precisely linear. A well-calibrated, smooth running tuning dial should be used on this—or any—VFO.



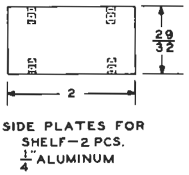


FIG. 2. DRILLING DIAGRAM for the chassis plate, and dial shelf plates. Holes marked "A" were made with No. 32 drill; "B" with No. 27 drill; "C" with 9/32-inch diameter drill; and "D" with a ⅝-inch diameter socket punch.

HIGH QUALITY insulation—steatite or ceramic—should be on the components selected for the oscillator wherever possible. This helps reduce frequency drift. The oscillator grid coil (L_1) had a measured "Q" of over 200 on the coil form specified, in spite of the small diameter.

CONSTRUCTIONAL DETAILS are covered in the photos and the drilling diagram for the chassis plate and shelf, FIG. 2. The shield box for C_1 is a 3 x 4 x 5-inch Minibox (***Bud*** CU-30). The shield under the chassis plate was made from ***See-Zak*** aluminum expandable chassis parts. The front and rear side rails are ***See-Zak*** R-34 (3 inches high, 4 inches long). A ***See-Zak*** P-44 chassis plate forms the bottom cover. Hole locations in the chassis plate for this shield should be marked from the shield parts.

A special mounting, as shown in the detail drawing, FIG. 3, was made for C_2 and C_3. This assembly is located next to L_1, as shown in the bottom view. The three 0.001-mfd feedthrough capacitors for the power leads, and the r.f. output connector, (J_2), mount on the rear side rail. The power leads and link on L_2 were made with insulated hookup wire; tinned No. 12 bus wire was used for r.f. leads.

TUNEUP consists simply of adjusting the tuning slug in L_1 so that the desired tuning range is covered. A specific frequency at either the lower or upper end of the tuning range may be reached by setting C_1 at maximum, or minimum, capacity respectively, and adjusting L_1.

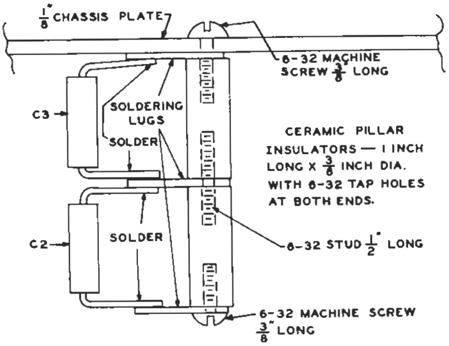


FIG. 3. ASSEMBLY DETAIL of the mounting for C_2 and C_3. Leads were clipped short and bent at right angles, close to capacitor body for rigidity. Threaded stud between pillars was made from 6–32 x ¾-inch machine screw with head removed.

Warmup frequency drift of the 12-megacycle model oscillator was about 1 kilocycle in ten minutes, after which the oscillator remained within 100 cycles of the nominal frequency. This was without temperature compensating capacitors and thus could have been reduced appreciably.

A bulletin is available with a full size chassis layout drawing, also a schematic diagram of a mixer, crystal oscillator and amplifier unit which, when used with this oscillator, forms a heterodyne type exciter.

Construction Notes for the Solid VFO

1. Size of the wire used to wind L_1 and L_2 was not given in the Parts List on page 3 of the July-August, 1959 issue of G-E HAM NEWS. The wire for L_1 is No. 18 enameled (try to use wire with Formex, Alkanex, or Formvar insulation; these insulations have higher r.f. resistance, as well as being more resistant to chipping and cracking). Use No. 24 enameled wire on all L_2 coils which must be home wound.

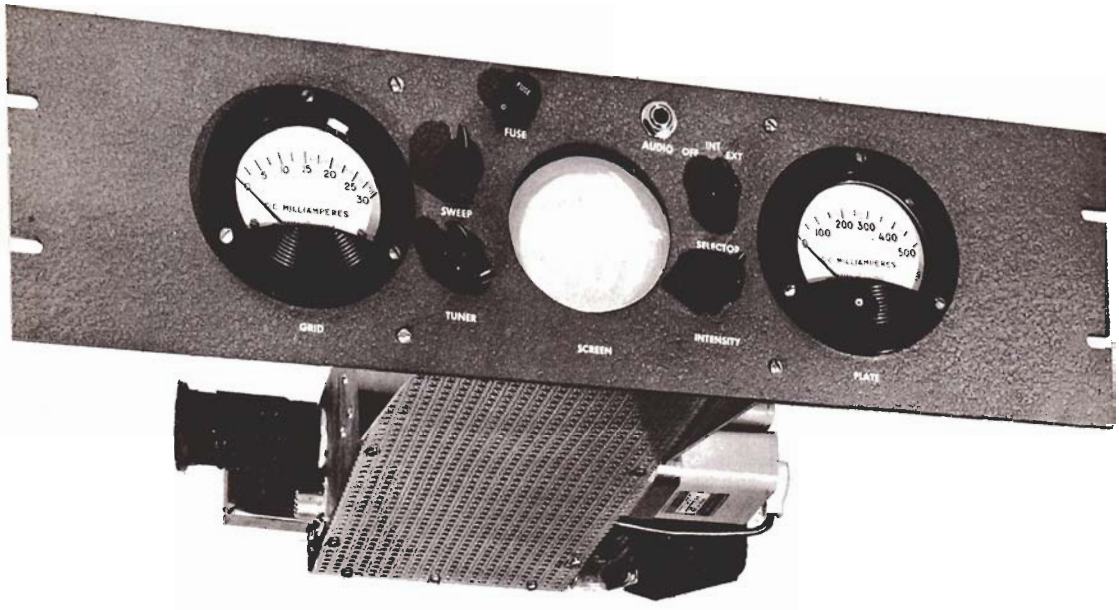
2. The CTC coil forms listed are products of the Cambridge Thermionic Corp., of Boston, Mass. They are available from several mail order radio parts distributors, including the Radio Shack Corp., 730 Commonwealth Ave., Boston (page 139 in 1959 catalog); Fort Orange Radio Dist. Corp. Co., 904 Broadway, Albany, N.Y. (page 79 in 1959 catalog); Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. (page 114 in 1960 catalog); Walter Ashe Radio Co., 1125 Pine St., St. Louis 1, Mo. (page 69 in 1959 catalog); and World Radio Labs, 3415 W. Broadway, Council Bluffs, Iowa (page 46 in 1959 catalog).

THE HAMSCOPE

GE ELECTRONICS

Monitors Your AM or SSB Transmitter

From September-October, 1956



The problem of visually monitoring your audio is solved by building a HAMSCOPE, as shown, between your amplifier grid and plate meters—or, if you prefer, in a separate unit constructed to suit your needs.

—*Lighthouse Larry*

THE HAMSCOPE

DESIGN CONSIDERATIONS

The "HAMSCOPE" is a simplified cathode-ray oscilloscope—designed specifically for checking the operation of amplitude-modulated and single-sideband transmitters operating in the 1.8–30-megacycle frequency range. The screen patterns will tell a more complete story about linearity, distortion, percentage of modulation, than meters or similar indicators. Since a linear sweep, vertical and horizontal deflection amplifiers and other complications are not needed for examining transmitter output, this 'scope is reduced to essentials—the cathode-ray tube; a tuned circuit for applying RF voltage to the vertical deflection plates; a 60-cycle or audio frequency sweep on the horizontal plates; and a high-voltage power supply.

Choice of the cathode-ray tube determines other factors, such as over-all size and voltages, and will be considered first. Even though a late type, the 3KP1, was used in this circuit, older cathode-ray tubes—the 3AP1, 3BP1, 3CP1, 3GP1, 3MP1, or the 2AP1, 2BP1, etc.—should be suitable. Many amateurs already have these tubes stored away, with the intention of putting them to work in a unit of this type.

A cathode-ray tube is similar to other thermionic vacuum tubes in that electrons emitted from the hot cathode are attracted toward a more positively charged anode. The main difference in C-R tubes is that the cathode and several disk or cylindrical-shaped elements, called the electron gun, concentrate the electron stream into a thread-like beam. These elements each have a small axially aligned hole through which the beam passes. The control grid, adjacent to and negatively charged with respect to the cathode, controls the intensity of this beam. The next element is the focusing anode, operating at 30 to 50 percent of the total supply voltage. The accelerating anode, next in line and having a high positive charge, pulls the electron beam through the gun and hurls it toward a phosphor-coated screen on the faceplate. A small spot appears on this screen when voltages applied to the elements have the proper relationship. Last element in the gun, four deflection plates arranged in pairs about the electron beam axis, bend this beam in accordance with a difference in potential between the pairs. Because each point on the fluorescent screen continues to glow briefly after being energized by the beam, the spot traces a composite pattern of any varying deflection voltages applied to the plates.

The electron beam also will be deflected by stray magnetic fields. Presence of a permanent magnet or inductance energized by direct current near the tube neck will cause the spot to move from its normal position. An alternating-current field, such as that which surrounds power transformers, will cause the spot to sweep back and forth at right angles to the plane of the field. For this reason, selecting a location for the power transformer which causes no stray beam deflection is usually the most critical mechanical problem encountered in constructing cathode-ray oscilloscopes. Since the transformer may induce a field into a steel chassis if it is fastened directly to that chassis, an adjustable transformer mounting bracket helps overcome this difficulty.

CIRCUIT DETAILS

Since current flow through a cathode-ray tube is quite small, voltages for the elements may be tapped from a high resistance voltage divider connected across a power supply which need deliver only a few milliamperes of current. Resistance values in this voltage divider, shown in the schematic diagram, Fig. 1, have been selected to offer a wide adjustment range on the "INTENSITY" and "FOCUS" controls, and to place some load on the power supply. Different values should not be necessary even with other cathode-ray tube types and higher supply voltages. Centering controls for positioning the pattern were considered an unnecessary refinement, since most cathode-ray tubes are constructed to place the undeflected spot within ¼ inch of the center of the screen.

If the cathode or control grid is operated near chassis potential (the "normal" method of connecting B-minus), the accelerating anode and deflection plates must have a high positive potential applied to them. This creates a dangerous shock hazard in circuits where the deflecting signal to be observed is connected directly to these plates. The danger is easily reduced by operating the latter elements near chassis potential and applying a negative high voltage to the control grid-cathode end of the voltage divider network. This system also avoids the necessity of using high-voltage coupling capacitors to isolate the deflection plates, the alternate method of reducing the shock hazard. Most 2- and 3-inch cathode-ray tubes will have sufficient pattern brightness for this application if at least 800 volts appear across the voltage divider, although operation at 1000 to 2000 volts insures some reserve brightness. One side of the cathode-ray tube heater is connected to the negative high voltage to insure that the heater-cathode potential difference will not rise above the rated value.

A built-in negative high-voltage supply is pictured in the schematic diagram, rather than depending upon the transmitter being monitored to furnish positive high voltage. Thus, the 'scope will check even ***flea-powered*** transmitters. Even though special oscilloscope power transformers are available (Merit P-3170 and Triad A-43-C), a conventional replacement-type power transformer delivering at least 600 volts across the ***entire*** secondary winding was used for T_1. Because of the low current drain, a simple half-wave rectifier and capacitor input filter, which charges up to the peak AC transformer voltage, is suitable. Capacitors C_1 and C_2 should have a working voltage rating at least 1½ times the transformer secondary voltage.

As only a 5-volt rectifier heater winding with no center tap was available on this transformer, the 2.5 volts required by a 2X2A rectifier tube is supplied by inserting dropping resistor R_1 in series with the heater. One section of a 5R4-GY full-wave rectifier tube may be used in place of the 2X2A, R_1 not being required for this tube. The maximum AC voltage-per-plate ratings of most other full-wave rectifier tubes will be exceeded in this circuit, and should not be used.

Both power and horizontal sweep selection are controlled by S_1, wired so that the 'scope is "OFF" in one position. The second position applies line voltage to the power transformer and 25,000-ohm sweep control potentiometer, and the third position also connects the power and applies an external audio voltage, fed through J_1 into this control. The primary of a single plate to push-pull grid interstage audio transformer is connected between the arm and one side of the potentiometer and both ends of the secondary winding connect to the horizontal deflection plates. A transformer with a large step-up ratio, 1:4 or higher, will sweep the full width of most cathode-ray tubes with 20–30 volts RMS applied to the primary. A linear horizontal sweep generator would needlessly complicate the circuit, since the center portion of a sine wave sweep is sufficiently linear.

The vertical deflection plates are connected across tuned circuit C_3—L_1, resonant at the frequency of the RF signal being checked. A small RF voltage fed through a coaxial cable plugged into J_3 is link-coupled to the tuned circuit through L_2. Any combination of variable capacity and inductance which will tune to the desired frequency may be used in place of the parts specified for C_3, L_1 and L_2. The large maximum capacity specified for C_3 enables the tuned circuit to cover all popular bands with only 2 coils, but a bandswitching coil system may be incorporated for added convenience.

MECHANICAL DETAILS

Most relay rack panels with holes cut for three 3-inch meters have about 6½ inches of space between the two outer meter holes, limiting one "HAMSCOPE" dimension to less than this figure. Over-all depth of the unit is regulated by the depth of the relay rack cabinet into which the 'scope will be mounted. Most cabinets are more than 14 inches deep, but the 6- by 14- by 3-inch chassis used on this model is the largest that may be safely accommodated. A chassis drilling diagram is not shown, since available transformers, capacitors, tubes, etc, may vary in size somewhat from the components pictured in Fig. 2. Instead, approximate dimensions for locating major parts have been marked on the side view illustration, Fig. 3. Actual parts to be used should be placed in and about the chassis to find locations which will not conflict with the cathode-ray tube, control shafts, brackets, etc.

Holes for the "SWEEP" potentiometer and S_1 are drilled as close as possible to the upper chassis corners, and corresponding holes for panel-bearing assemblies are drilled at the lower corners. On this model, the hole centers were three quarters of an inch each way from the outside chassis wall. The four control knobs will then form a rectangle about the tube face.

The faceplate end of the tube is not held in a clamp, but rests between two strips of rubber cemented to the underside of the chassis deck and bottom lip. A square hole in the panel end of the chassis for the tube is preferable to a round hole, since the bottom lip must

COIL TABLE

1.8—7.5 MEGACYCLES

L_1—32-uh, 34 turns No. 24 enameled wire, center tapped, wound in two 17-turn coils spaced ¼ inch, 1½ inches long on a 1½-inch-diameter 5-prong molded phenolic plug-in coil form.

L_2—3 turns No. 20 insulated hook-up wire at center of L_1.

9—30 MEGACYCLES

L_1—1.3-uh, 6 turns No. 24 enameled wire, center tapped, wound in two 3-turn coils spaced ¼ inch, ¾ inches long on same type form.

L_2—2 turns No. 20 insulated hook-up wire at center of L_1.

Commercially available coils which may be substituted for the above coils include the Bud CCL or OLS; or the B & W MCL, JCL and JVL series.

PARTS LIST

C_1, C_2—0.1 to 0.5-mfd paper, working voltage 1.5 times secondary voltage of T_1.
C_3—Two-section variable, 10–400-mmf per section.
F_1—Chassis-type fuse holder with 1-ampere fuse.
J_1—Open circuit midget 'phone jack.
J_2—Chassis-type male 2-prong power connector.
J_3—5-prong ceramic tube socket.
J_3—Chassis-type coaxial cable connector.
J_4—5-prong ceramic tube socket.
R_1—5-ohm, 10-watt adjustable resistor.
S_1—4-pole, 3-position, single section non-shorting tap switch (Mallory 3243J).
T_1—Replacement type power transformer with a 600–750-volt, 40-ma high voltage winding; 5-volt, 2-ampere and 6.3-volt, 0.6-ampere heater windings; 115-volt, 60-cycle primary.
T_2—Single plate to push-pull grid interstage transformer having a step-up ratio of 1:3 or higher (Stancor A-53-C, A-64-C).
V_1—2X2A or 5R4-GY rectifier tube (see "CIRCUIT DETAILS").

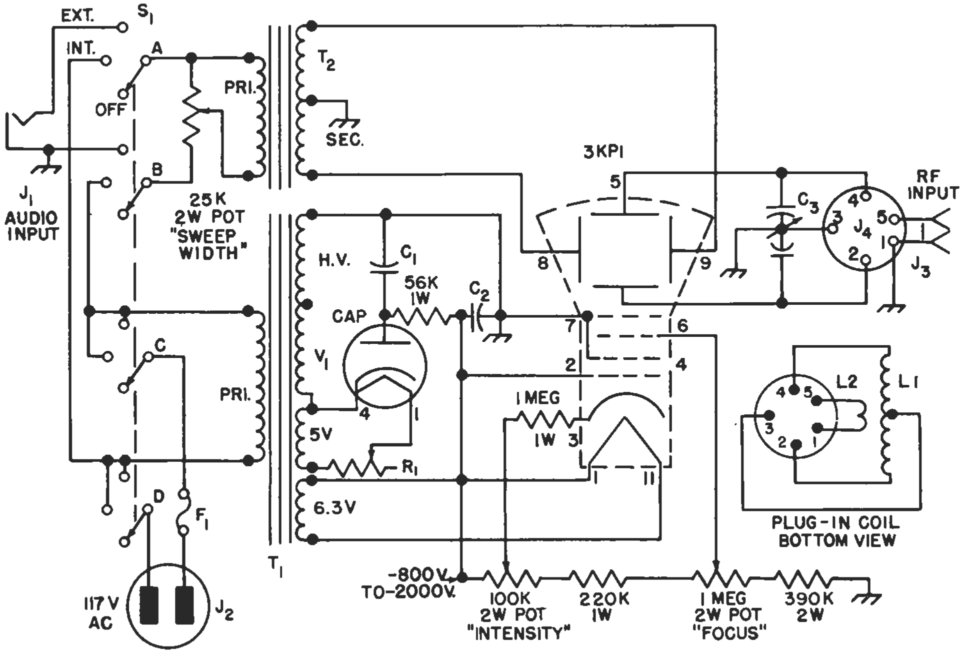


Fig. 1. Complete schematic diagram of the "HAMSCOPE."

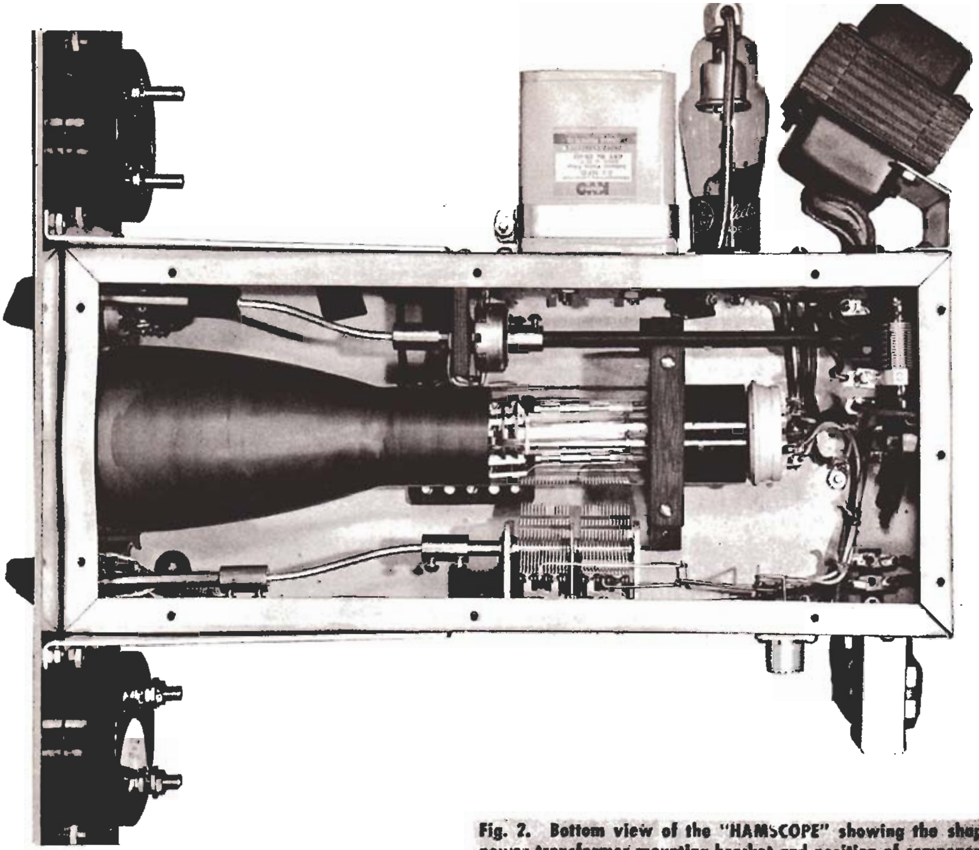


Fig. 2. Bottom view of the "HAMSCOPE" showing the shape of the power transformer mounting bracket and position of components inside the chassis. The plug-in coil has been removed.

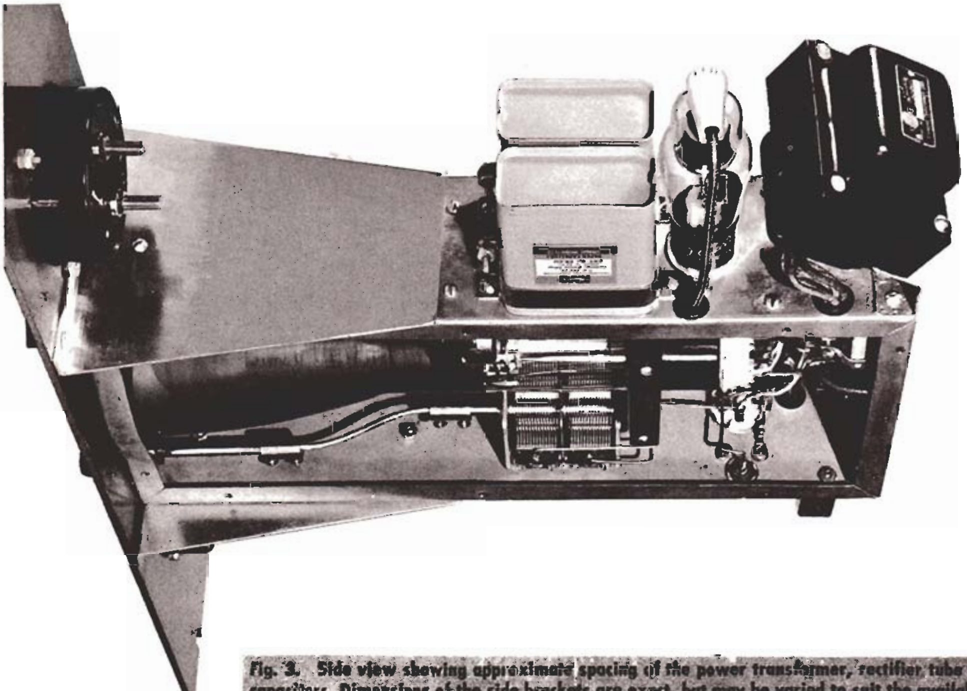


Fig. 3. Side view showing approximate spacing of the power transformer, rectifier tube and filter capacitors. Dimensions of the side brackets are exact, but may be varied to suit the available space.

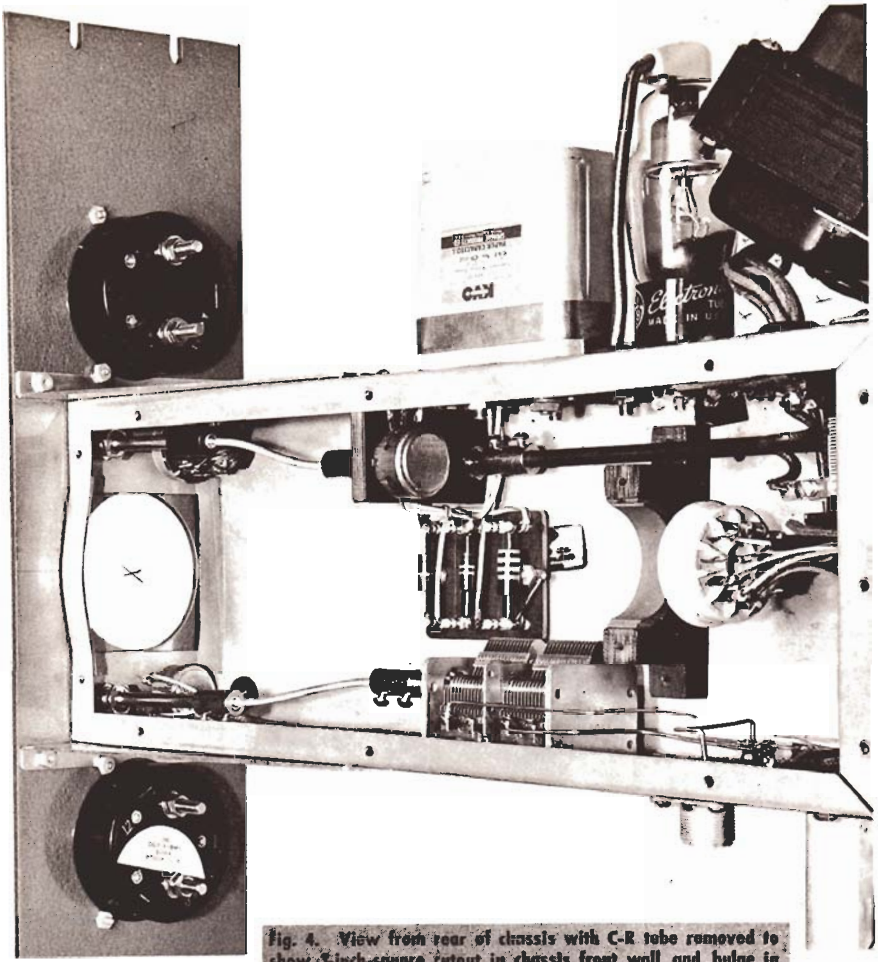


Fig. 4. View from rear of chassis with C-R tube removed to show 3-inch-square cutout in chassis front wall and bulge in bottom lip.

be bent down to clear the large end of the tube as shown in Fig. 4. With the tube in place, the chassis is positioned behind the panel so that the tube is centered in the meter hole. The chassis top deck measured about 1 inch down from the top edge of the rack panel in the correct position. The $\frac{3}{8}$-inch diameter chassis holes for the control shafts are now marked on the back side of the panel with a scriber or pencil and matching holes are drilled through the panel in these locations. Large holes for the fuse holder and J_1, and small holes for the chassis support brackets are also drilled. These brackets, shown in the side view, were made of $\frac{1}{16}$-inch-thick sheet aluminum and rigidly brace the chassis.

A clamp for the cathode-ray tube base end, pictured in Fig. 5, was fashioned from $\frac{1}{2}$-inch thick phenolic insulating board. A hole $\frac{1}{8}$-inch larger in diameter than the tube neck is bored, all small holes drilled, then the board is cut in half at the line indicated on the drawing. Finally, all holes are tapped, except the holes for the clamping screws on the top portion which are redrilled to clear the 6–32 by $1\frac{1}{2}$-inch-long machine screws which hold the clamp together. Then, cement two strips of $\frac{1}{16}$-inch-thick sheet rubber into the large hole to act as a cushion for the tube. A sheet aluminum bracket for fastening the power transformer may be fashioned after the proper transformer location has been determined by following the suggestions outlined under "OPERATION." Universal mounting transformers will require a bracket similar to that illustrated in Fig. 2. Upright mounting transformers normally have the bolting flange at the bottom, dictating a shorter type of bracket. Tubular-type filter capacitors with leads may be substituted for C_1 and C_2 by supporting them on a terminal board which is placed in an unoccupied portion of the chassis. A steatite 4-prong socket for the 2X2A, or octal socket for a 5R4-GY, is preferable to phenolic types because of the fairly high voltage.

The deflection circuit components mount on the opposite side of the chassis. Sweep transformer T_2 was located at the rear corner, also to minimize the effect of its stray fields on the 'scope tube. The plug-in coil socket, J_4, and the coaxial cable connector, J_3, may be mounted side by side if L_1 and L_2 are to be wound on molded plug-in coil forms. However, if the larger manufactured air-wound coils specified in the "COIL TABLE" are preferred, additional coil space may be obtained by moving J_4 toward C_3 and centering it vertically on the side wall. The variable capacitor should be a fairly compact unit; otherwise the rotor plates may strike the cathode-ray tube neck when the capacitor plates are about half meshed. If necessary, the tube may be positioned slightly off center in the chassis to obtain this clearance. The capacitor shaft is driven through a panel-bearing and shaft assembly coupled to a 3-inch flexible shaft.

A strip of $\frac{1}{4}$-inch-thick insulating board, shaped and drilled to dimensions shown in Fig. 6, is a convenient mounting for the "INTENSITY" and "FOCUS" potentiometers, both of which are insulated from the chassis. Insulated couplings, a 3-inch flexible shaft, and a shortened 3-inch shaft and panel-bearing assembly permit operation of the "INTENSITY" control from the front panel. A length of fiber shafting extends the "FOCUS" control to the rear of the chassis, since it seldom requires adjustment. The voltage divider fixed resistances are fastened to a small terminal board suspended on machine screws, with extra nuts as spacers, just above the cathode-ray tube neck where they may be conveniently wired to the potentiometers.

WIRING DETAILS

Leads from the power connector, J_2, on the rear of the chassis to S_1 are shielded wire, but all connections except the high-voltage leads are made with conventional hook-up wire. High-voltage wire was used on the rectifier anode, filter capacitor and voltage divider connections. Plastic insulating tubing was slipped over the transformer high-voltage and heater leads for added protection. Connections between the coil socket, variable capacitor and coaxial connector are made with tinned No. 14 copper wire. Leads to S_1 and the "SWEEP" control should be assembled before they are mounted in the rather restricted chassis corners. The cathode-ray tube socket leads should be connected so that pin 1 is *down* for a 3KP1 and have some excess length. For other tube types the pin number denoting the deflection plate axis is placed down.

The power transformer should be temporarily wired into the circuit with all leads left full length and running through rubber-grommeted holes in the power supply side wall. The transformer is permanently mounted following preliminary tests, leads are cut to proper lengths and any unused leads are clipped short and taped. Wiring to the fuse holder and J_1, above the chassis, runs up through rubber grommets placed in ⅜-inch diameter holes. Meters inserted in the outside panel holes are wired into the transmitter circuits by direct connection to the meter terminals. The power leads to J_2 may be connected to existing transmitter filament wiring.

OPERATION

After a final wiring check, set the slider on resistor R_1 to 1.5 ohms with an ohmmeter. Lay the power transformer, which is hanging by its leads, about 1 inch from the chassis in the position shown in Fig. 4. Insert the 2X2A rectifier tube, but do not connect its anode cap or plug in the cathode-ray tube at this time. Connect an AC voltmeter to pins 1 and 4 on the rectifier socket, turn S_1 to the "EXT." position and read the heater voltage. If 2.5 volts is not read, *turn off* the power and adjust the slider on R_1 until this voltage appears across the 2X2A socket with power on.

With the power off, connect the anode cap on the 2X2A, insert the cathode-ray tube and clamp it in place. Again turn S_1 to the "EXT." position and turn the "INTENSITY" control clockwise until a pattern appears on the tube screen. Next, adjust the "FOCUS" control until the pattern resolves into a sharp spot or line. If a line is observed, turn S_1 to the "OFF" position and note whether the line changes to a small spot before it fades from view. If it does, the stray field from the power transformer is deflecting the spot. With S_1 again in the "EXT." position, turn the transformer in various positions until the line reaches minimum length. Leave the transformer in this position and take measurements for the mounting bracket, described under "MECHANICAL DETAILS." Tests with three types of transformers indicate that it should be spaced at least 1 inch from the chassis.

The internal 60-cycle horizontal sweep now can be tested by setting S_1 on the "INT." position and turning the "SWEEP" control clockwise until a full-width line appears on the screen. With the sweep transformer specified in the "PARTS LIST," it should be possible to extend the sweep far beyond the tube face.

An external RF voltage is applied to the "HAMSCOPE" by running a small coaxial cable from J_3 to the device being checked. This cable should terminate in a small coil placed near the output tuned circuit in that device. The loop also may be coupled to the antenna tuning network or *balun* coils used with some transmitters. For convenience in making connections, an extra coaxial cable connector may be added to the unit in which the coupling loop is placed.

After tuning C_3—L_1 to the output frequency, the RF voltage on the vertical deflection plates appears as a band across the C-R tube face. Maximum height of this pattern can be set by adjusting the coupling loop; then the C_3—L_1 tank can be detuned to reduce the vertical deflection if desired. A wide pattern is developed on a 3KP1 even from the low output of a grid-dip oscillator coupled to the tuned circuit, indicating good deflection sensitivity. The width of this pattern will vary in accordance with the modulation applied to the transmitter. A detailed description of the patterns obtained from amplitude- or frequency-modulated, and single-sideband-suppressed-carrier transmitters will be found in amateur radio handbooks and magazine articles covering these forms of modulation.

Final dressing up includes: adding control knobs which match those in your station; marking these controls with *decal* labels; cementing a bezel made from ¼-inch-diameter plastic tubing around the C-R tube opening; and fitting a perforated sheet aluminum chassis bottom plate to the underside of the "HAMSCOPE."

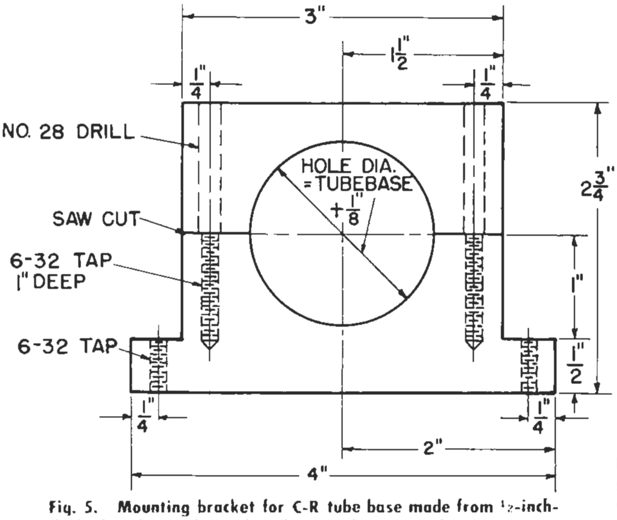


Fig. 5. Mounting bracket for C-R tube base made from ½-inch-thick phenolic insulating board or similar material.

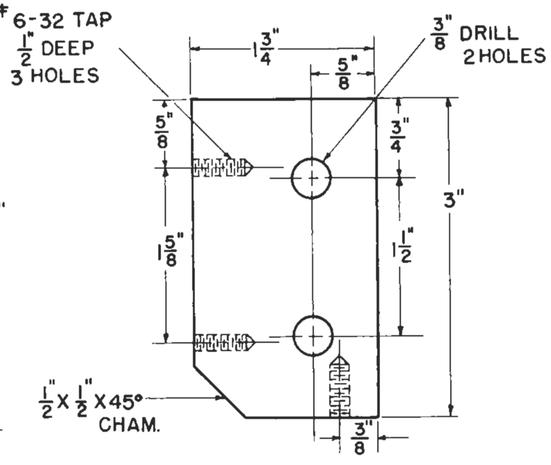


Fig. 6. Bracket made from ¼-inch-thick insulating board to hold the "FOCUS" and "INTENSITY" potentiometers next to the C-R tube neck. Mounting holes may be first drilled in the chassis, then marked on both brackets.

Other Ideas for the Hamscope

1. Several cathode ray tube types other than the 3KP1 tube recommended for the HAMSCOPE may be used if the changes listed below are followed.

2. For cathode ray tubes having the cathode connected internally to one side of the heater, (3AP1, 3CP1, 3EP1, 3GP1, 5AP1, 5BP1, 5GP1, 5HP1, 5JP1, 5NP1)
    a. Connect the end of the 1-megohm resistor shown running to the cathode, pin 3, to one side of the tube heater circuit instead.
    b. The cathode ray tube control grid should be connected to the negative side of the high voltage supply, as shown for the 3KP1, but the negative high voltage circuit should not be connected to one side of the heater circuit. This circuit is shown below.

3. The additional deflection plate shown on the basing diagram for a 3CP1 type cathode ray tube is an accelerating anode and should be operated at the same DC potential as the deflection plates. In the HAMSCOPE, ground this pin.

4. When a 5-inch cathode ray tube is operated in the HAMSCOPE circuit, it is recommended that at least 1000 volts DC be applied across the voltage divider

5. Cathode ray tubes which have one horizontal and one vertical deflection plate connected together and brought out to a common connection require some changes in the HAMSCOPE deflection circuit.
    a. The pair of deflection plates connected to one pin should be grounded.
    b. One end of the secondary winding on T_2 is grounded, and the other end is connected to the remaining horizontal deflection plate.
    c. A single gang 365-mmf variable capacitor is substituted for the two-gang type specified for C_3 and the rotor is grounded. The stator onn C_3 is connected to the remaining vertical deflection plate, and to pin 4 on J_4.
    d. Coil L_1 is wound with no center tap, and is connected between pins 3 and 4 on J_4. The center tap on commercially made coils is not used, and the connection from pin 3 to ground on J_4 is removed from the circuit. Pin 2 on J_4 should then be grounded. This circuit is shown below.

6. In the wiring shown in Fig. 1 on page 3 of the September-October, 1957 issue, the schematic diagram for the plug-in coil form is correct, but the pins are numbered wrong, and should be numbered as shown for J_4 in that diagram.

7. Cathode ray tubes having short persistence green, blue or white screens (P1, P4 and P11) will work best in the HAMSCOPE, but medium and long persistence screens (P7 and P 4) are useful for checking a transmitter modulated by a steady audio tone. The P7 and P14 screens will retain a pattern too long to be very useful for continuously monitoring a voice-modulated transmitter, however.

8. Technical data sheets for several types of G-E cathode ray tubes are available, as listed below. These sheets may be obtained by writing to: Technical Data Section, Cathode Ray Tube Department, General Electric Co., Electronics Park, Syracuse, N. Y. These types are: 2AP1-A, 2BP1, 3AP1-A, 3BP1-A, 3KP1, 3MP1, 5AUP24, 5CP1-A, 5QP4-A, 5UP1, 14UP4.

9. Technical data for the above types, and for other types of cathode ray tubes, can be found in the ARRL Radio Amateur's Handbook. Look in the tube technical data chapter, under "Cathode Ray Tubes."

10. A number of readers have inquired about converting the war surplus BC-929 oscilloscope to the HAMSCOPE circuit. An article has been published in QST magazine for August, 1957, page 32, describing the conversion of this oscilloscope to a modulation monitor similar to the HAMSCOPE, but with more elaborate circuits.

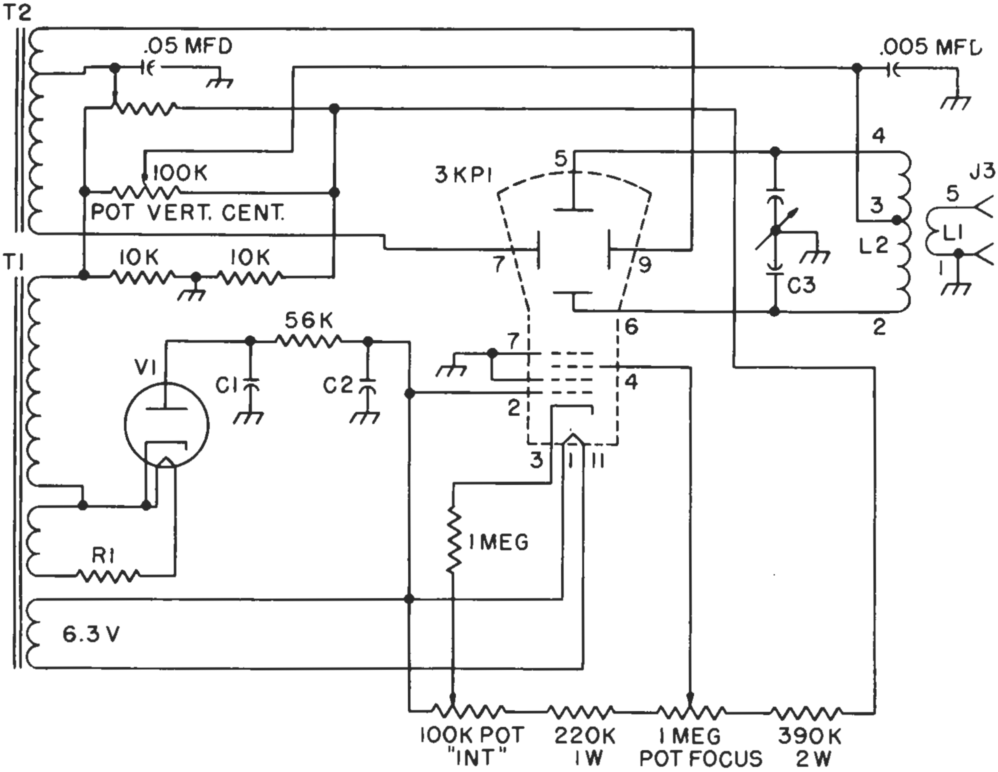


DIAGRAM SHOWING CIRCUIT CHANGES TO ADD CENTERING CONTROLS TO THE HAMSCOPE.

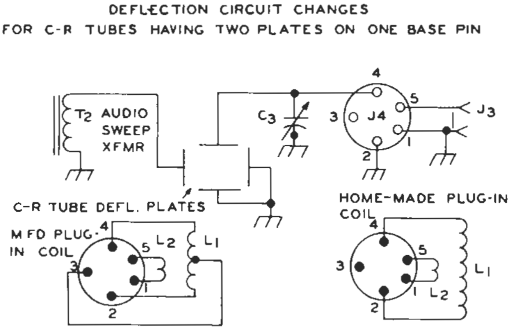

DEFLECTION CIRCUIT CHANGES FOR C-R TUBES HAVING TWO PLATES ON ONE BASE PIN

DIAGRAM SHOWING CHANGES IN HAM- SCOPE CIRCUIT FOR C–R TUBES WITH CATHODE TIED INTERNALLY TO ONE SIDE OF HEATER.

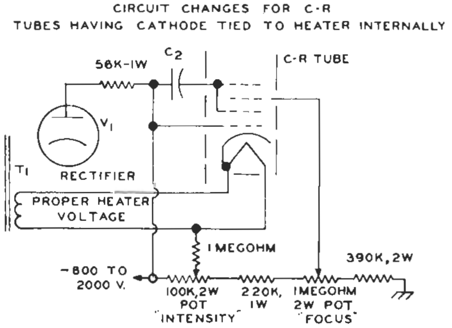

CIRCUIT CHANGES FOR C-R TUBES HAVING CATHODE TIED TO HEATER INTERNALLY

DIAGRAM SHOWING CHANGES IN DEFLEC- TION CIRCUIT FOR C–R TUBES HAVING 2 PLATES CONNECTED TOGETHER AND BROUGHT OUT TO ONE BASE PIN.

USING THE HAMSCOPE

Two types of patterns, wave envelope and trapezoidal, normally are used for checking AM or SSB transmitter modulation with an oscilloscope. The "HAMSCOPE" will present a wave envelope pattern simply by feeding the transmitter RF output into the vertical deflection circuit through J_3 and turning S_1 to the "INT." position. Modulation of the transmitter either by voice or an audio tone will cause the RF carrier band on the screen to vary in height. The pattern may move across the screen or remain stationary if the modulating frequency is an exact multiple of the 60-cycle horizontal sweep frequency.

When a trapezoidal-type test pattern is desired, an amplitude-modulated transmitter output is applied to J_3, but S_1 is turned to the "EXT." position. An audio voltage which is in phase with the audio being applied to the modulated amplifier stage is fed into J_1. With the transmitter unmodulated, no horizontal sweep appears, but the RF output is indicated by a vertical line. Applying 100-percent modulation should result in the usual trapezoidal pattern. Any phase difference between the sweep and modulator audio will cause oval-shaped traces to appear along the upper and lower edges of the trapezoid. This condition may be corrected by installing a 500-mmf capacitor and a 0.5-megohm potentiometer in series with the ungrounded audio lead to the "HAMSCOPE."

The modulation transformer secondary in plate, screen or control-grid type modulators, and the plate of a clamp-tube modulator, are suitable points to connect one end of a voltage divider from which the audio sweep voltage for the "HAMSCOPE" is obtained. This divider should include a: (1) coupling capacitor, (2) fixed resistance and (3) potentiometer, series-connected in that order between the tap-on point and the chassis. Suitable values for these components are: (1) capacitor, 0.005-mfd per megohm of total divider resistance; (2) fixed resistance, 1 megohm per 1000 volts DC potential at the tap-on point; (3) potentiometer, 0.1 megohm. The capacitor should have a working voltage rating equal to 2.5 times the DC voltage, and the fixed resistance should have one resistor for each 500 volts at this point. Audio is fed from the potentiometer arm to J_1 through a shielded cable.

Audio sweep voltage for checking single-sideband transmitters with a trapezoidal pattern on the "HAMSCOPE" may be taken from the output of the separate audio amplifier stage for the voice-controlled break-in circuit with which most SSB exciters are equipped.

RANDOM IDEAS

A smaller chassis, 5 by 10 by 3 inches, may be chosen for a "HAMSCOPE" built around a 2-inch or one of the short 3-inch cathode-ray tubes (3MP1, 3UP1). In this narrower chassis, the tube still should be placed 3 inches from the power supply wall of the chassis. The variable capacitor should be mounted outside the chassis, preferably in a small box, which also could house the plug-in coil socket. The shorter chassis also permits locating the power transformer directly behind the cathode-ray tube base where it is less likely to cause stray deflection effects. Another variation is to select a chassis large enough to also enclose the meters on the panel, which gives the constructor space to add future accessories to the basic 'scope circuit.

If your meter panel has three holes for 2-inch meters, a "HAMSCOPE" using a 2-inch cathode-ray tube may be constructed in a chassis up to 7 inches wide. The "HAMSCOPE" also may be adapted for table mounting by selecting a utility cabinet proportioned to house all components. Again, the principal design problem is locating the power transformer where its stray field does not affect the cathode-ray tube operation.

BIBLIOGRAPHY OF MODULATION WAVEFORM PATTERNS

Amplitude-modulated patterns:

1. The Radio Amateur's Handbook, 1960 edition, "Amplitude Modulation" chapter, pages 297 - 301.
2. The Radio Handbook, 15th Edition, "Amplitude Modulation" chapter, page 290; "Sideband Transmission" chapter, page 330.
3. QST, "Some Principles of Radiotelephony", Part I, May, 1954, page 37; Part II, June, 1954, page 13; Part III, July, 1954, page 34; Part IV, October, 1954, page 22.

Single-Sideband patterns:

1. The Radio Amateur's Handbook, 1960 edition, "Sideband" chapter, pages 309, 315-319 (Also, "Single Sideband for the Radio Amateur", pages 109, 112, 132, 135-139, 141).
2. New Sideband Handbook, "Linear Amplifiers" chapter, pages 151, 152.

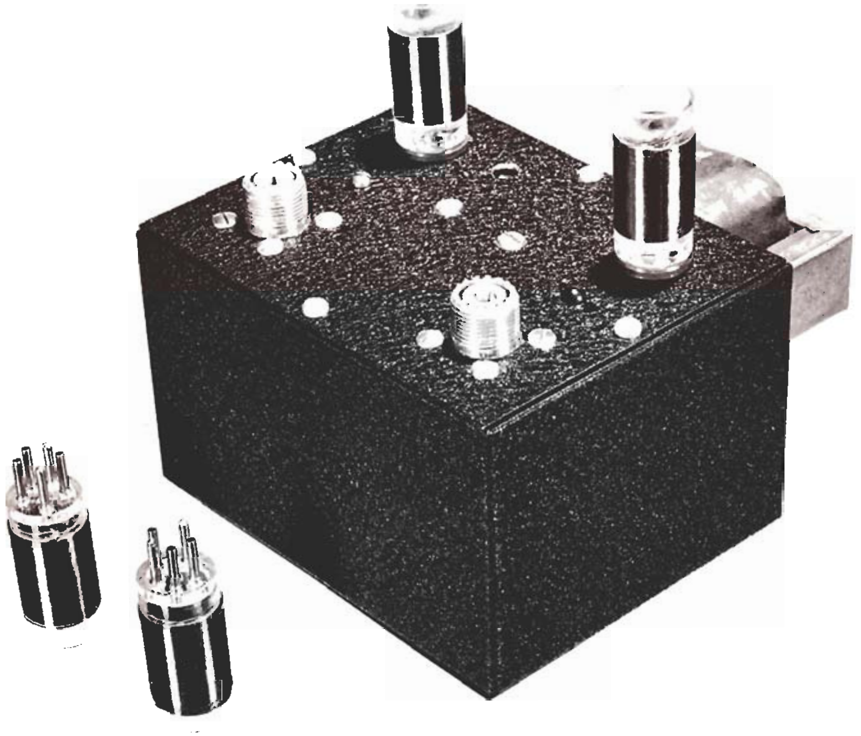
Double Sideband patterns:

1. CQ, "DSB Considerations and Data," October, 1957, page 64.
2. CQ, "Modulating the DSB Transmitter," March, 1958, page 32.
3. New Sideband Handbook, "Double Sideband" chapter, page 136.

THE DIOPLEX

Replaces the Antenna Relay in 50-ohm Coaxial Cable Antenna Circuits

From May-June, 1953



Here's the answer to the prayers of many a ham—an electronic circuit without switches or relays that permits a receiver to remain permanently connected to a transmitting antenna without damage to the receiver when the station transmitter is turned on.

The Dioplex taps into the transmission line and permits low-level incoming signals to pass into the receiver. However, when the transmitter is operating, the relatively high level signal voltage which appears on the line activates the Dioplex in such a way that the path to the receiver is blocked. Two words of caution at the outset: The unit is designed for 50-ohm coax; and as the operating frequency increases, the power-handling capacity of the Dioplex rapidly drops off. Of course, 80-meter boys are limited to 5000 watts!

—*Lighthouse Larry*

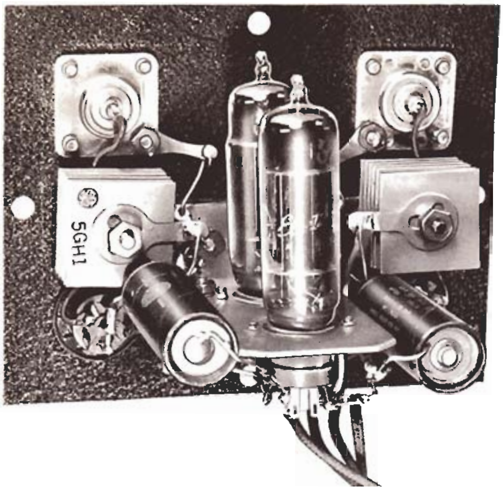


Fig. 4—Components of Dioplex mounted in space-saving arrangement

The Dioplex is a device for connecting a receiver to a transmitting antenna to obtain the advantage of as good an antenna for receiving as for transmitting. This is accomplished without moving parts—no relays with their clatter and possible erratic contacts to cause unexpected trouble. Since the action of the Dioplex not only is silent but instantaneous and positive, the receiver input circuits are afforded an even higher degree of protection from accidental or inadvertent damage than when a separate receiving antenna is used.

The Dioplex is used between a low impedance transmission line and the receiver as shown in Figure 1. With input and output impedances of 50 ohms, it is capable of protecting the receiver in accordance with the data in Table II. These figures are RF output—not d-c input. In most cases the allowable d-c input to the transmitter will be slightly higher. How much higher will depend, of course, on the efficiency of the final stage of the transmitter.

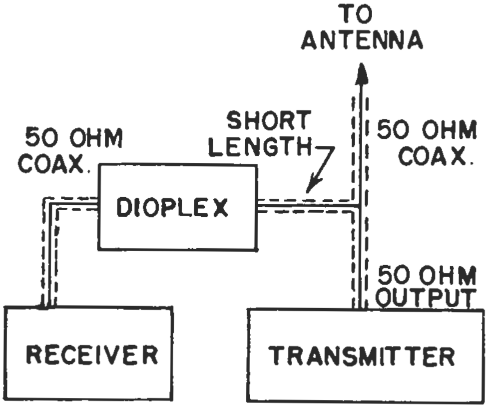


Fig. 1—How the Dioplex is connected

It is fortunate that at low frequencies where the receiving insertion loss is greatest, the practical effect on the received signal, though measurable, is still negligible. It is unfortunate, however, that the continuous power rating drops so rapidly with increasing frequency, and that the transmitting insertion loss, while constant, becomes a greater percentage of the permissible transmitter output.

CIRCUIT DETAILS

The complete circuit diagram for the Dioplex is shown in Figure 2. The input goes from a coaxial connector to a plug-in coil. Two biased 6X4 diodes operated back-to-back serve as a voltage-sensitive shunting element. Also, half of one of these tubes is used as a 60-cycle half-wave rectifier to provide diode bias from the transformer. The two selenium rectifiers serve merely as bias voltage stabilizers. The bias will be from 2 to 2.5 volts on each diode. A 3–30 micromicrofarad mica trimmer is used to compensate for variations in the internal tube capacities plus strays. Those interested in a more detailed description of the operation of the Dioplex are referred to the section headed "Thumbnail Theory."

CONSTRUCTION DETAILS

All components of the Dioplex except the transformer are mounted on one of the removable 4 x 5-inch plates of a Bud 3 x 4 x 5-inch utility box. The tube sockets are mounted on an L-shaped bracket that can be simply made of $\frac{1}{16}$-inch aluminum. Before the coil sockets and coaxial connectors are mounted, the paint should be scraped from the plate to assure good grounding. If sockets with built-in by-pass condensers are used (as in the model shown), the by-pass straps should be removed from pin 1 of V_1 and from pin 7 of V_2, since these points operate at RF potential. With ordinary sockets, ceramic by-pass condensers should be installed as close to the socket terminals as possible.

The transformer is mounted in the center of one of the 3 x 5-inch sides of the utility box with the leads from the secondary windings brought inside through a rubber grommet. The primary leads are left free for connection to the 110-volt a-c line. No switch is provided, since accidental damage to the Dioplex and possibly to the receiver can occur if the 6X4 tubes are not energized when transmitting.

Although wiring is not critical, a piece of tinned No. 14 wire is arched between the coil sockets. Keeping this lead in the clear reduces stray capacity and provides an easy method of connecting the plate of V_1, the cathode of V_2, and the "stator" of the mica compression trimmer. The "rotor" of the trimmer is bolted to the L-bracket next to the tube socket as shown so as to provide easy access to the adjusting screw through a $\frac{1}{4}$-inch hole drilled in the top plate. Tinned No. 14 wire also is used to ground the unused pins on the coil sockets, thus providing a measure of shielding.* Insulated wire is used for the other connections.

The high voltage and filament leads from the transformer—connected last—are left their original length and looped around inside the box after the top plate is attached. This makes it easy to remove the top plate should occasion rise.

COIL DATA

All coils are wound on Amphenol polystyrene 5-pin coil forms ¾ inch in diameter and 1⅝ inches long. Two identical coils are required for each band. Winding data is given in Table I. Since none of the windings is more than 1 inch long, the bottom turns can start ⅜ inch from the base of the forms. In each case, the bottom of the coil winding should connect with pin 3 of the plug-in form and the top of the winding with pin 1—thus providing the widest possible separation at the coil socket. If the winding information is followed closely, it should not be necessary to reset the trimmer condenser when changing bands. The turns should be sealed on the forms with Duco or G-E Glyptal No. 1286 cement. The end turns on each coil should be cemented all the way around the form, and then four strips of cement can be run lengthwise at 90-degree intervals to hold the entire winding in place.

Since polystyrene melts at a relatively low temperature, caution is advised in soldering the coil ends to the pins. The inside of each pin to be soldered should be reamed clean with a drill and a hot iron used just long enough to flow the solder into the pin tips.

GENERAL INFORMATION

It is necessary to assure that a d-c circuit path is

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* Some eagle-eyed readers may notice that six-hole sockets are used in the model illustrated. This is because they were at hand when this unit was built. The Amphenol 24-5H plug-in forms fit in the six-hole sockets made for the 24-6H coil forms.

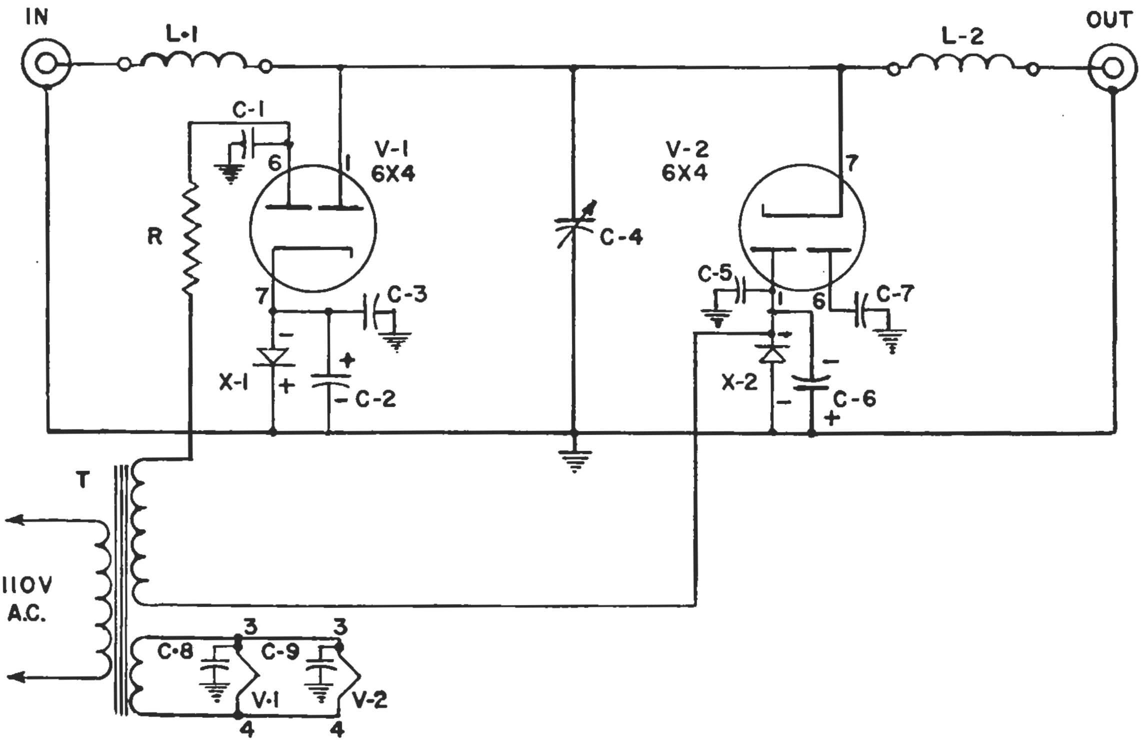

Fig. 2—Circuit diagram of the Dioplex

C_1, C_3, C_5, C_7, C_8, C_9—.001 mfd ceramic bypass
C_2, C_6—50 mfd. 50-volt electrolytic
C_4—3-30 mmf mica compression trimmer
L_1, L_2—(See text and Table I)
R—33,000 ohms, 1 watt
X_1, X_2—100 ma, 380-volt selenium rectifier (GE-5GH1)
T—Power transformer: Pri. 117 V 60 cy; sec. 117 V ½ wave @ 50 ma d-c, 6.3 V @ 2 A (Stancor PA8421)

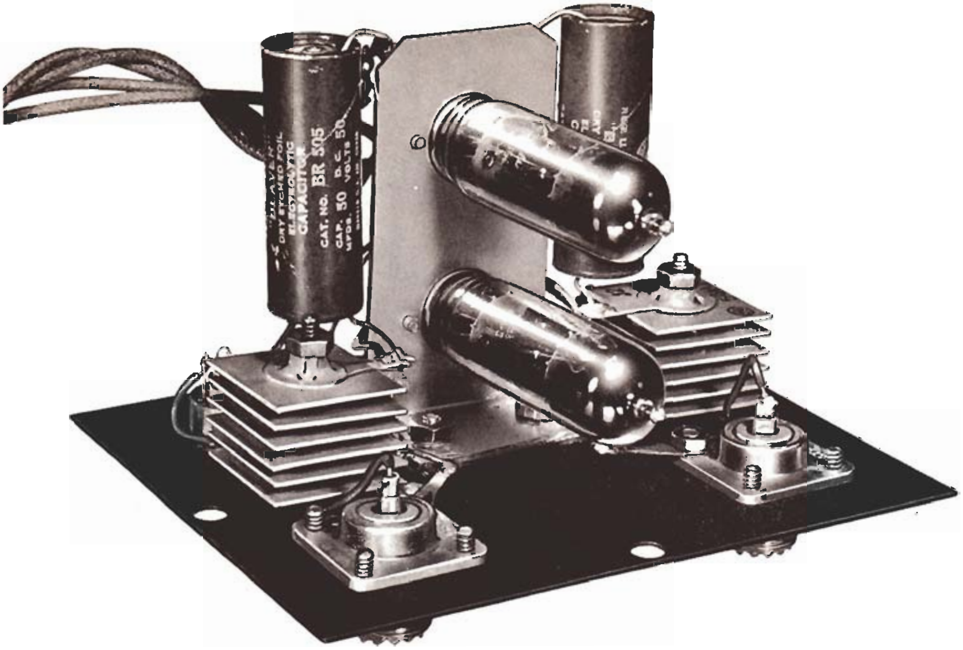

Fig. 3—The 6X4 diodes are mounted on a simple L-bracket

maintained between the coils and the chassis of the Dioplex. Ordinarily, the input coil of the receiver or the output link of the transmitter provides this path through the coax braid. In doubtful cases, this can be checked with an ohmmeter and if no d-c connection exists, a 2.5 millihenry pie-wound RF choke should be placed across one of the coaxial connectors of the Dioplex.

Since the Dioplex design is based on 50-ohm receiver input impedance, deviation from this value will affect principally the amount of power dissipated in the receiver when the transmitter is operating. If there is doubt about the input impedance of the receiver, a 51-ohm 1-watt resistor may be placed across the output connector of the Dioplex to assure that the combination of this artificial load and receiver never exceeds 50 ohms. In most cases, this shunting resistor will not degrade receiver performance.

The power ratings in Table I apply only when the input to the Dioplex—that is, the side that connects to the transmission line—is across a 50-ohm circuit. Simply using 50-ohm coaxial transmission line is not enough to assure that this condition exists unless the standing wave ratio on the transmission line is close to unity. The important consideration here, as far as the Dioplex is concerned, is that the RF voltage applied by the transmitter must not exceed 500 volts at 3.5 mc, 250 volts at 7 mc, 125 volts at 14 mc, 80 volts at 21 mc, and 56 volts at 28 mc. Keeping within these ratings will prevent a receiver from being burned out due to tube failure caused by overload.

The effect of a transmitter connection across the receiver input can be troublesome if the transmitter output stage is not biased beyond cutoff during reception. And with the Dioplex in place, the coupling between transmitter output stage and receiver is very good indeed for low-level extraneous signals sometimes generated in a transmitter that normally is considered "off." Operators of single-sideband stations know that an active output stage coupled to the antenna can cause local receiving difficulties. These difficulties will be greatly magnified with the Dioplex. Blocked-grid

TABLE I—COIL DATA

All coils wound with enamel or Formex insulated wire on ¾-inch plug-in forms (Amphenol 24-5H).

Band	Wire Size	No. of Turns	Length of Winding	Inductance (millihenries)
3.5	#32	110*	1 in.	0.125
7	#26	57*	1 in.	0.035
14	#19	29*	1 in.	0.00875
21	#19	20**	1 in.	0.004
28	#19	13**	¾ in.	0.0022

* Close-wound. ** Spaced.

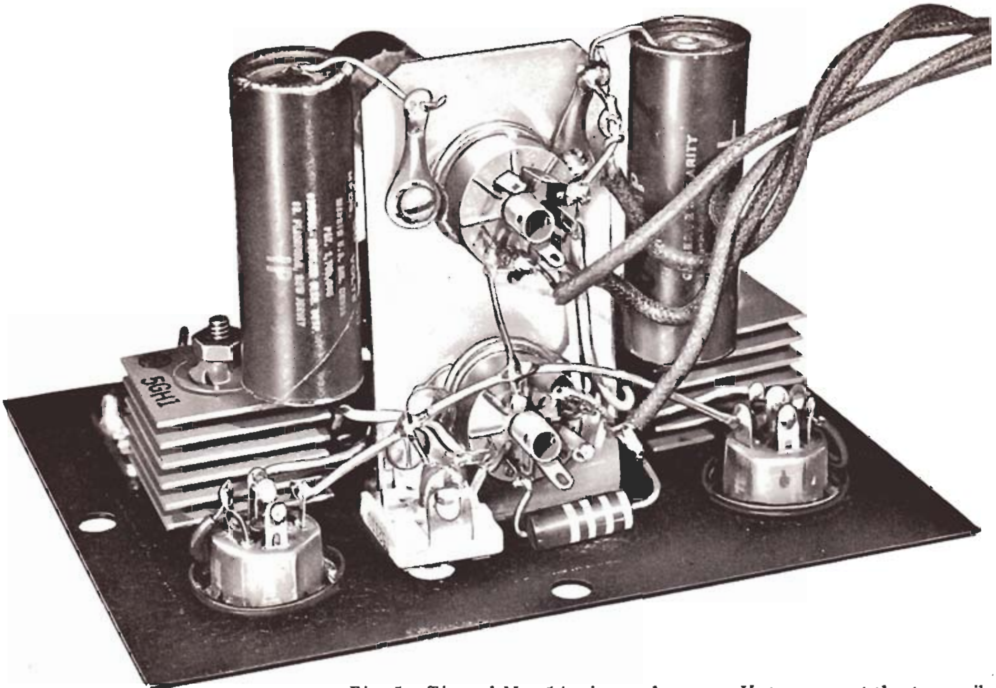

Fig. 5—Tinned No. 14 wire arches over V_1 to connect the two coil sockets

CW keying circuits or sufficient protective fixed bias on the output stage of the transmitter should prevent such troubles.

Note the polarities of the electrolytics and selenium rectifiers in the schematic. The cathode of V_1 should be positive with respect to ground, while plate 1 of V_2 should be negative with respect to ground. Thus the polarities indicated on the electrolytic condensers are correct. The selenium rectifiers are connected "backwards" to provide a stiff diode bias source without using much standby power. The GE-5GH1 rectifiers are marked with a red dot on one pole which in this case is connected where the plus signs are marked in the schematic. The d-c voltage across the electrolytic condensers should be checked before using the Dioplex to make certain only about 2 or 3 volts bias appears when the tubes warm up. Much more bias than this indicates either that the selenium rectifier connections should be reversed, or the rectifier is defective.

While in most applications the bias provided will be ample to prevent diode conduction during reception, exceptionally strong incoming signals reaching the Dioplex can cause cross-modulation. If this problem is encountered, two selenium rectifiers can be wired in series where one now is called for in the schematic. The bias then should be from 4 to 6 volts d-c on each 6X4 tube.

One final but important bit of advice. The transmitter never should be operated without the 6X4 tubes in place and the Dioplex energized. The primary of the Dioplex transformer can be connected in parallel with the primary of the filament transformer for the transmitter's output tube or tubes—thus assuring that a major part of the transmitter output will not be dumped into the receiver. Always use the coils for the band on which the transmitter is operating.

INSTALLATION AND OPERATION

As indicated in Figure 1, the lead from the transmission line to the Dioplex should be as short as practical. This connection can be made with one of the coaxial T-connectors, or the Dioplex input can be connected directly on the transmitter output terminals if that method is more convenient. The cable from Dioplex to receiver can be any convenient length. With the transmitter off, the proper Dioplex coils in place and the 6X4 filaments warmed for at least 30 seconds, the mica trimmer should be adjusted for best received signal strength near the high portion of the band. The same adjustment should hold for all bands. The Dioplex can, of course, be peaked for a favorite frequency.

Never attempt to run more than 5000 watts output on CW, AM or NBFM or 10,000 watts peak output on SSB on 80 meters! Similarly, keep within the ratings of Table II on other bands.

THUMBNAIL THEORY

The Dioplex is based on the principle of radar's "T-R box," using lumped-circuit constants instead of the transmission lines or waveguides common in radar techniques. A better description might be that the Dioplex is electrically a half-wave filter similar to the Harmoniker (G-E HAM NEWS, Vol. 4, No. 6, Nov.-Dec. 1949). But while best operation of the Harmoniker requires a reasonable impedance match, the Dioplex accomplishes its purpose by means of deliberate mismatch. In fact, the greater the degree of mismatch in this application, the better protection to the receiver.

A half-wave filter such as the Harmoniker effectively is "not in" a circuit of any impedance at the half-wave frequency. In describing the Harmoniker, a curve was given showing how the voltage on the center condenser varied with mismatch. The Dioplex takes advantage of this phenomenon so that a relatively light-duty short-circuiting device across the center condenser can thwart the efforts of a kilowatt rig to get into the receiver through the antenna terminals.

By placing biased diodes back-to-back across the center condenser of the half-wave structure, small signals do not cause conduction in the diodes—and the receiver is connected to the antenna feedline through the half-wave filter. However, when a signal from the transmitter appears across the input to the filter, the diodes become conducting and the receiver is substantially (but not entirely) isolated from the input. At the center condenser, the transmission line voltage is magnified by a factor approximately equal to the ratio of the reactance of one of the coils to the resistance of the load until conduction commences in the diodes. At this voltage, and at any higher input voltage, the magnification ceases and a current flows through the input coil into the diodes which have a net forward resistance of about 400 ohms.

Thus the device becomes a voltage divider of two stages—the first stage being the reactance of the input coil and the diode forward resistance, while the second stage consists of the reactance of the second coil and the input impedance of the receiver. Simply stated, then, the design objectives are: (1) As high a coil reactance as practical, (2) as low a diode forward resistance as possible, and (3) a relatively low load impedance.

These objectives place certain restrictions on the application of the Dioplex, and in effect limit its practical realization to low-impedance receiver input—from 50 to 300 ohms or so—and to operation in a low impedance point in the transmission line feeding the transmitter output to the antenna. This system works out nicely for 50-ohm coaxial circuits, and the design given for the Dioplex is for this application.

TABLE II—PERFORMANCE DATA

Band	Transmitter Output (watts)		Voltage at Receiver*	RF Input to Receiver* (watts)	Insertion Loss*	
	Cont. (Col. 1)	Peak (Col. 2)	(Col. 3)	(Col. 4)	Rec'g (Col. 5)	Xmt'g (watts) (Col. 6)
3.5	5000	10000	1.25	.03	6 DB	10
7	1150	10000	2.2	.1	3 DB	10
14	290	4500	4.5	.4	. .**	10
21	130	2000	6.4	.85	. .**	10
28	64	1000	8.5	1.45	. .**	10

NOTES

Col. 1—Determined by the safe continuous diode current.

Col. 2—Based on maximum safe input voltage, or an average duty cycle of one-quarter (whichever is lower) in the case of single-sideband suppressed carrier operation.

Cols. 3 & 4—Based on continuous CW, AM or NBFM output delivered to a 50-ohm receiver input. The RF power actually delivered to the receiver (Col. 4) will vary in direct proportion with the continuous transmitter output (Col. 1) in each band—*i.e.*, 145 watts continuous output at 14 mc. would deliver .2 watt to receiver.

Col. 5—Based on a coil Q of 100. Coils in unit described have a Q of about 150, so this rating is conservative.

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* Approximate.

**Negligible.

Inverted Speech Tricks That Can Be Performed with a Single Sideband Generator and Receiver.

Here's an interesting demonstration that can be performed before amateur radio clubs and other groups by someone who is willing to do an hour or two of rehearsal in advance. In fact, it would make an entertaining program to hold a contest among members at some club meeting to see who can talk in inverted speech the best!

I recently had the pleasure of addressing the Evansville-Owensboro Section of the Institute of Radio Engineers. My subject was the SSB Jr. rig described in this issue of the *Ham News*. D. E. Norgaard, W2KUJ, had also been invited to talk to this group, but he was unable to appear, so I made a wire recording of Don's talk and took it along with me.

Whenever Don or I give talks on single-sideband we like to demonstrate inverted speech, because it is so easy to produce with SSB equipment. As you know inverted speech is that strange sounding stuff that you hear on the short-wave bands on transoceanic communication systems. At least, inverted speech used to be used a great deal, although now more complicated systems of scrambling are employed.

At any rate, you produce inverted speech by taking an upper sideband, let us say, and placing it on the low frequency side of a carrier. This can be done on a receiver by tuning it on the high frequency side of a so-called upper sideband. The effect is to make low pitched sounds high in pitch and vice versa. You should hear the wolf-whistle coming through on inverted speech! I can guarantee that you would never recognize it.

In fact, until you become familiar with inverted speech it is practically impossible to recognize anything. For example, if you say "General Electric Company" into an inverted speech system, what comes out sounds like "Gwunree Oyucktruck Krinkino." Conversely, if you say the latter phrase into an inverted speech system, what comes out sounds like "General Electric Company."

In other words, you can form a new language, and if you speak this new language into an inverted speech system, what comes out is understandable English. As an example, "metz pee wee" means "nuts to you" and "eee wye" says "oh yeah." But you can go even further, as Don and I did. We decided that it would be nice to be able to recite the poem ***Mary Had A Little Lamb*** in inverted speech, and after an hour of intense concentration we succeeded in the decoding job.

We thought you would like to see this poem in "Sweeping the Spectrum," so here it is:

Naarow hod O yutty yarng,
Uts feeious yiz yelt uz snee,
Arnd I view hair bop naarow yump,
No yarng yiz sla pee bay.

A word of caution. When practising this poem in inverted speech language, make sure that you are alone. People have strange enough ideas of amateurs as it is!