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An All-Band Antenna and Coupler

By

J. H. Owens,*W2FTW

DO you want to work 75 or 80, 40, 20, and 10 meters with a single sky-wire? Is your space limited, and cost a factor? If so, here is a way to do it—with actual performance advantages over simple dipoles for each band.

The general idea is to take a 75/80-meter dipole and fold it so that desirable standing-wave voltage and current relationships are maintained on the higher-frequency, harmonically-related bands.

Fig. 1 shows the configuration and dimensions of the antenna. It is simply a 75/80-meter dipole with the ends folded back and over the center portion. It must radiate because it is resonant and unshielded. Since it radiates the energy that is fed to it, the only other major consideration is directivity. In this respect, it is less directional than a straight-line 75/80-meter dipole, and the angle of radiation is somewhat higher. This latter characteristic is desirable if you want to join the Rag Chewers on 75 and make regular contacts with stations inside a two- or three-hundred mile radius.

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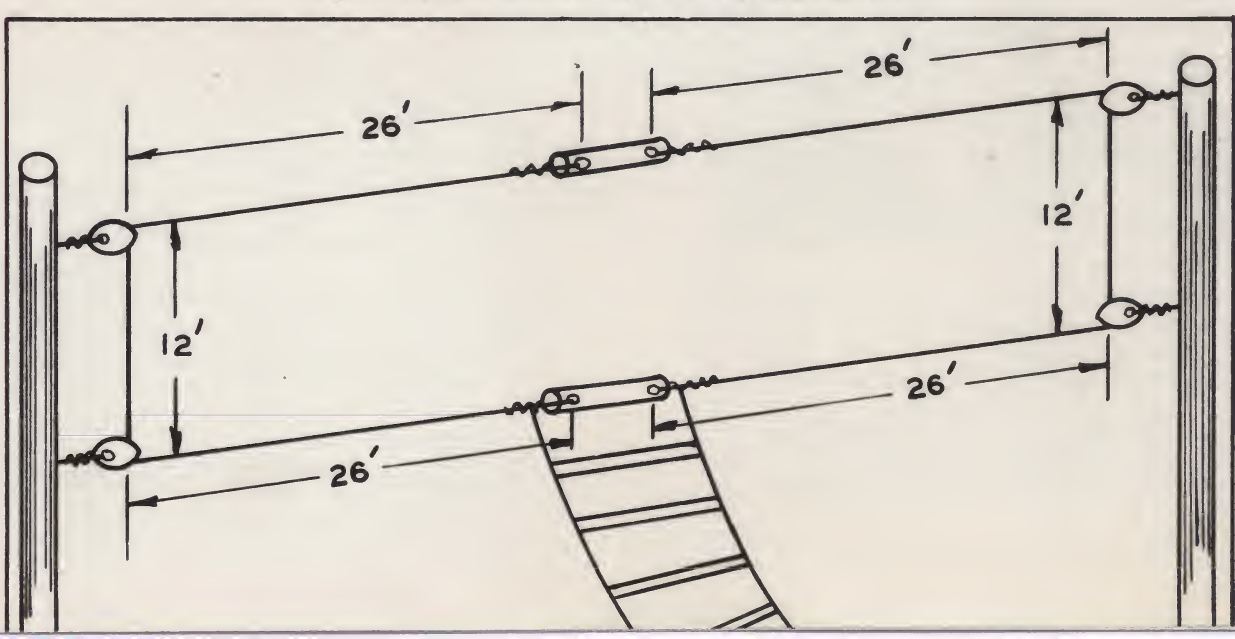
Fig. 2a shows maximum voltage points when the antenna is used on 40 meters. The antenna consists of two half-wave dipoles, partially folded, vertically polarized, and 180 degrees out of phase. The angle of radiation is somewhat lower than that of a dipole of equivalent height, and the directivity pattern is slightly end-fire.

Voltage points for 20-meter operation are shown in *Fig. 2b*. Here, the antenna approximates a beam because it provides two half-waves in phase on one side, which are in phase with the two in-phase half-waves on the other side. Best DX is obtained in the broadside direction in which the angle of radiation is low, but there are some minor lobes which provide satisfactory operation in all directions during periods of short skip.

Similarly, *Fig. 2c.* shows voltage points for ten meters. This arrangement provides two full-waves in phase on one side, but 180 degrees out of phase with the two in-phase full-waves on the other side. The field pattern is quite complex, and for all practical purposes may be considered omnidirectional. The pattern con-

Fig. 1. Layout and dimensions of the all-band antenna.



tains major lobes each having a low angle of radiation—a highly desirable feature for 10-meter DX.

Antenna Coupler

Like most all-band antennas, this one should be fed with tuned open-wire feeders employing four- or six-inch spreaders. An antenna coupler is employed to provide an impedance transformation, a means for tuning the antenna and feeders to resonance, and attenuation of harmonics. Any of the well-known antenna couplers will perform these functions conveniently and economically.

The coupler shown in *Fig. 3* is electrically the well-known, Pi-section filter with link coupling. It consists of two variable capacitors and a swinging-link, push-pull plate tank coil—the one for the next lower frequency band than the band to which the final amplifier is tuned. For instance, if the transmitter is being operated on 20 meters, the 40-meter coil would be used in the coupler.

Capacitors C_1 and C_2 can be of the split-stator type if the capacitance per section is double the values shown. Single-stator capacitors have been used with excellent results. The voltage rating of C_1 should be equal to that of the tank capacitor in the final amplifier, but C_2 need have a voltage rating of only half as much. Depending upon the length of the feeders, optimum loading may be obtained by connecting them across C_1 or C_2.

Tuning

In operation, the coupler is first tuned to resonance as indicated by an increase in the plate current of the final amplifier. The ratio of the capacitance of C_1 to C_2 is then varied to provide maximum loading of the final amplifier, and the swinging links are adjusted for desired plate current. The tuning procedure is the same for all bands.

Good results were obtained on all bands from 80 to 10 meters with an antenna less than 60 feet long and with its upper radiator only 20 feet above ground.

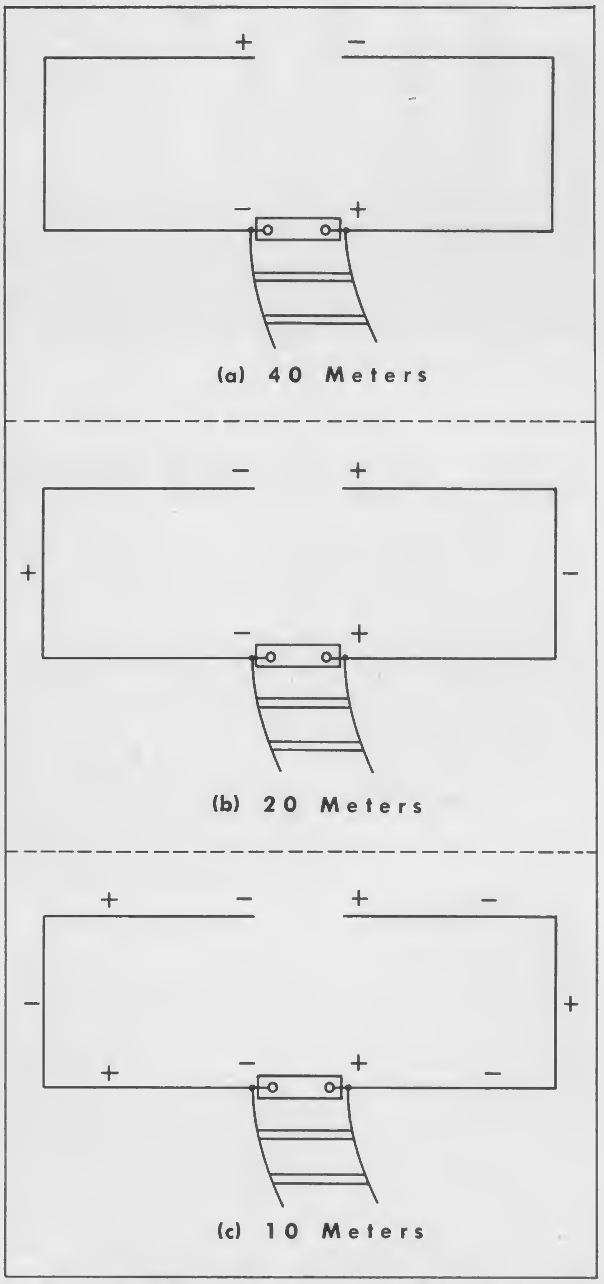


Fig. 2. Maximum voltage points on the antenna for 40-, 20-, and 10-meter operation.

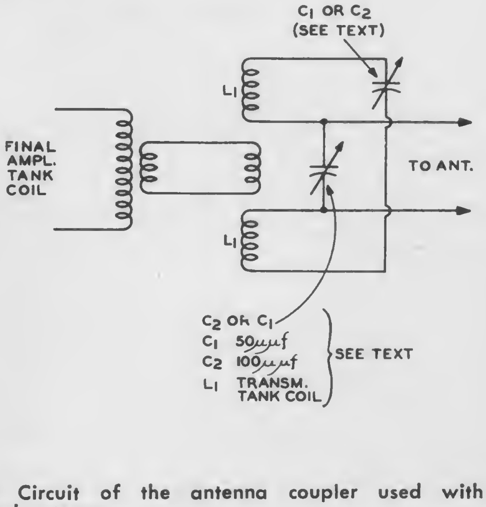


Fig. 3. Circuit of the antenna coupler used with the all-band antenna.

Do You Know of Any Would-Be Hams?

"You Can Be There" is an interesting pamphlet published by the American Radio Relay League to promote interest in the Novice Class, amateur-radio license. This booklet describes the romance and adventure to be derived from personal two-way, amateur-radio communication with stations throughout the world.

Copies of the pamphlet may be obtained by writing to the ARRL, West Hartford 7, Conn.

A New Superhet S-Meter Circuit

Combining the Second-Detector, AVC, Automatic Noise Limiter, First-Audio Stage, with a Bridge-Type Signal-Strength Meter

By
J. H. Owens, W2FTW

THIS article is another proof of the adage, "Necessity is the mother of invention." The equipment with which the author had to cope was a prewar "home-brew" receiver which performed better than many commercially-built receivers, but lacked such refinements as a signal-strength meter and an effective noise limiter. Although ways and means of adding these refinements are revealed in various publications, a new method had to be devised because the lack of chassis space prohibited the use of additional tubes.

It was indeed a difficult problem, but its eventual solution was accomplished by the use of well-known circuitry, two tubes, a 0-1 milliammeter, and relatively few components in a novel arrangement. The novelty lies in a unique circuit which takes full advantage of the many possible circuit arrangements for the multi-section tubes that were selected to replace those in the original complement. The circuit is shown in *Fig. 1.*

Second Detector and AVC Circuit

The second detector is the usual half-wave rectifier (one half of a 6H6) connected to the secondary of the last if transformer. The load network consists of R_2 and R_3, bypassed at the intermediate frequency by capacitors C_1 and C_2. AVC bias voltage is taken from the diode-load network and fed to the avc filter through R_1. If the receiver uses both sharp-cutoff and remote-cutoff tubes in the rf or if amplifiers, it may be desirable to supply two or more levels of avc bias.

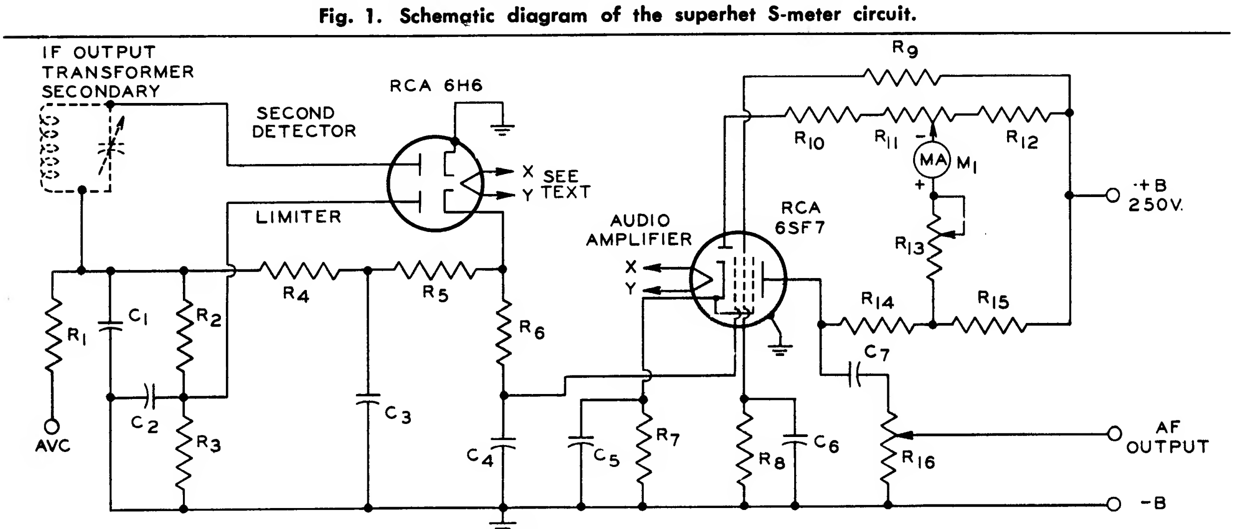
Tubes having a remote-cutoff characteristic should be biased through R_1 from the top of the network; tubes having a sharp-cutoff characteristic should be fed through another 2.2-megohm resistor from the center or other point on the network obtained by substituting two series-connected resistors in place of either R_2 or R_3. The rf amplifier tubes should be fed with only enough avc bias to prevent strong signals from overloading the if amplifier, because high gain in the rf stage is conducive to the best signal-to-noise ratio.

Automatic Noise Limiter

The popular "series-valve" circuit was selected for the automatic noise limiter because of its superior effectiveness, and also because it generates less of the raspy type of audio distortion so common to the "shunt-valve" circuits. The network is composed of the other diode section of the 6H6 together with R_4, R_5, C_3 and the diode-load network. A full explanation of the operation of this circuit can be found in the ARRL Handbook.

The only disadvantage of the series-valve limiter is a possibility of hum pickup. Capacitive coupling and ohmic leakage between the diode heater and its cathode can produce hum because the cathode is in a very-high-impedance,

Fig. 1. Schematic diagram of the superhet S-meter circuit.



Parts List

C_1, C_2 500 μμf, mica.
C_3 0.05 μf, paper, 400 v.
C_4 100 μμf, mica.
C_5 10 μf, electrolytic, 10 v.
C_6 0.05 μf, paper, 400 v.
C_7 0.05 μf, paper, 600 v.
M_1 0-1 milliammeter.

R_1 2.2 megohms.
R_2, R_3 270,000 ohms (See text).
R_4, R_5 1 megohm.
R_6 100,000 ohms.
R_7 150 ohms.
R_8 86,000 ohms (See text).

R_9 100,000 or 180,000 ohms (See text).
R_{10} 68,000 ohms.
R_{11}, R_{13} 500 ohms, w. w. potentiometer.
R_{12} 330 ohms.
R_{14} 47,000 ohms.
R_{15} 560 ohms.
R_{16} 1 megohm, potentiometer, audio taper.

NOTE
(All resistors ½ watt)

unbypassed circuit. Hum pickup can be avoided by employing a power transformer having a center-tapped and grounded heater winding. Another alternative is the use of a germanium rectifier; however, the conduction of this device in the reverse direction does not cut off completely—a characteristic which would lower its efficiency as a limiter.

In the author's receiver, one side of the heater-transformer winding is grounded; therefore, an RCA 6H6 was chosen for the limiter rectifier because its internal design is such that grounding either side of the heater transformer winding is just as effective as grounding a center-tap in keeping hum at a minimum. Because there are two 3.15-volt, series-connected heaters in the 6H6, the ac voltage difference between heater and cathode is reduced by 50 per cent as compared to that of many 6.3-volt, heater-cathode tubes. Furthermore, the RCA 6H6 employs double-helically wound heaters which make the tube inherently less susceptible to hum than a tube having a folded heater. The only precaution to be observed in grounding one side of the heater-transformer winding is the requirement that the limiter circuit employ the diode having the grounded heater. For example, if heater pin 2 is grounded, the diode connected to pins 3 and 4 should be used as the limiter; if heater pin 7 is grounded, then the diode connected to pins 5 and 8 should be used. The other diode section is then used as the detector. If these precautions are followed, no perceptible hum should be encountered.

Audio Amplifier

The audio amplifier is "diode-biased" for two reasons. First, this system keeps the ac/dc impedance ratio of the diode load near unity, a requisite for handling, with low distortion, signals having a high percentage of modulation. Secondly, this system provides a source of B+ voltage which varies in proportion to the input-signal level—a requisite for the S-meter circuit. Because the tube grid has to handle the avc voltage plus audio modulation, a low-mu or remote-cutoff characteristic is also required; otherwise, strong signals would cut off the plate current completely. The 6SF7 was chosen for this stage because of its large-signal-handling ability, plus the availability of a diode section which is used in the S-meter circuit. Note that the control-grid is fed through an RC network (R_6-C_4) which de-emphasizes frequencies above approximately 5 Kc.

The 6SF7 is shown in the circuit with its screen-grid voltage taken from a bleeder net-

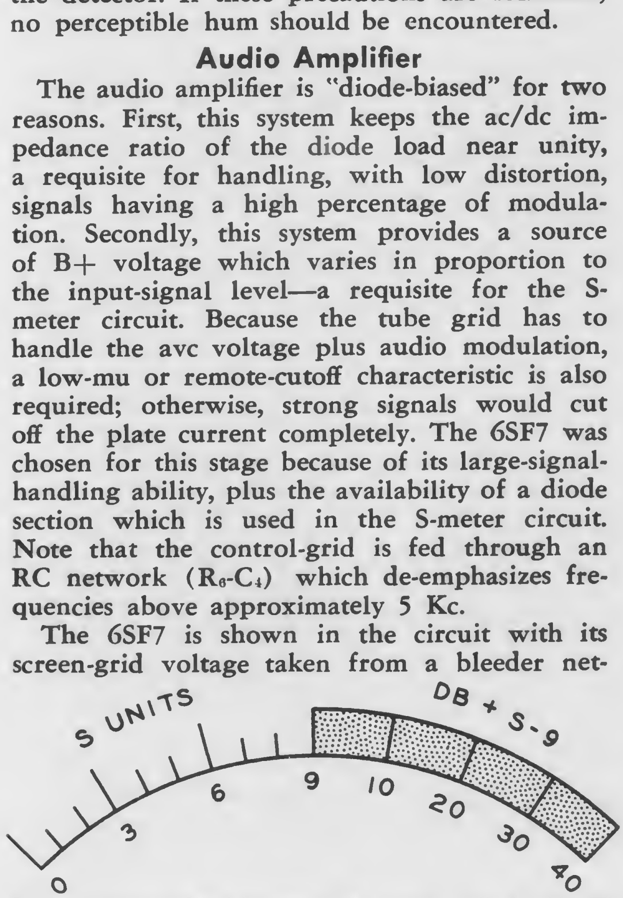


Fig. 2. Scale for the S-meter. The lower half is divided into nine equal divisions, and the upper half into four equal divisions (representing 10-db steps over S-9).

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J. H. Owens, W2FTW

W2FTW since 1946, ex-W3ASZ since 1932.

Home QTH: Merchantville, N. J.

Active on: 75- and 10-meter phone.

Rigs: 100 watts to an 829-B on 75, and 15 watts to a 2E26 on 10.

XYL: Marty.

Harmonics: James, Constance, and Susan.

Started career as a commercial radio operator. Joined RCA Photophone, Inc. in 1930. Transferred to Commercial Sound Div. of RCA during World War II. Joined Renewal Sales Section of the Tube Dept. in 1946. First post-war editor of HAM TIPS. Now Manager of Test and Measuring Equipment Sales.

work. This connection should be used if the receiver if amplifier uses only semi-remote-cutoff tubes (such as the 6SG7, 6BA6, or 6BJ6) and if the avc bias voltage is taken from the top of the diode-load network. If remote-cutoff tubes are used (such as the 6SK7, 6BD6, or 6SS7) in the if amplifier, the circuit should be modified so the 6SF7 acts like a triode insofar as avc signal bias is concerned.

This modification can be made by removing bleeder resistor R_8 and changing the value of dropping resistor R_9 to 180,000 ohms. The screen-grid voltage will then swing up and down with changes in signal level, and the cutoff characteristic of the tube will be greatly extended. With this circuit arrangement, the 6SF7 functions as a triode insofar as avc bias is concerned, but retains the high gain of a pentode insofar as audio is concerned. In both cases, a small amount of cathode-resistor bias is used to minimize the effects of contact potential, a variable factor which might upset normal operation of the circuit.

The output-circuit constants, coupling capacitor C_7 and volume control R_{16}, were chosen especially to feed the grid of a power-output tube. A pair of crystal phones will work well if it is connected between the arm of the volume control and ground. A modification can be made for efficient operation of magnetic-type phones by changing the volume control to a 100,000-ohm unit and adding a matching transformer with its primary connected between the volume-control arm and ground, and the phones connected across its secondary.

S-Meter Circuit

In the S-meter circuit, a novel adaptation of an electronic-bridge circuit is employed to obtain a difference in voltage between two points in a divider network. The 6SF7 plate and diode function as two arms of the bridge circuit so that the voltages across the bridge terminals depend upon the flow of electrons in a single tube. This arrangement prevents violent deflection of the meter needle when the receiver is first turned on because current starts to flow in each section quite uniformly as the cathode warms up.

This circuit has the desirable feature of up-scale meter deflection for an increase in strength of the received signal. Zero-adjustment is obtained by means of potentiometer R_{11}; this control locates a voltage point on the diode arm which is equal to the voltage at the junction of R_{14} and R_{15} (in the plate-circuit arm) during the absence of signal. When a station is tuned in, the detector develops a negative bias which is applied to the grid of the 6SF7 and, in turn, reduces the dc plate current without affecting the diode current. This reduction in plate current produces an increase in voltage at the positive meter terminal; the voltage at the negative meter terminal remains fairly constant. Thus, the meter is deflected by the current that flows as a result of the voltage difference across its terminals.

Depending upon the gain and the cutoff characteristics of the rf and if tubes used in the receiver, some minor adjustment of the bridge-circuit constants may be necessary in addition to the 6SF7 screen-grid circuit changes previously mentioned. High receiver gain and remote-cutoff tubes will act together to develop rather high avc bias which in turn causes wide-scale deflection with fairly weak signals. Conversely, low receiver gain and sharp-cutoff tubes can develop only a small amount of avc bias even when strong signals are received. Potentiometer R_{13} is a fine-adjustment control for setting the meter to S-9 for a signal that is just strong enough to quiet all of the receiver background noise.

No difficulty should be experienced if the screen-grid circuit of the 6SF7 is set properly so that its cutoff characteristic matches the cutoff characteristics of the tubes in the if amplifier, and if the proper avc bias on the diode-load net-work is selected.

Calibration of the S-meter scale is somewhat academic at best, inasmuch as the S-meter readings for most receivers are a function of receiver sensitivity (which varies with frequency) as well as with the level of the signal on the antenna-input terminals. In this circuit, meter deflection is quite logarithmic, thereby allowing uniform spacing of the scale divisions to indicate power levels in a db ratio. A satisfactory scale is shown in *Fig. 2.*

Adjustment

If a 22.5-volt "B" battery (such as the RCA VS102) is available, it will be found very useful in the adjustment of R_{13}. Connect a 50,000-ohm potentiometer across the battery terminals; then connect the positive terminal to ground. Next, connect the potentiometer arm to R_1 at the point marked "AVC." With the receiver rf gain control set at maximum, rotate the arm to the point where the receiver background noise disappears. The voltage on the arm of the potentiometer is now the same as the avc voltage that would be developed by an S-9 signal. Disconnect the arm of the battery potentiometer from R_1; connect it directly to the grid of the 6SF7, and adjust R_{13} so that the meter indicates S-9. This method is more convenient than listening for a signal of exactly S-9 strength.

Conclusion

This circuit was developed for a home-built communications receiver and is not intended as a suggested modification for commercially-built receivers. It is offered to the radio amateur who would like to further refine his own home-brew superhet.

It performs excellently, and the audio quality is good enough so that means for switching the limiter diode in and out of the circuit are not required.

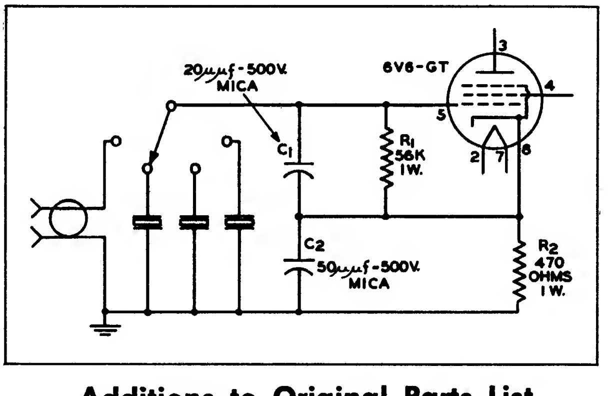
OMISSIONS
(Novice-Transmitter Article)

As originally conceived by W2BVS, the Novice transmitter described in the July 1952 issue of HAM TIPS was designed for operation on 80 meters.

The design was later changed to appeal to the General-Class operator by using plug-in coils for 80, 40, and 20 meters, and by modifying the basic crystal-oscillator circuit to the grid-plate type.

We neglected to inform our drafting department of the circuit changes; consequently, the schematic diagram on page 5 of the July issue contains the original oscillator circuit.

The changes shown in the following schematic diagram are necessary to obtain harmonic output from the oscillator.



Additions to Original Parts List

L_1	B & W 40M "Baby," 8 turns removed.
	B & W 20M "Baby," 6 turns removed.
	Optional Line Filter
C_A, C_B, C_C	0.01, μf, 600 v.
L_A, L_B	35 turns No. 12 solid enameled wire on a ½-in. diam. fibre (or wooden dowel) form. Wound to a length of 2½ inches.

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6L6		6F6	6F6	6F6	6F6			6F6
6J5						6J5	6J5	
6J5						6J7		
6L6		6L6	6L6	6L6	6F6		*6L6	6F6
6N7			6N7					6N7
6SJ7						6SJ7		
6SL7-GT							6SL7-GT	
6SN7-GT						6SN7-GT	6SN7-GT	
6V6-GT		6V6-GT	6V6-GT	6V6-GT	6V6-GT			6V6-GT
Miniature Types								
†5879						5879		
6AK6	6AF4							
6AK6	6AK6	6AK6	6AK6	6AK6				
6AQ5								6AQ5
6C4	6C4	6C4	6C4			6C4	6C4	
6J6	6J6	6J6	6J6	6J6	6J6			
12AX7						12AX7		

*Triode Connected †Special Type

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This suggested list of RCA Tubes is prepared for your convenience in selecting small-size tube types for economical low-power-level applications.

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Joseph Pastor, Jr., *Editor* W2KCN

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