RADIO

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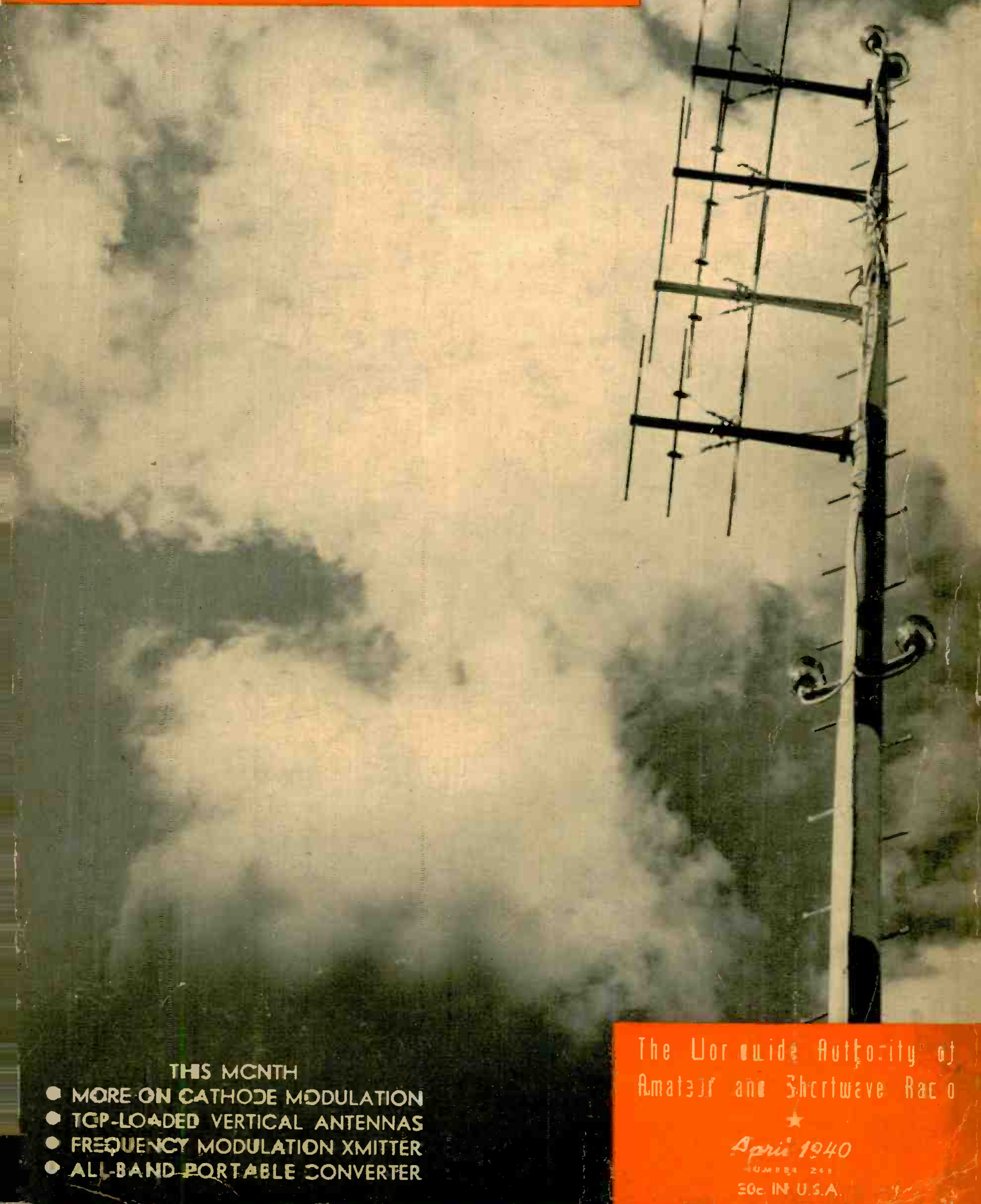

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April 1940
NUMBER 248
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THE EDITORS OF
RADIO technical publishers
1300 Kenwood Road, Santa Barbara
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Past • Present and • Prophetic

Duel

Anyone who doubts that the editors of this magazine are really and truly hams should listen in on one of the "discussions" that usually rages the minute any one of said editors starts extolling the advantages of a new piece of equipment he has designed. Take, for instance, the case of the field strength meter described last month. The standard field strength meter arrangement for lab use has been the one shown by Dawley in the April, 1938, issue. This meter combines low cost, portability and reasonably high sensitivity. However, Editor Smith thought it might be possible to build one with higher sensitivity that would require but few more parts. After running through all the circuits from a diode with d.c. amplifier to the superhet type he wound up with the grid leak detector arrangement described in the article.

When Smith's f.s. meter was finished Dawley immediately challenged him to a duel with field strength meters at any distance. The challenge was accepted and with various members of the staff standing by as seconds, cheering section and onlookers the test was run off. The result? Smith by a nose. And now we have two good field strength meters. Dawley's has a few less parts but Smith's is a little more sensitive to weak signals; take your pick.

Straw Vote

To help us to know what you want to read about we have been conducting a little "Gallup Poll" of our own on your interests. If you are one of those who received a questionnaire and have not yet dropped the reply card in the mail, will you please check it and send it on its way? Some of the things we are learning from the poll have rather surprised us. If anything really important or startling turns up we will let you know in a future issue.

80 and 160 in Your Own Back Yard

One of the things that we don't need a poll to tell us is that a large group of you want some dope on simple but effective "power gain" antennas (not necessarily directional) for the lower frequencies. This is a hard nut to crack. The broadcasters have put a lot of thought to the problem, and while they have some pretty effective antennas for their purposes they aren't exactly simple. However, Maurice Kennedy's top-loaded verticals on page 20 are one solution to the problem. And this type doesn't require an acre of salt marsh for effective operation.

History Repeats

Many years ago the amateurs were given everything below 200 meters because these frequencies "weren't much good for anything." It later turned out that these kilocycles were the most valuable portion of the spectrum; so the amateur had to give back the lion's share of these frequencies.

A few years ago the amateurs were given generous allocations in the u.h.f. range because "there is so much room down there and the frequencies are not needed for anything anyhow, at least for the present." A short time ago we lost some of our u.h.f. allocation; we couldn't prove that we were using it to good advantage.

What with the current scramble for u.h.f. allocations, now that these frequencies are in such demand for police, facsimile, frequency modulation, television, etc.; it behooves the brethren to begin making better use of the amateur frequencies above 30 Mc. This is especially true in view of the fact that the F.C.C. "reserves the right to cancel or change these frequencies without advance hearing or notice," when speaking of the 112- and 224-Mc. bands.

Besides, it appears that playing with frequency modulation on the ultra highs is going to be more fun than working dx, at least until some of the dx returns to the air. To help get things started Associate Editor Norton built up the f.m. tranmitter shown on page 11. If the 75 watts of output happens to be more than you need at the present, less power may be obtained by applying the same design principles to smaller tubes. A lower powered version will appear shortly.

You Can Take It With You

If you like to keep in touch with the amateur bands no matter where you happen to be, Technical Editor Dawley's battery powered converter on page 23 will prove to be a handy piece of equipment to keep in the car. With this converter the amateur and shortwave broadcast bands will be available wherever there is a broadcast receiver. When used with a battery portable broadcast set or

[*Continued on Page 91*]

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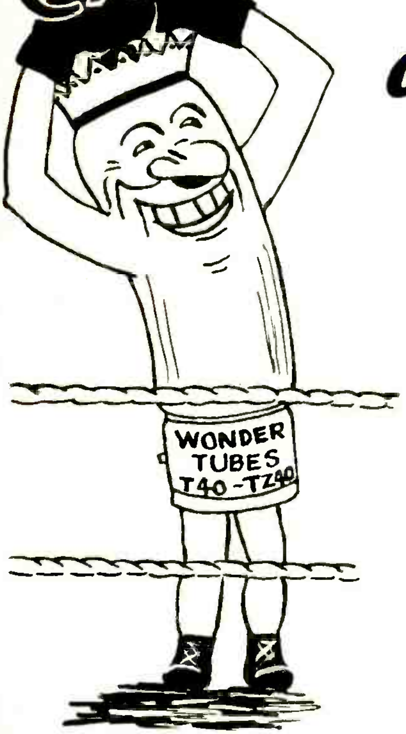
Taylor's



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Cover: The 2-meter beam antenna of WEOD atop the Yankee Network studios in Boston.

ARTICLES

MISCELLANEOUS FEATURES

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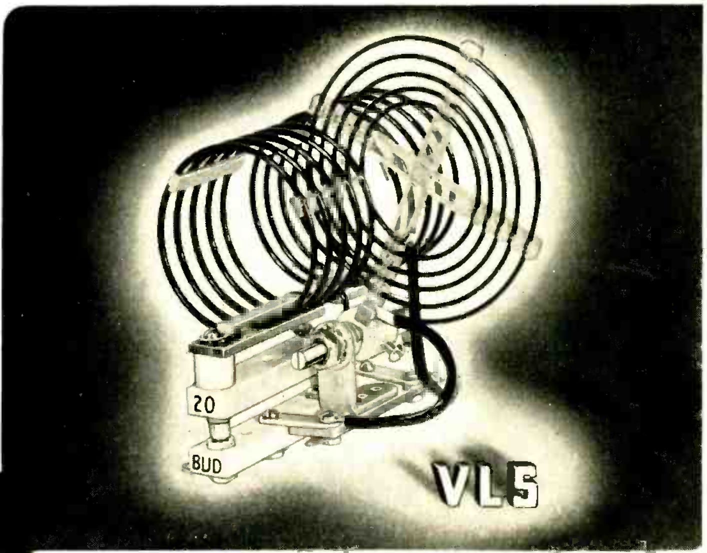

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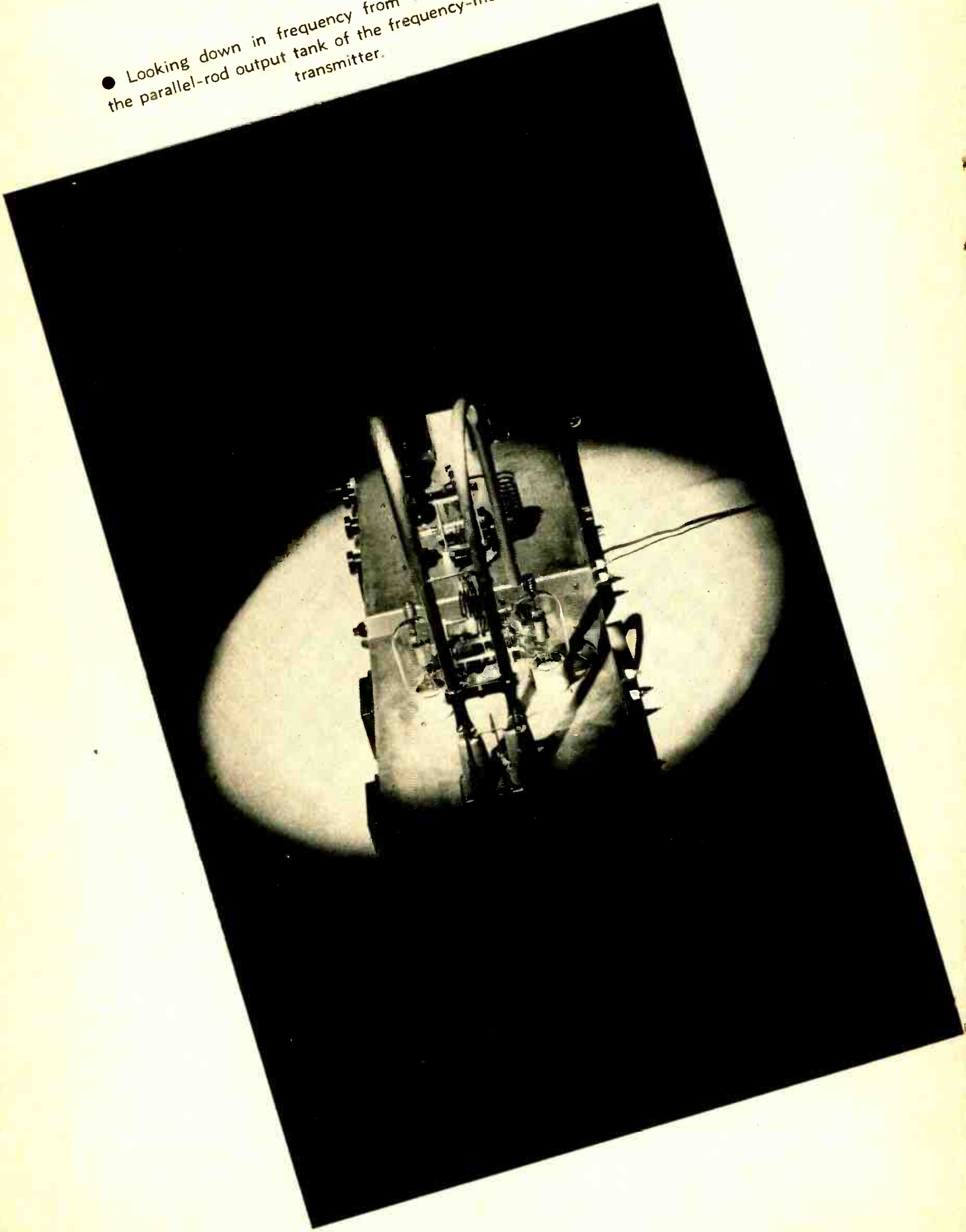
● Looking down in frequency from 114 Mc. through the parallel-rod output tank of the frequency-modulation transmitter.



A 2.5 Meter

FREQUENCY MODULATED TRANSMITTER

By LEIGH NORTON,* W6CEM

Frequency Modulation has caused quite a flurry of excitement in both amateur and commercial ranks. The transmitter described in this article is designed to put out 75 watts of f.m. in the 114-Mc. band. Those interested in the highly intriguing f.m. subject will find that the transmitter should answer their requirements in regard to power and "modulation capability."

Whether we like it or not it appears that we are going to have to put up a fight to retain our u.h.f. bands. The commercial television and frequency modulation interests are going to require large slices of ultra-high frequencies for these wide-band services, and non-occupancy of our portions of the u.h.f. spectrum is practically an admission that we are not interested in retaining them.

Frequency modulation, with the many advantages it shows—particularly those in regard to modulator power and noise suppression—is reviving general amateur interest in the 112- and 224-Mc. bands. This is a healthy sign and it is to be hoped that the advantages to be obtained through the use of f.m. will justify the renewed interest.

F.M. Fundamentals

The theory of frequency modulation has been well covered in the amateur press[1] and will not be gone into here except where it influences the transmitter to be described. One of these points of influence is in the choice of frequency "swing" under modulation which the modulator must provide. The noise-suppression characteristic of f.m. is directly related to the bandwidth used, or the swing each side of center frequency under modulation, and the audio pass band of the receiver. Generally speaking, the greater the swing the greater is the noise suppression for a given receiver *audio* pass band, provided the receiver i.f. stages will accommodate the wider swing. And here we have the insect in the ointment—using a wider swing in the transmitter than the receiver is designed to handle will result in distortion of the received signal. Therefore we must have some sort of a standard — some generally accepted amount of swing which, loosely speaking, will correspond to "100 per cent" frequency modulation in amateur practice. For this purpose the 50-kc. total swing suggested by Grammer and Goodman[1] would seem to be an entirely satisfactory starting point. A linear frequency-modulation voltage characteristic is not too difficult to obtain in the transmitter over this range, and a reasonable amount of amplification may be obtained in receivers using i.f. stages having a bandwidth of this order.

However, we must not make the mistake of definitely tying ourselves down to such a relatively small swing (compared to the 100-150 kc. range used by the commercial services) without first making a thorough investigation of the advantages, if any, to be obtained through the use of a wider band. In any case, the transmitter should be capable of

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* Associate Editor, RADIO.

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[1] Kruse, "Armstrong System of Modulation," RADIO, January, 1936, p. 62. Singer and Harrison, "Frequency Modulation Fundamentals," RADIO, January, 1939, p. 13. Seiler, "An Experimental Frequency Modulated Transmitter," RADIO, January, 1939, p. 75. Noble, "Frequency Modulation Fundamentals," *QST*, August, 1939, p. 11. Grammer and Goodman, "Wide-Band Frequency Modulation in Amateur Communication," *QST*, January, 1940, p. 11.

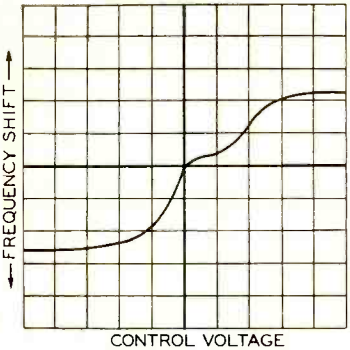

Figure 1. A typical frequency-voltage characteristic of some of the simpler modulators tried. The linear portions of the curve are too short to give any promise of successful use as frequency modulators.

the wider swing to allow its effective use with receivers capable of accommodating greater bandwidths; the maximum sensitivity in the receiver will be obtained when the transmitter swing corresponds to the swing which the receiver is designed to handle.

When a superregenerative type receiver is used, the receiver's audio output increases with the transmitter swing under modulation. In the transmitter to be described in this article the increase in audio output from a superregenerative receiver varied directly with the transmitter swing up to 800 kc., which is the maximum linear swing obtainable with the modulator used.[2]

These considerations seem to call for a wider frequency modulation capability in the transmitter than is expected to be necessary under most conditions. This is necessary if any worthwhile experiments are to be carried out, and also to allow the effective use of the simple superregenerative receiver whenever it may be deemed advisable or convenient to do so.

The Frequency Modulator

There are numerous methods of obtaining frequency modulation. These vary in complexity from the Armstrong phase modulation system[3] at one extreme to the simple loop-modulation process at the other. For amateur purposes it is essential that the frequency modulator be simplified as much as possible—as long as the simplification does not cause non-linearity or amplitude modulation. Almost any of the simpler systems will give linear frequency modulation over a small range of swing and still be essentially free from amplitude modulation. Unfortunately the linear range of the simpler systems is usually not great enough to permit a 50-kc. swing at 2½ meters. A hypothetical example of a typical frequency modulation voltage characteristic of an average simple system is shown in figure 1. This characteristic is not necessarily that of any one of the simpler systems in particular, it is merely representative of the average observed voltage-frequency characteristic of some of them. Some of the systems tried were worse than this curve shows, some were better. Some of them even showed a reversal of frequency-voltage relationship after a certain point was reached. In nearly every case a certain amount of amplitude modulation was observed. While amplitude modulation to a certain degree in a positive direction can be tolerated in a frequency modulated transmitter which has several stages between the oscillator and the antenna, its presence in a negative direction to any great extent will necessarily result in negative amplitude modulation of the output and must be avoided.

It is quite possible that some of the frequency modulation systems which were tried and rejected during the process of development of the transmitter may respond to compensating factors which be be introduced into them. Further experimentation along these lines is being carried out at the time of this writing. Some of the possibilities include the use of a vacuum tube as a variable resistance in a series with a reactance, either inductive or capacitive, coupled to the oscillator tank,[4] the use of the no 4 grid in a pentagrid converter tube such as a 6A8 as a frequency varying element,[5] and the use of plate voltage variable at audio frequencies on an e.c.o., the screen voltage being fixed and the output being taken from the grid tank. Another possi-

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[2] It might be thought that a swing of this magnitude would cause considerable interference, and this is true where amplitude modulation receivers are concerned. However, commercial experience has shown that as long as the ratio between the desired and undesired frequency modulated signals exceeds two to one no interference will be noticeable in a f.m. receiver.

[3] Armstrong, "A Method of Reducing Disturbances in Radio Signaling by a System of Frequency Modulation," *Proc. I.R.E.*, May, 1936.

[4] Travis, "Automatic Freqeocy Control," *Proc. I.R.E.*, October, 1935. Crosby, "Frequency Modulation Propagation Characteristics," *Proc. I.R.E.*, June, 1936. Mathes and Whitaker, "Radio Facsimile by Sub-Carrier Frequency Modulation," *RCA Review*, October, 1939.

[5] *RCA Application Note No. 87*, figure 4.

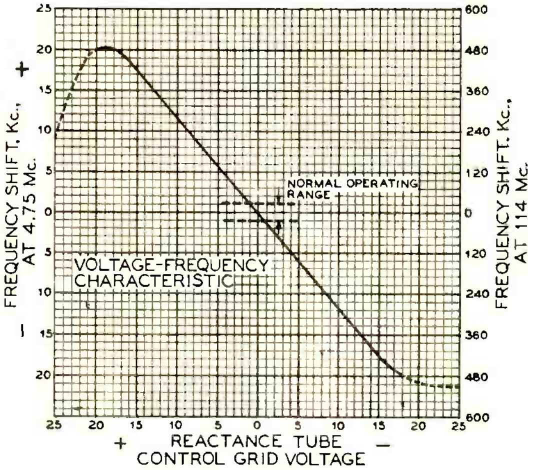

Figure 2. The voltage-frequency characteristic of the reactance-tube modulator. The portion of the curve labeled "normal operating range" is that part required for a 50-kc. total swing at 114 Mc. The drop-off at the extreme positive end of the curve is caused by the grid going considerably positive.

bility is the use of a short length of line to transform a variable resistance such as a vacuum tube to a variable reactance in series with the oscillator tank.[6]

Reactance Tube Modulator

The best of the frequency modulators tried in the experimental layout of the transmitter proved to be the conventional reactance tube. That is, the reactance tube modulator is conventional as far as the appearance of the circuit goes; the correct values of the components are rather critical in some parts of the circuit.

The reactance tube is a useful gadget originally intended to be used as a frequency-varying element in broadcast receivers using a.f.c. There are numerous variations of the basic circuit but the essential requirement is that the grid be supplied with an r.f. voltage of such a phase that the plate draws a lagging current, the plate-cathode circuit of the reactance tube being connected across the oscillator tank. The effect of the lagging current drawn by the reactance tube is to make it appear as an inductance to the oscillator tank. Thus the oscillator tank circuit has two inductances in parallel, the oscillator coil and the reactance tube. The effect of two inductances in parallel is a resultant inductance less than either of them. Hence the frequency of the oscillator is raised by the application of the reactance tube. Since the effective inductance presented by the reactance tube may be varied by varying its transconductance, a convenient method of varying the resultant oscillator tank inductance, and consequently the oscillator frequency, is provided. When this inductance is varied at an audio frequency we have frequency modulation at an audio rate.

There are probably a dozen different configurations of the basic reactance-tube circuit. The difference in the various arrangements is principally in the method used to obtain the required phase difference between the r.f. voltages on the plate and grid of the reactance tube. The simplest of these arrangements is the one used in the transmitter. Here a 90-degree shift is obtained by the use of a resistance-capacity network acros the oscillator tank. In this case R_6 is the resistance in question and the capacitance is provided by the grid-to-cathode capacity of the 6SJ7 and the distributed capacity of the r.f. choke. Condensers C_6 and C_7 serve merely as coupling condensers to isolate the d.c. voltages in the circuit. Resistor R_7 improves the linearity of the frequency modulator; when it is omitted from the circuit the voltage-frequency characteristic of the circuit falls off rapidly on the positive grid voltage side. The use of a series screen resistor and a rather high value of semi-fixed bias on the reactance tube are other factors which aid in giving linearity to the frequency modulator. The values of resistors shown should be duplicated exactly if similar results are to be expected.

The result of the experimentation which went into the choice of values for the reactance-tube components is shown graphically in figure 2.

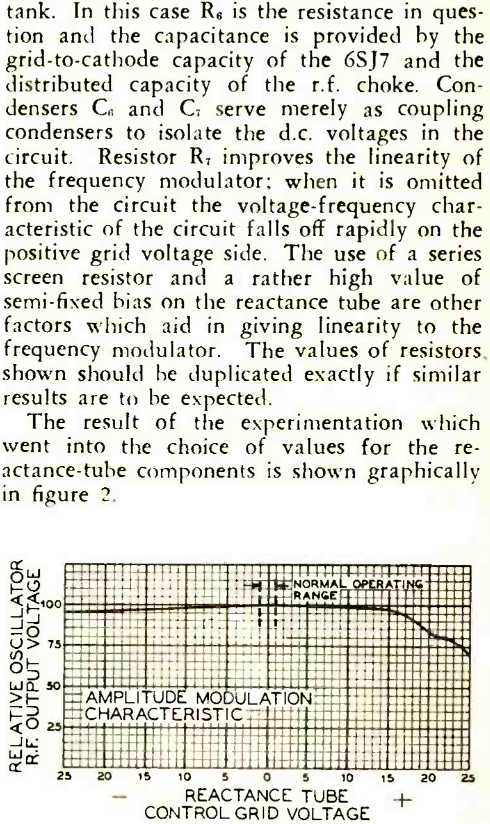

Figure 3. Amplitude modulation characteristic of the frequency modulated oscillator. The amplitude modulation may be seen to be so small as to be insignificant.

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[6] Eastman and Scott, "Transmission Lines as Frequency Modulators," *Proc. I.R.E.*, July, 1934.

From the graph it may be seen that the reactance-tube frequency modulator is linear far beyond the 50-kc. swing expected to be required for operation with a frequency modulation receiver. In fact the linearity extends approximately 400 kc. each side of center frequency, or a total swing of 800 kc. This wider range allows the effective use of a superregenerative receiver when the occasion may arise and also provides a linearity "safety factor" when used with conventional frequency modulation receivers, even when a swing of 200 kc. or more is required by the receiver for full output. For normal operation (50-kc. swing) a peak audio voltage of but 0.8 volt is required at the grid of the reactance tube.

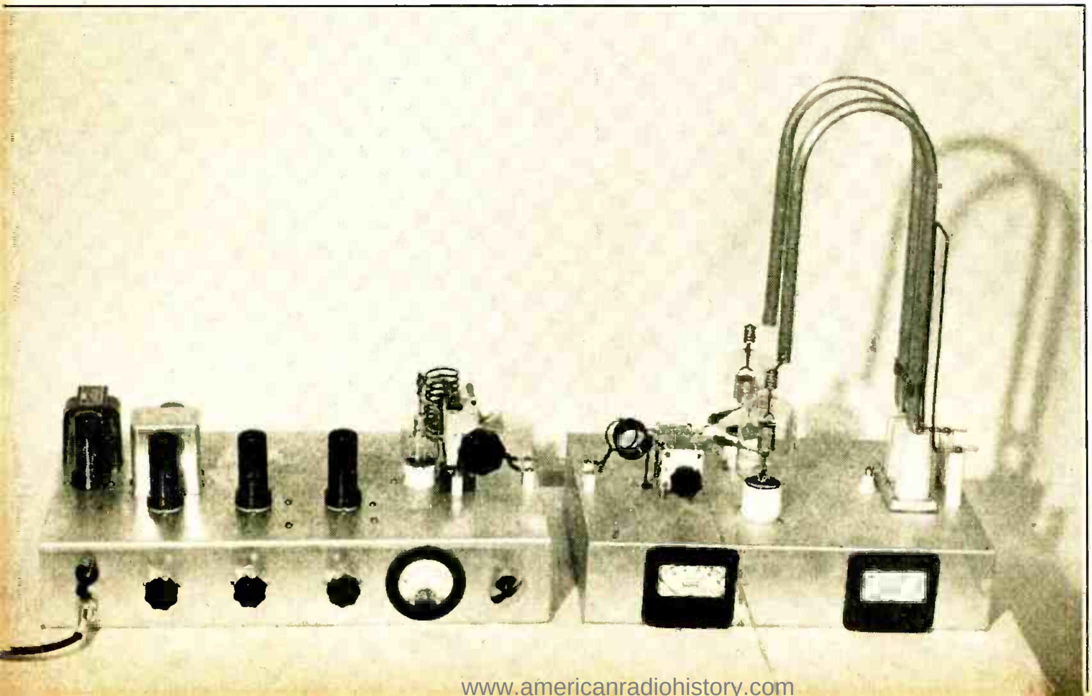
The amplitude-modulation characteristic of the oscillator is shown in figure 3. Here the relative oscillator tank r.f. voltages are plotted against the modulator grid voltage. As in figure 2 it may be seen that the circuit is capable of handling considerably more frequency modulation than is expected to be necessary. The amplitude modulation, while all in a negative direction, amounts to less than 5 per cent at modulator grid voltages corresponding to an 800-kc. total swing. Over the operating range (50-kc. total swing) no measurable amount of amplitude modulation was observed. A check on the complete transmitter showed no measurable amplitude modulation over the linear range of the modulator, indicating that the small amplitude modulation in the oscillator when it is frequency modulated to such an extent that a deviation of 400 kc. each side of center frequency is obtained is wiped out in the succeeding transmitter stages.

Exciter R.F. Lineup

The use of a power push-pull tripler as the output stage of the transmitter required that the exciter end up with a stage operating on 38 Mc. for an output frequency of 114 Mc. There are a large number of oscillator frequencies which in conjunction with various combinations with doublers, triplers, or quadruplers will yield the desired output frequency. However, since it was desired to use an HK-24 as a doubler in the output stage of the exciter and thus do away with neutralizing worries, the excitation requirements seemed to call for two doubler stages between the oscillator and the exciter output stage.

The original design of the exciter called for 6L6's in the doubler stages. The 6L6's looked all out of proportion driving the diminutive HK-24, however, so 6F6's were substituted to "see what would happen." Nothing happened except that the tube cost went down considerably — the output as indicated by the grid current to the HK-24 remained the same.

The transmitter is constructed on two chassis. The exciter at the left puts out frequency modulated r.f. at 38 Mc., which is tripled to 114 Mc. by the output stage at the right.



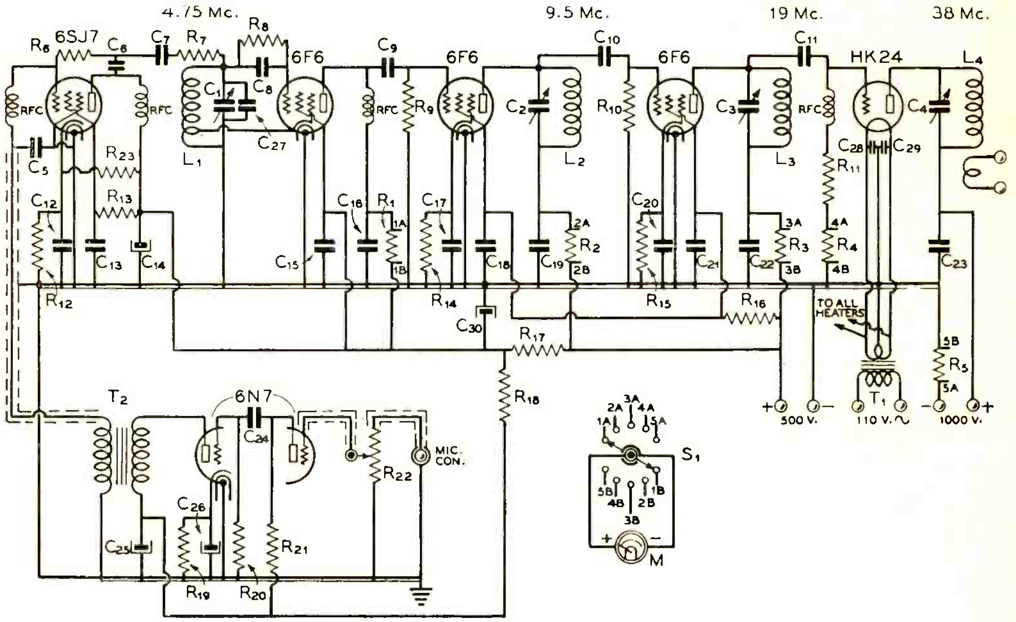


Figure 4. Wiring Diagram of the Exciter.

C_1—75-µµfd. midget variable
C_2—35-µµfd. midget variable
C_3—25-µµfd. midget variable
C_4—20-µµfd. variable, .070" spacing
C_5, C_6, C_7—.003 µfd. mica
C_8—.0001-µfd. mica
C_9—.0001-µfd. mica
C_{10}, C_{11}—.00005-µfd. mica
C_{12}—.01-µfd. 400 volt tubular
C_{13}—.003-µfd. mica
C_{14}—8-µfd. 450 volt electrolytic
C_{15}, C_{16}, C_{17}, C_{18}, C_{19}, C_{20}, C_{21}, C_{22}—.003-µfd. mica
C_{23}—.002-µfd. 2500 volt mica
C_{24}—.02-µfd. 400 volt tubular
C_{25}—8-µfd. 450 volt electrolytic
C_{26}—10-µfd. 25 volt electrolytic
C_{27}—100-µµfd. zero temperature coefficient ceramic
C_{28}, C_{29}—.003-µfd. mica
R_1, R_2, R_3, R_4, R_5—50 ohms, 1 watt
R_6—100,000 ohms, ½ watt
R_7—2500 ohms, 1 watt
R_8—60,000 ohms, 1 watt
R_9—100,00 ohms, 1 watt
R_{10}—150,000 ohms, 2 watts
R_{11}—25,000 ohms, 10 watts
R_{12}—1000 ohms, 1 watt
R_{13}—50,000 ohms, 1 watts
R_{14}, R_{15}—500 ohms, 10 watts
R_{16}—15,000 ohms, 10 watts
R_{17}—5000 ohms, 20 watts
R_{18}—10,000 ohms, 1 watt
R_{19}—2000 ohms, ½ watt
R_{20}, R_{21}—50,000 ohms, ½ watt
R_{22}—1 megohm potentiometer
R_{23}—50,000 ohms, ½ watt
S_1—Two section, 5 position "Ham-switch"
T_1—6.3 volts, 10 amps.
T_2—Triode plate to 500-ohm line
RFC—2½ mh.
M—0-150 ma.
L_1—17 turns of no. 22 d.c.c. wound to a length of ⅞ inch on 1¼" dia. form. Cathode tap 6 turns from ground end.
L_2—20 turns no. 14 enam. 1" dia., 1⅝" long
L_3—15 turns no. 14 enam. ¾" dia., 1⅜" long
L_4—10 turns no. 10 enam. 1" dia., 2½" long

The oscillator is also a 6F6. It is arranged as a conventional e.c.o. with impedance coupling to the following stage. Omitted from the diagram is a 25,000-ohm, 2-watt series dropping resistor to the oscillator screen. The output obtained across the plate r.f. choke is not great, but it is sufficient to excite the following doubler to full output. A moderate amount of capacity across the oscillator tank coil is provided by a 75-µµfd. midget variable in parallel with a 100-µµfd. zero temperature coefficient ceramic condenser. With the coil specified in the diagram caption the capacity required to hit 4750 kc. in the oscillator is about 160 µµfd., 100 µµfd. of this being supplied by the fixed condenser, of course.

The two doubler stages following the oscillator are quite conventional. The two stages are identical with the exception of tank circuits and grid leaks. R_9, the grid leak for the first stage is a 100,000-ohm 1-watt unit while R_{10} in the second stage has been made

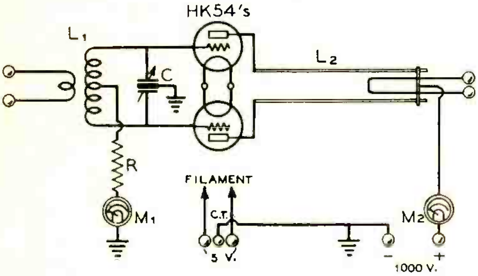


Figure 5. Wiring Diagram of the Push-Pull Tripler.

C—50-μμfd. per section, midget
R—20,000 ohms, 20 watts
L_1—8 turns no. 14 enam. 1" dia., 1¼" long
L_2—Linear plate tank, see text
M_1—0-100 ma.
M_2—0-300 ma.

a 150,000-ohm 2-watt resistor to allow for the increased excitation available at this point. Cathode bias is also used on both stages to provide a measure of safety in case the excitation should inadvertently be removed. A common series screen resistor R_{16} is used on both 6F6 doubler stages. A point leading to smooth, "bug-free" operation of these doubler stages is the use of the no. 1 terminal on the sockets as the ground point of the by-passes associated with each stage. The plate blocking, screen by-pass, and cathode by-pass condensers for each stage are grounded through the shortest possible lead to this point. The use of .003-μfd. "postage-stamp" mica condenser permits the length of the leads to be kept to a minimum.

The HK-24 exciter output doubler to 38 Mc. is also conventional. Here again care has been taken to bring the r.f. ground returns to a common point on the tube socket. A lug under one of the socket mounting screws serves as the ground point in this case. The method by which the plate blocking condenser is brought to this point will be discussed under *Mechanical Details*.

Meter Circuit

Complete metering is made possible through the use of a five-position "Hamswitch." This type of switch has wide spacing between its two sections so that the resistors inserted in the circuits to be metered may be soldered directly across the switch terminals. The diagram indicates the proper method of connection so that the meter polarity will be correct in each circuit. The circuits metered are the oscillator plate, 9.5-Mc. doubler plate, 19-Mc. doubler plate, HK-24 grid and HK-24 plate. The plate current to the HK-24 is measured in the power supply negative lead, and this requires that the 1000-volt negative be brought out to a separate terminal from the 500-volt negative, which is connected to the chassis. Metering the HK-24 stage in the negative keeps the high voltage off the meter switch and eliminates the possibility of shock from this part of the circuit.

Audio Section

To those not familiar with frequency modulated transmitters one of the most striking points of difference between f.m. and a.m. transmission will be the ease with which hum and other undesired modulation in the f.m. transmitter may be observed on a conventional communications receiver. Hum which causes an inconsequential amount of frequency modulation, as observed on a f.m. receiver, will cause the transmitter carrier to take on a very rough sound in the communications receiver. From experience with amplitude modulated equipment the natural inclination is to try to improve the character of the signal and to eliminate the formerly undesired frequency modulation. However, reception tests on a f.m. receiver will reveal that hum modulation which causes the signal to take on a T2 characteristic when listening to the second or third harmonic of the oscillator will not cause a noticeable amount of modulation when received on a f.m. receiver.

These considerations are mentioned here so that the prospective constructor of a frequency modulated transmitter will not unnecessarily worry about a small amount of ripple modulation in the transmitter output as observed on a conventional receiver with beat oscillator.

Every effort has been taken to reduce hum modulation in the transmitter shown. The amount of undesirable modulation taking place is directly related to the amount of impedance in the reactance-tube grid return circuit, since the grid will pick up hum in proportion to its impedance to ground. Shorting this grid return to ground (across C_5) should give a "p.d.c." note if the reactance tube is operating properly. The grid impedance to ground has been kept to a minimum through the use of a 500-ohm output transformer at T_2. With a crystal microphone the cascaded 6N7 speech amplifier will provide a peak undistorted audio output of 25 volts across the 500-ohm winding. This amount of voltage is sufficient to operate the modulator over the complete linear portion of its characteristic. Any amount of swing desired up to the full 800 kc. may be had by adjusting the speech gain control, R_{22}.

If it is desired to use a single-button microphone a 50-kc. total swing may be obtained by running the microphone directly into the grid of the reactance tube as illustrated in figure 6. If a wider swing is wanted with a single-button microphone a single stage of speech with a triode such as a 6C5 or 6J5 may be used, the output of the triode being fed into the reactance tube through a plate-to-500-ohm-line transformer.

Tripler Output Stage

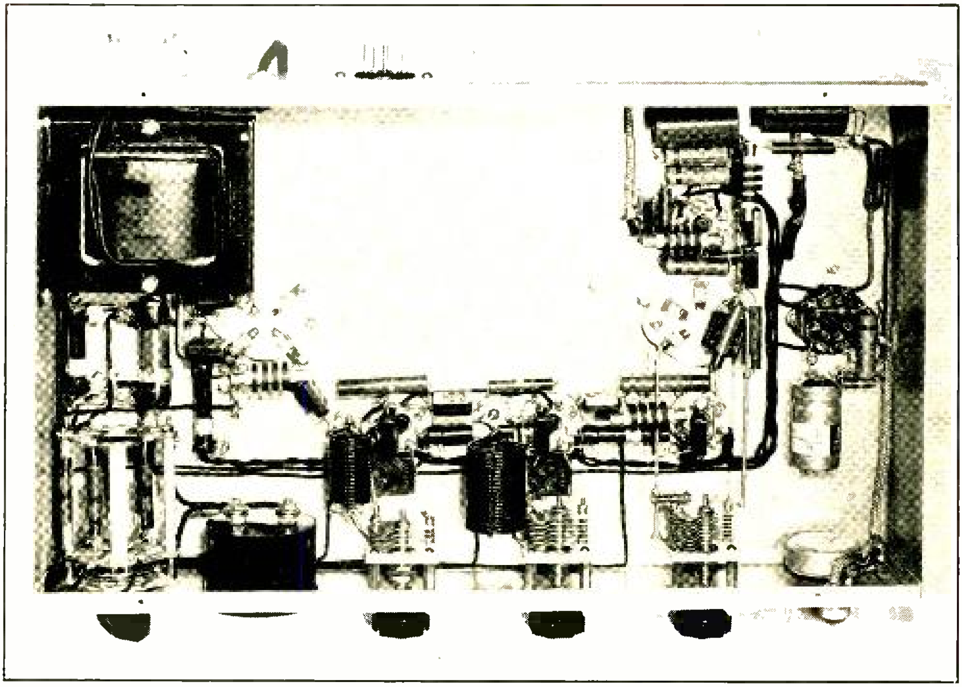
Due to the difficulty in obtaining a short, direct ground return in single-ended stages, push-pull frequency multipliers are almost universally used in u.h.f. equipment above 60 Mc. The push-pull arrangement is inherently balanced to ground so that no r.f. current flows in the external plate-to-ground circuit. Even harmonics cancel out in the push-pull output circuit but it is possible to obtain fair efficiency (considering the frequency) at the third harmonic.

The tripler stage grid circuit is arranged for link coupling to the exciter output tank. The split-stator grid condenser, C, (figure 5) has its rotor grounded to aid in establishing circuit balance. The ground connection does not need to be particularly short as the balance between the two tubes is so close that a very slight amount of r.f. current flows in the lead. Grounding the rotor to the most convenient point on the chassis will serve the purpose. The parallel-rod plate tank used is the best and least expensive way of obtaining good tank circuit efficiencies at 114 Mc.

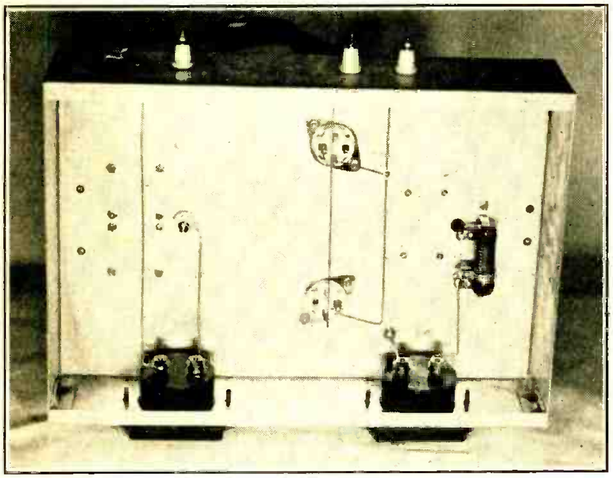
Meters are provided in the plate and grid circuit of the output stage so that an accurate check on the operation may be kept at all times. There is no need to place the plate meter in the negative lead to this stage since the large exposed plate tank should be sufficient warning to the operator to keep his hands a safe distance from the stage at all times.

Mechanical Details

The exciter chassis is a standard 10 by 17 by 3 inch item. The controls along the front drop of the chassis are, from left to right, audio gain, oscillator tuning, 9.5-Mc. doubler



Under-side view of the exciter chassis. The r.f. leads have been made as short and direct as possible and each stage has been made a more or less complete unit. The chassis has been made large enough so that no undue crowding results. The transformer at the rear of the chassis supplies filament voltage for the complete exciter.



Very little wiring is needed under the output stage chassis. The grid-bias resistor, meters and sockets are the only components located in this portion of the transmitter.

tuning, 19-Mc. doubler tuning, and meter switch. The microphone connector is located below the gain control, while the meter is centered between its switch and the second doubler tank condenser control. Each of the tubes up to the HK-24 stage is located directly behind its associated tank condenser.

The doubler stage coils are supported under the chassis on ½-inch pillar insulators. Soldering lugs on these insulators provide a termination for the coils, plate lead, and grid condenser to the following stage at one end. The positive connection and plate blocking condenser are attached to the lugs at the other end. Both doubler coils are "airwound" to the dimensions given under figure 4. The 9.5-Mc. doubler coil is supported along its length by running Duco cement between its turns after it has been mounted in place. One or two "strips" of the cement will be sufficient to restrain the coil from vibrating. No support other than the end terminations is needed on the 19-Mc. doubler plate coil.

The oscillator coil is arranged to be plug-in to facilitate adjusting its turns for the correct frequency and to allow a convenient form of mounting. It need not be made plug-in, however, if wound to the specifications given in figure 4. The coil is placed above the chassis and shielded to keep stray r.f. fields from affecting the oscillator. The shield can is a standard 2 by 2⅜ inch rectangular one which has been cut down to a height of 2½ inches. It is held in place by a pair of 6-32 spade bolts. As the photograph shows, the oscillator coil (in its shield) is placed directly behind the 6F6 oscillator tube.

The 6SJ7 reactance-tube modulator is located in a line with the oscillator tube and coil and behind the coil. Only the top of the 6SJ7 is visible in the photograph. The 6N7 speech amplifier and the output transformer, T_2, are located at the extreme left edge of the chassis. As the diagram shows, shielded single conductor is used on the grid leads to the first section of the 6N7 and to the modulator grid to eliminate any possibility of picking up r.f. in these leads.

The socket for the HK-24 is located on the center line of the chassis and 4 inches from the right edge. The tank condenser and the coil are arranged to permit the shortest possible lead length, both to the plate and to ground, to be used in this stage. The condenser is supported from the chassis by ½-inch pillar insulators and angle brackets. The coil stands vertically behind the condenser, being supported at the top by being connected to the rear condenser stator terminal and at the bottom by being soldered to a lug at the top of the rear condenser-supporting insulator.

A short ground return on the HK-24 stage is made possible by placing the plate by-pass condenser under the tank condenser. One terminal of the condenser is connected to the soldering lug which supports the bottom end of the coil and the other terminal is bent under and soldered to a lug under the tube-socket mounting screw. The filament by-pass condensers are grounded to this same screw under the chassis so the plate-to-filament return lead is as short as it is physically possible to make it.

Another pair of ½-inch pillar insulators serve as r.f. output terminals at the right edge of the chassis. A one-turn link of heavily insulated wire is pushed between the bottom two turns of the HK-24 tank coil and connected to these terminals.

A large bakelite knob which has its set screw placed in a small boss at the rear of the knob is used on the shaft of C_4. This large knob should preclude all possibility of shock unless the hand is placed directly on the condenser rotor. A further measure of safety may be provided, if desired, by using a small, inflexible insulated coupling between the knob and the condenser shaft.

Output Stage Construction

The push-pull HK-54 tripler stage is assembled on a chassis which has the same height and depth as the exciter chassis, but is only 14 inches long. The grid condenser is supported above the chassis on a ½-inch brass spacers to allow the shortest possible grid connections. To aid further in obtaining short leads the tube sockets are mounted so that the grid wires point inward at an angle of 45 degrees.

The idea of bending the plate rods back on themselves was borrowed from an article by Dawley[7] on a 28- and 56-Mc. transmitter. In fact the "borrowing" went farther than that since the same plate rods were used, after being trimmed down to the proper proportions. The rods are 24 inches long each, not including the ½ inch which is flattened and bent over at one end of each rod to serve as a mounting angle. The bending procedure is best quoted from Dawley's original article, since he did the job. Here it is with appropriate changes in regard to the length of the rods.

"These tubes are made of ½-inch o.d. no. 22 wall aluminum tubing cut to length and bent as shown. A great deal of care must be used in bending this tubing, as the author found from sad experience. Here is the proper procedure: First measure off the lengths required. (24½ inches, including the allowance for the mounting bend) and put a pencil mark on each tube 10½ inches from one end. Then put a cork in one end of the tube and completely fill it with very fine sand (beach sand is good). Keep tamping the sand by pounding the closed end on a block of wood, continually filling up the space left at the top of the tube by the receding sand. When you are tired of tamping it, and the sand does not seem to want to settle any more, pour out just enough sand from the open end of the tube to receive another tight cork. Following this procedure the tubing is ready to be bent. In our particular case this was done by very carefully and slowly bending the tubing around an old 2-qt. Mason jar, keeping the pencil mark opposite the center of the jar. Then after the bending is completed the corks are removed and the sand poured out."

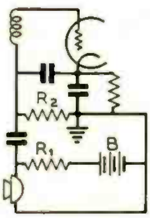
Figure 6. Single Button Microphone Connected to the Reactance Tube Modulator.

R1—500 ohms, ½ watt

R2—5000 ohms, ½ watt

Condenser between R1 and R2 — 0.5-µfd., 200 volt tubular

B—4½-volt C battery



After the bending has been completed each piece of tubing is flattened for a distance of one-half to three-quarters of an inch on the "long" end and a hole to pass a 6-32 screw drilled in the center of the flattened portion. The flattened portion is bent outward at right angles to the tubing to form a mounting foot for the rods. Similar sized holes through the tubing at the other end are used to terminate the plate connections. to the tubes. The short connecting lead between the tubes and the rods is thin, flexible copper strip ¼ inch wide. The standoff insulators at the shorted ends of the rods support them 2¾ inches above the chassis, and if the rods have been bent correctly their plate ends will be even with the tops of the plate connectors on the 54's. The shorting bar for the rods is made of two pieces of 1/16 by ½ inch hard copper, each of which has a U-shaped bend placed in it at each end. When a screw is passed through a hole in the center of the two strips they may be clamped firmly across the rods.

The spacing between the rods influences the length for resonance somewhat so the following measurements should be followed: Center-to-center at shorted end — 2 inches, center-to-center at plate end — 3¾ inches.

Output from the transmitter is taken from the conventional "hairpin" coupling loop. This type of coupling leaves much to be desired, as the antenna loading varies as the location of the shorting bar is changed. This makes it difficult to determine easily whether a dip in plate current when the shorting bar is moved in toward the plates is caused by resonance or decreased antenna coupling. The ideal type of coupling hairpin would be one

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[7] Dawley, "Higher Efficiency on the Higher Frequencies," RADIO, January, 1937, p. 30.

TOP-LOADED VERTICALS

By **MAURICE E. KENNEDY,*** **W6KQ**

In our enthusiasm to build larger and more efficient rotary beams for the higher frequency amateur bands, we have almost forgotten that efficient antenna systems and even directivity of signals on the 40, 80 and 160 meter bands is quite possible; even from the small space of a city lot or the roof of an apartment building.

The simple solution to the problem is in the erection of midget vertical radiators with efficient top loading.

Loading coils in the antenna circuit looks like an old idea; in fact loading an antenna with a series coil at the base of the mast or in the transmitter is as old as radio transmission. Base loading is not an efficient method of tuning the antenna to resonance however as you will see in (A) of figure 1.

Our experiments with the development of midget verticals started with the necessity of finding a suitable antenna to mount on the rear of a small communication truck. The 50-watt transmitter in the truck was required to operate on 2726 kc. or 110 meters. This frequency is between the 80 and 160 meter amateur bands and fish pole antennas are rather out of the picture on those bands. The thought of even approaching a fair radiator looked rather dubious.

Broadcast engineers and antenna design specialists have generally agreed that optimum efficiency from a vertical antenna operating in the broadcast band is approximately 0.53 wavelength. For most applications, and where space or expense prohibits the erection of such a high radiator, it is recognized that not too serious loss is experienced down to and including the quarter-wave vertical radiator. The efficiency of radiators shorter than one

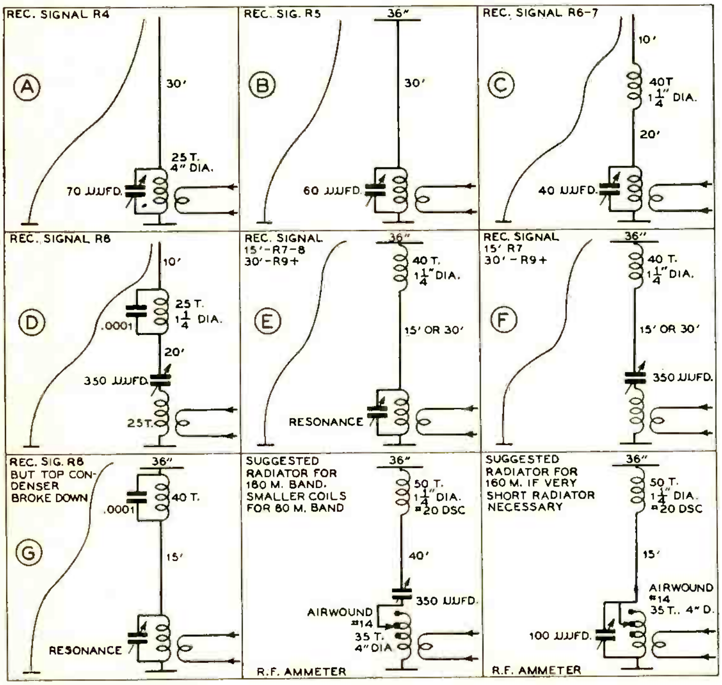

Figure 1. Result of tests made at 2726 kc. showing comparative signal strength measurements taken from a calibrated R meter at a distance of four miles. Measurements were for ground signal only and were taken under identical conditions. The wavy line to the left of charts A through G indicates the current distribution along the vertical radiator for the different loading conditions.

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* Communications Engineer, Los Angeles County Flood Control District.

quarter wavelength falls off rapidly and experience has shown that it is not advisable to attempt short-length verticals.

A quarter-wave vertical at our frequency of 2726 kc. meant something like 86 feet sticking up in the air. This was out of the picture for use on the back of the communication truck.

Placing the Current Peak

Most radio men accept the theory that greatest radiation takes place at or near the point of highest current on the antenna. This condition has been quite well established in the many forms of amateur directive arrays in which the voltage ends are bent down or folded back. The radiation losses from such practice have proven to be negligible.

Our experiments were intended to prove that almost any kind of an electrical waveform could be placed on a short piece of wire with the current peak wherever we decided it should be. We tried a dozen different types of loaded radiators with the results shown in figure 1.

The types shown as (E) and (F) were found to be best suited to our use.

The same types of verticals may be applied to the lower amateur frequencies at fixed locations. Portable stations may be hurriedly set up during emergencies without the problem of finding something to tie an antenna to or carrying bulky poles to support an antenna. The 80 and 160 meter amateur living on a lower floor in an apartment building can feed an efficient antenna system on the roof of the building by link coupling the transmitter's output stage to the antenna tuner at the base of the radiator.

Directive arrays are possible by the use of two or more vertical elements fed in such a manner as to permit control of the radiated signal. It is possible to tune the elements with a variable condenser, thus eliminating the problem of making length adjustments of the elements.

Two vertical elements of the same electrical characteristics may be spaced 45°, with the phase angle at 135° and equal current in each element, to give a radiation pattern in the form of a single lobe. By changing the phase angle of the same two elements to 180° a figure-8 radiation pattern may be obtained. It may be possible that an arrangement using closer spacing could be developed for restricted space.

Most of our tests were conducted at ground level and with fairly good ground connections directly under the base of the radiators. A quarter-wave single-wire counterpoise was found to work equally as well as the ground but some directivity was noticed in the direction of the outer end of the counterpoise.

If the radiator was intended for a roof top several stories above ground, a counterpoise or tuned ground lead should be used to maintain maximum current at or just above the base of the mast.

An Enlarged Version

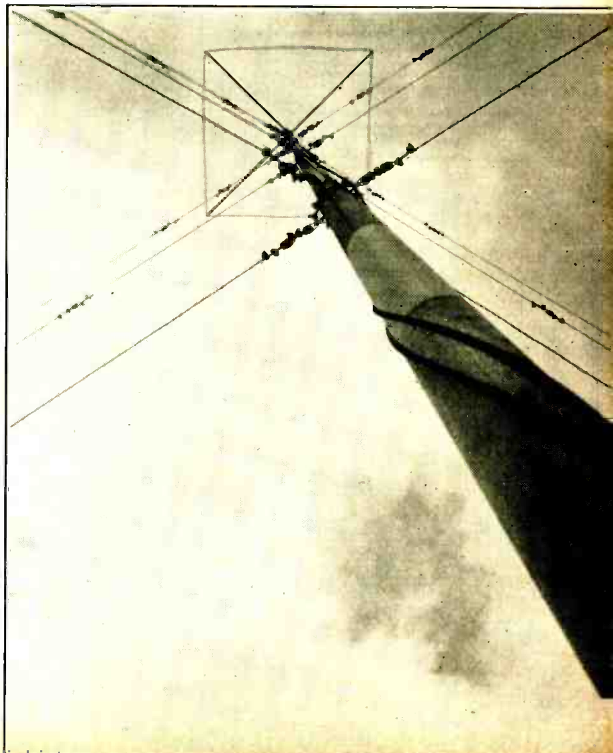
An example of a large version of the vertical radiator to which an outrigger for top loading has been added is shown in figure 2. This antenna is located on the roof of a downtown office building and works against a radial counterpoise. The steel frame of the building is also connected at the center of the counterpoise. The radiating system is fed with a concentric transmission line from a 500-watt transmitter down on the fourth floor of the building. The mast is 76 feet high with a 12-foot outrigger.

Figure 3 shows a part of the equipment used in the experiments described in this article.

Construction Details for a Midget Vertical

Vertical radiators with top-loaded sections may be built up at low cost by the use of standard ten-foot sections of thin-wall steel conduit. This conduit is available at all elec-

Figure 2. A 76-foot vertical radiator with loaded top section. The diagonal on the outrigger is 12 feet.



trical supply houses at about 60 cents a length for the ½ inch and slightly higher for the ¾ and 1 inch. Fittings are also quite inexpensive.

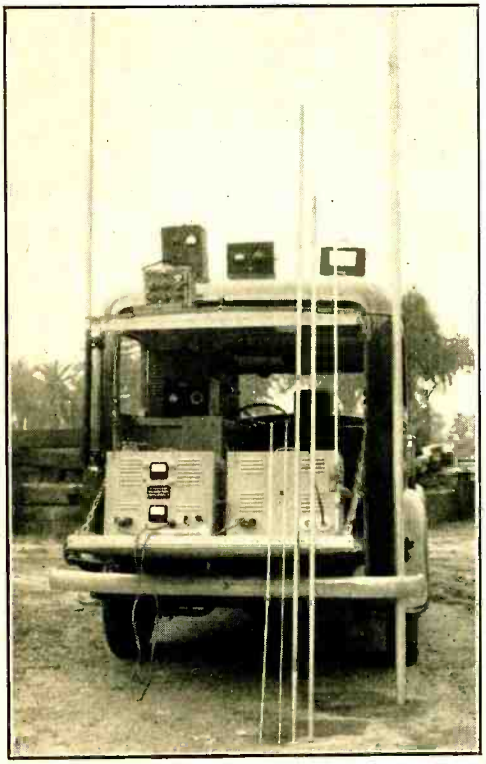
Short masts will work well down to about fifteen feet but considerable signal gain was noticed by increasing the length to thirty-five or forty feet. Masts of forty feet are easy to erect if reasonable care is taken in making up the joints.

One man can push up a forty-foot mast very easily if the base end is butted against a solid object. The conduit is very light in weight.

Standard fittings are available for the conduit joints, or the different sizes will slip inside each other with a little too much clearance. A shim or sleeve may be used to fill the space and the two sections bolted and soldered together. Good electrical connections should be made at all joints.

The shorter masts may be cantilever mounted at the base as shown in figure 3 of the section of pipe mounted to the truck body with heavy insulators. If guy wires are used on a tall mast, the wires should be well broken up with small airplane or egg insulators. The points of connection to the mast should have better insulation, especially the top set of guys which are nearest the voltage peak of the mast.

Figure 3. The mobile communication truck and equipment used to make the antenna experiments.



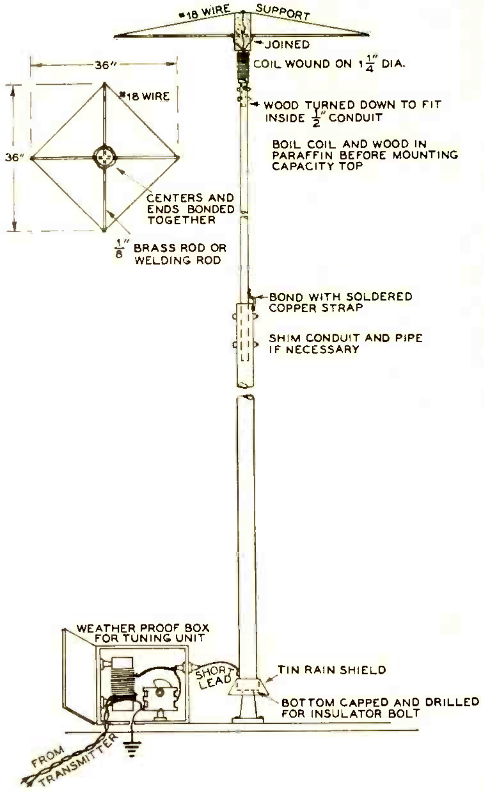


Figure 4. Suggested construction of a top-loaded vertical radiator. Details of the outrigger and base.

The mast should be insulated at the base. The guyed mast should rest on a standoff insulator of sufficient strength to hold the weight of the mast. A small shield should be placed over the base insulator to keep it dry in wet weather.

The Outrigger

The capacity top or outrigger should be as light as possible and yet large enough to offer considerable capacity to ground. The ribs may be made up of ⅛-inch brass rods or standard lengths of welding rod of the same diameter. A piece of No. 18 copper wire should be connected to the outside ends of the ribs. The outrigger used in our experiments measures

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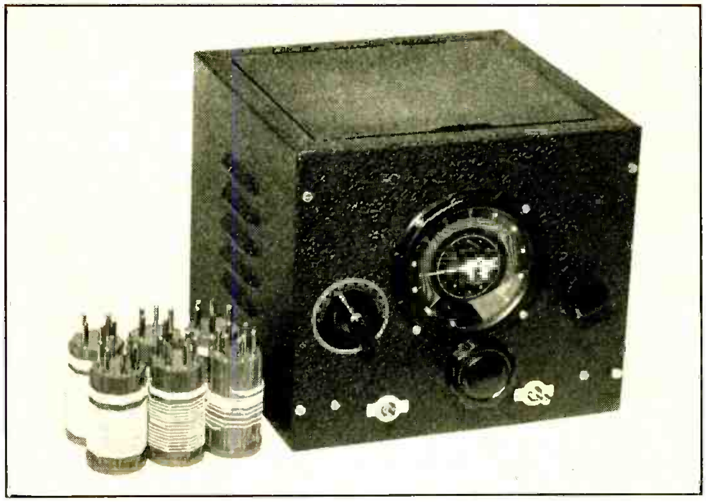

Figure 1. Front view of the converter installed in its metal cabinet. The coils for the 80-, 40-, and 20-meter bands are shown to the left of the unit. The front panel controls are: oscillator bandset, bandspread, and detector tuning; the left-hand switch is for filament voltage and the one to the right controls the b.f.o.

BATTERY POWERED CONVERTER

By RAY L. DAWLEY,* W6DHG

A description of a self-contained battery powered converter using the new miniature tubes and giving shortwave coverage from 3 to 35 Mc. when used with any broadcast receiver.

With the recent return to popularity of battery powered equipment there has been made available to the radio trade a wide range of tubes, batteries, etc. which can be applied to good advantage by the radio amateur who is interested in portable equipment. Last month we showed a 2½-meter transceiver and a field strength meter, both of which made use of newly designed 1¼-volt tubes and the batteries which go with them.

A few months ago RCA brought out four miniature 1¼-volt tubes especially designed to operate from a 45-volt B battery and to give good results when operated at this comparatively low plate potential. The tubes consisted of a pentagrid converter, 1R5; a power amplifier pentode, 1S4; a diode-pentode, 1S5; and an r.f. amplifier pentode, 1T4. All are extremely small, measuring only ¾" in diameter and 2⅛" long overall.

Two of these new miniature tubes, the 1R5 and the 1T4, have been used in the converter described in this article. The unit has been designed to be as versatile as possible so that its construction by the average amateur will be justified. One feature which increases the versatility of the unit is the use of alternative output circuit for either a high-impedance or a low-impedance load. For use with most receivers the low impedance will be best when fed into the antenna input circuit of the receiver. However, since the converter is completely portable and can be carried anywhere that one of the new midget portable broadcast sets can be carried, the high-impedance output provision has been made.

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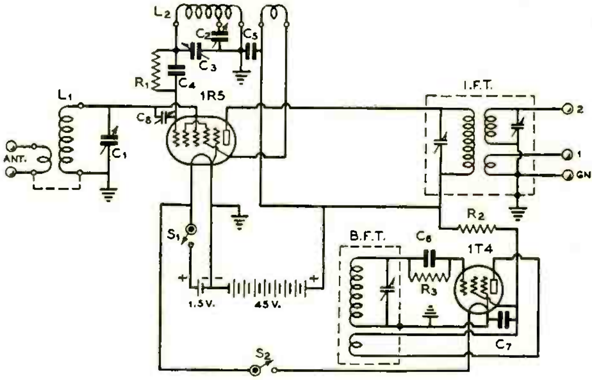
*Technical Editor, RADIO.

C_1—50-μμfd. midget variable
C_2—35-μμfd. bandspread variable
C_3—100-μμfd. bandset variable
C_4—.0001-μfd. midget mica
C_5—.01-μfd. 600-volt tubular
C_6—.0001-μfd. midget mica
C_7—.01-μfd. 600-volt tubular
C_8—3-30-μμfd. isolantite trimmer
R_1—100,000 ohms, ½ watt
R_2—100,000 ohms, ½ watt
R_3—75,000 ohms, ½ watt
L_1, L_2—See coil table
IFT—1500 kc. i.f. trans. with 10 coupling turns
BFT—1500 kc. beat osc. trans.
S_1—On-off switch
S_2—B.f.o. on-off switch
Batteries—See Buyers' Guide



Wiring diagram of the battery powered converter.

The reason for the high-impedance output provision is that a large number of these midget sets use a loop wound inside the cabinet as the first tuned circuit of the receiver. For use of the converter with sets employing the loop-type input circuit it is only necessary to remove the grid cap from the first tube and replace it with a shielded lead from the output of the high-impedance winding of the converter. A common ground between the converter and the portable set should be used so that normal grid bias will be placed on the grid of the first tube in the midget set.

Tube Complement

As was mentioned before, two of the new RCA miniature tubes are used in the converter: a 1R5 mixer and 1T4 beat oscillator. These tubes were chosen in preference to the conventional 1.4-volt battery tubes because of the improved operation that the new miniature tubes provide as compared to the older types when only 45 volts of plate supply is used. Another feature of the miniature tubes which led to their choice over the conventional 1.4-volt types is the considerably reduced interelectrode capacitances of the new tubes; the input and output capacitances are only about half the analogous capacitances in the conventional types.

Coil Table

All coils are wound on 1¼-inch diameter forms with no. 22 d.c.c. wire.
80-Meter Oscillator—22 turns 1¼ inches long, tap 15 t. from ground, tickler 6 turns.
80-Meter Detector—45 turns closewound, antenna coil 7 turns closewound.
40-Meter Oscillator—15 turns 1¼ inches long, tap 7 t. from ground, tickler 4 turns.
40-Meter Detector—30 turns closewound, antenna coil 6 turns closewound.
20-Meter Oscillator—7 turns 1 inch long, tap 3 turns from ground, tickler 3 turns interwound.
20-Meter Detector—14 turns 1½ inches long, antenna coil 5 turns closewound.
10-Meter Oscillator—3 turns 1¼ inches long, tap 1 turn from ground, tickler 2 turns interwound.
10-Meter Detector—7 turns 1¼ inches long, antenna coil 4 turns.

Circuit Design

When the converter is being used for the reception of phone signals in conjunction with a broadcast receiver only the 1R5 tube is used, as a mixer, and the filament of this tube only is lighted. Various oscillator-mixer circuits were tried to determine which one gave the most satisfactory results and the one shown in the accompanying diagram was found to be best. The number of possible circuits is limited in the first place by the fact that the 1R5 is a filament-type tube and in the second place by the fact that only three grids are brought out externally in comparison to the four brought out on most conventional mixer tubes.

The oscillator circuit finally used is tuned-grid tickler-screen arrangement with a bandspread tap on the oscillator coil. There is one disadvantage in using this type of circuit in a tube of this type and that is in the fact that there is no shielding between the oscillator anode (grids no. 2 and 4) and the r.f. input grid. In a preliminary arrangement before steps had been taken to overcome the difficulty there was very serious pulling between the input tuning and the frequency of the h.f. oscillator. This pulling was due, of course, to the capacitive coupling between the oscillator anode and the input grid of the tube. The pulling was overcome by the use of the neutralizing condenser C_8 between the oscillator grid and the input grid of the 1R5.

This condenser acts as a neutralizing condenser to couple an equal and out-of-phase voltage from the oscillator grid to the control grid to buck that coupled from the oscillator anode to the control grid. The condenser consists of a midget insolantite-mica trimmer condenser which is set by a screwdriver adjustment to give minimum pulling between detector tuning and the frequency of the oscillator. A capacity of approximately 5-$\mu\mu$fd. was found to be the best setting for this condenser.

The Output I.F. Transformer

The plate of the 1R5 mixer feeds into a 1600-kc. double-tuned i.f. transformer which has been revamped to give low-impedance output in addition to the output voltage from the other high-impedance winding on the transformer. The low-impedance winding consists simply of about 10 turns wound on the end of the dowel just below the winding which feeds the plate of the 1R5. One side of both the low-impedance winding and the high-impedance winding is grounded.

Beat Oscillator

The majority of the receivers with which a portable converter of this type will be employed will not have any provision for c.w. reception. Hence, it was deemed desirable to include the small amount of additional equipment in the unit which will allow c.w. reception with any receiver capable of tuning to 1600 kc. or thereabouts.

The circuit of the b.f.o. is merely a simple regenerative oscillator employing a 1T4 tube and a 1600-kc. b.f.o. transformer. It is just as feasible to feed the beat oscillator voltage into the input circuit of the b.c.l. set along with the signal voltage as it is to feed the beat oscillator voltage into the i.f. amplifier. Hence the use of the 1600-kc. beat oscillator in the converter unit shown.

No connection other than stray coupling within the set is used between the beat oscillator and the output circuit. With the mechanical arrangement shown the b.f.o. signal was ample for heterodyning anything up to a reasonably strong signal and still not too strong to mask out weaker signals. An advantage of an arrangement such as this is that both the beat oscillator and the high-frequency oscillator are completely battery powered. Hence, ripple or modulation introduced in the b.c. receiver does not affect the

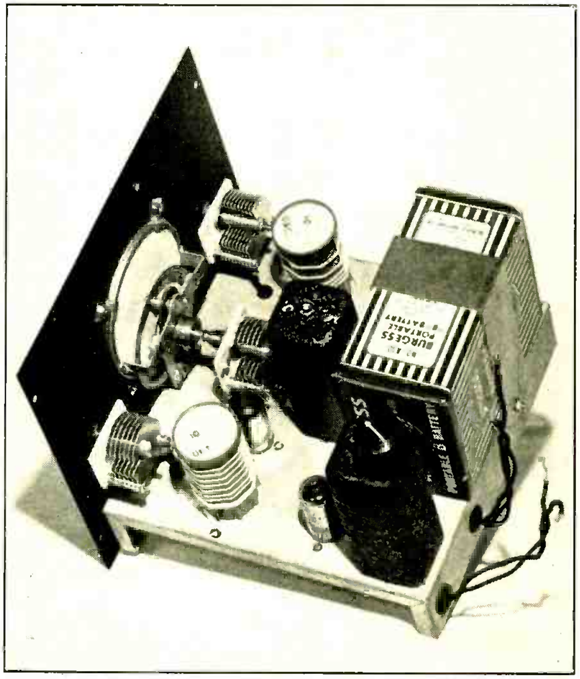


Figure 2. Top view of the chassis removed from the cabinet. The miniature mixer tube can be seen between the detector coil and the bandspread condenser, and the b.f.o. tube is placed just in front of the b.f.o. coil. The five leads coming out of the rear of the chassis are soldered to a terminal strip on the rear of the box which houses the unit.

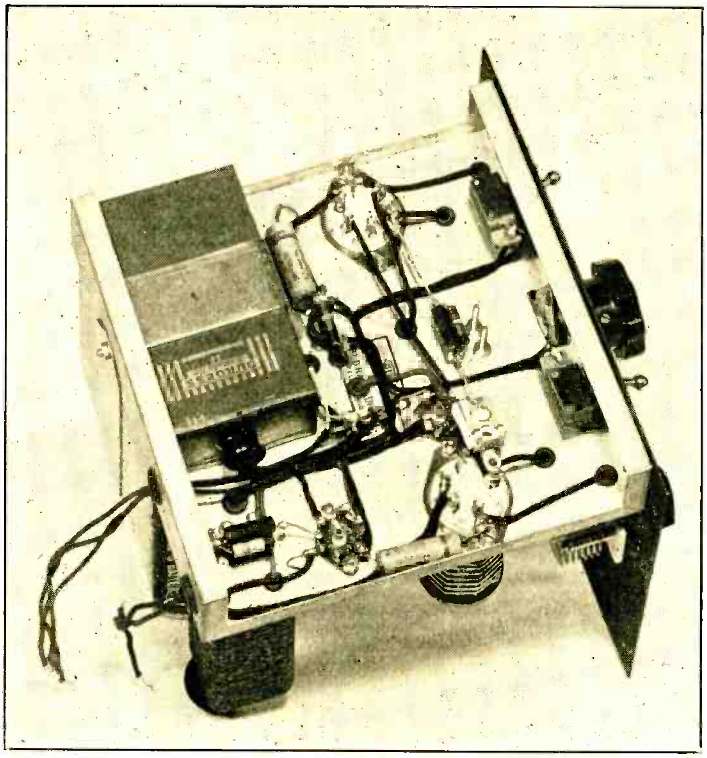


Figure 3. Under-chassis view—note the strap which holds the filament battery in place, the miniature sockets for the miniature tubes, and the screwdriver-set neutralizing condenser between the detector coil socket and the oscillator-grid terminal on the mixer tube.

note of the signal coming through it since the signal has already been "beated" by an absolutely pure note before entering the b.c.l. set. The clarity and purity of nearly all c.w. signals will be gratifying to those who are accustomed to listening to high-frequency c.w. on an a.c. operated receiver.

The filament of the b.f.o. tube is not lighted except when receiving c.w. signals to reduce the filament drain from the small A battery. Since the two switches are connected in series, opening the mixer filament switch also cuts off the filament voltage to the b.f.o. tube.

Mechanical Construction

The complete converter is built into a small 8″ by 8″ by 7″ cabinet of ready availability. The chassis is also a standard unit and is designed to be used with this particular cabinet.

Three controls and the two filament switches are mounted upon the front panel. The left control is the knob on the bandset control which consists of a 100-$\mu\mu$fd. variable connected across the h.f.o. coil. The center condenser is a 35-$\mu\mu$fd. midget and is controlled by an inexpensive 3-inch airplane dial. The right-hand control is the detector tuning condenser and consists of a 50-$\mu\mu$fd. midget connected directly across the grid coil.

A glance at the under-chassis and the top-chassis view will show that each battery is mounted by means of a piece of metal strap about 1¼ inches wide. The filament battery is of a convenient size to fit snugly below the chassis, and the plate 45-volt B battery, when turned on its side, is just about the same height as the i.f. and b.f.o. transformers.

Aside from this there are few points concerning the construction of the unit that will not be immediately apparent from the photographs. However, one thing that should be mentioned is that care must be taken in in-

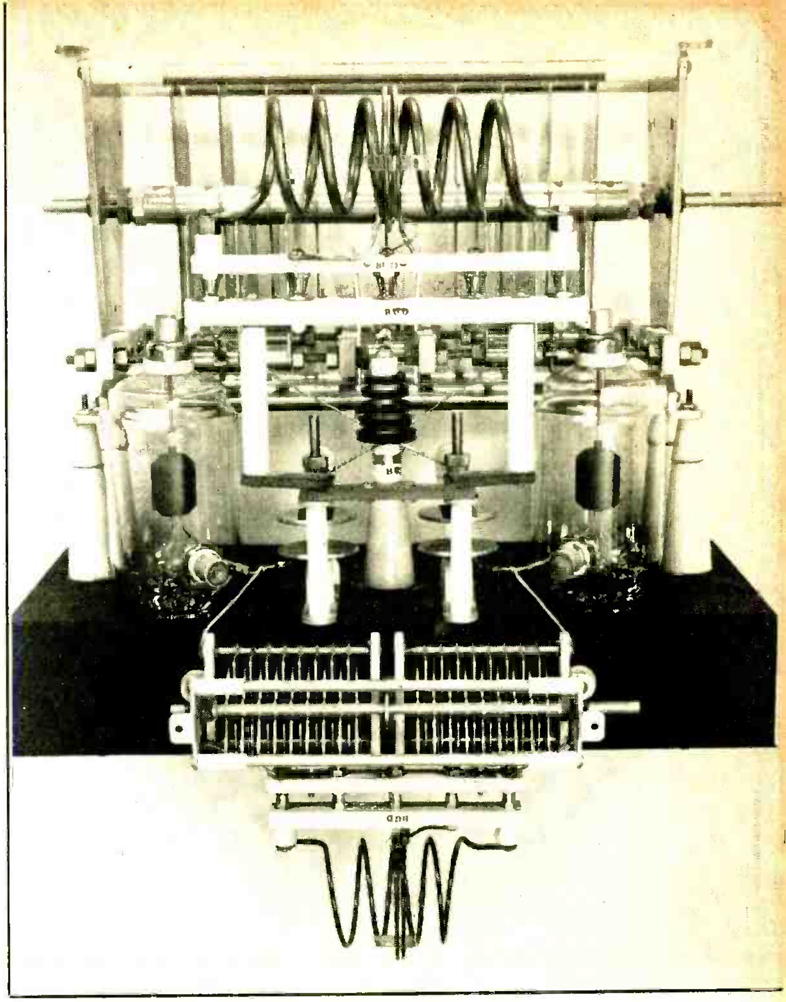
[*Continued on Page* 77]

TW-150'S *in a* HIGH POWER FINAL

By

RAYMOND P. ADAMS*

W6RTL



The mechanical arrangement of this kilowatt amplifier is somewhat unconventional. A compact unit with short r.f. leads is the result. The amplifier is designed for 5, 10, and 20 meter operation.

Building a kilowatt phone final which will lend itself to satisfactory all-band operation is for the average amateur a difficult and costly business. The physical size of components, particularly the plate tuning condenser, makes short r.f. leads impossible, and the price tags on the components—again particularly the plate tuning condenser—usually are something to scare a fellow back to his 100 watts at first sight of them.

On the other hand construction of a high power job exclusively for high frequency application is a bit more practicable when considered from the standpoint of cost and satisfactory design possibilities.

First of all, the tuning condenser need have no greater total or effective capacity than 25 $\mu\mu$fd., which is sufficient for use with most commercial 20, 10 and 5 meter coils. This brings down tank costs and permits a more compact amplifier.

The tubes used in this "skeletonized" kilowatt final amplifier are TW-150's. These have 10-volt 4.1-ampere filaments, an amplification factor of 35, a grid-plate interelectrode capacitance of 2 $\mu\mu$fd., and 50-watt bases. Set up in a class C amplifier designed for plate modulation, a pair of these tubes in push-pull at 3000 volts will provide a power output of 800 watts with an input of 990 watts, or an output of 590 watts with an input of 800 watts.

In the present amplifier (plate input 990 watts), total grid current to the two TW-150's is 80 ma., and the grid bias of —260 volts is obtained from a combination of —90 volts fixed supply (approximate cutoff) and a grid leak adjusted to approximately 4250 ohms. The plate dissipation is 180 watts, and the tube anodes operate at a cherry (and cheery) red heat at this rating.

Physically, the amplifier departs considerably from conventional layout. An eight-inch deep chassis is employed, and tubes are to-

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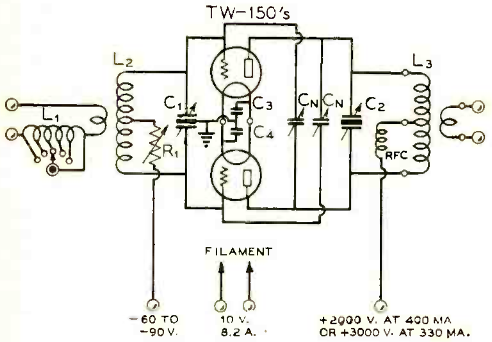
* 5161 Sunset Blvd., Hollywood, Calif.



The TW-150 Kilowatt Amplifier

C_1—55-μμfd. per section, 0.136 in. air gap
C_2—5-μμfd. per section, 0.5 in, air gap
C_3, C_1—.004-μfd. mica
C_N—Neutralizing condensers, at least 0.5 in. gap at 2 μμfd.
R_1—5000 ohms, 50 watts, with slider
RFC—2.2 mh, r.f. choke, 500 ma. or more

• • •

ward the front, protruding through three-inch diameter holes. The sockets are on the chassis bottom plate. Immediately behind the TW-150's and elevated so that stator tie rods are about an inch below the tube plate terminals is the plate tuning condenser. Between the tubes and forward from the condenser are the neutralizers, positioned so that short, direct leads are featured between lower plate connecting lugs and tube grid terminals. These neutralizers, incidentally, may look to be a rather small size for a kilowatt amplifier. But their use permits a more compact arrangement, and they are quite suitable electrically; the plate spacing is altogether sufficient at the capacity adjustment giving proper neutralization of the TW-150's.

A length of Mycalex strip between and above the neutralizers and fastened to them supports the plate circuit r.f. choke, and two shorter lengths similarly fastened and protruding to right and left over the tube grid caps support the 3-inch ceramic pillars which in turn support the plate tank mounting assembly. The grid tuning condenser mounts on the chassis front drop, while the grid coil and the adjustable grid leak mount below chassis on the bottom plate.

Connections from the plate coil and the tube plate cap terminals to the tank condenser run directly to the stator tie rod. The tie at the frame is made with clips which come with adjustable power resistors of the 50-watt type. Cross over neutralizer connections are made to the inside ends of these tie rods. Grid connections from neutralizers to tubes, tubes to tuning condenser, and condenser to coil assembly are all unusually short for kilowatt construction.

As the tank circuit has perfect mechanical symmetry, circuit balance is more or less assured, and we can get by very nicely with the plate condenser rotor left floating. This eliminates the necessity for a high voltage by-pass condenser and running of the rotor of the tuning condenser rotor at d.c. plate potential to minimize condenser flashover with modulation.

Final Assembly

The amplifier as shown remains something of an unfinished job. It goes into an enclosed rack, but the nature of the construction is such that with all panels added it's practically impossible to show much of the "works" in a photograph. For that reason the "innards" have been removed for the photo.

As the coils don't lend themselves to convenient change from the rear of a cabinet, nor the condenser to convenient tuning by means of dials on a front panel, an entirely unconventional method of final assembly has been utilized.

In the first place, the chassis is supported by 13-inch long brackets so that it sits back into the cabinet, leaving a five-inch space between chassis front and an 8¾-inch panel. This panel, incidentally, is provided with a glassed window through which we can observe the pretty red plates of the TW-150's. Immediately below this panel is a second one of similar size provided with a drop door through which access is had to the grid tuning condenser, the grid coil, and the adjustable grid resistor. Above the windowed panel is another drop door type providing access to the plate coil. The door in this window, when opened, releases a push-button switch cutting off line power to the high voltage transformer. As for plate condenser tuning, this is effected through lever-arm control of an insulated and extended shaft which protrudes through the right-hand cabinet wall.

Power Supplies

The high potential power supply should provide a maximum of 3000 volts at 330 ma. for 990 watts input and should preferably be primary tapped so that output may be dropped to as low as 2000 volts for lower power operation (800 watts input and 590 watts into the antenna). Incidentally, a number of builders will find 800 watts input entirely adequate for their purposes; this is still high power by

[*Continued on Page 84*]

A Universal

15-WATT AMPLIFIER

By GENE TURNEY,* W2APT

An amplifier that is truly universal in application. By choosing the proper output transformer, the unit can be used for cathode modulation of a medium power rig, plate modulation of a low power rig, p.a. use, or for driving a large modulator.

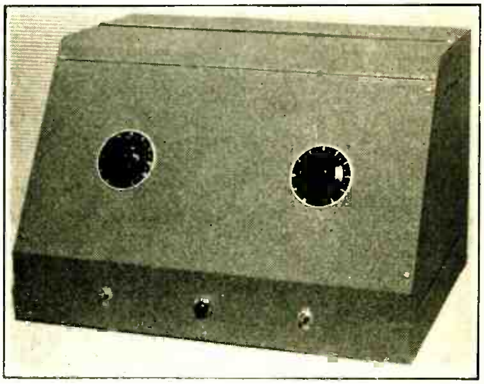
The latest application of an old but tried system of modulation, commonly known as cathode modulation, seems to have started an epidemic of amateur transmitter alterations the country over. And why not? Here is a system ideally suited to use by the amateur who hasn't much money to spend on modulation equipment.

These thoughts started the old wheels grindin' with the result that we were convinced there was a definite need for an inexpensive 15-watt amplifier having universal application. In other words, one which would perform the following tasks: firstly, cathode modulate a medium power transmitter; secondly, plate modulate a low power job; and lastly, make itself self liquidating for use in p.a. service. What ham can't pick up a few dollars these days renting out a p.a. system for a night or two, now that election time is drawing near. The result was the amplifier illustrated.

The tube lineup consists of a high gain 6SJ7 resistance coupled to a 6C5 triode, which is transformer coupled to a pair of 6V6's operating class AB_1. A 6H6 diode is utilized as a peak limiter. The amplifier has its own power supply using an 80 type tube. The input to the 6SJ7 is designed for any high impedance microphone (crystal or dynamic) having a level no lower than —73 db.

The entire unit is built on a chassis measuring 10"x17"x3". Placement of parts is shown clearly in the illustrations. Although a console cabinet is shown, the amplifier may be constructed for rack mounting merely by the use of a standard 8¾" panel. The power supply is conventional, employing a two-section filter with condenser input, thereby reducing the percentage of ripple voltage to an absolute minimum. Voltage for the 6V6 plates and screens is taken after the first choke. The higher ripple voltage at this point tends to cancel out in the push-pull 6V6 plate circuit. This layout is economical in that it requires but one high current choke, the second choke having only to carry the 6SJ7, 6C5 and bleeder currents.

The peak limiting circuit employs a 6H6 diode, bridged across the 6V6 plates by means of an ordinary interstage transformer with 100,000-ohm series resistors. A potentiometer mounted on the front panel controls the amount of positive bias placed on the cathode



The amplifier is shown here in a "console" type cabinet, but it can just as well be constructed with a standard panel for rack mounting.

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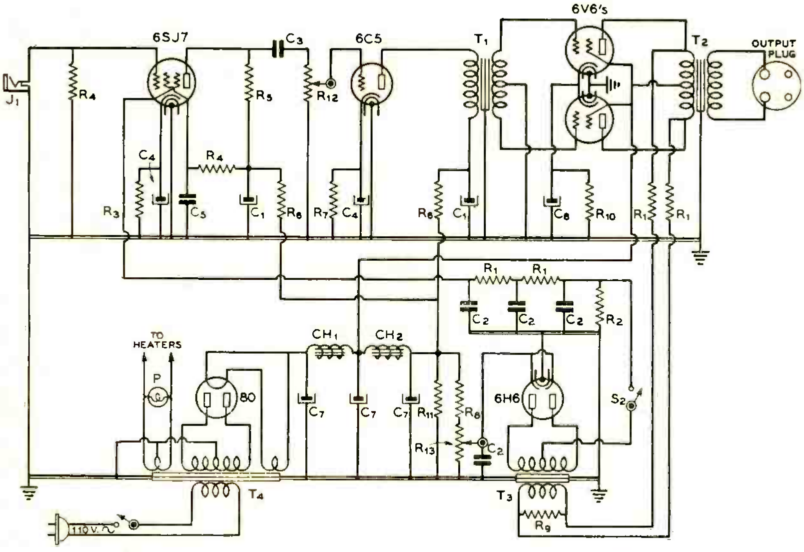
*Kenyon Transformer Co., Inc., 840 Barry St., New York City.



Wiring Diagram of Universal 15-Watt Amplifier.

R_1—100,000 ohms, ½ watt

R_2—250,000 ohms, ½ watt

R_3—1500 ohms, ½ watt

R_4—3 meg., ½ watt

R_5—500,000 ohms, ½ watt

R_6—10,000 ohms, ½ watt

R_7—1000 ohms, ½ watt

R_8—100,000 ohms, 1 watt

R_9—50,000 ohms, ½ watt

R_{10}—200 ohms, 10 watts

R_{11}—15,000 ohms, 25 watts

R_{12}—500,000 ohm pot., a.f. taper

R_{13}—50,000 ohm pot., linear taper

C_1—8-μfd. tubular electrolytic, 450 v.

C_2—0.1-μfd. tubular, 400 v.

C_3—.01-μfd. tubular, 600 v,

C_4—10-μfd. electrolytic, 25 v.

C_5—.05-μfd. fubular, 400 v.

C_6—25-μfd. electrolytic, 50 v.

C_7—8-μfd. can type electrolytic, 450 v.

T_1—Push-pull input trans., 1-1 pri. to ½ sec.

T_2—Suitable output transformer (depends upon application). 8000 or 10,000 ohm pri., 15 watts

T_3—Push-pull input trans.

T_4—650 to 675 v. v. c.t., 100 ma., and filament windings indicated

CH_1—10 hy. 200 ma.

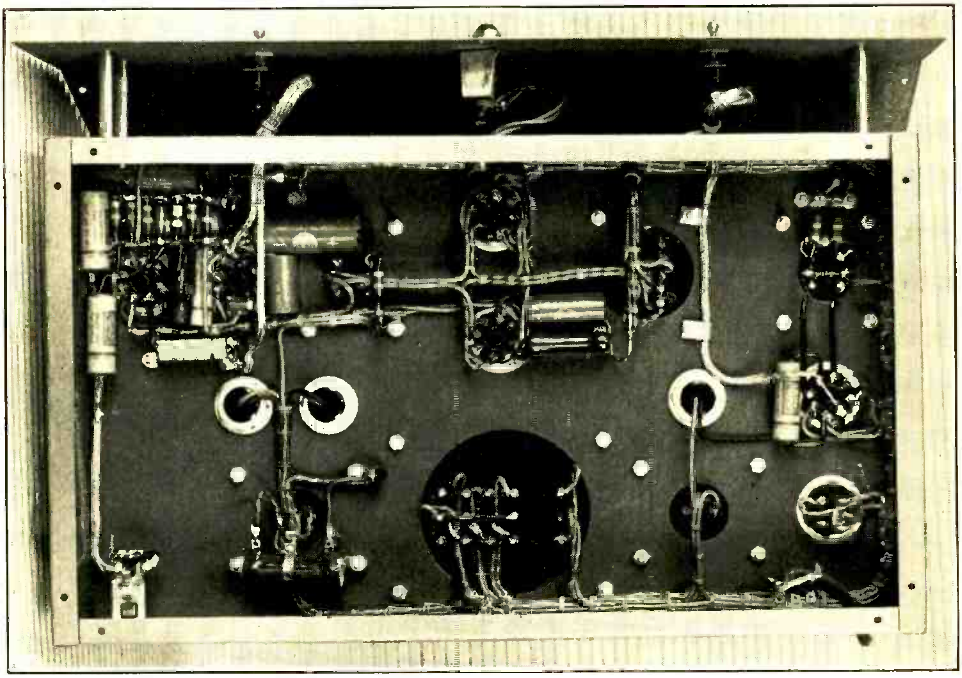
CH_2—30 hy., 90 ma.

of the 6H6, thus determining the point at which limiting action begins. A varying negative d.c. voltage filtered by a simple resistance capacity network to remove the audio component is applied to the suppressor of the 6SJ7.

A variation of from zero to 30 volts is obtainable by the limiter control. Obviously, the lower the bias on the 6H6, the more the limiting action. The average amplifier input level, of course, determines the correct setting of this control. A sufficient increase in level drives the 6SJ7 suppressor more negative, thereby reducing the gain of the stage. A switch in the diode plate circuit can be opened to discontinue limiter action entirely.

The selection of the proper output transformer depends on the type of service required of the amplifier. For cathode modulation the output transformer has impedance taps ranging from 40 to 3000 ohms, and the secondary can handle up to 300 ma. The same transformer may be used when employing the amplifier as a driver for higher power modulation. It must be borne in mind that this application isn't quite orthodox, due to the apparent failure of pentodes or beam type tubes to make the best drivers unless negative feedback is used. They are usable, though, in amateur transmission without objectionable distortion. If a sacrifice in gain can be tolerated, the screen of each 6V6 can be connected direct to plate (instead of to B plus) with a reduction in distortion for driver service.

For plate modulation the available secondary impedances are from 250 to 20,000 ohms, providing matches to any line or r.f. load. With the available audio this setup



Under-chassis view showing placement of components. The microphone lead is shielded. A resistor strip and cabling of all wiring add to the appearance, but are not absolutely necessary.

would be sufficient to modulate approximately 30 watts input to a class C stage.

Lastly, for use in public address service, the transformer will match both 500 and 200 ohm lines as well as 15, 8 and 4 ohm speaker voice coils or combinations totaling these figures. The mounting dimensions of these output transformers are similar, making them readily interchangeable when adapting the amplifier to individual requirements. Or, in a case where the unit would be utilized, as we mentioned before, for a number of adaptations, the change could be made by some sort of plug-in arrangement or by a switch for instantaneous change in output impedances. This variation is left to the reader's ingenuity and preference. The amplifier has gain of 108 db and has frequency response which is flat within 6 db from 60 to 10,000 cycles. At 100 cycles it is only off –3 db. It is evident from these figures that the amplifier has great possibilities for reproducing faithfully its input source whatever it may be, at the same time fulfilling its job of being truly a "universal amplifier."

See Buyer's Guide, page 98, for parts list.

Rear view of the amplifier with the dust cover removed. Observe the shielded leads to the gain potentiometer.

ANTENNAS for 112 MC.

By W. W. SMITH,* W6BCX

General design data and suggestions for 112-Mc. antennas, both for fixed and mobile service.

The amateur taking a first crack at 112 Mc. is usually surprised to find that some funny things occur at that frequency with regard to the antenna and feed system. While these anomalous effects begin to show their presence at 56 Mc., they do not really demand attention until we get up to 112 Mc. or above. So even if one has done a lot of experimenting with "u.h.f." antennas on 56 Mc., there are a few surprises in store on 112 Mc.

Feed Lines

The best feed line at 112 Mc. is still an open two-wire line, which is considerably better than a ceramic spaced concentric line so far as efficiency is concerned. Concentric lines are most often used more as a matter of convenience. While their losses are higher than for an open line, the losses are still quite low and a concentric line is much easier to install. Many amateurs seem to think that concentric lines are used primarily because their losses are so low, but actually this is not strictly true. The losses are *not excessive* for a *well-constructed* concentric line, and the line is much more convenient than a two-wire open line from a mechanical standpoint. Hence the popularity of concentric line in commercial u.h.f. installations.

On the other hand, concentric lines of the flexible type using a rubber dielectric and so popular with amateurs on the lower frequencies show a high attenuation/foot at 112 Mc., and the use of such line is not to be recommended except where the line is but a few feet long, as would be the case in a mobile installation.

While a two-wire open line can be made to have low losses on 112 Mc., this doesn't apply to "any old two-wire line." The line must have *close spacing,* be substantially flat, use good insulation, and avoid sharp bends if the losses are to be kept at a minimum. If the line spacing exceeds two inches or if the standing-wave ratio is high, even though the line spacing is not over 2 inches, there will be appreciable radiation from the feed line.

Another feed system that works well for feeding simple, non-directional antennas on 112 Mc. is the once highly popular single-wire-feed system. On 224 Mc. the single wire feeder shows up still better, as it is difficult to get any concentric or two-wire feed system to work very well at this frequency. When a single-wire feeder is used for reception with a highly directional array, however, the advantages of noise reduction will not be so great with a single-wire feeder, as such a feed line is bound to pick up some signal (including noise).

An excellent two-wire line for use at 112 Mc. can be constructed by using Johnson no. 132 spreaders and threading the *feed* wires *through the holes* instead of using the holes for serving wires as is commonly done to make a 2-inch line. When the feeder wires are run through the holes, the line spacing will be about 1⅜ inches. With no. 14 or no. 16 wire, this will give a surge impedance of about 475 ohms.

Mobile Antennas

When using a whip type auto antenna on the cowl or door hinge, it will be found that the antenna tends to act somewhat like a "bed-spring" antenna in that it does not show any well-defined resonance peak. This is probably due to the fact that there is no definite ground point on the auto body or transceiver when the antenna is worked against the transceiver chassis as a quarter-wave or three-quarter wave Marconi. Nevertheless quite good results will be obtained with a three-quarter wave Marconi antenna of the type illustrated in figure 1.

The radiator consists of an RCA cowl type antenna extending to 64 inches and having ceramic mounting insulators. This length corresponds to a 230-degree vertical radiator. The lead-in wire should be attached to the bolt

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* Editor, Radio.

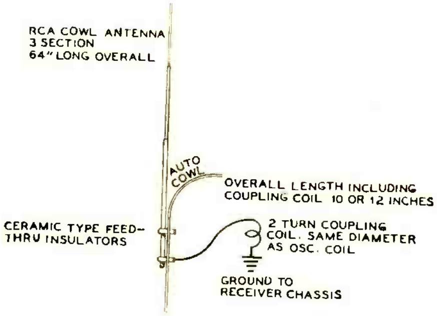

Figure 1. Effective 112-Mc. mobile antenna for use when transceiver is mounted within a few inches of the side of the cowl, as would be the case when the transceiver is mounted in the glove compartment.

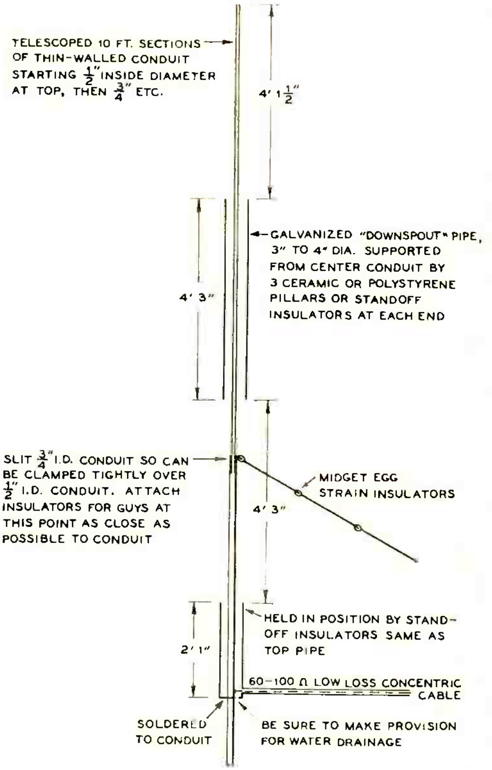

Figure 2. Vertical stacked colinear array using concentric phasing section and concentric matching section. The antenna delivers low angle radiation equally well in all directions and therefore is useful for "round table" work.

holding the bottom insulator and be of such length that the combined length of the lead-in and wire in the coupling coil is 11 or 12 inches, making the overall length of the system three quarters of a wavelength. If the transceiver is mounted on the dash or in the glove compartment, it will usually be possible to obtain a sufficiently short lead. Most of the radiation will be from the center portion of the external radiator, as the lead connecting the antenna to the transceiver is somewhat shielded and will not radiate appreciably or distort the vertical radiation pattern.

The shielding caps that come with the antenna and are normally used to cover the mounting bolts by snapping over the ceramic portion of the insulators are not used, as it is desirable to keep the capacity to the car body as low as possible at these points.

A two-turn coupling coil of hookup wire, shoved down between turns of the oscillator coil is used for coupling. The coupling coil should be placed at a point of low r.f. potential (usually half way between the center and the grid end) and pushed in and out until optimum coupling is obtained.

It is always desirable when using a telescoping type antenna to obtain one that is of the desired length when *fully extended*. Otherwise noisy reception will result on weak signals when the car is in motion. It is also important to obtain an antenna having ceramic insulation, as the composition type insulation used on many auto antennas is not sufficiently good at 112 Mc. except for use near a voltage node.

If the antenna need not be lowered (to put the car in a garage, etc.) a length of 1/8- or 3/16-inch brass or hard drawn aluminum tubing can be used for the radiator. It can be supported on the side of the cowl by two Johnson type 42 feedthrough insulators, connection being made to the bottom insulator terminal inside the car.

With any type of side cowl antenna the radiation pattern will show a unidirectional lobe in a line from the antenna through the center of the rear bumper. The antenna usually will show about 3 to 5 db better gain in this direction. This same effect has been noticed on 28 Mc., a vertical rod mounted on the rear bumper showing maximum radiation in a line through the diagonally opposite front headlamp. It would seem that the car should act as a reflector, but it seems to serve more as a director for antennas mounted in this fashion.

Fixed Station Antennas

The controversy still rages regarding vertical vs. horizontal polarization, but the fact that there is a controversy would seem to indicate that neither has much of an edge. The verticals produce greater line-of-sight field strength, and are slightly better beyond the line of sight over a highly conducting earth. Over average earth the signal strength beyond the line of sight will be about the same with either type antenna system. The commercials are using horizontal polarization for television, but that may be simply to put a better signal into receiving antennas so close by that both receiving and transmitting antennas must have the same polarization. Television receiving antennas use horizontal polarization (in the U.S.A.) in order to cut down man made interference.

For voice work with f.m., noise is not an item, and vertical polarization can be used on the receiving antenna without worry about ignition noise from passing cars. Nevertheless, it is felt that no attempt should be made to standardize on either type of polarization for amateur work on 112 Mc. until more conclusive data are obtained as to the comparative performance with vertical polarization and with horizontal polarization.

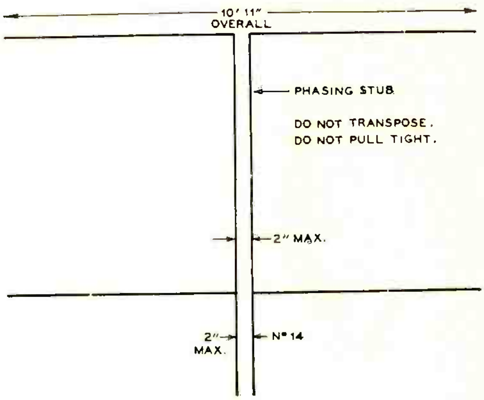

Figure 3. The X-H array is an excellent two-band antenna, and with the dimensions specified above can be used on both 56 and 112 Mc. The phasing stub should be made exactly 6′-9″ long. The spacing between the upper and lower elements is not critical, and may be between 5½ and 6 feet. The phasing stub may be pulled to one side with waxed cord to keep it from "flopping around." For vertical polarization the array should be oriented so that the radiating elements are vertical. The antenna is directional broadside regardless of whether it is oriented vertically or horizontally.

Concentric Co-Phased Vertical

The antenna system illustrated in figure 2 provides very low angle radiation and therefore lays down a good signal in all directions. This type of antenna is highly recommended for use where "round table" rag chews are indulged in, as everyone in the hookup will get the benefit of the non-directional, low vertical angle radiation. A fellow with only beam antennas is handicapped when he tries to work several stations simultaneously. A non-directional antenna is also of an advantage when calling a general CQ, as it increases the possibility of someone's hearing you. The array illustrated in figure 2 will lay down a greater field strength than a conventional two-element vertical colinear array, due to the fact that the two radiating dipoles are spaced a half wavelength instead of being juxtaposed. Adding more sections is not recommended, as the increase in signal strength will not be worth while. With more than two radiating elements it is difficult to get correct phasing and uniform current distribution. This applies to any end-fed colinear array, and not just to the one illustrated. The two-element array illustrated will show about 4 db gain over a dipole, but adding a third element will give only about 1 db more than two elements.

The big advantage of the array is the absence of feed wires or phasing stubs in the immediate field of the two radiating elements. This results in a truly non-directional pattern, with equal low-angle radiation in all directions.

The entire antenna can be constructed for a few dollars, because neither thin-walled conduit nor galvanized downspout pipe is expensive. The latter can be purchased in 3-inch diameter size for less than ten cents per foot.

The best point of attachment to the antenna for the inner conductor of the concentric feed line can best be determined by trial. A good point to start is about 2½ inches up from the bottom of the quarter-wave concentric matching section.

The half-wave concentric phasing section merely "floats;" it is not attached to anything. The radiation from this portion of the antenna is negligible, and what infinitesimal amount that does take place is *in* phase with that radiated from the rest of the antenna.

112-56 Mc. Horizontally Polarized Array

Illustrated in figure 3 is the X-H two-band array* with dimensions for operation on both 112 and 56 Mc. This array when oriented as shown makes an excellent antenna for checking horizontal polarization on both 112 and 56 Mc. The array will show slightly greater horizontal directivity (sharper beam) on 112 Mc

[*Continued on Page 82*]

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* Smith, "The Expanded Lazy H Array," Radio, July, 1939, p. 23.

Notes on CATHODE MODULATION

By FRANK C. JONES,* W6AJF

Optimum adjustment of a cathode modulated r.f. amplifier depends primarily upon the amount of audio power available from the modulator, assuming that there is a reserve of r.f. excitation. The r.f. excitation requirements are low under all conditions of adjustment; therefore ample r.f. excitation for all modes of operation will be assumed.

The ideal conditions for cathode modulation with a given r.f. amplifier and a.f. modulator are those under which the a.f. amplifier is called upon to deliver its maximum undistorted output at 100 per cent modulation. Under these conditions maximum efficiency and output can be obtained, and the voice quality as heard on the air will always be sufficiently good for amateur or communication work.

If the available a.f. power is approximately 5 per cent of the d.c. power input to the plate circuit of the modulated r.f. amplifier, the grid bias circuit should be by-passed back to ground (point C in figure 1). The full a.f. voltage should be applied to the grid circuit and the by-passed grid leak or fixed bias supply should connect to point C on the modulation transformer. The grid current should be low if complete modulation is desired, usually about 1 to 3 ma. per tube. The cathode impedance will be between 500 and 1000 ohms for orthodox amplifiers, either push-pull or single ended.

Measurements made with a number of different r.f. amplifiers ranging from a 6L6-G up to a 250TH gave approximately the same values of cathode impedance and little difference was noted when two tubes were operated in push-pull. Therefore a value of about 1000 ohms can be taken as average for the condition of adjustment in which the available a.f. power is approximately 5 per cent of the d.c. input.

If the available a.f. power is from 10 per cent to 20 per cent of the class C input, greater r.f. drive may be used and the efficiency and output will be greater. The grid bias return should be made to a tap on the output winding of the modulation transformer (point B). A center tap connection is suitable for a.f. powers of 10 per cent in the case of medium μ tubes. High μ tubes require less a.f. voltage in the grid circuit to produce the desired amount of grid bias modulation. With higher values of a.f. power, the grid leak should not be by-passed for audio frequencies, and it may be necessary to return it to a tap quite close to the filament end of the secondary of the modulation transformer (point A).

With greater r.f. drive there is less a.f. degeneration in the cathode circuit, and the cathode impedance will therefore be somewhat higher, usually between 1800 and 3000 ohms. A value of 2000 ohms can be taken as sufficiently close in all cases where the available a.f. power is 10 per cent of the d.c. input, or as 3000 ohms where the available a.f. power is 20 per cent of the a.f. input.

With the 10 per cent ratio, the d.c. grid current should be from 5 to 10 ma. per tube

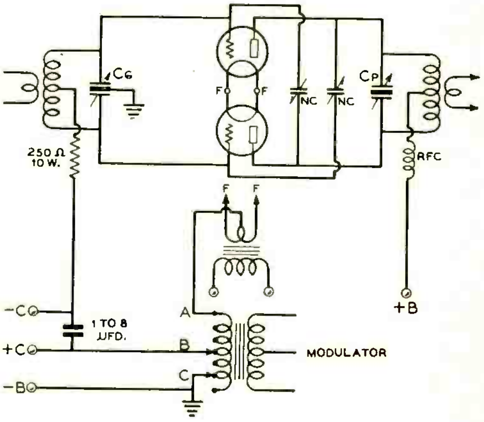

Figure 1. Standard circuit for push-pull amplifier. Equal loading and excitation must be provided or the output will not be twice that obtainable from one tube. The 250-ohm grid resistor serves as an r.f. choke. A regular r.f. choke might resonate with the plate choke and cause a low frequency parasitic. A parasitic choke may be required in one grid lead to one tube in order to prevent u.h.f. parasitics.

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and the d.c. bias should be from 3 to 7 times cutoff. Higher μ tubes should be run at a greater number of times cutoff. With a 20 per cent ratio (a.f. to d.c. input), the d.c. grid voltage should be at least twice cutoff for low μ tubes, 4 to 7 times cutoff for medium μ tubes (20 to 30) and 7 to 10 times cutoff for high μ tubes. The d.c. grid current should be from 10 to 20 ma. per tube. With the 20 per cent ratio, the carrier efficiency can be quite high due to the relatively high degree of r.f. excitation. In actual practice, efficiencies of from 65 to 70 per cent have been obtained with harmonic distortion of less than 6 per cent at 90 per cent modulation (20 per cent a.f. ratio).

Relative Operation Data

As an example of what to expect with a cathode modulated r.f. amplifier running at high plate voltage and limited to a plate dissipation of 100 watts, the following carrier powers can be obtained with modulation percentages and distortion tolerances suitable for amateur service:

5% ratio a.f./d.c. input	.....100 w. carrier
10% ratio	.....150 w. carrier
20% ratio	.....225 w. carrier

In case the cathode modulation transformer has no secondary taps, a 25,000-ohm 50-watt resistor with a slider tap can be connected across it, and the grid bias lead connected to the tap. With the tap in the center of the resistor, the two halves of the resistor act in parallel so far as the d.c. is concerned, and provide 6250 ohms of grid leak bias in addition to the regular bias.

An economical method of operation of a cathode modulated amplifier when the a.f. power is limited to between 5 and 10 per cent of the d.c. plate input is to drive the grid somewhat harder and not attempt to modulate quite as high a percentage. The grid current should be about 10 or 20 ma. per tube for this type of operation, and the bias between 6 and 10 times cutoff. The modulation transformer tap should be adjusted for 2000 ohms impedance, and a combination of fixed and grid leak bias used. A 10,000-ohm grid leak (*not* by-passed for a.f.) is typical for two tubes. About 100 volts of fixed bias (by-passed if not battery bias) should be supplied, or else an unbypassed cathode resistor of about 300-500 ohms used in the modulated stage. For a single-ended amplifier the same values hold except that the grid leak should be about twice as high in value.

Either neutralized triodes or any variety of screen grid tubes can be used for this type of operation. Screen grid tubes and very high μ triodes should be run at the highest possible plate voltage for good efficiency and ease of antenna coupling adjustment. Under these conditions, the antenna coupling is not critical and excellent voice quality can be obtained.

A typical amplifier operating at present in the 160-meter band under these conditions has 1500 volts on a pair of 812's, 300 ma. plate current, a 500-ohm cathode resistor, a variable grid leak, 40 ma. grid current, and a measured carrier output of 275 watts. The modulator consists of a pair of class AB_1 6L6's fed directly from a phase inverter. The 812's are being "pushed" a bit, but these values are given as typical of amateur operation. Oscilloscope patterns indicated a limit of about 60 per cent undistorted modulation, but all stations worked report excellent voice quality with the carrier heavily modulated. A check revealed less sideband splatter than when lower input and a greater modulation percentage was used, and the 100 per cent increase in carrier seems to more than offset the slight decrease in modulation percentage, the modulation percentage still being sufficient to elicit reports of "heavy modulation." Similar results were obtained with the transmitter operating on the higher frequency bands.

Parasitics

The importance of making sure the modulated amplifier is perfectly neutralized and free from parasitics applies to a cathode modulated amplifier the same as to any other type of modulated amplifier. Any parasitic oscillation due to lack of neutralization, electromagnetic feedback between grid and plate coils, r.f. choke low frequency parasitics, or (most important of all) u.h.f. parasitics, will usually produce poor voice quality and possibly splatter.

[*Continued on Page 82*]

Because cathode modulation can be used satisfactorily over a wide range of operating conditions, depending upon the relative amounts of plate modulation and grid modulation utilized, considerable confusion has arisen regarding optimum adjustments. In this article Mr. Jones gives some hints on design and adjustments which are of signal importance to every amateur interested in cathode modulation.

Four-Band Bandswitching
EXCITER-TRANSMITTER

By ROBERT M. STEPHENS,* W1JLT

The rapidly changing and improving styles in amateur transmitters had, until recently, left the equipment at W1JLT somewhat behind the times. But the pressure of competition from stations with more up-to-date transmitters made it necessary that something be done about modernizing the transmitting equipment.

The old transmitter, a rack and panel job, was fairly modern in appearance but was actually quite in a rut as far as changing from one band to another was concerned. It was almost too much trouble and bother to climb in behind the rig and change the necessary coils when switching from one band to another. It was so much easier just to leave the rig on the band upon which it was tuned and to hope that conditions on this band would improve.

The main problem, then, was one of bandswitching. Inasmuch as W1JLT is fairly active on 80, 40, 20, and 10, the first requirement was for a bandswitching exciter that would adequately drive the final amplifier on all these bands. Circuit arrangements to accomplish such a job are always plentiful and are usually pretty well worked out in advance. However, the real difficulty usually lies in working out a really clean-cut mechanical design.

Tube Lineup

Before even starting the mechanical layout, careful consideration was given to the problem of a satisfactory tube lineup. It is doubtful if any two amateurs would use the same line of reasoning in selecting the tube complement. In this case, and it undoubtedly would be the same in a majority of instances, the components and tubes on hand were influential in determining the final lineup.

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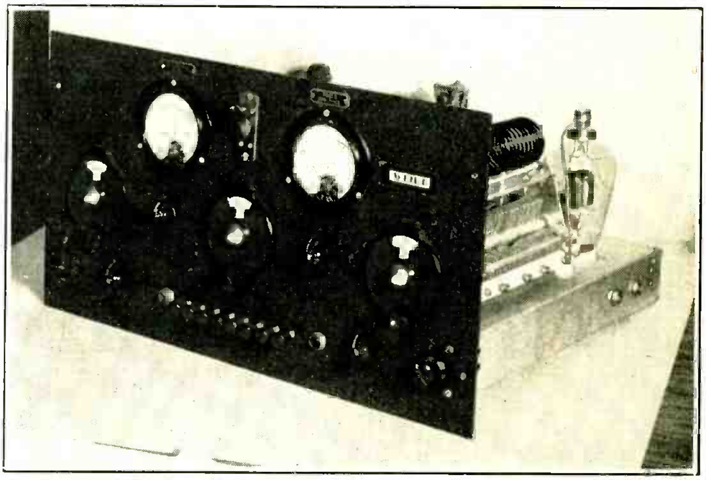
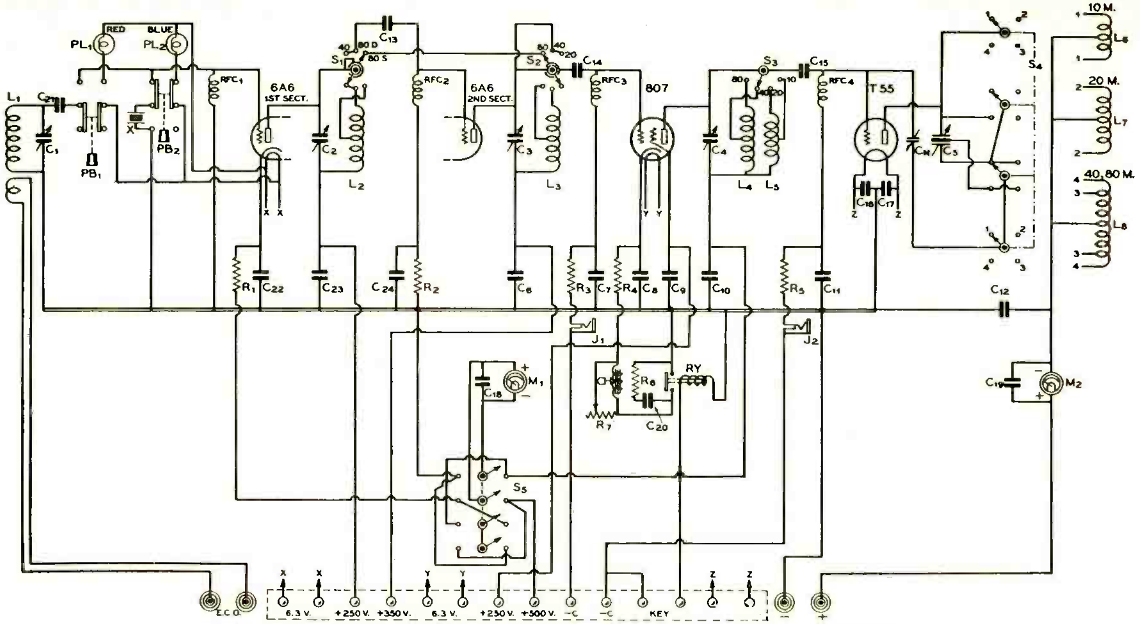


Front view of the four-band exciter-transmitter at W1JLT. The push buttons along the bottom select the desired crystal or the variable frequency oscillator at the operating position. The anti-capacity switch between the two meters switches the left-hand instrument either to the 6A6 or the 807 stages.



GENERAL WIRING DIAGRAM OF THE EXCITER-TRANSMITTER.

Values of Components

- C_4—75-µµfd. midget (in shield can with L_1)
- C_2—100µµfd. midget variable
- C_3, C_4 — 100-µµfd. variable, 1000-v. spacing
- C_5—100-µµfd. per section, .070" spacing
- C_6, C_7, C_8, C_9 — .01-µfd. 600-volt tubular
- C_{10}—.002-µfd. 5000-volt mica
- C_{11}—.01-µfd. 600-volt tubular
- C_{12}—.002-µfd. 5500-volt mica
- C_{13}, C_{14} — .0001-µfd. mica
- C_{15}—.00025-µfd. mica
- C_{16}, C_{17}, C_{18}, C_{19} — .01-µfd. 600-volt tubular
- C_{20}—0.5-µfd. 400-volt tubular
- C_{21}—.0001-µfd. mica
- C_{22}, C_{23}, C_{24}—.01-µfd. 600-volt tubular
- C_N—15-µµfd. midget variable, .070" spacing
- R_1—400 ohms, 10 watts
- R_2—50,000 ohms, 1 watt
- R_3—50,000 ohms, 2 watts
- R_4—450 ohms, 10 watts
- R_5—5000 ohms, 10 watts
- R_6—300 ohms, 2 watts
- R_7—1000 ohms, 10 watts
- L_1—80-meter coil with link
- L_2—80-meter coil tapped for 40 meters
- L_3—40-meter coil tapped for 20 meters
- L_4—80-meter coil tapped for 40 meters
- L_5—20-meter coil tapped for 10 meters
- L_6—10-meter coil
- L_7—20-meter coil
- L_8—80-meter coil tapped for 40 meters
- RFC_1, RFC_2, RFC_3, RFC_4—2½ mh. r.f. chokes
- CH—2 henrys, 100 ma.
- RY—S.p.s.t. keying relay
- S_1, S_2—Two-pole three-position selector switch
- S_3—Single-pole four-position selector switch
- S_4—Four-section four-position selector switch
- S_5—Four-pole double-throw switch
- J_1, J_2—Circuit-closing jack
- M_1—0-150 milliamperes
- M_2—0-200 milliamperes
- PB_1, PB_2—Push-button switch
- PL_1, PL_2 — Crystal-e.c.o. pilot lights
- X—80- or 40-meter crystal

A Taylor T-55 had been doing a quite satisfactory job of exciting the final on all bands with only 700 volts on its plate. Since the tube was still available it was decided to use this in the output stage. Then, past experience had shown that one of the 600-volt beam power tubes would provide ample excitation to drive the T-55 on all four bands. An 807, RK-41, or RK-39 would be suitable for this stage. Since almost anything will drive an 807 on these frequencies, the old reliable 6A6 was decided upon to serve as the combined crystal oscillator and frequency multiplier.

A number of 80-meter crystals were on hand so in our case the crystal oscillator runs on 80. However, provision has been made for the use of 40-meter crystals when they are available.

The first section of the 6A6 acts in all cases as an ordinary crystal oscillator whether it be operating with an 80- or a 40-meter crystal. Whenever straight-through operation is required the second section of the 6A6 must be left out of the circuit. Whenever higher-than-crystal frequencies are required, the second section of the 6A6 is used for doubling or quadrupling into the 807. Thus we have a really flexible tube lineup allowing the use of whatever crystals might be around the shack and having ample power output for the job at hand.

Combinations for Different Bands

In a preliminary setup using plug-in coils it was found that all the following combinations would give satisfactory output on the desired band.

For 80 meters the first section of the 6A6 acts as the crystal oscillator and, with the second section cut out, the T-55 could be excited easily through the 807.

For 40-meter output with a 40-meter crystal we can use the same arrangement as above. When using an 80-meter crystal the second section of the 6A6 may still be cut out and the 807 used effectively as a doubler to drive the T-55. Or, alternatively, the second section of the 6A6 may be used as a doubler, with the 807 acting as a buffer on 40 to drive the T-55.

For 20-meter output we again have several possibilities. Best results have been obtained by using either an 80- or a 40-meter crystal and both sections of the 6A6. With the 80-meter crystal the 807 acts best as a doubler; with the 40-meter crystal it acts best as a buffer amplifier.

For 10 meters we have two choices, the first being the use of 80-meter crystals and all tubes as doublers. The second choice is that of using 40-meter crystals with the 807 acting as a buffer-doubler to ten and the T-55 working straight through.

Our modernization plan dictated that all of the foregoing must be accomplished from the front of the panel. Quite a job, we will admit, but a worthwhile one to tackle.

The next step was to draw up the diagram of our bandswitching arrangement together with the tube layout and schematic (see wiring diagram).

Bandswitching Requirements

1. Crystal switching with an extra position for switching to a stabilized oscillator at the operating position.

2. Tap switch for 80- and 40-meter coil with provision for switching excitation either to the second section of the 6A6 or to the 807 (SW_1).

3. Two-circuit tap switch for cutting in the second section of the 6A6 with 40- and 20-meter coil taps, or by eliminating the second section of the 6A6 when working straight through (SW_2).

4. Tap switch for 80-, 40-, 20- and 10-meter coils in plate tank of the 807 (SW_3).

5. Multi-section tap switch for 80-, 40-, 20- and 10-meter coils in the plate tank of T-55 together with condenser switching. This later feature was deemed necessary in the T-55 stage. The arrangement is such that for ten and twenty meters the condenser sections are in series. For 40 meters one section only is used and for 80 meters both sections of the condenser are connected in parallel. This allows coils to have approximately the proper Q for each band, which otherwise would not be possible. Aside from the switching arrangement, the circuit is of course conventional.

Chassis and Panel Layout

The detail circuit diagram definitely tied down our physical requirements. As many of the component parts as could be obtained were assembled to assist in making the mechanical layout.

The space available in the transmitter determined the panel size. A glance at the photograph will show that the exciter is built on a standard 13" x 17" x 2½" cadmium-plated steel chassis, with a 10" deep dural panel.

At this point the old drawing board came in handy. With most of the parts on hand a scale size front elevation and plan view of the panel and chassis was drawn up. Nothing would do but that the parts on the panel be symmetrical; you will agree that careful planning gave the desired result.

The preliminary drawing was not done in great detail. Center lines for placement of all major parts, together with block outlines indicating space requirements, were laid out as shown on the drawing. With the drawing and the parts, it was then a simple matter to lay out the panel and chassis for drilling.

It will be noted, starting from the left of the chassis, that all components are mounted in five rows across the chassis running from front to back, and that all these parts are also located as symmetrically as is possible.

Obviously all of the coils in the exciter could be permanently mounted. However, for ease of mounting and convenience in getting at the coils for cutting them to size, plug-in mounting was used for all except the 10- and 20-meter coils for the 807, which are located underneath the chassis.

With the exception of three of the front of panel controls, the layout allowed the shafts to be run directly from the knobs or dials to the corresponding switch or condenser shaft. The photograph of the bottom view shows a flexible shaft drive for the T-55 neutralizing condenser, and flexible bronze cable drives for two of the tap switches. Small brass pulleys on the control knob shafts are used in conjunction with the flexible cable to transmit motion from the control shaft to the switch shafts. In one case the cable drive is used to operate a tap switch which is offset several inches from the control shaft, but in the same horizontal plane. In the other case cable and pulley drive is used to operate a tap switch which is offset and below the chassis in a vertical plane from the control shaft above the chassis.

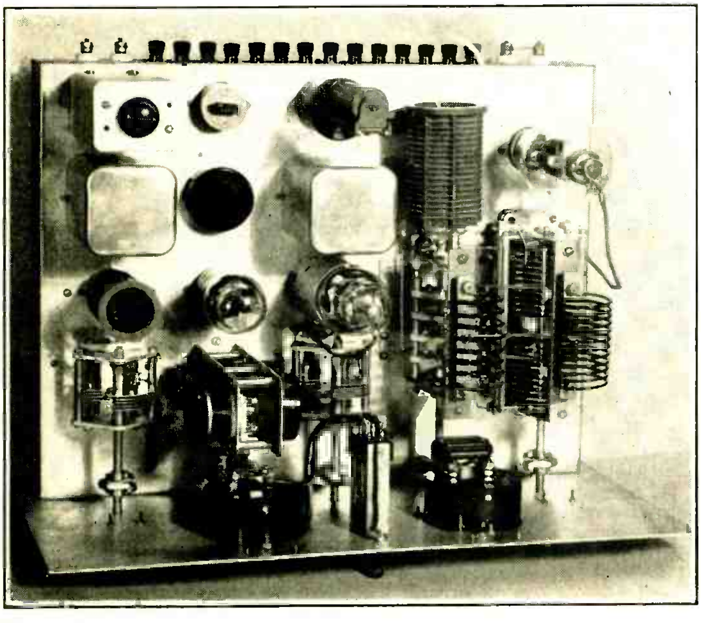
The 10- and 20-meter coils for the T-55 and 807 are self-supporting whereas coils for the lower frequencies are wound on standard coil forms.

All condensers are mounted on small feed-through insulators. All insulation is either mycalex or isolantite, with the exception of some of the low frequency coil forms which are of low loss bakelite.

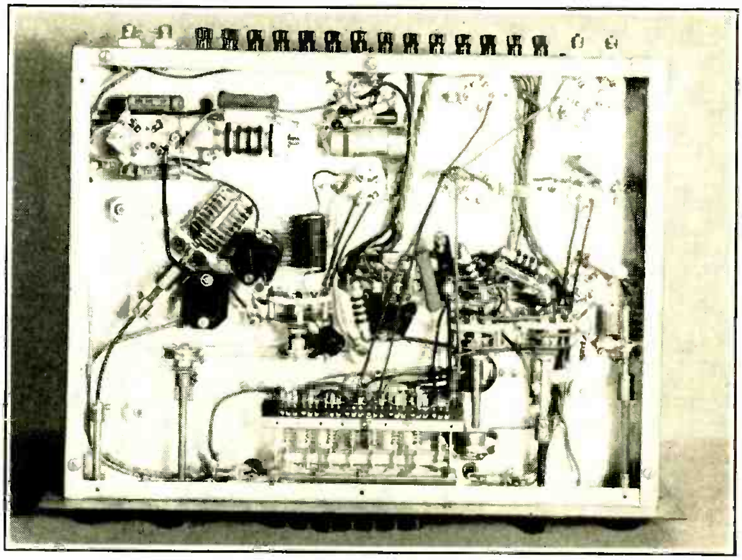
Push-Button Crystal Selector Switch

The new Mallory 8-position push-button selector switch offers many advantages. Each position is essentially a double-pole double-throw switch. This allowed 7 positions for crystals with the 8th position reserved for cutting in the stabilized oscillator located at the operating table. Furthermore, the switch automatically shorts all crystals not actually in use, and in this case is also used to operate indicating lights (green for crystal and red on v.f. oscillator). The other side of the double-pole switch may be used to control relays to the speech equipment when crystals in the phone bands are placed in the oscillator circuit.

The shielded plug-in stabilized oscillator coupler is at the rear left edge of the chassis



Looking down upon the exciter-transmitter. The vertical multiple crystal mounting can be seen just behind the left meter. The keying relay (plug-in type) is behind the plate coil shield for the 807. The final amplifier coils are mounted upon the final tuning condenser and upon the bandswitch for these coils.



Under-chassis view showing how shortness of leads has been facilitated by placing the various components as close as possible to the circuits in which they are incorporated. Extension shafts (flexible or solid) and pulley drives have then been employed to bring the controls to the front panel so that they present a symmetrical appearance.

and may be removed at any time should it be desired to use another crystal in place of it.

Meter Switching

The Federal 4-pole double-throw switch located between the two plate milliammeters is used for switching the left-hand instrument to either the 6A6 or 807 stages. The right-hand instrument is in the plate circuit of the T-55.

On the right-hand end of the chassis are located two jacks which are in the grid bias circuits of the 807 and T-55. Inasmuch as the grid current values are of use only in the tuning up and checking of the exciter, it was felt that continuous metering of the grid circuits was unnecessary.

Keying and the Keying Relay

Obviously any number of keying methods might be used. In this case the keying relay is located in the 807 cathode circuit. A telephone-type keying relay (Automatic Electric Co.) is used. This relay is mounted on an oversize tube base which is plugged into a standard socket on the chassis. Thus, the relay may be readily removed for adjustment. This particular relay operates on only 4 milliamperes of d.c. which is obtained from one of the bias supply binding posts on the rear of the chassis.

The T-55 Neutralizing Condenser

Only in the T-55 stage is any form of neutralizing necessary, and but slight adjustments are necessary when switching from one band to another. The neutralizing condenser is located beneath the chassis for convenience, and is operated by the lower right knob seen on the front of the panel.

Neutralization is of course accomplished in the usual manner. However, a tip here may be in order. The final amplifier following the T-55 stage has a grid milliammeter permanently connected. Perfect neutralization is indicated when plate current of the T-55 is minimum at the same time as when grid current to the final is maximum, when tuning the plate condenser of the T-55 stage. If the above does not occur, a slight adjustment of the neutralizing condenser will be necessary to insure readings as mentioned. (At the present writing an 814 is being installed in place of the T-55. This will of course eliminate neutralizing of the exciter final when it has been properly installed.)

The Crystal Holder

A crystal mounting holder was devised for holding five of the large size plug-in type holders and this is quite apparent in the photo of the top view. Two pieces of 1/16" sheet aluminum 2" wide were laid out to be mounted as shown. One was drilled for 3 sockets, and the other for 2 sockets staggered in between the other three holes. The sockets were assembled in these supporting pieces, wired and then assembled together with tubular spacers. The wires from the crystal

[*Continued on Page 83*]

Armstrong
FREQUENCY MODULATION

By **ROBERT S. KRUSE**

Once more a "worthless" thing has produced new and useful results. The familiar Biblical words, "The stone which the builders rejected, the same is become the head of the corner," apply with startling aptness, for some of the most prominent men in radio have condemned frequency modulation for its faults, and accused it of lacking any compensating advantages whatsoever. In this they were right, for they had in mind the *conventional sort* of frequency modulation which is no more than a "wabbling" back and forth of the carrier frequency, the wabbling being in accord with the variation of speech or music. This is the sort of modulation which appears as an un-invited by-product in amplitude modulated self-oscillators such as are found in most of the current "transceivers" and similar simple u.h.f. equipment.

Before attempting to show that the Armstrong method is not mere "wobbulation," let us cast back to the meaning of ordinary amplitude modulation, at present well-nigh universally used in radiophone transmitters making any pretense at good performance. In its commonest form this consists, as you know, of a "class C" triode which has 4 inputs:

1—The filament current, which is used for heating purposes only.

2—The d.c. plate input, which is unvarying and produces no sound in the receiver.

3—The radio-frequency grid input, which is likewise unvarying and produces no sound at the receiver.

4—The a.c. plate input, which is recovered at the detector of the receiver.

All the solicitude expended upon our radiophone equipment centers around the desire to deliver this no. 4 a.c. undamaged to a detector, so that it may proceed in its proper form to a loudspeaker and there be reconverted to sound just like that which was fed into the microphone and there generated the a.c.—or, if you please, the audio-frequency a.c. Quite justifiably there has been very great engineering and manufacturing expenditure to assure that this process shall be unmolested by variations in those inputs we have called 1, 2 and 3. Crystal control, re-design of generators and rectifiers, filter research, improved tubes, study of audio and r.f. amplifiers, and many another matter has contributed. At the receiver also, intense effort has been put into the job of avoiding every bad influence upon the safe conduct of the precious audio a.c.

In January, 1936, there appeared in RADIO an article on the mechanics of the Armstrong system of frequency modulation, based on a personal interview with Major Armstrong by the author of the article, R. S. Kruse. Apparently the article was several years ahead of its time, because at the time of its publication it caused little interest in amateur circles. The article remains, four years later, one of the most lucid explanations of f.m. we have seen, and because of the current interest in f.m. by amateurs active on 112 Mc., we are reprinting the article herewith.

Note the use of push-pull triplers as power stages, the use of limiting amplifiers in the receiver, and mention of the fact that interfering signals must be in a ratio of 2 to 1 or less before the interference is noticeable in the receiver.

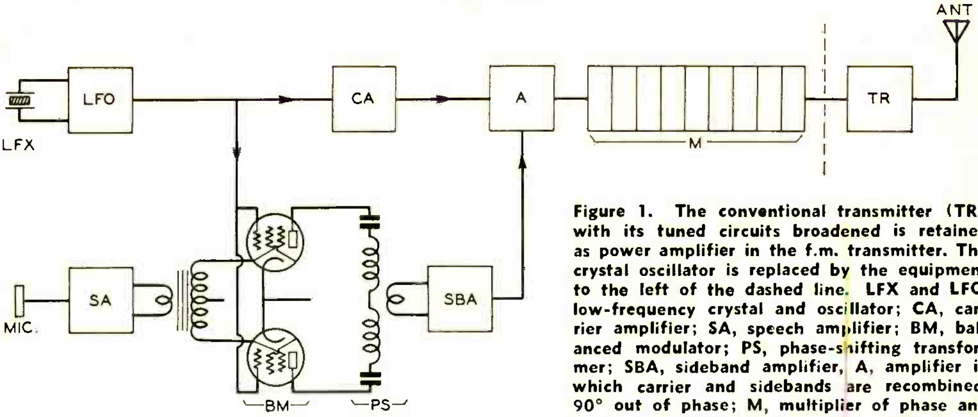


Figure 1. The conventional transmitter (TR) with its tuned circuits broadened is retained as power amplifier in the f.m. transmitter. The crystal oscillator is replaced by the equipment to the left of the dashed line. LFX and LFO, low-frequency crystal and oscillator; CA, carrier amplifier; SA, speech amplifier; BM, balanced modulator; PS, phase-shifting transformer; SBA, sideband amplifier, A, amplifier in which carrier and sidebands are recombined, 90° out of phase; M, multiplier of phase and frequency; TR, u.h.f. transmitter with broadened tuned circuits.

But Out in Space

But, alas, we cannot tie the transmitter to the receiver with a shielded wire. We must use that invisible, churning, and quivering electronic web we call "ether"—and in this ether many things interfere with our fine plans for the safe-conduct of the signal. Like a spider-web agitated by the impact of raindrops it twitches to electrical impacts from lightning and from a million lesser electrical effects, natural and man-made. Thus we hear "static." Its upper levels roll and tumble under the influence of the sun and other things quite beyond our control, and unfortunately radio signals as usually sent do rise to those upper levels and come down once more to arrive at the receiving point more or less altered by their journey and no longer in good agreement with the other portion of the wave, which has arrived by running on the ground. Thus a "sky wave" interferes with a "ground wave" and we hear fading of the signal-loudness.

Still another effect of somewhat the same sort gives us "selective fading" in which the damage is not so much to the signal strength as to the goodness of the sound-reproduction, or "quality."

What To Do About It

In facing these static and fading problems radio men feel like that airman who was ordered by the field's radio station to stay away and not make a landing, but retorted:

"Take it up with God; the motor's conked."

There just hasn't seemed to be any great help, despite the most positive orders from broadcast listeners, commercial operators, and users of the radio links in our telephone system. Of course there are partial cures. Greater receiver sensitivity and automatic volume control make some fading signals useful, at the cost of increased amplifier noise and greater noise pickup from outside during the fade-downs. Special antennas help somewhat. Stronger transmitters help by the brute-force process of overpowering weak interference, and forcibly shoving more signal out along the earth, with some chance that the sky-wave interference does not grow equally strong. This high power method is so very costly as to be staggering.

The core of all the difficulty appears to lie in the disposition of the receiver. *For years it has been painstakingly developed to respond in precise proportion to any audio-frequency voltage variation at its input terminals.* If the carrier amplitude changes at an audio rate, the loudspeaker says so at once, reproducing the variation as to pitch and amplitude. It is no matter to the receiver whether the carrier-amplitude change was caused intentionally or accidentally; as long as it is an audio-frequency amplitude change one hears of it. Therefore no discrimination exists between modulation at the transmitter and modulation in the ether, though one is caused by sounds before the microphone and the other by wave-effects in space. Static and other large voltages are able to upset this voltage-conscious device thoroughly, even though briefly.

If, then, the core of the difficulty is in a receiving device which depends on audio-frequency variations in a steady r.f. voltage, the possibility exists that a cure may be effected by some system such as:

A—A receiver intentionally made very obtuse to changes in the carrier-amplitude at any audio rate, or at least not primarily dependent on such changes.

B—A transmitter in which amplitude modulation has been replaced by modulation of frequency or phase.

C—The use of a transmission wavelength (the word is used for a purpose) for which static and fading are known to be moderate.

D—Some manner of response-limiter.

E—Some means of avoiding much effect at the loudspeaker from another disturbance not mentioned here previously, that of disturbing voltage arising in the tubes of the receiver.

How all of these features appear in the Armstrong system, and what their effect has been in tests, is to be the rest of this story.

Phase Modulation

If the frequency of an a.c. generator is increased by one cycle per second, then in comparison with the original frequency, we may say that the machine is "gaining one cycle per second" or that its "phase is advancing 360 electrical degrees per second." The two expressions in quotations are interchangeable, as one cycle is identical with 360 electrical degrees. This is merely to point out that a frequency change is a phase shift. A frequency increase is a forward phase shift; a frequency decrease is a backward shift of phase.

Thus if we begin with a crystal-controlled oscillator and apply phase shifts to its output we are frequency modulating it—that is, waving the frequency back and forth in accordance with the voice. This has been attempted in the past by causing the audio amplifier to flutter one plate of the crystal holder. It is the writer's recollection that a very small frequency range was possible.

In the Armstrong system it is desired to waver the frequency over a very wide range, say 60 kc. each side of the "resting" position (more in some cases). To do this at the crystal holder is pretty clearly out of the immediate probabilities—though the word "impossible" is not being much used just now. This problem is solved by applying the phase modulation to the output of a low-frequency crystal-controlled oscillator *after* which the modulated output is put through numerous receiving tubes working as frequency multipliers, with buffers and filters at intervals to side-track unwanted frequencies generated during the process. The original phase modulation, even for the loudest sounds, is kept down to 30 electrical degrees (1/12 of a cycle). This seems a hopelessly small modulation but Major Armstrong states that the frequency multiplier, without introducing any serious distortion, is in its present form able to increase the frequency several hundred to several thousand times and at the same time to multiply so greatly the modulation phase as to raise the original 1/12 cycle change to a frequency swing of as much as 75,000 cycles to either side of the "resting" frequency. This appears to involve phase multiplications of about a million, perhaps corresponding to the square of the frequency multiplication.

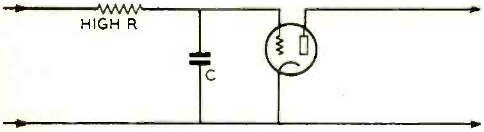


Figure 2. Principle of the audio correction network. The total drop across the sum of the resistor and condenser is approximately constant because of the high resistance, while the drop across the condenser is inversely proportional to frequency because the capacitive reactance decreases as the frequency increases.

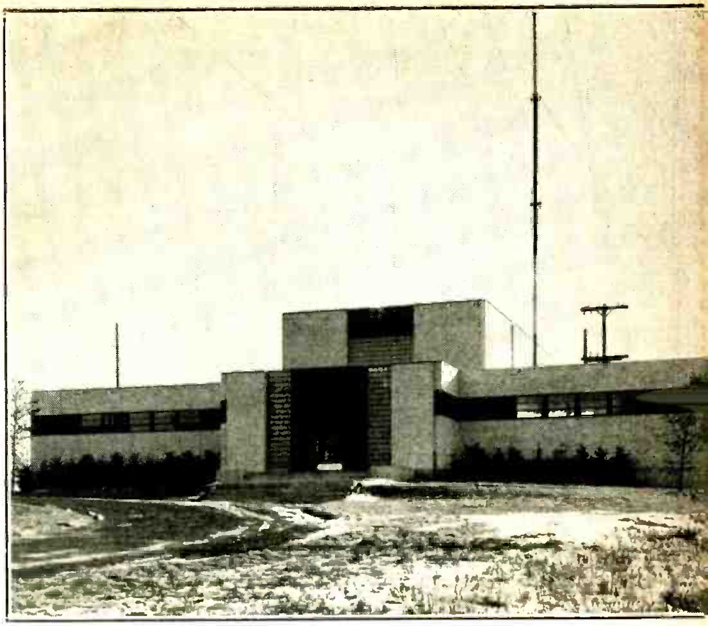
The Machinery

This varying frequency, still at a very modest power level indeed, is now supplied to the transmitter at the place where it is usually fed from the crystal tube; that is, at a point where a watt or two of r.f. suffices to drive the following stages. Beyond that point there is no further need of modulation, but the tuned circuits must be broadened to pass the very wide frequency-swing-band. This is done by resistance-damping and other familiar means.

However, the method of originally creating the 30 degree phase modulation of the low frequency has not been explained; we must retrace. The scheme is to feed from the crystal tube two channels. In one of them lies a straightforward amplifier stage, so that we may have a little more carrier and also some "buffer" action. In the other channel lies a "balanced modulator." This well-known device is a pair of tubes whose grids are fed in parallel (with r.f.) but whose plate coils are arranged to "buck" so that there is no r.f. output at all when "resting." Now if one grid (or screen) is made more positive while the same part of the other tube is made more negative, the balance is upset and some power escapes to the common output coil, which is coupled to both plates. This output is r.f., but not at the carrier frequency. It is sideband power; there is no carrier. Thus a balanced modulator is a device for generating sidebands without a carrier. The audio modu-

[*Continued on Page* 78]

● Speaking of frequency modulation, this is the transmitter building of the Yankee Network's 50-kw. W1XOJ atop Asnebumskit Hill near Worcester, Massachusetts.



DEPARTMENTS

- **DX**
- **U. H. F.**
- **Postscripts and Announcements**
- **Open Forum**
- **What's New in Radio**
- **Yarn of the Month**
- **Scratchi**
- **New Books and Catalogs**

"WAZ" HONOR ROLL

CW and PHONE

	Z	C
ON4AU	40	158
G2ZQ	40	147
J5CC	40	130
W8CRA	39	156
W2BHW	39	156
W8BTI	39	154
W2HHF	39	152
G6WY	39	151
W6CXW	39	150
W6GRL	39	150
W2GT	39	150
W9TJ	39	149
W2GTZ	39	149
W6CUH	39	143
W6KIP	39	143
W8OSL	39	143
W9KG	39	141
W6ADP	39	140
W6BAX	39	140
W80QF	39	139
W4CBY	39	138
W9TB	39	134
W2ZA	39	134
VK2EO	39	133
G5BD	39	133
W2GVZ	39	132
W6QD	39	132
W4CYU	39	132
W3EVT	39	131
W5KC	39	130
W2GWE	39	129
W6KRI	39	129
VE4RO	39	126
W7BB	39	123
W6HX	39	123
G5BJ	39	120
W2IYO	39	119
W8JSU	39	118
W2CYS	39	117
G2LB	39	115
W4IO	39	115
W7DL	39	115
W2GNQ	39	113
W6FZL	39	112
ON4HS	39	111
ON4FE	39	110
W1AQT	39	110
W6FZY	39	109
W9NRB	39	98
W6SN	39	96
W6GPB	39	94
XE1BT	39	90
K6AKP	39	78
W1BUX	38	152
W1CH	38	150
W2GW	38	143
W5VV	38	144
W3HZH	38	139
W3EMM	38	139
W8BKP	38	138
ZL1HY	38	138
W8LEC	38	136
W3EPV	38	136
W5BB	38	135
W9GDH	38	134
W3HXP	38	133
W4FVR	38	130
W9FS	38	130
W3EAV	38	130
W8JMP	38	127
W2GRG	38	127
ON4EY	38	126
W1ADM	38	125
W3EVW	38	124
W3GHD	38	121
W8AU	38	120
W8LYQ	38	120
W8DFH	38	119
W9PST	38	119
W8QXT	38	119
W8JIN	38	119
W3FQP	38	119
W8DWV	38	118
W1GDY	38	118
W2BMX	38	118
W1BGC	38	117
W6AM	38	117
LU7AZ	38	116
W3DDM	38	116
W9UQT	38	116
W3GAU	38	115
W8MTY	38	114
W9KA	38	114
W6VB	38	113
G6CL	38	112
W8HWE	38	112
G2QT	38	112
W8EUY	38	112
W9CWW	38	112
W2BXA	38	111
W6GRX	38	111
LY1J	38	110
W1AB	38	110
W6HZT	38	110
W9ELX	38	110
W8LFE	38	110
W4MR	38	108
W8KWI	38	108
W3BEN	38	108
W8BOX	38	106
W9ADN	38	106
W8OE	38	106
W9PK	38	105
W8GBF	38	105
ON4UU	38	104
G2IO	38	103
W8BWB	38	98
J2KG	38	95
G6XL	38	95
ON4FQ	38	92
W9VDQ	38	79
SU1WM	37	138
W2BJ	37	134
W6GAL	37	131
W8KKG	37	127
W7AMX	37	125
J2JJ	37	123
W1BXC	37	123
W2IOP	37	122
W1RY	37	120
G6NF	37	115
W8PQQ	37	115
W8ZY	37	114
W9RCQ	37	114
W3TR	37	113
ON4FT	37	112
W9RBI	37	112
W6MEK	37	112
W6ADT	37	111
G2MI	37	110
VE2EE	37	108
W4DMB	37	108
W7AYO	37	108
W3KT	37	105
W6NLZ	37	105
W9PTC	37	103
W6ITH	37	103
W3FJU	37	103
W9GBJ	37	103
G6GH	37	102
W3AYS	37	102
VK2DA	37	101
W6FKZ	37	101
W6JBO	37	101
W8KPB	37	100
W4DMB	37	100
W9AJA	37	99
W4EQK	37	99
ON4VU	37	99
W3EXB	37	98
ZL2CI	37	97
W6MHH	37	95
G2UX	37	91
W2BSR	37	90
W6MCG	37	84
W9UBB	37	77
W8AQT	36	120
W6MVK	36	117
K4FCV	36	107
W8AAJ	36	106
W3GGE	36	106
W6BAM	36	106
W8DOD	36	106
W9AFN	36	105
W5PJ	36	105
W8QDU	36	105
W5ASG	36	104
SP1AR	36	103
W6NNR	36	100
W6KWA	36	99
W8LZK	36	99
G6BJ	36	99
VE1DR	36	98
W9VES	36	98
W8LDR	36	97
W8AAT	36	96
W6DLY	36	96
W9GKS	36	95
G6YR	36	94
W2IZO	36	94
VE5AAD	36	92
W5ENE	36	91
W4ADA	36	90
W9LBB	36	90
W1APU	36	90
W8JAH	36	89
OK2HX	36	86
VK2NS	36	84
W6TI	36	80
W6GCX	36	76
W7DSZ	36	73
W2GXH	36	71
W1WV	35	117
W8OXO	35	113
W6GHU	35	103
W4QN	35	103
W9PGS	35	103
K6NYD	35	100
W8OUK	35	99
W8CJJ	35	98
W6HJT	35	98
W2WC	35	98
OK1AW	35	96
W3RT	35	95
W8CLM	35	95
W9EF	35	94
G6QX	35	94
W3DRD	35	93
W6AQJ	35	92
VE5ZM	35	92
LU3DH	35	89
W9GNU	35	88
W9ERU	35	88
K6CGK	35	88
W9VDX	35	86
W6KQK	35	85
W6ONQ	35	83
ON4NC	35	82
GI6TK	35	80
W4ELQ	35	80
W8QIZ	35	78
W6MUS	35	77
W6GK	34	105
W6HEW	34	103
K7FST	34	102
W8CED	34	102
W8BSF	34	100
W1APA	34	98
W2BZB	34	99
VK2AS	34	94
W8HGA	34	93
W3EYY	34	91
W8NV	34	91
W9MQQ	34	89
W2FLG	34	89
W6TE	34	88
G6WB	34	88
W6CVW	34	88
VK2OQ	34	87
G5VU	34	85
W9BCV	34	83
ZS1CN	34	82
W6PNO	34	82
VK2TF	34	81
W6MJR	34	81
ON4SS	34	80
W6HIP	34	76
VK2TI	34	75
W7AVL	34	75
W8JK	34	75
ZL2VM	34	72
W6LHN	34	71
VK2AGJ	34	70
VK2EG	34	70
VE5MZ	34	69
VK2VN	34	63
W9QOE	34	56
F8XT	33	112
W8ACY	33	106
W3DAJ	33	97
W6KEV	33	96
W8BWC	33	93
W9VKF	33	93
W6KUT	33	90
W6CEM	33	88

PHONE

W3LE	38	128
F8UE	38	103
W6OCH	36	107
W6ITH	36	97
W3FJU	36	87
VE1CR	36	81
W9NLP	35	95
W9TIZ	35	93
KA1ME	35	79
F8VC	35	78
W4CYU	34	100
W1ADM	34	93
ON4HS	34	92
W6EJC	34	84
W7BVO	34	80
W4DAA	34	71
W6NNR	33	88
GM2UU	33	84
F8XT	33	70
W3FAM	33	68
W6MLG	32	92
W8LFE	32	91
W2IKV	32	90
W4DRZ	32	89
W9QI	32	86
W1HKK	32	85
W8QXT	32	85
G5BY	32	85
W9BEU	32	85
VK4JP	32	85
W4DSY	32	84
W6OI	32	83
W9TB	32	82
W6IKQ	32	80
VE1DR	32	59
W3EMM	31	88
W1AKY	31	87
W8LAC	31	85
G6BW	31	83
G3DO	31	78
W1KJJ	31	78
W6FTU	31	77
G8MX	31	73
W8RL	31	71
W9UYB	31	71
W6AM	31	67
F8KI	31	58
W9ZTO	31	53
W4EEE	30	86
W2GW	30	86
W1JCX	30	81
W2IUV	30	79
W2AOG	30	77
W8AAJ	30	77
W9BCV	30	68
W6MZD	30	52
W2IXY	29	93
W4BMR	29	80
K6NYD	29	78
CO2WM	29	78
W9RBI	29	71
W6NLS	29	64
W6NRW	29	60
KA1CS	29	59
W2GRG	28	74
W6PDB	28	65
W7EKA	28	63
VE2EE	28	62
W4DRZ	28	62
W1BLO	28	62
VK2AGU	28	61
W6GCT	28	56
W3EWN	27	93
W2DYR	27	77
W2HCE	27	76
G6DT	27	59
W5CXH	27	52
G5ZJ	26	77
W5ASG	26	62
W8NV	26	62
W5VV	26	61
W4EQK	26	61
W8QDU	26	61
W9NMH	26	61
W5DNV	26	60
VK2OQ	26	56
W4TS	26	54
W6MPS	26	51
VE4SS	26	50
W6FKK	26	47
K6LKN	26	46
G6CL	26	46

DX AND OVERSEAS NEWS

by Herb. Becker, W6QD

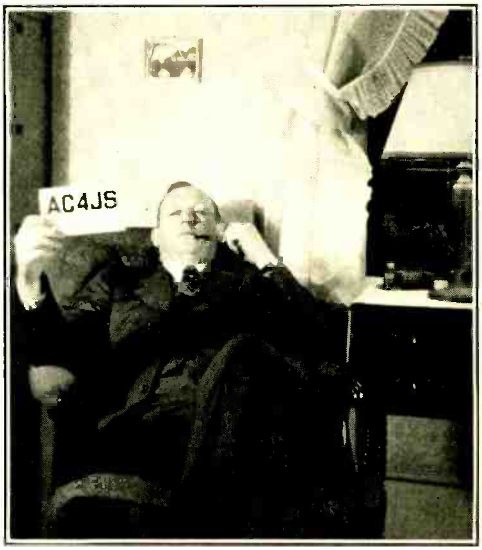
Send all contributions to Radio, attention DX Editor, 1300 Kenwood Road, Santa Barbara, Calif.

OFFICIAL RESULTS 1939 DX MARATHON

During the year 1939 RADIO conducted a contest based on the number of zones and countries worked. Each month the calls of the highest 50 c.w. and phone, and 25 phone were published together with their scores. This Marathon gave the fellows the incentive to work a lot of dx that they had already worked at some previous time. All in all it was pronounced a huge success and if it were not for the present conditions overseas we would surely have another one. There have been many that have been in the Marathon list from the beginning, faithfully reporting each month.

The 75 calls shown in the list only represent a minor number of those reporting each month. It is too bad that more of those who tried their darndest couldn't squeeze in under the wire.

The following is the official and final listing for the 1939 DX Marathon, as approved by the committee.



W3BEN—at peace with the world.

1939 DX MARATHON

- The Contest Committee takes pleasure in announcing the final standings of the contestants in the 1939 DX Marathon. The Marathon began January 1, 1939 and ended December 31, 1939. A "Winners Certificate" is being forwarded to W9TB in recognition of his achievement of winning the C.W. and Phone section, while an identical certificate goes to W3LE for winning the Phone Only section. The remaining 49 in the C.W. and Phone, and the 24 in the Phone, only, group will also receive similar certificates with their final standings noted thereon.

C. W. and PHONE

	Z	C
W9TB	39	115
W2HHF	39	113
VE4RO	38	114
W8LEC	38	107
W8OQF	38	106
W9TJ	38	104
W4TO	38	99
W9NRB	38	88
W2BHW	37	115
W8BTI	37	113
G5BD	37	113
W3EPV	37	108
W2ZA	37	97
W6MEK	36	104
W8LFE	36	103
SU1WM	36	102
W9GDH	36	100
W2AIW	36	100
W9CWW	36	99
W9VES	36	92
W9ELX	36	91
W4FVR	36	90
W6NLZ	36	87
W3HXP	36	86
W1BGC	36	82
W6SN	36	69
W5KC	35	104
W9RBI	35	102
K6NYD	35	100
W9GKS	35	84
W8AU	35	82
G2FT	35	82
K4FCV	34	99
W4FIJ	34	97
W8JIN	34	94
ON4HS	34	93
W3HZH	34	93
W5PJ	34	90
W9MQQ	34	84
W1RY	33	90
W5ASG	33	85
W2IZO	33	83
W4QN	33	79
W8CLM	33	79
XU8MI	33	76
G3AH	33	71
W6GK	33	69
W9VKF	32	86
W3FJU	32	81
W9ERU	32	74

PHONE

W3LE	38	115
W9TB	32	82
W8LFE	31	86
W6OCH	31	84
W1HKK	31	80
W8QXT	31	78
W1ADM	31	75
W6ITH	31	71
F8UE	31	71
F8VC	31	55
W9BEU	30	80
W1KJJ	30	77
W6NNR	30	75
ON4HS	30	74
W2AER	30	47
K6NYD	29	76
W1JCX	29	72
W1AKY	29	71
CO2WM	29	70
VK4JP	29	67
W2IKV	28	68
W3FJU	28	60
W7BVO	28	57
W6EJC	27	59
W6PDB	27	59

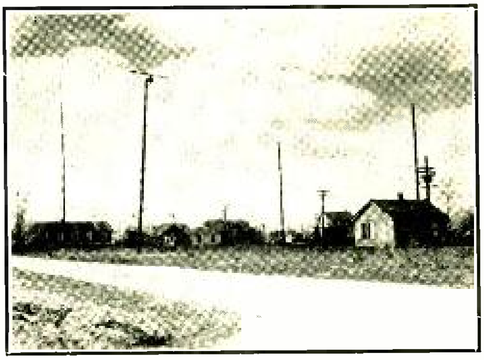
WINNER C.W. and PHONE

E. E. "WALLY" SCHROEDER, W9TB, CHICAGO, ILLINOIS

Wally deserves a great deal of credit for rolling up 39 zones and 115 countries. In awarding the winner's certificate to W9TB, for topping the c.w.-phone section, RADIO feels that he has really earned it. On the other hand, Wally claims he could have done a lot better if he had really tried. By observing the photographs of W9TB you will get an idea of what he used in the way of equipment and antennas. The final amplifier shown at the extreme left has four 860's in push-pull parallel, although now he is using two TW-150's. The rig hasn't been changed in 4 years.

The rest of the rig which runs down the length of the wall for about ten feet is shielded with copper screen. Wally mentions that the rig actually runs another foot to the right, but couldn't get it all in the picture. He says, "Now you can get an idea of why I hate to QSY." The potency of his homemade receiver, utilizing (about) 20 tubes and 15 knobs, is borne out by the kind of DX he works. (AC4JS three or four times, tsk, tsk.) The surroundings of W9TB can be seen in the picture showing his four poles and shack. Wally says when he moved out there quite a while ago he had most of the space to himself but recently he has been crowded a bit. In the spring he will set up his station at a new location, which he terms perfect. On one pole he has his 40-meter vertical and his two-band rotary can be seen on another.

Wally did a lot of smart operating and made the most of his time. He never was able to sit down hour after hour and comb the bands, due to being so tied up with work at CBS. This is an example of what can be done, if planned carefully so that every hour on the air counts. To "Wally" Schroeder, W9TB, our sincere congratulations on his achievement.

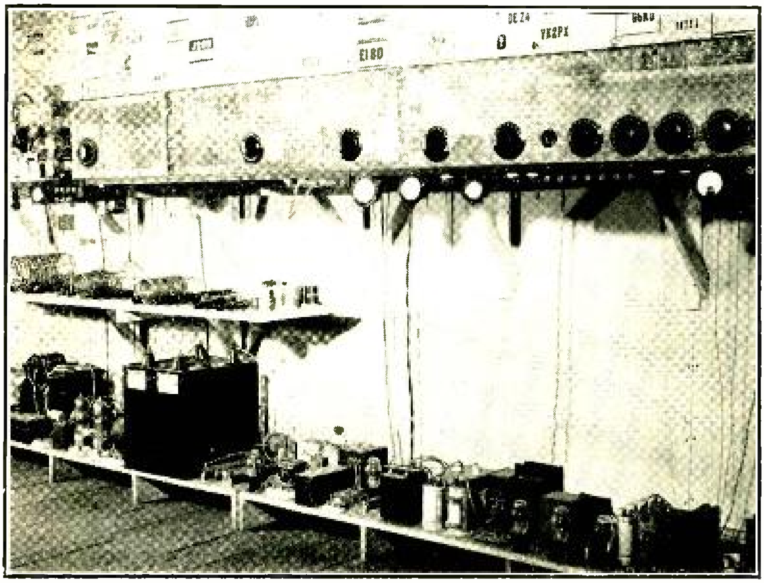


W9TB's shack with his four poles. The 40-meter vertical is on the extended pole to the left.

ZONES FOR W9TB

1. K7GSC
2. V06B
3. W6QD
4. W9JRZ
5. W2AIW
6. XE2N
7. TI2FG
8. K4KD
9. VP3CO
10. OA4K
11. PY2AC
12. CE4AD
13. LU8AB
14. G6NF
15. OH5OD
16. U2NE
17. U8ID
18. U9AW
19.
20. YR5AA
21. UK6WA
22. VU2FX
23. AC4JS
24. XU8MI
25. J5CC
26. XZ2DX
27. KA1ME
28. PK4KS
29. VK6FO
30. VK2TI
31. K6CGK
32. ZL1MR
33. FA8BG
34. SU1SG
35. ZD4AB
36. CR6AI
37. CR7AK
38. ZS6GI
39. VQ8AI
40. TF5C

[*Continued on Page 50*]

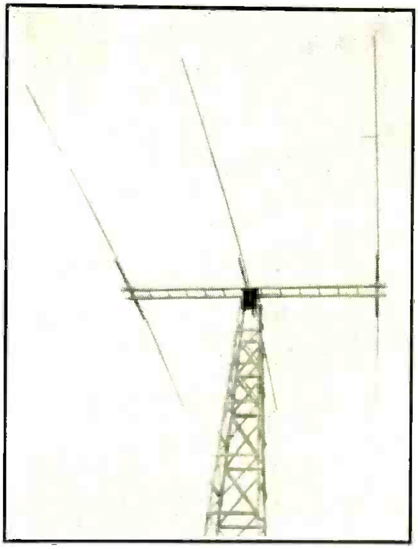


The transmitter at W9TB. Four 860's in p.p. parallel shown in the final although these have been replaced by a pair of TW-150's. A pair of 204-A's in class B are used as modulators.

WINNER PHONE SECTION
LOU BREMER, W3LE, BALTIMORE, MD.

Lou Bremer is head and shoulders above the next nearest in the phone section, and is thereby awarded the winner's certificate. This does not detract from the others because Lou was really out after the stuff during 1939. I can imagine the hours he has spent searching for new ones because any way you look at it 38 zones and 115 countries is a lot to work on two-way phone in one year's time. Furthermore, you haven't heard anything yet. . . . W3LE has all 38 of these zones confirmed as well as 99 of the countries. This should not be confused with his Honor Roll total; they were actually confirmations of contacts made during 1939. Lou says he always sends his QSL card as soon as he has finished working him. He never lets a day lapse. He also encloses one of his business cards, and says maybe this helps a little, or scares them into QSLing. You see, W3LE is with a detective agency in Baltimore, and they usually want to know how the investigating racket is getting along.

Now let's take a look at Lou's past and present. He received his first ticket in 1922 and has been a ham ever since. First rig was a 201 in a loose-coupled Hartley oscillator modulated by a 171 using the Heising system. Next in order were the 202 and then the 210. He managed to save enough to blow himself on a couple of 203's which set him back something like $38.50 apiece . . . one the oscillator and the other for modulator. W3LE has worked a total of 128 countries as shown in the WAZ Honor Roll listing. He has 116 confirmations. W3IK and W3LE were among the first to use protective relays in the grid circuits of buffer and final amplifiers. These relays were used to break the plate voltage for that particular stage if the excitation should fail. This is especially to advantage if the stage uses automatic bias.



The rotary at W3LE which helped him get 38 zones and 115 countries on two-way phone.

Lou (W3LE) taking it easy beside his transmitter. (Probably taken during the DX Contest.)

The present rig at W3LE is contained in two 6-foot racks. The tube lineup consists of an RK49 oscillator, TZ20, push-pull T40's and in the final push-pull T-125's. Speech: 56, 56, p.p. 56's, p.p. 2A3's into a pair of heavy duty 203A's in class B. Lou's receiver is a homemade 14-tube super, with noise limiter and crystal filter. Lou wants it known that he doesn't spend all his time reading magazines, although from the picture it would indicate otherwise. The rotary is 70 feet above the ground and is the Premax 6 element. Lou has done some pretty smart operating and it might be well to take a tip from his system and shoot out that QSL card just as soon after the QSO as possible. Of course, you can't all work for a detective agency, but you might have an angle just as good. RADIO extends its heartiest congratulations to Lou Bremer, W3LE, for topping the phone section of the 1939 DX Marathon.

ZONES FOR W3LE

1. K7AOC
2. VO6D
3. VE5OT
4. VE4AFM
5. VE1NU
6. XE2FG
7. YN3DG
8. K4EMG
9. HK1FR
10. HC2HP
11. PY2MI
12. CE3CG

13. LU5AN
14. G6ML
15. HA3N
16. U2SH
17. U9ML
18. U9AL
19.
20. SV1KE
21. YI2BA
22. VS7RA
23.
24. MX2A
25. J2MI
26. XZ2EZ
27. KA1CS
28. PK4DG
29. VK6AB
30. YK5BF
31. K6NYD
32. ZL1MR
33. FA3HC
34. SU1CH
35. ZD2H
36. VQ2PL
37. VQ4KTB
38. ZS4H
39. VQ8JM
40. TF3C

COUNTRIES FOR W3LE

1.	Alaska	K7AOC
2.	Algeria	FA3HC
3.	Argentina	LU5AN
4.	Australia	VK4JP
5.	Azores Islands	CT2BP
6.	Bahama Islands	VP7NS
7.	Baherin Islands	VU7BR
8.	Belgian Congo	OQ5AA
9.	Belgium	ON4HS
10.	Bermuda Islands	VP9G
11.	Bolivia	CP1BA
12.	Brazil	PY2MI
13.	British Honduras	VP1BA
14.	Burma	XZ2EZ
15.	Canada	VE5OT
16.	Canal Zone	K5AM
17.	Ceylon	VS7RA
18.	Channel Islands	G8MF
19.	Chile	CE3CG
20.	China	XU8RB
21.	Chosen (Korea)	J8CI
22.	Colombia	HK1FR
23.	Costa Rica	TI2AV
24.	Cuba	CO2EO
25.	Darien (Kanto-shu)	J8PG
26.	Denmark	OZ5BW
27.	Dominican Republic	HI7I
28.	Ecuador	HC2HP
29.	Egypt	SU1CH
30.	Eire (Irish Free State	EI6G
31.	England	G6BY
32.	Estonia	ES5D
33.	Federated Malay States	VS2AL
34.	Finland	OH2OI
35.	France	F8MN
36.	French India	FN1C
37.	French Indochina	FI8AC
38.	French Oceania	FO8AA
39.	Gibraltar	ZB2B
40.	Gilbert, etc. Islands	VR1AP
41.	Gold Coast	ZD4AB
42.	Greece	SV1KE
43.	Greenland	OX7ZL
44.	Guam	K6OPX
45.	Guatamala	TG9BA
46.	Guiana, British	VP3CO
47.	Haiti	HH2B
48.	Hawaiian Island	K6NYD
49.	Honduras	HR5C
50.	Hong Kong	VS6AB
51.	Hungary	HA3N
52.	Iceland	TF3C
53.	India	VU2CQ
54.	Iraq (Mesopotamia)	YI2BA
55.	Ireland, Northern	GI2CC
56.	Isle of Man	G6IA
57.	Italy	I1PB
58.	Jamaica	VP5BR
59.	Japan	J2KG
60.	Java	PK3WI
61.	Kenya	VQ4KTB
62.	Leeward Islands	VP2AD
63.	Lithuania	LY1J
64.	Madagascar	FB8AB
65.	Maderia Islands	CT3AN
66.	Malta	ZZB1R
67.	Manchukuo	MX2A
68.	Marshall Islands	J9PA
69.	Martinique	FM8AD
70.	Mauritius	VQ8JM
71.	Mexico	XE2FG
72.	Morocco, French	CN8AV
73.	Morocco, Spanish	EA9AH
74.	Mozambique	CR7AK
75.	Netherlands	PA0FB
76.	Newfoundland	VO4A
77.	New Guinea, Terr. Of	VK9VG
78.	New Zealand	ZL1MR
79.	Nicaragua	YN3DG
80.	Norway	LA1N
81.	Palestine	VC6NX
82.	Panama	HP1A
83.	Papua Territory	VK4HN
84.	Paraguay	ZP2AC
85.	Peru	OA4C
86.	Philippine Islands	KA1CS
87.	Poland	SP2HH
88.	Portugal	CT1AY
89.	Puerto Rico	K4EMG
90.	Rhodesia, Northern	VQ-2PL
91.	Rhodesia, Southern	ZE1JR
92.	Roumania	YR5AA
93.	Salvador	YS2LR
94.	Scotland	GM6RG
95.	Southwest Africa	ZS3F
	Soviet Union:	
96.	Fed. Soc. Rep.	U1BQ
97.	White Russian Soviet Socialist Republic	U2SH
98.	Asiatic Russian SFSR	U9ML
99.	Spain	EA7BA
100.	Straits Settlements	VS1AL
101.	Sumatra	PK4DG
102.	Sweden	SM7QD
103.	Switzerland	HB9BG
104.	Taiwan (Formosa)	J9CA
105.	Tanganyika Territory	VQ3HJP
106.	Tangier Zone	EK1AF

107.	Tasmania	VK7PA
108.	Tunisia	FT4AI
109.	Uganda	VQ5KLB
110.	Union Of South Africa	ZS4H
111.	United States	W6QD
112.	Uruguay	CX2CO
113.	Venezuela	YV5ACG
114.	Wales	GW5TJ
115.	Zanzibar	VQ1ZR

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COUNTRIES FOR W9TB

1.	Alaska	K7GSC
2.	Algeria	FA8BG
3.	Angola	CR6AI
4.	Argentina	LU7AZ
5.	Australia	VK2TI
6.	Azores Is.	CT2BJ
7.	Bahamas Is.	VP7NS
8.	Bahrein Is.	VU7BR
9.	Baker, Howland, Am. Phoenix, Enderbury	KF6DHW
10.	Barbados Is.	VP6FO
11.	Belgian Congo	OQ5IM
12.	Belgium	ON4FE
13.	Bermuda	VP9R
14.	Bolivia	CP1BA
15.	Brazil	PY2AC
16.	British Honduras	VP1BA
17.	Burma	XZ2DX
18.	Canada	VE2KH
19.	Canal Zone	K5AY
20.	Canary Is.	EA8AF
21.	Cape Verde Is.	CR4HT
22.	Ceylon	VS7RA
23.	Channel Is.	G8MF
24.	Chile	CE4AD
25.	China	XU8MI
26.	Chosen	J8CH
27.	Colombia	HK2BL
28.	Costa Rica	TI2FG
29.	Cuba	CM2OP
30.	Danzig	YM4AS
31.	Denmark	OZ9Q
32.	Dominican Republic	HI5X
33.	Ecuador	HC1PZ
34.	Egypt	SU1SG
35.	Ethiopia	I7AA
36.	Esthonia	ES5D
37.	Finland	OH5OD
38.	France	F8RJ
39.	Franz Josef Land	UX1CP
40.	Germany	D4BUF
41.	Gibraltar	ZB2B
42.	Gold Coast	ZD4AB
43.	Great Britain	G6NF
44.	Greece	SV1RX
45.	Guam	KB6ILT
46.	Guatemala	TG9BA
47.	Guiana, British	VP3CO
48.	Haiti	HH2E
49.	Hawaii	K6CGK
50.	Honduras	HR4AF
51.	Hongkong	VS6AL
52.	Hungary	HA8D
53.	Iceland	TF5C
54.	Ireland, Northern	GI5QX
55.	Irish Free State	EI9J
56.	Italy	I1TKM
57.	Jamaica	VP5BR
58.	Japan	J5CC
59.	Java	PK1TT
60.	Latvia	YL2BZ
61.	Leeward Is.	VP2AD
62.	Liechtenstein	HB1CE
63.	Lithuania	LY1KK
64.	Luxembourg	LX1SI
65.	Madagascar	FB8AH
66.	Madeira	CT3AN
67.	Manchukuo	MX3H
68.	Martinique	FM8AD
69.	Mauritius	VQ8AI
70.	Mexico	XE2N
71.	Morocco, French	CN8AV
72.	Mozambique	CR7AK
73.	Netherlands	PAOEA
74.	Neth. West Indies	PJ5EE
75.	Newfoundland	VO6B
76.	New Guinea, Neth.	PK6XX
77.	New Guinea, Terr.	VK9DK
78.	New Zealand	ZL1MR
79.	Nicaragua	YN1NP
80.	Norway	LA5B
81.	Panama	HP1X
82.	Papua	VK4HN
83.	Peru	OA4K
84.	Philippine Is.	KA1RP
85.	Poland	SP1MX
86.	Portugal	CT1ZA
87.	Porto Rico	K4KD
88.	Rhodesia, No.	VQ2CM
89.	Rhodesia, So.	ZE1JR
90.	Roumania	YR5AA
91.	Salvador	YS2LR
92.	Scotland	GM6NX
93.	European Russia	U3BM
94.	White Russia	U2NE
95.	Ukranian S.S. Rep.	U5KA
96.	Transcaucasia	UK6WA
97.	Uzbekistan	U8ID
98.	Asiatic S.F.S.R.	U9ML
99.	Spain	EA7BA
100.	Sumatra	PK4KS
101.	Sweden	SM7MU
102.	Switzerland	HB9J
103.	Tanganyika	VQ3TOM
104.	Tangier Zone	EK1AF
105.	Tasmania	VK7LZ
106.	Trinidad	VP4TO
107.	Union of So. Africa	ZS6GI
108.	United States	W6QD
109.	Uruguay	CX2AJ
110.	Venezuela	YV4AE
111.	Virgin Is.	KB4FCS
112.	Wales	GW3QN
113.	Windward Is.	VP2LD
114.	Yugoslavia	YU7LX
115.	India	VU2FX

"They Also Ran . . ."

W2HHF gave 9TB a run for his money when he came up there in a rush to finish with 39 and

One for the Book.

W3EMK and W3BEK were visiting the shack of W3EMM recently for the purpose of taking some still and moving pictures. The lights and cameras were set up and W3EMK, Burt Knight, sat down at the receiver to listen in. He let out a yell—lo and behold there was AC4JS calling CQ. Burt managed to get organized and gave him a call. This picture was taken of W3EMK at W3EMM actually working zone 23.

113, while VE4RO wound up with 38 and 114 as approved by the committee. Those that remained in the list at the end of the year have been consistently active, otherwise they would not have been able to hold their places. Some of the gang have not been able to get on the air during the past few months, but the totals they had accumulated previous to this were sufficient to withstand the last minute rush of others.

In the phone section there were a flock of them having 31 zones with country totals ranging from 55 to 86. W9TB did right well on phone . . . in fact, very well, ending up with second spot. Credit for this should go to W5BEN, because he has been doing most of the phone operating at W9TB. BEN is also with CBS so it makes a happy combination between the two of them. Incidentally, I don't think I am giving anything away when I say that BEN was the guy who first worked AC4JS for W9TB. He was supposed to be on phone at that particular time and found out that AC4JS was in there somewhere. He cranked it up on c.w. and gave him a blast . . . and back he came I don't know who was the most surprised but I have a good idea. (And now forgive me if I've said something that I shouldn't have.)

Now we'll drop the Marathon for a while and get into some really serious business. After the uneventful trip that Operative 1492 had last month I decided to do my own prowling. First, let's plow into the mailbag. It's comin' at you just as it comes to me . . . it'll be mixed up, but I'll try to keep the c.w. and phone news tagged so you won't have to guess at too much of it.

All of which reminds me of the little game a couple of the boys were playing with their e.c.o.'s. One would tell the guy he was working that he was going to QSY . . . try and find me. When he finally located him, it would be his turn to hide and the first fellow to seek. The one that would find the other the most times and in the shortest time would win. Luckily the band was practically dead at the time and it apparently didn't bother anyone. The payoff was that many of the gang who were sitting idly by enjoying the fun would join in with their e.c.o.'s and scoot down to where one of them had just plopped. Then all at once they would break out with, "Here he is." It all ended up with one of the screwballs way ahead, and the other never finding out why he was found in such a hurry. P.S. This is not recommended as a daily diet for any of you dx men because somebody may not like it.

It might be of interest to the 10-meter phone gang that VK2GU has actually kicked through with a letter to W6PKK. It has long been known that he has been reticent to QSLing or corresponding, but it took the xyl of George Cooper, W6PKK, to do the trick. She has a way of squeezing cards out of the almost impossible. Can't seem to figure out the secret but it might have something to do with her losing her shoes on New Year's Eve. Sort of a senseless crack, that, but just ask her sometime.

For the brasspounders, we find that LU7AZ is on 6995 kc. daily between 4 p.m. and 7:30 p.m., p.s.t., and that D4BIU has been in there around 7050. Also HK5ED at 7095. W6SN passes those along as worked. K6NYD has received his card from TA1AA, via ON4HS of course. W4DRZ also got his from the TA. K6NYD now is up to 29 zones and 78 countries in the Honor Roll—that, on phone, while the c.w. and phone shows up at 35 and 100.

ZL1HY informs us that recently his father was over for a visit from the Cook Islands. Dave says his OM told him the last ham left there over 2 years ago. His name was George Wood, ZK1AB. Dave's father is Chief Magistrate and Postmaster for his particular island. ZL1HY signed off in the Honor Roll with 38 zones and 138 countries . . . the last one being AC4YN.

From the T & R *Bulletin* I see where our old-time friend VP5PZ has donated his station to the Jamaican government for broadcasting purposes. We all remember the signal John Grinan's rig put out and if you want to hear it again listen at 4.8 Mc. or 62.5 meters. Still using the same call letters . . . it was a noble gesture on John's part.

W4DRZ says his jr. op. can now copy about 30 words per minute, which is pretty good for a four-month-old op. W2GT is up to 39 zones and 150 countries . . . has been there for some time but just didn't say anything. W7GGE is feeling honored these days and rightly so. It appears that he and ZL2NL had maintained a very close sked every a.m. for about a year on 20 c.w. A friendship developed, which resulted in naming of ZL2NL's jr. op. after W7GGE. W4EEE nabbed a new country on phone a short time ago, ZP1LB, frequency 14,065 k.c., and now has 30 and 86. W1ADM brings his scores up to date and stands at 38 and 125 while on phone only Carl has 34 and 93.

YS2LR Folds Up

YS2LR is no more. For those of you who haven't received your card from him you may get in touch with him as follows: Varel S. Grimes, 325 W. 15th St., Brownsville, Texas. Varel states that for those who have not already guessed it, HU5A was used every now and then, and those cards will be handled in the same manner. He will soon be on with a W5 call at that QTH. Varel wants to express his appreciation to the whole gang with whom he has had contacts, and quoting from him, ". . . and take it from me, there is nothing in the world more persistent than a dx hound! I love it."

W2AIW is using an e.c.o. drawing 5 ma. from a 45-volt B battery. W8CLM is a new one to the Honor Roll . . . has 36 zones and 97 countries. K7HNG wants the gang to know that if they have traffic for Seward, to just CQ and the chances are he will hear 'em. K7HNG uses a pair of 45's in p.p. with 19 watts on 20 and 38 on 40. Says the receiver is about 10 years old. W6QAP is now located in town (L.A.) and has been punching the key around QD a little bit. The other morning he couldn't sleep (poor guy) and rolled out of bed to work J2OP, 7160 kc., and J2IH, 7060 kc. OQ5IM is still sailing through on the high end of 20 according to Bud. W9EQ is now W4IQS and may be heard on 7006 quite often. And KC4USC has been doing a little traffic work on 6990 kc. Has worked a few hams in between times.

Dx unlimited—G2LB on the left and G2LU on the right.

W6GRL worked KC4USC on c.w. and then phone. I believe he was the first out this way to have a phone contact with the expedition. By the time you read this KC4USA, the West Base, should be perkin'. KF6ROV has mailed a batch of cards for Canton Island. They are postmarked Pago Pago, Samoa. W8CED has received a card from U8IB and has it almost worn out showing it around. But remember, I didn't say you were to go after him for the QRA.

I don't know whether I mentioned it before or not but in the country list published in the January 1940 issue we showed Newfoundland and Labrador as in zone 5. It should have been zone 5 and 2, as Labrador is in zone 2.

F8VC writes that he ran across G8MQ and G3MP at the front near where he has been stationed. Jean said that it was a thrill to see these fellows. K6MV has a new home on the windward side of Oahu and as "Lem" put it, ". . . and needless to say I had ham radio in mind in planning a nice workshop and shack." W8AU is still sputtering back there in Utica. Lou says that since dx hasn't been so hot during the past few months, they xyl feels as though she is married once again. She can't get over it . . . going to dances, shows and night clubbing a bit.

By the time most of you read this far you will be between the two week-ends of the A.R.R.L. Contest. Usually this contest is within the first two weeks of March but this year it is during the latter two weeks. In fact the Sunday of the last week-end being Easter, *all* of you fellows will miss a few hours while attending sunrise services. Easter Sunday is early this year . . . wonder if President Roosevelt had anything to do with it. It's a cinch he didn't change the contest, though.

[*Continued on Page 84*]

The Amateur Newcomer

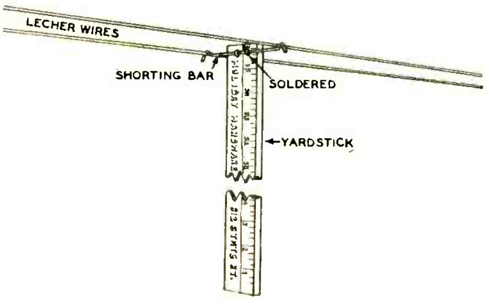
FINDING the 2.5-METER BAND

Many amateurs in isolated localities seem to be having difficulty in locating the 2½-meter band. Indeed, it has been reported that in certain large cities there have been two independent "2½-meter" bands, the operators on one having no knowledge of the other. Actually, the locating of the band may be done very accurately and with as simple equipment as a pair of Lecher wires.

A Lecher-wire measuring system consists of a pair of parallel wires, usually of about no. 14 bare copper and separated about 2 inches coupled to the tuned circuit of the transmitter or receiver whose frequency is to be determined. The energy coupled into the wires establishes standing waves of voltage and current along them, and these standing waves can be located with a shorting bar.

The sliding shorting bar can be moved along the parallel wires until two successive points are located which produce a change in oscillator plate or grid current, or in the receiver noise level, when the pickup loop of the parallel wire system is coupled to the circuit under test. The distance between these two points is a half wavelength, and this value may be converted from feet or inches into the wavelength in meters by multiplying the length in feet by 0.6096 or the number of inches by 0.0508.

The frequency in megacycles may be determined by *dividing* the number of inches between successive peaks on the Lecher wires into 5905. It is advisable in most cases to have the Lecher wires long enough so that several successive "bumps" may be found to insure greater accuracy in the determinations. The successive points of resonance will be very sharp and may be passed over if the shorting bar is moved too rapidly.



Three lengths which it is advisable to remember are: 112 Mc., 52.5″ or 4′ 4.5″ between successive "bumps"; 114 Mc., 51.75″ or 4′ 3¾″; 116 Mc., 51″ or 4′ 3″ between peaks. If the frequency of desired operation is known and it is necessary to determine how many inches correspond to this frequency, the frequency may be divided into the same factor 5905 to give the number of inches between successive Lecher-wire peaks.

The shorting bar can consist of a short piece of no. 10 bare or tinned copper wire, bent and fastened to the end of a yardstick as shown in the accompanying illustration. By using a combination gadget such as this the yardstick for measuring the number of inches between successive peaks will always be at hand as soon as the peaks have been determined. It is usually convenient to mark the places of resonance on the Lecher wires with a piece of scotch tape or adhesive tape and then to measure between the front edges of the pieces of tape to determine the measurement in inches.

A short length of twisted pair can be used to couple the device under measurement to the Lecher wires. A 1- or 2-turn link at the end of the twisted pair should be loosely coupled to the receiver or transmitter. This method of coupling is considerably easier than trying to keep the spaced, bare wires from shorting out or grounding when coupling them directly to the device whose frequency is to be measured.

Lastly, to change wavelength in meters to frequency in megacycles, simply divide 300 by the wavelength in meters.

U. H. F. . . .

By E. H. CONKLIN,* N9BNX

This month is generally the "zero hour" on the ultra-highs, with activity at an annual low. Not so this time. With ten meters passing out for F_2 layer dx and not enough dx stations left on the air to satisfy everyone's appetite, there is a very definite trend toward the ultra-highs, particularly to five and 2½ meters. The ten meter population has remained high, becoming a Utopia for phones, which should keep the band active on days when the dx limit is only a few hundred miles like it is on five meters in the absence of "skip". With twenty meters going dead on winter evenings, the next year or two should bring about even greater use of the ultra-highs, thus avoiding low frequency band congestion.

The simplicity of ultra-high equipment is illustrated by a four tube phone transmitter built by W9QDA that puts out ten watts on ten meters and five watts on "five" with only 250 plate volts. A 40 meter crystal in a 6L6 tritet doubler or quadrupler drives a 6L6 doubler final. The latter is modulated with a 6N7 class-B tube driven by a 6C5 speech amplifier. The rig was built for W9OMP mobile to operate from a 100 m.a. vibrapack, for which reason the 6N7 no-modulation plate current was reduced with grid bias to keep the current drain within the vibrapack rating. On February 14, QDA raised HC1FG on ten with this rig in his car.

An article in the January issue of *Electronics* points out that many beam tubes have a screen grid oscillation that often shows up as a parasite. This is aggravated by good short by-passing, but can be cured with a ten ohm resistor in the screen lead at the socket prong, without interfering with operation at the desired frequency.

Antenna Comments

What is the best method of adjusting properly a Western Electric type concentric vertical antenna? Recently Jim Dickert, W9PEI, ran some tests on 28.7 Mc. that may be of interest. He controlled the length of the tubing skirt used as the bottom half of the antenna by sliding another piece of tubing on it. Then he went through the whole range of adjustments of the pipe length for each length of "whip"—the rod used as the upper half of the antenna which is the extension of the transmission line inner conductor. The only indication of proper adjustment recorded was the final amplifier loading. When the curves showing the best pipe length for each "whip" length were examined, it was apparent that the whip should be 101⅜ inches and the concentric pipe "skirt" 96¾ inches. With this adjustment, the final amplifier tuning was not disturbed by loading it with the pick-up coil. A good indication of proper adjustment is the fact that when four feet of concentric transmission line was cut off, nothing changed. Even with this tuning, the Brown "ground plane vertical," which is a quarter wave vertical above four horizontal quarter wave fins, produced a better signal locally.

At the beginning of 1935, over five years ago, W1HBD in Hartford and W1XW in Boston maintained 2½ meter contacts several times a day during a week of schedules. This was a 90 mile path. Around the same time, the Bell Laboratories were maintaining a 70 mile circuit on 5 to 1.6 meters, with the 1.6 meter wave going below the noise level consistently only in winter. Yet here we are in 1940, turning out inferior results except from mountain tops. It not only can be done, but has been done. Two amateurs with enough experimental inquisitiveness can duplicate and surpass these results easily with present day equipment and power, if they will get to work on their antennas, feed lines, and sets. Don't stop at the transmitter—it is obvious whether that works. More care should be taken with the antenna, feeder and receiver. In this connection, Amphenol's table of losses for properly matched cable for 1000 watts fed into 100 feet is of interest:

Freq. (Mc.)	Twisted Pair	Rubber Co-axial	Amphenol Co-axial	Copper tube Co-axial
120	800	700	320	210
60	645	563	249	162
30	463	411	186	121
15	324	308	133	88
7.5	206	206	110	65
3.75	133	135	60	49
1.87	88	92	45	39

In the above-mentioned tests, the Bell Labortories used inverted V and both horizontal and vertical rhombics, all supported from a 60-foot pole surrounded by four 30-foot poles. The V was 140 feet long, supported at its center. The legs in either direction from the central pole were 77½ feet long. The far end was four feet off the ground. The near end led directly to the receiver. One vertical rhombic was adjusted from 123 to 130 feet

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* Associate Editor, RADIO, Wheaton, Illinois

long, with four 67⅓ foot legs, terminated at the far end with carbon lamps. A two-wire feeder fed the receiver. The bottom was six or more feet off the ground, the top supported on the 60 foot pole. Another vertical rhombic was 137 feet long with four 71-foot legs. The horizontal rhombics, supported on the 30 foot poles, were from 126 to 136 feet long, with 71 foot legs. These also were terminated with carbon lamps. All types were used for transmitting and receiving. The fore-and-aft diagonal, when adjustable, was increased for higher optimum frequency. These antennas are relatively easy to construct in many locations, and should be helpful in extending the range of u.h.f. stations not already using high multi-element rotaries.

Using a number of elements in a given area, ten watts in the antenna at 300 Mc. will produce the same field as 810 watts at 100 Mc., according to the *RCA Review*. The troubles with the higher frequencies are that equipment is generally less efficient, there is more scattering of signals, more attenuation in crossing cities, and the ground wave which falls off inversely as distance raised to some power, drops off more at the high frequencies. The latter effect presumably will be less important with air-boundary refracted signals.

Distance to the horizon in miles is given by 2.21 $\sqrt{h}$ where h is the antenna height. If both the transmitting and receiving antennas are to be considered, the equation is individually applied to both and the results added, to get the maximum line-of-sight distance. The height is expressed in feet.

Antenna Polarization

On February 5 during a 120 mile contact on 56 Mc. with W8CVQ, W9VHG switched over to a horizontal antenna which was pointed poorly, and could just hear CVQ's carrier. CVQ uses vertical broadsided W8JK antennas. VHG cut five feet off his feeders and can no longer load up his final properly on his horizontal. Attempting to hear W9ZHB (90 miles or more, horizontally polarized), he tried the vertical on several occasions with no results at all. W9MQM using a vertical has worked ZHB. W9GGH in Kenosha put up a 3-element job; VHG says that horizontal polarization to Kenosha just doesn't work, but the antenna at VHG is 45 degrees off for GGH. W9CLH used to work ZHB with a four section vertical W8JK, but the signal was sometimes weak, the distance being 80 miles.

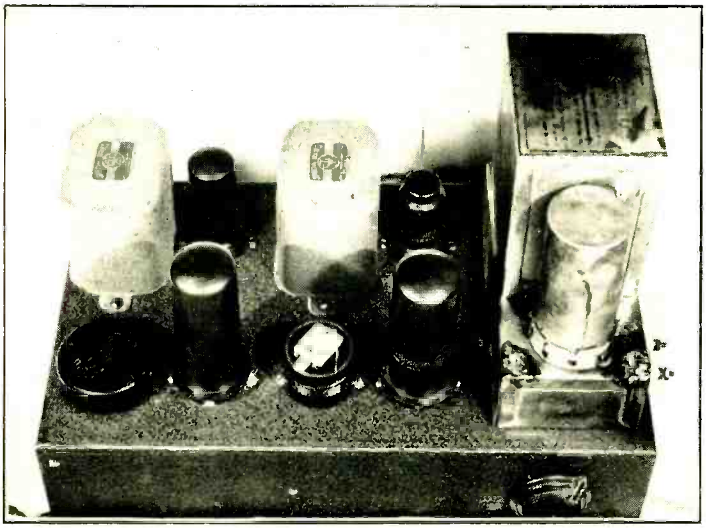
W8CVQ says that he is interested in what was said by the "Roving Reporter" in the February issue about the rotation of the plane of polarization of five meter signals over 100 mile paths. The few tests he has made at the receiving end have not shown that horizontals were better than verticals when the transmitted signal was vertically polarized. One test was with Grand Rapids (48 miles). The test with W9CLH seems inconclusive because several days intervened between tests, and contacts have been made (130 miles) using a lower four element horizontal at CLH. The higher vertical antenna supported by an old broadcast tower used to put out a better signal, it seems, but that this was due to the polarization is not plain. W8CVQ is sufficiently interested in the rotation idea to try horizontal reception compared with his present

56 Mc. DX
HONOR ROLL

Call	D	S
W9ZJB	9*	18
W3AIR	8	24
W3BZJ	8	
W3RL	8	24
W5AJG	8*	27
W8CIR	8*	29
W9USI	8	22
W8JLQ	8	
W8VO	8	
W9ARN	8	15
W1EYM	8	
W9CBJ	8	
W9ZHB	7	
W2AMJ	7	22
W2JCY	7	
W2MO	7	25
W3BYF	7	
W3EZM	7	24
W3HJO	7	
W4DRZ	7*	22
W4EDD	7	
W4FBH	7	20
W5CSU	7	
W5EHM	7	
W8CVQ	7	
W8QDU	7	
W9CLH	7	
W9SQE	7	22
W1HDQ	7*	18
W9AHZ	7*	14
W9BJV	7	12
W9VHG	7*	
W9WAL	7	
W9QCY	7	10
W9ZUL	7	11
W9GGH	7	
W1CLH	6	12
W1DEI	6	18
W1VFF	6	11
W1LLL	6	17
W2KLZ	6*	
W2LAH	6	
W6QLZ	6	
W8OJF	6	
W9NY	6	13
W1JMT	5	9
W1JNX	5	12
W1JRY	5	
W1LFI	5	
W2GHV	5	8
V3GLV	5	
W3HJT	5	
W6DNS	5	
W6KTJ	5	
W8EGQ	5	10
W8NOR	5*	16
W8OPO	5	8
W8PK	5	
W8RVT	5	7
W9UOG	5	8
VE3ADO	4*	
W3FPL	4	8
W6IOJ	4*	
W8AGU	4	
W8NOB	4	
W8NYD	4*	
W1KHL	3	
W6AVR	3	4
W6OIN	3	3
W6OVK	3	4
W7GBI	3	4
W8OEP	3	
W8OKC	3	6
W9WYX	3	3

* plus Canada. (reported in 1939)

Note: D—Districts; S—States



W9QDA's five and ten meter mobile transmitter after 17,000 miles of service. The tritet 6L6 doubles from 40 to 20 and the final 6L6 doubles to ten. On five the 6L6 tritet oscillator quadruples to ten and the final 6L6 doubles to five.

vertical antenna. Such tests, of course, do not refer to "skip" work where polarization is of little importance.

W8QDU says that he thought your conductor to be a pretty level headed sort of fellow—enough so that the Illinois gang couldn't hoodwink us into believing that horizontal antenna stuff for pre-skip work. Yeah, but don't confuse us with the "Roving Reporter"—that is someone else. Fred agrees that the important thing is to concentrate radiation at the useful low angles. Whether or not this can be obtained equally as well with stacked horizontals he is not sure but believes so providing enough elements are used with good current distribution and phasing and the whole array is at sufficient height above ground (apparently correct except where the antennas are near or over sea water when verticals have an advantage for low antenna heights—Ed.) Fred is open-minded on the problem at 100 miles but tests with W8MDA (30 miles), W8SLU and W8QQS (65 miles) indicated a preference for verticals. He does not mention the antenna types used at both ends, so it is impossible to judge the relative effectiveness, at low angles, of antennas used in these tests.

The reason for commercial preference for horizontals is summed up in this statement taken from *RCA Review*, January, 1937: "It is important to concentrate the energy into low angles in the vertical plane so as to obtain a power gain in transmission. This may be done for either vertical or horizontal polarization, but present known simple structures are most effective for horizontal polarization. For broadcast service, in terms of signal intensity, there appears to be no advantage in one polarization over the other (excluding transmission over sea water). The matter of signal reflections in and around building has not been fully investigated, but again there appears to be no advantage in one over the other. In considering noise interference, complete data are lacking, but some experience has indicated a slightly lower noise level for horizontal polarization."

A more definite idea of impulse noise levels received on each polarization may now be available, judging from this sentence on page 366 of the *RCA Review* for January, 1940: "this intensity is about that which would be received with horizontal polarization from the ignition system of the average automobile at a location about 125 feet from the road over which the automobile travels."

Trevor and George checked transmissions on 91.8 Mc. several years ago, out to 70 miles. Beverage says that there was apparently no consistent difference between horizontal and vertical polarization (at both ends) over land. An inspection of the chart in the first-mentioned 1937 issue, however, indicates that the vertical was better most of the time within 25 miles, and the horizontal beyond that distance.

Additional comments on ground wave (refracted-diffracted signal) field strengths appear in the statement of K. A. Norton on u.h.f. wave propagation, at the F.C.C. Television hearing January 15, 1940. This publication carries the number 38521.

Thank You . . .

We offer our heartfelt thanks to those enthusiastic RADIOmen who have bought more copies of the 1940 "RADIO" HANDBOOK than ever before, despite the lapse of buying from many foreign markets.

Note: If you have not already secured your copy of the 640-page, 1940 "RADIO" HANDBOOK, order from your favorite dealer. If he cannot supply you remit direct to us and we will send your copy to you postage prepaid. The standard edition is $1.50 in continental U. S. A., $1.65 elsewhere. The special cloth bound library edition sells for $3.00 in continental U. S. A. and $3.25 elsewhere.

THE EDITORS OF
RADIO *technical publishers*

1300 Kenwood Road, Santa Barbara
CALIFORNIA

Whatever the answer, it is to be regretted that both types of antennas are coming into use in some areas, splitting the five meter band into two groups of stations.

Neutralization

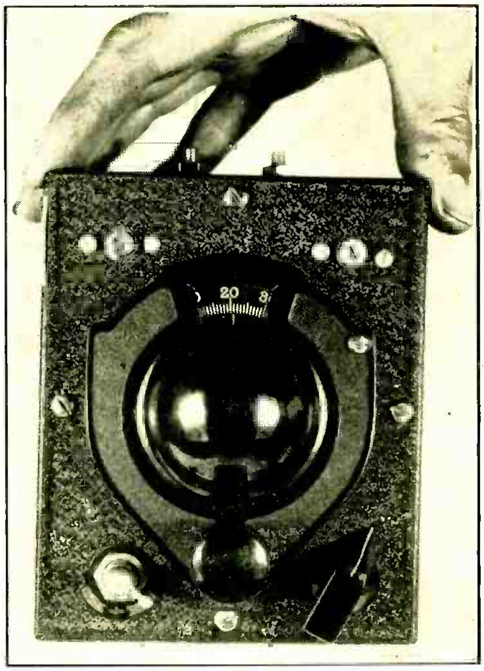
In neutralizing television amplifiers at 42-50 Mc., it is generally necessary to connect one filament to a shortened half wave piece of metal tubing, usually folded, with the other filament lead inside. The filament of the second tube is similarly handled, the two rods running parallel, shorted at an electrical half wavelength from the tubes' filaments. The short is adjusted as part of the neutralization procedure. Even when neutralization can be achieved without these rods, the filament lead reactance prevents attainment of 100 percent modulation as it permits radiation of the excitation power on negative modulation peaks. Presumably, the best small amateur tubes will not require filament lines (or chokes) below 100 Mc. U.h.f. neutralizing condensers can be short pieces of tubing connected directly to the plate terminals. Stray capacity between input and output circuits can then be reduced by using a telescoping inner cylinder connected to the grids, placed within the tubing hooked to the plates.

177 Mc. M.O.P.A.

An interesting 177 Mc. transmitter is used by RCA for television relay purposes. A large concentric line (inner conductor 2¼ inches, outer is 8 inches), ¼ wavelength long, controls the frequency. Half turn loops extend through the shorting disk on either side of the inner conductor. One loop is grounded near the inner conductor, the other grounded near the outer. The other loop terminals go to the grids of push-pull RCA 834's. Excitation is controlled by shorting the grids with different lengths of wire. Impedances are used in the filament leads. The plate inductance is a U-shaped shortened half wave concentric line about one inch in diameter, connected from plate to plate. At the neutral point on this line the inside conductor is exposed so that the power amplifier grid coil may be inductively coupled to it. While plate power was fed in with a choke, it could as well have been done with a small diameter quarter wavelength line used as a "metallic insulator." Only the half turn coupling loop appears in the amplifier grid circuit.

Single Tank Oscillator

Although an oscillator tube can be tapped on a concentric line with the cathode above ground and plate grounded, tube size and line length sometime make this inconvenient. Another way of doing it is to use half-turn grid and filament loops in the line as illustrated in RADIO for February, page 17. W9SQE found that an old 210, 250 and a T55 worked this way at five meters but as the inner conductor of the line was shortened, the wavelength dropped only to 3.4 after which no line was necessary. At this point, the loops themselves, together with the inductance and capacity in the tube, were sufficient to cause oscillation. If RCA can use 1 k.w. tubes in this circuit, amateurs should be able to do so. A little experimenting with other tubes and loop sizes may straighten out this trouble.

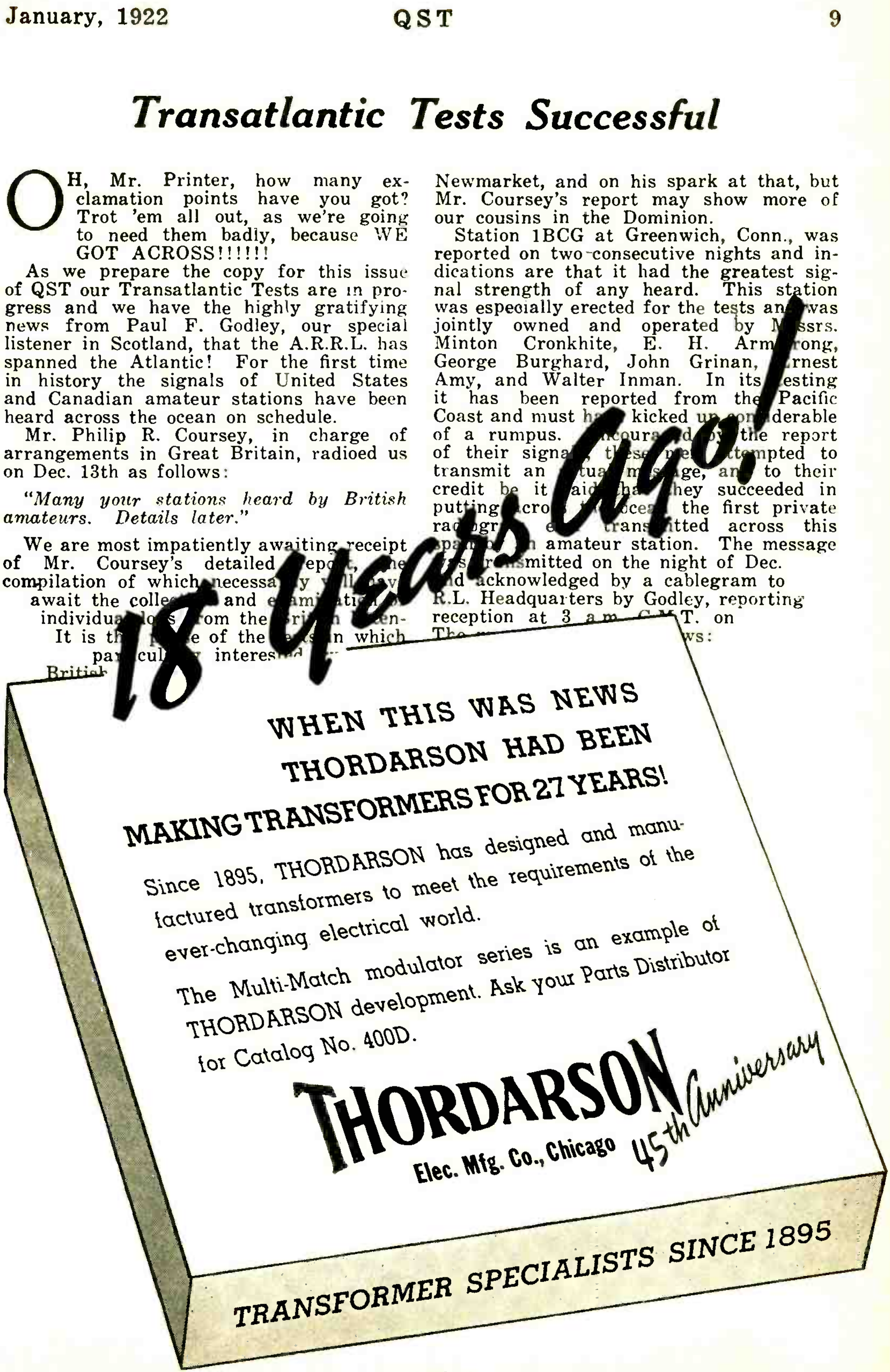


Small 1852-6C5 ten-meter converter used by W9QDA mobile. The large model was described in RADIO for July, 1939. The tubes extend out the rear of the box.

Power can be taken out with an unbalanced (concentric) feed line by tapping on the inner conductor, or balanced feeder using a half turn loop entering the side of the line. W9SQE tried one of these hairpins four inches wide on his receiver line on five meters and raised the signal strength better than two R's. Incidentally, without an r.f. stage he gets no images at all with a 2,600 kc. i.f.

Short Lines in Receivers

As a resonant transmission line is shortened, the impedance at the open end goes down



January, 1922 QST 9

Transatlantic Tests Successful

OH, Mr. Printer, how many exclamation points have you got? Trot 'em all out, as we're going to need them badly, because WE GOT ACROSS!!!!!!

As we prepare the copy for this issue of QST our Transatlantic Tests are in progress and we have the highly gratifying news from Paul F. Godley, our special listener in Scotland, that the A.R.R.L. has spanned the Atlantic! For the first time in history the signals of United States and Canadian amateur stations have been heard across the ocean on schedule.

Mr. Philip R. Coursey, in charge of arrangements in Great Britain, radioed us on Dec. 13th as follows:

"Many your stations heard by British amateurs. Details later."

We are most impatiently awaiting receipt of Mr. Coursey's detailed rep t, the compilation of which necessa y ll v await the colle and e ami ati individua lo s om the ri n en-

It is th p e of the n which pa cul interes

Britis

Newmarket, and on his spark at that, but Mr. Coursey's report may show more of our cousins in the Dominion.

Station 1BCG at Greenwich, Conn., was reported on two consecutive nights and indications are that it had the greatest signal strength of any heard. This station was especially erected for the tests an was jointly owned and operated by M ssrs. Minton Cronkhite, E. H. Arm rong, George Burghard, John Grinan, rnest Amy, and Walter Inman. In its esting it has been reported from the Pacific Coast and must h kicked u con derable of a rumpus. coura d y the report of their signa , th se e ttempted to transmit an tua m s ge, an to their credit be it aid tha hey succeeded in putting cro oce the first private ra gr e trans itted across this pa n amateur station. The message s tr smitted on the night of Dec. nd acknowledged by a cablegram to R.L. Headquarters by Godley, reporting reception at 3 a m. G. T. on

The ws:

WHEN THIS WAS NEWS
THORDARSON HAD BEEN
MAKING TRANSFORMERS FOR 27 YEARS!

Since 1895, THORDARSON has designed and manufactured transformers to meet the requirements of the ever-changing electrical world.

The Multi-Match modulator series is an example of THORDARSON development. Ask your Parts Distributor for Catalog No. 400D.

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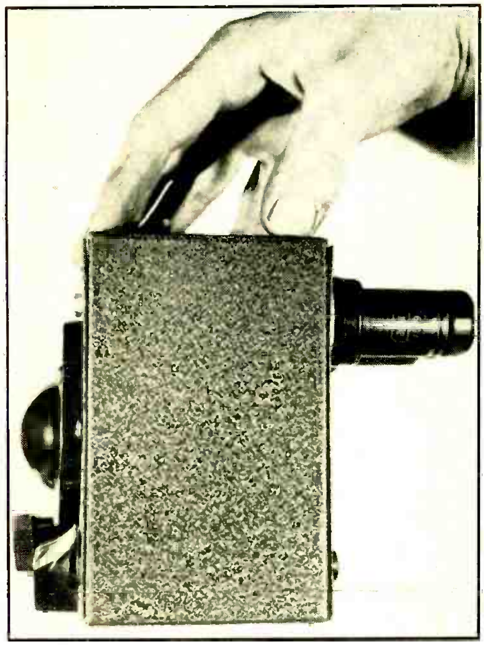
45th Anniversary

TRANSFORMER SPECIALISTS SINCE 1895



Side view of the W9QDA mobile converter.

almost as fast as the length does. Nevertheless, such a line can be quite short and still out-perform coils. With a 13-inch line three inches in diameter, propped on magazine covers above a 6K7 r.f. stage on ten meters, W9QDA tested a "haywire line" against the receiver's own coil. The inner conductor was no. 16 wire, supported between cardboard end plates. A 100 $\mu\mu$fd. condenser was used for tuning. The inner conductor instead of the former grid clip was brought to the tube cap. The outer conductor was grounded, and the far end of the line shorted across the cardboard end plate. The antenna was brought through the end plate on a narrow half turn "hairpin." Tuning was very sharp with this arrangement, and signal strength was fair in spite of the six inch leads. When one feeder was disconnected, however, the R-meter went off scale! The reason for no better results with two feeders was that Vic had put his hairpin astraddle the inner conductor instead of beside it with only one side of the hairpin close to it. Still, it was apparent that even with 6K7's, a short line with a properly coupled antenna would be much better than the receiver's coil. The test also checked the charts shown in the article in February RADIO, provided that the actual line length is an inch or so short in order to compensate for tuning condenser leads and inductance.

Metal for Pipes

One thing that retards the use of short lines as resonant circuits is the "difficulty" of getting the metal. Comments on the subject in this column have been requested.

A simple way to get pipes is to bend them up from 24 gauge or thinner copper or aluminum sheet. The cheapest pipe is aluminum stovepipe. Brass and cold rolled steel are cheaper than copper but should be copper or silver plated.

A very convenient way to buy copper tubing in small quantities is from a plumbing supply house branch, such as Crane Company. Their Type M 2⅛ inch o.d. copper pipe has a wall 0.058 inches thick and sells for a base price of 50 cents a foot—less, at present, a discount of 19 percent. This discount changes with the copper market. Still, 41 cents a foot is a reasonable figure.

According to the branch of Revere Copper and Brass, Inc., at 2200 No. Natchez St., Chicago, their twelve foot standard lengths run 60 cents in two inch diameter, and odd lengths at 67½ cents a foot if a piece already cut is available. Three inch tubing is a mill job for them. Charles H. Besly & Co. at 118 No. Clinton Street, Chicago, has two inch pipe with 0.064 inch wall at 82.6 cents a foot, and three inch at $1.27 a foot. Copper sheet will run less, particularly because thinner gauge material will be satisfactory.

Steel Sales Co., at 129 So. Jefferson St., Chicago, sells cold rolled steel and aluminum. The cheapest pipe available seems to be their aluminum (2S) which runs only 25 cents a foot for two inch and 41 cents for three inch. There is a 50 cent cutting charge. Aluminum stovepipe of 24 gauge (0.020 inch) runs 85 cents a three-foot length for three-inch diameter and a dollar for four inch diameter at Stebbins Hardware Co., Van Buren and State Streets, Chicago. The latter can probably be made up in a sheet metal shop.

Conductivity of Metal

The conductivity of various metals is important to us. The following table shows resistance in micro-ohms per cubic centimeter of metal and will give an idea of the relative standing of the various metals.

It will be seen that tin cans are none too good. For a temporary expedient, however, they may be useful to convince the chap above 100 Mc. that lines have their place in equipment.

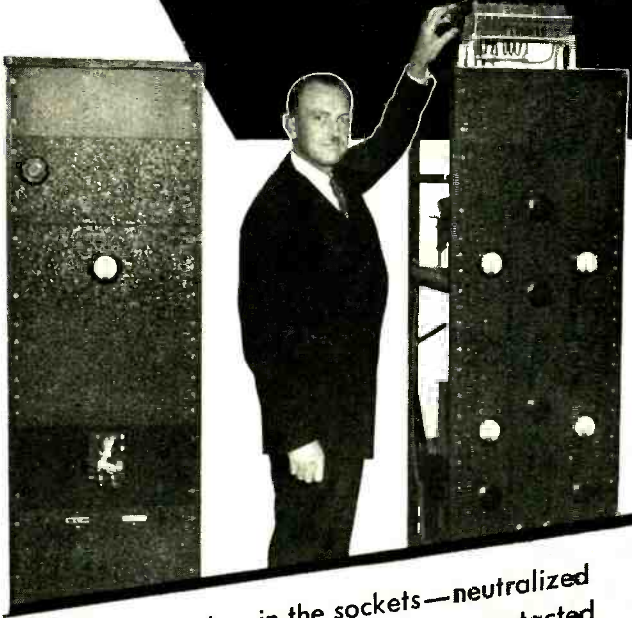
The other day a fellow on the train had a Type B2 one r.p.m. sync motor made by Warren Telechron Co., Ashland, Mass., for General Electric Company. It had been picked

Frank Carter W2AZ

First Member to make Century Club on Phone

Verified Contacts with more foreign countries than any other amateur phone station.

. . . a loyal user of Eimac tubes



Eimac 250T

Put Eimac tubes in the sockets—neutralized and tuned up the rig—and then contacted 123 countries with 103 of them verified—not once bothering to re-neutralize.

Performance like this can only be obtained with the very best equipment and Frank Carter was fully aware of that fact when he ordered Eimac tubes for his station. Frank's rig is a home-made affair with a pair of old type Eimac 300T tubes in the final which are modulated with a pair of Eimac 250TH's. During the time he was getting the 103 phone contacts the plate and grid current did not change even as much as one mill.

Frank says: *"No other tube I ever owned has maintained its characteristics so well, and I think the results say more than I could."* Why don't you follow the lead of the world's best known radio amateurs and technicians—adopt Eimac tubes for your transmitter—get better, more dependable performance and give the winners a run for their money? See your dealer—if he can't supply you write direct for full information.

Eimac TUBES

EITEL-McCULLOUGH, INC. San Bruno, California

Resistivity of Various Metals

Silver	1.62
Copper	1.72
Gold	2.04
Aluminum	2.82
Duralumin	3.35
Brass	5.7
Zinc	5.92
Cadmium	6.2
Nickel	7.24
Iron (not cast)	9.78
Tin	11.4
Lead	20.7

up for less than a dollar. It is just the thing to swing a receiver over the band in isolated locations, while the operator does other things. When the receiver does cross a signal, the speaker will blast out and the operator can tune it manually. This should be particularly good for summer dx. If the receiver condenser will rotate continuously, the motor will tune it across the band every 30 seconds.

112-224 MEGACYCLES

Some time ago, mention was made of a dx honor roll for 2½ and 1¼. This may be somewhat difficult to maintain, but there is no harm in trying. Perhaps the Bell Laboratories should get a rating for their field strength measurements for two years down to 1.6 meters over a 70 mile path, using inverted V and rhombic antennas. Only the highest frequencies dropped below the noise level in winter. Here is the way that the Honor Roll would appear:

Elevated Locations

Stations	Miles
W9WYX-?	160
W6NCP-OIN	98

Home Locations

Stations	Miles
W1HBD-W1XW (1935)	90
W8CVQ-W8?	48
W1LEA-BHL	45
W2MLO-HNY	40
W3CGU-W2HGU	40

Most of the 2½ meter news from New England reaches this column through the bulletin of the Merrimac Valley club in Lawrence, Mass. It is reported that W1LEA is heard consistently on 2½ by W1LAT of South Boston. W1JNU is using a HY615 tube in his receiver. W1IZE has a new antenna strung up on his flag pole. W1LGG is now on the band. W1LGY DOO HZB are about ready. W1HXE is on but is not sure that he has found the right frequency. W1IZE JNU JJE have gone into the business of making 1¼ to 10 meter receivers.

PA0FB and his Norwegian girl friend in Netherlands costumes.

W2MO in Livingston, N. J., may soon be trying to duplicate his excellent five meter work on 2½ with at least 100 watts into an eight element beam. W8PK says that several fellows around Rochester, N. Y., are planning 2½ meter work, and he may join them.

According to W8NOH, 2½ meter activity around Grand Rapids, Michigan, is increasing. W8TCG in Ada is building up mobile equipment using 6J5G's with 10 watts input. Someone in Grand Rapids is reported to have worked W8CVQ in Kalamazoo on February 5. CVQ has 25 watts input to HK24's, with frequency modulation unintended! He regularly puts an R9 signal into W8NZ at Battle Creek, 25 miles away. Walter is on 5 and 2½ every Monday night.

Down in Fort Lauderdale, Florida, W4DRZ is all set up for 2½ but can't get anyone else interested enough. A gang rebuilt transceivers for an air meet, but the apparatus probably reposes on shelves. W4EDD in Coral Gables has plenty of power on HK254's.

Somebody must read this column. W9CQV received a letter from a W4 who wants to buy the receiver pictured here several months ago. CQV says that a gang is organizing a

2½ and 10 meter harbor radio system for Chicago's south side yachtsmen. Joe's TZ20 transmitter has been causing a fuss in b.c.l. sets in the neighborhood. It was found that the grid line was not controlling the frequency of the rig at all, so it wasn't stabilized. When the grids load the tuned circuit heavily, this may happen; if it does, putting a coil in the grid and using lines in the filament and plate seems to be fairly satisfactory. The object of the filament line is to connect the filaments together at the far end of a (short) half wavelength line instead of at the tubes. One conductor carries one side of the filament on the surface and the other lead on a wire inside; the leads to the second tube are carried on and in the second conductor. The shorting bar is something less than a half wave from the filament and controls the regeneration somewhat. The plate tuning controls the frequency. The same type of filament line is often necessary in order to neutralize an amplifier at very high frequencies. A tube specifically designed to reach very high frequencies should be controllable with a high-*Q* grid circuit, so that CQV's experience is probably not universal.

In Evanston, Illinois, W9EDG disclaims the high power that was attributed to him a while ago. He says that six watts is closer. Consistent contacts are made with W9LRT YGW in Chicago. Consistent "interference" is had from W9ZUL's harmonic from Morton Grove. EDG has made another trip to Crane Co.'s local plumbing supply branch for more copper tubing, so new apparatus may be on the way.

W9RQG of Desplaines, Illinois, points out that the Lecher wire conversion shown on page 383 of the RADIO handbook should be 5.08 for converting inches to centimeters wavelength, and 60.96 for feet to centimeters. W9VHG in Glenview says that RQG has a 2½ meter rig working, which adds to the nice range of distances that the Chicago gang can work—or can they?

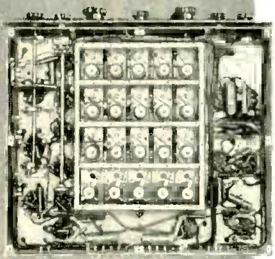
According to W6QKM in Beverly Hills, Calif., W6SDJ has an s.w.l. report from San Bernardino (70 miles). SDJ has a kilowatt—but it is on ten meters, with a three element beam. It did get him interested enough to put together a 150 watt rig using HK24's. The boys plan a resistance coupled i.f. superhet but they are not settled on the antenna design.

Another 2½ meter ham in Colton, Calif., is W6NCP who operates mobile incidental to business trips, having had over seventy contacts in a little over a year. While in the San Bernardino Mountains, he raised W6OIN mobile who was on Mt. Soledad near San Diego. At the first location, 5200 feet up, a fade-out killed the contact. A new location on Strawberry Peak, 5800 feet, brought signals back to R9 when the contact was resumed. This distance is about 98 miles. W6MKS at Mission Beach on i.c.w. was also heard. OIN ran 35 watts with gas engine a.c. generator. NCP has a genemotor-powered 76-42 "xcvr" with a ⅜ wavelength rod antenna; the oscillator input was six watts, output not determined! W6AVR was with NCP during the contact; W6DNS and W6VQ (shades of ten meters years ago!) were with OIN. NCP says that he also worked W6RVL in Los Angeles from the same mountains, a distance of about 65 miles. W6QUF with a similar mobile job and at the same QTH also worked RVL.

W9WYX whose first name is Frank and yet answers to "Bob" (your conductor is named Elmer but goes by "Bill" for an obvious reason), is on the band nearly every evening with 100 watts into HK24's on 2½ and 1¼, and a six element Yagi. He mentions his 160 mile contact from Pike's Peak to a car ten miles south of Cheyenne, Wyoming, and another contact from Genoa, Colorado to Mt. Evans. The mobile power supply is a kilowatt gas driven a.c. job. In Denver, W9VTK VGC IDB SPO are already on 2½ and WRO RNF QXJ DSD LNB LBV AUJ NWL claim that they will be on soon.

Perry Ferrell in Pleasantville, New Jersey, has his superregen on five dressed up with an 1852 and HY615, and a lot of things like inverse feedback in the audio. His new 2½ meter receiver uses a 6J5G until another HY615 arrives. Perry absolutely advises anyone on 112 Mc. who uses a standard tube, carefully to remove the detector (and r.f.?) tube base. Of course, these new miniature 1.4 volt filament tubes are convenient in that they have no bases, the tube leads plugging directly into sockets. A small 1.5 volt dry cell gives a season's life on the filament, and no hum modulation. Only 45 or 90 volts are needed. The elements in these tubes may or may not be better than in standard tubes, for u.h.f. purposes, so acorns are still to be preferred. Another comment from Perry is that care be taken in coupling the detector to the audio because the inductance of the choke may be too low. One that worked well on ten meters did not work on 2½ for him. He is thinking of using a concentric line in his next receiver—it is hoped that someone soon sends in a good 2½ meter receiver article using one or two of these lines; the detector might be made to oscillate by using an inductance of a few turns in the cathode lead, or by using a folded line that permits a cathode tap without a long lead.

[*Continued on Page 88*]



POSTSCRIPTS...
and Announcements

BATTERY TRANSCEIVER

The battery life of the A-B pack used in the little 2½-meter transceiver described last month can be increased appreciably by substituting a 1T5-GT for the 1Q5-GT in the audio system. No difference in operation can be detected, and the filament drain is only half that of a 1Q5-GT. No changes in the circuit constants or bias voltage are required; simply plug in a 1T5-GT instead of a 1Q5-GT.

Several have questioned why an HY-114 or similar u.h.f. tube was not used in place of a 1G4-G. The reason simply was a desire to keep the weight down, which means a small battery pack. And with such a small battery pack, both plate and filament drain must be minimized if reasonable battery life is to be obtained.

Where battery life is not an item, an HY-114 may be substituted for the 1G4-G. The filament chokes should be omitted and the tank wires made about 6½ inches longer than specified for the 1G4-G. The grid leak may be lowered to 10,000 ohms with a slight increase in output.

HANDBOOK CORRECTION

On page 382 of the RADIO HANDBOOK, sixth edition, the Lecher wire data should be corrected to read " . . . number of feet by 0.61 (0.6096) or the number of inches by .0508."

EXTENDED POSITIVE PEAKS

Many amateurs have written in wanting to know when we are going to follow up our original story on extended positive peak modulation in the December issue. The truth is that we are sort of waiting to see which way the cat will jump. So far the F.C.C. has not volunteered any comment as to their attitude on this type of modulation as applied to amateur practice.

In the meantime, we might make the following comments for the benefit of those who appear to be somewhat excited about the potentialities of this type of operation.

The modulation capability of most any well-designed plate modulated amplifier is anywhere from 150 to 200 per cent in a positive direction. Very few amateurs appear to be holding their mean percentage of modulation to 100 per cent, as will be evidenced by comparing the average "depth" of modulation of broadcast stations on speech with the majority of amateur stations.

Now so long as amateurs are going to modulate as heavily as they do, it would seem they might as well pole their modulation so that the extended peaks are in an upward direction in order to minimize negative peak clipping. As we have pointed out time and again, it is *negative peak clipping* that is primarily responsible for the hash and splatter that shows up many kc. away from the carrier of the offending station. And negative peak clipping "hash" is not prevented by the incorporation of any type of audio filter, as the harmonics and transients resulting from negative peak clipping are generated *right in* the modulated stage. While appreciable flattening of the positive peaks (as a result of insufficient modulation capability in the modulated stage or overloading of the modulator) will result in excessive harmonic distortion and consequently cause the signal to take up somewhat more room than it should, it is the transients that result from complete cutting off of the negative peaks which cause the *really bad* splatter.

If you are designing a new plate modulated rig, there is no point in going to extremes so far as the size of the class B modulator is concerned. Certainly there is no economy in using larger class B tubes than those used in the modulated stage (assuming push-pull). However, with a pair of 811's modulating a pair of normally excited 812's, or TZ40's modulating a pair of T40's, or HY-40Z's modulating a pair of HY-40's (ad infinitum), it is possible to realize a surprising amount of sideband power without objectionable splatter simply by poling the modulation correctly. Positive peaks under this type of operation will hit between 150 and 175 per cent, and there will be negligible clipping of negative peaks (average male voice).

To prevent overmodulation, an a.m.c. circuit having an adjustable threshold and working off the *negative* peaks should be employed. Another approach would be to flatten off or "round off" the negative peaks when they exceed about 90 per cent, in such a manner that the negative peaks would never be clipped regardless of the modulation percentage in a positive direction. The ideal rig would be a little complicated, but it would

[*Continued on Page 92*]

The Open Forum

Survey

Chicago, Ill.

Sirs:

I was very pleased to receive your questionnaire on what should go into RADIO to please the greatest number of readers. At first I got to figuring that just one more card returned wouldn't make any difference in the results; then it occurred to me that if everybody took the same attitude* the poll would not tell anything. So I sat right down and not only filled out the card but am taking the trouble to write this letter to tell you what a fine idea I think it is. After all, it is the only way to find out just what your readers want.

HARRY MARTINDALE

* Apparently they didn't, because the percentage returns was very gratifying.—*Editor.*

O. M. R. C.

Rockland, Mass.

Sirs:

About a year ago while having a QSO with HI7G and later in a QSO with W5ERV we all expressed a curiosity as to how many active amateurs there were who were over 50 years of age. So we got busy and contacted all hams that we learned about who were advanced in years. I succeeded in getting replies from about 35 hams who would send a card with their age and date of birth. A partial list was published in *QST* and served to acquaint many additional subsequent members with the organization.

I carried on with the idea until August last when I became inactive for five months due to a serious infection. W5ERV carried on during my absence in a very businesslike manner. Now that I am back on the job again I have compiled a complete list of all members which I hope you will see fit to publish in RADIO.

At the present time I am operating on 56 Mc. with a crystal-controlled transmitter consisting of a 6F6 oscillator with a 20-meter crystal, a 6L6 doubler to ten, a HY40Z doubling to five, and a T-55 in the final with about 100 watts input. The modulator ends up in four 46's in push-pull parallel class B. Although 28 Mc. has been poor you can be sure that 56 Mc. is not dead in this area since many of the hams in this area have doubled in the finals of their ten-meter rigs to get on five. It is quite common to renew acquaintances with old friends who have also come down to 56 Mc. due to poor conditions and excessive QRM on the low-frequency bands.

CHARLES F. LOUD, W1JIS

(The list sent in by Mr. Loud is printed herewith.—Ed.)

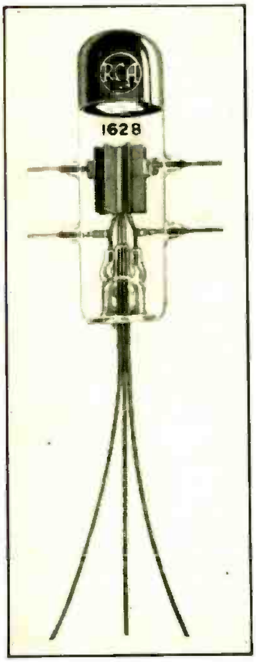
W1AUK	1880	W5BEF	1883	W7FWR	1888
W1AWQ	1874	W5BSC	1875	W7GVH	1881
W1DJ	1888	W5CQV	1886	W7UE	1873
W1FZU	1886	W5ERV	1871	W8BTO	1874
W1HK	1887	W5FMZ	1885	W8CVZ	1888
W1HXV	1887	W5MR	1887	W8DK	1889
W1ICI	1870	W5WN	1870	W8MIJ	1879
W1ILE	1888	W6BKT	1873	W8NA	1865
W1JAS	1889	W6BXB	1875	W8QBW	1870
W1JIS	1877	W6CEH	1875	W8QWB	1872
W1JPM	1888	W6HKO	1888	W8RRC	1882
W1KH	1887	W6IHH	1874	W8TCP	1878
W1LYK	1887	W6KDX	1877	W9BXU	1880
W1SS	1888	W6MZF	1886	W9CAB	1857
W1WV	1887	W6PBD	1885	W9CNS	1861
W2ATG	1889	W6PHH	1881	W9CWQ	1890
W2GAN	1867	W6PJM	1879	W9EFE	1873
W2GUW	1889	W6PLB	1887	W9IXN	1888
W2KZJ	1888	W6PSF	1880	W9MQR	1886
W2MB	1883	W6SAH	1888	W9NWN	1887
W2RS	1884	W6UO	1880	W9SXL	1877
W2RT	1866	W7ABK	1889	W9VLN	1874
W3AQM	1886	W7AXG	1879	HI7G	1871
W3EQ	1870	W7FRU	1880	UX8MA	1861
W4EMB	1887	W7FSH	1876	VE4AIX	1884
W4FLP	1871	W7FWD	1878	LU1DA	1873

●

To hams, the least familiar of all the clever instruments for electrical communication is the *telautograph*, that wiggly gadget that scrawls and scribes across a sheet of paper in railroad stations and in some department stores. Out of close to a hundred hams queried from time to time, only five had ever heard of the telautograph and neither of these had the faintest idea how it worked.

What's New . . . . IN RADIO

RCA 1628 UHF TRIODE



RCA has recently announced a new u.h.f. power triode which should be of interest to amateurs doing experimental work in the bands from 224 Mc. on up. The 1628 is a triode of the high perveance type designed for use as an oscillator or power amplifier at the ultra-high frequencies. It can be operated at maximum ratings at frequencies as high as 500 Mc. and with reduced ratings as high as 675 Mc. The maximum plate dissipation of the 1628 is 40 watts in class C telegraph service (these ratings also apply to f. m. transmission) and the rated power output as an amplifier at 500 Mc. is 35 watts.

Factors contributing to the improved u.h.f. performance of the new tube are: double-helical filament center-tapped within the tube to minimize the effects of filament lead inductance, double grid and plate leads which are brought out of the tube through individual seals to eliminate common impedances between neutralizing and tank circuits, and tantalum plate and grid closely spaced to increase plate efficiency at high frequencies by decreasing electron transit time between filament and plate.

R.F. AMPLIFIER KIT

A free illustrated instruction bulletin describing the PA-240, a 240-watt output phone or c.w. r.f. amplifier kit, is available at leading jobbers or direct from the Allen D. Cardwell Mfg. Corp., 81 Prospect St., Brooklyn, N. Y.

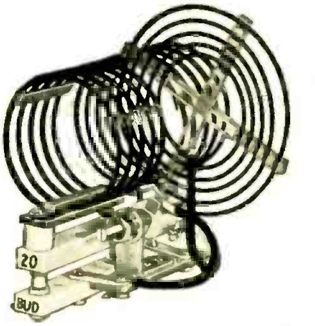
The kit is easily assembled and can be used with any tubes such as 812's, T-40's, HY-40, HY-51, HK-54's, 35-T's, etc. Band-switching is used in the grid circuit to minimize the time required for band change.

HIGH Q UHF TANK

The Lindberg Mfg. Co., 658 Roscoe St., Chicago, Ill., offers a low loss u.h.f. tank circuit particularly applicable to amateur u.h.f. equipment. The tank circuit consists of a pair of circular metal discs connected across a heavy duty coil. Tuning is accomplished by varying the spacing between the circular condenser plates by means of a threaded drive permitting fine adjustment. A very high Q is claimed by the manufacturer. The unit is supplied complete with the necessary mounting hardware.

500 WATT ADJUSTABLE LINK COILS

A complete new series of 500-watt "Airwound" adjustable link coupling coils has been announced by Bud Radio, Inc. of Cleveland, Ohio. This series of inductances has been designed to fill the various applications where it is desirable to adjust antenna loading by varying the link coupling. The link itself is the outstanding feature of this coil series. It consists of an entirely new spiral-wound design. This method of winding enables one link to be used for all bands and assures maximum coupling with the various diameters of coils used for the different bands.



It is evident from an inspection of the system, that, regardless of the diameter of the coil in use, there are always two turns of the link that are quite close in diameter to the diameter of the main coil. An adequate degree of coupling is thereby assured while keeping the proper form factor on each inductance.

[*Continued on Page 94*]

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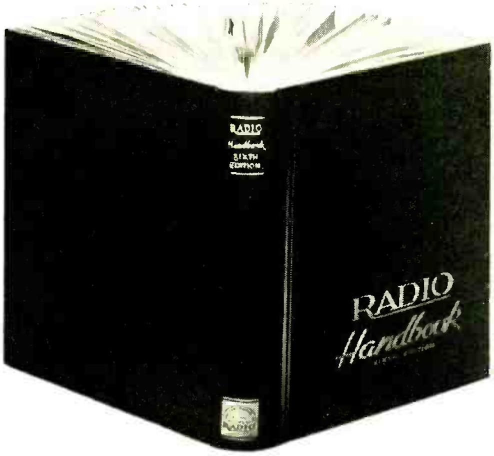

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THE EDITORS OF
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YARN *of the* MONTH

THE STORY OF THE HAM AND EGG

"It can't be done! It's impossible!" I asserted.

The Prof didn't say anything; he just stared at the floor. He had been working on his great idea for three years, and people had always said that very same thing—that it couldn't be done.

"I still maintain," I said, "that you can't transmit a hard-boiled egg by radio. It's the most ridiculous thing I ever heard of. Anybody will tell you that."

The Prof adjusted his spectacles.

"Yes," he agreed, "I know. But the reason it sounds ridiculous is because it has never been done before. They said the same thing about radio and television thirty years ago."

"Yes, but a hard-boiled egg—"

"But nothing!" he interrupted. "You took physics in college, didn't you?"

"Sure," I said.

"Then you know very well that all matter is composed of invisible particles called molecules. You should have learned that in high school physics. You also know that these molecules can be broken down still further into electrical charges, isn't that right?"

"Are you trying to tell me that you can smash the atom?" I asked, reaching for my hat.

"I can *squash* them," he replied. He pointed to a large, metal cylinder in the center of his laboratory. On top of the cylinder were four glass standoff insulators about six inches in height, to which were attached conductors of copper tubing. The other ends of these four conductors were attached to what looked like a kilowatt transmitter. It was a rack and panel job approximately six feet high, with about one hundred dollars worth of meters providing accurate reading of every circuit. In another corner of the room was a transformer, the size of those on telephone poles, and this was connected to the cylinder by means of solid copper wires about a quarter of an inch in diameter.

"My machine," continued the Prof, "is capable of converting solid objects into electrical charges and transmitting these electrical charges, one by one, to a radio receiving set where they are reconstructed into their original form—once more a solid object. By reversing the order of these electrical charges, we can turn a hard-boiled egg inside out. That is, the yoke will be on the outside, and the shell on the inside."

"I think you'd better worry about converting the solid object into electrical charges, first," I declared. "After that you can worry about reconstructing them."

"I'm not worrying about anything," he said. "I've been planning this thing for three years, and nothing can go wrong."

"Well, for your sake, I hope everything works out all right," I yawned, slipping one arm into my coat, "but I still think the idea's slightly screwy."

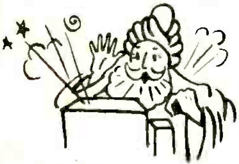
"And I could expect that from a radio ham," he mused.

"Don't forget," I reminded him, "You can't put that thing on the air without a license. Just don't forget."

As I left, I could see the Prof standing in the doorway, evidently still pondering over my final remark.

By HARRY O. BRUNN, Jr. W8MXT

LACKING an actual photograph we had our artist set the scene for our story. ZY4QQ, you see, found so many OW's a bit hard on the budget. So he mail-ordered (by camel express) a pair of cut-rate filter condensers. He installed them, but before the caravan was out of sight, they blew, taking out a pair of good 866's as well.



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GENERAL ELECTRIC

900-30

Days passed and I heard no more of the hard-boiled egg experiment, but this relief was only temporary. On the following Sunday, I was torn from a pleasant meal by the ringing of my telephone, and answering it, I found it to be none other than the Prof himself.

"Well, it looks like I am fully prepared to send my hard-boiled egg by radio," he proudly exclaimed.

"That's great," I said, wondering why he bothered to tell me about it—the person who had heckled him the most about his folly. "The best of luck to you."

"You could be of considerable assistance to me," he stated, clearing his throat.

I racked my brain for a plausible excuse, but thought of none.

"OK," I agreed, not thinking of anything else to say. "What do you want me to do, boil you an egg?"

"No, I want you to operate the equipment for me."

"Me?" I queried. "Why me? I should think you'd know how to work the darn thing if anybody does."

"Well, it's like this: There's a little matter of a federal license which I don't happen to have. I figured that maybe you could use yours, or is that contrary to the law?"

I took another bite of my sandwich.

"Oh, I can use my license as a portable license, if that's what you mean. I'll drop the radio inspector a postcard—it'll only cost you a cent," I said.

"I would greatly appreciate it," he said, "and at the same time I would gladly forgive you for all your thoughtless wisecracks in regard to my experiment."

"OK. I'll take great pleasure in being the first to witness the big fiasco."

"The experiment is set for Tuesday afternoon, then. I hope the time is convenient for you."

"Yes, I guess that'll be OK. Goodbye."

I arrived at the Prof's house as early as possible on Tuesday afternoon and found him nervously pacing the floor of his laboratory. On his workbench was a plate of hard-boiled eggs—about six of them, and near the exit was a fire extinguisher.

"What's the idea of the fire-fighting equipment?" I asked.

"One can never tell what will happen when thirty thousand volts are turned loose," he replied, pointing to this giant transformer.

"Thirty thousand volts!!" I exclaimed.

"Yes, high tension is needed for bombarding the hard-boiled egg, you know. I had to have special lines run to the house, because the usual 110-volt lines are not capable of standing the tremendous current drain. Many are the fuses I blew before I had the heavier lines run in."

"Well, our schedule is at three o'clock. We've got about fifteen minutes to make our preparations," he said, reaching for his telephone.

He dialed a number, then waited. "Hello, Warren? This is Felix—yes, we're all ready at this end. Is your receiving apparatus in working order?—I see—good—well, we'll throw our carrier on and you can give us a call on 160 meters when you've got us tuned in—all right, fine—goodbye."

"Who was that?" I asked when he was through telephoning.

"That was Professor Tristee of the University of Buffalo. He is in charge of the rest of my equipment at that end. He's going to use their station to let us know how the egg comes across."

"I always knew college professors were a bunch of screwballs, but I never knew they were *that* gullible," I said. "I don't think Tristee even knows what a hard-boiled egg looks like. He's a vegetarian, for one thing."

The Prof paid me no attention.

After glancing at his tubes to make sure the filaments were lit, he closed a triple-pole knife switch on the panel and watched the final milliammeter.

"These tubes are running very cool," boasted the Prof. "Although this transmitter is capable of emitting an 800-watt carrier, it is generating one of only 250 at present. You must understand, of course, that this leeway in power is necessary when transmitting such objects as hard-boiled eggs."

"I suppose a soft-boiled egg wouldn't be as hard on the transmitter," I said, wondering whether to duck or expect a laugh. The Prof ignored my remark as usual and continued to tune up his final stage.

When this was done, a modulator unit was cut into the circuit and the Prof suggested that I give the University a call.

"Hello, W8ZZKX," I began, grabbing the microphone. "Calling W8ZZKX, W8ZZKX, W8ZZKX. This is W8MXT, portable, calling you. Calling W8ZZKX for a 'radio-transportation' experiment and standing by. Go ahead."

Tuning across the band, I heard the University calling me back on 160 meters. Professor Tristee was at the microphone and he promptly congratulated me on my newly coined word—"radio-transportation."

I turned to the Prof.

[*Continued on Page 74*]

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"By the way," I said, slowly, "is there any chance of this piece of junk turning out an a.c. carrier wave when you start that funny business with the egg? After all, we're using my call letters and I have to be careful about the kind of signal—"

"Don't worry," interrupted the Prof, "there is no danger whatsoever of spurious modulation. Now let's throw her on the air again and then we'll try the egg."

I gave the University another call and then we disconnected the modulator.

"Hand me one of those hard-boiled eggs, will you?" said the Prof, pointing to the work bench.

I did so, and he placed it inside the cylinder and closed the cylinder door. After pulling an extra-large knife switch, the Prof regarded his giant transformer with renewed interest as it started to hum very loudly. Then he rushed over to the radio-frequency unit and glanced at the final plate meter, the needle of which was slowly rising.

"There! There!" shouted the Prof, "There goes the egg!! The egg is modulating the carrier wave!!!"

I placed my hand over my mouth to muffle a laugh, although I will admit it was a little exciting at the time.

My surprise came when he opened the door in the cylinder. The egg was gone!!!!

We listened on 160 meters for a report from the University.

"Calling W8MXT," came the voice from the loudspeaker. "Hurry up! Bring on that hard-boiled egg. We're hungry over here!"

I really felt sorry for the Prof, because I could see how badly he felt about it. His experiment was a failure.

However, there's still the question of what happened to the egg. Is it still traveling through space in the form of electrical charges, or was it entirely destroyed?

At any rate, the next time you think you smell burning bakelite in your receiver, look to see if it is tuned to 1951 kc. and take a more careful sniff; it may be a rotten egg.

2½-Meter F.M. Transmitter

[*Continued from Page 19*]

which slid along the rods with the shorting bar, thus keeping the coupling constant. This type of coupling arrangement would result in a considerable complication of the mechanical details.

Operation

If an accurately calibrated receiver which tunes to 4750 kc. is available, no difficulty should be experienced in getting the transmitter tuned up. The oscillator is simply set to this frequency and the following doubler stages in the exciter tuned to resonance with

the tripler output stage disconnected. Exciter meter readings should be about as follows: oscillator plate, 30 ma.; 9.5-Mc. doubler plate, 28 ma.; 19-Mc. doubler plate, 28 ma.; HK-24 grid, 12 ma.; HK-24 plate unloaded, 20 ma.; HK-24 plate loaded, 75 ma. These figures are for 500 and 1000 volt power supplies.

If the station receiver does not tune to 4750 kc. and it is impossible to borrow a receiver which will cover this frequency, the station receiver may be used to set the oscillator by utilizing its image response. Supers having an intermediate frequency of around 450 kc. will receive 4750 kc. as an image when they are tuned to 3850 kc. This assumes that the receiver oscillator is on the high frequency side, which is usually the case.

When the transmitter as a whole is being tuned up for the first time it is best to apply about 500 volts to all stages until one becomes familiar with the transmitter's operation. The correct coupling to the output stage grid is about as shown in the photograph of the complete transmitter, the link coil should be pushed about two-thirds of the way into the HK-54 grid coil for maximum power transfer. With the lowered voltage applied to the transmitter and the tripler grid circuit tuned to resonance and the shorting bar on the plate rods down against the standoff insulators, a screwdriver with a *well insulated* handle may be used to determine the resonant point on the plate rods. The screwdriver should be pressed firmly against both rods and slid along from the power supply end toward the plates. Resonance will be indicated by a sharp drop in plate current as the screwdriver passes over the proper point. This point will probably be from one to three inches up the rods from the power supply end. If resonance is not found until the screwdriver is to within 6 or 8 inches of the plate ends of the rods it is an indication that the rods are too short, as the resonance point 6 or 8 inches away from the plates is that for the fifth harmonic of the grid frequency, or 190 Mc.

When resonance has been found by the screwdriver, the shorting bar should be placed at this position and tightly clamped to the rods. The shorting bar may be moved back and forth a short distance in either direction to insure that the resonance point has been correctly determined, making sure to remove the plate voltage each time the shorting bar is touched.

After the shorting bar has been properly located full plate voltage may be applied to the transmitter and the currents in the tripler stage checked. These should be: grid current —25 ma.; plate current unloaded—125 ma. A 75-watt lamp bulb connected across the antenna terminals should glow at about normal brilliancy when the coupling hairpin is adjusted so that the transmitter is loaded to 225 milliamperes. This indicates that the tripler efficiency is approximately 30 per cent, which is about normal at these frequencies. The 150-watt difference between input and output would seem to indicate that the plate dissipation of the tubes was being considerably exceeded. However, the criterion in matters such as this is the plate temperature of the tubes, and their color does not seem to indicate that their 50-watt plate dissipation is being exceeded. Undoubtedly the 50-watt discrepancy between the total power loss and the plate dissipation can be accounted for in radiation and resistance losses in the plate tank.

Checking the Frequency Modulator

If desired, a curve similar to that of figure 2 may be plotted to determine the linearity of the frequency modulator. The lead from T_2 to the modulator grid should be disconnected from the transformer and connected to the movable contact of a 5000-ohm potentiometer which has its outer terminals connected to the positive and negative ends of a 45-volt battery. The center, or 22½-volt tap on the battery should be connected to ground. When the potentiometer is set with its movable contact at the center of the resistance strip the grid voltage as measured by a voltmeter across C_5 should be zero. Positive or negative voltages may then be obtained simply by turning the potentiometer shaft.

The grid voltage should be set to zero and the signal tuned to zero beat at 4750 kc. The frequency of the oscillator may then be shifted in either direction by putting positive or negative voltage on the modulator grid. The frequency shift may be determined by comparing the beat note in the receiver with a standard audio frequency such as 500 or 1000 cycles or to a variable audio oscillator.

The best control point for straightening up any nonlinearity that may occur is in changing the value of the bias bleeder resistance, R_{23}. Using less resistance at this point will cause the frequency shift per volt on the positive side to be more rapid, while more resistance will flatten off the curve on the positive side.

See Buyer's Guide, page 98, for parts list.

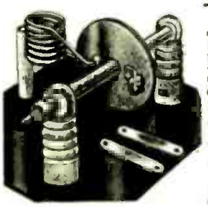
Top-Loaded Verticals

[*Continued from Page 22*]

36 inches across and is mounted as shown in the sketch of construction details.

Loading Coil

The top loading coil is wound with No. 20 d.s.c. wire on a section of maple shovel handle which was turned on a lathe to fit the inside diameter of the top of the mast. The coil and wood form was boiled in beeswax for twenty minutes and then protected from the weather by two layers of rubber tape. Capacity was tried across this coil as shown at (D) and (G) in figure 1 but it was impossible to find a satisfactory condenser to mount on the top of the mast that would stand the extremely high voltage at that point.



Loading of midget verticals to a half wavelength is possible with slightly higher masts. Some signal gain to local stations will be realized but the angle of radiation will be reduced, which may or may not be an advantage to the amateur station, depending on the type of coverage expected from the antenna.

Battery Powered Converter

[*Continued from Page 26*]

serting the miniature tubes into their sockets for the first time. The element-connection prongs for the tubes are merely extended pieces of molybdenum wire which are sealed into the glass base of the tube. If too much strain or tension is placed upon these wires there is a possibility that the glass envelope or the glass base of the tube may be fractured.

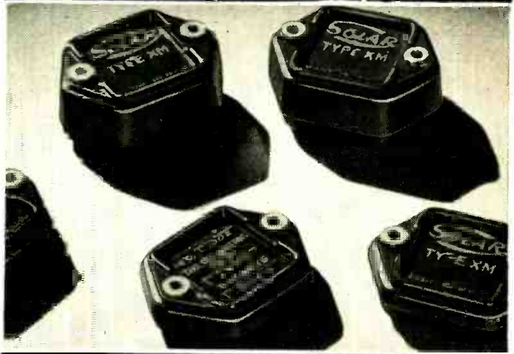
Tuning Up

Tuning up the converter is a comparatively simple process provided the coil table has been followed exactly and provided a high-gain broadcast receiver is available for the first test. The b.c.l. set is first tuned to 1600 kc. (or a point close to that frequency where no b.c. or police stations are audible) and the gain turned up until background noise can be heard. The 40-meter coils are plugged into the set and the filament switch turned on.

With the bandset condenser on the oscillator at about half scale tune the primary on the 1600-kc. output i.f. transformer in the converter at the same time that the detector tuning condenser is being rotated back and forth. A point will be found where the hiss (or perhaps a signal) comes in loudest. A retrimming of the i.f. transformer and of the detector tuning will then complete the tuning.

Note that 6-prong forms have been used for the oscillator coils and 5-prong ones for the detector. This has been done simply to insure that the proper coils will be inserted into the proper places. Four and five prong forms could have been used just as well since only four terminals are used on each of the forms.

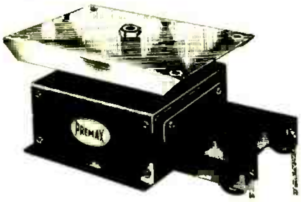
It will be found best to have the ten-meter coils in the converter when the neutralizing condenser C_8 is being adjusted. Set the bandset condenser to about 60, tune in a signal on the bandspread dial, and peak it up on the detector condenser. Then adjust C_8 back and forth until rotating the detector condenser back and forth gives the least pulling of the oscillator. The best setting will be found with the open edges of the neutralizing condenser separated about one-eighth inch. At the proper setting there will be only a very small amount of pulling on the ten-meter coils and practically a negligible amount on the lower frequency bands.



Those persons building this little converter will find that they have added a very worthwhile and satisfying piece of new equipment to that of the station. It will be found quite satisfactory for use with one of the midget battery powered b.c.l. sets and will give quite satisfactory sensitivity for portable use. Of course a small amount of image interference will be present on the higher frequency bands but it has been reduced to a value which will cause no trouble by the use of 1600 kc. as the intermediate frequency.

The converter can also be used as a mobile converter with the b.c. set in the car for portable mobile operation on 28 Mc., or it may even give a good account of itself when used with the home b.c.l. set during a period of absence of the station communication receiver.

See Buyer's Guide, page 98, for parts list.



Armstrong Frequency Modulation

[*Continued from Page 44*]

lating voltage, as suggested, could be applied to a grid in each tube. This has usually been done at the input grid of triodes, which accordingly must be in parallel at r.f. and in push-pull at a.f. To avoid the resulting choke-coil and stopping-condenser combination, one may instead supply the audio to the two suppressor grids, letting the r.f. have the input grids for itself.

The balanced modulator is followed by a sideband amplifier, which is just an ordinary r.f. pentode like the carrier amplifier in the other channel. The outputs of the carrier amplifier and the sideband amplifier are resistance coupled into another receiving pentode and thence to the multiplier-and-occasional-buffer-string which in the end feeds the front end of the original transmitter.

Several things are still wrong with this picture. The balanced modulator would appear to be producing ordinary amplitude modulation, which isn't wanted. Also it would seem as if the phase modulation, if produced, must be proportional to audio frequency — which also is not wanted. (The phase modulation, and its descendant the frequency departure of the final high-frequency carrier, are to be controlled by sound loudness only.) Two more devices are introduced to change this situation. One is a simple distortion device in the audio amplifier feeding the balanced modulator, such that the output of the amplifier falls off as the frequency rises, thus compensating for the objectionable effect mentioned in this connection. The other device produces a phase shift of 90 degrees in the balanced modulator's output before it is recombined with the carrier. This is done by the output transformer of the balanced modulator.

Why So Wide a Band

Bandwidths of 150,000 cycles sound rather tremendous when we are accustomed to a broadcasting system with 10,000 cycle channels.[1] The use of so wide a band automatically locates the system in the ultra-high frequency region, which still offers that much available space. But at the moment we are inclined to think of ultra-high frequency transmission as very limited in range—perhaps not with com-

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[1] Subsequent investigation has shown that the bandwidth required for amateur work is considerably less than that required for wide-range broadcast transmission. It has been found that the bandwidth needed is about 20 times the highest frequency to be transmitted. For amateur usage the maximum modulation frequency need not be higher than 3000 cycles, giving a total bandwidth of 60 kc., or 30 kc. either side of the average frequency (carrier).

plete justification. To such objections the workers with the system reply that the "primary coverage" of a 50-kilowatt broadcasting station is surprisingly small, and that in numerous tests a 2-kilowatt transmitter Armstrong-modulated has at distances of 75 miles or so delivered consistently better signals than 50-kilowatt amplitude modulated transmitters using the same program material. This argument is of course based on the idea that broadcasting is interested in city-area coverage; it does not include the other half of the people of the U. S. who live in suburban or rural areas and get along very well with 550 to 1500 kc. broadcast signals outside the primary coverage territory. However, half the population is 60,000,000 people, so an improvement giving staticless and fadeless reception to the city area is worth a very great deal. Obviously reception at a great many places in a city must be attempted to learn just how fully this hope may be realized.

This justifies the use of the ultra-high frequencies if they are the only means of using the Armstrong system, but again one asks, "Is so broad a band actually necessary?" This brings us to noise pickup at the receiver.

Noise Reduction

The receiver must accept all frequencies across which we propose to wave the transmitter's frequency. At first sight this looks to be equivalent to accepting much more noise than in an ordinary receiver, and so it would be if the receiver were "voltage conscious" to the extent of the ordinary receiver. Even so the noise would not be 15 times as great as for the ordinary receiver, though that figure might be suggested by the relative pass-band widths. Once the pass-band has become perhaps 20 kc. wide there is no great increase from there on, as additional width does not place more noise within audio range of the carrier, where it can beat with the carrier to produce audio. Though the carrier be wavering in frequency, it cannot at any instant be within audio-beat range of more noise. Thus it is justifiable to widen the band further if there be any advantage gained.

The Receiver

The signal entering the receiver is first passed through an "acorn" r.f. amplifier, then to an acorn translator or "first detector" where it is converted to a (resting carrier) frequency of about 6 megacycles, and then to the current limiter tube. Up to this point nothing but an unusually great superheterodyne amplification has taken place. At the current limiter something else does take place. The current lim-

iter "removes amplitude variations above a certain level"; it "suppresses the noise components which are at 0 or 180 degrees (phase) to the carrier, but has no effect on those which are at 90 degrees. These (components at 90 degrees) are not heard because they constitute phase modulation only." (Quotations from Major Armstrong during interview.) Each noise component in going through the current limiter creates an image of itself on the other side of the carrier and in the subsequent circuits is able to balance itself out, as are noises originating in the amplifier stages ahead of the current limiter. It is necessary that the received carrier be quite strong when it arrives at the current limiter as it is the backbone of this process of maintaining a quiet zone about itself. This both permits and demands high amplification prior to the current limiter.

Practical Results

The current limiter has a species of automatic volume control action. Given an adequate signal from the antenna, the enormous amplification "ahead" will load the current limiter to the "Plimsoll mark" even on the "fade down" of any reasonable signal. No room is left for a "fade up." Even at 85 miles the 2 kilowatt transmitter produced very little fading though a normal 50 kilowatt station nearby (near the 2 kw. Armstrong station) did fade considerably when received with a good broadcast receiver.

It is rather startling to be told that the signal-to-noise ratio is improved about 1,000 times as compared with amplitude modulation of a comparable transmitter. The argument on this is about as follows:

If the pass-band for full modulation is 200 kc. wide, then a noise voltage, as already outlined, cannot be productive of a large net effect upon the detectors because it cannot be heard if more than 10,000 cycles from the carrier (sounds above 10,000 hard to hear), and even 10,000 cycles is but 10% of the swing made by the fully modulated carrier. As a second factor the comparison between an Armstrong transmitter and the conventional type must be made at different carrier levels for the same tubes. The Armstrong system can work the tubes with a larger carrier output as there is no intention to modulate upward. For equal bandwidths the Armstrong system is stated to produce about 58% of the noise (same signal) as the amplitude system. Multiplying these factors together with appropriate squaring, an improvement ratio of about 1,000/1 emerges, and this is stated to have been confirmed by measurements by the experimental staff and others.

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K7HEN and W7HER are both yl calls.

Sainted Barbers, Caulif.

Dear Hon Ed.

Scratchi are so mad at your Mr. D. X. Becker he sizzle like a superregenerated receiver. In fack, if it were not that I are heer he are such a big guy I are tempted to make special trip to Lost Angels just to pin his ear back. But when I heer he are about six feets three in stocking feets, I are decide to be a good sport about the hole thing and excuse him this time. You may also renew my free lifetime prescription to RADIO which I are write in to you to cancel and refund my monies when I are get so mad.

You see, Hon Ed., the trouble are start when at last I have make enough zoans to get on the DX Hon. Roll by hooking up with K9PU, who are confide to me he are an unlicensed station on Dog Island, which are a new zoan for Scratchi, being in zoan 41 according to K9PU.

So what do Mr. Becker do? He say he are afraid that cannot count K9PU for new zoan for Scratchi, as Dog Island are located in the Dalmatian groop, and therefore doubt if Scratchi have worked a new zoan, and therefore Scratchi are not yet illegible for listing in the Hon. Roll.

Now Scratchi are not like being insulked by having Mr. Becker incinerate that Scratchi have not work Dog Island, but are realize that Mr. Becker are have to be a septic on account of numerosity of amchoors who are try to cheat and chisle on number of zoans worked. So instead of getting mad and canceling my free prescription to your Hon. rag, I are sending in photographic proofs of fack that Scratchi actually work K9PU. I are hook the fellow again and this time are smart enough to take pitcher of selfs working him, which should prove beyond all doubt that Scratchi are actually work Dog Island and therefore are entitle to be present in Hon. Roll along with other lyers.

Respectively yours,
HASHAFISTI SCRATCHI, ESQ.

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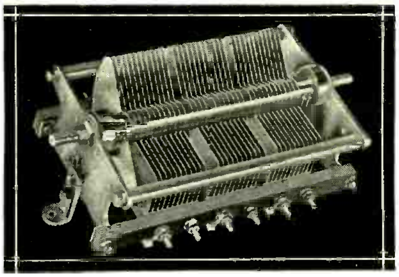
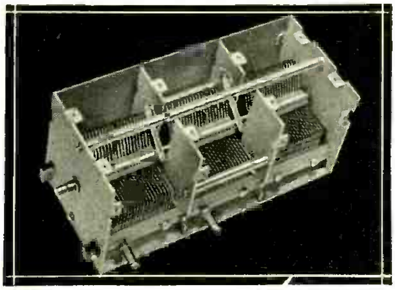
The first contact of W6SIR after receiving his license was with W6SHE.





Cathode Modulation Notes

[*Continued from Page 36*]

To test the amplifier for susceptibility to parasitics, proceed as follows: Remove the excitation, reduce the bias to zero, and apply reduced plate voltage of such value that the plate dissipation is less than the safe maximum. There should be no grid current reading, and the plate current should remain absolutely constant when first the grid and then the plate tuning condensers are rotated from minimum to maximum capacity. There should be no indication when a neon bulb is touched to various parts of the plate circuit. An Ohmite parasitic suppressor in *one* grid lead will in almost every case cure u.h.f. parasitics in an amplifier. Methods for checking for the presence of all kinds of parasitics and means of eliminating them will be found in the RADIO HANDBOOK. It is *extremely important* that all traces of parasitics be removed from the modulated amplifier before it is put on the air.

Amateurs appear to worry more about getting an "exact impedance match" between the modulator and the cathode circuit of the modulated stage, while actually it is of greater importance to make sure the amplifier is free of all types of parasitics and r.f. feedback. The cathode impedance is not critical, and an impedance mismatch of 2 to 1 or even 3 to 1 can be tolerated without noticeably affecting the voice quality. This applies especially to modulators using push-pull 6L6's, as the plate-to-plate load on 6L6's can be varied over wide limits without seriously affecting their modulating ability.

Antenna for 112 Mc.

[*Continued from Page 34*]

than on 56 Mc. The array is bidirectional, and for complete coverage should either be arranged for rotation through 135 or more degrees, or else two arrays used at right angles to each other.

Other Arrays

The close-spaced unidirectional arrays widely used on the lower frequency bands can be used with great success on 112 Mc. The elements may be oriented either vertically or horizontally, depending upon which type of polarization is desired. Close-spaced driven arrays of the W8JK type also can be used to give excellent gain and directivity. The important precaution to observe is to avoid, if possible, all insulation at voltage loops on arrays having low radiation resistance by making the elements self-supporting and anchoring them at points near the voltage node. When insulators are absolutely necessary, they should be of the very best quality when used at points of high voltage.

4-Band Exciter-Transmitter

[*Continued from Page 41*]

sockets run down through the chassis to the crystal selector switch. The mounting was such as to go over a regular 1¼" socket hole with its two holes for mounting screws. The other two crystals in the exciter are mounted in regular 5-prong sockets immediately to the rear of the 6A6 tube.

It will be noted that plenty of socket holes are provided on the chassis for possible future changes or additions to the tube lineup. For instance, 2 single tubes of any type could be substituted for the 6A6 without the necessity of any chassis changes whatever.

Output Circuit

The two-section Cardwell condenser is mounted on feedthrough insulators by means of special end brackets which also support the mycalex insulator for the plug-in coil directly above this condenser. Similar brackets support the 4-gang tap switch with another mycalex insulator and coil directly above the switches. The rear bracket for the tap switch also supports a socket for the plug-in coil form for the 80- and 40-meter coil. The coil switching and condenser switching, due to somewhat longer lead requirements, undoubtedly make toward some losses in this stage. There is a surplus of power on all bands and some losses can be tolerated for the sake of convenience.

Further Considerations

The tapped 80- and 40-meter coil for the 807 stage is directly back of that tube under the shield can, while the 20- and 10-meter coils are located under the chassis near the tap switch for the sake of short leads.

The other square shield can at the left covers the tapped 80- and 40-meter coil for the first section of the 6A6. The tuning condenser for this coil is located under the chassis.

There is nothing special about any of the coils. All were calculated to give approximately the proper Q for the frequency and circuit on which they were to be used.

Tuning Up the Bandswitching Exciter

Not having facilities for engraving the panel, no markings were made showing various switch positions. However, a pencil chart of the switch positions and the diagram will be of assistance until the switching arrangement can be memorized.

One of the major problems in first tuning

up this outfit on the high frequencies was that of getting stages resonant on intermediate harmonics rather than the desired ones. It was found that an absorption wavemeter was an absolute necessity in order to locate the desired harmonics.

The practicability and flexibility of the exciter was proven in the last dx contest when it was first used. The crystal switching and band changing features enabled this rig to cover much more territory on the air than had been possible before. While a very excellent stabilized oscillator is also used to get around in the bands, it is a lot of satisfaction to know that you are on a fixed crystal frequency rather than upon one which can be moved at will and where careful frequency checks are at all times necessary.

This article is offered, not so much as a construction article which can be followed in all details, but rather as an example of what can be done with a little careful planning and with consideration of all the excellent information given to us from time to time in our journals and handbooks.

See Buyer's Guide, page 98, for parts list.

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The F. C. C. has 280 ham neighbors. At the time of this writing there are just that many amateurs in Washington.

TW 150's in High Power Final

[*Continued from Page 28*]

any definition, and power supply costs will be lower.

The fixed bias supply logically should be provided by an a.c. pack with output variable from —60 volts for the lower power operation of the stage to —90 volts for the maximum power.

The fixed bias supply figures represent approximate cutoff voltage (amplification factor of 35 divided into 3000 volts, 2000 volts, or an intermediate voltage, as the case may be). The specified values of grid leak remain correct under operating conditions, which is to say when the amplifier is properly excited. The total grid bias will be —140 volts (low power) or —260 volts (maximum power). This is roughly three times cutoff.

Excitation

The driving power for TW-150's, according to manufacturer's ratings, is 17 watts per tube, or 34 watts for the pair in push-pull, inclusive of grid bias loss. This amount of drive would be quite adequate for relatively low frequency operation. However, the total grid drive formula used where plate voltage, normal grid current, and amplification factor are known quantities does not take into consideration various circuit losses which increase with increasing operating frequency. Therefore the exciter for this kilowatt final should provide a nominal driving power of about 65 watts, or twice the recommended value, for 10-meter operation.

If parasitics should be present due to the exact symmetry of r.f. components and wiring, a parasitic suppressor in *one* grid lead will effect a cure.

See Buyer's Guide, page 98, for parts list.

DX

[*Continued from Page 52*]

W2BHW worked KC4USC, who at the time was around 14,400 kc. Lindy adds his bit to the inactivity lately. Sez he likes it because he can become acquainted with the folks at home, brush up on his bridge and other indoor sports, and last but not least, solder up some of the old haywire joints in the rig. 2BHW worked KA1HR and XU8MI on 40 meters. Think XU8MI is around 7055 at 7 a.m., e.s.t. This would sure be a good spot to give 40 a sales talk, wouldn't it? Probably all of youse guys know by now what I think about 40 . . . and in case you don't maybe I'd better bear down again. I just heard a voice "off stage" telling me to lay off that stuff so all I will say is remember, 40 is not just a band on which to make the BPL.

AC4YN Is In Again

On Monday, February 18th, W2AIW hooked up with AC4YN at 7:45 a.m., e.s.t., the frequency being 14,268 kc. 2AIW says he started at about 14,260 and drifted to 268. Guess Reg Fox must have had a little trouble with his outfit as he hasn't been on for some time. Through the grapevine I have heard that W9HLF worked Reg on Sunday . . . gee, why is it some guys have all the luck. (Yeah, I know what you're saying . . . it isn't luck.) Reminds me of the cluck who said that whenever he wanted to raise a real rare station he held the key knob between his thumb and little finger. This may be a lucky method for him but I'd like you to try it some time and then see if you can copy your own fist. Would be a fine sounding mess in a contest if everyone followed this procedure.

W6QAP breaks down and gives a few frequencies. . . . J7CT, 7063 and 7230; J2KN, 7023; J2PK, 7143; J4DC, 7125; J2XC, 7035; J2KD, 7145; J8PD, 7160; J6CD, 14,380; J2MH, 14,400; J6DV, 14,325; J3FJ, 28,180; J3FZ, 28,480; HK5ED, 7095; PY1UR, 7030; PY2OE, 7060; PY1BC, 14,360; PY7BV, 14,315; PY5BF, 14,270; PY2NH, 14,310; CE3EX, 14,350; I1NZ, 15,400.

W6ITH explains about conditions picking up a little, at least enough for him to hear this dx, or I mean to work it. Anyway here it is: CE1AC, 14,130; CE1AS, 14,144; CE3DW, 14,076; LU4XA, 14,130; LU9AW, 14,092; OA4AI, 14,010; XE1BQ, 14,124; XE2FL, 14,214. Reg says that LU4XA is probably the most southern station on at the present time (excluding KC4USC, etc.). He is located at Puerto Deseado (Port Desire), Patagonia, Argentina, which is about 2000 kilometers south of Buenos Aires. The station is at the end of the southernmost railway line in the world, which runs from Bahia Blanca to Puerto Deseado. Power used was 200 watts and time was about 8:00 p.m., p.s.t. Other frequencies given by W6ITH are: CX1AA, 14,020; LU9HA, 14,057; CE2BX, 14,050; LU8EC, 14,084; LU5EZ, 14,009; CX2CO, 14,067; KF6JEG, 14,202; XE2FL, 28,250; HC1JB, 28,373; LU5HE, 28,108; LU1DA, 28,392; LU5AN, 28,080; and CE2BX, 28,305.

And Still It Comes About AC4JS

The location of AC4JS has boiled itself down to this. The Chinese claim the territory involving Choni and its immediate surrounding area. It is also claimed by Tibet and is populated by none but Tibetans. Furthermore it is beyond the Chinese Postal service. The Chinese claim dates back to the beginning of the Chiang-kai-Chek regime. They sent agents into the area which the Chinese government wished to incorporate into the Republic. The Choni area was ruled by a Tibetan Prince who would have nothing to do with the incorporating ideas, so it remained independent up to a few months ago, when the prince was killed. Since that time the region remains independent under his heir and takes its orders from Lhassa, Tibet.

However, those in this country who are "in the know" about foreign affairs say that Choni is considered as being in China, so we'll have to let the experts argue about it. It doesn't

look like I'll be able to get over the Choni to survey the situation personally, so until someone proves that there has been a monkey wrench tossed into the machinery, we will credit AC4JS as China and zone 23.

I suppose quite a few of you have been receiving your cards from TA1AA via ON4HS. At least the reports seem to indicate as much. To those who have not heard, in order to get your card for contacting TA1AA send a self addressed envelope to ON4HS, enclosing your own QSL for the QSO, of course. TA1AA was operated by a friend of 4HS in Turkey. We have several other sources of information which bear out the contention of ON4HS, that TA1AA was on the up and up. We would like to publish these sources but unfortunately "cannot do."

K4KD is on 3593.5 kc. every Sunday night at 0600 G.m.t. looking for states. If you haven't worked a K4 on 80, here's your chance. W3TR writes to say that there is no dx but he is still alive, and hopes that something breaks before long. Whadya want to break, Al? W6KQK formerly of San Jose, Calif., is now a K6. Andy is located at Box 3133, Honolulu, T. H., while the station is at Lualualei, Oahu. Andy worked CP6XF who said he was ex-D4YAE and came in at 14,290 T8. He also worked the Snow Cruiser, KC4USC, who was on phone, 14,180, while KQK was on c.w. W6NLZ worked D4BIU, CT1CX, OS5B and LZ5C . . . also UX3FI. About half of those look OK. John now has 37 and 105.

Some of the gang around L.A. seem to be getting hopped up in spirit as well as power for the coming dx contest. W6GRL has new antennas . . . some guy making a crack that Doc has so many they are inductively coupled to each other. Anyway, Doc is raring to go and by turning on your receiver you can probably hear him now. Oh yes, he also has new key contacts which should help. W6VB has his first itching to go, so has W6GRX. Don't know yet about CXW. He has been so busy in his new business he hasn't had time to string up any antennas lately. W6OEG is actually getting his station built up for this year's contest. He has never quite made it in time before. The only thing he needs now is an alarm clock that *won't* waken him.

Oh yes, I think QD will be in there somewhere goin' after it— and I hope they can find me once in a while. It probably is of no interest to you, but we've moved again. What, again . . . so soon??? 'Taint quite that bad, we just moved right next door. We tossed all the stuff out of the windows into the driveway, and then went out and threw it all in through the windows to the new house—a total move of about 50 feet. It wasn't quite as simple as all that, but we're all set up again. Oswald asked me if I had to move those four 75-foot poles, the answer being no. The poles and antennas are on a clear acre to the rear of all the homes on the street, so we can still move a few houses and only have to chance the feed line. As a matter of fact, the xyl has her eye on a place about four houses up the street, so you see, by taking them one at a time, we still have a few moves. That's about the works for this time except I'd like to see more of you take a little time and put up a 40-meter antenna. The band is definitely good and the more we get on it the more chances are some dx will follow along. Anyway, you can't ignore the fact that 40 is a lifesaver for W9's. That's a little feeble, I'll admit . . . will do better next month.

U. H. F.

[*Continued from Page 64*]

February 10-11 Relay

Comments on the u.h.f. relay of February 10-11 have been provided by W9VHG of Glenview, Illinois. Total activity apparently was lower as indicated by contacts with only five stations, but distances covered were normal. Twenty-three messages were handled by VHG, mostly between W8CVQ in Kalamazoo and W9ZHB in Zearing. Seven messages received via ZHB reached W8CIR in Pennsylvania, according to a report-back message. The only west-bound message handled was from W8BHY/3 operating in Maryland. At this date it appears that the gap in Pennsylvania (or New York or Maryland) was not bridged this time. Whether this was due to a missing station or to conditions is not clear.

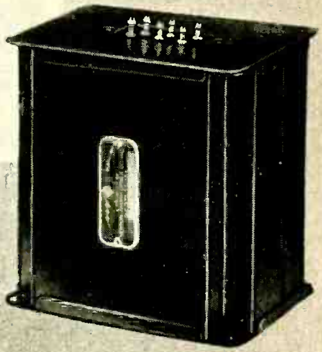
VHG is contemplating a private Chicago-Milwaukee field day soon. He heard W9NY last summer and used to hear W9ANA. W9GGH in Kenosha has not been hearing Milwaukee, but some of his difficulty (including trouble working VHG on the horizontal beam) has been attributed to tin roofs next door. The antenna will be moved to the garage to get it more in the clear. W9ZGD in Milwaukee received a letter from W9LRT in Chicago suggesting 2½ meter tests.

56 MEGACYCLES

A new system of 75 Mc. airways radio beams is to be installed between New York and Chicago at 125 mile intervals. These should make good indicators of conditions for stations in line with them.

W1JNX in Mansfield, Mass., left five last summer but now finds activity better again. He will be back in April with 300 or 400 watts into HK54's, and a converter ahead of his RME70. W1HXE and W1LCC report increased activity around Lawrence, Mass.

W2MO keeps W1HDQ advised of five meter news in weekly contacts, but doesn't think he had better rely on similarly consistent five meter schedules with the ninth district. Lower signal strengths were noted during December and January on MO's 200 mile schedule with W3DBC in Washington, supplemented with 160 mile contacts with W3IIS of Catonsville, Maryland. At the worst season, schedules were 80 percent held! W3BKB of York, Penna., 150 miles west, dropped below audibility in January though he re-



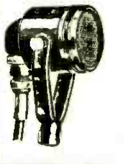
ported hearing MO. W3BYF of Allentown, Penna., is active but midwinter signal strength cuts down his contacts. On several QSO's with MO, the flutter fade appeared. Since October, MO has held nightly schedules with W1LLL Hartford, W1LFS Bristol, W1KLJ Fall Mountain (Conn.), and W1KEE in East Long Meadow, Mass., about 100 to 125 miles away. Contacts were made from 60 to 90 percent of the time. In January W1DEI in Natick, Mass., 200 miles away, joined the schedule and reports MO sixty percent of the time. MO hears him 40 percent of the evenings which, for mid winter, is not at all bad. W3HOH is a consistent station, 30 miles west of New York City. W2AMJ is rebuilding. W2FBA in Albany is reported back on the band. MO also worked W3RL (Herndon, Va., about 200 miles), W3CGV and W3GGR in January.

With business booming for him in Fort Lauderdale, W4DRZ has had little spare time. However, he put his five meter antenna back up and worked W4EDD in Coral Gables. They have a campaign on to get more fellows on the band—it's too exclusive now. How about some of the Havana gang, Bud?

W4EDD has mounted his five meter five element horizontal Yagi above ten and twenty meter beams, on a single bearing. On ten he puts a kilowatt into Taylor TW150's. On five and 2½, he has TW150's and HK254's.

W4FLH in Miami has joined the nightly 7 p.m. schedules of DRZ-EDD. They would like to cover the whole state of Florida with this net.

From Tucson, Arizona, W6OVK says that he did not write because he was afraid that contributions from non-subscribers would not be welcome. How would we know who is whom? Anyway, this column started out to disseminate information and increase interest—the typesetting, paper and mailing, provided by RADIO, Ltd., are the real contributions. OVK checked ten and twenty meter phones for five meter interest. Twenty percent were somewhat interested and ten percent had five meter equipment. Well, Jim, even if the most prevalent excuse given to you does happen to be the present stability requirement, those fellows will probably have to go up or down in frequency during winter evenings for the next few years in order to work someone. OVK's new acorn receiver is quite



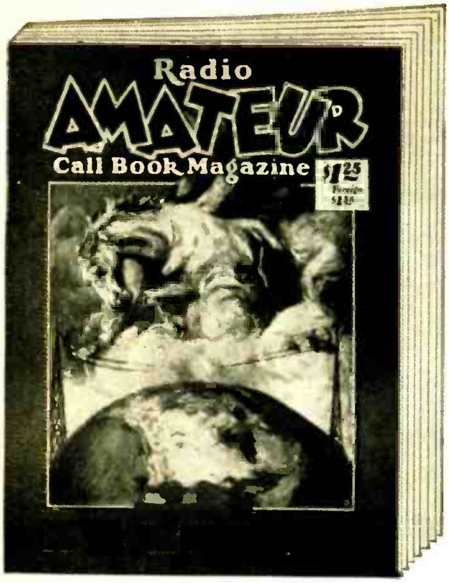
an improvement over his old job. The transmitter uses three 6L6's in the exciter which drives 809's at 140 watts phone and up to 300 watts on code. His last contact with it on five meters was December 15 when he raised W5AJG. He replaced a twisted-pair-fed vertical with a delta-matched job that increased his signal at two miles from R6 to off scale on an observer's R-meter. Now he is building one of W6QLZ's dwarfed Lazy H arrays. He uses long wires for reception.

In Detroit, W8QDU is back on five. The transmitter still is a pair of HK54's with 375 watts phone and 500 on code. Fred is well aware of the desirability of vertically stacked antennas for concentrated low angle radiation, and talks of putting up a non-directional stack of three co-linear co-axial half waves. His present antenna is a half wave concentric which is ⅛ wave above some horizontal quarter wave radials. This seems to be as good as his previous three element co-linear. He notices that W8JLQ near Toledo and W8NZ in Battle Creek put in weaker signals than many more distant stations at higher elevations and with better antennas. There is no doubt about the advantage in high effective height antennas and good high locations. How about a few articles describing high towers or masts, to encourage the erection of better and higher antennas?

W8CVQ in Kalamazoo has been working W9VHG MQM and other stations across the lake with good signal strength. He is on every Monday night for schedules, as are W8RFW TBN in Grand Rapids. W8RKE LNW TCX NOH are also on occasionally. W8LMP joined the "silent keys" in January—he was very active on five and 2½. W8NZ in Battle Creek was off for several months. W8CVR in Marshall has a beautiful rotary beam but he has no transmitter on five at the moment. W8MDA in Ann Arbor has been off since November. W8SLU near Pontiac is scheduled to be back during February. W8NKJ in Detroit breaks through at CVQ when conditions are at all good.

According to W8NOH, W9LMX in Elkhart, Indiana, is putting up a four section horizontal W8JK for five meters. That vertical antenna gang in Toledo, Detroit, and various other points within a hundred miles will soon have him putting up a high vertical so he can join their dx contacts.

W8SCS in Benton Harbor, Mich., is using a pair of HK54's and a horizontal beam on a 50 foot pole. He is putting concentric lines in his converter.



South Dakota sounds like a state where five meter activity might be low. But W9BJV in Watertown says that there are many stations within a hundred miles about ready to get on: W9DB PZI AZE DRK ORE QIQ ZQC. He has 12:30 and 6:30 p.m. schedules daily with W9USI at Brookings (don't they eat anything but breakfast?). He is regularly heard by W9TI at Milbank and W9CJS at Bryant. The T40 transmitter on 56,792 now takes 250 watts input. The 4-element horizontal rotary has been replaced with a co-axial pending construction of a new horizontal beam.

The station in Davenport, Iowa, that the Illinois net has been looking for, may be W9UOB. He is considering junking his low frequency transmitter, replacing it completely with 56 Mc. equipment. W9CLH has moved the rig from the old—and high—location near Elgin, Illinois. The new spot is about eight miles north of Glen Ellyn, where a flat H array, rotary on a telephone pole, carries the burden of pushing out a signal. For a month he has been off the air, apparently because he is trying to make one speech amplifier serve on two rigs in different counties.

W9ZUL in Morton Grove has worked W9ZHB in the Illinois net. ZHB is 14 miles northwest of La Salle, Illinois.

From Kansas City, W9ZJB writes that he is going back to the hospital in May to have that zipper put in. Then he will get back on five and try out a concentric line r.f. stage on his 5-10 receiver, hoping not to lose the signal between the two units. Vince is still working on the relay net. New prospects in Kansas are W9YZX Wichita, W9PV Emporia, W9PKD Salina.

In Denver, W9WYX now uses a 76 oscillator, 807 and 809 doublers, and 100 watts into a pair of 809's in the final. He hasn't added any states to his worked list since 1938 when he used a pair of 807's in a modulated oscillator.

28 MEGACYCLES

Cross-country work on ten is continuing at this writing although for one week early in February conditions were not up to par. At noon on February 7, the National Bureau of Standards calculated that the maximum usable frequency was only 17.7 Mc., compared with 31.7 Mc. the week before.

In January, W6PMB was holding schedules with OQ5AB, and W9QDA reported the latter to be "off scale" some noons.

PA0FB says that ham radio in Holland is "pretty tough" now with all transmitters taken away. In January, he was hearing W's like next door neighbors.

As expected, G2YL's letter came a day late for the last issue. Conditions in December were fair in England, with our hemisphere heard daily except December 7 and 8. Fewer stations were heard, possibly because eastern beams are pointed west. W's were heard calling these odd ones: I1BA, HA3CK, OS5D, TO7SH, XX1A, ZZ1A.

In two weeks, W4GJO worked 25 states from his car using a Radio Transceiver Lab. set and an 8-foot vertical rod antenna on the rear bumper. The car radiates three times as well forward as it does to the rear.

Past, Present and Prophetic

[*Continued from Page 6*]

an auto receiver it is just the thing for portable or emergency operation.

Not Continued Next Month

In case you wondered what went on the end of the leads marked "output" on Stevens' v.f. exciter described last month, the answer will be found on page 37, where the rest of the exciter stages are described. No, we don't expect to have an article on the final amplifier next month.

Power Politics

Every time we run an article on a high power rig or amplifier stage we get a few complaints from the "low power" contingent. Whether said low power devotees think that we are guilty of disseminating capitalistic propaganda or what, we don't pretend to know. Anyhow we are certainly ready to stick our necks out when it comes to an affair like Adams' 1-kw. final on page 27. If you happen to be one of those with whom high blood pressure and the mention of high power are synonymous, try to visualize the amplifier with TW-75's in place of the TW-150's; the mechanical arrangement is equally applicable to lower power stages.

●

Princeton's Progress

A Princeton University junior struck a new note in education early in 1940 when he passed in a required 20,000-word treatise entirely in the form of recordings. Covering both sides of ten 12-inch discs, the "paper" is believed to have been refreshing to the belabored instructors who as a result could close their weary eyes and turn on their ears for a stretch.

●

The average rate of frequency change in the primary standard at the Bureau of Standards amounts to one part in a million per year.

THE EDITORS OF RADIO 1300 Kenwood Road, Santa Barbara
CALIFORNIA

Kindly send me the items listed below for which I enclose $
in payment.

- ☐ "Radio" (one year)
- ☐ "Radio" (two years)
- ☐ "Radio" (three years)
- ☐ "Radio" Handbook (standard edition)
- ☐ "Radio" Handbook (library edition)
- ☐ "Radio" Antenna Handbook
- ☐ "Radio" Amateur Newcomer's Handbook
- ☐ "Radio" Noise Reduction Handbook
- ☐ Radio Technical Digest (one year)
- ☐ Radio Technical Digest (two years)
- ☐ Radio Binder
- ☐ Radio Technical Digest Binder
- ☐ New W. A. Z. Map

Name .... Call ......

Address ....

....

Note: All shipments are **prepaid** by us. Current editions are always supplied unless previous or future editions are requested in the original order.

Postscripts and Announcements

[*Continued from Page 66*]

contain a "peak flattening outer and rounding offer" in the modulator or speech amplifier, so adjusted to start working at about 90 per cent modulation on negative peaks and around 150 per cent on positive peaks, and an a.m.c. arrangement to knock the gain down before the peaks were flattened sufficiently to impair the intelligibility. A low pass filter following the peak clipper or between the modulator and modulated stage as suggested in the predistortion article in the February issue would knock out the high order harmonics and the signal would be clean despite a very high average percentage of modulation, because in such a setup there would be no harmonics or transients generated in the modulated stage itself—*no matter how loud you bellowed into the mike.* All that would happen when too much gain was used would be a reduction in intelligibility.

But, as we have said before, until the F.C.C. permits such operation it all remains of academic interest.

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Kilocycle Dissolving Fluid

To lower the frequency of a crystal by as much as several kc., simply apply the necessary number of coats of sodium silicate to the crystal. Martin Winston, W2EZC-W8QGW, claims that this method is superior to the common practice of applying india ink or lead pencil graphite to the crystal.

Commonly sold as "water glass," enough sodium silicate to doctor several crystals can be obtained for a nickel. The strength of the solution is not important, though the weaker the solution the greater number of coats must be applied to lower the frequency a given number of kilocycles. The solution is applied with a small camel's hair brush and each coat is allowed to dry before another coat is applied.

The doctored crystal will be just as active and stable an oscillator as it was before the solution was applied, and no change in characteristics will be apparent with aging.

If it is desired to *raise* the frequency of a doctored crystal, simply wash off enough silicate to produce the desired frequency. If several coats of silicate have been applied, several washings will be required to restore the frequency to its original value.

Naturally there is a limit to the business, and a point is reached after several coats have been applied where the application of additional silicate has no effect upon the frequency. There is no point in applying additional silicate after this point is reached, as the only effect will be to reduce the output slightly.

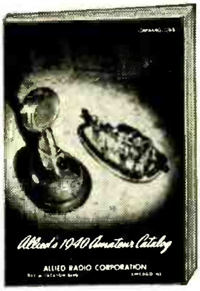
When applying a coat of the silicate, be careful not to wash off the silicate present from previous applications.

New Books AND TRADE LITERATURE

G.E. TRANSMITTING TUBE LIST

General Electric has made available to interested persons a four-page pamphlet listing the G.E. transmitting tubes, a condensed set of characteristics, and the prices of the various tubes. Both ICAS and CCS ratings have been given for the tubes for which these ratings have been formulated. This pamphlet is available on request to News Bureau, General Electric Co., Schenectady, New York. Please ask for pamphlet number GEA-3315 to clarify your request.

NEW ALLIED AMATEUR CATALOG



The Allied Radio Corporation, Chicago, has just released a new catalog directed especially to the amateur. Its 36 pages contain complete listings of items in every major equipment line. In addition there is a large selection of the small "gadgets" required in every rig. This catalog, because it is exclusively amateur, does not contain the general run of miscellaneous parts which are listed in other books of this type. It has been designed to be a directory of every worthwhile piece of gear available today and has only those items which are exclusively amateur.

This catalog is available from Allied Radio Corporation, 833 West Jackson Blvd., Chicago, Illinois.

SUPREME PUBLICATIONS SERVICE

The circuit diagram for any radio set made can be obtained at 25c per copy. This service is offered by Supreme Publications, 3727 W. 13th Street, Chicago, to radio servicemen, experimenters and set owners. Diagrams of 99% of all radio receivers, models 1919 to date, are in stock. Four-hour service promised. The name of the manufacturer and the exact model number must be given in ordering.

1940 MASTER CATALOG

United Catalog Publishers, Inc., announces the publication of its 1940 edition of Radio's Master Encyclopedia. Since its inception this master catalog has grown in size and value each year until now it is well over 800 pages. Between the hard bound covers are illustrations, prices and specifications of almost every radio part,

equipment or accessory. This up-to-date master catalog is regarded as the bible of the industry and is a "must" book for anyone connected with the radio field.

The Radio's Master Encyclopedia is published with the cooperation and approval of all the leading manufacturers and brings to you the products of the entire radio industry.

BRASS POUNDER'S BOOKLET

The Signal Electric Mfg. Co., Menominee, Mich., has just published a new catalog folder listing their line of telegraph instruments such as keys, buzzers, relays, etc. The folder is available on request.

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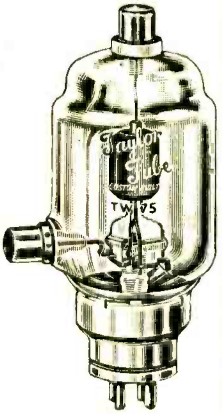
What's New In Radio

[*Continued from Page 68*]

The link is mounted directly on the base into which the coils are plugged, and is fitted with a shaft for panel control from either side. Coils are changed by merely rotating the link completely in the open position and inserting the proper inductance in the jack bar. Coils in this series are rated at a maximum of 500 watts input to the stage in which they are to be used.

TAYLOR TW-75



Another thin walled carbon anode tube has been released by Taylor Tubes, Inc. Designated as the TW-75, the tube features a processed carbon anode which is visible at operating temperatures, completely shielded grid, hard glass envelope, and low interelectrode capacities.

The 7.5 volt filament draws 4.15 amps, and the tube has an amplification factor of 20. A maximum of 2000 volts may be applied to the plate, and the maximum rated plate current is 175 ma. The tube is easy to excite, and gives good efficiency even at the ultra high frequencies. The maximum rated plate dissipation is 75 watts.

NEW RCA COMMUNICATION RECEIVER

A new medium-priced radio receiver designed to provide maximum performance for amateur radio communication, as well as for general use wherever a radio receiver is required for distance reception, has been announced by the RCA Manufacturing Company.

Designated as "General Purpose Communication Receiver Model AR-77", the new instrument is complete with built-in power supply, variable selectivity crystal filter and tubes. An eight-inch permanent magnet dynamic loudspeaker giving an unusually high degree of sensitivity and faithfulness of reproduction, and housed in a metal cabinet to harmonize with the receiver, is recommended for use with the AR-77.

The AR-77 has three outstanding new features: polystyrene insulation, which contributes to improved reception by keeping circuit losses at a minimum; "stay put" tuning, which insures against bothersome frequency drift due to temperature; and negative feedback (applied at will by a special switch) which provides better audio fidelity by smoothing out and extending the audio response.

Another important feature is a new calibration of the two illuminated tuning dials, so the operator can tell at a glance to what part of the radio spectrum the receiver is tuned. Only the calibration of the range in use is visible. Apertures in the slide shutters installed in the dial openings move up or down with the setting of the range switch.

In addition, the bandspread calibrations have been extended to nearly the full rotation of the dial for the 10, 20, 40 and 80 meter bands, making "split-kilocycle" readings possible.

Selectivity is variable in six steps employing an efficient i.f. crystal filter circuit. The average sensitivity throughout the tuning range is about two microvolts for 2-to-1 signal-to-noise ratio. An optimum balance between maximum sensitivity and minimum circuit noise has been chosen to render the greatest possible usable sensitivity for weak signals.

An improved "noise limiter" circuit has been devised for making signals intelligible through local auto ignition and certain other types of electrical interference. The limiter has a variable adjustment, making it possible to attain a setting to gain maximum reduction of interference.

The tuning controls are designed to permit long periods of operation without muscular, optical or nervous fatigue. The most frequently used controls have been placed within easy reach along the lower edge of the panel, with the standby and audio volume controls placed at the ends.

RADICALLY NEW TUBES

Eitel-McCullough have just released dual and quadruple versions of their popular 75T. Consisting essentially of two 75T's in a single envelope, the 152TL has twice the transconductance, dissipation, and plate current rating of a single 75T. Better performance is obtained at very high frequencies than with a pair of paralleled 75T's because of the virtual elimination of plate jumpering leads and the reduction in the length of the grid jumper to a fraction of what it would be with two paralleled 75T's.

The 304TL consists of a battery of four units in one envelope, thus making it the equivalent of two 152TL's or four 75T's. The dissipation and

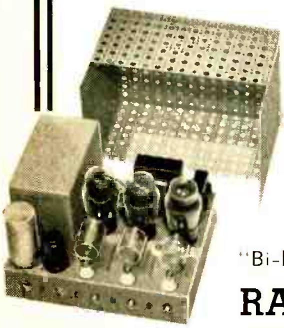


plate current handling ability are increased correspondingly.

The advantages of these new multiple-unit tubes are small physical size, high power output at low plate voltage, low driving requirements, and high efficiency at low plate voltage.

The tubes are designed for operation either from 5-volt or 10-volt filament supply.

PRECISION FREQUENCY MONITOR

The Browning Laboratories, Winchester, Mass., has recently announced a custom-built laboratory calibrated frequency monitor for checking any three bands of frequencies from 1.5 to 60 Mc. A 100 kc. crystal is used as a secondary standard. This may be readily checked against WWV. Very stable e.c. oscillators are used to cover a band of frequencies from 50 to 100 kc. wide. The transmitter frequencies which it is desired to check are included in this narrow band. The circuit is so arranged that the electron-coupled oscillators can be accurately checked at numerous points by means of the 100 kc. crystal. Transmitter frequencies checked by the zero beat method which is indicated visually on a cathode ray tube and aurally by means of phones plugged into a jack provided. The accuracy of this frequency monitor is better than 1/100 of 1%.

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In discussing radio noise from automobiles, diathermy, etc., the F. C. C. says "The states of Maine and Washington, and the Territory of Hawaii, have had statutes on the interference problem for years, two of them since 1921."

California Hamfest

The San Joaquin Valley Radio Club will hold its 4th annual Hamfest on April 20, 1940, in the Fresno New Memorial Auditorium. Elaborate plans are being made to entertain some five hundred amateurs and their friends. Already preparations for large caravans from the northern and southern parts of the Pacific Coast are being promoted; and the hearty support of the other California Clubs has been pledged. Hamfest was attended by 476 Hams, XYLS, and YLs. There is every indication that the 1940 Hamfest will be the largest event of its kind ever held on the Pacific Coast. A $1.50 registration fee will cover the entire program cost. Those desiring further information should correspond with Erwin S. Martin, W6HYR.

●

Radioddities

Crystals are ground with crystals. Carborundum is a crystalline compound. Beautiful iridescent crystals of the substance were used in the early days of radio for detectors.

The F. C. C. has set the minimum construction cost of a one-hundred-watt broadcast station between 5,000 and 8,500 dollars.

It is claimed that the electronic microscope will magnify objects a million times.

Advertising Index

The Marketplace

Classified Advertising

(a) Commercial rate 10c per word, cash with order; minimum, $1.00. Capitals: 13c per word. For consecutive advertising, 15% discount for 3d, 4th, and 5th insertions; 25% thereafter. Break in continuity restores full rate. Copy may be changed as often as desired.

(b) Non-commercial rate: 5c per word, cash with order; minimum, 50c. Available only to licensed amateurs not trading for profit; our judgment as to character of advertisement must be accepted as final.

(c) Closing date (for classified forms only): 25th of month; e.g., forms for March issue, published in February, close January 25th.

(d) No display permitted except capitals.

(e) Used, reclaimed, defective, surplus, and like material must be so described.

(f) Ads not relating to radio or radiomen are acceptable but will be grouped separately.

(g) No commissions nor further discounts allowed. No proofs, free copies, nor reprints sent.

(h) Send all Marketplace ads direct to Santa Barbara accompanied by remittance in full payable to the order of Radio, Ltd.

TRANSMITTING TUBES REPAIRED—Save 60%. Guaranteed work. KNORR LABORATORIES. 5344 Mission St., San Francisco. Calif.

QSL's—Samples. Brownie, W3CJI, 523 North Tenth Street, Allentown, Pennsylvania.

CRYSTALS—Police, marine, aircraft, amateur. Catalog on request. C-W Mfg. Co., 1170 Esperanza, Los Angeles. Calif.

AC Generators and plants. Have some good buys in used machines. Ideal for emergency. Katolight. Inc., Mankato, Minn.

RACKS. Cabinets. Panels. Chassis. Priced right. R. H. Lynch. 970 Camulos, Los Angeles, Calif.

METERS, microphones. pickups, repaired—W9GIN, 2812 Indiana, Kansas City, Missouri.

RECONDITIONED guaranteed receivers and transmitters all shipped on ten day trial. Practically all models cheap. For example: Crystal Super Pros $129.00; HQ-120Xs $99.00; RME—70s $89.00: RME-69s $89.00; SX-17s $89.00: PR-15s $69.00; S-16s $64.00; NC80Xs $59.00; SX-10 Ultra-Skyriders $44.00; SX-12 Skyrider Commercial $44.00; S-18s $39.00; S-15s $34.00; Howard 438s $34.00; NC-44s $34.00; Sky Champions $29.00; FB7XAs $19.00; Sky Buddies $15.00; FB7s $9.00; SW3s $6.00. Terms. Write for free list. W9ARA, Butler, Missouri.

PRECISION TRANSFORMERS: Superior quality at lower prices. Full line—All types. Send for list. Custom winding and rebuilding. PRECISION TRANSFORMER COMPANY, Muskegon. Mich.

QSL's—That lead all others! Fritz—455 Mason—Joliet, Ill.

CUSTOM ground 40M Xcut crystals in ceramic holders $2.50. 160 or 80M crystal $1.00. KORADIO, Mendota, Illinois.

SELLING OUT used and new receiver parts, new tubular condensers 2½c up. send for list; will trade for shop equipment. 1130 Truro Inglewood, California.

110 VOLT. DC 400 Watt. Gas-Driven Delco Generator with Briggs-Stratton 1 or 2 H.P. Motors. With Automatic Starter. $60.00. Manual, $50.00. Brand new, factory guaranteed. W8RSK.

WANTED: 450's, 654's, 833's, or larger; or equivalent tubes. State age; hours; etc. Remember times are hard. and money is scarce. Tubes subject to inspection. S. T. Carter. Box 343, Charlotte, N. C.

WANTED: used ham receivers and gear. Northwest Used Radio Supply Co. 8547—18 N. W., Seattle, Washington.

QSL's—HIGHEST QUALITY—LOWEST PRICES. RADIO HEADQUARTERS, FT. WAYNE, INDIANA.

U. T. C. SX-80. Ready to operate on 40 Meters. Never used. Best offer accepted. W2KZA, 2313 Creston Avenue, New York City.

CUSTOM Built RME 69 with DB 20 Preselector. 0A1 Oscilloscope amplifier, LS 1 Noise Silencer. 3 inch RCA oscilloscope, additional push pull 6L6 audio with variable impedance output for 4 speakers or recording head. All built into beautiful 5 foot enclosed rack, aluminum panels, gray crackle finish. Plenty of room for transmitter to be built in same rack. Scope gives modulated envelope or trapezoid pattern. Cost over $400. Must sell and will sacrifice for $250. f.o.b. Redlands, Calif.—W6CV.

FOR SALE: SX-17 with tubes and crystal but without speaker. Absolutely in perfect shape. like new. Going to sea and must sell this receiver for best cash offer. Address inquiries to BOX NO. 5. c/o "RADIO", Santa Barbara, Calif.

ALL Star Sr 20-40-80 mtr. coils-spk. $17.50. W6JUC. Apt. 4, 3426 W. Pico, Los Angeles, Calif.

PR10 with Preselector, Speaker, Headphones $20. Xmitter $12. W6LOG.

WANTED—National HRO Broadcast Coils Reasonable. W6QNW, Tarzana, Calif.

SELL or TRADE RME9D receiver complete. Excellent condition. Best reasonable offer. Details. Phil Hendricks, 209 South Euclid, St. Louis, W9YFE.

MUST Sell my new Thordarson, 100-watt, multi-band transmitter. Deluxe cabinet, coils for 160, 20, 10. antenna tuner, used three months. $80, f.o.b. Berkeley. W6PEV.

SACRIFICE: Skyrider S9 Receiver; three band 200 watt transmitter, 35T final heavy duty 2000 volt supply, $80 complete. W6EHP, 651 Woodruff Ave., Bellflower, Calif.

Buyer's Guide

Where to Buy It

PARTS REQUIRED FOR BUILDING EQUIPMENT SHOWN IN THIS ISSUE

The parts listed are the components of the models built by the author or by "Radio's" Laboratory staff. Other parts of equal merit and equivalent electrical characteristics usually may be substituted without materially affecting the performance of the unit.

NORTON FREQUENCY MODULATED TRANSMITTER

Page 11

EXCITER CHASSIS

C_1—Cardwell ZU-75-AS
C_2—Cardwell ZR-35-AS
C_3—Cardwell ZR-25-AS
C_4—Cardwell MT-20-GS
C_5 to C_{11}, inclusive, C_{13}, C_{15} to C_{22}, inclusive—Aerovox 1467
C_{12}, C_{24}—Aervox 484
C_{23}—Aerovox 1456
C_{26}—Aerovox MM25
C_{27}—Centralab ceramic
R_1, R_2, R_3, R_4, R_5—IRC BW-1
R_6, R_{19}, R_{20}, R_{21}, R_{23}—IRC BT-½
R_7, R_8, R_9, R_{12}, R_{18}—IRC BT-1
R_{10}, R_{13}—IRC BT-2
R_{11}, R_{14}, R_{15}, R_{16}, R_{17}—Ohmite Brown Devil
R_{22}—Mallory-Yaxley O
S_1—Mallory-Yaxley 151L
T_1—Thordarson T-19F99
T_2—Thordarson T-62A26
RFC—Bud 920
Octal steatite sockets—Meissner 25-8439
HK-24 socket—Bud 954
Pillar insulators—Meissner 27-1013
Tubes—RCA and Heintz and Kaufman

OUTPUT STAGE CHASSIS

C—Cardwell ER-50-AD
R—Ohmite Brown Devil
Tubes—Heintz and Kaufman

●

DAWLEY BATTERY POWERED CONVERTER

Page 23

C_1—Cardwell ZR-50-AS
C_2—Cardwell ZR-35-AS
C_3—Cardwell ZU-100-AS
C_4, C_6—Cornell-Dubilier 5W-5T1
C_5, C_7—Cornell-Dubilier DT-6S1
C_8—Bud 833 trimmer
R_1, R_2, R_3—IRC BT-½
L_1—Meissner 16-8100
L_2—Meissner 17-8175
S_1, S_2—Arrow H&H s.p.s.t.
A battery—Burgess 2F
B battery—Burgess A30
Coil forms—Bud 595 and 596
Dial—Crowe 123M
Tubes—RCA miniature
Chassis—Bud CB-41
Cabinet—Bud C-973

●

ADAMS TW-150 AMPLIFIER

Page 27

C_1—Bud type JC-1576
C_2—Bud type GC-1818
C_3, C_4—Solar type XM-6-24
L_1—Bud ALV-1 Auto Link Control
L_2—Bud VCL-10 with AM-1356 base
L_3—Bud MCL-10 with AM-1354 base
RFC—Bud CH-568
Sockets—Bud S-226

●

TURNEY 15-WATT AMPLIFIER

Page 29

Carbon resistors—I.R.C. type BT
R_{10}, R_{11}—Ohmite Brown Devil
C_1, C_4, C_6—Cornell-Dubilier type BR
C_2, C_3, C_5—Cornell-Dubilier type DT
C_7—Cornell-Dubilier type KR
T_1, T_3—Kenyon type T-58
T_2—Cathode modulation, Kenyon T-472; plate modulation, T-489; p.a. service, T-302
T_4—Kenyon T-206
CH_1—Kenyon T-152
CH_2—Kenyon T-153
Jack and pilot—Mallory-Yaxley
Punched chassis—Par-Metal B-4526-K
Cabinet—Par-Metal SF-504

●

STEPHENS' EXCITER

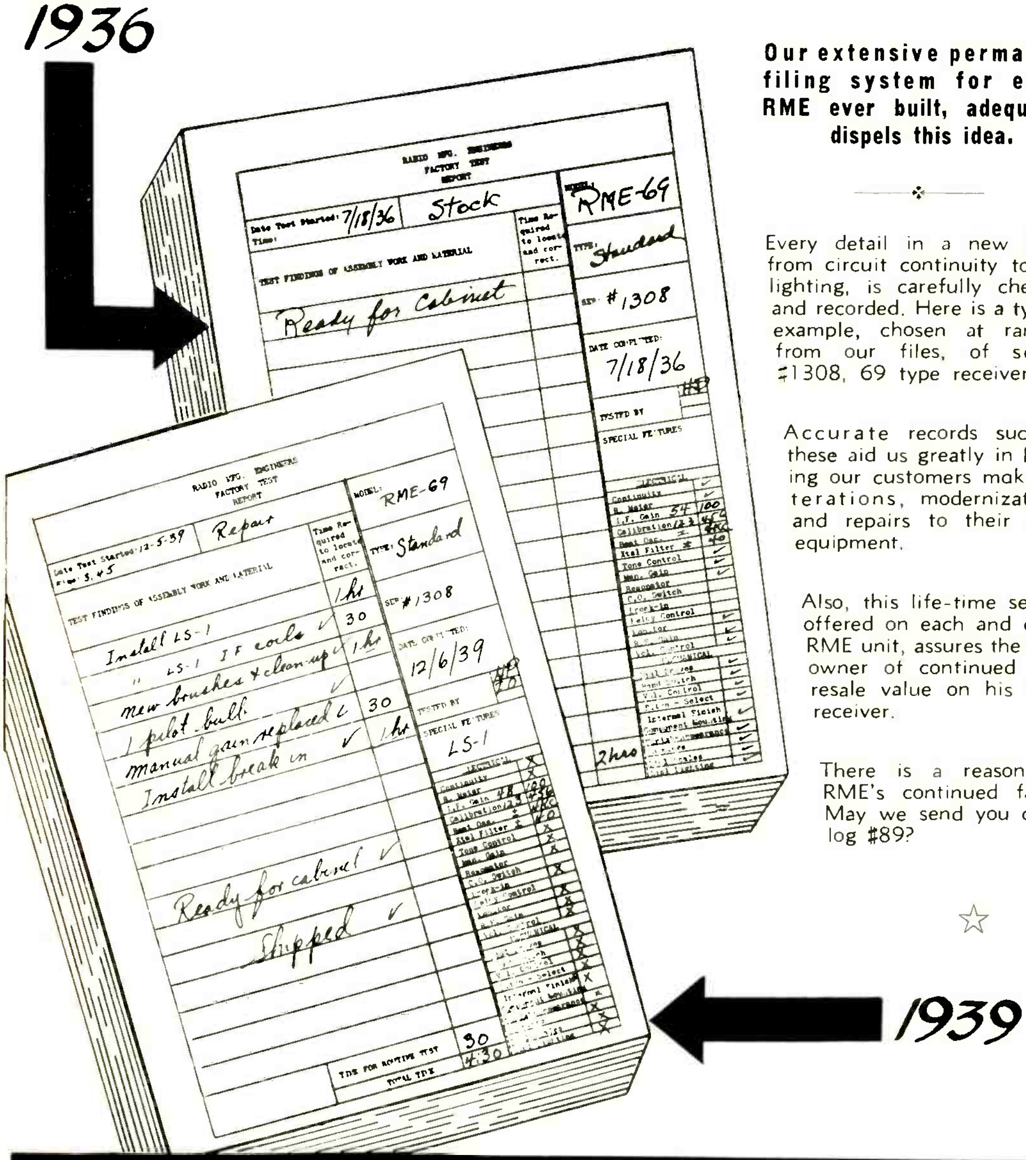
Page 37

C_2—Cardwell ZU-100-AS
C_5—Cardwell MT-100-GD
C_6, C_7, C_8, C_9, C_{11}, C_{16}, C_{17}, C_{18}, C_{19}, C_{22}, C_{23}, C_{24}—Aerovox 684
C_{10}, C_{12}—RCA Faradon "F"
C_{13}, C_{14}, C_{15}, C_{21}—Aerovox 1467
C_N—Cardwell ZT-15-AS
R_1, R_4, R_5, R_7—IRC AB
R_2—IRC BT-1
R_3, R_6—IRC BT-2
S_1, S_2—Centralab 2505
S_3—Centralab 2501
S_4—Centralab 2545
J_1, J_2—Mallory-Yaxley A-2
PB_1, PB_2, etc.—Mallory-Yaxley 2188
6A6, 807—RCA
T-55—Taylor

HUGHES PRINTING CO.
EAST STROUDSBURG, PA.

THE PERFORMANCE RECORD OF AN RME.....

THE OWNER OF AN RME MAY REST ASSURED THAT HE IS NOT THE OWNER OF A "FORGOTTEN CHILD"



RADIO MFG. ENGINEERS
FACTORY TEST
REPORT

Date Test Started: 7/18/36 Stock
Time:
MODEL: RME-69
TYPE: Standard
SER. #1308
DATE COMPLETED: 7/18/36
TESTED BY
SPECIAL FEATURES
TEST FINDINGS OF ASSEMBLY WORK AND MATERIAL
Time Required to locate and correct.
Ready for Cabinet
2hrs
ELECTRICAL
Continuity
R. Meter 54 100
I.F. Gain
Calibration
Beat Osc.
Xtal Filter
Tone Control
Man. Gain
Resonator
C.O. Switch
Selectivity Control
R.F. Gain
Vol. Control
MECHANICAL
Band Switch
Internal Finish
Dial Lighting

RADIO MFG. ENGINEERS
FACTORY TEST
REPORT

Date Test Started: 12-5-39 Repair
Time: 3.45
MODEL: RME-69
TYPE: Standard
SER. #1308
DATE COMPLETED: 12/6/39
TESTED BY
SPECIAL FEATURES LS-1
TEST FINDINGS OF ASSEMBLY WORK AND MATERIAL
Time Required to locate and correct.
Install LS-1 ✓ 1 hr
" LS-1 IF coils ✓ 30
new brushes & clean-up ✓ 1 hr
1 pilot bulb ✓
manual gain replaced ✓ 30
Install break in ✓ 1 hr
Ready for cabinet ✓
Shipped ✓
TIME FOR ROUTINE TEST 30
TOTAL TIME 4.30
ELECTRICAL
Continuity
R. Meter 48 100
I.F. Gain
Calibration
Beat Osc.
Xtal Filter
Tone Control
Man. Gain
Resonator
C.O. Switch
Selectivity Control
Vol. Control
MECHANICAL
Internal Finish

Our extensive permanent filing system for every RME ever built, adequately dispels this idea.

Every detail in a new RME, from circuit continuity to dial lighting, is carefully checked and recorded. Here is a typical example, chosen at random from our files, of serial #1308, 69 type receiver.

Accurate records such as these aid us greatly in helping our customers make alterations, modernizations, and repairs to their RME equipment.

Also, this life-time service offered on each and every RME unit, assures the RME owner of continued high resale value on his RME receiver.

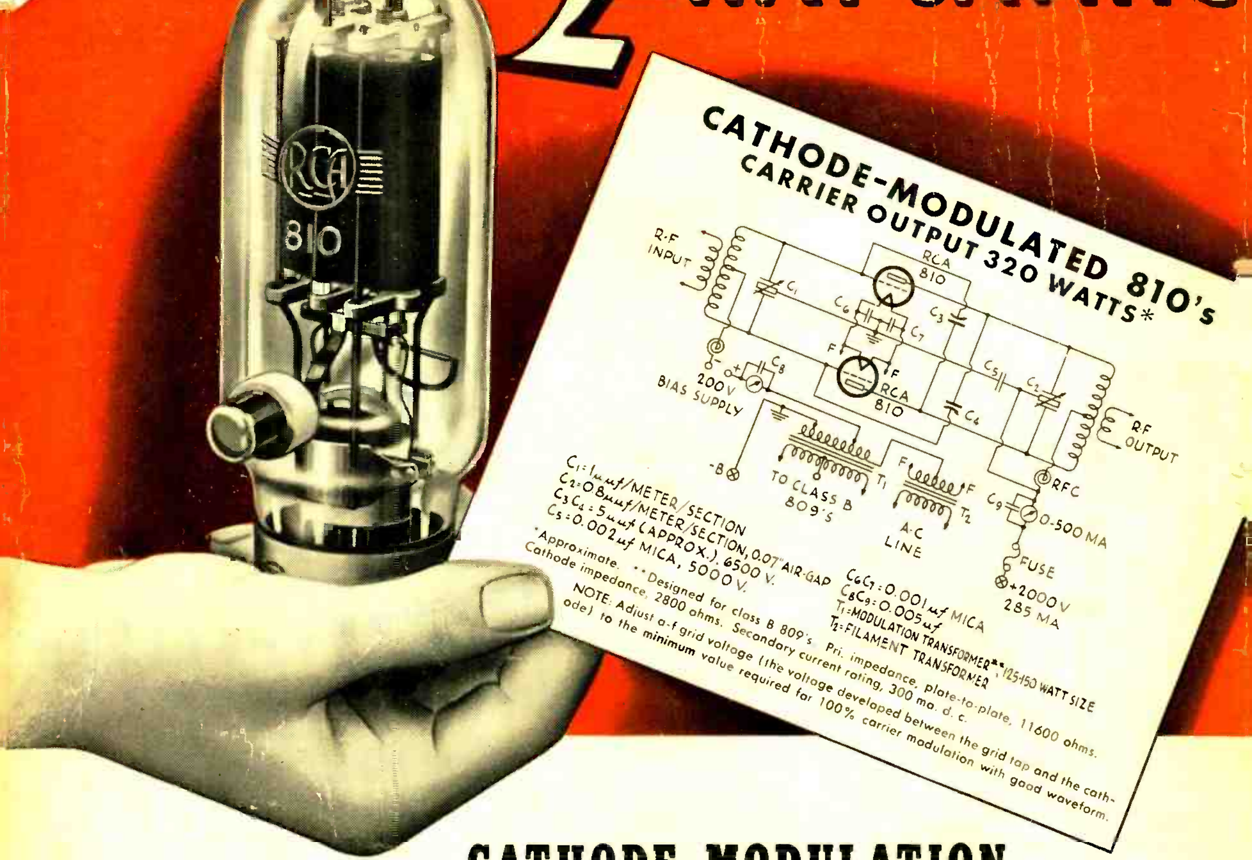
There is a reason for RME's continued favor. May we send you catalog #89?

☆

RME
TIME WILL TELL

RADIO MFG. ENGINEERS
INCORPORATED
111 HARRISON STREET
PEORIA ILLINOIS

OR A 2-WAY SAVING



CATHODE-MODULATED 810's
CARRIER OUTPUT 320 WATTS*

C1: 1μμf/METER/SECTION
C2: 0.8μμf/METER/SECTION, 0.07" AIR-GAP
C3C4: 5μμf (APPROX.), 6500 V.
C5: 0.002μf MICA, 5000 V.
C6C7: 0.001μf MICA
C8C9: 0.005μf
T1: MODULATION TRANSFORMER**, 125-150 WATT SIZE
T2: FILAMENT TRANSFORMER

*Approximate. **Designed for class B 809's. Pri. impedance, plate-to-plate, 11600 ohms. Cathode impedance, 2800 ohms. Secondary current rating, 300 ma. d. c.

NOTE: Adjust a-f grid voltage (the voltage developed between the grid tap and the cathode) to the minimum value required for 100% carrier modulation with good waveform.

CATHODE MODULATION
plus RCA HIGH-PERVEANCE TUBES

Following are ICAS (Intermittent Commercial and Amateur Service) Class C Telegraphy Ratings on several popular RCA Tubes.

RCA-806—Tantalum-plate triode
Max. plate voltage . . . . . . 3300 V.
Max. plate input . . . . 1000 W.
$22.00 Amateur Net

RCA-809—High-mu triode
Max. plate voltage . . . . . . 1000 V.
Max. plate input . . . . 100 W.
$2.50 Amateur Net

RCA-810—High-mu triode
Max. plate voltage . . . . . . 2250 V.
Max. plate input . . . . 620 W.
$13.50 Amateur Net

RCA-811—High-mu triode
RCA-812—Medium-mu triode
Max. plate voltage . . . . . . 1500 V.
Max. plate input . . . . 225 W.
$3.50 each, Amateur Net

When you start out with Cathode Modulation for economical radiotelephony, go all the way! Get double economy plus extra efficiency by using RCA high-perveance transmitting tubes. RCA Tubes last longer. They give you greater power output with less driving power for a given plate voltage. You can get not only 100% modulation, but also relatively high plate-circuit efficiency and high carrier output with the push-pull 810's shown in the circuit above.

The high-perveance of the 810's permits you to obtain optimum results with a low-power, inexpensive modulator such as the class B 809's shown in this circuit. And remember! A cw transmitter using RCA-810's can be changed over to 'phone cheaply and easily. Grid drive requirements are no greater, and a large, high-power modulation transformer is unnecessary.

In short, RCA's are not only economical in themselves but they pave the way for economies throughout your rig—and assure you of ample power to put your signals "where you want them when you want them!"

See RCA HAM TIPS (Jan.-Feb., 1940) for further data on Cathode Modulation. Ask your jobber for a copy—free.

RCA *Radio Tubes*

RCA MANUFACTURING CO., INC., CAMDEN, N. J.
A Service of the Radio Corporation of America

FIRST IN METAL — FOREMOST IN GLASS — FINEST IN PERFORMANCE