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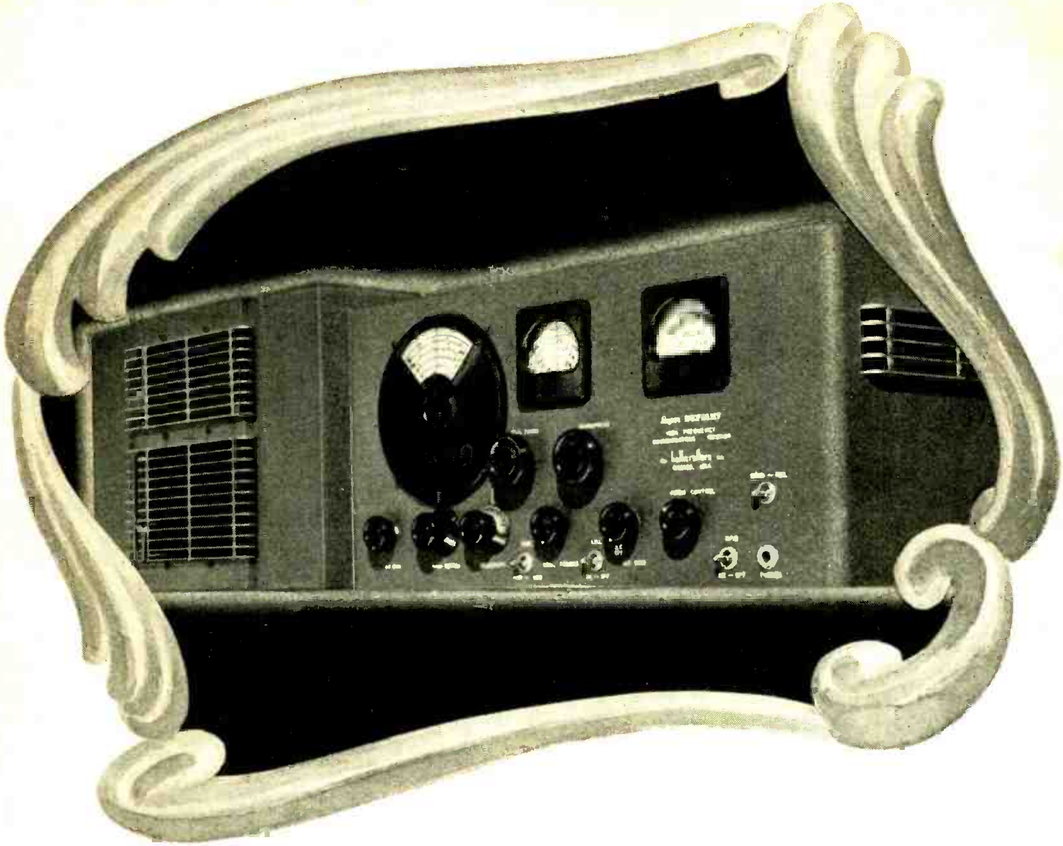

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THE EDITORS OF
RADIO technical publishers
1300 Kenwood Road, Santa Barbara
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Past • Present and • Prophetic

Obituary

As you might guess from the front cover, we have been doing a little experimenting with short concentric lines. The object of the experimentation being to find out just how short the line can be with respect to frequency and still equal the performance of a coil. The experiment was progressing nicely when our one remaining 316A "mud turtle" met its untimely end from parting of the filament. The parting was occasioned by the tube's rolling around on the bench for several days and receiving considerably more than its share of banging around. We continue undaunted by our sudden loss, however, and are preparing a sorrowful masterpiece to accompany the u.h.f. tube back to the factory telling how it just "wore out," obviously from a manufacturing defect.

The Water's Fine

We know that our readers will share our disappointment to learn that Frank C. Jones, for many years a major contributor to RADIO and member of our editorial staff, is severing his connections with Radio, Ltd. in order to devote his energies to a new publishing venture in which he is one of the owners.

Needless to say, we wish Frank well in his new enterprise, even though it puts him in the category of a competitor. As in every other line of business there is always room for one more.

Concentric Conklin

The graph which forms the background for the cover shot is from Conklin's u.h.f. tracking article starting on page 11. Conklin has been extolling the virtues of linear tank circuits for some time now, and tests in the laboratory show that, as usual, he knows what he is talking about. More extensive tests are getting under way and the lab will soon be turning out constructional article material utilizing shortened concentric tanks.

When it became necessary to construct a short concentric line to test the possibilities of covering several bands with a single tank circuit, the lab being fresh out of such items at the moment, a member of the staff was armed with plenty of folding money (the belief being that such material was expensive) and sent on a foray of the Los Angeles metal-supply houses. This emissary returned with all the materials for a 3-inch diameter 16-gauge copper tank 12 inches long and a sales slip attesting that he had squandered the staggering sum of $1.86. This is the same price anyone would pay as there was no discount and the material was bought at the highest rate possible, since it was cut from a longer length. A little pencil work will show that this price is a little higher than the cost of two low-loss coil forms and, if experiments prove that three bands can be covered effectively with a single tank of this length, the cost is practically the same as that of three coil forms, and the convenience is considerably greater.

Scrimshaw

We don't know what our Newcomer's department would do without the untiring Broderson, W6CLV. When it gets to that time of month when we begin to think about what the newcomer might like for the next issue an article from Broderson always manages to show up in the nick of time. This month it happens to be a multi-tester, a scrimshaw (we found that one in the dictionary the other day while looking for another word and have been looking for a place to use it ever since) which every newcomer should have—plenty of old-timers would do well to build one, too.

Like A Tent

Thanks to Technical Editor Dawley with his "Parallel Cathode Modulation," beginning on page 40, RADIO has now covered three phases of the cathode-modulation subject. Just for the record, the first modern article on the subject appeared in the October issue, and the succeeding articles in the December and January issues. Those, with this February article, cover three types of cathode modulation and the general operating data applicable to the three methods.

Hint

When it comes to dropping hints as to what you may expect in forthcoming issues of RADIO this department is forced to be hazy on details, since we do not relish having any of our pet ideas appear somewhere else before we get them whipped into shape. However, it is doubtful if the dope given here will enable anyone to build a receiver similar to our noise-free set which has been in the

[*Continued on Page 91*]

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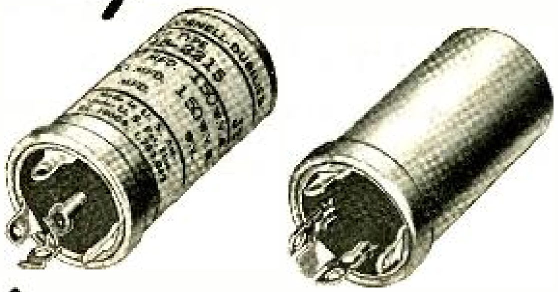

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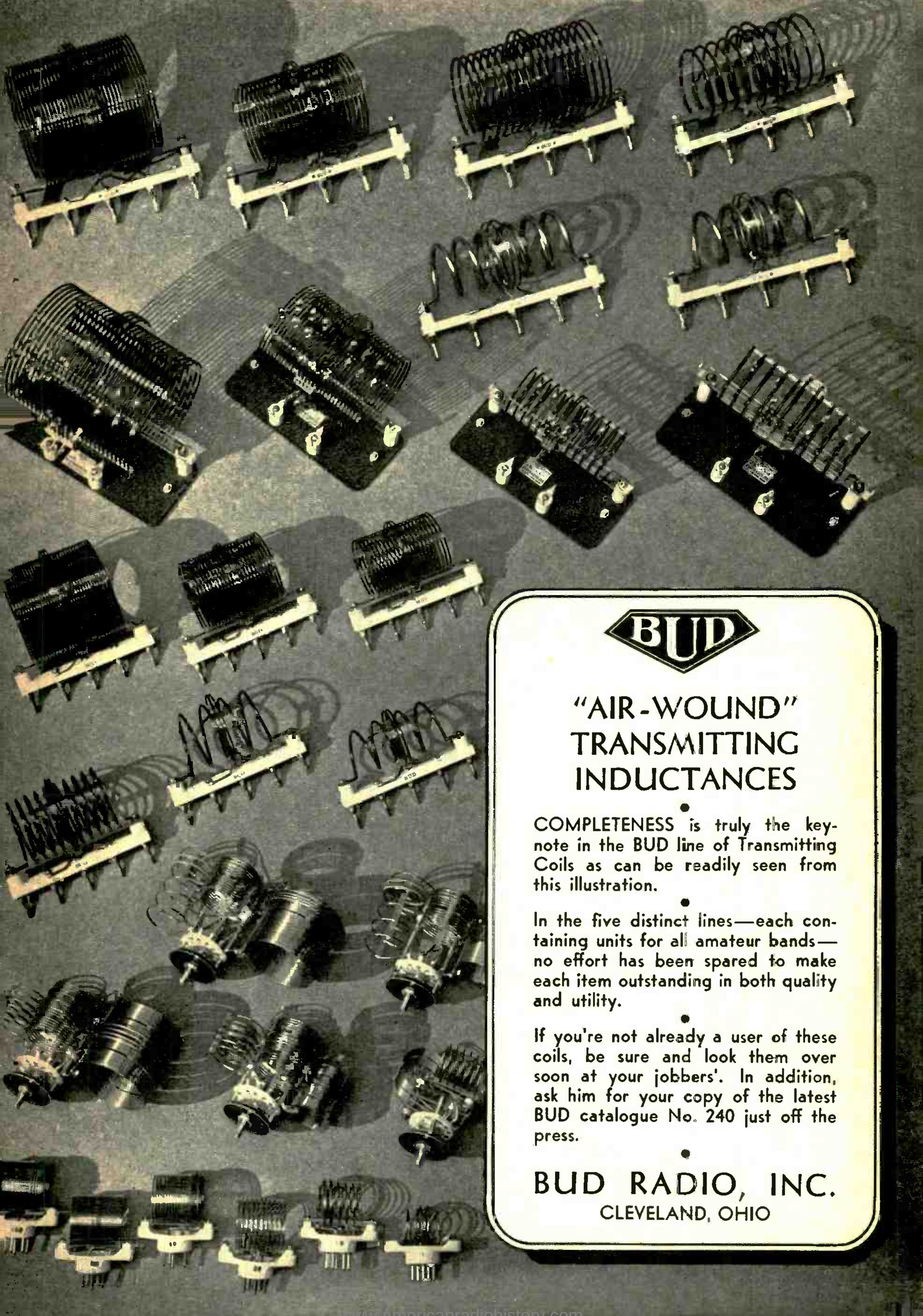

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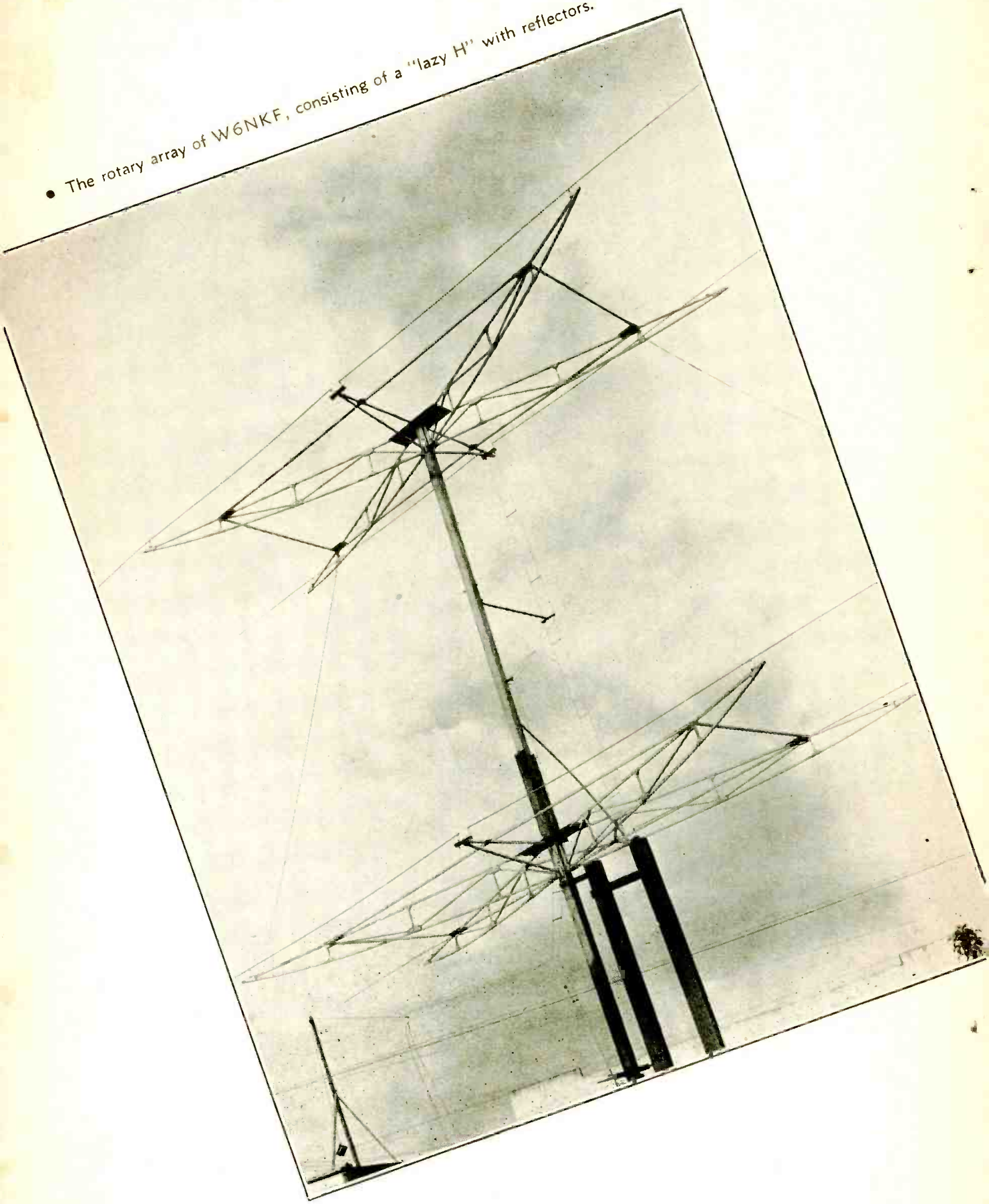

SUPERHET TRACKING

at Ultra-High Frequencies

By E. H. CONKLIN,* W9BNX

A very useful article on the application of electrically lengthened concentric line circuits to ultra-high frequency receiver and transmitter design.

One of the greatest pleasures in amateur radio is derived from a satisfaction of the desire for something better—not necessarily for more power than the fellow in the next block or the W6 on your pet crystal frequency, but for something better than the apparatus you were so satisfied with a few years ago. Yet it often takes a long time for most of us to digest a "new" idea and incorporate it in our equipment. The superheterodyne circuit, for instance, had been known for years before any substantial part of us abandoned regenerative detectors.

There is room for improvement on the ultra-high frequencies, a fact that has attracted many hams who get more fun out of solving a problem than out of repetitious contacts over the air. The ultra-highs have both advantages and disadvantages compared with lower frequencies for pushing a signal out 100 or 200 miles; an advantage is the ease of constructing high gain beam antennas capable of helping to push a signal several hundred miles with reasonable regularity while a disadvantage is the loss of stage gain in amplifier circuits due to the unsatisfactorily low impedances developed by the usual coil and condenser circuits. This loss of stage gain makes it more difficult to bring a weak signal through above the noise level generated in the first stage unless an efficient antenna and transmission line deliver a good signal to the receiver.

More Receiver Gain?

Many of our correspondents say that they could not use more receiver gain because of a high noise level at their location; often these statements come from fellows who have a lot of gain *after* the first stage in their receivers, thus amplifying the set noise created by the first stage. Something can be done about this. If the first stage gain is improved substantially, the signal and outside noise will predominate over set noise (which then needs less amplification *after* the first stage) in the receiver output, and a noise silencer will then become effective. The silencer would have been of no great value when sharp outside noise peaks are of a strength comparable with the more even set hiss.

In addition to improving the antenna and transmission line, what else can be done to increase the signal-to-set-noise ratio? This question can be answered by examining the receiver's r.f. stage. First, the signal should be coupled into the grid circuit with as much step-up as possible. Second, the grid circuit itself should be designed for reasonably high impedance. Third, the tube should be one that has a high input impedance so that it will not ruin the good tuned circuit called for above. Fourth, the tube should have a high transconductance if this can be obtained in conjunction with the third requirement. Fifth, the output tuned circuit should have a high impedance in which may be built up a signal voltage that is sufficient to operate the relatively inefficient mixer tube well above the noise in this circuit.

The first requirement calls for matching the transmission line as carefully in the receiver as in the transmitter, with none of this coupling-condenser-to-grid business used in the past. The second and fifth can be met by throwing out coils and substituting short lengths of transmission lines, especially con-

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* Associate Editor, RADIO, Wheaton, Illinois.

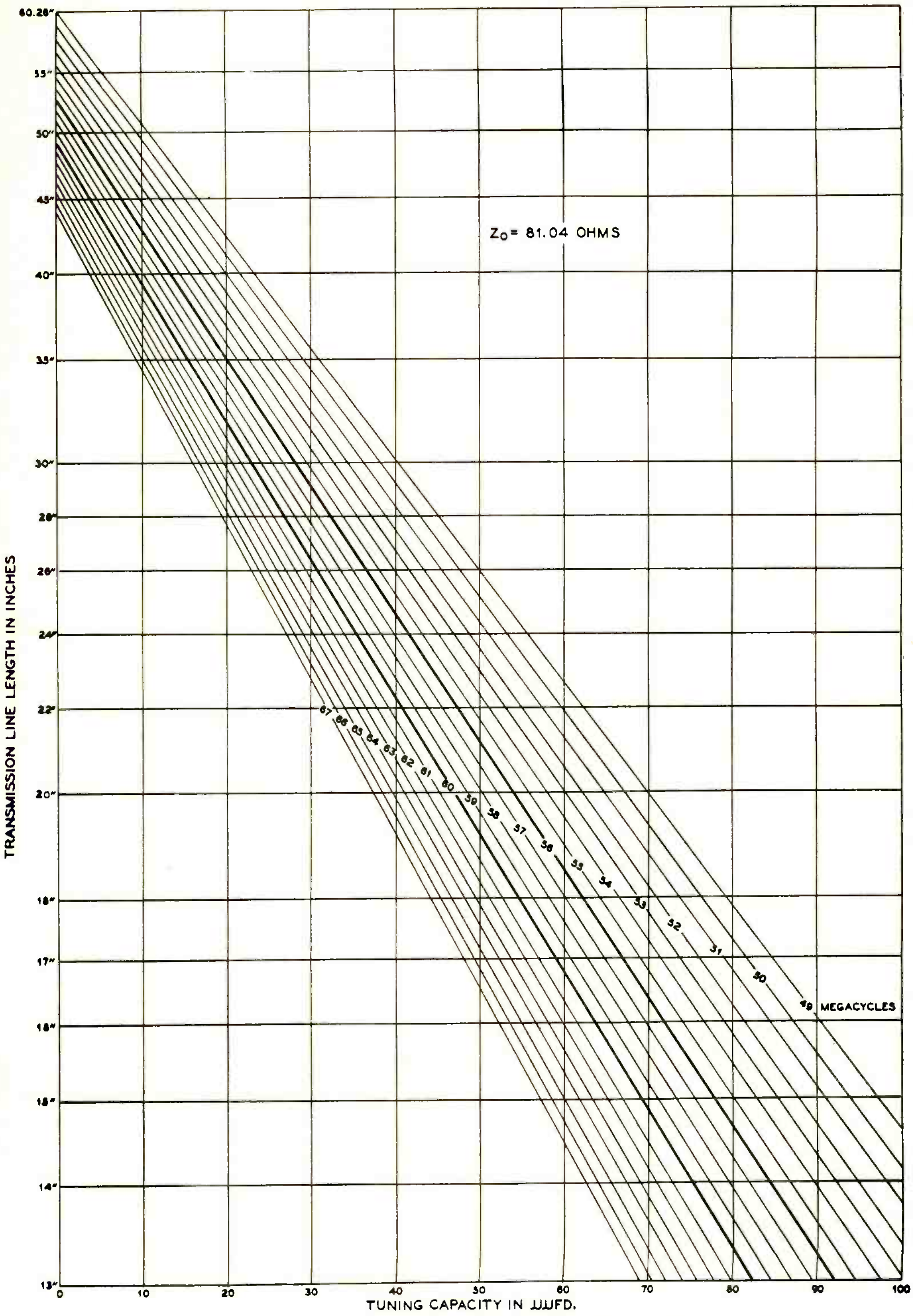

Figure 1. Chart showing capacity necessary to resonate shortened lines of 81.04 ohm surge impedance. See text for method of converting this chart to other frequencies and surge impedances.

centric lines, a policy which is becoming widespread in commercial and laboratory practice. The third and fourth will be satisfied by the use of acorn tubes which are now widely reported to be giving satisfactory life when operated within their ratings.

Of all of these, only the use of concentric lines as tuned circuits represents any substantial departure from practices that are familiar to most amateurs. It is hard for some to understand that better tuned circuits can be built with a hack saw or tin shears than with some wire and a coil form. Many favorable comments have been made by satisfied experimenters who have taken the plunge into plumbing circuits, while the author has yet to hear from anyone who has tried concentric lines and has returned to coils.

Various phases of the design and application of transmission lines to ultra-high frequency equipment have been treated in past issues of RADIO, particularly those for January, 1938; January, April, May and June, 1939. Neither those articles nor the present one should prove too technical for anyone who did not fail in his grammar-school arithmetic. So, on with the dance!

Short Concentric Lines

Single-ended circuits are best made (so far as we know today) from sections of concentric lines. These may develop a Q of several thousand whereas a coil and condenser will be doing well if they measure up at a couple of hundred.

It is not necessary to use pipes a yard long, or even 28½ inches as pictured in RADIO for June, for two reasons. First, a reasonably good circuit results from the use of a line considerably less than a quarter wavelength long (the Civil Aeronautics Authority Radio Section was well satisfied with a 60-142 Mc. receiver using lines two inches in diameter and only 8⅜ inches long). Second, a higher Q results from the use of a line half as long and twice as fat. Therefore, it is quite practical to build short lines into the bottom of a receiver chassis, using either round or square outer conductors, the latter bent up from sheet metal and bolted to the chassis. In fact, satisfactory tuned circuits for 2½ and 1¼ meters will probably result from the use of a coil can or tube shield as an outer conductor. Someone will probably try a tennis ball can!

Before we leave the subject of Q, let us clear up a point that is easily overlooked. Q provides selectivity. The sending-end impedance (Z_s) of the tuned circuit produces the gain. Optimum design for Q and Z_s are *not* necessarily the same. A ratio of outer conductor inner diameter to inner conductor outer diameter of about 3.6 gives the best Q and is preferred for oscillator stability or for transmission line efficiency, but a much higher ratio (smaller inner conductor) will produce a higher Z_s. When a shortened line loaded with a variable condenser is used, it appears possible that an even higher ratio will be preferred in an r.f. stage in order to sacrifice less impedance (Z_s). The short, higher ratio line can be tuned to resonance with a smaller condenser than can another short line with a lower ratio of conductor sizes.

Another comment worth inserting at this point is that the damaging effect of placing the input (grid) circuit of a tube across the open end of the line will be less in the case of a short than a long line, because effectively the tube is tapped down on the line.

The use of these pipes is not confined to superheterodynes nor, for that matter, to receivers. A plain regenerative or a superregenerative receiver is improved just as much by the substitution of lines for the coils.

Tuning Charts

In order to assist users of transmission lines of any type to find what capacity is necessary to resonate them at various frequencies near amateur bands, figures 1 and 2 have been prepared. These show "curves" for several frequencies.

Figure 1 is for a characteristic impedance of 81.04 ohms which, in the case of a concentric line, results from the use of a ½-inch inner conductor and a two-inch outer conductor with 0.035 inch walls, giving an inside diameter of 1.93 inches. Figure 2 is for a Z_o of 139.9 ohms which results from a reduction of the inner conductor size to 3/16 inch. This higher impedance line will usually be more satisfactory for receiving because very short lines do not require as much capacity across the open end to resonate them.

By selecting a line length along the scale at the left of the charts, the corresponding capacity to resonate will be found on the scale at the bottom. The "curves" have been made straight by plotting the lengths in terms of the cotangent of the electrical length (in degrees) of the lowest frequency shown in the figures; the equations have appeared in RADIO for April and May, 1939.

One set of curves is good for one characteristic impedance (Z_o) either for concentric or open wire lines. The accuracy is such that these lines are now being used to measure inductance and capacity at very high frequen-

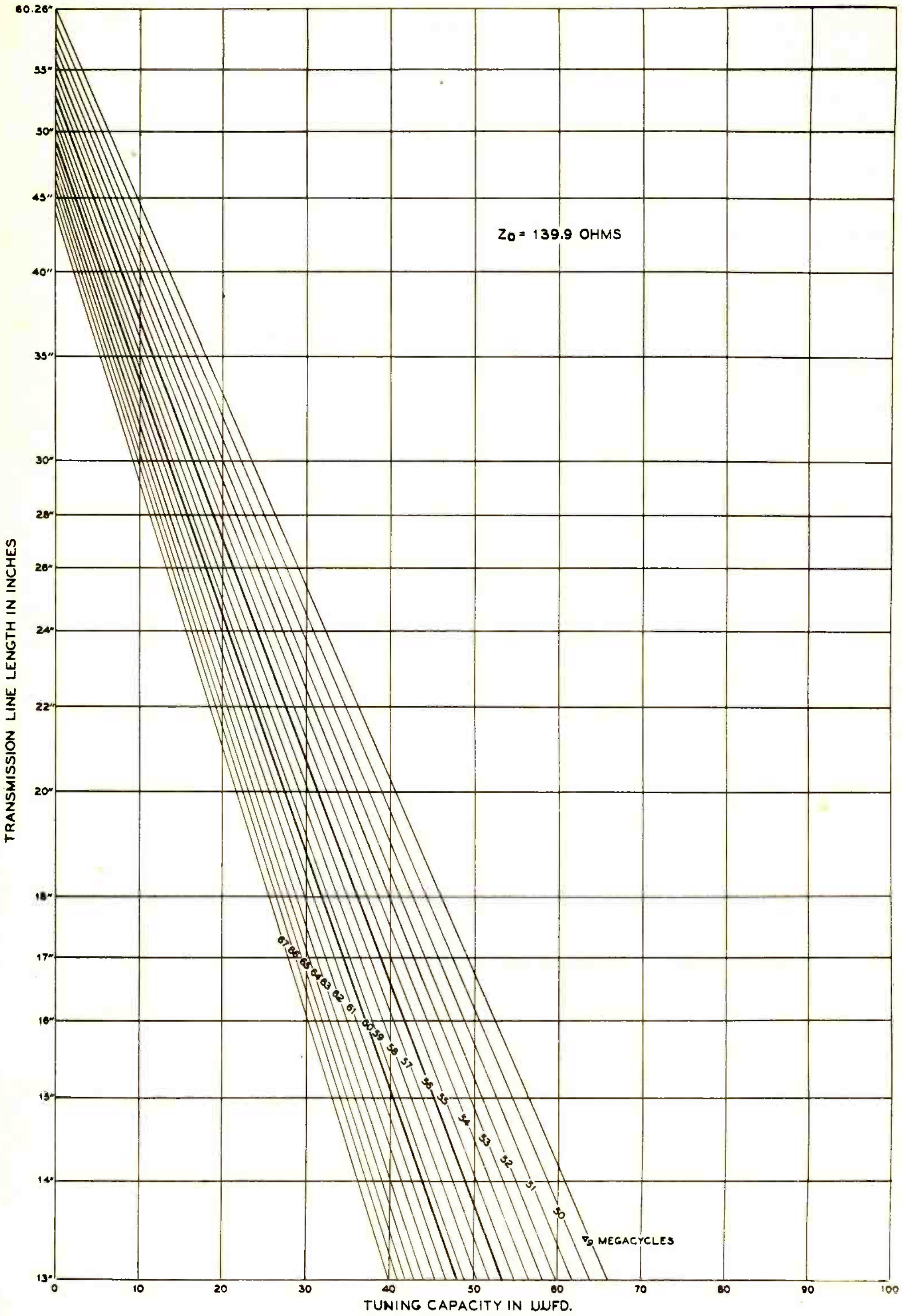

Figure 2. Chart showing capacity necessary to resonate shortened lines of 139.9 ohm surge impedance.

Table I

Megacycles	¼ wave (in.)	C ($\mu\mu f$)
49	60.260	40.36
50	59.055	38.31
51	57.895	36.37
52	56.784	34.55
53	55.712	32.82
54	54.682	31.21
55	53.688	29.65
56	52.727	28.20
57	51.804	26.81
58	50.910	25.49
59	50.048	24.23
60	49.213	23.03
61	48.405	21.90
62	47.625	20.82
63	46.870	19.78
64	46.137	18.79
65	45.428	17.85
66	44.739	16.94
67	44.072	16.07

cies. The inductance of the shorting disc or bar has been neglected, but this is generally of small importance in amateur work. In fact, when a tuning condenser or tube is placed across the open end of a line, it might be well to consider the conductor length as including the lead to the condenser shaft or tube elements.

The data for any other characteristic impedance (Z_o) than those shown in the charts can be determined easily because the tuning capacity is inversely proportional to the characteristic impedance for a given line length. That is, a line of twice the impedance will tune to a given frequency with half the capacity.

The charts can also be used on other bands very simply. For 112 Mc., use the 56 Mc. curve but divide the capacity and line length scales by two. That is, if an 81.04 ohm line 30 inches long will tune to 56 Mc. with 28.20 $\mu\mu$f capacity, an 81.04 ohm line 15 inches long will tune to 112 Mc. with a 14.10 $\mu\mu$f condenser. Likewise, a 60 inch line of the same impedance will tune to 28 Mc. with 56.40 $\mu\mu$f; of course, this sounds like a lot of condenser—which can be reduced to 28.20 $\mu\mu$f by using a 162.08 ohm line—but this circuit will out-perform a coil both as to gain and selectivity. The capacities mentioned include circuit capacity; in the case of a mixer preceded by an r.f. stage, this will amount to about 10 $\mu\mu$f with acorn tubes.

To facilitate converting figure 1 for other characteristic impedances, there is shown in Table I the capacities necessary to resonate an 81.04-ohm, 30-inch line to various frequencies. The exact lengths of a quarter wave are also given.

Tracking Methods

On ultra-high frequencies, most amateurs pad the oscillator, mixer and r.f. circuits with capacity until the receiver is lined up at mid-band. Seldom is it even necessary to rebuild the oscillator coil, because the tuned circuits are so broad that accurate tracking is unnecessary. With concentric line circuits, this method—or lack of method—can still be used whether the oscillator circuit is a coil or pipe, but it will probably be necessary to touch up the tuning with a trimmer condenser between ends of a band because the r.f. and mixer circuits have become more selective.

If an identical "pipe" is used on the oscillator, it is found that on five meters, using relatively long (30 inch) lines with a 3.86 ratio of conductor diameters and a 2 Mc. intermediate frequency, the r.f. and mixer circuits will be out of tune 213 kc. at 56 Mc. if lined up at mid-band (58 Mc.). A higher i.f. would result in a greater misalignment. Conversely, a lower i.f. will track more closely, and may be practical in view of the excellent selectivity of the lines which provide a good image ratio. Shorter, more convenient lines will be broader and require less careful tracking. High ratio lines (with a small inner conductor) will also be somewhat more broad. However, excellent tracking within a band can be obtained by any of several methods, all of which will be reviewed below.

It would be possible to obtain better tracking if a smaller or larger condenser were used to tune the oscillator than to tune the mixer. With the lines described in the above paragraph, the oscillator can be tuned with a condenser 10 per cent smaller on the high frequency side or 11 per cent larger on the low frequency side of the signal frequency.

In present broadcast practice, special condensers are avoided by the use of a condenser in series with the tuning condenser, together with a parallel padder. Using this system on the above example, adjusting for perfect tracking at 57 and 59 Mc. (selected as cross-over points of the tuning curves), it is found that the maximum error in tracking would be 6.2 kc., which is well within both the i.f. band width and the r.f. band width. It would be "perfect" in any u.h.f. receiver. One possible objection to this standard method is the need for three condensers, another is that a little cut and try on the series and parallel adjustments will be necessary in order to achieve the best theoretical tracking. The series condenser, of course, should reduce the tuning condenser capacity 10 per cent in the above example.

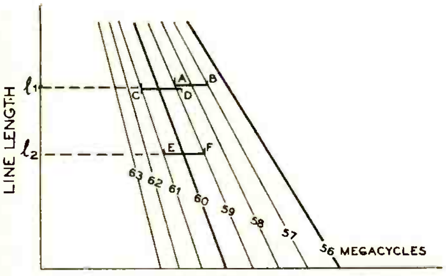

Figure 3. Exaggerated chart similar to figure 1, to illustrate method of tracking oscillator by shortening line, as described in text.

Automatic Tracking

With concentric lines as tuned circuits, there are additional possibilities of obtaining satisfactory tracking by "hack saw" methods. One of these is to make the oscillator line longer or shorter than the r.f. and mixer lines. The longer line is impractical because one naturally wants to use the maximum possible length in the r.f. circuits for high gain, and a shorter oscillator line provides satisfactory oscillator stability anyway.

Figure 3 will help to demonstrate, by exaggeration, the method by which the oscillator line length for good tracking, using the same size condenser as in the signal frequency stages, can be determined. Here again the object is to track at 57 and 59 Mc., hoping that the circuits will not be badly out of tune at 56, 58 and 60 Mc.

A horizontal pencil line, AB on figure 3, can be drawn at the line length, l_1, selected for the mixer, and the separation between the 57 and 59 Mc. curves measured with dividers. In the case of a 2 Mc. higher heterodyne oscillator frequency, the dividers are next moved to the left until the 61 Mc. line is encountered, at CD, then moved to the lower right until the horizontal distance, EF, between the 59 and 61 Mc. lines, is equal to the comparable separation between the original points, AB. Inasmuch as horizontal separation represents a given change in tuning capacity, an oscillator line of length l_2 can be tuned in track with a mixer line of length l_1, using similar tuning condensers.

The only requirement is the adjustment of a parallel condenser on the circuit requiring the higher capacity, or a change in the relative position of the ganged condenser sections, to give alignment on 57 or 59 Mc. This will result in tracking within a few kilocycles throughout the band. Using a 3.86 ratio of diameters as in figure 1 or a 10.3 ratio as in figure 2, suitable tracking will result from the following approximate selection of oscillator line lengths, for a 30-inch line on the mixer:

Table II

Intermediate Frequency	Zo 81.04 ohms	Zo 139.9 ohms
2 Mc.	26.0″	26.5″
4 Mc.	23.8″	24.2″
7 Mc.	18.5″	19.3″

Tracking by Choosing Pipe Ratio

The remaining variable that can be used to obtain tracking is the ratio of outer to inner conductor diameters, which determines the surge or characteristic impedance (Z_o) of the line. In this case the tuning condenser, and line length as well, can be the same for the oscillator as for the other circuits. Because the oscillator is most stable with a high Q line (around a 3.6 ratio) whereas the r.f. and mixer gain will be highest with a higher ratio line, it appears better to use a heterodyne oscillator frequency above the signal frequency, requiring a larger inner conductor diameter on the oscillator.

Fairly good tracking with only a one point crossover of the curves results from selecting an oscillator inner conductor of such size that the tuning capacities are equal. This is not difficult to do, inasmuch as the capacity necessary to resonate short lines is inversely proportional to their characteristic impedance (Z_o).

In figure 1, the mixer will tune to 58 Mc. with an 81.04 ohm, 30 inch line and 25.49 $\mu\mu$f of capacity. If we assume a 4 Mc. i.f., the oscillator will have to be on 62 Mc., calling for only 20.82 $\mu\mu$f capacity with an identical line. Substituting in the equation $Z_{02} = Z_{01}\ C_2\ /\ C_1$, it is found that $Z_{02} = (20.82 \times 81.04)/25.49$ or 66.2 ohms as the necessary characteristic impedance for the oscillator line to tune to 62 Mc. with the same capacity as tunes an 81.04 ohm line to 58 Mc. Substituting in the characteristic impedance formula $Z_0 = 138.15 \log (b/a)$, where b and a are outer and inner conductor sizes, it follows that $66.2 = 138.15 \log (b/a)$, giving a ratio of 3.015. This ratio would be satisfied with an outer conductor inside diameter of 1.93 inches and an inner conductor of 0.64 inch; it is approximated by 1½ and ½ inch or 3 and 1 inch sizes. To align, it is necessary only to trim to resonance at the mid-band frequency.

Table III

Intermediate Frequency	Multiply Z_0 by
1 Mc.	0.9535
2 Mc.	0.9031
4 Mc.	0.8217
7 Mc.	0.7093

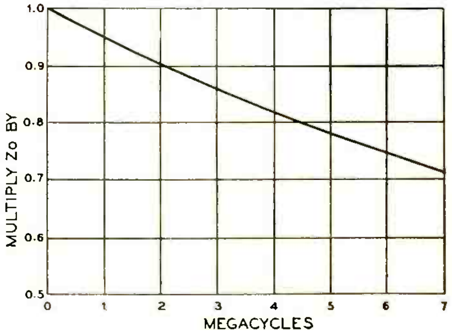

Figure 4. Chart showing constants by which mixer line surge impedance can be multiplied in order to obtain oscillator line surge impedance for tracking with lines of the same length.

For a 30 inch line, the tracking will be within 10 kilocycles throughout the five meter band, and closer for shorter, less selective lines or for a lower i.f.

Two Point Crossover

Two-point tracking is also rather easy. This requires that the *change* in capacity between two frequencies be the same for the mixer and oscillator. Returning again to figure 1, it takes a change of 2.58 $\mu\mu$f to tune the mixer from 59 to 57 Mc., whereas the oscillator requires only 2.12 $\mu\mu$f to go from 63 to 61 Mc., assuming a 4 Mc. i.f. and identical 30 inch lines. Substituting again in the "inversely proportional" equation of the above paragraph, Z_{02} is equal to $(81.04 \times 2.12)/2.58$ or 66.59 ohms as the proper impedance for the oscillator line for good tracking. The conductor size ratio again can be determined from the formula $Z_0 = 138.15 \log (b/a)$ which gives a ratio of 3.034. This will be satisfied by a 1.93 inch outer conductor inside diameter and 0.637 inch inner conductor, and is again close to but not exactly a 3-to-1 ratio as in the above example.

Inasmuch as this procedure gives the proportionate Z_0 for any selected i.f., the first step in the above procedure often can be eliminated by reference to figure 4 or to Table III, for the proper Z_0 for the oscillator line if on the high frequency side of the signal.

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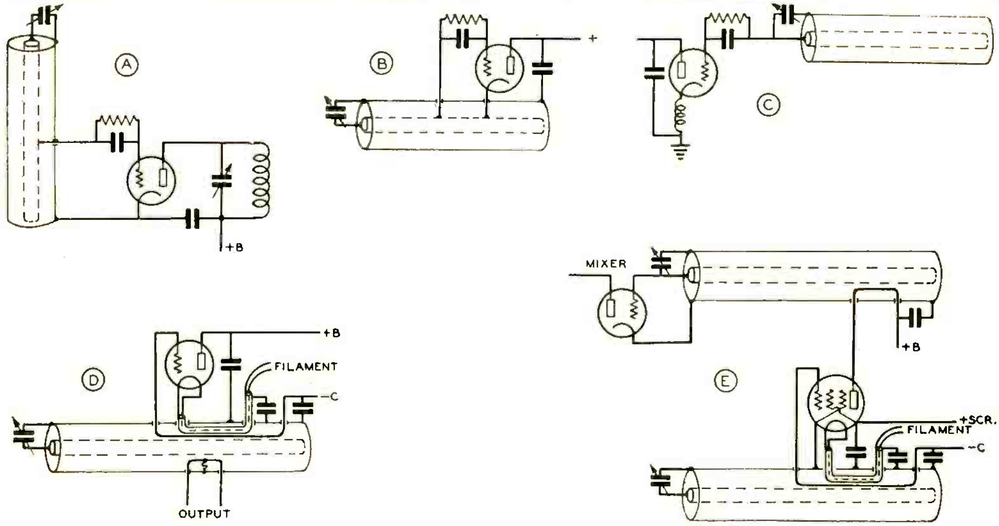

Figure 5. (A) concentric line tuned grid, coil tuned plate oscillator. (B) cathode-above-ground type oscillator circuit with concentric line. (C) single control oscillator circuit without tap on line, although stability can be increased by tapping the grid down. (D) RCA's oscillator circuit used in a broad band transmitter having good stability, requiring only one tuned circuit. (E) similar to (D) but showing pentode tube and balanced loop coupling to mixer stage.

An Economical

5-TUBE SUPER

A LOW-COST RECEIVER COMBINING SIMPLICITY AND OUTSTANDING PERFORMANCE

By LEIGH NORTON,* W6CEM

The receiver to be described in this article, like Topsy, "just growed." Its ancestry is a long and honorable one beginning clear back with the justly famous Super Gainers and running down through the simple three-tube super shown in the 1940 RADIO HANDBOOK, which is the immediate parent. Since the 3-tube job was so easily transported and placed in operation, it was in great demand for "location" checking when all of the staff were house hunting in Santa Barbara after moving from Los Angeles. As this receiver passed from hand to hand, so to speak, the conviction grew that the little-super idea should not be permitted to end here. The question was just exactly what should be added to the little set to make it better without running up the cost too much. The argument waxed long and warm with the opinion about evenly divided between an r.f. stage and an i.f. stage. In order to pacify everyone it was finally decided to include both the r.f. and i.f. stage, and thus we have the five-tube set shown in the photographs.

Since the original set had reasonably good sensitivity on all bands except ten meters, and even there the sensitivity was sufficient for ordinary work, there did not seem to be much advantage in adding an 1851 or 1852 r.f. stage with the attendant grid loading, oscillation and kindred troubles which so often accompany the use of such high-gain tubes. Consequently, a 6K7 is used as an r.f. stage with the result that the sensitivity is all that is usable.

Single-ended tubes in the front end would undoubtedly have improved the appearance of the set, and possibly would have led to shorter leads. However, it was desired to keep the shielding to a minimum and previous experience with single-ended tubes had led to the conclusion that even though the interelectrode capacitances are quite low in this type of tube, considerable shielding is necessary to eliminate undesired coupling between the grid and plate circuit wiring.

> Here is a receiver that is midway between the "jalopy" amateur superhet and a full fledged de luxe communications receiver. It costs very little more than the least expensive three-tube super, yet the performance is substantially better. The c.w. man will have to go a long way to build a better set or plunk down many sheckles to buy a better set, and on phone it isn't exactly to be sneezed at. If you can't afford the best you can still have a pretty good set for a lot less money.

Mechanical Layout

The r.f. stage is located on the left front corner of the 7 x 11 x 2 inch chassis. The mixer stage is placed at the rear left corner of the chassis, with the shield partition visible in figure 1 separating it from the r.f. stage. Placing the r.f. and mixer coils toward the edge of the chassis removes them from the proximity of the front-to-back shield, which otherwise might lower the gain obtained in the tuned circuits. This type of layout, in which the tubes and coils are placed in line with each other, rather than diagonally opposite, admittedly results in a longer plate lead for the r.f. stage. However, in this case the additional length of r.f. plate lead amounted to only a matter of one-half inch or so, and, as the r.f. and mixer stages are ganged, it was deemed better to have them symmetrically located in respect to the shielding.

The under-chassis view, figure 2, shows the location of the two 50-$\mu\mu$fd. ganged condensers used to tune the r.f. and mixer stages. By reversing the usual mounting procedure on these condensers and hanging them stator side down from the chassis, the shafts are brought out at the center of the front drop. A small isolantite coupling is used to gang the two condensers.

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* Associate Editor, RADIO.

Figure 1. Looking down on the receiver. R.f. stage at the front, mixer at the rear and the i.f. and audio strung out along the rear and far edge of the chassis. A corner of the oscillator coil may be seen peeking around the front-to-rear shield.

The 6K8 Mixer

A 6K8 was chosen for the mixer since this type has shown itself to be a mighty good mixer in previous receivers. Another, though secondary, reason for choosing the 6K8 is that its low input capacitance (6.6 $\mu\mu$fd.) more closely matched that of the 6K7 r.f. tube than any of the other available mixers, thus allowing more accurate ganging of the tuning controls.

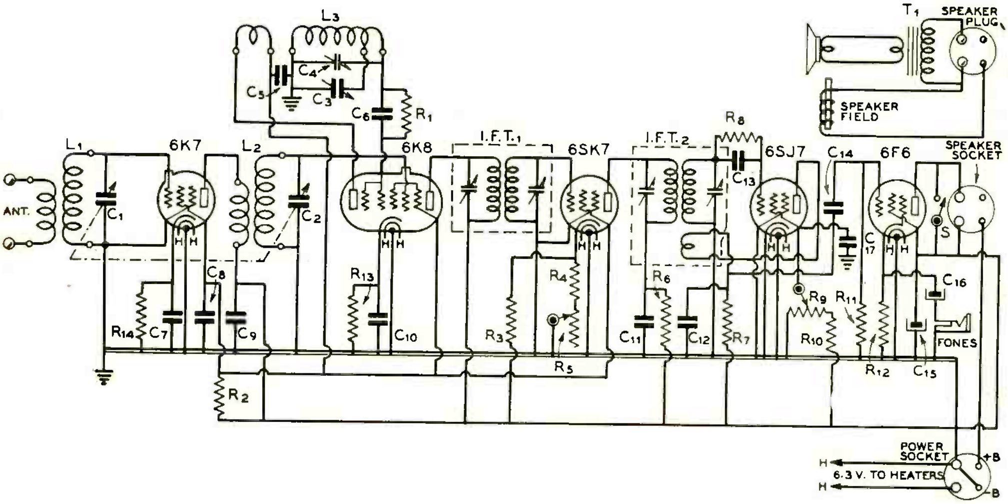
The mixer oscillator section coil is located in the center of the chassis directly behind the dial and the 25-$\mu\mu$fd. bandspread condenser. Tapped-coil bandspread, a system which is convenient and easily adjustable, is used. The taps are located to give nearly full-dial bandspread on all bands.

Regenerative 1500-kc. I.F.

R.f. output from the mixer goes to the input i.f. transformer at the rear center of the chassis. The i.f. stage is a conventional 1500-kc. one with nothing unusual or tricky in the circuit. Regeneration in the i.f. stage is sometimes helpful in a small receiver of this type, but when it is desired both to control gain and obtain regeneration in a single stage operating difficulties become greatly increased. In fact, the regeneration control is generally used as a combined regeneration and gain control, thus making it impossible to secure low i.f. gain and a high degree regeneration at the same time. Where there is another i.f. stage available which can be run "wide open" as far as manual or automatic gain control goes, it is perfectly feasible to use controlled regeneration in the latter stage. But combining both regeneration and gain control in a single tube is liable to lead to premature grey hair.

To secure a satisfactorily wide range of i.f. gain adjustment a bleeder resistor, R_3, is connected from the positive supply voltage to the 6SK7 cathode. The particular gain control used is supplied with an adjustable stop which allows its clockwise rotation to be stopped before the movable arm has come to the end of the resistance strip, thus providing a "minimum-bias" resistor within the gain control. This stop should be adjusted so that the minimum resistance is in the neighborhood of 300 ohms.

The i.f. amplifier tube is a 6SK7, the single-ended construction causing no difficulty at the relatively low frequency of the i.f. amplifier. Originally the intention was to use an 1852 or 1853 in this position, but the amount of decoupling and by-passing necessary to secure stable operation was not consistent with the slight additional gain achieved.



General wiring diagram of the five-tube super.

C_1, C_2—50-μμfd. midget variable

C_3—25-μμfd. midget variable

C_4—140-μμfd. midget variable

C_5—0.1-μfd. 400-volt tubular

C_6—.0001-μfd. mica

C_7—.01-μfd. 400-volt tubular

C_8, C_9, C_{10}, C_{11}—0.1-μfd. 400-volt tubular

C_{12}—.0005-μfd. mica

C_{13}—.0001-μfd. mica

C_{14}—.01-μfd. 400-volt tubular

C_{15}—8-μfd. 450-volt electrolytic

C_{16}—10-μfd. 25-volt electrolytic

C_{17}—0.1-μfd. 400-volt tubular

Note

Omitted from the diagram was a condenser from the 6SK7 i.f. stage cathode to ground. This condenser should be a .01-μfd. 400-volt unit.

R_1—75,000 ohms, ½ watt

R_2—25,000 ohms, 2 watts

R_3—60,000 ohms, 1 watt

R_4—300 ohms from stop on R_5 (see text)

R_5—10,000-ohm potentiometer

R_6—2000 ohms, ½ watt

R_7—250,000 ohms, ½ watt

R_8—1 megohm, ½ watt

R_9—10,000-ohm potentiometer

R_{10}—100,000 ohms, 1 watt

R_{11}—250,000 ohms, ½ watt

R_{12}—600 ohms, 10 watts

R_{13}, R_{14}—300 ohms, ½ watt

IFT_1—1500-kc. input i.f. transformer

IFT_2—1500-kc. input i.f. transformer (see text for alterations)

S—S.p.s.t. toggle switch

L_1, L_2, L_3—See coil table

T_1—Pentode output transformer (on speaker chassis)

The Grid Leak Second Detector

After trying several different types of second detectors, the gridleak detector shown in the diagram was finally selected. This faithful circuit proved to be the best of the autodyne detector arrangements, for this particular receiver at least. Originally it had been hoped that the use of an audio power pentode for a second detector might be feasible, and thus allow the elimination of one tube from the set. However, tests with several detector arrangements using such a tube led to the decision that the circuit was too tricky and unreliable. Even when everything was cranked up "right on the nose" the audio output was too low to operate the speaker satisfactorily on any except the stronger signals.

Rebuilding the I.F. Transformer

Making the necessary alterations in IFT_2, the i.f. transformer feeding the second detector, is probably the only difficult task in the whole construction job, if adding a few turns of wire inside an i.f. transformer can be called "difficult." The tickler winding consists of three turns of small silk or cotton covered wire wound around the fibre spider at the bottom end of the i.f. transformer mounting dowel. These turns are wound "spider-web" fashion, using the spacer as a form and crossing the wire from one side to the other through the small slots at the edge of the spacer. Inspection of the i.f. transformer will make it obvious how the job should be done. As the tickler is wound at the bottom of the transformer the bottom winding must be used as the grid coil of the detector instead of as the plate winding for the i.f. stage, as the manufacturer specifies. All that is necessary is to make certain of the color of the leads coming from the bottom coil and tie one of them to the grid and the other to ground. The remaining two wires are used for the plate and positive connections to the i.f. stage, of course. If oscillation is not obtained at the "full on" position of the regeneration control, reverse *either* the two leads to the grid coil or the leads to the tickler.

Phones or Speaker

The 6F6 audio stage is quite conventional, except for the position of the phone jack. The circuit closing jack is placed in series with the cathode by-pass condenser, C_{10}. There is just enough audio voltage across the cathode resistor to give comfortable headphone signal strength at this point. It would have been quite feasible to use a jack with an additional set of contacts to replace the s.p.s.t. switch, S, which allows the 6F6 output to be shorted when headphones are used. However, the wiring begins to get complicated with arrangements of this type, as was discovered when a jack which switched two circuits was used in the three-tube super previously mentioned. With the arrangement shown in the diagram, however, it is possible to use either the phones or speaker separately, or both together, the latter method of operation being quite useful in some cases.

The Panel Controls

The only control on the panel which *had* to be located where it is was the r.f. and mixer trimming control knob. The tuning dial was placed in the center of the 8 x 12 inch panel, bringing it and the oscillator tuning condenser directly in front of the oscillator coil.

When it came to choosing a spot for the oscillator bandsetting condenser, C_4, it was found that several factors would have to be taken into consideration. Short leads, while desirable in an oscillator, are not an absolute necessity. From the point of shortest lead length it would seem that the bandsetting condenser should be located directly below the tuning dial, or below and slightly to the right. However, previous experience has shown that when the bandsetting condenser control is placed on the panel the best policy is to keep it a good distance from the main tuning knob so that it cannot be easily hit by the hand when operating the tuning knob. The result of all this cogitation on a seemingly simple subject was the decision to place the bandsetting condenser so that its tuning knob came out at the right end of the lower row of controls. That this location also resulted in a symmetrical panel layout, with the r.f. and mixer knob at one end and the oscillator bandsetting control at the other, merely is a happenstance; it does make a nice looking panel, but that was a result rather than a cause.

The i.f. gain and the regeneration control are spaced evenly between the two outer controls. The choice of which should be on the left and which on the right may lie with the individual constructor. The i.f. gain control is used more often than the regeneration control; in the set shown in the photographs the i.f. gain is the left one of the inner two.

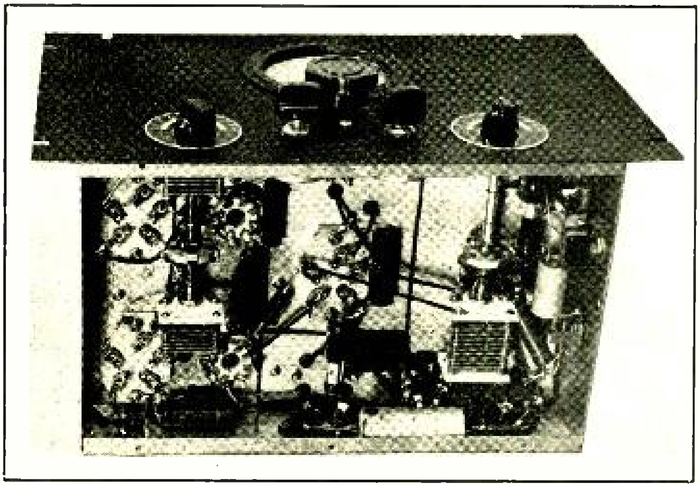


Figure 2. Most of the "works" are under the chassis. The two ganged r.f. and mixer tuning condensers are visible in this photograph, as is the oscillator bandsetting condenser.

COIL TABLE

Band	L1	L2	L3
80	Grid—42 turns closewound Antenna—7 turns closewound Form—1½" dia.	Grid—42 turns closewound Plate—9 turns closewound Form—1½" dia.	Grid—20 turns spaced to 1½" Tickler—8 turns closewound Tap—15 t. from ground end Form—1½" dia.
40	Grid—21 turns spaced to 1½" Antenna—6 turns closewound Form—1½" dia.	Grid—21 turns spaced to 1½" Plate—7 turns closewound Form—1½" dia.	Grid—10 turns spaced to 1¼" Tickler—6 turns closewound Tap—6½ t. from ground end Form—1½" dia.
20	Grid—11 turns spaced to 1¼" Antenna—4 turns closewound Form—1½" dia.	Grid—11 turns spaced to 1¼" Plate—6 turns closewound Form—1½" dia.	Grid—6 turns spaced to 1" Tickler—4 turns closewound Tap—4 t. from ground end Form—1¼" dia.
10	Grid—6 turns spaced to 1" Antenna—4 turns closewound Form—1¼" dia.	Grid—7 turns spaced to 1" Plate—4 turns closewound Form—1¼" dia.	Grid—3 turns spaced to 1" Tickler—3 turns closewound Tap—2 t. from ground end Form—1¼" dia.

All coils are wound with no. 22 d.c.c. wire

Coils

If the data given in the coil table are followed closely no trouble should be experienced in getting the r.f. and mixer stages to track accurately. It will be noted that the r.f. and mixer coil secondaries are identical on all bands except 10 meters, where the r.f. stage has one less turn. It is a simple matter to check the tracking. All that is necessary is to loosen the set screws on the coupling between the r.f. and mixer condensers and resonate each condenser separately. By observing the amount of capacity used to resonate each stage near the center of the band in question, it may be determined whether an increase or decrease in the inductance of either coil is necessary.

As mentioned previously, the oscillator bandspread tap location given in the coil table will give nearly full-dial coverage of each band. Individual constructors who may have different ideas as to the proper amount of bandspread to use may move the taps along the coils to obtain any desired amount. The 20- or 75-meter phone bands may be spread across the whole dial, for instance, by moving the taps on the coils for these bands nearer the grounded end. Conversely, any one of the bands may be packed into a few dial divisions by moving the tap on that band to the grid end of the coil.

Shielding

The shielding shown between the r.f. and mixer stages in figure 1 requires a little explanation: The receiver was designed to be used with a sheet-metal cabinet which fits rather closely alongside the chassis and bolts to the panel. This cabinet more or less completed the shielding around the two coils on the edge of the chassis. However, with the cabinet removed the shielding is insufficient to keep the r.f. stage from oscillating on 20 and 10 meters. This situation boils down to the fact that a shield must be placed alongside the left edge of the chassis when the receiver is used without the cabinet. The additional shield should extend an equal distance each side of the interstage partition so that the inductance of each coil will be lowered by the same amount, thus retaining the original tracking of the tuning circuits.

It will be noted from the diagram that there are no by-pass condensers at the screens of the 6K8 and 6SK7 stages. This is a result of following a little different procedure than is usual when building equipment in RADIO's laboratory. Usually by-passes and decoupling circuits are placed in every circuit where there is the slightest possibility that they might be required. This procedure obviates the unpleasant task of finding a place for such decoupling circuits if they are later found to be needed. However, it is sometimes a matter of conjecture as to whether all the decoupling circuits are actually needed, although it is admittedly good practice to include them. In the five-tube super, however, all decoupling circuits were omitted when the receiver was originally tried out, and only those which were found to be needed were included after the initial "tryout." Fortunately, only one decoupling circuit was found to be needed, R_7-C_{12} in the i.f. stage positive lead. Getting back to the by-passes, their apparent absence in the diagram is due to the vagaries of schematic representations of circuits. Actually, the by-pass C_8, which in the diagram appears to be only on the screen of the 6K7 r.f. stage, is so located physically in the set that it acts as a by-pass for the screens of the mixer and i.f. stages as well. The same situation holds true in the case of C_9, the main positive by-pass;

[*Continued on Page 73*]

The Three-Band
ROTARY ANTENNA

By JOHN D. KRAUS,* W8JK

By applying the multi-wire doublet principle to the design of the 3-element rotary it is possible to raise the center impedance of the driven doublet to a point which permits simple direct coupling systems. Also the selectivity of the array is reduced to a point which will allow complete band coverage without detuning, and the array can, by switching, be adapted to cover three bands.

The three-element rotary beam antenna first described in November, 1938, by Gioga and Dawley,[1] and based on the data of Dr. George H. Brown,[2] has found very wide acceptance. This type of antenna possesses many desirable features, such as substantial gain, high directivity, and compactness. However, in common with nearly all types of antennas using closely-spaced elements, the radiation resistance at the current loop or feed point of the driven element is very low. This low resistance can be a limiting factor in the performance of this type of antenna, in the same manner as has been discussed for the flat-top beam antenna.[3] In addition, it is difficult to build an efficient matching system to operate into such a low resistance.

It is the purpose of this article to describe a 3-element type of rotary beam antenna in which a 4-wire half-wave doublet is used as the driven element. This improvement permits the connection of an open-wire transmission line directly to the terminals of the driven element. As a result, the feed arrangement is greatly simplified and also the antenna efficiency is increased. In addition, the antenna can be readily adapted for operation on 3 harmonically related frequency bands, hence the name "3-band rotary."

For convenience let us designate the band on which the 4-wire doublet is a half-wave long, and the antenna is a 3-element beam, as the fundamental frequency. The antenna may also be used on its second harmonic as a 6-element beam and on a frequency one-half that of the fundamental as a quarter-wave doublet directional antenna. The parasitic elements are inoperative on this band. Thus, an antenna constructed for fundamental operation on the 14-Mc. band can also be used on the 7- and 28-Mc. bands.

A horizontal 3-band rotary of this type, for 7, 14, and 28 Mc., has been in experimental operation at W8JK and is shown in the photograph of figure 1. This shows the 4-wire doublet at the center as the driven element, and the single-conductor tubing elements as the close-spaced director and reflector. The overall dimensions of the antenna are approximately 34 by 14 feet. One-tenth wavelength spacing of both director and reflector is used on the fundamental frequency of 14 Mc. The antenna structure is turned by means of a remotely-controlled motor driven rotator. Adjustments during the experimental work on the antenna were facilitated by means of the catwalk on the tower as shown in figure 1. The open wire transmission line feeding the antenna extends vertically up inside the ladder-type tower and connects by means of short flexible wires directly to the center of the driven 4-wire element.

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* Arlington Blvd., Ann Arbor, Michigan.

[1] "The Three-Element Rotary," P. Gioga and R. L. Dawley, RADIO, Nov. 1938, p. 13; also see "More on the 3-Element Rotary," E. H. Conklin, RADIO, Jan. 1939, p. 35.

[2] "Directional Antennas," G. H. Brown, *Proc. I.R.E.*, Jan. 1937, p. 78.

[3] "Characteristics of Antennas with Closely-Spaced Elements," J. D. Kraus, RADIO, Feb. 1939, p. 9.

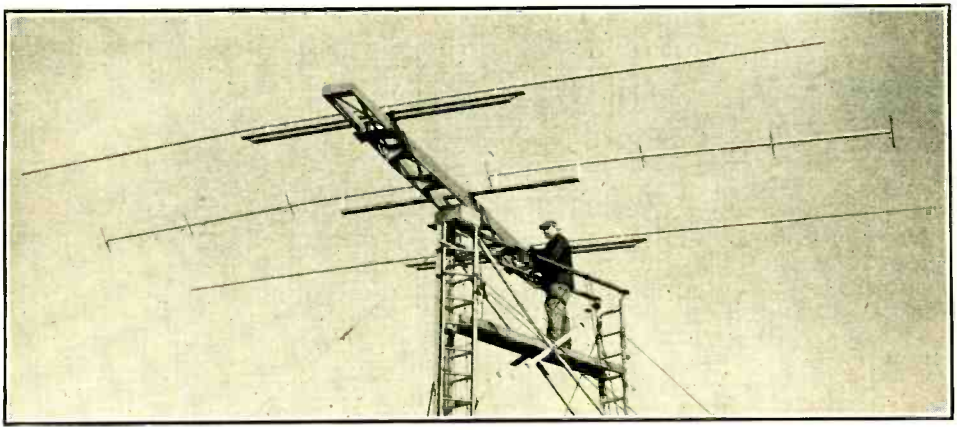

Figure 1. 3-band rotary antenna at W8JK using 4-wire doublet as driven element.

With the exception of such antennas as the center-fed single-section flat-top beam[4] and the 2-band beam described by Schroeder[5] most rotary antennas are strictly one band affairs. Accordingly, it is of particular advantage to have a single rotary antenna system which can be operated on 3 bands. But even without the 3-band feature, the 4-wire driven doublet makes for a sufficient improvement in fundamental frequency operation to warrant its adoption for this one band alone.

The principal features of the "3-band rotary" described in this article may be summarized as follows:

(1) 3-band operation.
(2) Simple, efficient, and direct feed with relatively high feed point resistance.
(3) Non-resonant line and direct match on fundamental frequency. No adjustments on driven 4-wire doublet required.
(4) 3-element beam on fundamental.
(5) 6-element beam on second harmonic.
(6) Single element directional antenna on half of fundamental frequency.

4-Wire Driven Doublet

A 2-wire half-wave and a 2-wire three-quarter wave doublet were described in RADIO for May, 1939.[6] The 2-wire half-wave type has also been discussed by Carter.[7] A 3-wire half-wave doublet was described in RADIO for June, 1939.[8] Either the 2- or 3-wire doublet can be applied to beam antennas. Applications of the 2-wire three-quarter wave doublet to the "Compact-H Beam" antenna,[9] and the 3-wire half-wave doublet to the "Twin-3 Flat-Top Beam" antenna[10] have been given. The 4-wire doublet is a still further extension of the multi-wire principle,[6] and is particularly well suited for use in a 3-element type of beam antenna. The diagram and current distribution for a 4-wire half-wave doublet is shown in figure 2A. As is indicated, the currents in the four very closely spaced conductors are all in phase at a given instant. The length is approximately one-half wave, while the overall spacing, d, can be a very small fraction of a wavelength.

The feed point resistance of the 4-wire half-wave doublet in free space is very high as compared to the current loop resistance of a single half-wave element. For the single half-wave element the resistance is about 73 ohms, whereas it is about 1400 ohms for the 4-wire doublet. When the 4-wire doublet is used as the driven element of a 3-element beam, the feed point resistance is considerably less than the free space value, but is still great enough to permit the direct connection

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[4] "Rotary Flat-Top Beam Antennas," J. D. Kraus, RADIO, Dec. 1937, p. 11.

[5] "The Two-Band Three-Element Rotary," E. E. Schroeder, *QST*, Aug. 1939, p. 16.

[6] "Multi-Wire Doublet Antennas," J. D. Kraus, RADIO, May 1939, p. 24.

[7] "Simple Television Antennas," P. S. Carter, *RCA Review*, Oct. 1939, p. 168.

[8] "Multi-Wire Type Antennas," J. D. Kraus, RADIO, June 1939, p. 21.

[9] "Compact-H Beam Antenna," J. D. Kraus and H. E. Taylor, RADIO, Oct. 1939, p. 34.

[10] "Twin-Three Flat-Top Beam Antenna," J. D. Kraus, RADIO, Nov. 1939, p. 11.

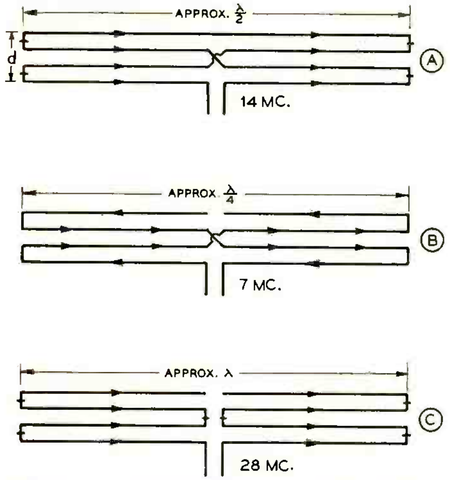

Figure 2. Arrangements of 4-wire doublet and current distributions for operation on 3 bands.

of an open wire transmission line. Open wire lines of 300 ohms characteristic impedance or higher can be directly connected to the driven doublet with a very satisfactory match. Even a 600-ohm line can be connected directly with excellent results, but for a more precise match a Q section may be inserted as will be described.

On a frequency one-half that of the fundamental, the length of the doublet is approximately one-quarter wavelength. For operation on this frequency one wire is opened at the center of the doublet. This is indicated in the diagram of figure 2B, which shows the current distribution of the doublet on this frequency. The antenna is actually a 4-wire quarter-wave doublet on this band. A similar type quarter-wave doublet using two parallel conductors has been described by Lindenblad.[11]

On the second harmonic, the 4-wire doublet is approximately a full wavelength long overall. The connections and current distribution on this frequency are shown in figure 2C. On this band the radiation characteristics are similar to two colinear half-waves in phase.

Construction

The experimental design used for the 4-wire doublet of the 7-, 14-, and 28-Mc. rotary is shown in figure 3. The radiating portion of the doublet consists of four parallel wires of number 12 gauge. As seen in end view the wires of the doublet are arranged like the corners of a square measuring 10 inches on a side. The wires are held in place by means of insulators carried on radial members which in turn are supported by a 1.5-inch diameter thin-wall aluminum tube. This tube is located centrally with respect to the wires and runs parallel to them. As actually constructed, the entire 4-wire doublet is made in two identical sections, the design for one of which is shown in figure 3.

As assembled on the rotary beam, the inner ends of each section are spaced about 3 feet apart and supported by the center cross-boom (see figure 1). Each section is 15 feet long and the total or overall length of the 4-wire doublet is 32 feet 10 inches.

The 1.5-inch diameter aluminum tube of each 15-foot section is broken up into three non-resonant pieces of approximately equal length. Insulating plugs are inserted between the sections of tubing. For supporting the wires, radial members of wood or small diameter aluminum tubing project out from the large aluminum tubing center member at a number of points along the section, as shown in figures 1 and 3. The completed element is very light in weight and, even without the wires, the section is quite strong. However, with the wires in place and fastened to the radial supports along the section, the element becomes very strong and rigid. Other designs for the 4-wire doublet are, of course, possible. For example, four parallel tubes

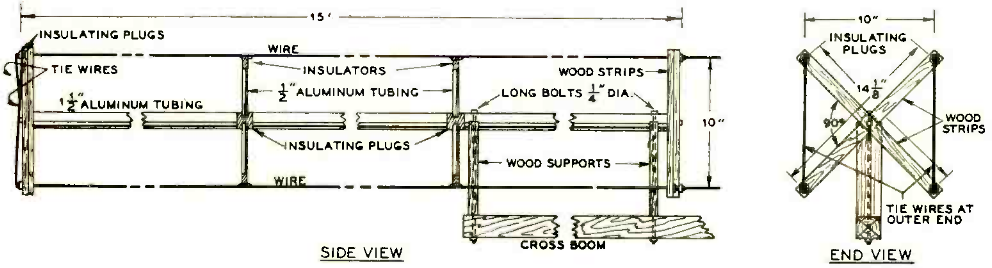

Figure 3. Experimental design of 4-wire doublet.

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[11] "Television Transmitting Antenna for Empire State Building," N. E. Lindenblad, *RCA Review*, April 1939, p. 387.

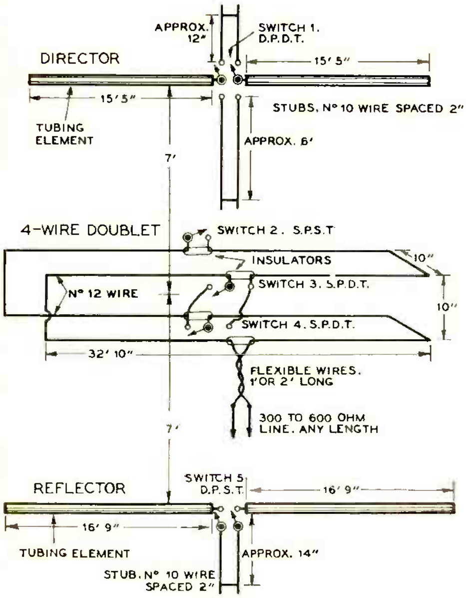

Figure 4. Dimensions and switching arrangement of 3-band rotary for 7, 14, and 28 Mc. operation. For positions of switches see table I.

could be used, but for any design other than that shown in figure 3, the proper length would need to be determined by some means. By using the design shown, the 4-wire doublet can be completely constructed with no need for adjustments.

The insulating material used for supporting the wires on the doublet is lucite. Tie wires are used at the outer ends of the 4-wire doublet. At one end the two tie wires are vertical and at the other end they are horizontal. This is shown by figure 4, which gives the wiring diagram for the entire antenna. The complete 4-wire doublet which has been described is an experimental model constructed for the author by Mr. R. S. Brown of the Bee Engineering Company, Detroit.

Dimensions and Switching

The director and reflector elements of the rotary antenna are of the conventional single-conductor tubing type. On the fundamental frequency a spacing of one-tenth wavelength from the center of the driven doublet to both director and reflector is employed. The complete wiring diagram with dimensions and switch locations for operation on the 7-, 14-, and 28-Mc. bands is given in figure 4.

The dimensions given are suitable for use on any frequency in the 7-, 14-, and 28-Mc. bands. The 4-wire doublet requires no adjustment. Also the length and spacing of the parasitic elements will require no change. However, the length of the stubs[12] on the parasitic elements should be regarded as only approximate, since it is, of course, understood that these stubs must be tuned to the particular frequency of operation which is chosen. The stubs should, accordingly, be made slightly longer than is indicated to allow for this adjustment. The procedure for tuning will be discussed later.

When the parasitic elements are tuned for a certain frequency, the antenna will then give optimum performance at this frequency and over a fairly wide range of frequencies to either side. For example, if the beam is tuned up for 14.2 Mc. it can be used with very little change in performance over the entire 14-Mc. band. Likewise, tuning the antenna to 28.6 Mc. for second harmonic operation will permit use of the beam with substantially constant performance over most of the 28-Mc. band.

To facilitate changing bands, switches can be employed as shown. These can be manually operated as was done in the present case, but an automatic, remotely-controlled switching system could be arranged. In efficient transmitters and receivers, the use of switching systems for multi-band operation has long been the accepted practice. It is only logical that switching in some form also be applied to antennas for multi-band operation.

Five switches are required to adapt the antenna to 3-band operation. These may be of a fairly heavy knife switch variety with porcelain base. At the director a double-pole double-throw switch is used to connect either a short stub, about one foot long, or a longer one about 6 feet in length, to the center of the director. For convenience this is designated as switch number 1. The 6-foot stub may be supported horizontally along the main boom, extending from the director almost to the center of the driven doublet.

The 4-wire doublet has three switches, one single-pole single-throw and two single-pole double-throw switches connected as shown in figure 4. These are switches numbers 2, 3, and 4. The reflector has one double-pole single-throw switch for connecting or disconnecting a short stub at the center of the reflector. The proper positions for the five

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[12] "Practical Design of Close-Spaced Unidirectional Arrays," W. W. Smith, RADIO, June 1938, p. 38.

TABLE I

SWITCH POSITIONS FOR FOR 3-BAND OPERATION

SWITCH→ BAND↓	1	2	3	4	5
14 MC.	UP	CLOSED	TO RIGHT	TO LEFT	CLOSED
7 MC.	UP	OPEN	TO RIGHT	TO LEFT	CLOSED
28 MC.	DOWN	OPEN	TO LEFT	TO RIGHT	OPEN

switches on the three bands are listed in table I.

If operation on only one band is desired, the switches can, of course, be omitted and the connections made permanently. This somewhat simplifies the antenna system.

Feed System

The main boom of the 3-band rotary is supported and turned by means of a model T, Bee Engineering Company, rotator. This unit has an unobstructed hollow shaft running vertically through the entire rotator. This permits a very simple feed arrangement as shown in figure 5. Two flexible insulated wires extend from the center of the 4-wire doublet, through the rotator shaft, to the transmission line which terminates just below the rotator platform. The wires are stranded, having the equivalent cross-section of about a number 16 gauge wire. The insulation is heavy solid rubber. Wire such as used in ordinary twisted lamp cord could probably be employed equally as well. In the present installation each wire is about 20 inches long, although longer or shorter lengths may be employed. The two wires are *not* twisted together initially but run through the rotator shaft separately. Enough slack is left in the wires, however, so that with the rotation of the beam, they may twist together many times.

The presence of this short length of closely-spaced flexible line has no noticeable effect on the antenna performance on the fundamental frequency and permits continuous rotation of the beam in either direction for many minutes. There is rarely any occasion for rotating the beam more than one or two complete turns in a given direction. But assuming a beam rotation speed of one revolution per minute, the beam can be rotated for as long as 20 minutes continuously in one direction, stopped, and run for 40 minutes in the reverse direction with not more than 20 twists at any time in the flexible leads.

Under ordinary operating conditions, the beam can be rotated approximately as often clockwise as counter-clockwise. By following this procedure, it has been found that even over long periods there are never more than a very few twists in the flexible line at any time.

The connections of the flexible wires to the transmission line are arranged so that they will pull off if the line twists too far. Thus, if the beam is inadvertently left turning for 30 minutes or so, the line will disconnect itself rather than twist to the breaking point. Slip rings, either metallic or mercury type, could be used with this antenna. The flexible wire arrangement was employed, however, because of its extreme simplicity.

The open wire transmission line extending from the flexible wires to the transmitter may be of any characteristic impedance from 300 to 600 ohms. The match on the fundamental frequency (14 Mc.) to a 300-to-400 ohm line will be excellent. The match for lines up to 600 ohms will likewise be good enough for all practical purposes. However, in the case of a 600-ohm line, the insertion of a quarter-wave Q section having a characteristic impedance of about 420 ohms between the flexible wires and the transmission line was found to result in some improvement in match. Whether this improvement is actually worth the effort, however, is questionable and, accordingly, the use of the Q section is entirely optional. The Q section used was constructed of half-inch diameter tubing spaced 7.5 inches as indicated in figure 5. Number 10 wire spaced 1.75 inches could be used equally well. The Q section is one-quarter wavelength long on the fundamental frequency, or 17 feet for 14 Mc. On 7 and 28 Mc. the Q section remains connected although it serves no purpose.

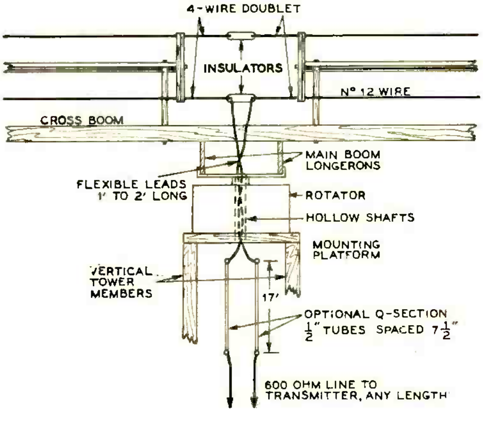

Figure 5. Transmission line connection to 4-wire doublet.

Adjustments

The 4-wire doublet is constructed according to the data given in figures 3 and 4. The feed line is connected as indicated in figures 4 and 5. No adjustments are required on this 4-wire doublet provided the construction closely follows that described.

14 Mc.: The 4-wire doublet switches are thrown as indicated for 14-Mc. operation in table I. In tuning the parasitic elements a choice of several methods is available. In the present case, the method used by Lynch[13] was employed. The director switch (number 1) is opened and the beam turned so that the reflector is between the driven element and a field intensity meter set up some wavelengths away. The reflector switch (number 5) is closed and the shorting bar on the reflector tuning stub is adjusted for a minimum of field intensity as indicated by the meter. The shorting bar is clamped permanently in this position and the beam rotated through 180 degrees so that the director is facing the field intensity meter. The switch number 1 is then connected to the short stub (about 1 foot long) and the shorting bar moved to a position giving a maximum of field intensity at the meter. No further adjustments need to be made on the beam for 14-Mc. operation.

7 Mc.: For 7-Mc. operation switch number 2 on the 4-wire doublet is opened. The switches on the parasitic elements may he left in any position, open or closed, as they will have practically no effect on the 40-meter operation. No adjustments are required on the antenna for 7-Mc. operation.

28 Mc.: For this band all switches are thrown as indicated in table I. That is, switch 1 is thrown to connect to the long stub about 6 feet in length, switch 2 is opened, switch 3 is thrown to the left, switch 4 to the right, and switch 5 opened. The only adjustment required for operation on this band is on the director stub. The beam is turned so that the directors face the field intensity meter and the shorting bar on the stub is adjusted for maximum field intensity.

Once the stubs have been properly adjusted for 14- and 28-Mc. operation, it is then only necessary to throw the proper switches in changing bands.

There are large standing waves on the transmission line on both 28 and 7 Mc. due mainly to reactance presented by the antenna to the transmission line. The standing waves may be reduced on these bands by applying a closed stub to the transmission line some distance from the antenna, in a manner similar to that described for second harmonic operation with the twin-3 flat-top beam.[10] However, the feeders can be operated satisfactorily as a tuned line with all of the tuning done at the transmitter. In case difficulty is encountered in loading the transmitter when using tuned feeders, an improvement may be obtained by adding or subtracting up to one-quarter wavelength of feed line or up to about 8 feet on 28 Mc.

TABLE II

CHARACTERISTICS AND MEASURED PERFORMANCE DATA OF ROTARY ON 3 BANDS. SEE ALSO FIGURE 6

BAND	TYPE OF ANTENNA	PATTERN (SEE FIG. 6)	FRONT TO BACK RATIO	FRONT TO SIDE RATIO
14 MC. FUNDAMENTAL	3-ELEMENT BEAM	UNI-DIRECTION.	29 DB OR 800-1 IN POWER	23+ DB OR OVER 200-1 IN POWER
7 MC. ½ FUNDAMEN.	1-ELEMENT DIRECTIONAL	BI-DIRECTION.	0 DB OR 1-1 IN POWER	23 DB OR OVER 200-1 IN POWER
28 MC. 2ND HARMON.	6-ELEMENT BEAM	UNI-DIRECTION.	14 DB OR 25-1 IN POWER	35+ DB OR OVER 3000-1 IN POWER

Performance

14 Mc.: On its fundamental frequency, the rotary operates as a 3-element beam. The measured radiation pattern is shown by figure 6A and the important performance data are tabulated in table II. The beam has a very well defined unidirectional pattern. The front-to-back ratio was measured to be about 29 db or about 800 to 1 in power and the front-to-side ratio over 23 db or over 200 to 1 in power.

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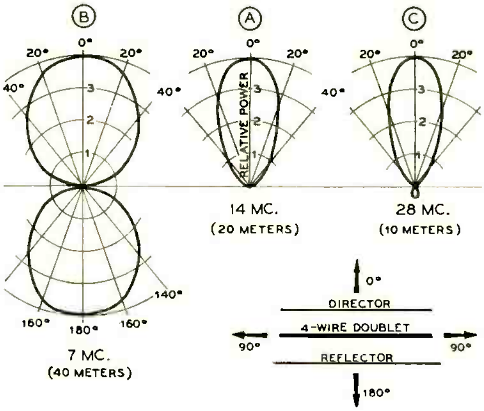

Figure 6. Measured horizontal radiation patterns of the rotary on 3 bands. The curves are plotted in terms of relative power and all curves are adjusted to the same maximum so that only the shapes of the curves are significant.

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[13] "More Thoughts on Effective Antennas," A. H. Lynch, *QST*, Nov. 1939, p. 11.

Predistortion Applied to Amateur Radiotelephony

By W. W. SMITH,* W6BCX

By incorporating a standardized filter, simple and inexpensive, in all amateur receivers and radiophone transmitters, many benefits would be realized. QRM would be greatly reduced, yet a worthwhile increase in effective sideband power would be obtained.

By incorporating in the speech system of an amateur voice transmitter a band pass filter having a response characteristic similar to that of curve A in figure 1, many advantages are to be obtained with negligible loss in articulation and practically no sacrifice in quality or "naturalness."

By incorporating a similar filter in a receiver tuned to the transmitter using the curve-A band pass filter, the noise level will be greatly reduced and the voice will sound exactly the same as when no filter is used on the receiver.

To get back to the transmitter, let's see just what the advantages are. First, the suppression of bass frequencies permits heavier modulation at the more useful voice frequencies in the middle range (about 1500 cycles) without overmodulation. The advantages of bass suppression have been pointed out in numerous articles and many amateurs now incorporate bass suppression in their transmitters.

Secondly, the suppression of frequencies above 3000 cycles results in a tremendous reduction in QRM to stations operating in adjacent channels. Greatest reduction in QRM will be obtained when the low pass filter (giving sharp 3000 cycle cutoff) is connected to the output of the modulator, as high frequency harmonics generated in the modulator stage then will be suppressed. A filter in one of the speech amplifier stages will do almost as much good in most cases, however, and is less expensive. Few listeners will even be aware that the higher voice frequencies are being lopped off, except for the fact that the signal occupies a much narrower channel.

The possible and practical reduction in bandwidth of amateur phone stations by the suppression of modulation frequencies above about 3000 cycles has been known for a long time. But because it helps the other fellow instead of the amateur who puts in the filter, little progress has been made in this direction. It is doubtful if there is a single phone amateur who wouldn't be willing to incorporate a band pass filter in his rig *if he were assured every other amateur would do the same.*

A regulation requiring a suitable filter on every amateur phone transmitter would be a blessing, as it would be the same as widening the band by 50 to 100 per cent. But one can hardly expect an amateur to go to the trouble and expense (even though it may be small) of installing a filter when the majority of amateurs are still cutting a 15 kc. swath in the band.

Undoubtedly some kind of campaign will be required in order to get voluntary, unanimous adoption. Perhaps a "Restricted Sidebands" club would start the ball rolling.

The receiver is an easier problem. Putting on a filter, or proportioning the various coupling and cathode by-pass condensers in the a.f. portion to cut off everything below 300 and above 3000 cycles, benefits the owner of the receiver, not the other fellow. It isn't necessary for everyone to adopt a receiver filter before anything is gained.

Noise is distributed fairly evenly over the audio spectrum. A surprising reduction in background noise, which is usually the limiting factor in weak signal reception, can be achieved by cutting off everything below 300 and above 3000 cycles in the receiver. It is fortunate that most communications receivers have rather poor response above about 3500 kc., or the background noise would be worse than it is. This applies especially to receivers having a sharp i.f. amplifier, in which the

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* Editor, RADIO.

higher frequency sidebands are attenuated.

The reduction in background noise that can be obtained simply by whacking off the high end is rather obvious in any receiver that has a so-called "tone control." The trouble with the customary tone control is that when it is set to give a worthwhile attenuation at, say, 3500 cycles, there is considerable attenuation at frequencies as low as 1500 or 2000 cycles. In other words, the tone control does not provide sufficiently sharp cutoff. That is why the voice sounds muffled and the intelligibility is impaired when the tone control is adjusted so as to give an appreciable reduction.

With uniform response out to about 3000 cycles and then very sharp cutoff, this muffled effect is not present, and background noise, high frequency "monkey chatter" and heterodyne from adjacent channel stations, etc., are greatly reduced in amplitude.

Few communications type receivers have provision for bass suppression. The response is generally poor, below 100 cycles, but there is considerable gain between 150 and 300 cycles. By cutting off everything below 300 cycles with a sharp filter, a substantial reduction in background noise results, with no impairment of speech intelligibility and very little reduction in quality or "naturalness."

An elaborate filter is not required; simply reducing the value of the coupling condenser feeding the grid of the power amplifier (assuming a single pentode is used in the output) and reducing the value of the cathode by-pass condenser to an appropriate value will give a fairly sharp cutoff. When this treatment is applied to two cascaded audio stages and the values are chosen correctly, the cutoff is surprisingly sharp.

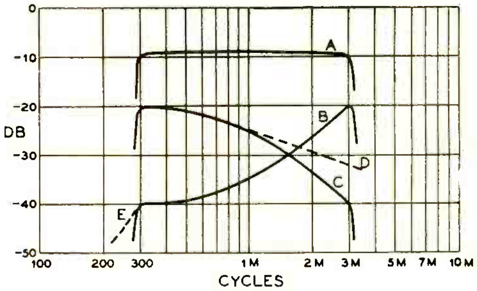

Figure 1.

Curve A is that of a typical band pass speech filter having sharp cutoff and high attenuation, useful on both transmitter and receiver. In spite of the restricted response, a high degree of articulation and quality will be maintained.

Curve B represents the response of a filter recommended for high frequency pre-emphasis for amateur voice work. The filter need not have exceedingly sharp cutoff on the low frequency end, the dashed continuation E being sufficiently sharp. This filter is used on the transmitter.

Curve C indicates characteristic of perfectly complementary restoring filter for reception of voice transmitted via pre-emphasizing filter having response indicated by Curve B. Curve D represents attenuation of typical "tone control" when turned to "bass." This curve will provide satisfactory restoration for reception of pre-emphasized voice transmission.

High Frequency Pre-Emphasis

Because the lower voice frequencies represent the greatest power, both average and peak, it is possible to use a speech amplifier with a characteristic similar to that of curve B without increasing the peak amplitudes appreciably when maintaining a fixed low frequency (300 cycle) level. The reason for this is that the peak amplitude of the 3000 cycle component in male speech is generally about 15 db lower than the 300 cycle peak amplitude. By designing our band pass filter to have a rising characteristic, it is possible thus to emphasize the higher voice frequencies and transmit them at a higher level without increasing the peak modulation percentage.

Maximum peak speech energy for the average male voice occurs in the vicinity of 300-400 cycles, falling off rather uniformly towards the higher frequencies. This means that the higher frequencies may be emphasized without increasing the peak amplitude of modulation, or "modulation percentage." By correspondingly attenuating the higher audio frequencies in the receiver, background noise is greatly reduced and the voice is restored to its original character. High frequency pre-emphasis will often permit reading of a weak signal otherwise unreadable.

In actual practice it will be found desirable to design the filter to have a 20 db rise, so that overmodulation will usually occur first at the higher voice frequencies instead of in the lower register. However, a filter providing sharp 3000 cycle cutoff with high attenuation *must* be used in order to prevent excessive interference to adjacent channel signals. It is for this reason that pre-emphasis and band pass speech transmission are so tied up together.

High frequency pre-emphasis at the transmitter makes your voice sound somewhat high pitched and causes your "s" sounds to hiss excessively when heard on a receiver that has

[*Continued on Page 84*]

MODULATION MONITOR *and* PRE-AMPLIFIER

By BILL DAVIS,* W5GHU

In looking for something in the way of a modulation monitor that would tell a little more about the condition of a phone carrier than the simple diode type of carrier-shift indicator, this monitor was finally evolved from the mess of parts that made up its highly experimental ancestors. Also, in view of the clutter of separate gadgets that had been seen on the operating desk, I decided to center as many of the usual transmitter controls as possible in the one unit. Hence the built-in pre-amplifier for the microphone, and the large blank space down the left side of the chassis. The wide open spaces on the left are reserved for an electron-coupled oscillator to be installed as soon as the all important pocketbook permits. Room has also been left in the middle of the pre-amplifier for a high-pass filter to drop all the unnecessary audio power below about 300 cycles.

The monitor consists of a 6H6 half-wave carrier rectifier, a 6C5 audio frequency amplifier, a 6H6 full-wave audio rectifier, and a 6N7 vacuum-tube voltmeter to furnish readings from the d.c. output of the two rectifiers. Looking at the top view in figure 3, the left-hand row, reading back, shows the input coil, 6C5 audio amplifier, and the 6N7 voltmeter. The next row over to the right, front to back, consists of the 6H6 r.f. rectifier, audio gain control for initial calibration, and the 6H6 full-wave audio rectifier.

The front view (figure 2) shows the monitor controls grouped in the center of the panel, just below the meters. The knob in the center tunes or detunes the input circuit to vary the amount of the r.f. input to the monitor. The knobs to left and right of this adjust the meters above them to zero by biasing the two sections of the 6N7 to cutoff. In the rear view (figure 3) the six-prong plug to the power supply and the auto-radio type socket into which a short antenna is plugged for r.f. pickup are shown.

The circuit for the pre-amplifier starts with a pentode connected 6K7, and continues through gain control to a triode connected 6J7. This feeds through either a .01-μfd. condenser or the high-pass filter (at present a .001-μfd. condenser) to a 6J7 triode connected output tube which is coupled to the modulators through a 200-ohm line. The grid return resistor of this last stage is a potentiometer whose variable tap is connected to the grid of a 6J7 used as an amplifier in the volume compression circuit. This stage is transformer coupled to a 6H6 full-wave rectifier which applies a negative bias to the suppressor grid of the 6K7 input stage. Delay voltage for the compression rectifier is obtained from the plate supply through a series resistor and a potentiometer biasing the 6H6 cathode positively so compression starts at some level decided upon between about 70 and 90 or 95 per cent modulation. This delay adjustment can be seen

Figure 1. The modulation monitor shown in its natural habitat on the operating table to the right of the receiver. It is shown mounted in a cabinet matching that of the receiver, with a row of indicator lights for the remotely controlled transmitter below it.

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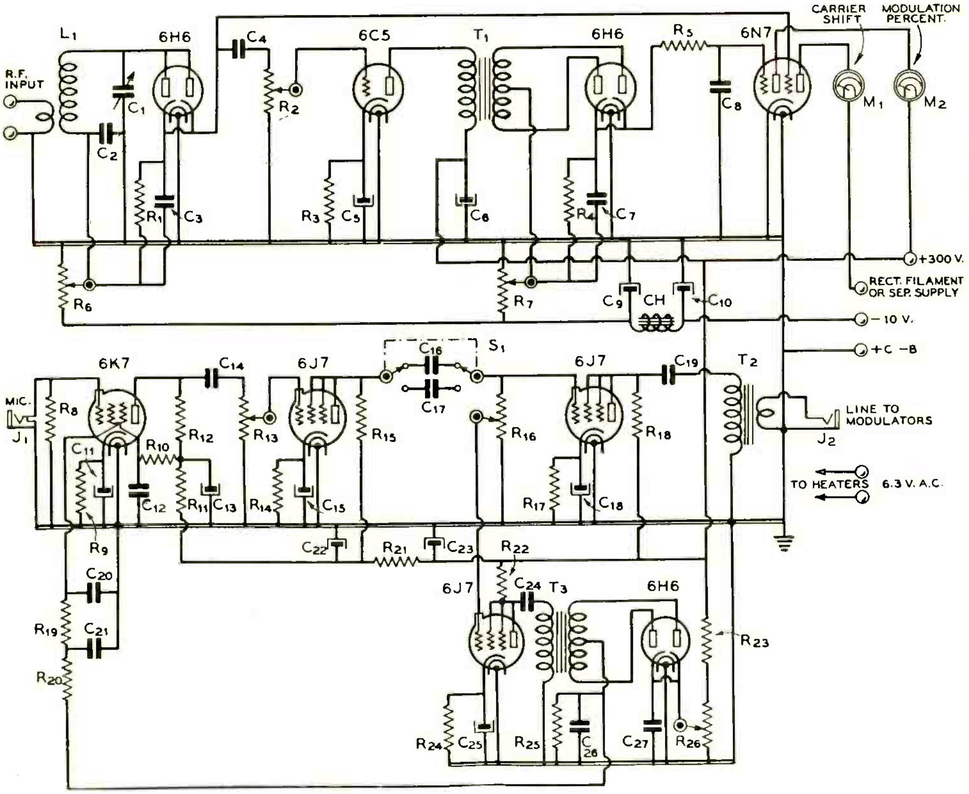
* 2905 Hamilton St., El Paso, Texas.



Wiring diagram of the combination modulation monitor and pre-amplifier.

C_1—35-µµfd. midget variable
C_2—.05-µfd. 400-volt tubular
C_3—.00005-µfd. midget mica
C_4—.05-µfd. 400-volt tubular
C_5—10-µfd. 25-volt tubular
C_6—8-µfd. 450-volt elect.
C_7—.05-µfd. 400-volt tubular
C_8—.05-µfd. 400-volt tubular
C_9—25-µfd. 25-volt elect.
C_{10}—10-µfd. 25-volt elect.
C_{11}—25-µfd. 25-volt elect.
C_{12}—0.1-µfd. 400-volt tubular
C_{13}—8-µfd. 450-volt elect.
C_{14}—.05-µfd. 400-volt tubular
C_{15}—25-µfd. 25-volt elect.
C_{16}—.01-µfd. 400-volt tubular
C_{17}—.001-µfd. condenser or high-pass filter
C_{18}—25-µfd. 25-volt elect.
C_{19}—0.1-µfd. 400-volt tubular
C_{20}, C_{21} — 0.1-µfd. 400-volt tubular
C_{22}, C_{23}—8-µfd. 450-volt elect.
C_{24}—0.1-µfd. 400-volt tubular
C_{25}—25-µfd. 25-volt elect.
C_{26}—0.1-µfd. 400-volt tubular
C_{27}—.25-µfd. 400-volt elect.
R_1—50,000-ohms, 1-watt res.
R_2—500,000-ohm potentiometer
R_3—1250 ohms, 1 watt
R_4—1.0 megohm, 1 watt
R_5—1.0 megohm, 1 watt
R_6, R_7—5000-ohm potentiometer
R_8—500,000 ohms, 1 watt
R_9—1000 ohms, 1 watt
R_{10}—1.0 megohm, 1 watt
R_{11}—20,000 ohms, 2 watts
R_{12}—250,000 ohms, 1 watt
R_{13}—500,000 - ohm potentiometer
R_{14}—5000 ohms, 1 watt
R_{15}—100,000 ohms, 1 watt
R_{16}—500,000-ohm potentiometer
R_{17}—2000 ohms, 1 watt
R_{18}—75,000 ohms, 1 watt
R_{19}, R_{20}—250,000 ohms, 1 watt
R_{21}—20,000 ohms, 2 watts
R_{22}—100,000 ohms, 1 watt
R_{23}—75,000 ohms, 2 watts
R_{24}—2000 ohms, 1 watt
R_{25}—250,000 ohms, 1 watt
R_{26}—10,000-ohm potentiometer
M_1,M_2—See text for values
S_1—D.p.d.t. switch
CH—15-hy. midget choke
L_1— Coil to tune to band of operation
J_1—Microphone jack
J_2—Output jack
T_1—Plate to push-pull grids
T_2—plate to line
T_3—Plate to push-pull grids

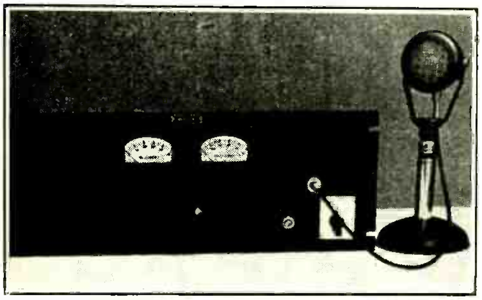


Figure 2. Closeup view of the monitor shown removed from its cabinet.

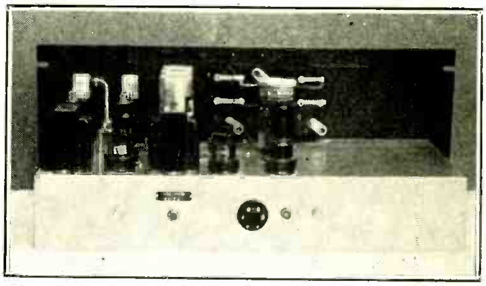


Figure 3. Rear view of the monitor-speech amplifier. The plug-in coil for 14-Mc. operation can be seen in place. The six-prong socket is for the power plug from the remote power supply.

next to the output jack in figure 3 near the right-hand end of the chassis.

In figure 4 starting from left to right on the pre-amplifier section and going from front to back are the filler condenser and output transformer in the center, the 6J7 second stage, 6J7 output stage, and the 6H6 compression rectifier in the middle row. The 6K7 input tube, 6J7 compression amplifier, and push-pull input transformer T_3 are on the right side. In figure 2 the gain control is on the right side of the panel with the frequency response selector switch just to its left. The locking type microphone connector is just above these two controls. The gain control for the compression amplifier is located between and just in front of the 6J7 output and 6J7 compression amplifier tubes. The rest of the circuit details are shown in the diagram.

Calibrating the Monitor

The best way to adjust the monitor is to borrow some fortunate friend's oscilloscope. If this can't be done a vacuum-tube peak voltmeter or modulometer may be used. Another method would be to connect a temporary negative peak indicator to the rig and use it to find the point where the transmitter is 100 per cent modulated. The meters should be set so that the needles fall slightly to the left of zero on the dials with the power off. but come up to zero with the power on. This gets the operation of the voltmeter somewhat up off the bend in the plate current curve and makes the readings a little more linear.

With the power supply on and the meters adjusted to zero, a short antenna is connected to the monitor and C_1 is tuned until the "carrier" meter reads half scale wth the transmitter on. Any other value could also be selected as long as the same value is always used when using the monitor.

Modulation is applied to the carrier at a known percentage, and the potentiometer in the 6C5 grid adjusted until the "per cent modulation" meter reads the appropriate value on its scale. It would simplify matters considerably if a special scale were used on the percentage meter. One calibrated 0 to 100 would be about right. Higher calibrations would be of little use since we are supposed to stay below 100 per cent. The meter circuit is one which reaches peaks quite rapidly, but the pointer is somewhat slowed on its return to zero which makes the indications quite accurate in use and very easy to follow with the eye. If none of the above methods of calibration is available, the whole works could be lugged around to some station where at least one of them could be found.

The Pre-Amplifier

The pre-amplifier adjustment is quite simple. With both the compression controls set

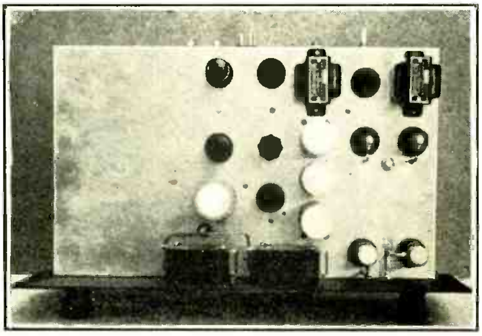


Figure 4. Looking down upon the chassis. The large space to the left is for possible future use as a mounting for a variable-frequency oscillator unit for transmitter control.

at zero the gain is adjusted to about normal for the microphone in use and then a fixed audio tone of some sort is substituted for the mike. Input is increased until the per cent modulation meter has reached the value desired for cutoff to begin. The gain on the compressor is then advanced quite a bit and the threshold bias cut down until the modulation percentage just begins to drop. The compressor gain is then adjusted so further increases in input fail to overmodulate the transmitter. These two adjustments will probably have to be gone over a few times as the controls interlock to some extent and too rapid compression will cause very noticeable distortion in the signal.

The power supply requirements will vary with the meters used. With the 6N7 voltmeter tube any meters up to 15 ma. may be used with a 300-volt power supply. With the high current meters a voltage-regulated power supply will be needed, but for meters of 5 ma. or less the voltage regulation would be an unnecessary refinement. Any ordinary power supply of good regulation with an output of about 300 volts at 50 to 60 ma. should be sufficient for most meters. It should also have provision to deliver about 10 volts of bias for the 6N7. The supply actually used is parked under the desk out of the way and is also used to supply power to the transmiter control relays. Regulation of the power supply could be either by the neon tube, 57-2A3 method or by using a pair of VR-150's in series. Poor regulation will show up as "phoney" carrier shift on the meters.

All in all it's a very handy gadget to have next to the receiver, and promises to become more so when the e.c. oscillator is installed in that blank space.

• • •

Amendments to Regulations

The Amateur Rules were amended, effective December 1, 1939, as follows:

Section 152.25. *Frequencies for exclusive use of amateur stations.*—The following bands of frequencies are allocated exclusively for use by amateur stations:

1715 to 2000 kc.[2]
3500 to 4000 "
7000 to 7300 "
14000 to 14400 "
28000 to 30000 "
56000 to 60000 kc.
112000 to 116000 "
224000 to 230000 "
400000 to 401000 "

Section 152.27. *Frequency bands for telephony.*—The following bands❖ of frequencies are allocated for use by amateur stations using radiotelephony, type A-3 emission:

1800 to 2000 kc.
28500 to 30000 "
56000 to 60000 "
112000 to 116000 kc.
224000 to 230000 "
400000 to 401000 "

Section 152.29. *Television and frequency-modulation transmission.*—The following bands of frequencies are allocated for use by amateur stations for television and radiotelephone frequency-modulation transmission:

112000 to 116000 kilocycles
224000 to 230000 "
400000 to 401000 "

Section 152.30. *Facsimile transmission.*—The following bands of frequencies are allocated for use by amateur stations for facsimile transmission:

1715 to 2000 kc.[2]
56000 to 60000 "
112000 to 116000 "
224000 to 230000 kc.
400000 to 401000 "

Section 152.32. *Types of emission.*—All bands of frequencies allocated to the amateur service may be used for radiotelegraphy, type A-1 emission. Type A-2 emission may be used in the following bands of frequencies only:

56000 to 60000 kc.
112000 to 116000 "
224000 to 230000 kc.
400000 to 401000 "

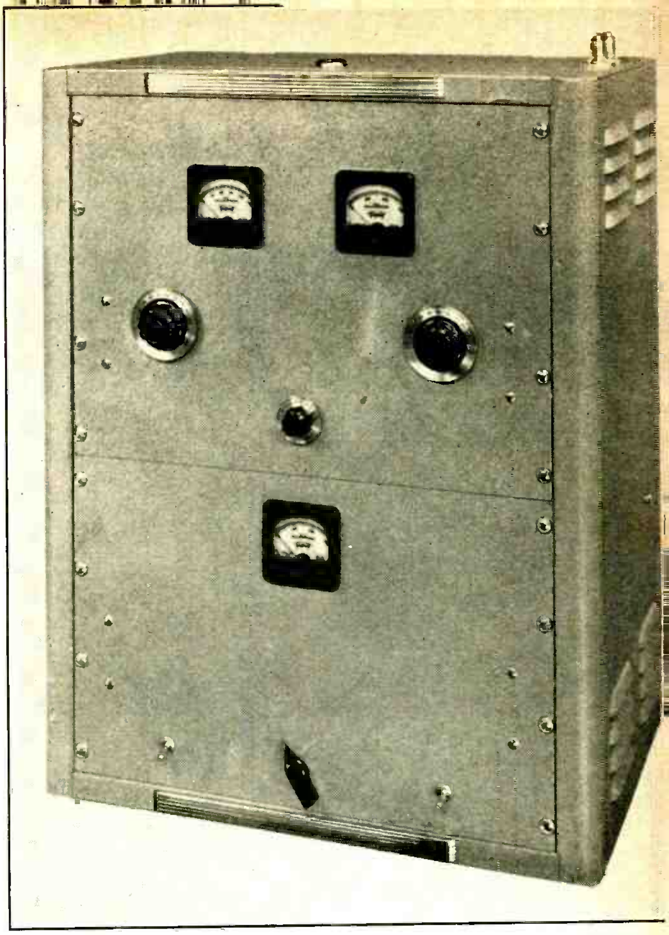
Section 152.43. *Modulation of Carrier Wave.*—Except for brief tests or adjustments, an amateur radiotelephone station shall not emit a carrier wave on frequencies below 112000 kilocycles unless modulated for the purpose of communication.

❖ *Editor's Note:* Omission of the 3900-4000 kc. and 14150-14250 kc. phone bands from this section indicates *only* that they have *not* been amended. The bands have *not* been withdrawn from use.

[2] Subject to change to "1750 to 2050" kilocycles in accordance with the "Inter-American Arrangement Covering Radiocommunication," Havana, 1937.

125-WATT 1940 TRANSMITTER

By W. T. BISHOP,* W9UI



NEATNESS AND SIMPLICITY IN AN ALL-BAND PHONE AND C.W. TRANSMITTER.

This transmitter was designed with the idea that it must be compact, self-contained neat appearing and last but not least, economical to build. The illustrations show that these requirements have been fulfilled. The cost of the entire unit is about $175 at amateur prices, including cabinet, tubes, crystals, coils, etc. It fills the bill for the amateur who has limited operating space and desires a moderate power transmitter at reasonable cost.

The r.f. line-up is an old standby, one that has proven itself in amateur use and is widely popular. It has been brought up to date with minor refinements and now incorporates some new components that have become available during the past year.

The oscillator uses a T-21 operating either at crystal frequency or double crystal frequency, a tritet circuit being used to give optional harmonic output. By keeping the plate voltage below 300 volts and the screen voltage below 150 volts the crystal current is low enough that there is no crystal heating. No tuning controls are brought out for the crystal stage, as once the tank circuits are adjusted for a particular band they require little attention thereafter. The coil forms have provision for mounting a small tuning condenser inside them, and each coil has its individual air trimmer. A fixed capacity of 100 $\mu\mu$fd. is permanently connected across the cathode coil socket, eliminating the need for more than a 50-$\mu\mu$fd. tuning condenser in each cathode coil.

The following stage is a TZ-40 used as a buffer-doubler and operated at reduced power, since it is only required to drive a single T-55 in the final. The plate coil of the TZ-40 is link coupled to the grid coil of the final. Small manufactured coils are used on both cases, center linked for the plate and end linked for the grid coil.

The final amplifier uses a Cardwell type AFU foundation unit which consists of a

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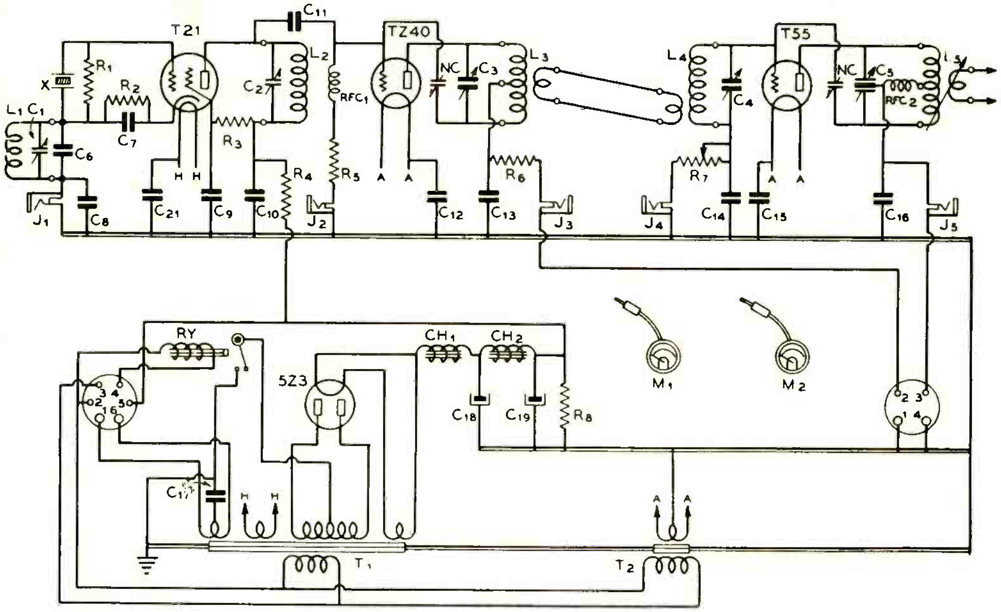
* Engineering Dept., Taylor Tubes, Inc.



Wiring diagram of the r.f. section and the low voltage power supply.

C_1, C_2—50-μμfd. air padder

C_3—50-μμfd. 3000-volt variable

C_4—50-μμfd. midget variable

C_5—100-μμfd. per section 3000-volt variable

C_6—.0001-μfd. 1200-volt mica

C_7—.001-μfd. 600-volt mica

C_8, C_9, C_{10}—.005-μfd. mica

C_{11}—.00005-μfd. 1200-volt mica

C_{12}—.005-μfd. mica

C_{13}, C_{14}—.001-μfd. 1200-volt mica

C_{15}—.005-μfd. mica

C_{16}—.001-μfd. 2500-volt mica

C_{17}—.005-μfd. mica

C_{18}, C_{19},—8-μfd. 600-volt elect.

C_{21}—.005-μfd. mica

NC—7-μμfd. midget neut. cond.

R_1—50,000 ohms, 1 watt

R_2—200 ohms, 10 watts

R_3—10,000 ohms, 10 watts

R_4—5000 ohms, 20 watts

R_5—10,000 ohms, 10 watts

R_6—10,000 ohms, 100 watts

R_7—7500 ohms, 25 watts

R_8—50,000 ohms, 25 watts

T_1—1040 c.t., 180 ma.; 5 v., 3 a.; 6.3 v., 3 a.; 6.3 v., 3a.

T_2—7.5 volts, 8 amperes

CH_1—5-20 hy., 200-30 ma.

CH_2—10 hy., 200 ma.

M_1—0-150 d.c. milliammeter

M_2—0-300 d.c. milliammeter

Coils — See Buyer's Guide

J_1—Crystal cathode current jack

J_2—Buffer Grid Current Jack

J_2—Buffer plate current jack

J_4—Final grid current jack

J_5—Final plate current jack

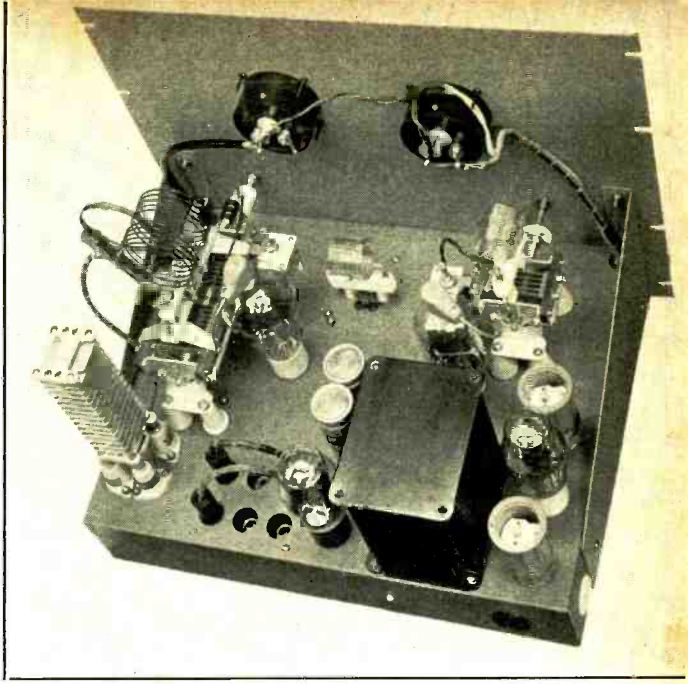
RY — Exciter-speech supply relay

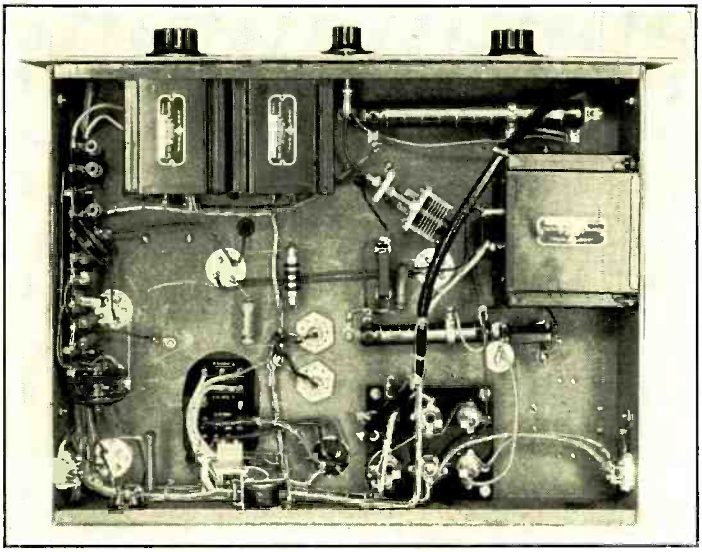
RFC_1—2½-mh., 125-ma., r.f. chokes

MT-100-GD tuning condenser, two neutralizing condensers, and two brackets to take a manufactured plug-in coil assembly. Since the final amplifier is single ended only one neutralizing condenser is needed; the extra one is removed and used for the buffer-doubler stage. The tuning condenser will cover the 10- to 80-meter bands inclusive with standard coils, and if 160-meter operation is desired it is only necessary to plug in a 100-μμfd. fixed air condenser across the two stators of the tuning condenser. Note that the plate voltage is connected directly to the frame of the condenser, which makes it necessary to insulate it quite well from the chassis.

Metering of the r.f. section is done with only two meters. Five closed circuit jacks are mounted on a small bakelite panel under the chassis and so connected to measure oscillator, buffer and final amplifier plate current, buffer and final amplifier grid current. Once the transmitter is adjusted the meters are plugged into the final amplifier plate and grid current jacks. Any change in the performance of the transmitter will usually be reflected in these meters. The plugs are never touched

Top view of the r.f. section shelf which also contains the plate supply for the crystal oscillator. The air-padder condensers can be seen inside the cathode and plate coils for the crystal stage. The plug-in loading capacity for the final tank circuit can also be seen along the left rear of the chassis.





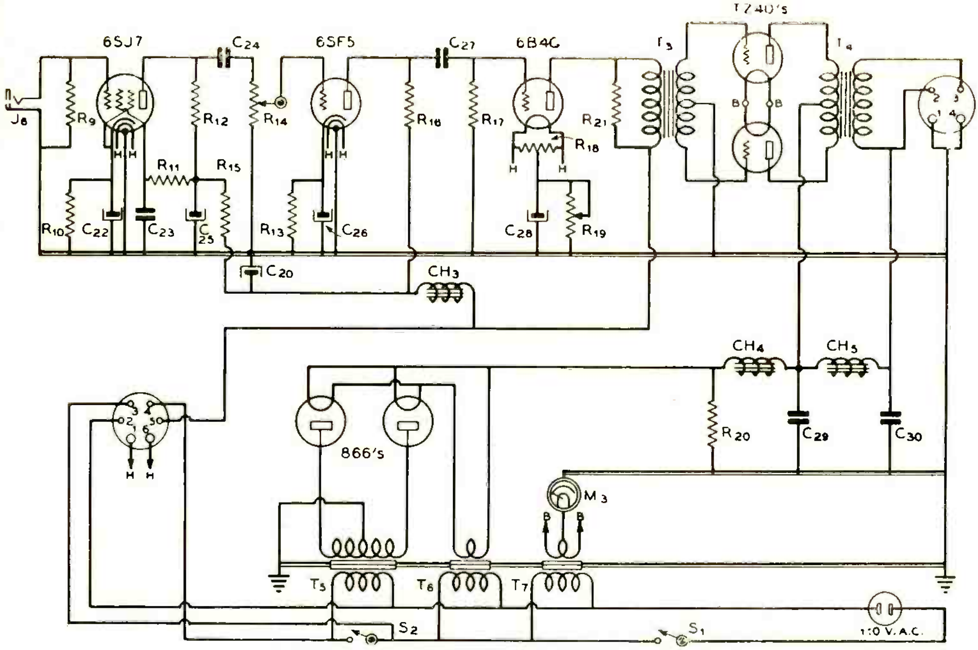
Bottom view of the r.f. section chassis. The grid condenser for the T-55 stage has been mounted at an angle and more close to the grid of the tube in order to clear the swinging choke. The condenser is rotated by means of a flexible shaft. Note the bakelite terminal board with the five jacks mounted upon it for metering the various circuits.

without first turning off all plate voltages.

The r.f. section is mounted on a standard 17 x 13 x 3 inch chassis which also contains the low voltage power supply for the crystal oscillator and speech amplifier.

The other chassis contains the speech amplifier, modulator and high voltage power supplies. The high voltage power supply delivers 1250 volts to the final amplifier, modulator, and to the buffer through a series resistor. The modulator is operated at zero bias and with no signal input the plate dissipation is approximately 42 watts per tube. With signal input the plate efficiency of the modulator improves so that the average plate dissipation is less than the rated 40 watts.

In order to conserve space and keep the cost as low as possible a very simple speech amplifier was used. The driver stage is a single 6B4G. It does the job nicely because



Schematic of the speech, modulator, and the high voltage power supply.

C_{20}—8-µfd. 600-volt electrolytic

C_{22}—5-µfd 25-volt elect.

C_{23}—.05-µfd. 600-volt tubular

C_{24}—.01-µfd. 400-volt tubular

C_{25}—8-µfd. 450-volt elect.

C_{26}—5-µfd. 25-volt elect.

C_{27}—.01-µfd. 400-volt tubular

C_{28}—25-µfd. 50-volt elect.

C_{29}, C_{30} — 2-µfd. 1500-volt coil

R_9—5 meghoms, 1 watt

R_{10}—1700 ohms, 1 watt

R_{11}—2.5 megohms, 1 watt

R_{12}—500,000 ohms, 1 watt

R_{13}—4500 ohms, 1 watt

R_{14}—500,000-ohm potentiometer

R_{15}—50.000 ohms, 1 watt

R_{16}, R_{17}—500,000 ohms, 1 watt

R_{18}—50 ohms, c.t., 1 watt

R_{19}—800 ohms, 25-watt slider

R_{20}—50,000 ohms, 75 watts

T_3—Driver trans. 2:1 stepdown

T_4—125-watt multiple-match modulation transformer

T_5—2920 c.t., 500 ma. trans.

T_6—2.5 volts, 10 amperes

T_7—7.5 volts, 8 amperes

M_3—0-150 d.c. milliammeter

S_1—Filament power switch

S_2—Plate power switch

CH_3—20-hy., 50-ma. choke

CH_4—5-20-hy., 400-50-ma. swing choke

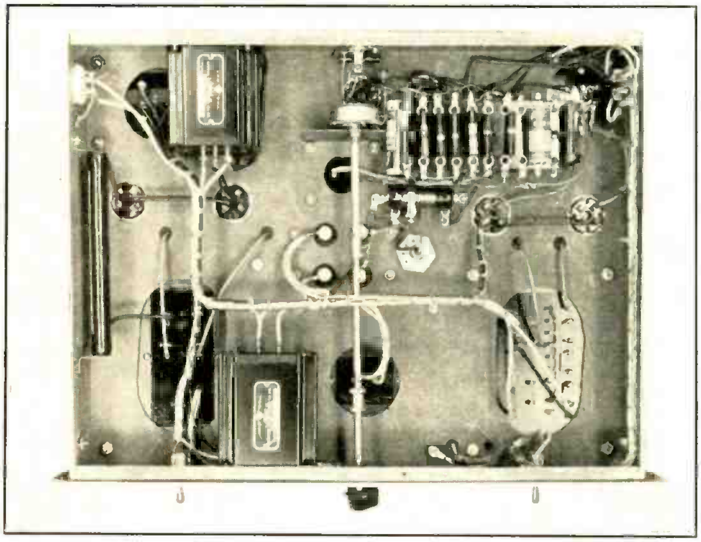
CH_5—10-hy., 200-ma. choke

J_8—Microphone jack

the modulators take so little driving power for the required output. A load of 14,000 ohms plate to plate is recommended for the modulators. The fore part of the speech amplifier consists of a 6SJ7 and a 6SF5 tube. The amplifier is conventional except for the use of the new single-ended tubes. In assembling the amplifier a "pre-assembly" was made containing all resistors and condensors. It is a simple matter then to make the few remaining connections to the tube sockets.

There was some doubt as to the feasibility of mounting the speech amplifier on the same chassis as the high voltage power supply and in the same cabinet as the r.f. portion of the transmitter. The power supply caused no trouble at all. Some r.f. feedback was experienced on 10 and 20 meters when the audio gain control was in excess of three quarters open.

Top view of the power supply, modulator, and speech amplifier deck. The microphone plugs into the jack on the rear of the chassis, allowing a very short lead from it to the grid of the first speech tube. Note the use of safe, protected plate caps for the 866's.



Under-chassis view of the speech amplifier, modulator, and main power supply deck. The speech amplifier components are arranged along the extreme rear of the chassis. Note the use of a large mounting bracket for the volume control and the low-level input stages of the speech amplifier.

It was found that the shell of the 6SJ7 tube was not acting as a good shield. When touched, violent feedback would result, although the number one socket pin was properly grounded. An ohmmeter revealed approximately 0.25 ohms d.c. resistance between the shell and the number one pin. A short piece of wire soldered from the pin to the shell completely cured all the feedback. It appears that this resistance is in most of the metal tubes for the purpose of getter flashing, and is occasionally responsible for instability in high gain audio stages, especially when in strong r.f. fields.

The transmitter operates on all bands with an input of 175 to 200 watts, and will deliver an output of approximately 75% of the plate input.

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

Parallel
CATHODE MODULATION

AN ALTERNATIVE SYSTEM OF CATHODE MODULATION FOR MEDIUM-POWERED EQUIPMENT

By RAY L. DAWLEY,* W6DHG

Cathode modulation, as has been discussed in previous issues of RADIO, consists of the simultaneous plate and grid modulation of an r.f. amplifier in the proper relative amounts by the injection of the audio energy into the cathode circuit of the amplifier. This audio energy may be impressed into the cathode circuit by means of a transformer, [1, 2] a dynamically variable series resistor,[3] or by means of a common choke in the cathode circuits of the amplifier and the modulator. It is this latter system which will be described in this article.

Experience with many types of cathode modulated amplifiers has shown that the value of driving impedance to be inserted into the cathode circuit should be of the order of 500 ohms. The correct impedance value seldom varies over a ratio of more than two to one from this mean. [1, 2] Degenerative feedback experience and theory has also shown that when the audio energy from a single-ended amplifier stage is taken from the cathode circuit, the output impedance of the audio amplifier is also effectively reduced to this same order of magnitude.

Obviously, then, an audio amplifier tube with the audio energy taken from its cathode circuit and with the plate by-passed to its plate supply is ideally suited to use as a cathode modulator for an r.f. amplifier with nothing more than a common choke for the coupling medium. Figure 1 illustrates the method of connection by illustrating how a tube such as the 2A3 might be used to modulate an 809 or similar tube with 50 or 60 watts input.

Advantages of Parallel Cathode Modulation

Cathode modulation has certain advantages over other systems of amplitude modulation, and a thorough inspection of the diagram of figure 1 will show that parallel cathode modulation has two main advantages over other cathode modulation systems for use with medium-powered equipment. These are: First, since the cathode impedance of the modulator tube is very closely the same as

The October, 1939, issue of RADIO introduced practical cathode modulation. The December issue clarified conventional cathode modulation, gave constructional information, and introduced an alternative system, series cathode modulation. In this issue we introduce another alternative system, parallel cathode modulation. It is best suited to use in portable and medium-powered equipment, but is also applicable to higher power.

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* Technical Editor, RADIO.

[1] "Cathode Modulation," Jones, RADIO, October 1939, p. 14.

[2] "Cathode Modulation Operating Data," RADIO Staff, RADIO, December 1939, p. 16.

[3] "Series Cathode Modulation," Dawley, RADIO, December 1939, p. 24.

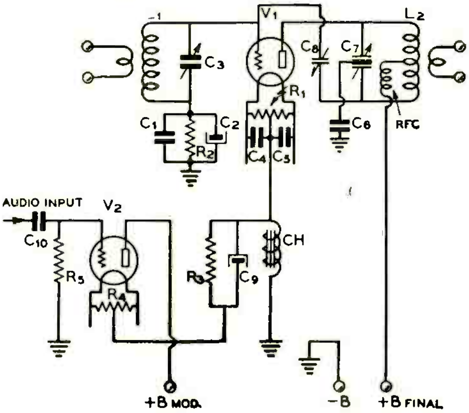


Figure 1. Wiring diagram of a single-ended r.f. amplifier being modulated by a triode parallel cathode modulator. R_3, by-passed by C_9, plus the drop across the choke CH furnishes the bias for the modulator tube V_2.

C_1—.005-µfd. mica
C_2—8-µfd. 450-volt elect
C_3—Conventional for band of operation
C_4, C_5—.001-µfd. mica
C_6—.002-µfd. 5000-volt mica
C_7—Conventional for band of operation
C_8—Neut. condenser for V_1
C_9—10-µfd. 100-volt elect.
C_{10}—.05-µfd. 400-volt tubular
R_1—C.t. resistor or tap on fil. trans.
R_2—10,000 to 25,000 ohms, 10 watts
R_3—500 ohms, 10 watts
R_4—C.t. res. or tap on fil. trans.
R_5—100,000 ohms, 1 watt
L_1, L_2—Coils for band operated
RFC — Conventional for band operated
CH — 3-to-10 hy. 150-ma. filter choke
V_1—809, T-20, or similar
V_2—2A3 or pair 45's in parallel

that of the cathode circuit of the tube to be modulated, no matching transformer is needed as a coupling impedance between them; it is only necessary to insert a common choke in the common cathode circuit of the two tubes. Second, the tubes in the parallel cathode modulator are operating with 100 per cent degenerative feedback; the plate is returned to the h.v. power supply and all the audio voltage output of the stage is impressed upon the grid of the tube 180° out of phase with the incoming voltage.

Degenerative Feedback

It is this inherent degenerative feedback which lowers the effective plate impedance (or cathode impedance, if you want to call it that) to such a great extent. Although the percentage of feedback will be the same in all cases (100 per cent), the value of feedback expressed in decibels will be a function of the amplification factor of the tube. The amount by which the plate impedance is lowered, however, is dependent upon the amount of feedback expressed in decibels. Thus a 2A3 operating under rated conditions will put out 133 peak volts into a 2500-ohm load with a 45-volt grid swing. With 100 per cent degenerative feedback it will put out the same peak voltage but will require a driving voltage of 133 plus 45 or 178 volts. From these values we determine that the feedback around the stage is slightly less than 12 db. This value of feedback will lower the effective plate impedance of the 2A3 to a value in the vicinity of 300 ohms. This value will operate very well into the cathode circuit of the amplifier to be modulated.

On the other hand a 6L6 operating into its rated load and at the rated plate and screen voltages will put out slightly over 300 peak volts with a 17.5-volt peak grid swing. With 100 per cent degenerative feedback the new grid swing that will be required is about 320 peak volts, thus giving about 25 db of degenerative feedback. This much greater amount of feedback will lower the much higher plate impedance of the 6L6 to an effective value in the vicinity of 500 ohms.

Modulator Tubes

From the preceding paragraph we see that as long as high trans-conductance tubes are used the plate impedance will be lowered to a value that will be satisfactory for use as a parallel cathode modulator. A single 2A3 can be figured to give an output of about 5 watts; a single 6L6, about 12 watts; and a pair of 6L6's, about 25 watts. Suggested modulator and r.f. amplifier combinations are: a single 2A3 operating at 300 volts and 55 volts bias to modulate an 809 or T-20 with 750 volts at 75 plate ma.; a single 6L6 at 375 volts plate, 250 screen, and —17.5 grid to modulate an 811, T-40, HK-24, or 35T at 1250 volts and 75 to 100 plate ma.; a pair of 6L6's in parallel at the above conditions to modulate a pair of the amplifier tubes either in parallel or push-pull at the same plate voltage (1250 volts) and at twice the plate current.

At inputs greater than about 250 watts (the highest of the above conditions) other systems of cathode modulation are more desirable. At lower inputs than the above other tube combinations will suggest themselves; there are a number of tube combinations that would be suitable for battery operated and portable equipment. Since all high transconductance tubes will have an effective plate (cathode) impedance of the order of 500 ohms with 100

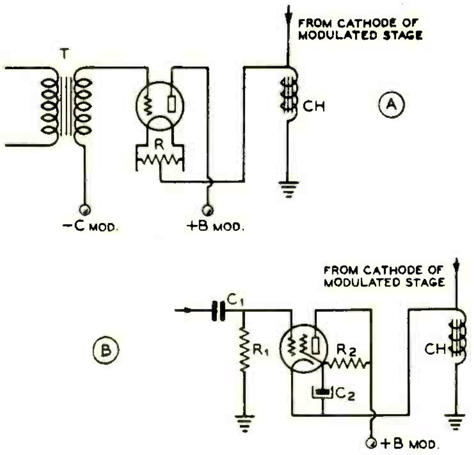


Figure 2. **(A) Using external bias with triode modulator tube and transformer in grid circuit. CH—See figure 1 and text. T—2-to-1 or 3-to-1 audio trans. (B) Connection of beam tetrode modulator tube with drop across choke as modulator bias. R_2—50,000 ohms, 3 watts; and C_2—8-µfd. 450-volt electrolytic, act to furnish proper screen voltage to the beam tetrode and to keep the screen at cathode potential with respect to audio. C_1 and R_1 can be as indicated in figure 1 or a step-up transformer as in figure 2A may be used.**

per cent degenerative feedback it is only necessary to determine the power output of the modulator tube from the tube characteristic tables and multiply this by a factor of 8 or 10 to determine the input to the r.f. stage which may be satisfactorily modulated.

Due to the fact that there is such a large amount of degenerative feedback around the modulator tube, distortion within this tube will be greatly minimized. Single-ended beam tubes operated in the conventional manner have a rather large percentage of harmonic distortion: 8 to 15 per cent is not uncommon. However, with the audio energy being taken from the cathode of the tube, not only is the plate impedance lowered but the harmonic distortion is lowered by a comparable amount.

Another thing that will be noticed by reference to the paragraph under *Degenerative Feedback* is that the voltage swing required on the grid of the modulator tube is quite high, and that it is determined almost primarily by the power output of the tube rather than by the amplification factor as it would be in a conventional amplifier stage. This again is a result of the degenerative feedback, and would be obvious from the fact that the cathode impedances of all high transconductance tubes are approximately the same. Thus the 2A3 will require about 200 peak volts of grid swing and the 6L6 will require about 325 volts. The last stage of the speech amplifier should be designed with this thought in mind; it can best be a 6C5 or similar tube operating into a 2- or 3-to-1 (step-up) audio transformer with about 300 volts on the plate of the 6C5. No driving power is required of the stage but plenty of voltage output is needed.

Biasing the Modulator

Alternative methods of connecting the parallel cathode modulator into the circuit are illustrated in figure 2. Figure 2A shows the method to be used with triodes such as the 2A3 (or larger tubes such as the 242-A, 211, 845, or similar should they be available and should it be desired to use them). Bias for the grid can be obtained from batteries or from the bias pack of the transmitter. The full amount required by the tube will not have to be supplied in this position since the drop across the choke due to the plate current of the modulated amplifier and the modulator will be added to the external bias. The amount which will be contributed by the choke can be calculated by adding the modulator and amplifier plate current together (expressed as amperes) and multiplying this current by the d.c. resistance of the choke. A semi-fixed resistor in series with the choke can be used to supply the additional bias if the extra voltage drop can be tolerated. With a large, low μ tube such as an 845, this drop would be appreciable.

Since the drop across the choke will normally be between 10 and 30 volts, the circuit shown in figure 2B can be used with 6L6 tubes as modulators. These tubes require only this amount of bias so that the total grid bias for the tubes can be taken from the voltage drop across the choke. Notice also that when using 6L6 tubes (or other beam tubes) as modulators, the screen is by-passed to the *cathode* and not to ground as it would be in a conventional amplifier with the cathode grounded. If the screen were by-passed to ground and not to the cathode in this mode of operation, the tube would be operating as a high μ triode instead of as a beam tetrode and the transconductance would be greatly decreased. Cathode-resistor biasing of the parallel cathode modulated tube is shown in

[*Continued on Page 76*]

A 5-Meter Amateur Net

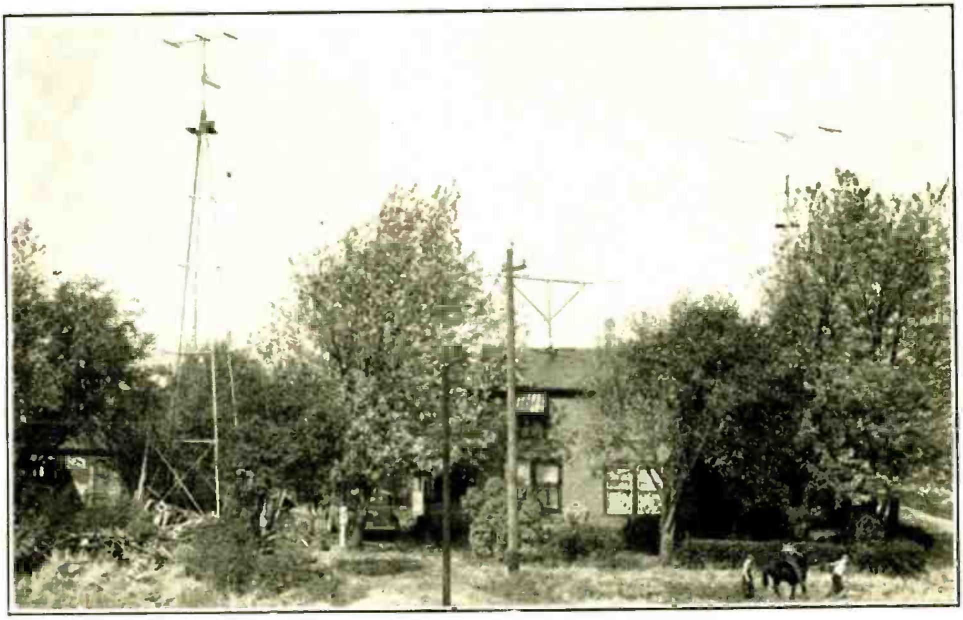
By THE ROVING REPORTER

The participation of mid-western stations in 5-meter experimentation has been less prominent than that of stations located in several other sections of the country. This has been true for at least two reasons: (1) the fallacious theory that consistent, moderately long distance transmissions cannot be maintained over flat terrain such as found in the mid-west; and (2) lack of sufficient incentive in carrying on such experimentation due to relatively great distances between stations resulting in few contacts and little cooperation.

Reviewing accounts of 56-Mc. activity during the past few years, it is discovered that the majority of such news originates in either the east or extreme west coastal stations. In these two sections are found conditions which have been considered almost ideal for 5-meter work; namely, high places from which to transmit and receive, and a concentration of stations providing an incentive to QSO short distances with the almost certain knowledge that a contact will result with another station.

It is little wonder, then, after being exposed for years to such accounts, that we, along with the majority of our mid-western brother hams, have been led to believe that our flat, billiard table-like topography is very poor for the transmission of good 56-Mc. signals. Accordingly, we consider it a revelation of major importance when we do hear of concerted 5-meter activity with consistent contacts upward from 120 miles.

Until recently it may safely be said that news of 5-meter work in this section had been sparse. It is to be regretted that such a situation should have existed, even though much good groundwork was laid for the future by this early work. However, since the introduction of the new FCC regulations requiring adequately filtered power supplies and stabilized oscillators, this situatinn has been vastly improved and at last 5 has taken on a semblance of respectability. No doubt in the not so distant future the ultra highs will take their rightful places along with the lower fre-



W9ZHB, Zearing, Illinois. The beam of the left is for 56 Mc., the one mounted upon the house in the center is for 14 Mc., and the one above the trees on the right is for 28 Mc.

Ed. Grabill rotating the antennas at W9ZHB. All three antennas are turned simultaneously by moving the lever.

quency ham bands as a means of practical communication.

The new regulations certainly reduced local occupancy of the band. Transceiver and modulated oscillator equipped stations have completely forsaken 5; a few of them migrating to 2½, but the majority have given up the ultra highs entirely. It had been generally concluded that the additional expense necessary for the construction of crystal controlled transmitters was not warranted, especially since the meager results obtained in the past from the use of inferior apparatus was so fresh in mind.

However, such a conclusion, especially when derived from a source such as this one, should definitely not be adjudged as a final estimate of 5-meter worthiness. Do you suppose for an instant that the fine communication which is being carried off on the 28-14 Mc. bands and the lower frequencies could be at all possible using the antiquated and simple apparatus with which 5 has been subject? No, of course not! Then why shelve 5 for its apparent lack of ability to produce reliable results.

The answer to this question is that there is no really good reason for relegating 5 to the junk-box, since the use of apparatus similar to that used on the lower frequencies—superheterodyne receivers, stabilized signals, and beam antennas—has allowed 5 to produce some really amazing results.

A Northern Illinois 5-Meter Net

Several times in the past year we had heard rumors of truly remarkable activity on 5 meters by a group of stations located here in Northern Illinois, but until this time had never taken the trouble to investigate thoroughly. The other day we decided to take a turn around the countryside and visit a few of the stations which rumor had it were getting excellent results from 5. This we did. We read logs. We saw with our own eyes. We took pictures, and we chewed the rag with the operators visited. After seeing for ourselves it must be said that our enthusiasm for this band now knows no bounds.

Some of the things which have been accomplished are truly remarkable. Even at this writing we have heard accounts of *consistent* 200-mile dx on 5; and, we, personally, have witnessed contacts of 130 miles with perfect communication over more or less flat terrain, and using antennas of only average height.

Here in Northern Illinois there exists a rather unique group of stations whose one major aim in radio has been to study the propagation of 5-meter signals. These stations are situated at strategic points so that tests may be made over almost any intermediate distances up to and including the maximum separation between any two stations (in this case, 136 miles, Elgin to Canton). This arrangement is particularly valuable in permitting the two most widely separated stations to remain in communication at all times, by relay, even if not directly. However, since the time the two most widely separated stations have first heard each other there hasn't been the slightest difficulty experienced in maintaining contact at all times.

W9ZHB

Perhaps the most active and successful of the half-dozen stations comprising this group

Map of Illinois showing the locations of the towns which are important to the Illinois 56-Mc. Net and the distances between certain ones of them.

The operating position at W9CBJ.

is W9ZHB located at Zearing, Illinois. Zed H B is the key station of the net since its location is closest to all the others.

W9ZHB is the club station of the Black Cat Radio Club of Northern Illinois. Located at Zearing, a small town situated in the north central part of the state, W9ZHB is surrounded by the flattest of flat land. Zearing is noted, industrially, for nothing of greater import than as the junction of two branches of the Chicago, Burlington, and Quincy Railroad. But prestige lacked commercially is certainly made up for in radio. The Black Cat Club, through the activities of W9ZHB, has really put this "railroad center" on the map.

The chief op at the club station is Ed. Grabill. Incidentally, it is his home in which the station is located. Accordingly, he does most of the operating; also he has done almost all the construction and design work on the rig.

W9ZHB has been active on 5 for somewhat more than 2 years. During this period many contacts have been made on both 5 and 10. At first 160 was used for the purpose of arranging schedules, but now 5 and 10 are operated almost exclusively.

Ed has used no black magic or trick circuits to obtain his unusually successful results His equipment is commonplace, everyday apparatus available to all hams. There are three rotary antennas. One is for 20, one for 10 and the other is for 5. They are all of the remotely rotatable type with a parasitic director, reflector, and radiator transmitting in the horizontal plane. Ed will have nothing whatsoever to do with vertical radiators, and from the results he has accomplished perhaps he is correct in his judgment.

A unique part of the antenna system is the fact that all three beams are rotated *at once* by manual power. Directly above the operator's chair, mounted in the low ceiling, may be seen a large cardboard circle calibrated in degrees. In the center of this circle is located a gear mechanism and a horizontal pipe assembly for rotating the three beams. Outside, a system of belts and pulleys moves the antennas. The 5-meter antenna is about 45 feet high, the 10-meter beam is 69 feet, and the other radiator is mounted directly on the roof just above the operating room which is on the second floor of the house.

The transmitter, which is located in a separate room by itself, consists of a 6A6 crystal oscillator and doubler, a 6L6 doubler to 10 meters, an 808 doubler-driver to 5 and a pair of HK-24's in the final with about 100 watts input, with of course the necessary audio and modulation equipment.

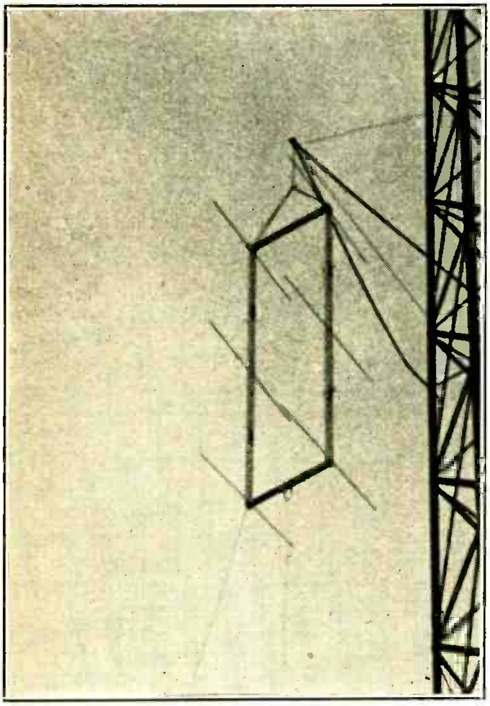
Ed's pet peeve is that often when 5 is open for some good dx he can make no QSO's due to lack of stations on the band. Eight or nine years ago, 10 meters was much the same. But once it became popular it really went to town, as is evidenced by the QRM on that band today. All indications point to the opening of 5 in the same manner. For example Ed. said that on last July 6, 5 was open to the 4th and 5th districts. At 1:15 p.m. harmonics were heard throughout the whole afternoon and early evening up until the band went out at 6:45. During the whole period only two QSO's were made. These were with W4ALH and W5AJG. If other stations had only been on, contacts would have been extremely easy to make.

Judging from 5-meter standards already

established, but not proven, W9ZHB's poor location out on the flat prairie should indicate a lack of contacts rather than a goodly number. But these stations of the Illinois Net are in many respects shattering precedent. W9ZHB, in the 97-day period beginning May 5 and ending August 10, 1939, made over 450 contacts with 5-meter stations located in 8 U. S. districts and 1 Canadian. We wonder how many 160-meter phone stations could equal this record with 100 watts input?

The second station in the group of six to be described is W9CLH of Elgin, Illinois. Elgin is located at the extreme north end of the net, 130 miles from the southern-most station. CLH is using a pair of 250TH's with 900 watts input, 3 stacked horizontal antennas in phase 100 feet high, and an RME-69 with a DM-36. This station is the relay outlet for the Illinois Net to Chicago and the East.

The third station, traveling south from W9ZHB's, is W9CBJ located at Washburn, Illinois. His activity on 5 has not quite matched the enthusiasm of the others because of his intense interest in amateur photography. (Ed. says that is one of the things that is holding 5 back—too much picture taking.) However, since CBJ does manage to tear himself away from his darkroom long enough for a 5-meter QSO once in awhile his rig should be mentioned. He uses a 6N7 crystal oscillator and first doubler, an 807 second doubler, an HK-24 doubler-driver, and a pair of HK-24's in the final. His antenna system is a director, radiator, and reflector.



The stacked array at W9CLH. This antenna is supported 100 feet in the air from the side of a b.c. station tower.

Southwest of Washburn about 25 miles is found the fourth station, W9RGH, at Peoria. RGH uses 100 watts input to a 35T final feeding an antenna similar to CBJ's, a reflector, director, and radiator.

The fifth station is located in Bartonville, a suburb of Peoria, and its call is W9ARN. ARN was one of the first stations to successfully work 5 in that vicinity. It was he, with W9ZHB, who first bridged that gap of almost 70 miles between Bartonville and Zearing. Jack, the chief op, is well known on both 5 and 10 meters for his pioneer work in developing these bands. His rig is quite elaborate, ends up in a 35T final, and the antenna is rotatable beam with director, reflector, and radiator.

The sixth and last station in the net, but by no means the least, is W9BHT located at Canton, Illinois. This station is located at the extreme southern tip of the net. The transmitter ends in a 150T doubler. Antenna is a director, reflector, and radiator.

Operation of the Net

During the first days of experimentation between W9ARN and W9ZHB in bridging the gap of 70 miles from Bartonville to Zearing, 160 meters was used for the arrangement of schedules. There came a time when QRM became too great for the two to QSO successfully, so 5 was tried. At the time signals between the two stations were not at all audible on 160, but 5 maintained maximum signal strength at both ends of the circuit, with absolutely no QRM, no static, and a privacy comparable to a land telephony system.

This was so much of a revelation to ZHB that he immediately tore down his 160-meter rig and deserted the band entirely. On 5 he found that he could work consistently to greater distance with less power input.

From side by side reports it is being discovered, at least in this vicinity, that 5 is comparing favorably with 160 meters in daytime distances covered. But smaller antenna systems, less chance for interference to broadcast services, and a much wider band in which to transmit is offered by 5.

Schedules are maintained between most of the stations of the Illinois Net daily at 8 a. m.

The operating position at W9RGH, Peoria, Illinois.

and again at 7 p. m. Day in and day out schedules have provided much reliable data concerning the propagation of 5-meter signals. These schedules, of course, are made using the "normal" distance range of consistent signals; whenever abnormal conditions present themselves, whenever the band "opens up," these stations naturally work all the dx possible.

It is regrettable that so many of the active 5-meter stations have apparently shut down for the winter. Many times recently the band has been open for some really good dx, but due to the lack of stations few QSO's have been made. Here in the mid-west we have heard stations on the east coast merrily chatting with each other across the street, or at the most across town, with never a thought to listen for dx, while we call our heads off hoping for a contact.

The outmoded theory that wintertime is no time for 5-meter dx must be replaced by the one which says, "Activity is all that's necessary for consistent contacts *at all times on 5.*"

At this writing successful relays have been maintained to the east coast. Relays from the east have reached as far west as Canton, Illinois (W9BHT). It is up to us to extend this relay to St. Louis for a possible outlet to some of the chains in Oklahoma and Texas. As yet there is one gap to be filled from Chicago to St. Louis. That is from Canton on.

We do not believe that the so-called transcon relays will travel the middle or northern routes to the west coast, but will proceed south from us to attempt the crossing of the Rocky Mountains in Arizona and Southern California. But we might be fooled in this respect. Anything may happen on 5, and usually does.

There has been rumor of a 250-watt station being constructed in Davenport, Iowa (see map) but as yet no one in the Illinois Net has heard it. If this rumor proves to be true the addition of this station will quite materially enlarge the net.

Successful communication on 5 is not difficult to obtain if certain rudimentary principles are faithfully followed. It is very important that transmitters and receivers of high quality are used; this means stabilized transmitters and ultra-sensitive receivers of the superhet variety. Beam antennas are a vital necessity. It is quite essential that signals be controlled at least in directional propagation, and preferably should be controlled in angle of radiation as well.

Jack Roelfs, operator of W9ARN, Bartonville, Illinois.

Russ Planck, W9RGH, caught slightly unawares.

W9ZHB himself, Ed. Grabill.

At least for the present, vertical antennas have been ruled out both for transmission and reception. All the stations in the Illinois Net are using horizontally polarized antennas. It has been demonstrated that signals leaving a vertical antenna although at first vertically polarized rapidly shift to horizontal polarization. Since this is true, all stations using vertical antennas for reception purposes are losing most of the signal energy available. Perhaps this accounts for the poor results obtained by many stations.

There is every indication to believe that in the near future we shall experience a new type of communication provided by the ultra highs. It will be a type of communication which will experience no fading, no QRM or natural QRN, and which will permit a privacy not possible on any other band.

We amateurs have a band which is 4000 kilocycles wide. A band which is right on the edge of opening up into our most valued possession; but which is also smack in the middle of a rich commercial field. It is said "a stitch in time, saves nine" so let's show activity now and later when the commercials come we'll have a better case to state.

We have all dreamed of that shiny brass wheel on the front of our rig which we turn to shoot our signals where we want them. This wheel is at last a reality when it is tied to a rotatable beam on 5 meters. The band is waiting, gang, why not give it a whirl and see for yourself?

●

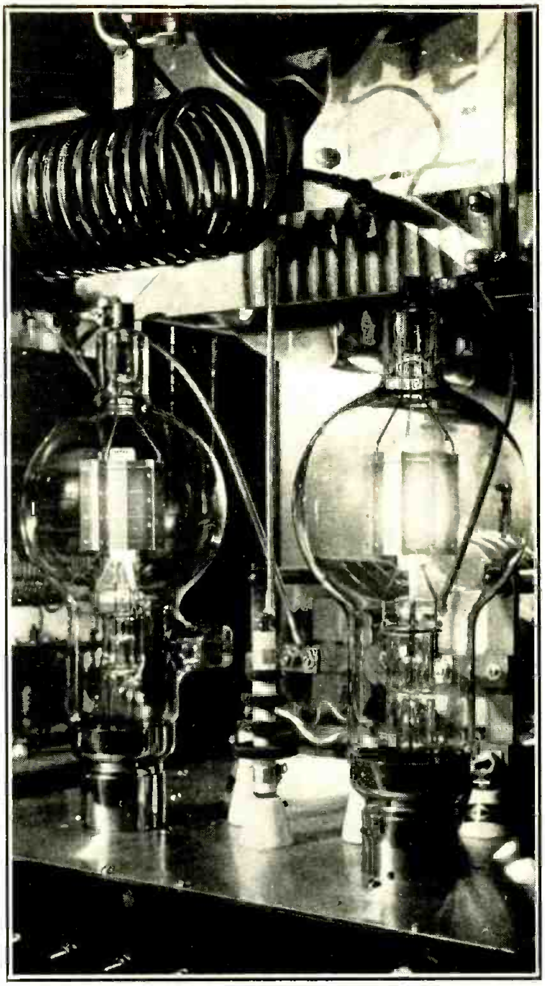
Grid Bias Frequency Modulation

Now that it appears that f.m. signals can be received with good results on an ordinary superregenerative receiver, many amateurs are interested in putting an f.m. signal on the air as cheaply and painlessly as possible. Eventually anything except a first class f.m. transmitter will be frowned upon even on 112 Mc., but for a while there is no harm in using makeshift methods to take a fling at f.m. before investing in more elaborate equipment.

The object is to get frequency modulation of a self-excited 112-Mc. oscillator without getting too much amplitude modulation in the bargain, as a combination of the two results in excessive interference. If the tank circuit does not have too high a Q, a low percentage of plate modulation can be used to effect the required amount of frequency modulation. Many amateurs are using this simple method

[*Continued on Page 92*]

DEPARTMENTS



● The final at W6ONQ, Oakland. Johnny Woerner, the operator, was active in the operation of W6USA, at Treasure Island.

- **DX**
- **U. H. F.**
- **The Open Forum**
- **New Books**
- **The Amateur Newcomer**
- **Yarn of the Month**
- **What's New in Radio**

"WAZ" HONOR ROLL

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W6GRL	39	150
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W2GTZ	39	149
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W2CYS	39	117
W8JSU	39	117
G2LB	39	115
W4IO	39	115
W7DL	39	115
W2GNQ	39	113
W6FZL	39	112
ON4FE	39	110
W6FZY	39	109
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W6SN	39	96
W6GPB	39	94
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K6AKP	39	78
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W2GW	38	143
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W3FJU	37	103
W9GBJ	37	103
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W6FKZ	37	101
W6JBO	37	101
W8KPB	37	100
W4DMB	37	100
W9AJA	37	99
W4EQK	37	99
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W4ADA	36	90
W9LBB	36	90
W8JAH	36	89
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W8CED	34	101
W8BSF	34	100
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W2BZB	34	99
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W8HGA	34	93
W3EYY	34	91
W8NV	34	91
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W6TE	34	86
G6WB	34	88
W6CVW	34	88
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W8LFE	32	91
W2IKV	32	90
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W4DSY	32	84
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W9ZTO	31	53
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W1JCX	30	81
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W4EEE	29	81
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K6LKN	26	46
G6CL	26	46
W7AMQ	26	45

DX AND OVERSEAS NEWS

by Herb. Becker, W6QD

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

The *World Wide DX Contest* for 1939 is history. The dx men were almost unanimous in saying that the Contest was a success. Generally speaking it was as good as one could want considering the limited number of zones and countries available. Let's take a look over the scores that have been submitted. These are not segregated according to their proper division, nor are they listed as final totals. The official standings will be published in an early issue.

PHONE SCORES

W1FOV	15,200	W8LFE	25,500
W1ADM	14,900		
W1APQ	9,300	W9BEU	49,100
		W9ZYL	11,500
W3BET	24,100		
		K6BNR	481,000
W5EDX	18,100	K6MVA	442,000
		LU7BK	391,100
W6OCH	254,800	XE1CQ	77,700
W6RCD	90,000	XE1AC	40,500
W6AM	45,000	XE1FF	13,000
W6AED	35,200	OA3B	26,000
		CO2WM	7,300
W8LW	54,100	LU4DJ	5,000

CW SCORES

W1RY	63,200	W7DVY	49,200
W1APA	12,100	W7DWH	17,500
W2UK	154,400		
W2CJM	29,500	W8OQF	175,000
W2WC	26,000	W8ZY	112,400
		W8IOT	36,400
W3FQP	79,700	W8CED	32,800
W3EMM	50,900	W8MOA	27,800
W3EPV	41,800	W8PUD	14,300
W3ASW	37,800		
		W9GDH	152,200
W4QN	34,200	W9GKS	95,400
W4FIJ	31,700	W9PK	44,100
W4BJX	17,600	W9NRB	29,700
		W9VW	16,600
W5KC	172,800	W9VES	13,900
W6GRL	328,000	K6LKN	339,300
W6QD*	238,000	K6CGK	322,000
W6QAP	150.000	K6PAH	130,000
W6VB	112,000	K6IAE	23,800
W6NGA	87,500	K4KD	15,200
W6BAM	49,600	XE1CM	154,500
W6CHE	35,000	XU8MI	68,400
W6GPB	34,100	YS2LR	2,190
W6PNO	33,800	HH2MC	1,250

* *Ineligible* for awards.

Every contest brings out many incidents which are remembered for a long time. It might be some screwy call that popped loose for the contest, or it might be some dx station which required many hours of struggle before a contact was made. There are many sidelights which make dx contests fascinating . . . it's not only the sitting at your rig and knocking off a dx station every now and then that gives you that feeling. It's the little things all of us experience that give it spice. For example, when PZ6ZK opened up outside the high end of 14400, everyone went slightly nuts trying to land him next. Of course, the fact that our eyebrows are lifted on PZ6ZK doesn't alter the picture. He still caused plenty of commotion, as did VU2XX and VE7AC. All of these have a rather uncertain degree of authenticity about them but at this early date we cannot definitely commit ourselves. Others that should be treated with caution are VR6AY, VS5AD, LX1AW.

'Phone Scores

From the figures on hand at the present time it looks like K6BNR is leading the 'Phone division with a huge total of 481,000 points. Emil made 322 contacts in 18 zones, with 24 countries on 20 and 4 on 10 meters. A few of his better contacts were with CP2AC, ZP2AA, EK1AF . . . and yes, he did work a few W6's. K6MVA isn't far behind BNR, with his 442,000. MVA had more QSO's, which incidentally totaled 341, but worked one less zone and had fewer country multipliers. However, with this system of scoring it wouldn't have taken many contacts to bring his total up to BNR. Anyway you look at it these two K6's really went to town and must have exhausted Honolulu's supply of throat gargle after the contest was over. To give you an idea of the sort of operating K6MVA must have done . . . we notice that during a 10-hour stretch at the mike he worked 115 stations. This makes 11½ QSO's per hour, or one contact nearly every five minutes. During this same 10-hour period K6BNR logged an even 100 QSO's.

LU7BK had a merry time in running up 391,100 points. He found them in 16 zones while his total country multiplier was 34. LU7BK was one of the most consistent stations heard during the test and always put in a good signal. In Mexico it looks like XE1CQ leads off with 77,700. He made 152 contacts in 14 zones with the country multiplier of 25.

In U.S.A. W6OCH is head and shoulders above anyone else with his 254,800 points. Larry worked 144 stations in 20 zones. Countries on 10 meters were 16 and on 20 he logged 20 countries. W6OCH has a nice setup in the little town of San Leandro and runs antennas around the landscape with reckless abandon. Larry said he could have done better if there had been more stations on the air, and if he hadn't had such a dry throat. If moistening the windpipe will do it, by all means do so, Larry. W6RCD did very well in rolling up his 90 grand from 17 zones. W6AM said he had a lot of fun during what time he could spend in the contest. He has around 45,000. Others who are the highest yet heard from are W8LW 54,100, and W9BEU with 49,100.

Brasspounders Scores

The highest yet reported is K6LKN, Dave Enomoto with 339,300. Dave worked 238 stations on the three bands, and got 15 zones. He was very satisfied with the Contest considering everything and said he had a lot of fun. Dave couldn't spend as much time on the air as he wished but I think he did a swell job. Right behind him, too close for comfort, is K6CGK with his 332,000. Kay ran up 288 contacts but didn't have quite the multipliers of LKN. Both of these fellows were putting through fine signals and are swell operators.

XE1CM had probably more contacts than any station in the world with 480 of them being logged. His total score is 154,500 and the zone count is 13 with country multiplier of 23. Needless to say XE1CM worked more stations per hour than anyone else, and all but 20 of them were in U.S.A. Next comes XU8MI, Otto Miller, who is in Shanghai. Otto had 68,400 points and total contacts were 118, while the zones amounted to 11. He said he had a swell time and 40 meters was a life saver, although that band, too, could have handled a lot more signals. YS2LR sent in his log which totaled to around 2,200 points. Most of his contacts were with W's and I imagine that a lot of you are thankful that he was on in order to land a YS. HH2MC did his bit and was on as much as he could be. His total was 1,250. So far K4KD is the only K4 heard from and he had 156 QSQ's in 7 zones for 15,200 points. There were plenty of K4's on during the contest and we hear that K4DTH really ran up a nice big score.

Just to prove that TA1AA does (or did) exist, a reproduction of his card sent to W6QD.

Looking over U.S.A. it appears that W6GRL has the largest total . . . 328,000. GRL made 146 contacts, zones 22, and country multiplier of 50. Many of their contacts were the first for the dx stations, and by the same token, much time was spent in explaining the rules of the Contest to those who were not able to hear about it previously. I could name a number of outstanding examples where W6GRL was heard carefully explaining the rules, and after he had finished and exchanged numbers, the dx station would really go into it in earnest. Many continued as though they had prepared for it weeks in advance.

This is as good a spot as any to mention the extra-fine cooperation from the whole gang . . . in U.S.A. and out of it. They all had a crack at explaining the rules to some one. It is true that many hams in foreign countries had never

1939 DX MARATHON

C. W. and PHONE

	Z	C
W9TB	39	116
VE4RO	38	116
W8LEC	38	107
W9TJ	38	104
W8OQF	38	101
W4TO	38	99
W9NRB	38	88
G5BD	37	113
W8BTI	37	113
W3EPV	37	108
W2ZA	37	97
W2BHW	36	105
W6MEK	36	103
W8LFE	36	103
SU1WM	36	102
W9GDH	36	100
W9CWW	36	99
W9VES	36	92
W9ELX	36	91
W4FVR	36	90
W3HXP	36	86
W6NLZ	36	85
W6SN	36	69
W5KC	35	104
W9RBI	35	102
K6NYD	35	92
W9GKS	35	84
W4FIJ	34	97
W8JIN	34	94
ON4HS	34	93
W8CED	34	91
W5PJ	34	90
W3HZH	34	89
G2FT	34	76
K4FCV	33	95
W1RY	33	86
W5ASG	33	85
W2IZO	33	83
W4QN	33	79
W1BGC	33	79
XU8MI	33	76
G3AH	33	71
W6GK	33	69
W9VKF	32	86
W9MQQ	32	83
W3FJU	32	81
W9ERU	32	74
W2GVZ	32	71
W6TE	32	67
VE5ZM	31	87
W8BWC	31	80
VK2EO	31	67
W3GHD	31	60
PHONE		
W3LE	37	99
W8LFE	31	86
W1HKK	31	80
W8QXT	31	78
W6ITH	31	71
F8UE	31	71
F8VC	31	55
W6OCH	30	82
W9BEU	30	80
W1KJJ	30	77
W6NNR	30	75
ON4HS	30	74
W1JCX	29	72
W1AKY	29	71
K6NYD	29	71
CO2WM	29	70
VK4JP	29	67
W1ADM	29	64
W2AER	29	45
W2IKV	28	68
W3FJU	28	60
W7BVO	28	57
W6EJC	27	59
W6PDB	27	59
W9NMH	26	61

K7HCX, "Whit" Lewis, Fairbanks, Alaska. Whit, being a former W6 from Manhattan Beach, looks a little out of place in his "sport togs." Wonder what size "tennis rackets" he wears?

heard of the contest, but considering that this was RADIO'S first attempt at sponsoring a contest, I believe the results were very gratifying. It is only natural to assume the first contest would not gain as much publicity as future ones, and for this reason everyone's effort is greatly appreciated.

Now let's take a peek at the scores by districts. The best from the first district so far is W1RY with 63,200 and 19 zones. W2UK has the best in his neck of the woods with 154,400. Tommy had 81 contacts in 20 zones, and says if he didn't like duck so well he could have had more time on the air. W3FQP in the third district is the best so far with 79,700 points. His zones were 17. Others who were active in this district are W3EMM, W3EPV and W3ASW. Next we find W4QN with 34,200 points and W4FIJ with 31,700. These are the highest so far reported from the fourth district.

W5KC stands out alone in the fifth with 172,800. 5KC contacted 80 stations in 20 zones and had a country multiplier of 40. Vincent only spent about 30 hours on the air, he forgot to work a station in U.S.A. for Zone 5 multiplier, and forgot to grab a W on 10 and 20 for the country on those bands. In the sixth district, outside of W6GRL who was mentioned above, it appears that the next highest score belongs to W6QD, who managed to get 238,000. However, due to being "on the inside" . . . or in other words, on the staff of RADIO . . . 6QD is ***not*** eligible for any award. This, of course, was taken care of by the committee when the rules were formulated. I might mention here, too, that another member of the staff, W6CEM, (a brass-pounder) entered the contest with good intentions. However, due to just moving into a new apartment, and not having time to put up proper antennas, he had to give up. CEM said that when he punched the key, half the lights in the building went out and the other half got brighter.

We're still in the sixth district . . . it looks like the fellows out here spent more time on the air than the east coast boys, or maybe conditions favored the west. The latter seems improbable, but if so it will be the first time in history. Anyway, W6QAP of Tucson, Arizona did very well in rolling up 150,000 points. Bud said the coffee pot played just as an important part for him as his key. Zones for QAP were 16. Other W6's who accounted for quite a number of points are W6VB, 112,000, W6NGA with 87,500 and W6BAM 49,600. 6VB started a day late after getting balled up in the starting time. The first Friday night he sat around the house just reading the newspaper while the rest of us were breaking our neck to work dx. W6NGA is the highest reported from the San Francisco locality, while W6BAM upheld the Santa Ana honors.

The seventh district never does seem to have many representatives and the best so far is W7DVY with 49,200. The eighth district broke loose with a couple of high scores with W8OQF showing up with 175,500 and W8ZY with 112,400. W8OQF worked 88 stations in 21 zones and country multipliers totaled 40. W8ZY worked 17 zones and his total QSO's were 85. It was good to hear Karl batting them off in there. The ninth district brought out W9GDH with 152,200. Johnny worked 73 stations, 20 zones and country multiplier was 43. Next in this spot is W9GKS with 95,400. He worked 68 stations in 19 zones—and took time out to handle a little traffic with KA1HR.

That is about all of the contest news we have for this time but as soon as the logs are checked and we can dig out from under the deluge of contributions, we will publish the official and final results of all contestants. Once again on behalf of the entire Contest Committee, I want to thank all of the fellows who sent in their logs and the hundreds who, although not competing, sent in their lists in order that the other fellow would receive credit. I know that everyone cannot get the time to enter a contest for real competitive purposes, and I know too, that many do not go for any kind of a dx contest. These fellows never-the-less like to get on the air a little and have a few QSO's, and it is these who have cooperated in sending in their lists no matter how small. Some of them only list one QSO while others include a dozen or so.

While on this dx contest subject there is another angle which I think should be brought out. There are some of the dxers who get on and really roll up quite a number of dx contacts and yet they do not send in a long or even the total points. The usual excuse for not doing so is because they feel that their total score is not "tops" and have an idea they should feel ashamed of having it published. I wonder if it wouldn't be a good idea to begin right now and change that attitude.

In the first place a fellow, who we'll say is in the medium level of scorers, will work a lot of stations and if he does not kick through with a log, he may be detracting from someone else's score, because of not being able to cross-check. This is not fair to the other guy who might have been very conscientious in his dx contest work. Secondarily, and yet we do not feel selfish in asking it, is that the sponsor of the contest, whoever it might be, likes to have it as well represented as possible. When the returns are published it will give the readers a truer picture of the participants in said contest.

To those who feel like they want to have the largest score or none at all, let's try and get over that idea. Let's go into any contest for the fun of it and for all we are worth. When it is over you will have the satisfaction of knowing that you have done the best you possibly could do with the time and facilities available. Every part of the country has its "top" stations and they score heavily and consistently in every contest. These stations naturally have advantages, and there are three things that make these stations "tops" . . . smart operating, better han average location, and efficient equipment. We cannot all have these assets (darn it) and have to be content with what we have. This may sound like a good ol' fight talk for "Alma Mammy" but why not think it over.

Things 'n Stuff

W2IUV brings his standings up to date. His Marathon Phone score reads 26 and 61 with the addition of OQ5ZZ and XU1B. His Honor Roll phone total is now 30 and 79 while his grand total is 32 and 84. FB8AH also helped him out, W6PNO worked U5KY giving him a new country. W8BWB breaks loose with his list showing 38 zones and 98 countries for the Honor Roll. W8OQF added a few countries and now has 38 and 136. Those who helped are CR6AI, TG9BA and LX1SS. Another new one to the Roll is W2GNQ with 39 zones and 113 countries. He wonders if AC4JS is ok.

Just in case it is missed elsewhere in the column, I might mention again that AC4JS is located at Choni, Kansu Province, China. He began operating by signing XU4JS and then switched to AC4JS because he no doubt thought that went along with Zone 23. It just so happens that there is quite a bit of territory outside of Tibet that is also in this zone. Some fellows think because a guy is in 23 he is automatically in Tibet. Consequently when you send in your list AC4JS or XU4JS will count as Zone 23 and for the country it will be China. XU8MI informs us with the above and it is appreciated. It seems that it is pretty hard to tell where the border of Tibet and Kansu Province really is but to clarify it for you fellows Choni is 118 miles south of Lanchow, which is the capital of Kansu Province. Years ago Tibet was much larger than it is at present. The Chinese government took over part of it and made two new provinces, namely Sinkiang and Tsingtai (Hinghai on some maps). These two provinces are located between Kansu and what we now know as Tibet, and are both shown on RADIO'S new Zone map. All three of the above provinces are in Zone 23. All right now, go dig out your Atlas.

YU7AY, Yugoslavia. Ivo Bricelj surprised some of the boys when he got on in the Contest and worked about 20 stations.

Now then, as for XU8MI himself—he's doing all right. Otto acquired 33 zones and 76 countries during 1939. He will only be there for possibly another few months and is very anxious to contact the following states: Alabama, Mississippi, Arkansas, New Mexico, Utah, and South Dakota. Maybe some of you fellows can give him a lift. He can usually be found on the high end of 20.

W2BJ has put up a lazy H antenna and it seems to be doing him some good. Speaking about 2BJ brings out this crack, "Is it ever going to be wedding bells, or is it liberty bells we're thinking of?" W8PQQ has received cards from the following stations: VP8AD, VP7NU, CR4MM, VQ4KTB, J9CA, LX1RB and LX1SI, so this would prove they were ok. A few new ones that W3GHD is just adding to his list are HB1CE, VU7BR, K7GOR, KA1FG, which makes his total 38 and 121.

W9QOE has fallen by the wayside and now has a Class A ticket. Therefore he is on fone these days. As a matter of fact his xyl has a ticket and her call is W8QMS. They have put 9QOE on ice for a while and with 9QMS they have worked 24 zones and 43 countries on two-way fone. W1APA has two new ones in LZ1ID and KB6RSJ giving Gil 34 and 98. W9GKS added a few in the contest making 36 and 94, and in the Marathon it is 35 and 84.

I might mention here that the stations in LX that look the best are LX1RB, LX1SI, LX1SS, and LX1UU. The others do not look so good.

Cards for LX1AW and LX1AG are being returned. W9ERU enters the Honor Roll with 35 zones and 88 countries, and in the Marathon he has 32 and 74. W8CED had a lot of fun getting his 32,000 points in the contest and in there also, were several new ones for him: XU5YT, FY8AD, CR6XX making 35 and 101. In the Marathon he has 34 and 91. CR6XX says to QSL to Box 77, Mossamedes, Angola. Take it or leave it. Wonder where ZB4UC is, and VU2XX, and PZ6ZK. They must have lots of points in the contest.

W9VDX is up to 35 and 84 . . . latest was EA7AV. W9TB is doing more phone operating lately and seems to be hauling in a little dx at that. Heard him a few times during the test but Wally says he didn't have enough time to spend at it. W9YXO is thankful for the contest because it gave him the opportunity to make his first 7-Mc. WAC not only once but twice. YXO ends up with saying that he is managing to keep out of the Marathon list by keeping his total down to 26 zones and 61 countries.

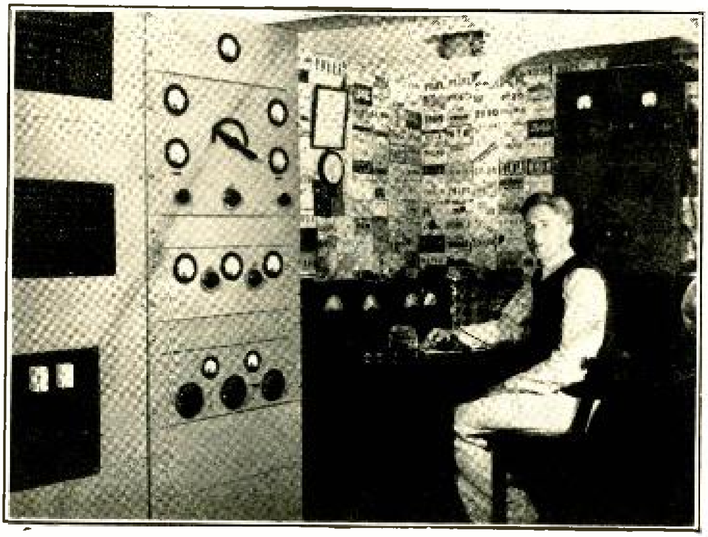
W3DAJ has been trying to get in the Honor Roll for some time but never can quite get enough zones and countries to squeeze on the page. However, now he has at last landed XU8WS for his 33rd zone and 94th country. I believe he will just make it. W3DAJ says he could only work five stations during the first week-end of the contest as conditions were so lousy. Must be something wrong because others around that neck of the woods did some better than that. W9CWW says his xyl caught up with him just as he was getting organized in the contest and he didn't get much time to pound brass from that point on. However, Charlie did manage to boost his Marathon to 36 and 99, while the Honor Roll total is now 38 and 112. W3ASW did mighty well in the contest by getting 37,800 points. Dick really has some handicaps consisting of being in an apartment house and having room for only one vertical antenna which he uses on three bands. The power is only 100 watts and cannot use more without getting into difficulties with the tenants. Dick says that if anyone wants to QSL to HK4DF, they may do so by addressing the ENVELOPE to Arturo Alzate, Box 239, Medellin, Colombia. Be sure to enclose card in a plain envelope and DO NOT mention radio on it. 3ASW has 31 and 90, and is hoping to get in the Honor Roll.

W8LFE has two new ones on phone, XU1B and ZP2AA. Bob also mentions working SV2S on phone who gives his QTH as Elias Fonaris, Island of Syra, Greece. Bob just received a card from CR6AF and his QRA is as per the Callbook. CR6AF works on about 14440 kc. W9PK says he has two excuses for not doing better in the contest. One is that he cannot run more than 160 watts until after 11:30 p. m. because of blinking lights, and the second is that he had an R9 power leak during which he bit off ten finger nails and was just beginning on his toes. All in all he feels it was well worthwhile and probably would do it all over again. Jack scored 44,000 points, and has 38 zones and 105 countries.

W9VES has 36 zones and 98 countries to date but is having quite a time getting Asians. He says for every Asian . . . J or XU . . . he works he will send them free a recent issue of the Call book. W9VES uses 100 watts into a T-40 and has two non-rotary and very haywire antennas which he rotates by changing positions of the 16 foot masts. W9CDP worked UK9AN for a new one. Said it sounded like a keyed power leak. W6SN has added a few to his Marathon boosting it to 36 and 69. His Honor Roll now has 39 and 96 with the addition of YN5C. W8JSU has joined the Zone 23 Club by getting AC4JS. Charlie says he must have had his hair parted on the right side that night. He now has 39 and 117.

A line from ex-VE4RO tells about him using his audio oscillator to keep his speed up. Said it sure burned him to not be able to get in the

[*Continued on Page 93*]



George Gray, ex-VK4JP. While on the air George made quite a dent in the ether and was well known on 14- and 28-Mc. phone. Receiver is an RME-69 and the transmitter used a pair of HK-54's in the final.

U. H. F. . . .

By E. H. CONKLIN, W9BNX*

28 MEGACYCLES

A round table to end all round tables (we hope!) was held in the Chicago area November 28 on ten meters. Starting at seven p.m., W9UZ-FXB-QDA called "cq round table," and added stations to the list giving each a number to designate his turn. Due to conditions, a W8, W9's in South Bend and Indianapolis, and others beyond 100 miles from Chicago were included. Bv the time that the ceremony wound up, at 1:20 a.m., 62 stations had participated of which 59 were properly checked in. The stations were W8PYP W9JN QDA UZ RSQ EJF PEI FXB OFO GZK YUC POP AI QLD KVV GA ROP ZCN TMT JII YRR BLI WIF HZQ ABL DFS MQM CAH LEU WCD OUX YSV IJX NHF FID TLQ PRD EQB ZHB AUK ABF PRC NN WBB CSB BEK WBM YLV UOV UWQ SEN AR ZEO MAY TDO CMC NHL.

This happened during a period in the last half of November when, every evening, signals beyond 100 miles came through, apparently on "extended ground wave." W9YRR in South Bend had his beam pointed south one night for local contacts and noticed some faint carriers. Swinging the beam brought in stations around Chicago on a direct path. W9QDA raised stations north of Milwaukee and used only ten or twelve watts, and many others in Central Illinois. Beams were not necessary but, if used, had to be pointed at the station. This condition became noticeable daily after the W6's go out, and continued on into the early morning.

On the next morning, W8RSX in Kingston, Penna., was coming through at W9QDA in Chicago while calling a station in Haiti, the receiving beam being pointed south-southeast rather than east which is the true direction. Stations all the way to New York City have regularly been heard this way in Chicago when the band is open for dx east. On December 15, a St. Louis station about 300 miles away came through when the beam was S.S.E. also. This condition compares with the W6 work along the California coast, when beams are pointed southwest, and when K6 or ZL signals are coming in. We still hope for an explanation of this phenomenon.

During the second week in December, starting with the night that five meters opened, there was a considerable amount of "summer short skip" apparently due to sporadic-E layer reflections. This occurred all week in Chicago and must have appeared elsewhere because on December 11, W7HJE in Seattle heard W6NAJ in Salt Lake working a W7 in Spokane. HJE worked W9NWL-WYX in Denver.

56 MEGACYCLES

It has been suggested that the terms used in describing various types of u.h.f. transmission be defined in order to clarify them in many minds. That suggestion appears to be a good one. The writer of a column like this (ye u.h.f. ed. celebrates the fifth anniversary of the column in July) after a while wonders how often such things should be repeated.

Horizon, local, or direct point-to-point reception refers to two points between which there is no obstruction to the waves. This might be a mile or two hundred, depending on the altitude of the antennas and nature of the intervening land. In the case of ground as smooth as a billiard ball, there is not actually a discontinuity of the signal at the horizon; that is, an airplane taking off beyond and below the horizon would begin to encounter the signal below an altitude actually in sight of the transmitting antenna. So already the next class has been entered.

Because the signal consistently is heard beyond the horizon, the term *ground wave* is usually applied out to 30 or more miles—and much longer when one or both antennas are so high that the horizon is distant—which is consistent at a good location with suitable equipment, with very little or no fading. The waves are propagated, presumably by *diffraction* or dispersing around the curve in the earth's surface in the same way as light is diffracted around a sharp corner. Out to this distance, the transmitting and receiving antennas are reported to give best results when both are either vertical or horizontal.

Pre-skip, extended ground wave, or low atmosphere bending dx are sometimes used to mean the same thing. All refer to distances out to perhaps 200 or 300 miles, in the absence of unusual aurora or magnetic activity. Beams are pointed close to the direct line between the stations. The first two terms refer to the distance but not to the

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method by which the transmission is accomplished, and presumably differ from the local or ground wave type only because the greater distance is covered as a result of more power, better antennas, or more sensitive receivers. *Low atmosphere bending,* on the other hand, in the narrow sense refers to pushing the signal over at the same distance with the aid of a temperature inversion in the lower atmosphere that bends the waves, rather than just simple brute force methods implied by the other terms. This type is often accompanied by slow fading at an interval of perhaps several minutes. It averages better at night than in daytime, better in summer than winter, and is generally predictable from weather information several days in advance, but is not so noticeable on normal wavelengths as are the following types.

The same and longer distances can be reached during periods of visible displays of aurora borealis, and during magnetic disturbances. This has been called *aurora-type* dx. It is generally not accompanied by "skip" although transmission may not be possible in all directions. Signals may be accompanied not only with fade, but sometimes with even tone or rough modulation which may make phone unintelligible. It has often been reported that if a beam is used on receiving, best signals result when it is pointed in some northerly direction, regardless of the true direction of the transmitting station. Presumably the beam should be pointed the same way on transmitting. This type of condition was not noticed much before 1939 but this year may be prevalent during strong magnetic disturbances which are expected to reach a peak in 1940. Low frequency bands often act abnormally, such as poor signals on 80 meters, due to a churning of the ionosphere, giving an indication that something may happen on 56 Mc.

Sporadic-E layer dx takes place in hops out to 1250 miles each, with a skip distance that may be as short as 300 miles during a summer at the sunspot peak but now may be 600 to 1200 miles. Two- or three-hop signals have been reported only five or six days in 1938 and 1939. This type produces the strongest and best long distance signals on five meters, and usually identical dx on ten meters. It may last a few minutes or many hours, at any time of the day or night, but much more often in May through August than in the balance of the year. Horizontal antennas are every bit as good as verticals for this work, apparently, and the polarization of the transmiting antenna need not be the same as that used for receiving. Beams show some directivity but generally are not as sharp as in pre-skip dx, possibly due to better signal strength or an angle of reception several degrees above the horizontal.

F_2 layer transmission out to 2200 miles or so per hop, with a skip distance of probably 1600 to 1800 miles, is theoretically possible in the early afternoon in midwinter during the peak of the sunspot cycle. There was some evidence of transmission by this method in 1937 and 1938, but the ionosphere and sunspot records suggest that it may now be 1947 or so before there is another favorable time for this kind of work.

The National Bureau of Standards points out that an irregular *G layer* may explain some poor-quality 28-Mc. work but most of

56 Mc. DX
HONOR ROLL

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

* plus Canada. (reported in 1939)

Note: D—Districts; S—States

E. K. Doherr, W8CIR, at the operating position of the transmitter.

the reports attributed to it apparently could have been sporadic-E layer reflections.

If we missed anything, please call it to our attention.

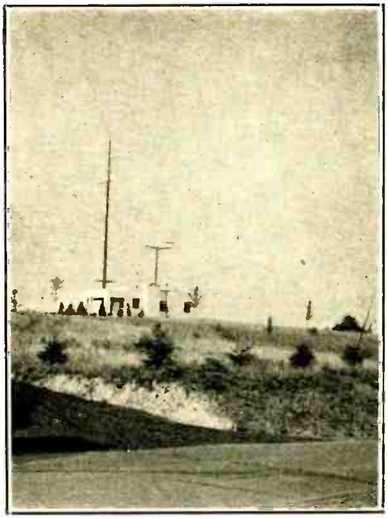
December 8

At six p.m. on December 8, W9VHG SQE YSV in the Chicago area heard numerous loud harmonics on five meters from the 4th district and some from W5. It was difficult to segregate harmonics from fundamentals. After several calls, W4AUU FBH FPC in Georgia and Florida were raised by VHG and SQE. W9CBI FFP were also reported to have been in on the opening.

From Atlanta, W4FBH writes that the band was open from 7 to 9:10 p.m. Central time on the 8th. He worked W9VHG ZHB GHW ARN USI ZD VWU, the last on c.w., adding Kansas to his list of states worked. Roy brings up the question of why ye u.h.f. ed. doesn't get on five meters sometimes. Well, that's a long story. With the children on the loose, it does not seem advisable to have a haywire transmitter around. The old one k.w. rig was too terrible on ten meters to expect it to work on five. If this column and article writing did not consume so much of the available spare time, something might be done about it.

G6DH, before leaving home for his new experimental and development job with the Royal Navy at Portsmouth, summarized conditions in England. The upper frequency limit for F_2 layer dx has been peaking up as is usual for early November; W signals up to 46 Mc. were heard on one day, and up to 43 Mc. on about four days but not giving much promise of getting up to 56 Mc. unless on a spasmodic peak. He thinks that 28 Mc. will be good for two or three winters yet, before closing down for several years around 1943-44. He outlines summer sporadic-E layer dx to Italy and Portugal, mentioning particularly the times when the band was wide open for commercial harmonics but without an amateur signal. This sounds like 28 Mc. here in 1933-34.

In his five-meter bulletin, W1DEI mentions having received dx reports for September 30, October 3, 7, 8 and 13, although October 3 and 13 were days of aurora display. Incidentally, it seems that we created the wrong impression by mentioning that three very good dx days last summer were separated by 27 day intervals. This may have no significance whatsoever, and may not happen again. It did look like the "dx cycle" figure. The dx cycle idea is based on the thought that a disturbance on the sun may still be effective on the sun's next rotation, although admittedly two disturbances or more may be overlapping, and they may have healed by the next time around, or may last for several rotations. The sun twists on its axis like taffy on a stick; the period of rotation increases with latitude, and has been determined as 25-38 days. Sunspots, however, with but few exceptions appear within 30 degrees of the equator, varying somewhat with the different parts of the cycle. Sunspots are probably not directly responsible for the sporadic-E layer, because of the sometimes small area on the earth involved and the fact that it



The location of W8CIR. A 3/2-wave vertical is located atop the telephone pole and a 7-element Yagi mounts on the rotary affair on the roof.

is as likely to happen on the dark side of the earth as on the sunny side.

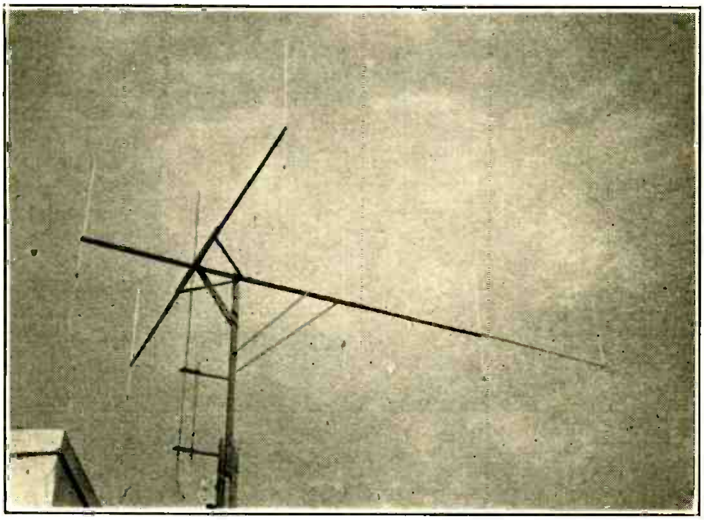
On July 27, W8CIR heard some W6's not previously reported to us. He worked W6-QLZ in Arizona, but heard W6RR NQO ragchewing, very steady. Although the Yagi beam seemed quite broad on them, they were almost inaudible on the high vertical dipoles. W6IOJ and W6LDP were heard calling cq on i.c.w. and c.w. respectively.

Aurora-Type DX

Last month additional reports were mentioned, to the effect that beams pointed north produce better signals during aurora displays. On August 12 when W8CIR worked W1-KTF W2JCY AMJ HEJ W3CUD BYF RL, he had noticed that his low Yagi produced signals 2 R's better than a high three-half-wave vertical. However, to get the best signals, the Yagi had to be turned from northeast to north to northwest, coinciding with the point of greatest aurora display at that particular time. The "bubbling and boiling" signals were thought to result from the multipath transmission, with many signals arriving badly out of phase. At other times, this general northward direction for the beam during an aurora display was noticed on signals; on October 13, the beam brought in plenty of raspy noise when pointed just east of north, but this came in poorly on the high vertical antenna. That evening, W2AMJ and W1-DEI came in for a short time. Summer dx at CIR that may have resulted from aurora, rather than low atmosphere bending or sporadic-E layer reflections, was reported on May 8; July 8; August 12, 13, 21, 22; September 2, 15, 16; October 3 and 13.

Low Atmosphere Bending

With all the aurora displays and extensive dx being worked, it is becoming very difficult to segregate this from what is variously termed ground wave, pre-skip or low atmosphere bending dx. W8CIR has done a considerable amount of work to Michigan, Ontario, across Pennsylvania, into Washington, D. C., and even to New England during the past sum-



Closeup view of the stub-fed 7-element Yagi array.

mer and fall. The most unusual evening of the year, he says, was September 14. He heard W1KLJ at 9:35 p.m., followed by W2MO who was R9 from then until he signed off after midnight. Contacts included W1HDQ KLJ W2MO W3BZJ HOH. There was no evidence of skip on any of these contacts, all being very steady; there was no difference between the low Yagi and the high three-half-waves vertical. W8RUE in Pittsburgh, east of CIR, is reported to have raised MO but W8LKD sixty-five miles west, in Ohio, could not even hear him. On the next evening, W2MO and W1KTF were worked with clean R8 signals at first, then weaker garbled signals having characteristics of the aurora-type, ending with clean R8 signals at midnight.

Ed says that he could not have worked 25 per cent of his pre-skip dx without the Yagi, even with the high 3/2 wave antenna available. It has proved to be excellent on receiving, and usually just as good on transmitting, giving a reduction in background noise and sometimes a signal gain that will often do wonders. He uses an acorn converter with plenty of bandspread and a slow motion dial that makes him tune over the band slowly enough to avoid missing signals. As a last shot he adds, "and for gosh sakes, Bill, tell the gang to use c.w. I don't know how many more contacts I could have had if the boys would only use it."

Other antenna experiments have been going on at W9VHG ZUL GGH where horizontals have been tested for work out to 100 miles, especially to bring in W9ZHB who is not generally heard on vertical antennas. It certainly appears to us that similar polarity is required for consistent work over not only short distances but even out to 100 miles or so. Although commercial surveys have been made which indicate that antenna polarization can be independent beyond a mile or so, there is reason to suspect that they are not strictly applicable to all cases, and will have to be supplemented with amateur tests and measurements before one can feel certain of the answer to the antenna polarization problem.

More Receiver Tests

W9SQE has been using a concentric line 20 inches long on a 6K8 mixer, with no r.f. stage. Substituting an 1852 brought up the noise with the signal. Putting in an acorn 954 reduced the circuit capacity so much that he had a choice between putting in a loading condenser or removing the shorting screw thus lengthening the line to 30 inches. This line and acorn tube brought up signals without a corresponding increase in noise, making a noticeable improvement. Using an 8-inch U-shaped antenna coil for coupling a two-wire feeder into the shorted end of the concentric line increased signals another 2 R's over the old coupling method of grounding one wire and tapping the other on to the inner conductor.

W9VHG built up an acorn r.f. stage using a grid line with a square outer conductor, open on one side, but with a coil-tuned plate circuit to provide coupling to his receiver. Although this stage brought loud signals up 2 R's, it has not been demonstrated that signals near the noise level come in any better. He is considering using a line in the plate circuit too (in which case he may go ahead and make a whole converter), realizing that best results are obtained when both the grid and plate tanks are efficient.

Miscellany

W9ZJB sent sixty letters to amateurs from Wichita to St. Louis hoping to encourage five-meter work. W9AZL in Sedalia, Missouri, was the first to promise to get on the band. The plan is to organize a route covering Wichita-Newton-Emporia-Topeka-Kansas City-Sedalia-Columbia or Jefferson City-St. Louis. An additional station on either side of St. Louis will probably be necessary to complete the hop to W9ARN and from there to the east coast by the established route. The 70-mile jump from W9ZJB in Kansas City to W9VWU in Topeka has been raised from a c.w. to a phone basis.

In Natick, Mass., W1DEI finds it possible to work beyond New York City with low power and a high gain beam, but has not done as well to the Albany-Buffalo area. There are high obstacles near him that may have a great deal to do with it. It has been mentioned that the best way to hop over mountains may be to get back away from them in order to reduce the angle to the mountain top over which the signal must bend. The suggestion that hilly country may be easier to work over than flat country is based on the thought that the crest of a hill on or below the horizon may help to diffract the signal down around the earth's curvature without requiring low atmosphere bending to do it.

On September 16 just after noon, W8CIR worked W3BYF and W3FQS at the other end of Pennsylvania and across the mountains. He also heard W1KTF. This may have been "aurota-type" dx because signals

[*Continued on Page* 77]

The Open Forum

River Forest, Ill.

Sirs:

I was quite interested in your recent article entitled "Comes the Revolution," inasmuch as the data contained therein explains something I ran across about two years ago when working with a small fifteen watt, one—sixty meter, phone transmitter. This transmitter consisted of a pentode crystal oscillator and a triode (6A3) class C amplifier. The latter was modulated, Heising method, by a single 6L6 operating class A. I found that in reversing the leads to the secondary of the microphone transformer that one connection gave much heavier modulation and considerably less splatter. For a while I was at a loss to account for this phenomenon, but after observing and studying some of the oscillograms given for various musical instruments (in *The Science of Musical Sounds*, by Prof. Dayton Miller) it seemed to me that perhaps the speech wave was also non-symmetrical and that this might be the explanation. So I meekly suggested same to several of the "engineers" around this vicinity, to be greeted with such vitriolics as, "You Communist," and, "Why don't you go back to Russia," or, "Say, I know a good psychiatrist," etc.

Perhaps, then, you are to be complimented on your choice for the title, as you should be for the article. Now the mystery is cleared up perfectly in my mind and I hope in several others.

CHAS. ROCKEY, W9SCH
River Forest, Ill.

Incidentally, this method *will* work with *high quality* telephone mikes, such as Western Electric type F1.

Burwood, N.S.W.
Australia

Sirs:

We boys over here in "VK" feel that we are out in the cold since the war put us off the air and we hear you fellows still going strong over in "W" and we sure do envy you.

I expect that by this time you have received all the news of the closing down over here but just in case you have not had any word from "VK" I thought a bit of information would be in order so as to let the gang in the States know that we are still here and are all hoping it won't be long before we can fire the old rigs up again and chew the rag with you chaps as we did before.

The order to close down came by urgent telegram on the 2nd of Sept. and we were instructed to cease immediately all transmissions and remove tubes, tuning coils, transformers and keys and mikes from the equipment.

Some days later by letter we were directed to dismantle the antenna if same was designed for transmission and so down came all the beams that were going up round here.

It sure was a blow.

Our experimental licenses were then converted into broadcast listeners licenses, and so we now none of us have even a call sign.

At 2AEC a new rig had just been completed and was working out fine. Now it's just an ornament.

Still we are hoping.

It sure is tough trying to get accustomed to the idea that Australia is off the air but after a little over a month we are most of us becoming resigned to it.

Listening on the bands only makes one feel more discontented; so the receiver hardly gets any use these days.

If anything worth reporting should come along will send you a note so that the gang can have some idea what's doing over here.

T. R. Anthony,
Ex VK2AEC.

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[*Continued on Page 96*]

INEXPENSIVE MULTI-TESTER

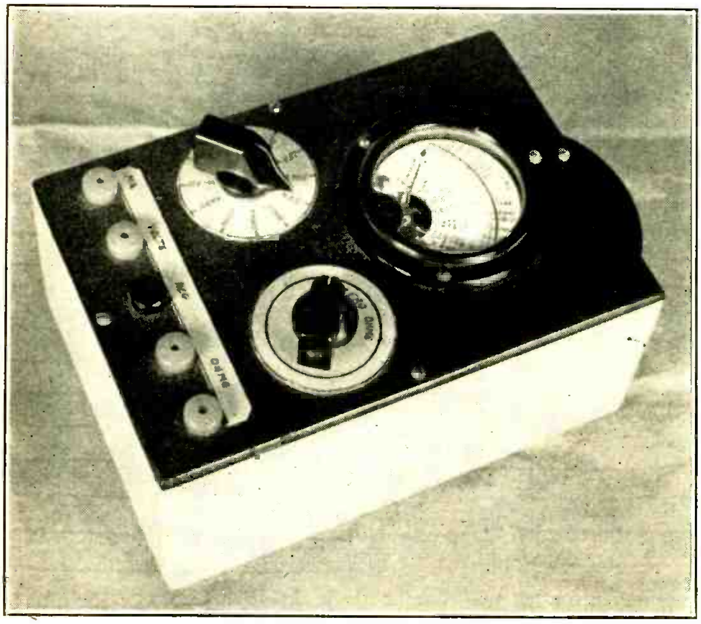
By LLOYD V. BRODERSON,* W6CLV

Upon completion of his station, the newcomer invariably is content to sit back and enjoy his handiwork. However, there is one additional unit—a reliable multi-tester—that should go hand in hand with the station equipment. Eventually it becomes necessary to check various voltages, currents and resistances. If the proper measuring equipment is not available, the maximum efficiency of which the station as a whole is capable cannot be very satisfactorily achieved.

Any project is seldom duplicated in its entirety. Test equipment, more so than other allied accessories, usually undergoes radical changes in the process of construction—the builder preferring to substitute his own pet ranges for those specified. Sometimes this is easily accomplished; more often, the novice finds the necessary calculations assuming perplexing forms, and Ohm's law becomes a complicated formula.

To aid the constructor in designing his own multipliers, shunts and resistance ranges, a resume of calculations has been included and operation of the individual circuits comprising the instrument explained in elementary terms. Several perplexing points are clarified.

The instrument here described has the following specifications: d.c. voltages, zero to 10, 100, 250, 500, 750, 1000, 2000 and 3000. Its d.c. ma. scale reads zero to 100, 250 and 500. Resistances as high as 100,000 ohms may be



The completed multi-tester mounted in its cabinet. The panel is made of tempered presdwood and the box itself is of pine, lacquered to give a smooth durable finish. This type of mounting makes for easy portability.

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* 515 Salinas Nat'l Bank Bldg., Salinas, Calif.

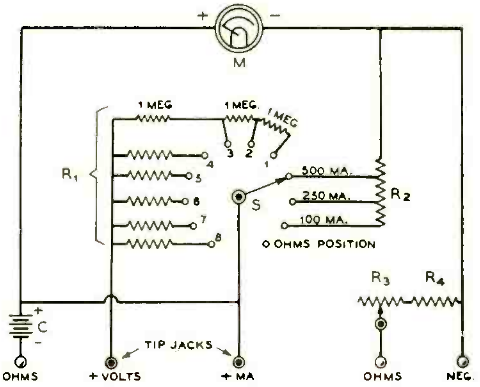


Figure 1. Schematic of the multi-tester.

C—4.5-volt C battery
R_1—Voltage multipliers: 8, 9967 ohms (10 volts); 7, 100,000 ohms (100 volts); 6, 250,000 ohms (250 volts); 5, 500,000 ohms (500 volts); 4, 750,000 ohms (750 volts); 3, 2, and 1, 1 megohm (1000, 2000, and 3000 volts).
R_2—Current shunt
R_3—2000-ohm rheostat
R_4—3000-ohm wirewound
S—12-contact rotary switch
M—0-1 d.c. milliammeter

read directly. There are no toggle switches to throw; it is lightweight, compact and entirely self-contained. A single-gang, twelve-contact selector switch and five tip jacks suffice for all ranges. With a little judicious planning, its cost can be kept surprisingly low.

Circuit

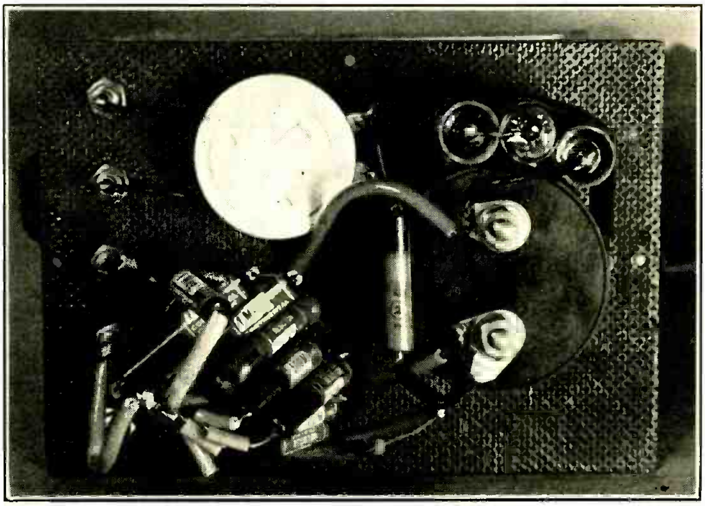
A 0-1 d.c. milliammeter is employed as the indicator for all measurements. The series type ohmmeter is conventional, consisting of a 4.5-volt battery and a calibrating resistance, one section of which is variable. The various d.c. voltage and current ranges are secured by rotating the selector switch to the range desired. It will be noted that one contact on the selector switch has purposely been left disconnected and reserved for the "ohms" position. This is purely a precautionary measure. Further study of the circuit will disclose that resistance readings may be taken with the switch remaining on any of the voltage ranges. Should the selector switch inadvertently remain on a current range, however, a direct shunt is placed across the meter. For this reason, the ohms position should be utilized for all resistance measurements.

Construction

Assembling and wiring the various components will consume but little time, inasmuch as there are few precautions to be observed other than mounting all parts solidly and making current shunt leads as short as possible. Some parts which no doubt will be salvaged from the proverbial "junk-box" and pressed into service, should be checked thoroughly. The efficiency of a good test instrument depends almost entirely upon the accuracy of the parts used in construction.

The panel layout diagram insures most parts being wired as directly to their terminating points as possible, and should therefore be followed quite closely.

The 4.5-volt battery in the ohmmeter circuit consists of three 1.5-volt penlite cells connected in series and taped to the meter case. The five tip jacks terminate their individual circuits as follows: one jack for negative (com-



If the panel is unbolted and removed from the box, this is the view that greets the eye. All components of the tester itself have been mounted directly upon the presdwood panel.

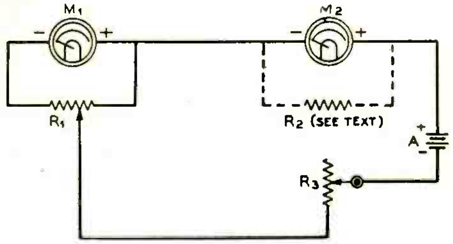


Figure 2. Current shunt calibrating circuit.

M_1—Milliameter to be calibrated for shunts
M_2 — Any standard milliammeter — preferably 0-500 d.c ma.
R_1—Approx. 12" resistance wire from old rheostat or c.t. resistor
R_2—Shunt to extend range of standard milliammeter if range less than 0-500 ma.
R_3—75-ohm variable resistor or rheostat
A—Two 1.5 volt dry cells in series—3 volts

mon) ma. and volts, one for positive ma., one for positive volts, and the remaining two jacks for ohms. Before assembling and wiring the presswood panel may be given a coat of black, crackle-finish enamel.

The case is constructed of ½-inch white pine. Two coats of French grey enamel, a black three-inch composition handle, and four small rubber feet cemented to the base complete the project.

Indicators

While it is possible to purchase a ready-made scale for the meter, there is no reason why it cannot be duplicated by the constructor. The original meter face markings may be scraped with a razor blade and new readings printed in black India ink. A fine lettering pen is indispensable for this work. Indicators for the selector switch, rheostat and tip jacks may be fashioned from colored cardboard and glued to the panel.

The resistance calibrations occupy the upper section of the meter scale while voltage and current is indicated on the lower portion. Three voltage ranges (zero to 100, 250 and 500) also serve as current references, thereby conserving space. If desired, the three highest voltage ranges (easily calculated mentally) may be omitted.

Operating Precautions

An excellent rule to follow when checking for voltage and current is to assume that these values are unknown and proceed with the selector switch on the highest range. The lower ranges may then be cut in to obtain a more readable meter deflection. It should be borne in mind that each time the selection switch is rotated on current ranges, a momentary open circuit occurs. For this reason, the tester should first be disconnected from the project under analysis before a new range is selected.

The only precaution necessary to observe when measuring resistances is to be certain that the meter reads full scale (zero ohms) when the test prods inserted in the "ohms" tip jacks are shorted.

Voltage Multipliers

It is felt that the newcomer would welcome an explanation as to just what is required in a resistor intended for increasing the voltage range—also, how the values of these resistors can be easily calculated. Perhaps it would be expedient first to clarify that phrase one so often hears, "ohms per volt." This means the resistance it is necessary to insert in series with the meter for each volt to be measured. It is computed from Ohm's law: R equals E/I. Thus, a 0-1 d.c. milliammeter (.001 ma.) would require 1000 ohms for one volt. To read 500 volts, a 500,000-ohm resistor must be inserted in series with the meter, etc.

When calculating multipliers for voltages over 50, the meter resistance may be disregarded. Meter resistances are usually in the neighborhood of 25 to 75 ohms and this low value would represent a very small percentage of the total resistance in the circuit. For volt-

[*Continued on Page 85*]

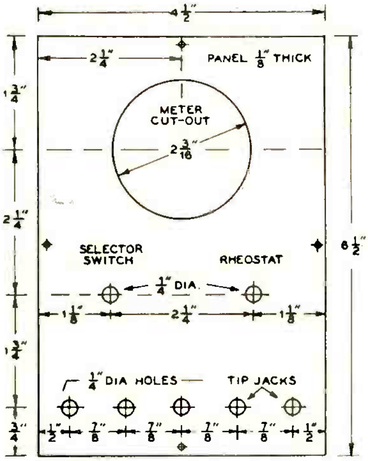


Figure 3. Front panel layout of the multi-tester.

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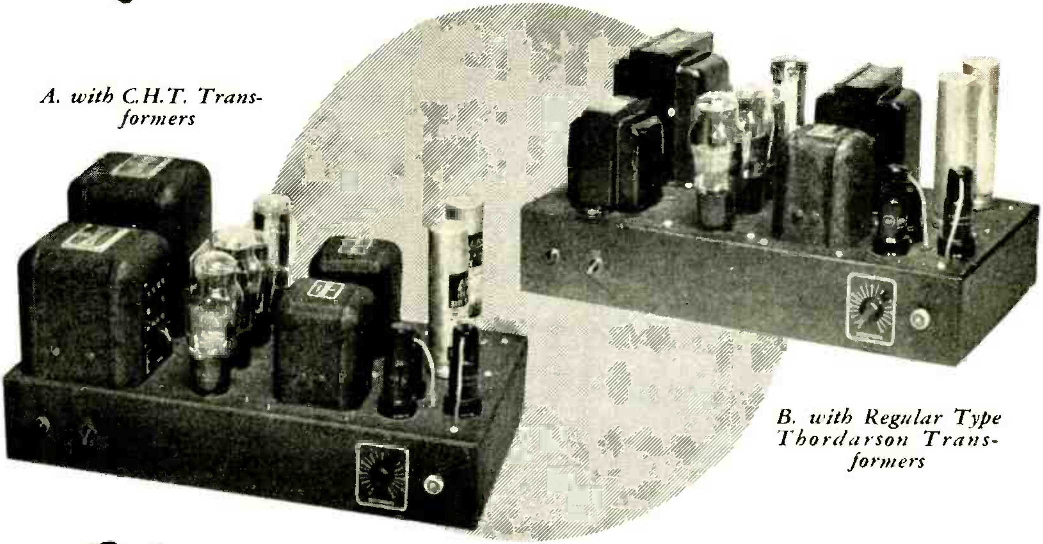

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YARN of the MONTH

PERILS OF POSTON

My pal J. Revel "Pronto" Poston, known on the other side of the tracks as W5AJ, is quite a job. He's about as high as a good sized nickel phonograph and built kinda like a 204A, with just about as much hair. He's got an ever-lovin', long-sufferin' wife by the name of Zelma and a Jr. op that's just about as bright as the plates of my 35T's. My knowledge of the defendant dates back to the days in Venezuela when we operated FX outlaw and stayed outta the local "cast-iron corral" by staying under some tables at Francisco's bar. Them were the days when we had less circumference and more latitude!

One bright day Pronto breezes up to me and unloads: "Chum," says he, "Lo these many years W5AJ has chirped, wobbled, blooped, scratched, and sometimes even gargled c.w. signals into the air. It is time that I put away such childish things. I have become a Man. I shall build me a phone transmitter! I was reading. . . ."

"That's the trouble with you hedge-hurdlers from East Texas," says I, "some misguided cluck teaches you to read and you go and take it seriously!"

"Besides, I was at the club last night and W5BHO says . . ."

"Listen," I breaks him, "You stay away from them boys. They ain't fitten company for a nice guy like you. Why, I hear that they sometimes take *two* shots of strawberry in their sodas! Why, I even heard yesterday . . ."

"Dismount, I'm serious! You can continue talking with your hands if you wanta. I'm layin' in a dray of doo-dads and I'm gonna start dubbin'. It'll probably bankrupt the family, but dear Science must not suffer. Don't be surprised if Zel is over bummin' your wife for some cast-off clothes!"

"If 'Skinny Duggan' ever casts anything off it will probably be her 'Lord and Master'," says I, takin' a powder an' lettin' Pronto tend his own balloon ascension.

The same p.m. I was on 14 Mc. seein' how close to the edge of the band I could get before the "Old Gentleman" at Grand Island started noticin' his beard curl when Zel phoned and said she had some ice cream and cookies and would we come over and stoke-up. I smelled a rat, but Skinny wanted to go, so we fired up that 28 Mc. hash-generator that Henry jokingly calls a Ford and kankarooed over.

There Pronto was, stretched out on his stomach on the floor. He had Handbooks, Radio's, *QST's*, diagrams, dope sheets, catalogs, pencils and paper all over the floor. Zel and the sma-one were sitting in the corner. Zel looked as though she didn't know whether Pronto wuz gonna set fire to the pile or go get the scissors. Pronto looked up and grinned: "I can think better in this position," he explained.

"Well," says I, "at least the pressure is in the right place!"

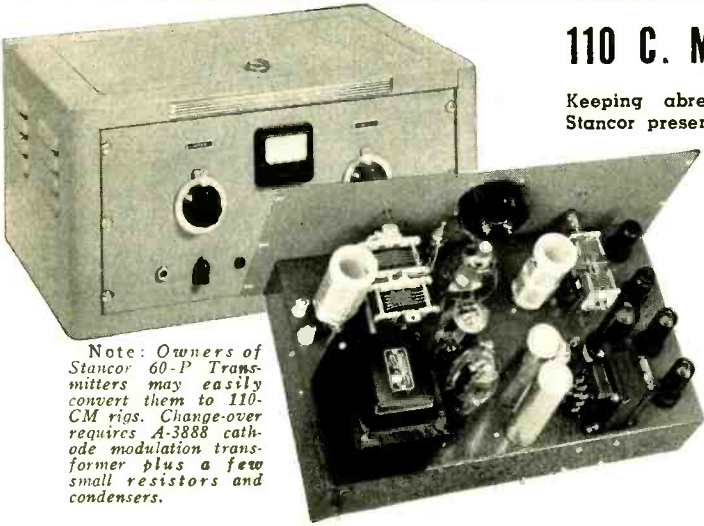
"You are, or rather were once an EE," he accuses. "Your immediate attention is called to this matter. I need to dope out a speech amplifier and modulator system."

"Simple," says I. "Just like raisin' W9's when you CQ dx. Gimme your longest slipstick and a pair of roller skates and I'll show you."

[*Continued on Page 68*]

By J. C. (SALTY) JOHNSON, W5LS

Cathode Modulation BY Stancor



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Note: Owners of Stancor 60-P Transmitters may easily convert them to 110-CM rigs. Change-over requires A-3888 cathode modulation transformer plus a few small resistors and condensers.

YOUR NET COST **$48.75**

AND TWO BRAND NEW CATHODE MODULATION TRANSFORMERS

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For modulating R.F. amplifier inputs up to 250 watts. Eight output impedances from 150 to 2500 ohms available.

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"Seriously," he says, "I'm all confused. I've got three handbooks and they all disagree. I'm so messed up that I can't figure the gain for two stages of R/C coupled 6C5's!"

"I've never seen any two 'authorities' on anything makin' love to one another," I reminds him. "The last time I had a phone transmitter was on 230 meters with a 202 loop-modulated, and even then the telephone authorities and I could never agree on how much r.f. one of their mikes could stand."

"Should I use Class A, A_1, B, grid, suppressor, or cathode modulation? Bein' as I'm startin' from scratch, I've a pretty large field to choose from."

"Bein's you gotta pair of 03A's in the final, it'd be a little mystifyin' to see you suppressor modulate 'em. Or maybe you're gonna join hands with Mr. Armstrong and frequency-modulate 'em!"

"You're positively insultin'," he accuses. "Why I associate with such an electronic scarecrow as you, I know not. You probably think that FCC is a French commercial."

Seein' the ice cream and cookies fast gallopin' over the hill, I kinda let up and see if I can help him dope out some of his problems. It's been quite some time since I gave audio an audition, but it kinda came back. Besides, at that point in my higher eduction, Spring and Skinny were in the air, and I thought impedance was the name of a sorority house mother. Now don't get me wrong, I wasn't falling for any of this phone guff. I was merely tryin' to help Pronto and at the same time protect my calories!

I didn't see Pronto for another coupla weeks, but I did kinda miss him, in reverse. I started working some of those XU's he used to rob me outta. Meantime I got me a three-element 14 Mc. rotary up, after scarin' Duggan into a dead faint, nearly fallin' offa the tower on my sconce, and droppin' an insulator on the neighbor's pooch. (I *still* contend it was accidental.) I also dropped one of the elements across a telephone cable. Gramma Bell oughtta either retire or start takin' "Carter's Little Liver Pills" as she's sure cranky in her old age!

The payoff came when I was tring to tune the unreasonable thing. Somebody sees me climbin' the tower with a f.s. meter and turns in a call for the "wagon." They dislodge me and tell me soothingly that there are lotsa trees to climb where they are takin' me, and forthwith toss me in the city's padded cell. It's Pronto that has to come down and tell 'em that I don't think I'm Tarzan, only a poor, harmless c.w. man that always acts that way when there is a certain pollen in the air!

That p.m. I was callin' a PA0 for about a half hour, only to hear him come back and give W5DM an R8. I was makin' mental note to either buy me an 805, or else switch to "Ten High," when something comes through the cans that leaves the receiver practically a nervous wreck. It's something that makes speech-inversion sound as intelligible as an NBC announcer after he gets his plates broken in. I was thinkin' maybe the boys on the wagon had something after all when the phone rang. It was A. J.

"Say, will you listen to my 160-meter fone? I gotter on!"

"That's what I've been listening to," I sighed, breathing freely once more.

"F.B. How does she sound?"

"Dunno how she sounds on 160, but she does all over 20."

Feelin' more or less in debt to the runt, I decided I'd better help him. Alone, I would've had a tough time trying to convince that bunch of horse doctors on the Sanity Board that I wasn't up that tower lookin' for Lupe Velez!

Pronto and I both hung up the phone. I finally got the receiver over being skitish every time his carrier came on, and we started testing. When he'd run the audio gain up it'd sound like a room full of jungle cats garglin' sulphuric acid. He'd run the gain down and a 120-cycle hum would smight the ether a mighty wallop. Every time he would modulate her over 60% the carrier would shift right up and keep KXYZ company. Before he got through I'll bet them "Dainty Diapers" they were advertizin' had scallops on 'em! I told him to ga, as nobody could identify him unless they were psychic, or I sold him down the river.

"Lissen," he wails over the land line, "I think one of my class B bottles is sour."

"Pull 'er out and I'll take a listen."

"How's this?" he asks, and warbles something I rashly guess to be "one-two-three-four."

"About twice as good as before," I tells him maliciously. "Now pull the other one out and maybe I can understand you!"

He put a permanent wave in my poor old crystallized eardrum by bangin' down the phone, so I figure I'd better go over and square things, meantime cussing myself for a blather-puss.

We really put in a night! About all we had left of the original wires in his rig was the wiring in the light meter, and we'd have fixed that too if we'd had a glass cutter. Between the two of us we finally got the plate

[*Continued on Page 81*]

"COÖPERATION"

has long been my motto

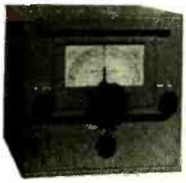
I HAVE FOUND, from years of experience in the radio business, it pays dividends to coöperate to the fullest extent with my customers. A satisfied customer is the best advertising obtainable. Accordingly, I keep my customers happy by prompt and fair dealings.

But I cannot give such satisfaction without the coöperation of the manufacturers, so I maintain an unusually close contact with my suppliers. In this way I am able to keep my customers informed of the newest and best apparatus available as it is being developed.

For example, since coöperation has been so very close with the RME Company I am ready at all times to supply you with complete information on their Receivers and Expanders.

RME's DM-36 Band Expander is one of the finest pieces of five meter equipment I have ever seen. Enthusiastic users of it report "5" wide open for DX.

And the RME-70, pictured below, is one of the better communication instruments which I gladly recommend as an outstanding example of craftsmanship.

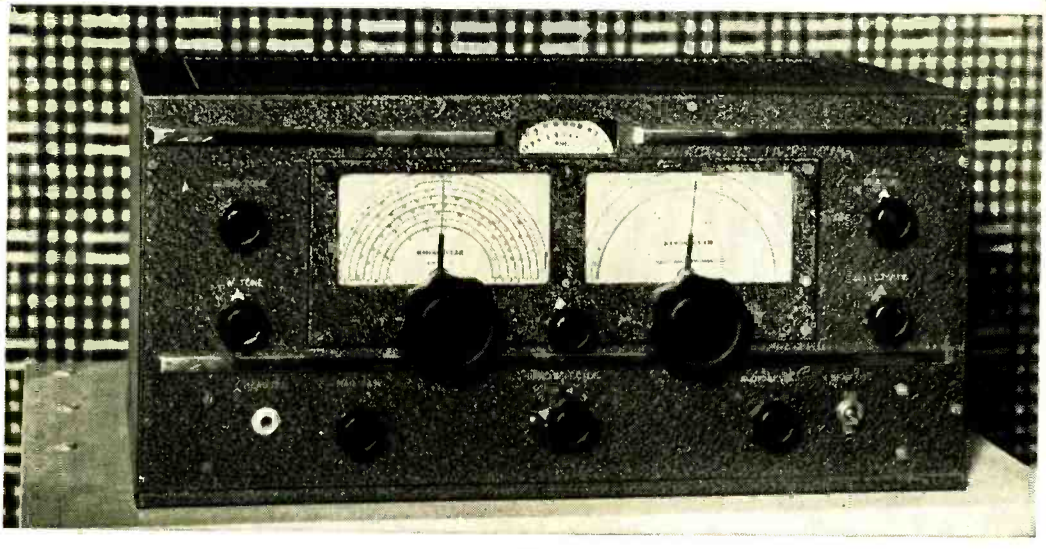


Whatever you need in the RME line I have it for you. You can order on my personally financed 6% installment plan. You can trade in your receiver. Prompt shipment from Butler, Mo., in factory sealed carton or shipment direct from RME factory. All equipment shipped on ten-day trial. If you aren't satisfied, you don't buy.

I have a complete stock of all receivers, transmitters, parts. I guarantee you can't buy for less or on better terms elsewhere. Your inquiries and orders invited.

Bob Henry
W9ARA

HENRY RADIO SHOP BUTLER MISSOURI



What's New . . . .
IN RADIO

GENERAL ELECTRIC TRANSMITTING TUBES

The General Electric Company has recently entered the transmitting tube field with a series of tubes which undoubtedly will be of considerable interest to the transmitting amateur. For the most part the new GE tubes have identical ratings and characteristic numbers to the more commonly used RCA types but the numbers are prefixed by the letters GL instead of RCA. The amateur net prices are standard for the appropriate type number.

KENYON CATH-O-DRIVE TRANSFORMERS

The Kenyon Transformer Co., Inc., 840 Barry Street, New York, has announced a new series of three transformers known as cath-o-drive units which are designed to cathode modulate various types of transmitters. Specifications are as follows: T-471, 200 ma. max. secondary current, for a single 6F6 audio tube; T-472, 300 ma. max. secondary current, for p.p. 6V6's or 2A3's; and T-473, max. secondary current 450 ma., which is designed to handle a pair of 6L6's in push-pull class AB_1 or AB_2.

NEW HALLICRAFTERS S20-R

The Hallicrafters announce the improved "Sky Champion" communications receiver, Model S20-R. Priced under fifty dollars, its features appeal not only to the amateur but to short-wave listeners, dx'ers, and for various commercial applications as well.

The tuning range is from 540 kc. to 44 megacycles in four bands of 540-1770 kc., 1.72-5.4 Mc., 5.3-15.7 Mc., and 15.2-44.0 Mc. The tube line-up includes: 6SK7 tuned r.f. stage, 6K8 oscillator-mixer (with special input tuned circuit which provides approximately twice normal conversion gain at frequencies above 14 Mc.), two 6SK7 i.f. stages, 6SQ7 detector-a.v.c.-first audio, 6F6G audio power stage, 6H6 automatic noise limiter, 6J5GT beat-frequency oscillator, and 80 rectifier.

The S20-R

Special features include unusually high r.f. gain and consequent high signal-to-noise ratio, provision for either line or battery operation (for emergency, mobile or marine applications) with instant changeover from one to the other, electrical bandspreading in all ranges, rubber-cushioned built-in loudspeaker, a.v.c. applied to all r.f. and i.f. amplifiers, special frequency-stabilized oscillator to minimize effect of line-voltage variations, provision for remote stand-by control, connection socket for connecting external "S" meter, and fully automatic noise limiter circuit to trap out ignition and similar interfering noise.

The new "Sky Champion" is housed in a steel table cabinet, finished in gray with stainless steel trim. Main and bandspread dials are internally illuminated.

STANCOR CATHODE-MODULATION TRANSFORMERS

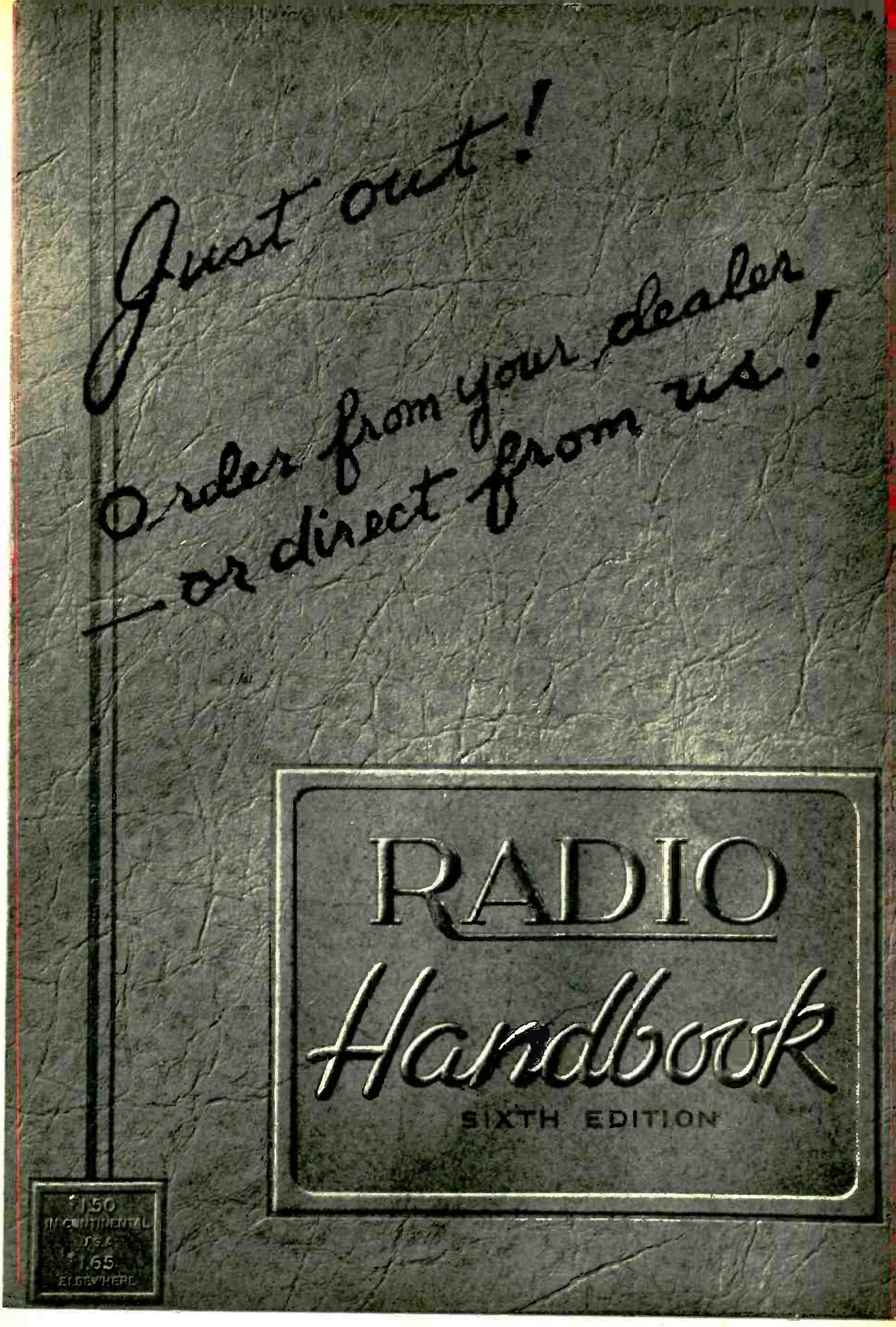
The Standard Transformer Corporation, 1500 No. Halstead Street, Chicago, Ill., is manufacturing two transformers designed for cathode modulation. Both have a wide range of secondary impedances to accommodate the various combinations which may be encountered in practice. The smaller of the two, A-3888, is designed to pass a maximum current of 250 ma. through the secondary. The larger, A-3889, is designed to pass any current up to 450 secondary ma.

The transformers are described in a booklet put out by the manufacturer which gives cathode modulation data in tabular form for a large number of different tube combinations. In addition, the article in the December, 1939, RADIO giving cathode modulation operating data has been reprinted in the booklet to assist those who are experimenting with the modulation system for the first time.

New RME Equipment
DM-36A AUTOMOBILE EXPANDER

The DM-36A is a 5- and 10-meter band expander designed especially for use with an automobile broadcast receiver. This unit is very easily installed with a minimum of expense and effort, and since it comes complete with antenna changeover switch, regular broadcast reception may be had on a moment's notice.

[*Continued on Page 89*]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From the PRIVATE LIFE of RADIO

As the spirit moves, we present in this column from time to time a bit of gossip about RADIO, its affiliated publications, and those who produce and distribute them.
—"From the private life of RADIO".

Perfume

We've been subjected to a bit of good-natured kidding about the perfume advertisement which appeared in the "Marketplace" section of the November issue. What on earth possessed a manufacturer to pay perfectly good cash-in-advance to advertise perfume in RADIO we'll probably never know. Our regulations for this page provide that non-radio advertising is acceptable, but will be grouped separately. Unfortunately, through a misunderstanding of mechanical instructions the printer "boxed" this ad instead of setting it off separately, and it quite "stole" the page.

Hawaii is in U. S. A.

Noting that our extra charge of 15c on copies of the RADIO *Handbook* sent to points outside the continental U. S. A. applies to their islands, several Hawaiian residents have tartly informed us that the territory is part of the U. S. A. and that the same parcel post rates apply. Right; it's a matter of average costs, not sentiment. Books are usually sent by cheaper means than parcel post in the continental U. S. A. The 15c charge to territories represent on the average only the extra cost of shipment to territorial points, not the total cost. We note, in passing, that several similar books charge 25c extra while still more charge list price at the publisher's office, plus full transportation charges.

Those who like to have a little fun figuring the whys and wherefores of things, may try their teeth in this one: a copy of the current handbook may be mailed to any foreign country including those "at the opposite ends of the earth" for about 27c while a copy to U. S. territories costs 37c!

Antenna Book

A number of inquiries have come in as to whether or not the 3rd edition of the RADIO *Antenna Handbook* will appear this fall. No, the 2nd edition is still current and no new edition is contemplated at least for several months. If you already have the 2nd edition and just must have a new antenna book right away, cut the antenna chapter out of the new big RADIO *Handbook*, and you'll have one which we could hardly better at the present time, except by going into a bit more detail and including a few of the rather uncommon antennas. Incidentally (and this "mention" will probably give our circulation manager another grey hair), this antenna book is no longer the "only book of its kind." It has a rival—and, let us be the first to admit, a darn good one.

To Our "Ham" Subscribers

We'd like to add your call-letters to our addressing stencils, and we believe you would like to have us do so.

If your call is not already shown on the stencil which addresses your copies of RADIO (or if you are in doubt), just send us your QSL card or an ordinary postcard and say, "Please add my Call". Be sure to give your name and address legibly.

The Editors of RADIO
Circulation Department

An Economical 5-Tube Super

[*Continued from Page 22*]

it is so located that it is an effective by-pass for the plate supply to both the r.f. and mixer stages.

The procedure for placing this receiver in operation is similar to that used with any other superheterodyne. After the receiver has been connected to a power supply delivering from 250 to 300 volts and a speaker having a field resistance of 1500 to 2500 ohms, the i.f. stage and second detector input circuit should be aligned. This is best accomplsihed with the aid of a signal generator operating in the 1500-to-1600 kc. range coupled loosely to the grid of the mixer. The detector should go into oscillation very smoothly when the regeneration control, R_8, is advanced. If oscillation does not take place it is probable that the tickler is improperly phased, and the tickler connections should be reversed.

After the i.f. amplifier has been aligned, a set of coils should be plugged in and the oscillator bandsetting condenser set to the proper capacity for the coils in use. With a 0-100 scale, with zero at the low capacity end, this setting will be as follows: 10 meters, 35; 20 meters, 80; 40 meters, 60; 80 meters, 60. Next, the r.f. and mixer tuning control should be brought into resonance and, after the oscillator bandsetting control has been adjusted to center the band on the dial, the receiver is ready for use.

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

●

We've often seen the plates on toggle switches turned upside down so that they said "NO" and "FFO" but the payoff comes in the fact that toggle switches in Spanish speaking countries say "NO" and "SI", or literally, 'NO" and "YES."

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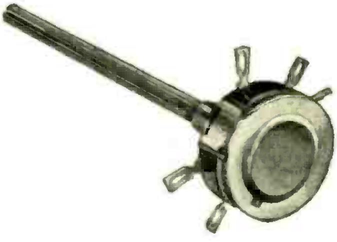
Circulation Department



The 3-Band Rotary Antenna

[*Continued from Page 28*]

On 14.2 Mc. the measured standing wave ratio was very low, about 1.2. This indicates an exceptionally good match as the transmission line (570 ohms) is 150 feet long and makes a number of right angle bends in this length. Also the standing wave ratio was low and quite constant over the frequency range of the entire 14.0 to 14.4 Mc. band. The transmitter loading was likewise quite constant over the entire band and showed no noticeable variation as the antenna was rotated to any position. In addition, the horizontal radiation pattern of the beam was measured at various frequencies over the range of the 14-Mc. band and was found to change to so small an extent as to be of no practical importance. Furthermore, the standing wave ratio and transmitter loading were found to remain substantially constant during a change from dry to wet weather conditions.

7 Mc.: On half of the fundamental frequency the parasitic elements are inoperative and the antenna operates as a horizontal quarter-wave doublet with a measured radiation pattern as shown in figure 6B. The pattern is bidirectional, the maximum radiation being at right angles to the wires of the 4-wire doublet. The pattern is quite broad at right angles to the doublet but the null off the ends of the doublet is sharp and deep, giving a front-to-side ratio of 23 db or 300 to 1 in power. The front-to-back ratio is of course, 0 db or 1 to 1 in power.

28 Mc.: On its second harmonic the rotary functions as a 6-element beam. The driven 4-wire elements are equivalent to two colinear half waves in phase. The parasitic elements are equivalent to two colinear half-wave directors and two colinear half-wave reflectors making a total of 6 elements. The spacing of the driven elements to the directors and also to the reflectors is 0.2 wavelength on this band. The measured horizontal pattern is shown in figure 6C.

The beam is somewhat sharper on 28 Mc. than on 14 Mc. as may be noted by comparing the curves in figures 6A and 6C. This is a result of the greater number of elements, operating as colinear pairs. A somewhat greater gain on 28 Mc. is also obtained.

The 28-Mc. beam has a well defined unidirectional pattern. There is some backward radiation which might be reduced by a more elaborate adjustment of the antenna but it is relatively small. The front-to-back ratio even under the condition measured is about 14 db or a ratio of 25 to 1 in power. The front-to-side ratio is very high, being over 35 db or over 3000 to 1 in power.

The curves of figure 6 are all adjusted to the same maximum so that only the shape of the patterns is significant. The patterns are given in terms of relative power. The measurements were obtained with a calibrated field intensity meter set up some distance from the antenna, the antenna being rotated through 360 degrees. These data were in most cases also compared with reports from local and distant stations.

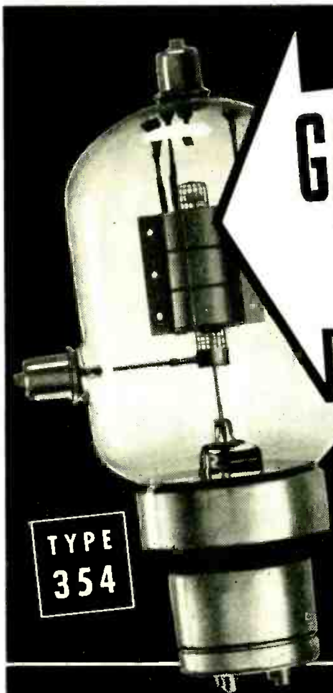
Results

The 3-band rotary described in this article and used at W8JK has given excellent results. For example, on 14 Mc. the first four calls with the rotary resulted in two-way telephone contacts with the following stations: TI2AC, San Jose, Costa Rica; YV5ABF, Caracas, Venezuela; and XU1B, Canton, China. Very good reports were received.

On long-distance contacts the beam sometimes appears to be very narrow, it being reported that the signals drop down and disappear when the beam is turned only a relatively few degrees either side of the direction of the distant station. However, depending on the conditions, the height of the antenna above ground, and the distance of the station, this angle or width of the beam may appear to vary considerably. On short skip (1000 miles or less) the station may report receiving the signals through a complete 360-degree rotation although a very large variation from front to back is noted.

On 7 Mc. the pattern of the rotary is broad except for the nulls off the ends. These are most evident on tests with local stations, the report being that the nulls are sharp and very deep. The directional properties of the antenna may also be apparent both transmitting and receiving on long distance contacts. In general, however, for skywave communication on 7 Mc., relatively little directional effect will be evident and the nulls may appear to be hardly noticeable. This results from the fact that on this band the effective vertical angle of radiation is usually fairly high and a quarter-wave doublet radiates nearly as much at these vertical angles in the direction of the ends of the doublet as at right angles. The antenna has no gain on 7 Mc. but nevertheless the 4-wire quarter-wave doublet is a highly effective as well as a very compact radiating system.

On 28 Mc. the 3-band rotary, operating as a 6-element beam, has given an excellent account of itself. On rotation tests the antenna has shown a high front-to-side and



front-to-back ratio and fine signal strength reports have been received.

Fundamental Operation on 28 Mc.

The above description has reference to a 3-element rotary beam having a fundamental frequency of operation of 14 Mc., and, thus, permitting operation on 7, 14, and 28 Mc. By constructing the entire antenna to one-half the dimensions given, a 3-band rotary can be built for fundamental operation on 28 Mc. The rotary will then be a 3-element beam on 28 Mc. and can also be used as a quarter-wave doublet directional antenna on 14 Mc. and a 6-element beam on 56 Mc.

2-Element Beam with 4-Wire Doublet

The 4-wire doublet can be applied to a 2-element beam[14] as well as to a 3-element type as has been described. Thus, for a 2-element 14-Mc. rotary beam, using a half-wave driven element, and a half-wave director spaced one-tenth wavelength, the driven element may be replaced by the 4-wire half-wave doublet. A 500-to-600 ohm line can be directly connected to the terminals at the center of the 4-wire doublet. The dimensions for the 4-wire doublet can be the same as those given in figures 3 and 4, the wiring of the doublet for fundamental operation being the same as for the 3-element beam described. For a 2-element beam used on a fundamental frequency of 28 Mc., the 4-wire doublet can be constructed to one-half the dimensions given for 14 Mc.

The 4-wire half-wave doublet can be used to advantage not only with 3- and 2- element beams as has been discussed, but also with beams having more than 3 elements.

Acknowledgments

The writer is indebted to Mr. R. S. Brown of the Bee Engineering Company for the construction of the 4-wire doublet and various other parts of the antenna system; and to Henry Newburgh, W8MDA; Roden Rogers, W8EPC; and Harold Taylor, W8RNC, for assistance in some of the tests.

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[14] "The Compact Unidirectional Array," W. V. B. Roberts, RADIO, Jan. 1938, p. 19.

Parallel Cathode Modulation

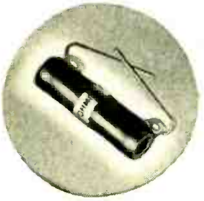
[*Continued from Page 42*]

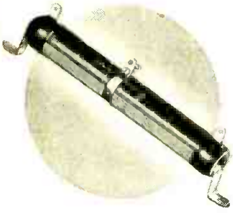
figure 1. A separate filament transformer should be used to supply the 6L6 modulator tubes. The heater of the tube may be connected to the cathode or not, as desired.

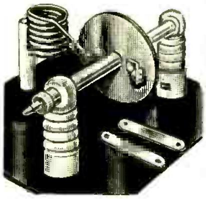
Another thing to remember when using this system of modulation is that the modulator stage must always be operated single ended. If more than one tube is to be used in the *modulator* the tubes must be operated in parallel. They cannot be operated in push-pull since there is (theoretically) no fundamental frequency component in the cathode circuit of matched push-pull tubes.

The Choke

The only item of coupling between the modulator and the modulated amplifier is a conventional choke. It is only necessary that this choke have reasonably low resistance (less than 150 ohms) and that it be capable of carrying the combined plate currents of the modulator and of the modulated amplifier stage. It need not have very high inductance (3 to 10 henries is ample) since the impedance in the common cathode circuit of the two







amplifiers is quite low. An additional inexpensive filter choke of the type that would be used in the power supply to the modulated amplifier will be ample for use in this position.

Operation

The other conditions for operation of this system of cathode modulation are identical to those of the system using a step-down transformer to couple the modulators to the cathode circuit of the modulated amplifier. These conditions: excitation, grid bias, grid leak or power supply bias, series grid resistors, loading, etc., have been thoroughly covered in the article which appeared in the December, 1939 issue of RADIO.

(We wish to thank Mr. Peter G. Sulzer, W3HFW, for certain suggestions added to this article upon the reception of a letter from him mentioning the use of cathode modulation with a cathode coupled audio stage, which consists of a T-40 cathode modulated by a cathode coupled 6L6.)

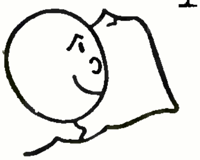
U. H. F.

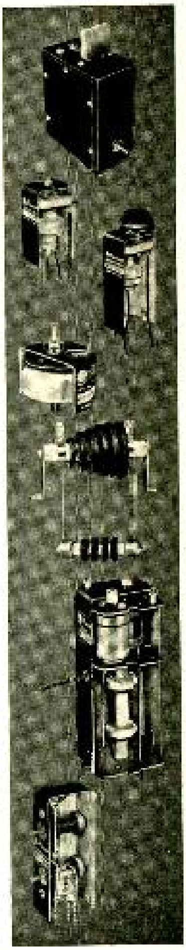
[*Continued from Page 60*]

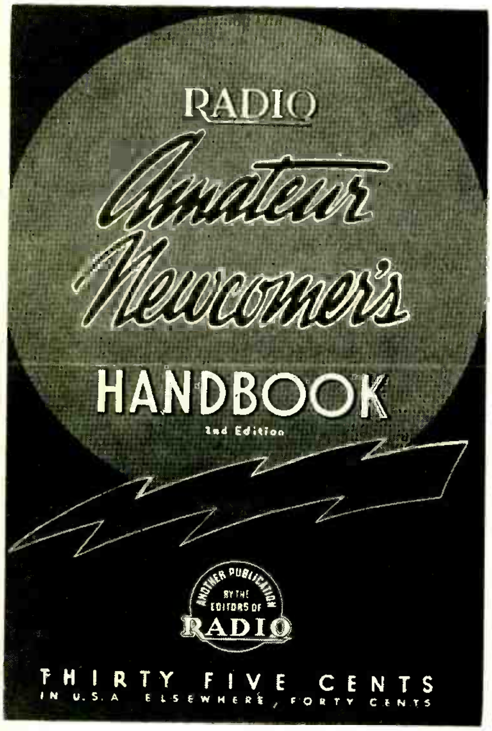
were garbled at intervals and of one second duration. That evening, CIR got W2MO (direct) to ask W1KLC on Cape Cod to start a message west which followed the route W1KLC - W2MO - W8CIR - W8MDA. This was from east of Boston to west of Detroit with only two intermediate relays. A return message went from W8MDA via W8CIR to W1KTF where it was halted overnight, awaiting delivery to W1KLC the next morning.

While still talking about CIR, it might be well to mention his mobile trip to Cape Cod. Ed's little five watter did not raise a thing until he arrived at the Fair grounds in New York, when W2AMJ (35) miles was contacted. He even had spare pencils with him to write down all the QSO's he was going to have in New York, and then heard only one New Jersey station! After several evenings at Cape Cod, he got some action out of several Boston stations about 40 miles away, following which he had pleasant contacts with W1SI, W1KUD (Wooster—70 miles), and W1KLJ (Bristol, Conn., 150 miles). W2JCY heard him too, a good long distance for a small mobile rig. On the way back to Aliquippa, Ed visited W2AMJ whom he had never contacted on five from his fixed location—and the next night on arriving home, made the first contact direct.

Wisconsin contacts during the summer were often provided by W9GGH in Kenosha. One of his rigs starts with a 6V6 electron coupled oscillator doubling to 10, an 807 doubling to







5 and a T40 final. The other is an all-band affair using two 6A6's to go from an 80 meter crystal to 10 meters, then an 807 doubler and RK47 final. The antenna is a three-element vertical. A horizontal is being erected for test purposes with W9VHG. Receivers are a 5-10 Skyrider and a home-made super. Boardman will be glad to participate in test schedules.

112 MEGACYCLES

W1AVV in Stamford, Conn., has heard W2BZB in Palisade, N. J., just over 30 miles, and now promises to get on 114 Mc. with a transmitter, too.

W2BZB is using T20's in a tuned filament circuit with plate lines, taking 50 watts input. Receiver is 6C5-6F6. The antenna is a vertical five-element Yagi with close spacing, rotatable within his attic. Best contact has been W2JND in Syosset, 23 or 24 miles away, together with the W1AVV report mentioned above. JND puts in an R9 signal. Activity to the north may pick up, with W2HMT in Ossining, N. Y., coming on to add a possible 35-mile contact for BZB and longer for the Long Island stations. New Jersey activity is low, W2HCL HGU being the only others known to be on in November. The main difficulty with 2½ seems to be inactivity. BZB considers the band to be superior to 5, with stronger local signals and less shadow effect.

According to the bulletin of the Merrimac Valley Club, W1JMW and others from Reading, Wakefield and Stoneham, Mass., are eager to test on 2½ with the Lawrence gang. W1DEI is another who is giving 2½ a try.

Recently, W9SQE shorted his concentric lines in a 954 mixer and 6C5 oscillator 56 Mc. converter, thus bringing in 2½ meter stations with much less trouble than making and trimming coils. Signals were found to do a considerable amount of drifting (was any of it in the receiver?), thus requiring retuning because of the selectivity of the set-up which was made for stabilized signals.

Cecil Yates, W6AVR, has been doing some 2½ meter work in Colton, Calif., since five-meter dx became less frequent in the fall. He uses an HK24 doubler to 2½ to drive 35T's in the final on 112.04 Mc. With 140 watts input, he can light a 75 watt Mazda lamp to full brilliance. On five, he used three ways to resonate antenna feed sections, of which only two gave reasonably close results. Curiosity caused him to work on some antenna problems on 2½. For this, he used a temporary shorting bar with a 60 m.a. dial lamp connected across one-half inch of it. Because he had difficulty resonating an extended two-half-waves-in-phase antenna, the first problem was to determine how long a quarter wave stub should be, when made of 3/16-inch copper tubing spaced two inches with a Johnson 132 spreader insulator. This done, he started to turn out the open end of the stub to make a short dipole resonated with the shortened stub in the middle. This is illustrated in the accompanying figure 1.

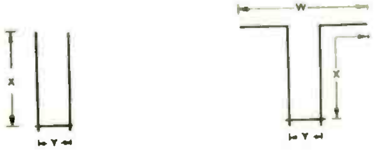


Figure 1. Illustrating the significance of W, X, and Y in the measurements to determine the effect of different W lengths upon 2X plus Y.

The stub spacing, *Y*, is two inches. But as the stub length, *X*, is bent out to form the dipole *W*, the total length must be changed in order to resonate the circuit. His measurements are as follows:

W	X	2X + Y
2 inches	25 inches	52 inches
7	26	54
10-1/4	26-1/4	54-1/2
15	26-13/16	55-5/8
20-1/4	27-5/8	57-1/4
23-3/4	28-3/16	58-3/8
27-1/2	28-5/8	59-1/4
32-1/8	28-13/16	59-5/8
37	28-9/16	59-1/8
41-7/8	28-1/4	58-1/2

Power was fed by shock excitation from the transmitter connected to a dipole, but separated a considerable distance to avoid interaction. With the information above, an extended double zepp was at last resonated with the dimensions shown in figure 2. This totals 160.5 inches for the three half waves on 112.04 Mc. Subtracting the fifth measurement in the above table for the center half wave, he arrives at 102.5 inches as the remainder of the antenna attributed to the end two half waves. This seems to check closely with recommended dipole lengths if only two end effects are figured in.

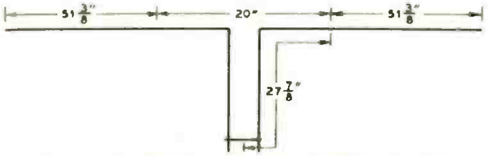


Figure 2. Final optimum lengths for the 112-Mc. extended double zepp.

2½ in Chicago

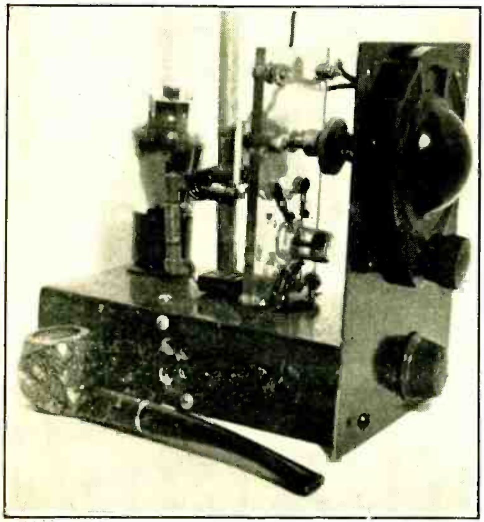
Active 2½ meter stations in Chicago are as follows:

North Side		South Side	
Call	Input	Call	Input
W9CQV	30	W9LRX	10
W9AVE	10	W9UTS	10
W9EMX	10	W9EDG	50
W9LAO	2	W9OBW	
W9LLX	2	W9KUW	
W9WBB	10	W9DYV	
W9UOV	2	W9QLN	
W9AUK	1	W9SSU	100

Just to prove the YL's can talk turkey on u.h.f. matters, the following letter from Kay Sheffer, W9CQV, is quoted:

> "This letter originates from W9CQV and its purpose is to have you and your fine magazine help us to stimulate activity on the 2½-meter band on both north and south sides of Chicago.
>
> "The band seems to be much the same as 5 meters, except that the sigs do not travel quite as far. I would say about ¼ less; however, I believe that distances of from 35 to 40 miles can be worked regularly with the average ham equipment. W9CQV on the south side and W9LRT on the north side are making contacts and we have heard sigs as far north as Evanston from W9EDG which is a distance of about 25 miles. We use a receiving antenna mounted on the receiver rather than out in the clear.

The ingeniously built 2½-meter transceiver in use at W9CQV. The pipe is for comparison purposes only.



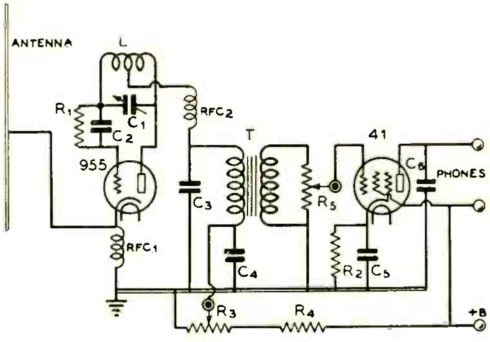


Figure 3. The 112-Mc. receiver circuit used by Kay Sheffer, W9CQV, showing the unusual method of cathode antenna coupling. Note that the r.f. section is mounted upon a piece of lucite.

C_1—10-µµfd. midget variable
C_2—.00025-µfd. midget mica
C_3—.006-µfd. midget mica
C_4—0.1-µfd. 400-volt tubular
C_5—10-µfd. 25-volt elect.
C_6—.006-µfd. midget mica
R_1—500,000 ohms, ½ watt
R_2—500 ohms, 10 watts
R_3—50,000-ohm potentiometer
R_4—50,000 ohms, 2 watts
R_5—500,000-ohm potentiometer
T—3:1 audio transformer
$RFC_{1,2}$—Ultra - high r.f. chokes
L—6 turns no. 14, ½ inch o.d.

> "The transmitters are very simple and easy to build, most of the tubes used on 5 meters work o.k. on 2½ and give good output. However, the receivers take more care and thought. Tubes such as 76's will work fair as a detector, if the wiring is made short and direct and it will superregenerate better if an r.f. choke is placed in series with the cathode to ground instead of a direct ground. I have also found that if this choke is made correctly that you can connect the antenna direct to the cathode of the tube and the sensitivity is improved.
>
> "The transmitter is of conventional design, using a pair of 76's as a push-pull self-excited oscillator with ¾ inch diameter tubing in the plate circuit. It has about 8 to 10 watts output, modulated with a 6F6 and a 6C5 as speech.
>
> "The receiver uses a 955 detector, transformer coupled to a 41. The circuit is similar to receivers in the HANDBOOK except for the components and the r.f. choke in the cathode, along with the method of connecting the antenna. (See figure 3 for diagram. Ed.)
>
> "With better equipment, we hope for more distant and better contacts in the future."

Yarn of the Month

[*Continued from Page 68*]

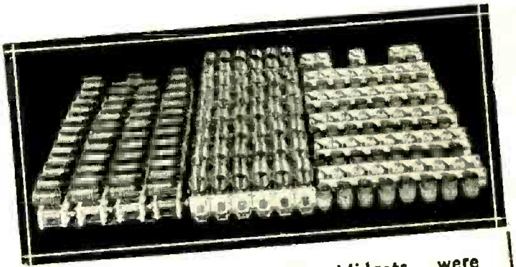
meter in the final r.f. stage to at least stay on scale during modulation. Don't get me wrong, I was only doin' it to help a pal. Besides, he knew more than I about it. Course the thing didn't sound like KOA, but we finally got the voice a few db above the hum. We didn't have enough drive to unwind the final grids, both of us being c.w. men at heart, but we got enough to get by. Pronto finally got off his high hoss and commented that somewhere in the FCC rulings he had seen where it was unlawful for a 160-meter fone to be more than 75% intelligible anyway.

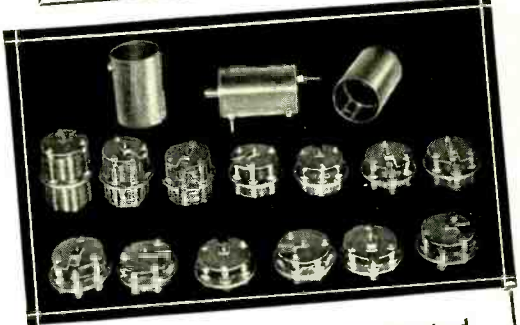
It was about daylight when I finally got back to our ducky litle domicile (a la FHA). Duggan woke up, smelled my breath to see if I had been over to see W5DM's 805, remarked that I was ruining my health, her sunny disposition, and all my clothes, and promptly went back to her timber work. Next to having an all-band, push-button sunshine-kilowatt, I'll take a sparring partner that's on good terms with Morpheus.

Coupla weeks later I was almost floored when I heard W5AJ on c.w. about R4. On hooking him I found he'd found some guy that figured radio junk was worth more than Confederate currency and had bought his 160-meter fone. Besides he had gone down and had reckoned with the man behind the mahogany desk and got himself a Class A ticket, and was building himself a 20 meter fone transmitter. All of which proves I don't know at which station to get off, accusin' Skinny of doin' all the sleepin'.

If you think we had trouble with the 160-meter rig, you shoulda been in the offing watching us tryin' to coax the r.f. section to sign a "mutual assistance" pact with the audio on 14 Mc. We nursed a bad case of colic in the r.f. section for a week. We had r.f. everywhere except on the grids of the final amplifier. The plates of all the bottles assumed the color on the pans of a bunch of old maids at a Paris peep show. Zel burned her nose with r.f. off a coat hanger in the closet. If we coulda figgered a way to couple the plates of the 866's to the antenna, well, the war woulda been over! One trouble was that we'd always used breadboard and we shoulda let RCA have them pig-iron panels all to themselves. A coupla hundred watts on 160 and a kw on 14 Mc. are two hosses with different pigmentation—and the latter's distinguished by havin' a barbed-wire tail!

I gotta admit, though, Pronto's got the stuff that heroes are made of. About a week of this and every time an electron would sneeze at me I'd jump on the table! I shook his pudgy little hand, racked up the balls and went home to try and convince Duggan that





the gospel-merchant wasn't foolin' when he said "Until death . . ." Seems like lately she's been using the same tone on me that she uses on my cousin Elbert (the one with the pool-hall tan) when he comes to visit us. Me, I'm too good a sailor to think the Coast Guard's celebratin' Labor Day when they hoist up them storm warnings!

There wasn't any harm done that a coupla shows and a coupla dinners out couldn't fix up, so we dives into the Houston Social Cyclone with all the ease and airy grace of a hippo hoppin' into a hogwallow. We even visited the McSnooks, an outfit that's got about the same plate dissipation as a pair of 1G4G's, where I listened to Mable and Duggan make dresses (verbally) and listened to old McSnooks drool about his lousy stamp collectin' for about the same length of time a W9 CQ's before signin'. Deliver me from these slugs with a single track mind!

One p.m. some time later while I was tellin' a W6 that he might put a variable dummy load on his resonant filter and play "My Merry Oldsmobile" at me, and Skinny was reknitting that skirt for the fourth time, we got a call from Pronto. He was as excited as a crystal in a 6L6G tritet. He'd been reading again. He'd torn his kw down and started from scratch. Now that it had been rebuilt, we were to come over to the unveiling. Skinny declined very sweetly and suggested that I go right ahead. (Shows you gotta know how to handle these dames.)

When I finally got there the stage was set. The xmtr sure looked nice. It had more innovations than a 1940 Plymouth: automatic band changing, automatic voice control, automatic voice operated super reflex feedback control and overdrive (air conditioning optional). In fact, it had every thing except a neon sign that said "Poosh here to QSO VK's." Pronto's chest was pushed out so far that you could even *see* it! Zel and the wee-one were sitin' back on the sofa with far-away looks on their faces. Zel was lookin' like she might have been thinkin' it was a good thing that the Community Chest Drive went over, what with winter comin' on and all.

"This, my cadaverous comrade, is a transmitter that will make your heart sing!"

"That remark would do justice to the reticence of our curly-headed chum 'Soupy Groves' " I retorts. "When you de-bugged it did ya find any 'tantalum-termites'?"

"This is a rig without bugs," he proudly states. "It was designed by the brilliant engineer Simon S. Sidebands."

"Is the middle S. for 'spurious'?" I enquires to be social.

"Lissen, lid, this thing is laid out wire-for-wire according to instructions and there's gonna be no hair-tearin' with this one!"

He'd had the filaments going, and without further ado, he walks over and slaps them pretty bottles in the puss with 2500 volts. He just hadn't oughtta done it! He had failed to reckon with "Butch," the pet tomcat, who was asleep in the rectifier! The room was lighted up by a long bluish-green flash. Butch made a noise like a banshee through a kilowatt p.a. and lit out the window, paying scant heed to the screen! Boy, if the Army could get their backfield in motion that fast they'd be a cinch for the Rose Bowl! Pronto ducked just in time to keep from getting fried when the mike cord burst into flame! I got me behind a chair to keep the overload relays from snapping at me. Zel screamed somethin' about going home to mother, and made a dive for the infant, but he was a better broken field runner than she bargained for! By that time he had taken up residence under the sofa! The rest, if any, I missed because at that juncture I followed the trail Butch had blazed!

I kept looking in the paper for a week, hoping to learn something of the Postons, but all I could read was about "The Little War that Wasn't There." Finally, one afternoon I heard W5AJ on c.w. At the speed he was sending, you'd think he was Sea Biscuit in the backstretch! If the guy at the other end got more than I did he's wastin' his time not markin' a grain board! I figures the time was ripe, so I bullied my spavined shanks into takin' me up to see the Postons.

When I wheezed into the Poston Patio, the sky was blue, and the birds a-singin'. Even Butch looked happy, lyin' on the back porch smilin' like a ham that finally got a QSL outta VP5PZ! Junior was playin' "fire engine" astride something that looked strangely like a class B modulation transformer.

"What, my litle fellow, do you call that?" I asked.

"You'll have to ask Pop," he replies. "I told Jimmy McCluskey what Pop called it, and Mama washed my mouth out with soap!"

A more complete hunk of marital bliss woulda been just too much to take! Pront and Zel were lookin' at each other like a coupla high school kids on a hay ride. Zel even seemed happy to make me some coffee, and Pronto was sockin' them 250TH's (breadboard) till the power lines sagged! He coulda used the lite meter as a keyin' monitor! All the time he was grinnin' like he had discovered the 14Mc band all by himself!

. . . and with the parts I have, and those Pronto gave me . . . Ten's sure a good fone band . . . So I was reading . . .

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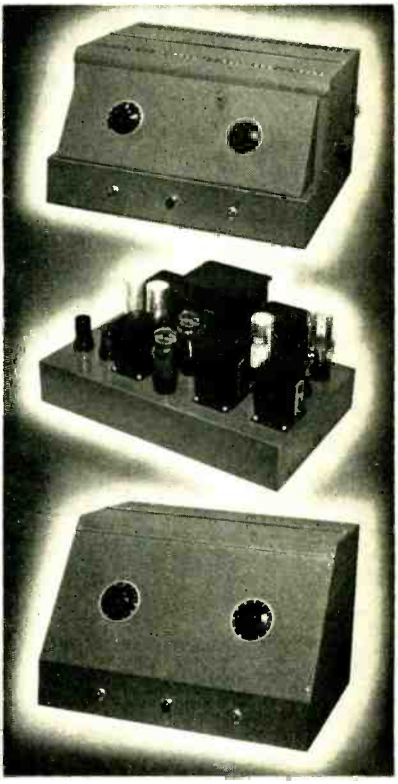

Predistortion Applied to Amateur Radiotelephony

[*Continued from Page 30*]

substantially flat response to 3000 cycles. The signal will cut through QRN and other noise much better because most of the weaker voice sounds are the higher pitched ones, and the pre-emphasis permits them to override the static and other noise when they might otherwise be lost. But the quality will not be pleasing to listen to.

The answer is simple: a filter on the receiver with a restoring characteristic, such as curve C, so that the result is a substantially flat response (as heard in the receiver). The band pass filter advocated for use in the receiver can easily be designed to have a "drooping" characteristic, similar to curve C. This cuts down both the high frequency noise and the high frequency voice components by the same amount; so the voice components that were pushed up above the noise level by high frequency pre-emphasis no longer sound excessively high pitched.

In actual practice it will be found desirable to have a restoring characteristic with somewhat less droop than the pre-emphasis filter has rise; the droop should be just sufficient that the signal does not sound objectionably high pitched. Some emphasis on the higher voice frequencies (1500-3000 cycles) is actually desirable in order to override background noise that is bound to ride in with the lower voice frequencies. 8 db or even 10 db rise will not be found objectionable to listen to, and satisfactory restoration can usually be accomplished on a conventional communications-type receiver simply by adjusting the tone control for about 10 db attenuation at 3000 cycles.

This means that if you should use high frequency pre-emphasis in your transmitter it will not be necessary for the fellow who receives you to have a special filter on his receiver for satisfactory reception. He can simply throw the tone control over towards "bass" until you begin to sound ok. (With many receivers it will be necessary to turn the control all the way over to "bass.") If you are boiling in "R-9 and three plusses" it won't make any difference; but if you are just neck and neck with the noise level, the pre-emphasis will permit the other fellow to read you when your voice would otherwise be lost in the noise. And that is equivalent to an increase of about 100 per cent in your power.

Which is cheaper, a simple filter or twice the power? The case for high frequency pre-emphasis combined with band pass speech in amateur radiotelephony doesn't require much in the way of an argument; it is simply a matter of getting a little concerted action, a drive to make speech filters as commonplace in all amateur radiophone transmitters and receivers as are the vacuum tubes.

Bibliography

Fletcher, *Speech and Hearing*.
Terman, *Radio Engineering*.
J. L. Hathaway, "High Frequency Pre-Emphasis," *Electronics*, November, 1939.

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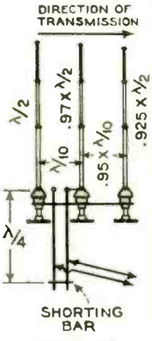
Add to the list of phonetic broadcast station calls: WOLF, Syracuse, N. Y.; KALE, Portland, Oregon; KNOW, Austin, Texas; KNOX, Knoxville, Tennessee.



The Amateur Newcomer

[*Continued from Page 64*]

ages under 50, however, the meter resistance should be deducted from the total. For example, to measure 10 volts employing a 0-1 d.c. milliammeter having an internal resistance of 33 ohms (a common value) a resistor of 9967 ohms would be necessary. As it is very seldom that the instrument will be left across voltage circuits for any length of time, resistors rated at one watt will be satisfactory for intermittent service. With the foregoing fundamentals in mind, multipliers may be calculated for any desired voltage range.

There are numerous multipliers available commercially which are guaranteed to within an accuracy of 1%. Others are rated at 2%, 5% and 10%. Ordinary resistors usually are accurate only to within 15% or 20% of their stated value. While perfectly applicable to the circuits they were designed for, these ordinary resistors should never be used "as is" in any test equipment. It is obvious that a deviation of 15% or 20% plus or minus would prohibit their use in any precision measurement.

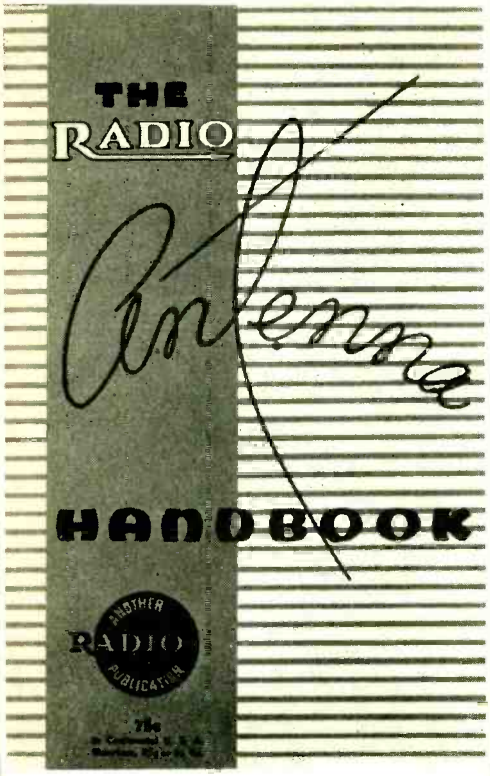
Some constructors prefer to "roll their own," securing these ordinary resistors of the carbon type and "doctoring" them until the meter reads full scale for a known voltage. There are very few amateurs, especially newcomers, who can boast of a variable d.c. voltage source accurate enough to calibrate these resistors. Some ranges may be available, but usually the accuracy of supposedly known voltages over 500 will be found too much in error.

Multipliers guaranteed to be within 5% plus or minus their stated value can be purchased for little more than ordinary resistors and are entirely satisfactory for the multitester described. The time saved in doctoring and calibrating is well worth the slight increase in cost.

Current Shunts

Although a variety of shunts for extending the current range of a milliammeter are obtainable commercially, suitable shunts may be constructed with little difficulty and at a worthwhile saving. While the circuit of figure 2 eliminates the necessity for calculating shunts, a brief explanation of the formula used will no doubt aid the constructor.

When computing shunt values the internal resistance of the meter must at all times be taken into consideration. For example: A 0-1 d.c. milliammeter is to be extended to read 100 ma. The meter carries 1 ma. (.001 am-



pere) so the shunt must carry the remaining 99 ma. (.099 ampere). The value of this shunt in ohms is found from the formula:

$$R_s = \frac{R_m}{N-1}$$

where:

R_s is the unknown shunt resistance in ohms,

R_m the internal resistance of the meter,

N the multiplying ratio

This may then be written:

$$R_s = \frac{33}{99} = .33 \text{ ohms}$$

From this simple formula one can calculate shunts to extend any existing current range.

Resistance wire from center-tap filament resistors may be used for current shunts, or, if unavailable, a few feet of manganin resistance wire will be sufficient for several shunts. The value in ohms of center-tap resistors is usually stamped on the article. The ohms per foot of resistance wire that is purchased is stated by the manufacturer. Thus, by totaling the shunt values, a rough approximation may be obtained as to the length the shunts will assume.

The current calibrating circuit of figure 2 will enable the various ranges to be correctly tapped off on the resistance wire. Its operation is as follows: The 75-ohm variable resistance is adjusted until the standard milliammeter reads the desired range. The lead from the end of this variable resistor is then moved along the shunt resistance wire until the meter being calibrated is identical in its reading with that of the standard milliammeter. A tap may then be taken off at this point to be connected to its proper contact on the selector switch. It should be mentioned at this point that after shunt connections have been made permanent to the selector switch, the meter will usually read a trifle lower than full scale, denoting that the shunt resistance has been lowered. This may be remedied by filing a portion of the shunt (raising its resistance) until full scale deflection is indicated.

In the event a 0-500 milliammeter is not available for the calibration circuit, a 0-100 milliammeter may be substituted for the standard. Adjust the 75-ohm variable resistor until the meter reads full scale, 100 ma. A short piece of resistance wire is then connected across the meter terminals and its length increased or lessened until the meter reads 20 ma. This reading now represents 100 ma., and it follows that 50 ma. will indicate 250 ma. and full scale deflection 500 ma.

Ohmmeter Circuit

Another bugaboo of the layman is the supposedly mysterious performance of ohmmeter circuits, especially those which read their scale backwards.

Referring to the circuit diagram of figure 1, it will be seen the resistors R_3 and R_4 total 500 ohms. This value is computed by the formula R = E/I—in this case, E being the 4.5-volt battery, and I the current range of the meter, 1 ma. (.001 ampere). This may now be written:

$$R = \frac{4.5}{.001} = 4500 \text{ ohms.}$$

If the tip jacks marked "ohms" are shorted, the meter will now read full scale. For all practical purposes the meter resistance can be disregarded. When the battery voltage drops below 4.5 the meter will no longer read full scale. To compensate for this, R_3 is variable. It is obvious, then, when a resistor is placed across the ohms terminals, additional resistance is introduced into the circuit. Consequently, less current flows and therefore the meter reads lower. In other words, the larger the resistor being measured, the lower the meter will read. Therefore, zero ohms occurs at maximum deflection and high resistances at minimum deflection. When the meter reads half scale the external resistance is equal to the setting of R_3 plus R_4. This "backward" reading characterizes all series-type ohmmeter circuits.

It is not mandatory that R_3 and R_4 be duplicated. These were used for no other reason than that they were already on hand. It is possible to divide R_3 and R_4 into several values. Thus, R_3 could be 1500 and R_4 3500 ohms, or, R_3 1000 ohms and R_4 4000 ohms.

Calibrating the Ohms Scale

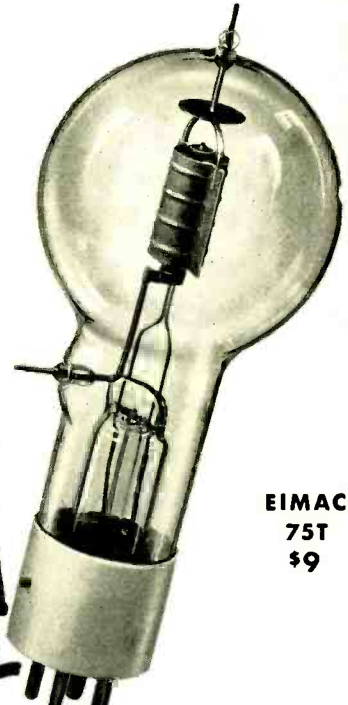
The easiest method of calibrating a meter scale to read directly in ohms is to measure several accurate resistors and mark their known values on the scale. However, it is very seldom that a sufficient number of accurate resistors will be found at hand and mathematics must be resorted to. The formula for this calculation is:

$$R_x = \frac{R\,(M—m)}{m}$$

Where:

R_x is the unknown resistor,
R the total circuit resistance,
M the range of the meter,
m the meter reading

To illustrate: A resistor placed across the ohms terminals causes the meter to read 0.9



W9IBC says:

From time to time I meet "Hams" who are surprised to learn that we supply our customers annually, several thousand items which aren't listed in our catalog. As a matter of fact, there are few, if any, items used in radio today that we can't supply when you want them.
For instance, lots of the fellows no longer bother about writing to us when a new item is announced by any of the manufacturers—they just send us the order, knowing that shipment will be prompt, and the price will be right.
Of course, if it's something new by any of the well-known manufacturers such as National, Hammarlund, Cardwell, etc., we usually stock it as fast as it's announced. But, no matter who makes it, we'll get it for you as fast as possible as soon as we get your order. And we won't tack on any extra charges for getting it, either! As a matter of fact, we have several people in our organization who spend all their time getting "special" items for our customers!
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D. L. Warner, W9IBC

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ma. The formula would then be written:

$$R_x = \frac{4500\,(1-0.9)}{0.9} = 500 \text{ ohms.}$$

Thus, the meter reading 0.9 ma. may be designated on the scale as 500 ohms. Calculating the main divisions of the meter scale will result in a series of ohms readings which may be marked on the scale and henceforth resistors as high as 100,000 ohms may be read directly. The above formula makes no mention of the internal resistance of the meter. Its value of 33 ohms would make slight difference in calculations and may be omitted.

Should the builder desire, the range in ohms may be increased to read as high as 1 megohm. The formula remains the same. As 1 megohm is ten times the existing range, the circuit resistance and battery voltage must be multiplied by ten. Meter readings also will be ten times as great.

Conclusion

If more than casual attention has been given the foregoing, the newcomer should now have a clearer understanding of the necessary calculations and circuit requirements in the design and construction of a multi-tester. The builder will find he possesses a valuable piece of equipment when it is completed. Familiarity with its functions will suggest numerous applications other than routine checking. Most important, he will have a working knowledge of what is going on and electrical measurements will hold an added interest.

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

●

Soldering Iron Tip

A soldering iron will stay tinned several times as long if the following tinning procedure is followed, provided it is not dipped in soldering paste or acid. By using rosin core solder and wiping the iron off instead of dipping it in paste to clean it, the iron usually will remain tinned for several months.

After filing the iron smooth to remove all pits from the tip, polish the tip on a buffing wheel until it shines like a mirror. This closes the pores in the copper. Then heat the iron and tin it with rosin core solder just as soon as it is sufficiently hot. —*W6QZA*

4-WIRE DOUBLET

Improve your 2, 3, or 4 element rotary beam with a 4-wire driven doublet. Greater efficiency; no adjustments; also permits three band operation. See article "3 Band Rotary", this issue. Complete 4-wire doublet kit half wave long on 14 meg, ready for assembly. **Amateur Net $29.50. Also MODEL T SKYROTOR, $29.50.**

BEE ENGINEERING CO.
403 W. Baltimore Ave. Detroit, Mich.

www.americanradiohistory.com

What's New In Radio

[*Continued from Page 70*]

Its construction includes the finest in ultrahigh frequency engineering. Its cast aluminum chassis frame, 1852 type r.f., 6J5 oscillator, and unit coil assembly make it outstanding in this respect.

LF-90 FREQUENCY INVERTER

The LF-90 Frequency Inverter is a unit designed for the purpose of providing reception of signals located in the two bands 90 to 250, and 240 to 608 kilocycles. This unit when used in conjunction with any standard superheterodyne receiver capable of tuning to a frequency of 1550 kilocycles, will provide excellent reception of ships at sea, aircraft beacon stations, weather reports, time signals, and the many other services located in the low frequency range.

Two tubes are used in this unit: a dual purpose tube, the 6K8, as mixer; and a 6ZY5G, as rectifier.

AIR COOLED TUBE CONNECTORS

A new series of connectors designed to radiate heat away from the grid and plate connections of transmitting tubes has recently been announced by Bud Radio, Inc., 200 Cedar Ave., Cleveland, Ohio. These tube connectors have a distinct advantage over the usual type of wire and cap connectors as they readily radiate heat present at the tube connections due to internal heating and contact resistance heating. This feature protects the glass seals of the tube, reducing the possibility of tube failure due to this cause. Connectors come in four sizes to accommodate both large and small wire leads and large and small cap leads. The new catalog No. 240 just off the press gives the complete data on all BUD lines and is free for the asking.

HIGH CAPACITY IN COMPACT FORM

There are numerous low-voltage radio and electrical applications, including "A" eliminators, rectifiers, and dynamic speaker installations, which require extremely high capacity for maximum operating effectiveness. For such services Cornell-Dubilier offers the Type FA capacitor.

It is now possible to supply these high capacities in extremely compact form, with the result that the FA-1220 unit, for instance, which provides 2000 mfd. at 12 volts, is only 1⅜" in diameter by 4⅛" in length. Other units vary in size from 1⅜" x 2½" to 2½" x 4⅛".

Ceramic base
Lava insulation

Standard FA units are made for working voltages of 12, 15, 18, 25 and 35 volts, and in capacities of 500, 1000 and 2000 mfd.

IMPROVEMENTS AND NEW ITEMS IN H-M LINE

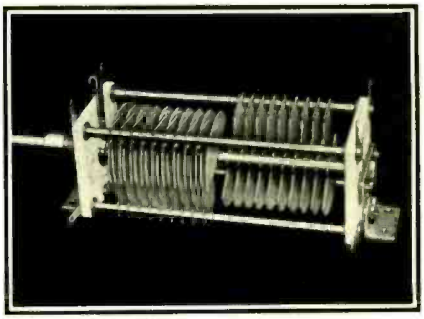
Hughes-Mitchell, manufacturers of the "X-EC", announce that this device is available with keying facilities for perfect "break-in" operation. Break-in keying may be had when the unit is operating either as an e.c. or crystal oscillator, and the note is clean and sharp with no "blooping" effect whatsoever. Another new feature in the "X-EC" is full coverage of the 80 meter band, from 3.5 to 4.0 megacycles, as well as the 7, 14, and 28 Mc. bands as heretofore.

The HM-401 10 meter mobile converter has been improved in operating ease and appearance. The bandspread has been increased and the dialing is very smooth. An electron coupled type of oscillator circuit is used in this converter, which lends itself to stability.

The HM-102 Ten-meter transmitter utilizes a power supply capable of long life at full voltage. Within the base of the unit will be found two relays, one for controlling the filaments and the other to handle the antenna changeover and plate supply. This allows remotely controlling the transmitter without the use of heavy conductors.

All units are supplied wired and tested, and are licensed by RCA.

NEW COMPACT TUNING CONDENSER



In the case of split stator tuning condensers it is common practice to use them with the rotor not at ground d.c. potential. In the case of single ended stages the rotor is usually bypassed to ground and connected to positive high voltage to put the same d.c. potential on both the rotor and the stators of the condenser, permitting closer plate spacing without arc-over. In push pull stages, the condenser is either connected as above or just left "floating." In any event the condenser frame must be supported by insulators, and an insulated shaft coupling used to afford protection to the operator.

A new type of split stator brought out by Hammarlund embodies new design features which make auxiliary mounting insulators and high voltage shaft coupling unnecessary. This new condenser is known as the Hammarlund type "HFB" and has Isolantite end plates which insulate the mounting feet. The danger of shock has been overcome by an insulated control shaft. In other words, the entire rotor assembly is electrically isolated.

Soldered brass plate construction is used in order to reduce series contact resistance. After assembly, the entire unit is cadmium plated to reduce corrosion and present a pleasing appearance.

RADIO

Past, Present and Prophetic

[*Continued from Page 6*]

"works" for nearly a year now. Work on the 1940 HANDBOOK brought the development work to a complete standstill for 6 months, but now that more time is available the fight will be resumed in earnest. Theoretically the set should be essentially free from noises of all kinds and the preliminary work has shown that the theory is pretty well borne out in practice. The main objection to the idea as it now stands is that the circuit is somewhat complicated and the operation tricky. However, there are none of the usual silencers, limiters, or what have you in the receiver; it operates on an entirely different principle. When it refuses to work in the laboratory it is known as "that blankety-blank brainstorm" but when it does work it is affectionately called the "bootstrap receiver" because it—but maybe we have talked too much already.

Sacramento or San Joaquin Valley?

On December 30 we received the following telegram:

REFER POSTSCRIPTS. HOW COME THEY MOVED SACRAMENTO VALLEY DOWN TO SANTA BARBARA? WHAT BECAME OF SAN JOAQUIN VALLEY AND ALL ITS HAMS? ACKNOWLEDGE IN NEXT MONTH'S RADIO.

BERT AND DOC
W6DDO AND W6KMQ

We hereby acknowledge the above telegram and apologize for referring to the lower end of the Sacramento Valley instead of calling it the San Joaquin Valley.

We still have trouble with our directions here in Santa Barbara since the Ocean is more or less southeast and Los Angeles is almost east from our fair city.

It's informative, authoritative, complete! But best of all, it saves you money on everything you buy. With over 30 pages of HAM values, this catalog includes all the nationally advertised names, all the hard-to-get parts—everything in radio. Save time and money—order at home. Get the best for less! Send penny postcard today for your own copy of the "Buy Word" book in radio. It's **FREE!** Write Dept. **6B.**

LAFAYETTE RADIO 100 Sixth Ave., New York

I guarantee you the fairest and squarest deal . .

It will pay you to write to me whenever you need any Amateur Equipment!

I will give you

—the latest and best apparatus.
—the lowest prices obtainable—anywhere!
—the fastest service.
—the most liberal trade-in allowances.
—easy, time payment terms at only 6% cost.
—ten day trial of any receivers.
—my personal attention and full cooperation.

In short, I give you every possible reason for dealing with me—and continuing to deal with me.

For complete and lasting satisfaction—be sure to write me.

73,
Bill Harrison, W2AVA

HARRISON RADIO CO.
9 WEST BROADWAY, NEW YORK CITY

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Authorized Factory Distributors of **ALL**
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NEW SPEECH AMPLIFIER *with* Peak Limiter

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TIME PAYMENTS

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15-DAY TRIAL

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MONEY-BACK GUARANTEE

Another outstanding contribution to amateur radio equipment by MONTGOMERY WARD! This time a Speech Amplifier, built by Hallicrafters. It gives your amateur phone transmitter a tone quality heretofore unapproached. Assures a full 10 watt output of undistorted power. Built-in Peak Limiting Circuit provides heavier modulation without over-modulating . . . increases station range without increasing carrier power . . . the principle used today by 98% of broadcasting stations. Volume level meter tells how loud to speak into the mike. Many more advantages! This is only one of the many new amateur instruments and equipment described in WARDS new Amateur Catalog. Mail coupon today for your FREE copy.

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Dept. AW-34 Chicago, Ill.

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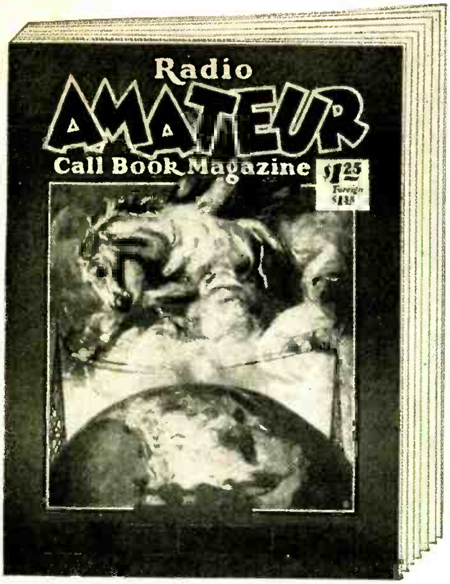

Grid Bias Frequency Modulation

[*Continued from Page 48*]

of f.m. with fair results. The oscillator must not have too much stability or it will be impossible to get the desired amount of frequency modulation without getting excessive amplitude modulation. Such an oscillator requires a very well filtered plate supply or hum will appear when f.m. reception of the signal is attempted.

Another method of frequency modulating a 112-Mc. oscillator that does not have a very high-Q tank is to use grid-bias modulation. The grid leak should be bypassed for voice frequencies with a condenser of about 1 μfd., and the audio inserted between the grid leak and ground. Very little audio power is required, and the secondary of the modulation transformer may be anything between 500 and 5000 ohms. For best results the oscillator grid leak should be semi-adjustable, and the grid leak and antenna coupling adjusted until the voice sounds best. If the correct value of grid leak and proper amount of loading are used, the required amount of frequency modulation can be obtained with but little amplitude modulation.

Because so little audio power is required, a single 6F6 can be used to modulate several hundred watts input to a 112-Mc. self-excited oscillator in this manner.

Approximate grid leak values are given as follows:

For tubes with μ of 30, 3000-ohm grid leak with 1-μfd. bypass. For tubes with μ of 20, a 5000-ohm grid leak with 0.5-μfd. bypass. For tubes with μ of 15, a 7500-ohm grid leak with 0.5-μfd. bypass. For tubes with μ of 10, a 12,500-ohm grid leak with 0.25-μfd. bypass. If two tubes in push pull are used, divide grid leak resistance by two and double the capacity of the bypass condenser. The bypass condenser should be placed just across the grid leak, not across the grid leak and transformer winding.

With low-power oscillators, it is likely that overmodulation will result until the operator becomes familiar with the equipment and notes how little audio power is required for full modulation.

As with plate modulation, the oscillator tank should not be designed for too great a Q, or it will be impossible to obtain sufficient frequency modulation without excessive amplitude modulation.

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Shopping? *The Marketplace* may have just what you want.
See page 97 for latest offers.

DX

[*Continued from Page 55*]

DX Contest. He did plenty of listening though. George also adds that a lot of the hams are in the army and navy now. Another dxer blew in again the other day . . . ex-G6HB. "Beau" was here during the summer and was back again for about a two-weeks visit. G6HB says most of the fellows we know in G are in some branch of the service. Ex-VE5JP paid us a visit during the month as did W7BJS from Afton, Wyoming.

W3LE has added CP1BA, K5AM and a YS to his already imposing totals, since putting up his new rotary. This gives Lou 38 zones and 128 countries on phone. He is also in No. 1 spot in the Marathon with 37 zones and 99 countries.

Did You Work TA1AA?

ON4HS once again sends through some very valuable and quite good news for some of you fellows. It seems that ON4HS has a very good friend who was living in Turkey for a while, and during this time he was on the air signing TA1AA. His home is actually in England. TA1AA regrets that he was unable to QSL any of his contacts but due to operating restrictions in Turkey . . . well, you know the rest. However, all is not lost because our good friend Harold Simmons, ON4HS, has made arrangements with TA1AA to send a card to each station worked. There are just 250 cards to cover the contacts made by TA1AA. Here is what you fellows must do to get your card—that is, of course, just those who have worked TA1AA. In the first place there is, or was, another TA1AA on the air near 14400 kc., but this is not the one we're talking about. The one who will QSL always operated on 14280 kc. and was crystal controlled.

Getting back to this QSL card business, you must send your QSL card to Harold Simmons, ON4HS, Uccle, Brussels, Belgium. It must be made out to TA1AA showing date of QSO, time, and the signal report.

With your QSL card you must send along a stamped envelope, or the International Reply Coupons. This is important because ON4HS cannot be expected to shoulder the burden of postage. After your card is received and checked ON4HS will promptly send you the card from TA1AA. Some of those worked by TA1AA include W9TJ, W4BQZ, W3LE, W8LFE, W4CYU, W5ASG, W7BVO, W7EKA, W6ITH, W9NNO, W7QC, W9KXB, W7GWA, W9CVN, W9PQG, W1COO, W1ATZ, W1LBJ. A few other than W's are K6NYD, FN1C, TG9BA, CR4HT, FM8AD, VP4TK, CE1AH, XU8OG and K7FST. The

[*Concluded on next Page*]

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SOLAR CATALOG

Solar catalog number 10-A is available to amateurs, servicemen, and others using capacitors. Wet, dry, paper, mica, and trimmer condensers are listed as well as the new Solar capacitor analyzers. The catalog is available from leading jobbers or direct from the Solar Mfg. Corp., Bayonne, New Jersey.

above are just a few and approximately 200 others were worked.

The personal activity of ON4HS is nil of course, due to being off the air, but he is happy after receiving a card from VK6MW whom he never had suspected as OK. To date Harold has 38 zones and 111 countries, while on phone he has 34 and 92. His Marathon score is 34 and 93 and phone only 30 and 74. ON4HS is still holding his breath waiting for a card from AC4YN. He really doesn't think he worked the real AC4YN but he isn't going to give up hope completely for a while. Many thanks to you, Harold, for the very fine information.

Once again it shows the swell dx fraternity we have in this world of ours. The fellows overseas who at present are not on the air, still haven't lost their interest, and the best way we can keep intact is to keep everyone posted regarding our dx pals.

KH6RZQ, American Samoa

KH6RZQ opened up for operation the first of December on about 7025 kc. The station is operated by a couple of hams who are with the P.A.A. Bill Johnson is the one doing most of the operating and says that they have 30 watts into a long Vee beam . . . 8 waves per leg. KH6RZQ is actually on a small island 8 miles wide and 10 miles long, and it is away from the main island of Samoa. They report that it will be impossible to QSL very promptly due to the infrequent visit of ships. Earlier in the evenings they are on 14050 kc. so all in all this is a good chance to pick up a new one. We have a list of those W's he worked in the Contest so due credit will be given.

Very shortly we will publish the official final scores of the 1939 DX Marathon, and as soon as we can get to the logs of the DX Contest we will do likewise. In the meantime if you fellows have any suggestions for the bettering of this column, I wish you would spring them. As a matter of fact a number of questions were listed in the closing paragraph of last month's column, which should give you some ideas. An expression from all of you is asked otherwise we will assume the department is being conducted satisfactorily in its present form.

I'm really sorry that more of our staff didn't participate in the DX Contest but it seems that due to moving to Santa Barbara a great deal of time is required to get them going again. I understand that both Smith and Dawley received nice keys for Xmas, and I'm sure that if they had gotten these before the contest you would have heard W6BCX and W6DHG actually on c.w.

Well, gang I've done my little bit for this session and if all goes well I'll see you at this time next month. As a matter of fact I'll probably see you even if all does NOT go well. The shack of W6QD looked more like a Club meeting during the two week-ends of the contest . . . and according to the xyl it sounded exactly like one. Which brings to mind the "equation" of J2GX, which was in last month's column (page 119) only here is the sequel "Ham + DX = Minus XYL." We still are interested in getting all the information we can about what's going on overseas in regards to former hams. All contributions should be in by the 10th of each month. And that is all there is for February, except one parting remark, "No, I haven't touched a W9 since the Contest."

●

Some Fun!

The United States Supreme Court has accepted for review one of the cases in which the powers of the FCC in dealing with competition between commercial broadcast stations will come in for review. The decision of the court, whichever way it goes, will do much to clarify the powers of the Commission and to reveal to broadcasters the kind of competition which they are apt to face.

Superhet Tracking

[*Continued from Page 17*]

To line up the receiver with this tracking method, it is necessary only to set the mixer on either 57 or 59 Mc., the crossover points, and adjust the padding condenser until the oscillator is on the correct frequency as indicated by noise or signal at the receiver's output.

Oscillator Circuits

Considerable has been said about using a concentric line as the tuned circuit in an oscillator, without any suggestion as to the circuit. The HANDBOOK shows a concentric line tuned grid and coil tuned plate oscillator, as in figure 5a, but this has two disadvantages. First, it has two controls, although the plate circuit is so broad that retuning it may not be necessary over large parts of the band. Second, the plate circuit tuning reacts on the frequency to some extent. A single circuit oscillator of the "cathode above ground" type is possible, as in figure 5b, but it requires placing the tube somewhere along the line, with the cathode and grid leads brought into the line at different points which may make long leads necessary except with large tubes or very high frequencies.

Another easy approach to the "two terminal" or single tuned circuit oscillator appears in figure 5c. The cathode coil is cut so that the oscillator output peaks at mid-band. The disadvantages are that oscillator output varies a little with frequency, and frequency stability may be reduced somewhat by the presence of the coil. The circuit places the tube at the open end of the line (although it can be tapped down for better stability) like in the r.f. and mixer stages, which facilitates construction. A condenser shunted by a choke coil has been tried in one case in place of the cathode coil, but the oscillator output was not as good.

An oscillator that is purely single control is shown in figure 5d. This circuit has been found suitable for a 1 k.w. test transmitter covering a wide frequency range, used by R.C.A. with a large triode. It can be adapted to pentode tubes, as in figure 5e, providing electron coupling if desired, or the output can be taken out of the oscillator tank with a balanced loop inserted in the line or from a tap on the inner conductor for unbalanced output. In this circuit, loop coupling into the mixer can be used to avoid difficulties which might otherwise result from having the mixer and oscillator tubes at opposite ends of their lines. The coupling of one of these half-turn loops can be increased by making the loop wider, or by bringing it closer to the center conductor. In the oscillator circuit where there are two loops, the grid loop must be larger and closer to the inner conductor than the cathode loop in order to accomplish the same effect as "tapping down" the cathode on the coil of an e.c. oscillator.

The circuit of 5d should not be overlooked for transmitting on 2½ and 1¼ meters.

Antenna Coupling

Methods of coupling an antenna into a concentric line have given some fellows trouble except when a concentric line feeder is available. Some have hooked on a two-wire feeder in the same way as a concentric line, as illustrated by figure 6b, causing a slight feeder unbalance.

Another method of shifting from balanced to unbalanced feed, and of coupling a balanced feeder directly into a concentric line resonant circuit, are shown in figures 6c and 6d. In the latter, coupling can be increased by placing the loop nearer to the inner conductor, and by increasing the width of the loop. There is no information at hand as to the size of the loops, but one amateur found that a U-shaped antenna loop gave excellent results on a 600 ohm line, when it was about eight inches wide (using 28 inch line). This

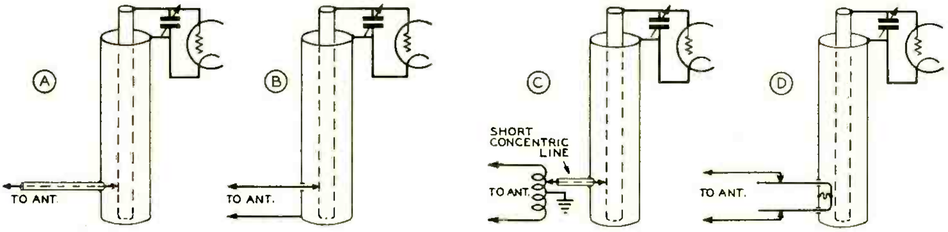

Figure 6. (A) coupling a concentric line feeder to a concentric line resonant circuit. (B) unbalanced method of coupling two wire line into a concentric line circuit. (C) balanced-to-unbalanced method of coupling a two wire line to a concentric line resonant circuit. (D) balanced loop method of obtaining good coupling from two wire line to a concentric line circuit.

method increased signals more than 2 R's over the arrangement of figure 6b. In any event, proper coupling is very important on ultra-high frequencies. After all, who would hook a feeder on a transmitter in any old way without checking its effectiveness?

We hope that the material in this paper will serve to encourage construction of equipment making use of short sections of transmission lines as tuned circuits.

Advertising Index

New Books

[*Continued from Page 61*]

ments and accessories for specific work in laboratory, plant or field, many instrument users will find this condensed catalog a useful guide.

A copy will be sent promptly to anyone who asks Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, for Catalog E—"Electrical Measuring Instruments For Research, Teaching And Testing."

JOHNSON CATALOG

The E. F. Johnson Mfg. Co., Waseca, Minn., has just released their new general catalog number 966, containing their entire line of amateur equipment. This includes variable condensers, coils, r.f. chokes, sockets, antenna accessories, tuning knobs, porcelain insulators of many types, and miscellaneous radio transmitter hardware. A free copy of catalog 966 will be sent upon request.

REPLACEMENT TRANSFORMER ENCYCLOPEDIA

The new THORDARSON Replacement Transformer Encyclopedia and Service Guide No. 352-E lists the proper replacement for the power transformer, first filter choke, second filter choke, first audio transformer, second audio transformer and output transformer in thousands of radio receivers, including amateur and communications types. Included is the Service Guide covering timely technical and sales subjects for better servicing. This book is being distributed free by leading parts distributors, or can be obtained by writing direct to the Thordarson Electric Manufacturing Company, 500 West Huron Street, Chicago, Ill.

MICROPHONE CATALOG

A new 8-page Turner Microphone Catalog is now off the press and offered free to anyone requesting it of The Turner Co., Cedar Rapids, Iowa.

The new catalog shows and explains all the microphones and equipment in the complete Turner line.

Included are microphones for amateur, commercial broadcast, recording and public address use.

MALLORY MYE SUPPLEMENTAL SERVICE

Radio servicemen-amateurs will be interested in the Mallory Supplemental MYE Monthly Technical Service. The MYE Supplemental Service is available to everyone who is interested. It may be subscribed to in conjunction with the 3rd edition of the Mallory-Yaxley Radio Service Encyclopedia or separately.

Supplement No. 1, dated October, 1939, was a complete listing of the receiving tube characteristics of all manufacturers. No. 2 covered all phases of dry electrolytic capacitors in a 35-page issue of the supplement. No. 3 was devoted entirely to Useful Servicing Information and contained much valuable information, including many graphs and charts, in an easily available form.

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.

PRACTICAL Radio and Communication Engineering Course for Home Study offered by Smith Practical Radio Institute, Department R20, 1311 Terminal Tower, Cleveland, Ohio. Information Booklet Free.

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, Minnesota.

CRYSTALS in plug-in heat dissipating holders. Guaranteed good oscillators. 160M—80M $1.25. (No Y Cuts) 40X $1.65. 80M Vari-frequency (5 Kilocycle variance) complete $2.95. State frequency desired. C.O.D.'s accepted. Pacific Crystals, 1042 South Hicks, Los Angeles, Calif.

YES: A 14" rack with 2—8x14" panels, 2—8x12 ⅜x1½" "U" chassis, brackets, dust cover and leather handle for $6.85. Mobile steel cabinets. Racks. Chassis. Panels. Specials. Hole punching. At your service anytime. R. H. Lynch, 970 Camulos, Los Angeles, Calif.

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

QSL's—By W8NOS—"The QSL Craftsman"—13 Swan St., Buffalo, N. Y.

RECONDITIONED guaranteed receivers and transmitters. Practically any model you want cheap. For example Sky Buddies $15.00, Sky Champions $29.00, FB7s $9.00, SW3s $6.00. Send for complete list. All shipped on ten-day free trial. Terms. W9ARA, Butler, Missouri.

BUY direct for less—Highest quality Plate, Modulation and Filament transformers. See past advertisements. PRECISION TRANSFORMER COMPANY, Muskegon, Michigan.

RADIO KITS—$3.95 up. Complete. Single band; all-wave; 5-10 tubes. Save 50%. Radio and parts catalog—FREE. McGee Radio, P-2015, Kansas City, Missouri.

EQUIPMENT CONSTRUCTED—Any apparatus described in current magazines, constructed as described. Coxie's Electric Service, Rushville, Indiana.

A.C. Relays, used 1 volt G.E., D.P.D.T. large silver contacts, $1.25 ea. P.P. Money back guarantee. W6MWK, 357 Tehama St., San Francisco, Calif.

NATIONAL NTX-30 transmitter with two 4-in-1 xtal holders, fixture for E.C.O. connection, $95; Harvey UHX-10 transmitter and UHX-10P coils for all bands, $90; NC-100A receiver, (conversion) $85; National NSA speech amplifier, $55; Meissner Signal Shifter with 80 meter coils, $30; fob Seattle, W7GXP.

SELL entire station. Harvey 100-T with factory built grip-to-talk operation, all tubes, coils, xtals for 10, 20, 80 operation, Astatic microphone in grip-to-talk stand. HRO receiver with all tubes, coils, speaker and power supply, Triplett modulation monitor model 1295. All equipment in new condition. Inquiries invited. Best reasonable offer accepted. W8KIP.

SELL IPS Rubber xtal signal shifter. 10, 20 meter coils, power supply in separate cabinet, airplane dial for bandspread. All tubes included. Cost $50.00 new. Inquiries invited. Best offer accepted. W8KIP.

NEW 6L6-6L6G Transmitter—complete for $10. Write for details. W5HL.

WESTINGHOUSE D.C. Generators 2,000 volts 1.5 amperes $65.00. 1,000 volts 500 mils $30.00. Perfect condition. Miller Watkins, Rt. 4, Murfreesboro Rd., Nashville, Tennessee.

ECONOMY SUPERHET described in this issue, complete with tubes and 40, 20, and 10 meter coils, but less speaker and power supply, $21 f.o.b. Radio Ltd., 1300 Kenwood Rd., Santa Barbara, Calif.

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THE EDITORS OF RADIO
1300 Kenwood Road, Santa Barbara
CALIFORNIA

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 5-TUBE SUPER

Page 18

C_1, C_2—Cardwell ZR-50-AS
C_3—Cardwell ZR-25-AS
C_4—Cardwell ZU-140-AS
C_5, C_7, C_8, C_9, C_{10}, C_{11}, C_{14}, C_{17}—Cornell-Dubilier DT-4P1
C_6, C_{13}—Cornell-Dubilier 5W-5T1
C_{12}—Cornell-Dubilier 5W-5T5
C_{15}—Cornell-Dubilier BR-845
C_{16}—Cornell-Dubilier BR-102-A
R_1, R_6, R_7, R_8, R_{11}, R_{13}, R_{14}—Centralab 710
R_2—Centralab 516
R_3, R_{10}—Centralab 514
R_5, R_9—Mallory-Yaxley G
R_{12}—Ohmite Brown Devil
IFT_1—Meissner 8091
IFT_2—Meissner 8099
Tubes—RCA

BISHOP 125-WATT 1940 TRANSMITTER

Page 35

C_1, C_2—Hammarlund APC-50
C_3—Cardwell MT-50-GS
C_4—Cardwell ZT-50-AS
C_5—Cardwell MT-100-GD
NC—Cardwell ZS-7SS
C_6—Cornell-Dubilier r-12T1
C_7—Cornell-Dubilier 1W-5D1
C_{11}—Cornell-Dubilier 4-12Q5
C_{13}, C_{14}—Cornell-Dubilier 4-12D1
C_{16}—Cornell-Dubilier 4-25D1
C_{29}, C_{30}—Cornell-Dubilier TJU-15020
T_1—Kenyon T-213
T_2—Kenyon T-359
T_3—Kenyon T-253
T_4—Kenyon T-495
T_5—Kenyon T-671
T_6—Kenyon T-360
T_7—Kenyon T-359
CH_1—Kenyon T-506
CH_2—Kenyon T-152
CH_3—Kenyon T-157
CH_4—Kenyon T-516
CH_5—Kenyon T-152
R_2, R_3, R_4, R_5—Ohmite Brown Devil
R_6—Ohmite 0965
R_7—Ohmite 0579
R_8—Ohmite 0224
R_{14}—Yaxley N Control
R_{15}—Ohmite c.t. Wirewatt
R_{19}—Ohmite 0374
R_{20}—Ohmite 0793
M_1, M_2, M_3—Triplett illuminated

COIL TABLE

160-Meter Band:
  L_1—50 turns no. 22 enam. closewound 1½" dia.
  L_2—80 turns no. 22 enam. closewound 1½" dia.
  L_3—National 160C
  L_4—National 160E
  L_5—B & W 160BVL plus Bud FA-181 air cond.

80-Meter Band:
  L_1—15 turns no. 22 enam. closewound 1½" dia.
  L_2—30 turns no. 22 enam. closewound 1½" dia.
  L_3—National 80C
  L_4—National 80E
  L_5—B & W 80BVL

40-Meter Band:
  L_1—5 turns no. 22 enam. closewound 1½" dia.
  L_2—14 turns no. 22 enam. closewound 1½" dia.
  L_3—National 40C
  L_4—National 40E
  L_5—B & W 40BVL

20-Meter Band:
  L_2—7 turns no. 22 enam. double spaced 1½" dia.
  L_3—National 20C
  L_4—National 20E
  L_5—B & W 20BVL

10-Meter Band
  L_3—National 10C
  L_4—National 10E
  L_5—B & W 80BVL

BRODERSON NEWCOMER MULTI-TESTER

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R_1—Voltage multipliers: Continental Carbon, 5% accuracy
R_3—IRC Type W wirewound
R_4—IRC BW-1 wirewound
S—Yaxley No. 32112 switch
M—Triplett 221 0-1 d.c. milliammeter
Tip jacks—Bud PJ-837
Also required—3 penlite cells, blued wood screws, hookup wire, washers, lugs, crackle-finish black and flat grey enamel, resistance wire, wood for box and presdwood for top and bottom.

RME TIME WILL TELL

is chosen by the P. F. D.*

The Portland (Oregon) Fire Department maintains a complete disaster truck, prepared for any type of trouble. This truck has been specially outfitted with over 12 tons of all types of emergency and rescue apparatus, from a complete power plant to a miniature hospital. Streamlined, yet ruggedly constructed, this unit stands for durability when the "chips are down". Every piece of equipment which it carries must be tested and retested for complete insurance against failure at a crucial moment.

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THE true reputation and integrity of a company is fashioned from the service which it renders to its patrons. RME counts among its hundreds of satisfied customers many expeditions and special services, whose very success depend almost wholly on the dependability of their apparatus.

THOSE of you who have had the opportunity for close examination of RME construction methods KNOW the reason why our units are chosen; to those who have not had this opportunity of close inspection . . . let us send you our complete literature with details of our receivers and expanders.

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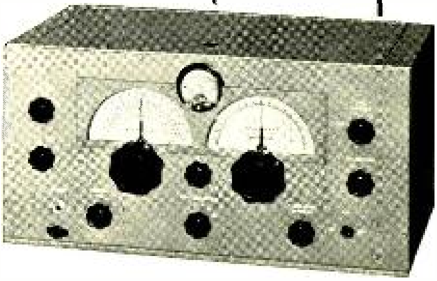
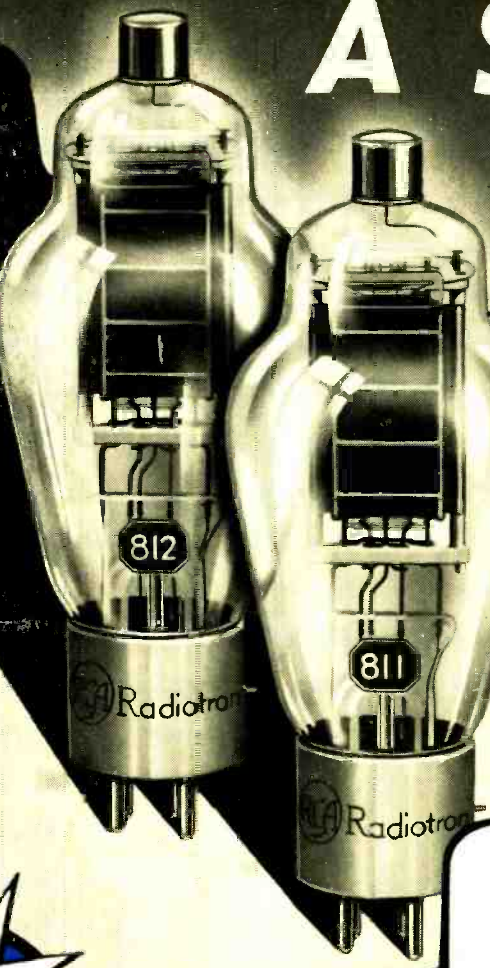


A SMASH HIT!



RCA-811 • RCA-812

High-mu Triode | Medium-mu Triode

Plate voltage	1500 V.
Plate input	225 W.
Plate dissipation	55 W.

Amateur Net $3.50 each

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FIRST WITH MICANOL BASE
New low-loss type. Has excellent insulation qualities at high frequencies, together with low moisture-absorption characteristics.

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Watt for watt, dollar for dollar, RCA-811's and RCA-812's establish new highs for dependable economy.

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