

# RADIO

ESTABLISHED 1917

A-239



- BAND LIMIT FREQUENCY SPOTTER
- MULTI-WIRE DOUBLET ANTENNAS
- 100 WATT BANDSWITCHING XMITTER
- NEW U. H. F. MOBILE CONVERTERS

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May 1939

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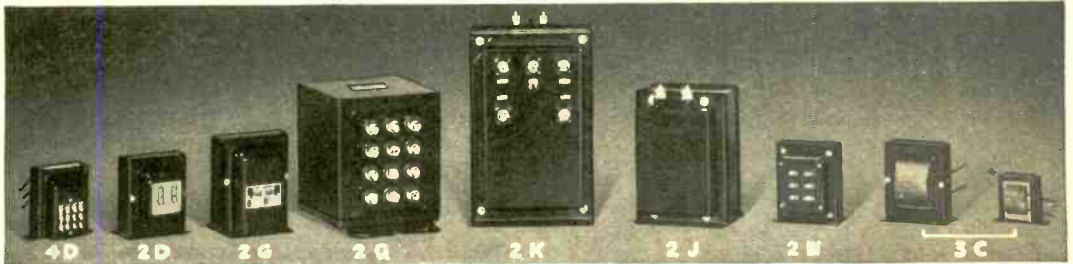


Illustration above shows mounting figures for "19" Series.

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T-19P56	900-0-900 800-0-800	750 600	225	2 G	4.80
T-19P57	1075-0-1075 507-0-507	1000** 400	125 150	2 G	6.00
T-19P58	1200-0-1200 900-0-900	1000** 750	200 150	2 G	7.80
T-19P59	1560-0-1560 1250-0-1250	1250 1000	300	2 K	9.60
T-19P60	1875-0-1875 1560-0-1560	1500 1250	300	2 K	11.10
T-19P61	2125-0-2125 1875-0-1875	1750 1500	300	2 K	12.00
T-19P62	2420-0-2420 2125-0-2125	2000 1750	300	2 K	12.90
T-19P63	1560-0-1560 1265-0-1265	1250 1000	500	2 K	13.80
T-19P64	1875-0-1875 1560-0-1560	1500 1250	500	2 K	17.70
T-19P65	3000-0-3000 2420-0-2420	2500 2000	300	2 K	17.70
T-19P66	2125-0-2125 1875-0-1875	1750 1500	500	2 K	22.50
T-19P67	2450-0-2450 2125-0-2125	2000 1750	500	2 K	25.50
T-19P68	3000-0-3000 2450-0-2450	2500 2000	500	2 K	30.00

\*This transformer has a bias tap at 30 V. \*\*These transformers designed for double rectifiers and will deliver both secondary ratings simultaneously.

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Type No.	Ratio	Total Pri. to 1/2 Sec.	Mtg. Fig.	Your Cost
T-19D01	1:1, 1.2:1, 1.4:1, 1.6:1, 1.8:1	4 D	\$3.60	
T-19D02	2:1, 2.2:1, 2.4:1, 2.6:1, 2.8:1	4 D	3.60	
T-19D03	3:1, 3.2:1, 3.4:1, 3.6:1, 3.8:1	4 D	3.60	
T-19D04	4:1, 4.5:1, 5:1, 5.5:1, 6:1	4 D	3.60	
T-19D05	1:3.15, 1:2.75, 1:2.5, 1:2.25, 1:2	4 D	3.60	

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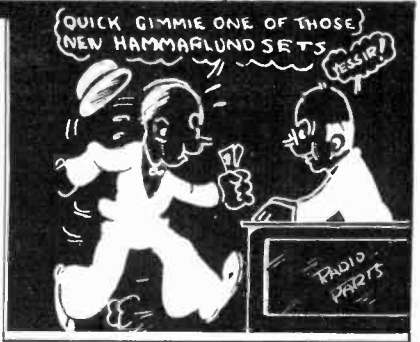
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## Table of Contents

Cover—John Howard and Gail Patrick shown in one of the scenes of "Grand Jury Secrets," a Paramount Picture. (See page 34).

Frontispiece: Four-Tube 18-Mc. Converter . . . . . 8

### ARTICLES

Improved Converter Design— <i>Ray L. Dawley, W6DHG, and Leigh Norton, W6CEM</i>	9
A 100-Watt Transmitter with 4-Stage Bandswitching Exciter— <i>George W. Shuart, W2AMN</i>	17
Construction of Plywood Radio Towers— <i>Millard P. Koopman</i>	21
Multi-Wire Doublet Antennas— <i>John D. Kraus, W8JK</i>	24
A Band-Edge Frequency Spotter— <i>Ray L. Dawley, W6DHG</i>	26
Conquering the Q— <i>H. Burgess, W9TGU</i>	31
You're in the Movies Now— <i>Eugene Kearney, W6PCV, and George A. Johnson</i>	34
Increasing Your Copying Speed— <i>Donald G. Reed, W6LCL</i>	37
Five-Band Coil-Switching Exciter— <i>Frank C. Jones, W6AJF</i>	38
The 4-Element Rotary Beam— <i>Rex Bassett</i>	41
Transmission Lines as Circuit Elements, Part II— <i>E. H. Conklin, W9BNX</i>	43
A New Communication Receiver Kit— <i>McMurdo Silver</i>	50
Suggestions Regarding Close-Spaced 10-Meter Beam Antennas— <i>Murray Bolen, W6ABR</i>	50
Resurrecting the D.C. Relay— <i>Harry C. Burnett, W1LZ</i>	52

### MISCELLANEOUS FEATURES

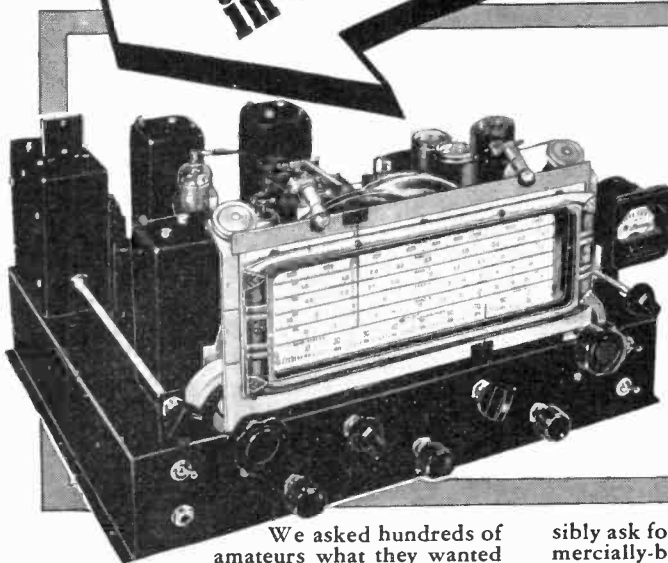
Just a Decade Ago . . . . . 80	Ode to a Ham Who Has Gone on Phone . . . . . 97
The Day Off . . . . . 88	Marketplace . . . . . 98
Ten Meter Comment . . . . . 90	Advertising Index . . . . . 98
Buyer's Guide . . . . . 96	

### DEPARTMENTS

DX . . . . . 55	Scratchi . . . . . 72
The Amateur Newcomer . . . . . 61	What's New in Radio . . . . . 73
U.H.F. . . . . 66	Open Forum . . . . . 74
Postscripts and Announcements . . . . . 70	Question Box . . . . . 74
Yarn of the Month . . . . . 71	Calls Heard . . . . . 86

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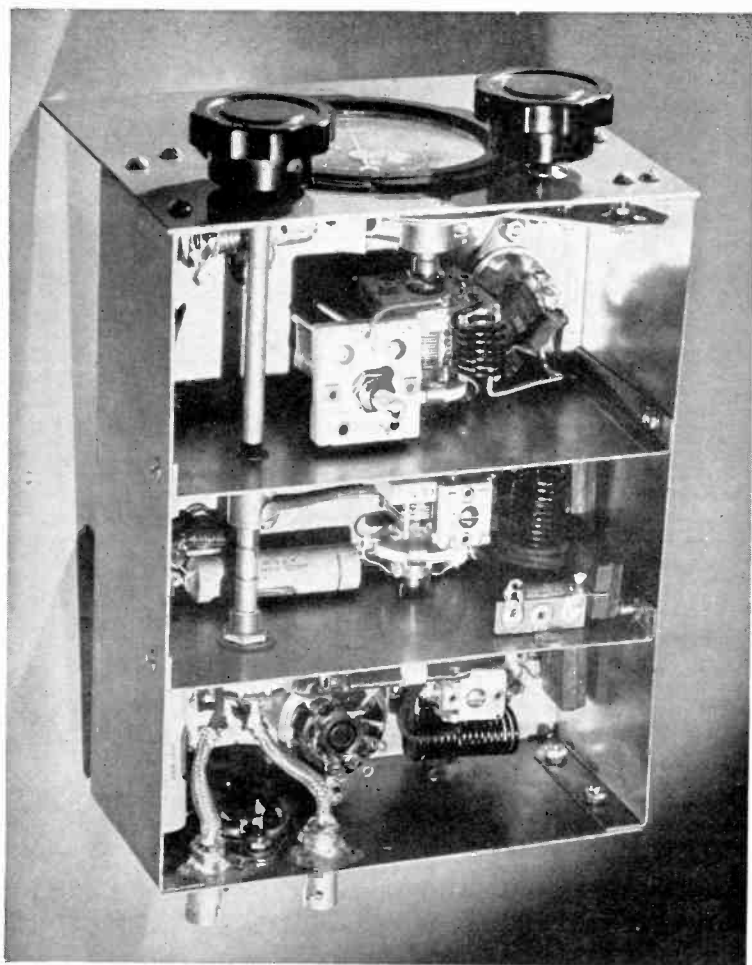
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Looking under chassis in the four-tube 28-Mc. converter described in the article beginning on the facing page. The oscillator compartment is in the front, nearest the dial. The small and rigid oscillator coil can be seen mounted upon the tuning condenser and alongside the air padder condenser. The next compartment toward the rear houses the mixer stage and the rear compartment houses the r.f. stage, the sunken socket for the VR-150-30, the rotary on-off switch and the entering and leaving plugs.



# Improved

# CONVERTER DESIGN

By RAY L. DAWLEY,\* W6DHC  
and LEIGH NORTON,\*\* W6CEM

A discussion of recent improvements and innovations in the design and construction of u.h.f. converters which may be used both for mobile and fixed-station usage.

Much experimentation has taken place in RADIO's laboratory since the first article on modern u.h.f. converter design<sup>1</sup> and since the article on the adaptation of the oscillator-mixer circuit of this converter to mobile use.<sup>2</sup> As a result of these experiments it has been possible to make improvements in circuit design which have given greater sensitivity, greater stability, and improved signal-to-noise ratio.

## The 1852 Mixer

The greatest improvement in the operation of these units over previous designs can be attributed to the use of the 1852 tube as a mixer. The mixer tube in a u.h.f. super-heterodyne has always been the greatest stumbling block. Although greatly improved operation with respect to previous tubes was obtained when the 6K8 and 6J8G tubes were announced, the 1852 has been found capable of far greater improvements over these latter tubes than they were capable of giving over the older types. In other words, the 1852 is really a "hot" mixer.

The most noticeable, and of course the most valuable improvement of the 1852 over the previous types is in the increased gain obtained from the mixer stage. And, to make matters even more interesting, this increased gain is obtained with considerably improved signal-to-noise ratio.

\* Technical Editor, RADIO.

\*\* Technical Assistant, RADIO.

<sup>1</sup> Dawley, "A Five- and Ten-Meter Converter," RADIO, Dec., 1939, p. 22.

<sup>2</sup> Gonsett, "Ten-Meter Auto-Radio Converter," RADIO, Jan., 1939, p. 52.

The average conversion transconductance of the 6K8 is in the vicinity of 300 micromhos. The 6J8G has approximately the same value. But the 1852 under the same measurement conditions has been shown to have a conversion conductance as high as 3600 micromhos. Twelve times as high a  $G_m$ —and the measurements were made at 60 cycles where the improvement in u.h.f. characteristics of the 1852 over the other types doesn't have a chance to appear.

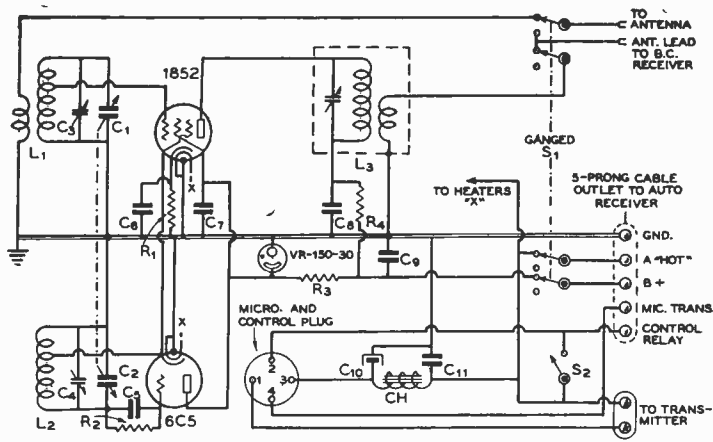
In an actual test with a signal generator on 30 Mc. the 1852 mixer gave an improvement of 20 db (approximately 4 "R" points) over a conventional converter using a 6K8. A 6J8G was substituted for the 6K8 and the results were approximately the same. Even with this large improvement in conversion gain the conversion hiss came up only about 10 db making a net improvement for the 1852 of about 10 decibels. An improvement well worth noting when one is attempting to pull a weak 28-Mc. signal out of the background noise.

## Injection

Another thing that was noted with respect to the 1852 is that it is not at all critical as to injection voltage, method of injection, or cathode bias resistance. The article announcing these tubes<sup>3</sup> stated that control-grid injection was recommended, but it did not give the results that were obtainable with other systems of injection.

Different arrangements of both control-grid and suppressor injection were tried in the ex-

<sup>3</sup> Kauzmann, "New Television Amplifier Receiving Tubes," *RCA Review*, Jan., 1939, p. 271.



Wiring diagram of the three-tube converter.

C<sub>1</sub>—10- $\mu$ fd. midget  
C<sub>2</sub>—15- $\mu$ fd. midget  
C<sub>3</sub>—3-30- $\mu$ fd. mica trimmer

C<sub>4</sub>—75- $\mu$ fd. air trimmer  
C<sub>5</sub>—0.001- $\mu$ fd. mica  
C<sub>6</sub>, C<sub>7</sub>—0.02- $\mu$ fd.

bakelite-cased paper  
C<sub>8</sub>, C<sub>9</sub>—0.1- $\mu$ fd. 400-volt tubular

C<sub>10</sub>—25- $\mu$ fd. 25-volt electrolytic  
C<sub>11</sub>—0.1- $\mu$ fd. 400-volt tubular  
R<sub>1</sub>—600 ohms, 1/2 watt  
R<sub>2</sub>—60,000 ohms, 1/2 watt  
R<sub>3</sub>—5000 ohms, 10 watts  
R<sub>4</sub>—1000 ohms, 1/2 watt  
L<sub>1</sub>—Secondary, 15 turns no. 14 enameled 1/2" dia., tapped at 9 turns from ground end. Primary, 5 turns of hook-up wire inside of secondary  
L<sub>2</sub>—6 turns no. 14 enameled, tapped one turn from ground end  
L<sub>3</sub>—Rebuilt 1500-kc. i.f. transformer, see text  
CH—Primary of small filament transformer  
S<sub>1</sub>—4-pole, double-throw tap switch  
S<sub>2</sub>—S.p.s.t. toggle switch

perimental versions of the converter. All methods gave virtually the same gain but suppressor injection had the advantage that there was no tendency toward pulling. Some trouble with pulling of the oscillator by the mixer grid circuit was had with control-grid injection; the same difficulty was also experienced with certain arrangements using the combined mixer types such as the 6K8 and the 6J8G.

The conventional method of injecting into the suppressor with a coupling condenser and a 50,000-ohm resistor to ground was compared with connecting the suppressor directly to the oscillator cathode. No measurable difference in gain between the two systems was noticeable so the additional resistor and condenser were discarded. The utter simplicity of the injection arrangement—the mixer suppressor connected directly to the oscillator cathode—has much to commend it for mobile use where any additional part carrying r.f. may be a source of instability due to vibration.

The plate of the 1852 is fed through the primary of a rewound and cut-down 1500-kc. i.f. transformer. The secondary coil and its associated trimmer are removed from the supporting structure inside the transformer can and 12 turns of the secondary wire are rewound about 1/8 inch below the bottom of the primary winding. The i.f. can on the four-tube converter was cut down to 1 3/8

inches and the transformer re-assembled. The i.f. can on the three-tube unit was cut down to a height of 2 3/4 inches.

Screen voltage for the mixer is taken directly from the lead that goes to the oscillator plate. Thus the screen, through the regulating action of the VR-150-30, is maintained at 150 volts regardless of supply voltage fluctuations. This tends to stabilize the characteristics of the mixer since the tube is much less sensitive to plate voltage variations than it is to fluctuations in the screen supply.

### The High-Frequency Oscillator

Much of the stability—or instability—of a u.h.f. receiver or converter is attributable to high-frequency oscillator design. And a good, stable h.f.o. is a necessity for satisfactory mobile operation. Stability in such an oscillator is determined, of course, by two things: proper circuit design and proper mechanical design.

The circuit should, first, be an inherently stable one, and the series-fed Hartley has been proven through long years of usage to be about as stable a circuit as can be found. Only one small coil is needed, the circuit is a ready oscillator even with quite high C, and the arrangement lends itself readily to use with the injection system desired.

The coil used in the tuned circuit of the oscillator is very small, wound of heavy conductor, and is made more rigid by small strips of celluloid cemented into place. The fixed padding condenser across the oscillator is a 75- $\mu\text{fd.}$  maximum capacity air padder. The normal setting for this condenser is approximately 80 per cent meshed giving a fixed padding capacity across the entire tuned circuit of about 60  $\mu\text{fd.}$  plus tube and circuit capacities. Thus the tuned circuit itself is unusually high C which helps considerably in reducing warm-up drift, instability with respect to changing plate voltage, and any tendency toward pulling which might be present due to coupling between the oscillator and mixer.

Upon first inspection of the oscillator circuit it may appear to some to be similar to an electron-coupled arrangement. Of course this is not true since the injection voltage is coupled directly from the cathode of the oscillator to the suppressor of the mixer. However, the relative r.f. potentials of the cathode and plate of the oscillator have been reversed for two reasons: first, so that the rotor of the tuning condenser may conveniently be grounded to the chassis; second, to eliminate the additional components that would be required were the plate of the oscillator hot to r.f.

As a further aid to the stability of the oscillator its plate voltage is maintained as closely as possible at 150 volts through the use of a VR-150-30 regulator tube. As was mentioned before, this tube also regulates the

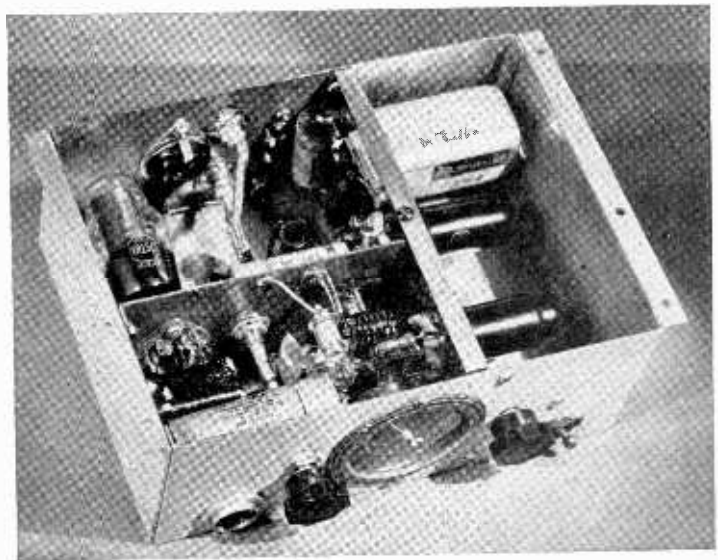
screen voltage to the mixer stage. Either a 6C5 or a 6J5 may be used in the oscillator stage. The 6J5 was designed to be a better high-frequency oscillator in certain circuit arrangements, but in this particular arrangement with its low inherent losses and high circuit capacity both tubes appear to operate almost exactly the same.

#### Additional R.F. or I.F. Amplifier

The first converter using the 1852 mixer comprised only the mixer, the h.f.o., and the voltage regulator plus the additional transmitter control equipment shown in the diagram. While the unit operated very satisfactorily and gave excellent results in any normal receiving location, when the ignition interference was extremely bad the signals were overridden by it. Of course it is impossible to expect that it would be possible to receive weak signals through the type of interference encountered in heavy traffic. But it is true that if the entire signal level is brought up by one means or another before it is fed to the auto set, the apparent signal-to-ignition noise level will be increased. In other words, with increased gain there will be another layer of weaker signals that will arrive at the input of the auto set with enough strength to actuate the a.v.c. and thus knock down the apparent ignition noise.

There are various ways in which this additional gain may be obtained. The easiest way would be to place a 1500-kc. amplifier stage after the mixer. This was tried, by building

Looking down into the three-tube converter with the cover removed. The type of vertical-chassis construction employed in this unit can be seen in this photograph. The outlet to the left of the front panel is for the mike and control leads, the next control is the switch, then the dial and its control knob and the transmitter control switch.



an outboard amplifier between the output of the 1852 in the three-tube converter and the input of the auto set, and considerable additional gain was obtained. However, the conversion noise in the mixer was brought up considerably and although all signals were louder, weak signals were still unable to cut down the ignition noise to any great extent.

Next, an outboard r.f. stage was tried and with very much improved results. All signals were brought up as before, but due to the increased selectivity of the r.f. stage and to the fact that the gain was ahead of the mixer, the signal-to-noise ratio was considerably improved. The unit really went down to background noise level and dug the signals out. This assembly formed the basis of the design for the four-tube converter.

#### The R. F. Stage

The r.f. stage as used in the four-tube converter is more or less conventional and may use either a 6SJ7 or a 6SK7 tube as the amplifier. The single-ended construction of the new tubes contributes greatly to the making of extremely short and direct leads from the elements to the tuned circuits. As in the three-tube unit, the screen voltage is taken from the 150-volt line that is regulated by the VR-150-30. Plate voltage is taken directly from the positive high-voltage line. The amplifier has a gang-tuned input circuit and its plate is inductively coupled to the grid circuit of the 1852 mixer.

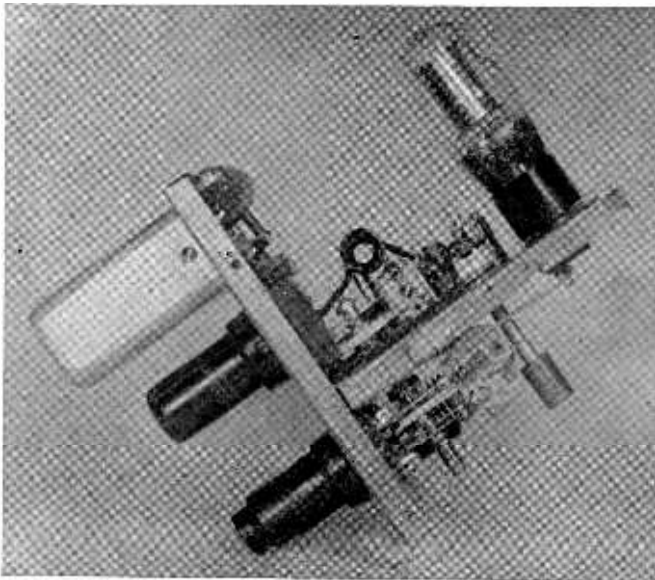
#### Bandspread

As will be noticed in the diagram captions, different values of tuning condensers are used in the three- and the four-tube converters. The values given will give proper tracking with the coils shown in either of the units, but the three-tube affair has more bandspread; conversely, the four-tube unit covers a wider frequency range. In the three-tube unit, 28,000 kc. comes at about 5 on the dial and 30,000 kc. comes at approximately 95. In the four-tube affair, 28,000 can be made to come at about 30 on the dial, whence 30,000 kc. will come at approximately 85.

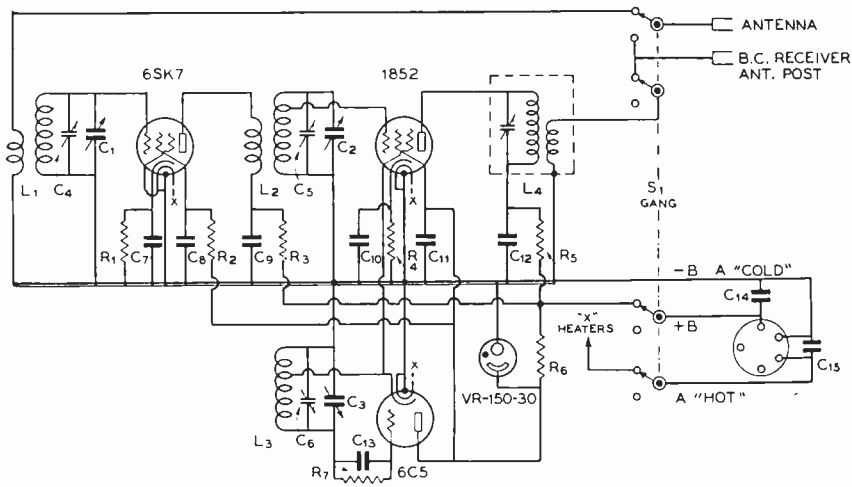
#### Plate Voltage and Current

Both of the converters are quite uncritical as to the plate voltage at which they operate. They have been tried at values from 125 to 350 and operation is satisfactory over this entire range. However, the noise level increases when the supply is much less than 150 volts and the VR tube does not operate unless the maximum supply voltage reaches 180. The best operating value seems to be from 200 to 225 volts, a value which will be supplied by most auto sets even under the additional load of the converter.

The three-tube converter has a current drain of 15 to 20 ma. at normal auto-set voltages and the four-tube one will draw about 4 ma. more. Although this is a sizable drain, almost any auto set will be capable of supplying the additional drain current at the expense of a



The vertical chassis of the three-tube converter removed from its case. This view is from the bottom of the chassis as contrasted to the top view shown in the photograph before.



**Wiring diagram of the four-tube converter.**

- C<sub>1</sub>, C<sub>2</sub>—13- $\mu$ fd. mid-  
get
- C<sub>3</sub>—25- $\mu$ fd. midget
- C<sub>4</sub>, C<sub>5</sub>—3-30  $\mu$ fd.  
mica trimmer
- C<sub>6</sub>—75- $\mu$ fd. midget
- C<sub>7</sub>, C<sub>8</sub>, C<sub>9</sub>, C<sub>10</sub>, C<sub>11</sub>—  
.02- $\mu$ fd. bakelite-  
cased paper
- C<sub>12</sub>—0.1- $\mu$ fd. 400-  
volt tubular
- C<sub>13</sub>—0.001- $\mu$ fd. mica
- C<sub>14</sub>, C<sub>15</sub>—0.1- $\mu$ fd.

- 400-volt tubular
- R<sub>1</sub>—300 ohms, 1/2  
watt
- R<sub>2</sub>, R<sub>3</sub>—1000 ohms,  
1/2 watt
- R<sub>4</sub>—600 ohms, 1/2  
watt
- R<sub>5</sub>—1000 ohms, 1/2  
watt
- R<sub>6</sub>—4000 ohms, 10  
watts
- R<sub>7</sub>—60,000 ohms, 1/2  
watt

- L<sub>1</sub>—Secondary, 15  
turns no. 14 enameled  
1/2" dia. Primary, 5  
turns of hook-up wire  
inside secondary
- L<sub>2</sub>—Secondary, 15  
turns no. 14 enameled  
1/2" dia., tapped at  
9 turns from ground  
end. Primary, 5 turns of

- hook-up wire wound  
over ground end of  
secondary
- L<sub>3</sub>—6 turns no. 14  
enameled, tapped  
1 turn from ground  
end
- L<sub>4</sub>—Rebuilt 1500-kc.  
i.f. transformer, see  
text
- S<sub>1</sub>—4-pole, double-  
throw tap switch

slight decrease in the maximum audio output of the power stage.

**Transmitter Control Circuits**

It will be noticed, by looking either at the diagram or the photographs of the three-tube converter, that the transmitter control lead and the microphone leads are brought to the converter and thence to the front panel. There is a hash filter, consisting of a 25-volt 25- $\mu$ fd. electrolytic condenser and the primary of a small filament transformer, which serves to remove vibrator hash, generator noise, and other forms of interference from the 6-volt d.c. that is fed to the microphone.

The microphone may be plugged into the front panel of the converter and the remote transmitter may be operated either by a switch mounted upon the mike or by the switch on the front panel of the unit. Of course these conveniences are optional. They had not been included in the four-tube converter at the time the photographs were taken. However, they are to be included before the unit is

permanently installed in the car; it is for this reason that a five-contact power plug was used on the rear of the chassis.

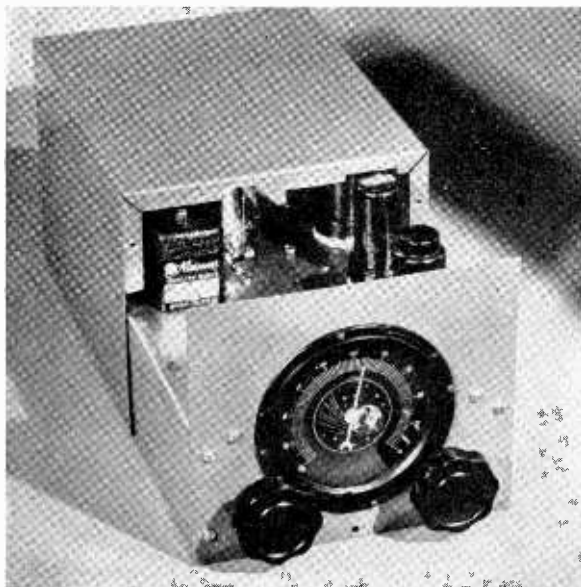
**Mechanical Layout**

Much time and thought have gone into the mechanical layout of these two converters. Numerous "paper" designs were tried and discarded before the arrangements used in the final versions were derived. While the fundamental design of the two units is very similar, there are quite a few more or less minor variations in their construction. Therefore, the construction of the two units will be described separately.

**The Three-Tube Model**

The principal keynote in the mechanical design was compactness, and it was this factor which dictated the layout used in the first unit. Since the converter was to mount under the dashboard of the car, every effort was made to keep it as "thin" as possible. The ruling factor in this dimension proved to be the dial

●  
 Front view of the four-tube  
 converter shown partially re-  
 moved from its case.  
 ●



—and its escutcheon plate. This resulted in a depth of  $3\frac{1}{2}$  inches. In order to accommodate the rest of the components the box was made  $8\frac{1}{2}$  inches wide and  $6\frac{1}{2}$  inches deep.

The converter itself is built on a T-shaped chassis which slides into the box from the top. The "leg" of the T measures  $5\frac{3}{8}$  inches, while the top is  $6\frac{1}{2}$  inches long. With the chassis in the box, three compartments are formed. One of these compartments runs down the right side of the unit from front to back and contains the r.f. tubes and the output transformer. Another compartment across part of the front contains the oscillator circuit, the dial and the microphone filtering circuit. The third compartment, at the rear of the box, contains the mixer circuit, the changeover switch and the voltage regulator tube. As the "leg" of the T is somewhat off the center of the top, the front compartment measures  $2\frac{3}{4}$  by  $5\frac{3}{8}$  inches rather than  $3\frac{1}{4}$  by  $5\frac{3}{8}$  inches, as it would if the leg were centered on the top. The layout of these three compartments is clearly shown in the photographs.

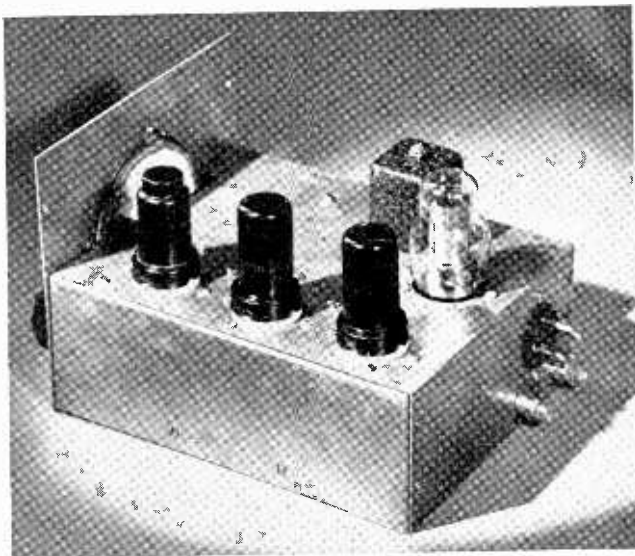
With the chassis and box measurements given, the tuning condensers fall directly under the tube sockets. In fact, it was necessary to bend over some of the socket terminals to keep the rotors from striking them as they revolved. With the condensers this close to the tubes it becomes a simple task to

make extremely short leads. None of the leads carrying high-frequency r.f. is over one inch long, and most of them would measure less than half an inch.

Mounting the oscillator tuning condenser presented somewhat of a problem as there was no panel on which to fasten it and no convenient place to secure a mounting bracket to the chassis. The condenser was finally mounted by turning it around backward and using two short pieces of threaded 4-40 brass rod to support it from the partition between the oscillator and mixer stages. The rotors of the two condensers are tied together by a short piece of threaded 6-32 rod and two locknuts.

All of the components in the oscillator compartment are firmly tied down so that they cannot vibrate and cause frequency flutter when driving. The oscillator coil itself is mounted directly on the tuning condenser and the turns are braced by means of three small celluloid strips which are placed inside the coil after it has been soldered in position. As the dial light necessarily comes quite close to the oscillator coil, it is braced back to the shield partition by a piece of heavy wire which is soldered to both the lamp socket and the partition.

Both the air padding condenser on the oscillator and the MEX trimmer on the mixer are held in place by the simple expedient of soldering their stator terminals (the fixed



Three-quarter rear view of the four-tube converter shown completely removed from its case. The placement of the various tubes, the cut-down output i.f. transformer, and the power and antenna connection leads can be seen in this photograph.

plate in the MEX being considered the "stator") directly to lugs on the tuning condenser stators and then running a heavy lead from the rotor terminal to the nearest ground. The tuning controls on both condensers are placed downward so that adjustments may be made through two holes in the bottom of the box which line up with the condensers. A similar hole in the side of the box allows tuning adjustments to be made on the output transformer after the unit is installed in the car.

#### Difficulties

As construction on the first unit progressed, it became evident that in spite of the planning which had gone into the design, there were several "bugs" in the mechanical layout. The most annoying of these was that nearly a dozen connections had to be unsoldered from the various terminals at the rear of the box before the chassis could be removed. In addition, considerable prying and twisting had to be done before the dial could be cleared from the front panel. Either of these difficulties could have been solved by making the rear of the box removable and sliding the vertical chassis out from the rear.

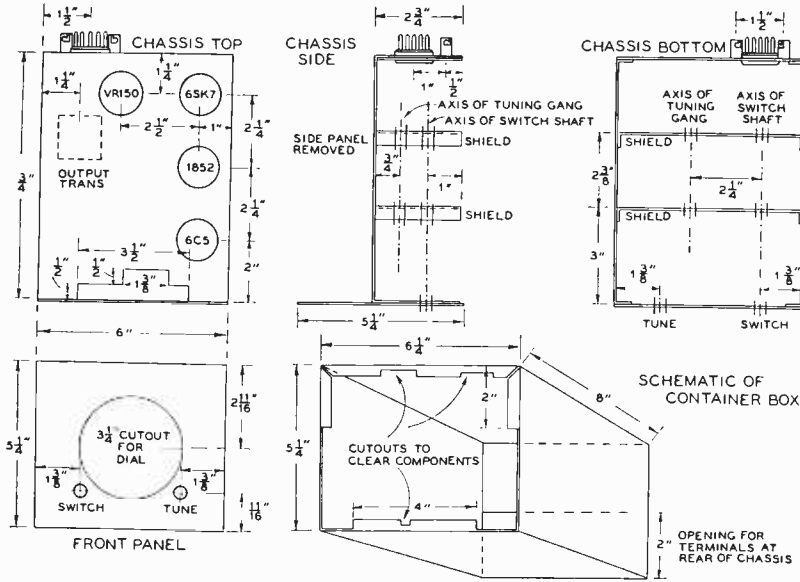
A third disadvantage practically doomed the first layout, however. This was the fact that the converter was too wide to mount over the clutch pedal on the left side of the steering column. Consequently, the unit was placed in the center of the dash, directly below the auto-receiver controls. Mounting it in this position caused difficulties of a most

serious nature; namely—it was death on silk stockings. Now the writers do not ordinarily wear silk stockings, but several young ladies of their acquaintance have been known to do so on occasion. Taking the line of least resistance, it was decided to move the converter.

#### The Four-Tube Model

In the design of the converter with the r.f. stage it was decided to employ a type of construction which allowed the whole assembly to be removed from its box by merely loosening the panel screws. This resulted in a more or less conventional chassis construction. Once again the dial became an important factor in determining the depth of the box and, as the dial was somewhat larger than that used on the first converter, this depth turned out to be  $5\frac{1}{4}$  inches. By mounting the tubes and the output transformer above the chassis, it became possible to cut the width down to 6 inches. By a careful choice of parts and the use of care in their placement the three stages were crammed into a depth of  $7\frac{3}{4}$  inches. The drawing gives full details as to the chassis and box dimensions. Note that there is a space of  $\frac{1}{4}$  inch between the rear of the chassis and the back of the box. This space was left to allow the screws which hold the removable side of the chassis in place to clear the back when the unit is assembled.

One side of the chassis was made removable to facilitate the wiring to the tube sockets. This side was put in place after all the wiring was completed. Both of the partitions under



Mechanical layout drawings of the chassis and case for the four-tube converter.

the chassis are also removable, allowing plenty of working room.

The tuning condensers are mounted directly on the under side of the chassis by means of a screw through the chassis into the bracket which is an integral part of each condenser. Small flexible isolantite couplings are used to couple the rotors together. With the condensers and sockets mounted on the chassis, the various resistors and by-pass condensers may be fitted into the remaining space around the sockets. One interesting sidelight on the construction of a unit such as this is the tendency of the constructor to overestimate the importance of short leads. When the parts are so arranged that many of them may be connected by merely soldering their terminal lugs together, a piece of wire an inch long seems a very long lead indeed. Thus the lead from the oscillator cathode to its coil, which is slightly over an inch long, seemed to be entirely too much wire. A little thought on the problem, however, brought the realization that a lead of this length would be considered quite short in ordinary receiver construction. Also, even though the lead was longer than any of the others, it certainly would not im-

pair the operation of the unit.

Because of the fact that one side of the chassis is removable and that the partitions between stages may be removed, the wiring is greatly simplified. The r.f. stage should be wired first. When its wiring is completed, holes should be drilled in the rear partition to pass the leads running between stages and this partition installed in the chassis. The mixer stage should be wired in a similar manner, the wiring progressing from back to front. After the oscillator has been wired, the panel should be drilled for the dial and both the panel and the removable side of the chassis installed in position.

In order to place the chassis in the box it is necessary to cut out three small pieces of the front lip of the box. The position of these cutouts may be seen in the drawing. The two at the top are to pass the tubes, while the small slot at the bottom is to pass the rotor shaft of the oscillator tuning condenser. No provision need be made for adjusting the trimming and padding condensers through the box as the converter may easily be removed from the box for this purpose.

[Continued on Page 76]



# A 100-WATT TRANSMITTER

## *With Four-Stage Bandswitching Exciter*

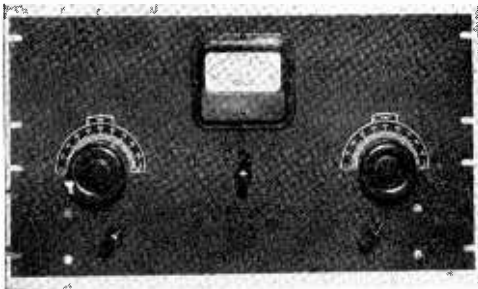
BY GEORGE W. SHUART,\* W2AMN

A description of a bandswitching transmitter utilizing separate 6L6 doubler stages with fixed-tuned plate circuits for each band, meter switching in all stages, and a 100-watt beam-power amplifier tube in the final.

The modern trend in amateur transmitter design is definitely toward the compact flexible all-band unit which can be placed alongside the modern communications receiver on the operating desk. The main requirement of the exciter portion is flexibility. This unit must operate on at least 4 bands—80, 40, 20 and 10, with approximately the same power output on all of them. The power output of this exciter should be sufficient to drive a medium-power tetrode such as the RCA-814, RK47 or a similar beam tube.

The trend is, naturally, toward building separate units for the amplifier and exciter. However, this tends to make the transmitter larger and more complicated. The best arrangement would be to combine the exciter unit and the amplifier. With this in mind, the unit shown in the photographs was built.

\* Hammarlund Mfg. Co., Inc., 424 West 33rd St., New York City.



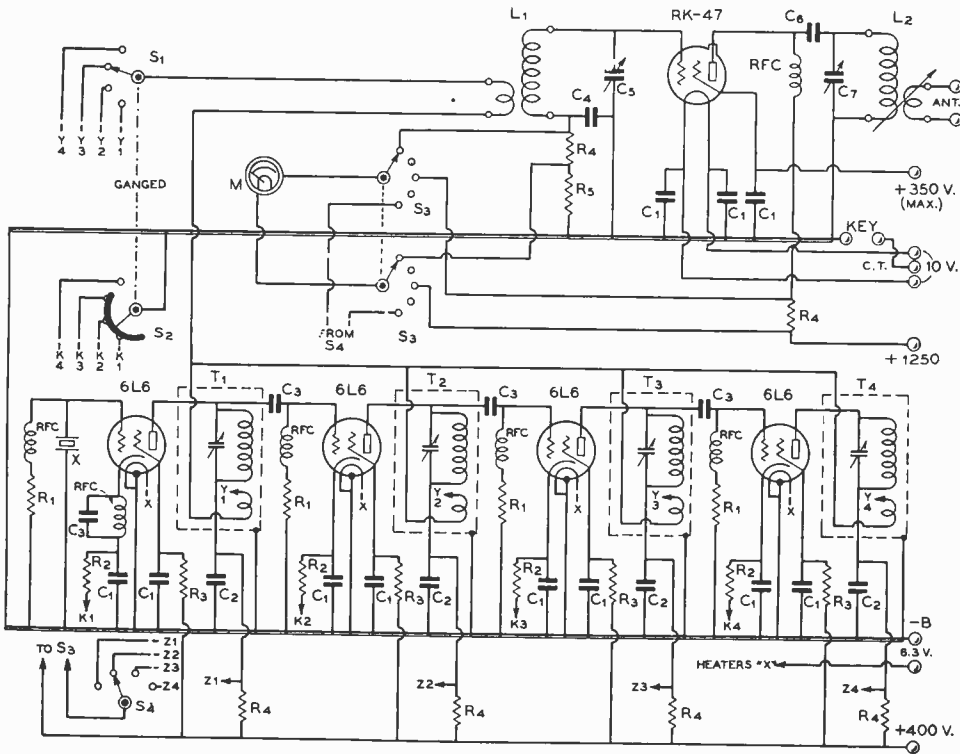
Panel view of the transmitter. Only the plate and grid circuits of the final are tuned; the tank circuits of the exciter are fix-tuned on each band. The switch to the left is the band-switch, the one in the center is the main meter switch, the one to the right is the auxiliary meter switch on the exciter.

### Exciter Design

Since panel space is more valuable than other dimensions of the transmitter all large components were built into the unit in a horizontal plane. The exciter unit has a panel length of 17 inches and is only  $2\frac{3}{4}$  inches high. The depth behind the panel is 8 inches. The crystal oscillator stage and the three multiplier stages are built along the rear edge of a diminutive chassis. Starting from right to left, we have the plug-in 80-meter crystal, the oscillator tube and its plate tank unit which is about the size of an i.f. transformer; then comes the 40-meter multiplier tube followed by its tank assembly; then the 20-meter multiplier, the 20-meter tank, and finally, the 10-meter multiplier and its tuning unit at the extreme left.

Since the exciter unit is only  $2\frac{3}{4}$  inches high, there is plenty of space above it for building the amplifier stage. The top plate of the box-like chassis is drilled for mounting the various amplifier components. By building the entire transmitter around this type of chassis, it was possible to keep the overall dimensions down to 17 inches long by 8 inches deep by  $9\frac{1}{4}$  inches high. This is a very compact unit when it is considered that it represents a complete 100-watt transmitter including everything but the power supplies.

Much thought was given to "trick" circuits that provide all-band operation with only a couple of tubes. However, if the unit is to be foolproof and really flexible, such circuits are usually handicaps. They usually present greater problems than those they are supposed to overcome. Therefore, we believe the best arrangement is one where separate tubes are used for each band. This called for a crystal oscillator and three multiplier stages in order to obtain operation on all bands, 80 to 10 meters.



Wiring diagram of the bandswitching 100-watt transmitter.

C<sub>1</sub>—0.01- $\mu$ fd. mica  
 C<sub>2</sub>—0.001- $\mu$ fd. mica  
 C<sub>3</sub>—0.0001- $\mu$ fd. mica  
 C<sub>4</sub>—0.005- $\mu$ fd. mica  
 C<sub>5</sub>—100- $\mu$ fd. mid-  
 get  
 C<sub>6</sub>—0.0005- $\mu$ fd. mica,  
 5000 volt  
 C<sub>7</sub>—100- $\mu$ fd., .070  
 spacing  
 R<sub>1</sub>—10,000 ohms, 1

watt  
 R<sub>2</sub>—400-ohm wire-  
 wound  
 R<sub>3</sub>—20,000 ohms, 2  
 watts  
 R<sub>4</sub>—100 ohms, 2 watts  
 R<sub>5</sub>—10,000 ohms, 10  
 watts  
 T<sub>1</sub>—80-meter tank  
 circuit in shield can  
 T<sub>2</sub>—40-meter tank

circuit in shield can  
 T<sub>3</sub>—20-meter tank  
 circuit in shield can  
 T<sub>4</sub>—10-meter tank  
 circuit in shield can  
 RFC—2.1-mh r.f.  
 chokes  
 X—80-meter crystal  
 M—0-150 d.c. mil-  
 liammeter  
 L<sub>1</sub>—Plug-in grid coil,

see text  
 L<sub>2</sub>—Plug-in plate  
 coil, see text  
 S<sub>1</sub>—Band selector  
 switch  
 S<sub>2</sub>—Cathode circuit-  
 closing switch  
 S<sub>3</sub>—Final amplifier  
 meter switch  
 S<sub>4</sub>—Exciter meter  
 switch

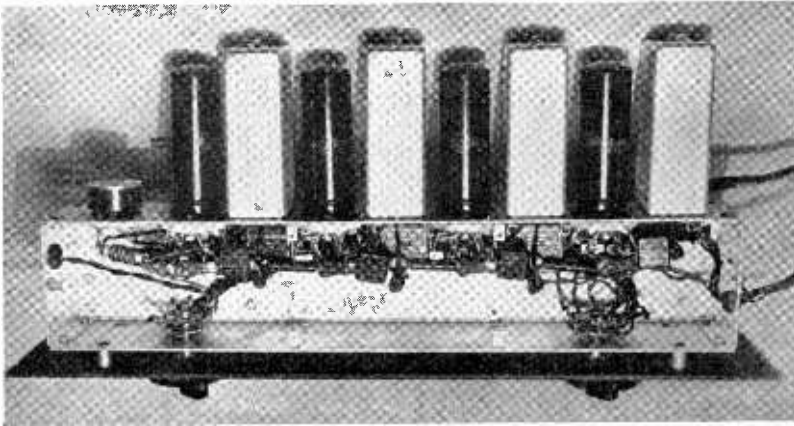
The tubes selected for the purpose were naturally 6L6's because they have proved to be ideally suited to this sort of job.

### Bandswitching

The next problem was selecting a simple method of bandswitching. Several of the more popular methods were tried but they all seemed too complicated. The final arrangement proved highly satisfactory. The cathode circuits of the unused stages are opened and the output link is connected to the multiplier stage being used. A special, but simple, switch was designed to accomplish this job. As the

switch is rotated clockwise, it adds the multiplier stages to 80, 40, 20 and 10 in this order. At the same time, the link is connected to the last stage that is operating. This arrangement of switching in the various stages puts the switch in a position where no high r.f. voltage is present.

If the switch were called upon to remove excitation from the unused stages, it would mean that a compensating capacity would have to be switched into the circuit to allow for removal of the capacitive loading of the following tube. Otherwise, it would be impossible to keep the circuits in perfect align-



Bottom view of the exciter chassis with the cover plate removed. The simplicity of construction afforded by the use of the fixed plate tank circuits is clearly shown in this photograph.

Exciter Coil Data				
Band	Turns	Wire	Link Turns	Wire
80	56	no. 24	6	no. 24
40	28	no. 20	6	no. 24
20	14	no. 20	6	no. 24
10	7	no. 20	4	no. 24
Plate coils wound on $\frac{7}{8}$ " tubing spaced to a length of $1\frac{7}{8}$ ". Link coils close wound and spaced $\frac{1}{16}$ " from plate coil. Enameled wire used.				
Amplifier Grid Coil Data				
Band	Turns	Wire	Link Turns	Wire
80	36	no. 22 enam.	6	no. 20 d.s.c.
40	18	no. 20 enam.	6	no. 20 d.s.c.
20	9	no. 20 enam.	6	no. 20 d.s.c.
10	4	no. 20 enam.	4	no. 20 d.s.c.
Grid coils spaced to a length of $1\frac{1}{2}$ ". Links on 80- and 40-meter coils wound over cold end of grid coil for proper loading. 20- and 10-meter links placed below grid coil.				
Amplifier Plate Coil Data				
Standard swinging link manufactured coils are used. Short out or remove turns on 40-, 20- and 10-meter coils to resonate with condenser plates meshed about one inch.				

ment. This, however, is not true with the system used in this exciter. The capacity across the circuit remains relatively constant even though the load is removed. The input capacity of the following tube is always across the preceding stage. The loss of power with this arrangement is negligible and would present no problem anyway because so very little power is required to excite the 100-watt stage.

The entire arrangement is foolproof in operation; there is no high potential r.f. in the

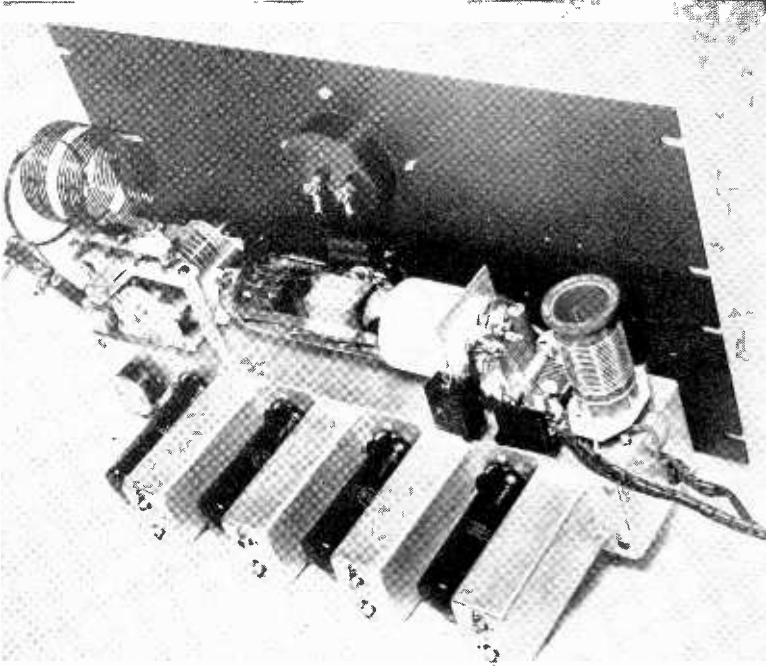
switch and all circuits remain in perfect alignment. This method does, however, require a power supply with excellent regulation because the current drain varies widely as the stages are switched in and out. Each stage draws in the neighborhood of 30 ma. with no load. A power supply with poor regulation results in excessive oscillator voltage when operating on 80 meters and low voltage when operating on 10 meters. The output of each of the 4 stages is more than sufficient to drive the grid current of the 814 or RK47 to 20 ma. with a 10,000-ohm grid leak. This is just twice the grid current required. Ten ma. appears to provide maximum efficiency.

#### Meter Switching

With the bandswitch problem solved, it then became necessary to work out a simple meter switching arrangement. The switch used for this purpose is a standard single-pole 4-point rotary affair. Investigation showed that a 100-ohm resistor could be connected across a 0-150 ma. meter and the error introduced would be many times smaller than the guaranteed accuracy of the meter. Each plate circuit to be metered has a 100-ohm 2-watt resistor connected in series with it and the meter is switched across these various 100-ohm resistors. This 100-ohm resistor introduces a 1-volt drop for every 10 milliamperes flowing through it. This drop of 3 or 4 volts, of course, has no effect on operation of the multiplier stages. The increase of 3 or 4 volts that occurs when the meter is switched across the resistor is also of no importance.

#### Crystal Oscillator Tuning

The diagram provides complete details of the circuit and needs little explaining. In prac-



Rear view of the transmitter showing the small horizontally-mounted exciter chassis and the manner in which the power amplifier stage is mounted above it. The metal cans between each of the 6L6 tubes are the fixed-tune doubler plate circuits for each band. The grid and plate coils for the final are plug-in and must be changed when switching bands.

tice, it was found that the crystal oscillator stage was slightly "fussy" when using an ordinary none-too-active crystal. However, by connecting a 2.1-mh. r.f. choke in series with the cathode and by-passing it with a 100- $\mu\mu\text{fd}$ . condenser, all signs of temperament vanished. This slight change lowered the plate current considerably and increased the r.f. output. The plate circuit of the oscillator tunes exactly the same as do the amplifier stages. It should be adjusted for minimum current and not for some compromise value as is usually necessary with a straight crystal oscillator using a 6L6 tube.

#### Tuning Units

The tuning units used in this exciter are standard ready-wound Hammarlund units consisting of two 25- $\mu\mu\text{fd}$ . midget variable condensers connected in parallel. The coil is wound on a  $\frac{7}{8}$ -inch diameter and 2-inch long threaded bakelite form. Complete data as to the number of turns required for each band is given in the coil table for those who may wish to wind their own.

#### The Power Amplifier Stage

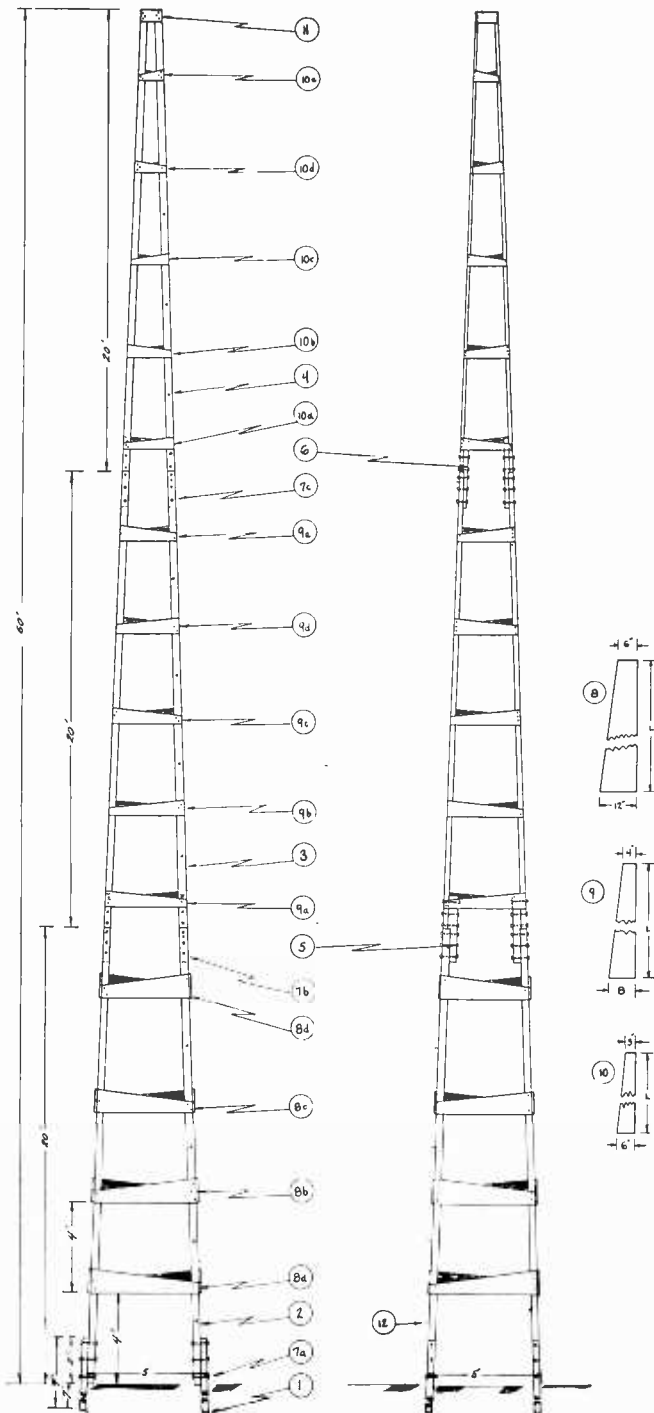
The 814 or RK47 amplifier stage is conventional and employs plug-in coils. Bandswitching can be used in this stage also with slight modifications. Parallel or shunt feed is used in both plate and grid circuits for safety and simplicity. This eliminates the necessity for insulating the condenser rotors. The plate condenser has a capacity of 100  $\mu\mu\text{fd}$ . and a plate spacing of .070". The grid condenser is a 100  $\mu\mu\text{fd}$ . midget of the receiving type.

The same system of meter switching used in the exciter is used in this stage also. One-hundred ohm resistors are connected in the plate and grid circuits. Although a separate switch is employed, the same meter is used for measuring the currents of the amplifier circuit. This isolantite-insulated switch has two poles and five positions. All positions are not used. The first, third, and fifth positions are employed so as to permit wide spacing between contacts.

[Continued on Page 77]

# Construction of PLYWOOD RADIO TOWERS

By  
MILLARD P. KOOPMAN\*



Many types of modern antenna designs require at least one good tower from about 20 feet to around 60 feet in height. It is anticipated that in the near future the remotely controlled rotating beams will be supplemented by remotely controlled transmitters. In other words, if the beam is mounted on top of a 60-foot tower, the transmitter can be mounted in the tower directly under the beam. The transmitter would of course be contained in a weatherproof housing and provision could be made so that the essential indicating meters could be observed in the operating room.

However, for immediate purposes this article is primarily intended to describe an improved type of wood mast construction, regardless of the type of antenna contemplated.

The comparatively new development of hot-pressed waterproof plywood opens up the possibility of constructing a sizable radio tower at a very low cost.

This new fir plywood is actually waterproof. One builder in using this material for a house exterior surface, left the plywood exposed to the elements for a year, unpainted. The plywood bonds stood up perfectly during that period

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through all kinds of weather. As a matter of fact, the material is now used extensively in boat construction, even below the water line.

Plywood could be used exclusively in the design of radio towers, provided facilities for fabricating uprights were available on the site of the tower. In that case towers of practically any desired height could be constructed economically and they would be free from any of the parasitic effects common to steel towers.

For the amateur, the most convenient design is one where the tower uprights are solid wood, the use of waterproof plywood being confined to the cross bracing. The fact that these cross braces can be nailed into position greatly simplifies the assembly operation.

The drawing accompanying this article covers a 60-foot self-supporting tower which can be constructed in most localities for a material cost of thirty-five to fifty dollars. Using the materials specified it is not absolutely essential to paint the tower although a good grade of outside paint will materially increase its life.

This design for a 60-foot tower can be used for other heights. For example, a 40-foot tower would be made by using the material called for in the two upper 20-foot sections. An 80-foot tower can be readily constructed by adding, at the bottom, an additional section identical to the original 20-foot bottom section.

#### Material Selection

The selection of a good species of lumber for the uprights is very important and the choice depends upon the geographical location of the builder.

In the northern states or eastern Canada, eastern spruce is suggested. Amateurs located on the west coast have the choice of western spruce or redwood. Down south the builder can use either long-leaf yellow pine or cypress. All the above species will give service over a long period of years.

The hot-pressed waterproof plywood now available is manufactured of fir. The material is stocked by most lumber yards and also by plywood warehouses. The plywood braces need not be painted if one intends to use the tower for only a few years.

For a 60-foot tower the foundation holes need not be more than 7 feet deep, and if dug in solid ground, it will not be necessary to fill the holes with concrete. Foundation supports made of any of the species mentioned above will not ordinarily rot under ground even if untreated. However, redwood supports will be found to give the best life.

All of the above species of lumber men

tioned for the uprights come in a wide range of grades. It will simplify matters to specify that the material be "sound and square edge and free from any knots over  $\frac{1}{4}$  inch in diameter on any face." This assures that you will obtain good strong uprights.

A complete bill of required material is given. The uprights 1, 2, 3 and 4 are purchased cut to size and it is only necessary to drill a few holes for the connecting bolts at the upright joints. The connecting pieces 5 and 6 must be cut as shown in the drawing and are also drilled for the connecting bolts. The balance of the assembly process consists of simply bolting the uprights together, and, as the assembly progresses, the nailing on of the cross braces.

After the four foundation holes are dug, the assembly can be started. These holes can be dug 7 feet deep and about a foot in diameter by using a post hole shovel or digger.

One of the foundation supports, 1, is placed in each of the four foundation holes. An upright, 2, is bolted to each of the foundation supports. Before tamping ground around the foundation supports, the first plywood cross braces 8d, 8b, 8c and 8a are nailed into position temporarily with only one nail at each of the 8 corners.

This temporary assembly facilitates placing a plumb line so that the foundation supports and uprights can be lined up symmetrically and so that the centerline can be made actually vertical.

The foundation supports can then be tamped in solidly and the plywood cross braces nailed on permanently, followed by adding the balance of the cross braces for these lower uprights. Fortunately, plywood can be nailed very close to the edge of a piece without any danger of splitting.

The balance of the assembly work is simplicity itself. The center uprights, 3, are bolted into place and the corresponding cross pieces 9a, 9b, 9c, 9d and 9e are nailed into position. The top uprights, 4, are then ready to be bolted into place. This is followed by nailing on the upper plywood cross pieces 10a, 10b, 10c, 10d, 10e and finally the top finish pieces, 11, and the job is complete.

It is perfectly all right to step on one set of cross braces in order to reach the succeeding set of braces. However, it is well to wear soft or rubber soled shoes and to step on the braces close to the uprights. It is also advisable to wear some sort of substantial safety belt around yourself and the nearest upright.

The cross braces are well spaced 4 feet apart, starting at the bottom. To facilitate climbing the tower, lag screws are placed

between each set of cross braces, on one face of the uprights. After the tower is completed, these steps can be removed, if desired, to discourage others from climbing the tower unnecessarily.

From the bill of material it is noted that three different thicknesses of plywood are

specified, corresponding to the three sections of the tower. The plywood can be obtained in sheets, or cut exactly to the size and shape required for this design. As there is no "grain" to consider, there is practically no waste in obtaining the sizes and shapes specified as taken from stock sheets.

BILL OF MATERIAL		
PART NO.	QUANTITY	SPECIFICATIONS
1	4	Foundation supports . . . . . 4" x 4" x 9' Rgh or S4S
2	4	Lower uprights . . . . . 4" x 4" x 20' S4S to 3 1/2" x 3 1/2"
3	4	Center uprights . . . . . 3" x 4" x 20' " " 2 1/2" x 3 1/2"
4	4	Top uprights . . . . . 2" x 4" x 20' " " 1 1/2" x 3 1/2"
5	4	Lower connectors . . . . . 4" x 4" x 3' " " 3 1/2" x 3 1/2"
6	4	Upper connectors . . . . . 3" x 4" x 3' " " 2 1/2" x 3 1/2"
7a	12	Machine bolts, galvanized iron, square head each complete with 2 washers and 1 nut, 7/8" dia. by 9" long
7b	24	Ditto 3/4" dia. by 8" long
7c	24	Ditto 5/8" dia. by 6" long
8a	4	Pieces plywood 4'—8 1/2" long (see detail) (7/8")
8b	4	" " 4'—5 1/2" " " " "
8c	4	" " 4'—2 1/2" " " " "
8d	4	" " 3'—10 1/2" " " " "
9a	4	" " 3'—7" " " " "
9b	4	" " 3'—4" " " " "
9c	4	" " 3'—1" " " " "
9d	4	" " 2'—9" " " " "
9e	4	" " 2'—6" " " " "
10a	4	" " 2'—3" " " " "
10b	4	" " 1'—11" " " " "
10c	4	" " 1'—8" " " " "
10d	4	" " 1'—5" " " " "
10e	4	" " 1'—1 1/2" " " " "
11	4	" " 1' x 6" x 5/8"
12	14	Lag screws or pole steps 1/2" dia. by 6" long, galvanized iron.
	5	Pounds 5d (1 3/4") galvanized iron nails.

**Neon Bulb Hint**

Many amateurs are not aware of the fact that while not so commonly available, G. E. neon bulbs are available in the 1/4, 1/2, 1, and 2 watt sizes *without* the resistor in the base. Such bulbs are useful in test instruments, oscillators, voltage regulators, noise silencers, etc.

Because of the comparatively small demand for them, the resistorless types cost a few cents more than the corresponding types having a resistor in the base. However, if you have gone through the agony of removing the base of one of these bulbs in order to amputate the resistor, you will be only too glad to pay the extra few cents.

**Fresno Hamfest**

On April 22, the San Joaquin Valley Radio Club will again be hosts to the hams of California at the Annual Fresno Hamfest. Registration all day Saturday at the Hotel Fresno, with the banquet and stellar entertainment program beginning at 7 P.M. in the new Fresno Memorial Auditorium. Tickets at \$1.50 cover everything, including the door prize drawing for many prizes. Advance registration prize will be an oscilloscope, with a receiver for first door prize. Attendance this year is expected to pass the 500 mark. For advance registration and other information communicate with Horace S. Walling, 1348 Wishon Ave., Fresno, California.

# MULTI-WIRE DOUBLET ANTENNAS

By JOHN D. KRAUS,\* W8JK

It is common practice to locate a transmitting antenna at some distance from the transmitter and to deliver the radio frequency energy to it by means of a transmission or feed line. Tuned or resonant feeders (zepp type) are widely used and provide a flexible feed system since a wide range of antenna impedances can be readily coupled to the transmitter. Large standing waves are usually present on tuned feed lines.

A more efficient system makes use of an untuned or non-resonant transmission line. When properly terminated, the standing waves on this type of line are either entirely absent or very small. This type of line is particularly desirable where the antenna is at a considerable distance from the transmitter. When open wire construction is used, a line having a surge impedance of about 600 ohms is commonly employed. Unless the antenna has the same impedance at its feed point as the untuned transmission line, some kind of matching arrangement between the line and antenna is necessary to eliminate large standing waves. Stubs, Q-sections, and delta matching arrangements are commonly used for this purpose.

In some cases, however, such matching systems may not be convenient and other arrangements may be more desirable. It is the purpose of this article to describe a system in which the antenna itself is so constructed that the value of the resistance at the feed point is suitable for the direct connection of an open-wire line, such as the 600-ohm type.

## The Multi-Wire Principle

A single half-wave antenna presents a resistance of about 70 ohms when opened and

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measured at the current loop point. If a second half wave is located parallel to the first and at a small distance, as shown in figure 1, and the two elements are fed in phase, the resistance at the current loop of both elements is increased. By adding a third parallel in-phase wire, the loop resistance can be further increased. The increased resistance at the loop is accompanied by decreased resistance at the current node or voltage loop point.

## The Two-Wire Half-Wave Antenna

A 14-Mc. antenna to which this principle has been applied is shown in figure 2. The system uses two parallel half-wave elements spaced 1 foot apart. The elements are connected together at the ends and fed by opening one of them at the center. A 600-ohm untuned transmission line is connected at this point as shown.

The resistance at the feed point of this antenna is actually somewhat less than 600 ohms. There is, accordingly, some mismatch, but it is much less than often used in amateur practice. For a more exact match, a one-quarter wave Q-section can be inserted between the 600-ohm line and the antenna. However, the match of the 600-ohm line directly to the antenna is sufficiently good that there is little point in using a Q-section unless the transmission line is many wavelengths long, such as 500 feet or more on 14 Mc.

## The Two-Wire Three-Quarter Wave Antenna

Another arrangement whereby a 600-ohm untuned transmission line can be directly connected to the antenna is shown in figure 3. This antenna is three-quarters wavelengths

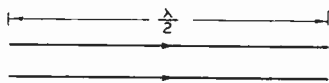


Figure 1.

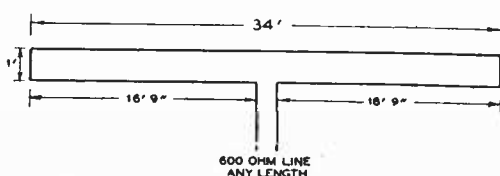


Figure 2. The two-wire half-wave antenna. Dimensions for 14 Mc.



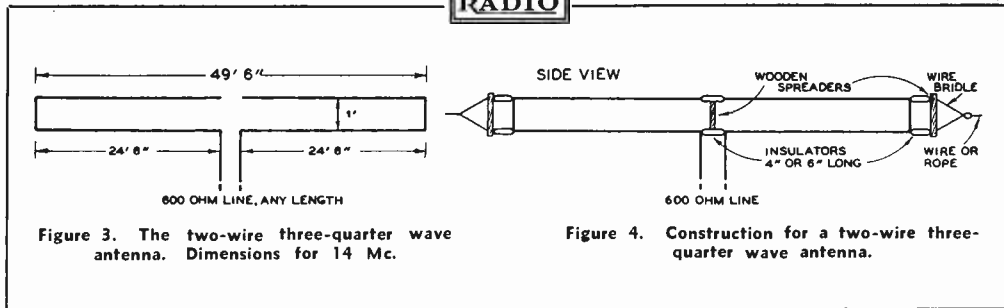


Figure 3. The two-wire three-quarter wave antenna. Dimensions for 14 Mc.

Figure 4. Construction for a two-wire three-quarter wave antenna.

long overall or about 50 feet on 14 Mc. Both wires are opened at the center and the 600-ohm line connects into one of them with a very satisfactory match.

**Dimensions**

The dimensions given in figures 2 and 3 are suitable for use in the 14.0- to 14.4-Mc. band. For the 28-Mc. band the dimensions should be divided by two, and for 7 Mc. multiplied by two.

Multi-wire antennas of both the half and three-quarter wave types, as shown in figures 2 and 3, have been used on 14 Mc. at W8JK. A characteristic of these antennas is that they tune very broadly. In other words, the antennas remain in tune over a wide frequency range. The antennas are, likewise, not critical as to the exact dimensions. For example, either an increase or a decrease of 2 feet in the overall length of the two-wire three-quarter wave antenna of figure 3 produced only a 20 per cent increase in the standing waves on the transmission line. For most practical purposes, this is a negligible increase in standing waves.

**Construction**

The construction of a two-wire three-quarter wave antenna is illustrated in side view in figure 4. Wooden spreaders 14 inches long are used at both ends. At the center another wooden spreader is fastened by wire or cord to the center insulators in order to maintain the proper separation of the antenna wires (one foot on 14 Mc.). These short wooden spreaders can be made to hang either vertically, as shown in the figure, or horizontally. The operation of the antenna is the same in both cases. Good quality strain insulators at least 4 inches long can be used at the center and ends. Number 12 wire is a satisfactory size for the antenna elements. The 600-ohm line is constructed of number 12 wire spaced 6 inches. Number 10 wire spaced 6 inches results in a line with 570-ohm surge im-

pedance which can also be used satisfactorily, if desired, instead of the 600-ohm line.

The construction of a two-wire half-wave antenna is the same as shown in figure 4, except that the upper wire is not opened at the center. Thus, the upper center insulator can be omitted on this antenna.

The directive properties of both antennas are much like those of a simple half-wave type. Due to its greater length, the three-quarter wave type radiates slightly more broadside. The antennas are not beam antennas in any sense. They are merely half and three-quarter wave types which permit the direct connection of an open-wire feed line without the need for any type of stub, Q-section, or delta matching arrangement.

The resistance of any antenna depends to quite an extent upon its height above ground. Hence, the feed point resistance of the antennas described may vary somewhat according to their height. The magnitude of the standing waves on the transmission line will, thus, also depend to some extent on the antenna height.

The antennas described are probably most conveniently used horizontally. They can, of course, also be operated vertically if desired.

Many other applications of the multi-wire principle are possible. This article describes the application of the principle to the common half-wave antenna, as well as to a three-quarter wave type.

**RADIOODDITIES**

Add to the list of amateurs whose names live up to their hobby these two operators, both of whom live in Ontario, California: W6KHV, D. C. Mast and W6CVV, O. M. Watt.

We all know about dx from 160 to 5 meters, and even a little on 2½. Imagine our surprise to learn that a 500 cycle tone has been transmitted as far as 250 miles in water, without even a radio set!

## A Band-Edge

# FREQUENCY SPOTTER

By RAY L. DAWLEY, \* W6DHC

A description of an inexpensive 50-kilocycle frequency standard whose amplified harmonics give calibration points every 50 kc. from the broadcast band through 30 megacycles.

"152.44 . . . . . The licensee of an amateur station shall provide for measurement of the transmitter frequency and establish procedure for checking it regularly. The measurement . . . . . shall be made by means independent of the frequency control of the transmitter and shall be of sufficient accuracy to assure operation within the frequency band used."

So reads the FCC rule regarding frequency measurement of amateur transmitters. The rule says in effect that we cannot rely on the frequency marked on a crystal by its manufacturer as a suitable method of frequency checking in any case. Neither can we, if edge-of-band operation is contemplated, rely upon the dial readings of the station receiver for frequency measurement. Some independent method of accurately determining frequency is required. Such an instrument is shown in the accompanying photographs.

The unit consists essentially of a 50-kilocycle oscillator and a tuned harmonic amplifier with a small resistance-capacity filtered and voltage-regulated power supply. It is in the choice of standard frequency for the oscillator that this unit differs considerably from others of similar intended usage. Previous frequency standards of this type invariably have used a 100-kc. oscillator. This meant that in order to spot the edges of the 14-150-to-14,250-kc. phone band it was necessary to do some fancy juggling in listening to the harmonics of an auxiliary oscillator while hoping that the oscillator would not shift as the receiver was switched back and forth between the 10- and 20-meter bands. If any other 50-kc. points were desired the calibration became so involved that most amateurs were content to get along with the 100-kc. points and to make a wild guess at interpolating the 50-kc. ones.

In contrast to the type using a 100-kc. oscillator, the unit to be described provides 50-kc. points of usable and adjustable strength on all the amateur bands up to and including

30 Mc. For that matter it also gives usable calibration points every 50 kc. on the frequencies in between the amateur bands should they be needed for some special purpose. These 50-kc. marker points give the edges of all the amateur bands, phone and c.w., except the low-frequency edge of the 160-meter c.w. band (1715 kc.). When and if the 160-meter band is changed to 1750 to 2050 kc. in accordance with the Havana agreement the unit will provide points at both ends of this band as well.

### The 50-Kilocycle Oscillator

A 6K8 tube is used as a combined 50-kilocycle oscillator and electron-coupled doubler to 100 kc. The triode portion of the mixer tube is connected as a series-fed Hartley with the plate grounded as to r.f. and the cathode tapped up on the coil. This places the grid of the oscillator at a high r.f. potential and since the injection grid of the tetrode portion of the 6K8 is directly connected to the oscillator grid, this element is at a high r.f. potential also.

A number of different tubes and tube combinations were tried in the oscillator portion of the circuit. All had disadvantages in one respect or another. Either the harmonic output was low so that usable harmonics on the 10-meter band were not available, or there was pulling between the oscillator portion and the output amplifier as it was tuned through resonance. The circuit shown proved to be the best in the elimination of these difficulties.

### Padding and Trimming Capacity

The oscillator coil is a Meissner 456-kilocycle beat-oscillator unit with the mica trimmer removed. By loading this comparatively high-frequency coil to the low frequency of 50 kc., the oscillator tuned circuit becomes quite high Q. The stability with respect to tube and circuit temperature variations and plate voltage variations is greatly improved

\* Technical Editor, RADIO.

by the high oscillator lumped capacity. Actually, the capacity required to tune this oscillator coil to 50 kilocycles is very close to 0.00625 microfarads. This capacity is obtained through the use of a .006- $\mu$ fd. fixed mica (preferably of the silver-plated type) in parallel with a .0002- $\mu$ fd. mica and a 100- $\mu$ fd. midget variable. It is important that the identical coil as shown in the Buyer's Guide be used (and that the mica trimmer thereon be removed) if the values of capacity shown are to hit 50 kilocycles.

The 100- $\mu$ fd. midget trimmer condenser is brought out to the front panel and allows the frequency of the oscillator to be tuned about one-half kilocycle either side of the operating frequency of 50 kilocycles. This adjustment will ordinarily compensate for any small variations in coil inductances and in circuit capacity. If, however, it is impossible to tune this circuit to 50 kc. by a variation in the capacity of this condenser, the addition or subtraction of .00005  $\mu$ fd. from the fixed value of .00625 will usually allow it to be accomplished. This variation may be accomplished by the substitution of a .00015- $\mu$ fd. or a .00025- $\mu$ fd. condenser for the .0002- $\mu$ fd. one shown. However, the tolerance in these coils is normally small enough that the values originally given in the circuit diagram will allow the circuit to be tuned to 50 kc. with no substitutions of capacity.

#### 50-Kc. Coil Connections

The oscillator coil, as it comes from the manufacturer, is not a single tapped unit but rather a two-winding affair with four leads brought out from the coils. It will then be

necessary to series these two coils as shown in the manufacturer's diagram as the connection for an electron-coupled oscillator. The cathode of the oscillator-mixer tube is then connected to the tap. The actual connections to the coil are as follows: blue wire, ground; green wire, grid; red and black wires are connected together and go to cathode.

Much experimentation with the values in the output tuned circuit of the mixer portion of the 6K8 was necessary before a satisfactory distribution of the energy on the various harmonics was obtained. At first it was thought that it would be best to tune this coil to some frequency either in the high-frequency end of the broadcast band or to 160 or 80 meters. When this was done the harmonic output in the broadcast band and on 80 and 160 meters was very good but the signal strength of the harmonics decreased as the higher frequencies were reached until they were just audible on the 14-Mc. band.

The explanation to the situation seemed to be that the harmonic amplifier was receiving so little excitation (since the mixer portion of the 6K8 was multiplying frequency ten or twenty times) that it was unable to multiply frequency satisfactorily. The answer seemed to be to supply more excitation energy to the amplifier, regardless of its frequency.

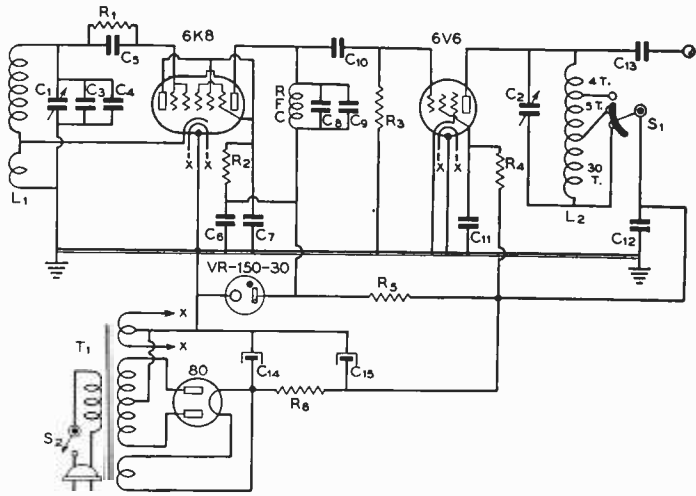
This was accomplished by tuning the output circuit of the 6K8 to 100 kilocycles. Thus the tetrode portion of the 6K8 was required only to double the oscillator frequency; hence, there was ample excitation voltage to the amplifier.

The output circuit of the 6K8 consists of a 2.1-mhy. conventional r.f. choke shunted by a .001- $\mu$ fd. and a .0001- $\mu$ fd. mica condenser,

Front view of the frequency spotter. The control to the left of the front panel is the trimmer on the 50-kilocycle oscillator. The right-hand control is the harmonic amplifier coil switch and the center control is the trimmer condenser across this coil. The output post of the unit is the stand-off insulator on the right edge of the chassis. The VR-150-30 and the 80 are to the rear; the 6K8 oscillator-doubler and the 6V6 harmonic amplifier are in front.



- C<sub>1</sub>, C<sub>2</sub>—100- $\mu$ fd. midget variable  
 C<sub>3</sub>—0.006- $\mu$ fd. silvered mica  
 C<sub>4</sub>—0.0002- $\mu$ fd. midget mica  
 C<sub>5</sub>—0.0005- $\mu$ fd. midget mica  
 C<sub>6</sub>, C<sub>7</sub>—0.1- $\mu$ fd. 400 volts  
 C<sub>8</sub>—0.001- $\mu$ fd. mica  
 C<sub>9</sub>—0.0001- $\mu$ fd. mica  
 C<sub>10</sub>—0.01- $\mu$ fd. mica  
 C<sub>11</sub>—0.1- $\mu$ fd. 400 volts  
 C<sub>12</sub>—0.1- $\mu$ fd. midget mica  
 C<sub>13</sub>—0.0005- $\mu$ fd. midget mica  
 C<sub>14</sub>, C<sub>15</sub>—8-8  $\mu$ fd. 450-volt elect.  
 R<sub>1</sub>—100,000 ohms, 1 watt  
 R<sub>2</sub>—25,000 ohms, 2 watts  
 R<sub>3</sub>—2 megohms, 1 watt  
 R<sub>4</sub>—50,000 ohms, 2 watts  
 R<sub>5</sub>—20,000 ohms, 10 watts  
 R<sub>6</sub>—10,000 ohms, 10 watts  
 S<sub>1</sub>—Shorting-type 1-pole 3-position switch



Wiring diagram of the frequency spotter.

- S<sub>2</sub>—S.p.s.t. a.c. line switch  
 L<sub>1</sub>—456-kc. b.f.o. coil with trimmer removed

- L<sub>2</sub>—39 turns no. 20 d.c.c. on 1"-dia. form tapped at 9 and 4 turns; last 4 turns spaced

- RFC—2.1-mh., 125-ma. r.f. choke  
 T<sub>1</sub>—650 v. c.t., 40 ma.; 6.3 v. 2 a.; 5 v. 2 a.

both connected in parallel. With this value of capacity (.0011  $\mu$ fd.), plus the circuit capacities, the r.f. choke is tuned to 100 kilocycles. Although this circuit tunes comparatively sharply, the tolerance in a number of 2.1-mhy. r.f. chokes tried was close enough so that resonance was very closely obtained when the .0011  $\mu$ fd. of capacity was connected across the choke.

To assist in stabilizing the standard with respect to variations in line voltage, a VR-150-30 voltage regulator was placed across the plate supply to all the elements of the 6K8. The dropping resistor, R<sub>2</sub>, lowers the 150 volts from the plate of the 6K8 to 50 or 60 volts which supplies the oscillator plate and the mixer screens. Incidentally, the normal control grid of the 6K8 (the one brought out to the top cap) is connected in parallel with the screen grid of this tube and with the oscillator plate. This raises the doubling transconductance of the tetrode portion of the 6K8.

The VR-150-30 holds the plate supply voltage to the 6K8 within a very small percentage variation of 150 volts with all normal line variations. Short-period line surges have no measurable effect on the output frequency of the oscillator. However, long-period variations, which will change the operating tem-

perature of the cathode of the 6K8, do affect the frequency to a small extent. Hence, if absolute frequency stability is desired, it will be best to operate the heaters of the standard from a storage battery. For all normal amateur applications, however, with the normal line-voltage variations encountered, the frequency stability will be more than satisfactory.

#### The Harmonic Amplifier

As in the oscillator, a number of different tubes and circuit combinations were tried in the harmonic amplifier. The final outcome of this experimentation is the simple circuit arrangement shown with a 6V6 operating as a tetrode amplifier with grid leak bias and a tapped-coil tuned output circuit. It is not absolutely necessary to use a 6V6 in this position as a 6F6, 42, or 6F6G will give essentially the same results. However, it was found necessary to use a power tube rather than a conventional r.f. amplifier tube in this stage to give ample signal strength on the higher harmonics.

The output circuit of this stage consists of a tapped coil which is resonated by a 100- $\mu$ fd. midget variable. With the whole coil in the circuit the output can be peaked at any frequency from about 7500 kc. down to about 3500 kc. Nevertheless, there is ample output

with this coil in the circuit down through the broadcast band. It is not necessary to resonate the output circuit at these low frequencies; there is more than ample output for all measurements and for calibration.

With the switch in the second position all but 9 turns of the inductance are shorted and the coil will resonate at any frequency from about 7000 down through 18,000 kc. This tap peaks in the middle of the dial for strong signals on the 14-Mc. band. With the switch on the last tap, with only four turns in the circuit, the circuit peaks up in the 28-Mc. band and for a considerable distance either side of it.

Coupling of the output circuit to the external load is accomplished by means of a .00005- $\mu$ fd. mica condenser which connects between the plate of the 6V6 and the output terminal. The decrease in the reactance of this condenser with increasing frequency tends to equalize the signal strength output of the unit over a wide range of frequency.

#### Power Supply

A simple resistance-capacity filtered power supply using an 80 rectifier is used for plate voltage to the unit. Ample filtering for the harmonic amplifier stage is attained through the use of the RC filter. The VR-150-30 voltage regulator with its associated resistors and condensers supplies very pure direct current to the 6K8 oscillator and first multiplier.

#### Tuning Up and Calibration

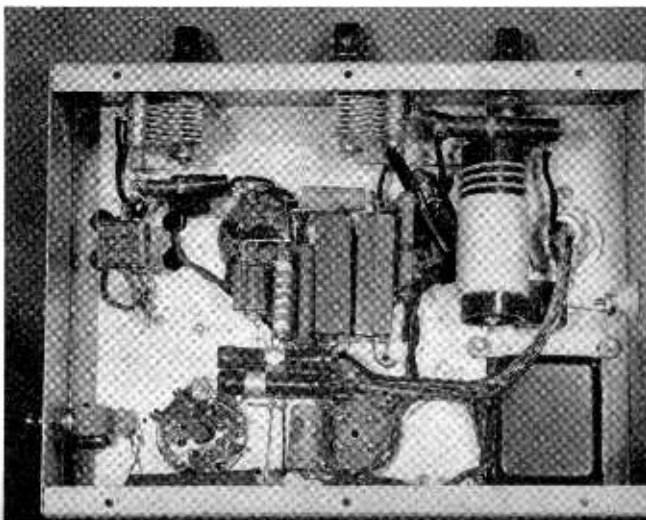
If the oscillator coil specified has been used and if the exact values of capacity shown have been placed across the coil, no difficulty should be experienced in tuning up the oscillator. After all, it is only necessary to get the oscillator going on the proper frequency of 50 kilocycles; when this is once done, all

other adjustments become very simple and the unit calibrated in itself.

For tuning up the frequency spotter the only additional piece of equipment required is a calibrated broadcast receiver and a few incoming broadcast signals on frequencies that are integral multiples of 50 kc. With the oscillator operating (with the output coil on the no. 1 tap—all the coil in the circuit) run a wire from the output terminal of the spotter to the antenna post on the b.c.l. set and connect a small external antenna to the receiver. With the trimmer condenser in the oscillator set to about mid-scale tune the b.c.l. set to the low-frequency end of the dial and pick up the first harmonic of the oscillator that can be tuned in. Mark down the frequency of this harmonic as determined from the calibration of the b.c.l. set. Then tune to the next harmonic (they will be plenty strong and easy to identify because of their lack of modulation) and mark down its frequency as again determined from the b.c.l. set. Keep doing this until 8 or 10 points are determined. Then subtract each frequency from the next higher one all the way down the line and average the resulting differences in frequency between the harmonics. If any one of the differences falls very far out of line recheck its frequency to see if an error has been made or to see if a harmonic has been missed.

If the average of all the differences in frequency falls very near to 50 kilocycles (say 48 to 52 kc.) the unit is ready for calibration. If not—if some other coil has been used or if one of the condensers was inaccurate—the values of padding condenser across the oscillator coil will have to be changed. If the differences in frequency of the harmonics (and this is the frequency of the oscillator) are too low, remove a small amount of the capacity and repeat the harmonic-checking process. If

Bottom view of the chassis showing placement of the few components. The tapped amplifier output coil is to the right and the r.f. choke with the two paralleled condensers across it comprising the plate circuit of the 6K8 is just to the left of the center of the chassis.



the oscillator frequency is too high—add capacity. In any case if the oscillator frequency is more than a kilocycle or so from 50 kc. it will be necessary to add or subtract capacity until the differences between harmonics fall very close to 50 kilocycles.

After the differences have been made about 50 kilocycles—and only after this has been done—it will be possible to set the oscillator accurately to 50 kc. If the exact values shown in the circuit diagram and the same makes of components are used, the oscillator will hit very close to 50 kc. with no further adjustment. When the oscillator has been adjusted very closely to 50 kc. by the difference-between-harmonics method, pick out a broadcast station that is operating on some multiple of 50 kc.; one in the vicinity of 550 to 1100 kc. will be best. Tune in this station, turn on the oscillator, and adjust the beat between the harmonic of the oscillator and the broadcast station to zero. Then find another b.c. station on a harmonic of 50 kc. and see if it also is at zero beat. If the second b.c. station is not at zero beat or within a few cycles of it, the oscillator definitely isn't on 50 kc. and the frequency will have to be rechecked by the procedure given in the preceding paragraphs, fixed condensers being added or subtracted depending on whether the frequency is high or low.

If the second station is at zero beat with the harmonic, check with a few more stations on multiples of 50 kc. just to make sure all is well. As mentioned before, if the values and components given are used it will only be necessary to adjust the trimmer condenser across the oscillator tank, which is brought out to the front panel, to hit 50 kc. and hence to arrive at this stage of the adjustment.

It will now only be necessary to set the trimmer condenser so that the harmonics in the broadcast band fall exactly at zero beat with the b.c. stations and the unit will thenceforward be calibrated. Of course all the stations on multiples of 50 kc. will not be at zero beat at the exact same time since they are allowed a tolerance of 50 cycles one way or the other from their assigned frequency. However, very few of the better stations deviate more than 10 cycles at most from their assignment. Actually, the majority of them will be within 3 to 5 cycles after the rig has been on the air for 6 hours or so.

By judicious listening and by carefully shifting the oscillator back and forth it will be possible to determine which stations are high and which are low—providing, of course, that four or five stations on multiples of 50 kc. are audible. Perhaps, by this method, it will be possible to find one station that is

between the limits of variation of the other audible ones. This station will, by all the laws of probability, be closer to its assigned frequency than the others. Then, since b.c. stations are usually on the *same* frequency day after day, whether it be a few cycles high or low—after the warm-up period, of course—it will be safe to set the oscillator so that its harmonic falls exactly to zero beat with this station for subsequent calibration. It will then be tuned to within a few tenths of a cycle of 50 kilocycles. This station can be relied upon as the checking station to calibrate the spotter when great accuracy is desired.

#### Amateur Band Harmonics

When the frequency of the oscillator portion of the 6K8 has been accurately set to 50 kilocycles the output of the unit may be coupled to the antenna input of the communications receiver or, if one receiver is used both for broadcast and communications reception, this receiver may be switched to the 160-, 80- or 40-meter band. The strength of signals will be strong on all bands but may be peaked up on the two higher frequency ones. Then, if checking signals are desired in the 14-Mc. band the switch may be placed in the center position and the tuning condenser on the 6V6 adjusted until the desired strength is attained. The same procedure is followed for 10-meter signals except that the coil switch is placed in the third position where only four turns remain in the circuit. In any case it will be found that changing the coil tap or the tuning condenser on the 6V6 stage will have no effect on the frequency of the 50-kc. oscillator.

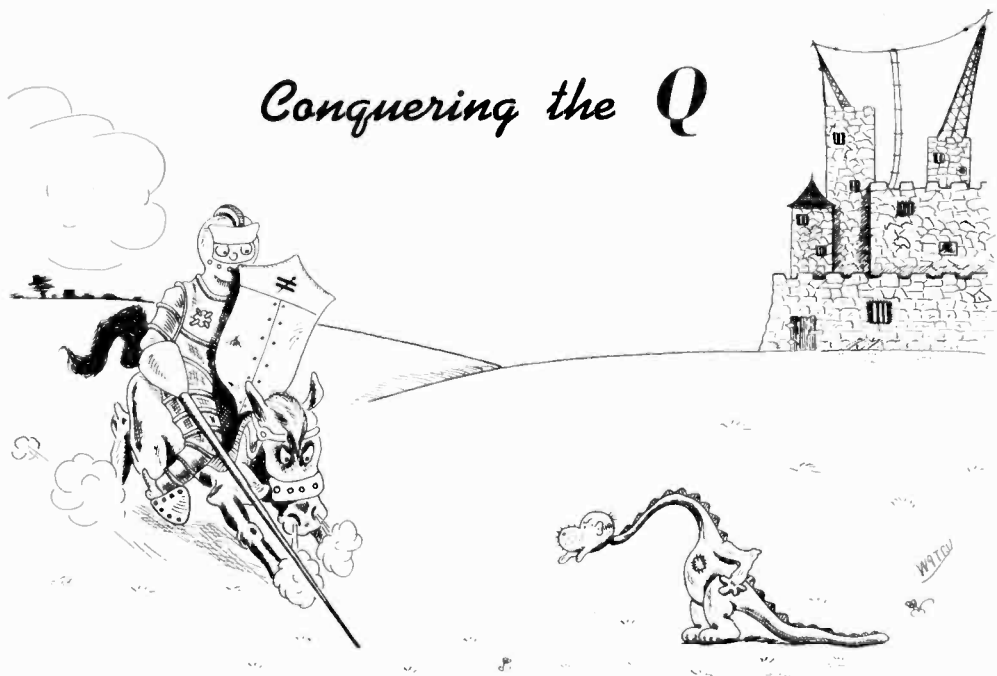
It will be found that strong, steady signals are available every 50 kilocycles throughout all the amateur bands from 160 through 10 meters. These signals can be used as band-edge markers for either the phone or c.w. bands. Or, if a receiver with substantially straight-line-frequency tuning and an accurate dial is in use, the frequency of any incoming or locally generated signal may be determined to a good degree of accuracy by interpolating between the 50-kilocycle points with the dial.

#### In or Out of the Band?

There is another advantage to having the trimmer condenser for the 50-kilocycle oscillator brought out to the front panel. Suppose you are listening to the 7000-kc. harmonic of the oscillator and there is a c.w. station beating against it at a low audio frequency. Since the incoming c.w. station is so close to the band edge it is impossible to tell by the dial

[Continued on Page 78]

# Conquering the Q



By H. BURGESS,\* W9TCU

The Q factor is like the weather. Everyone talks about it but few do anything about it. A few make use of it, some are vaguely aware of its existence and the others evade the issue by stating that with them, ham radio is just a hobby and there is no need to take it too seriously. The latter frequently change the subject by asking why their 40- $\mu$ fd. condenser isn't doing so well in the 160-meter tank or how they can reduce the harmonics from the final.

The Q factor, though very real, leads a rather indefinite life. Like the decibel you can neither weigh nor smell it. Like the decibel it is just a ratio. Q indicates the ratio of the reactance (either inductive or capacitive) of a tuned circuit to the total resistance of the circuit. To make this more simple it may be stated as:

$$Q = X/R.$$

Q can also be taken as the ratio of the impedance of a parallel resonant circuit to the reactance of either the inductance or the capacity. Or as:

$$Q = Z/X.$$

As the impedance and resistance are variable, this green-eyed monster of the tank circuits has the power to expand or contract almost at will. That is, with no mechanical change in the tuned circuit, it is possible to vary the Q over a comparatively wide range.

All tuned circuits contain capacity, inductance and resistance in various amounts. For each application there is a combination of these three that gives the best results. Figure 1A is the fundamental diagram of a tank circuit. The impedance presented to the plate-filament circuit of the tube is composed of C, L and R and can be expressed by the formula  $Z = X^2/R$ , where Z is the impedance, X the reactance of either the coil or condenser and R is the total resistance of the circuit including the load and the resistance of the coil and leads.

Figure 1B is the usual method of coupling a load to the output of a tube but for calculations the load may be considered as the resistance R in 1A. This is known as reflecting the resistance. The less coupling between  $L_1$  and  $L_2$ , the smaller R becomes until with no coupling, R is only the resistance of L and the leads plus radiation losses and losses in shielding in the vicinity

\* Elliott, Iowa.

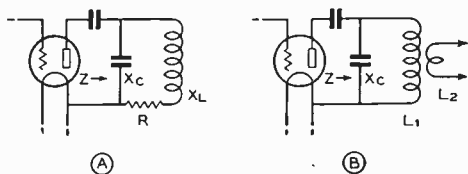


Figure 1. (A) Theoretical representation of an amplifier tube operating into a tank circuit into which there is coupled an external load, R. (B) Practical representation of the same circuit showing how the external load is coupled into the tank circuit by the coupling coil,  $L_2$ .

of the coil. As the coupling is increased, R becomes larger until a maximum is reached when  $L_1$  and  $L_2$  are tightly coupled.

It is now easy to see that if the Q of a circuit is the X to R ratio, it is definitely controlled by the amount of coupling to the antenna. Also if we see that  $Z = X^2/R$  and  $Q = X/R$  it is then apparent that  $Z = X \times Q$ . This means that the impedance offered to the tube is influenced by a change in Q, or a change of impedance will change the Q. This also brings out the fact that there is a definite relation between plate current, plate voltage, inductance, capacity, resistance and frequency. A variation in one will shift the appropriate value of all the others.

### How Much Q?

So far we have said little about the value that should be given the Q ratio and why it is important. In class-C amplifiers where the grid is working beyond the plate current cut-off, plate current flows only on part of the positive swing of the grid. Thus the tube delivers power only part of the time. For proper results the C in the tank circuit must be large enough so that it will store enough energy during the short pulses of power to carry over during the time that the tube is delivering no power and so to deliver a constant flow of power to the load. This is commonly known as the fly-wheel effect. The distorted wave form due to high grid bias also causes the output to be rich in harmonics. If a tank circuit is used which contains high C or high Q, the harmonic content will be reduced.

Authorities differ on the amount of Q that should be used in amateur transmitters and recommended values varying from ten to twenty-five. Broadcast stations use a factor nearer twenty-five. As new improvements have made power cheap and as it is embarrassing to make explanations to the FCC, a Q factor in the upper limits should be used

for phone and a lower value is permissible for c.w. A Q of 20 is not too high for phone use though some authorities state that a Q of 10 is not too low. A factor of 10 is satisfactory for c.w. Excessive C or Q is evidenced by a high minimum plate current even though not loaded and a low Q from low C is characterized by high harmonic content, high efficiency and the inability to load up properly.

From the foregoing it might seem a difficult task to design an amplifier and to determine the proper setting for which plate input, output, impedance, resistance, Q and L/C ratio were all at the optimum figure for the frequency and type of tube in use.

As a matter of fact it is not at all difficult and for amateur use the results are not at all exacting. Variations of 10% are not at all serious. As few amateurs are equipped to make coils of a specified inductance, all figures will be in terms of capacity. As the reactance of the coil and condenser are the same at resonance, this is quite satisfactory. We can determine the correct capacity and the coil can be made to resonate at the proper frequency by cut and try.

As plenty of actual coil and condenser sizes are given in the RADIO HANDBOOK, we will work just one example to show one of the possible methods of finding the proper values.

### Practical Example

For example, suppose we are planning to use an 801 as a final amplifier in a low-power plate-modulated phone transmitter with grid neutralization. Suppose we say on 1800 kc. According to manufacturers' typical ratings the conditions for phone operation are 500 plate volts and 55 plate milliamperes. Substituting in Ohms law ( $R = 500/.055$ ) we find that under these conditions the tube will have a d.c. resistance of 9090 ohms. For re-

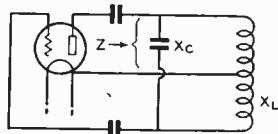
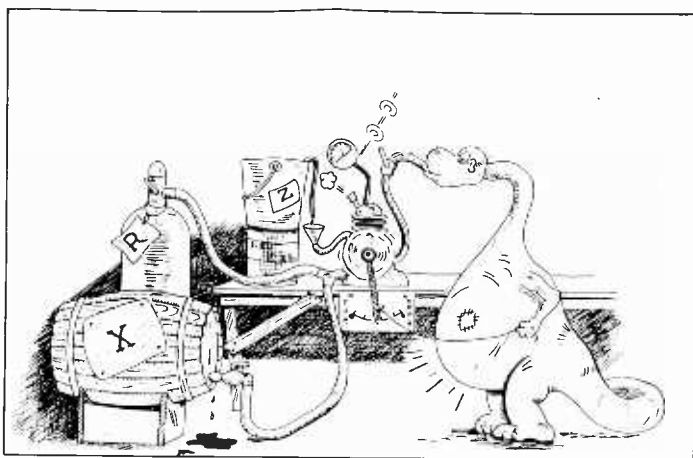


Figure 2. Graphical representation showing how, when a split plate tank is used, the output circuit of the tube is across only half the total number of turns in the circuit. Since this portion has only one fourth the circuit impedance, the total impedance of the tank must be four times as great as when an unsplit output tank is used.



" . . . this green-eyed monster has the power to expand almost at will."



sults accurate enough for our use we can assume the a.c. plate impedance to be one half of the d.c. resistance, or 4545 ohms.

In the earlier paragraphs we saw that  $X = Z/Q$  and that  $R = X/Q$ .

If we have set our  $Q$  at 20 all we have to do is substitute and we will have found all of our unknowns except one. We have found the following:

Plate voltage	500 volts
Plate current	55 ma.
Plate impedance	4545 ohms
Modulator load	9090 ohms
Capacitive reactance	227 ohms
Load resistance	11.3 ohms

Now by finding what capacity has a reactance of 227 ohms at 1800 kc. we can find the proper size of condenser to use. To find this, all we have to do is substitute 227 in the following formula:

$$C = \frac{1}{6.28 \times X \times F} = .0003897 = 390 \mu\text{fd.}$$

$X$  being the capacitive reactance,  
 $F$  being the frequency in megacycles,  
 $C$  will be in  $\mu\text{fds.}$

From all of the above formulas the following may be obtained and the amount of  $C$  found in one operation.

$$C = \frac{Q}{3.14 R F}$$

The  $C$  will be in  $\mu\text{fds.}$ ,  $R$  is the ratio of d.c. plate voltage to d.c. plate current (500/.055) and  $F$  is the frequency in megacycles. While the results are not absolute, they are close enough for amateur use.

From the foregoing we can easily see that the  $Q$  factor is very important in transmitter design. Examination of the formulas will show the mistake in the belief held by some that all high- $C$  circuits are high  $Q$  and that all low- $C$  circuits are low  $Q$ . A low-voltage high-current circuit with fairly high  $C$  can be quite low  $Q$  if loaded heavily. On the other hand a circuit with high voltage and low current can be high  $Q$  even with relatively low  $C$ . This is true only if the tube is not loaded too heavily. So if your tank condenser is a little too small to give the desired  $Q$  for a certain frequency, by reducing the coupling to the load the  $Q$  will go up. Although the useful output is lowered the loss is many times more than offset by the advantages of the raised  $Q$ . This is one of the reasons why reduced antenna coupling will result in a reduction of harmonics.

#### Q Determination for Split Tank Circuits

The size condenser determined by the formulas just given is suitable only for stages with unsplit tanks. When using a tank with either split inductance or capacity (figure 2) the plate-to-filament circuit of the tube is across only half of the tank circuit. As the impedance of a coil is proportional to the square of the turns and as the tube is across only half of the coil, the impedance presented to the tube is only one fourth of the tank impedance. To load the tube properly then, the total impedance must be increased four times. This is done by doubling the number of turns on the coil. With the inductance increased four times, the capacity must be reduced to one fourth of the original value to maintain resonance at the desired

[Continued on Page 78]

# You're in the Movies Now!

By EUGENE KEARNEY, W6PCV

and

GEORGE A. JOHNSON

I suppose there isn't a ham living who has seen Hollywood's version of amateur radio who hasn't felt that his hobby was being crucified. I know I have.

I recently made a tour around the states and dropped in on many of the fellows with whom I had been in QSO but never met. Because I was from Hollywood they all asked the same question: "Why in the name of common sense don't they show amateur radio as it is . . . an adult hobby . . . instead of this kid stuff? Doesn't anyone out there *know* what a rig looks like and how a ham talks? If they don't, why don't they find out?"

Well, I'm an actor; at least I'm a member of the Screen Actor's Guild, and I do get on the sets once in a while. I've seen doctors, nurses, aviators and plumbers acting as technical advisors, but I've never seen a ham called in to give them advice on amateur radio. So to these questions I'd just shrug my shoulders and say, "What can I do about it?"

I'd been back for some months when one day I got a call from Central Casting to report to the "Grand Jury Secrets" set at Paramount studios.

As I waited for the director to call, "Places everybody!" my eye picked out and clung to a plate on the front of a car. It read W6YSO. Of course I was interested at once. But those call letters didn't seem to click. You don't have to be told that it indicated a school or institution in the sixth district. In the back, there was a large transmitter—strictly a dummy, of course, and the instrument panel was fitted nicely with a mike.

Well, here was my chance at last. It was the answer to my question—what can I do about it? Strolling ever so casually over to the assistant director, I made some comment about the plate, and then asked if he knew that the letter Y was issued in the sixth district to schools only. He didn't, but was anxious to rectify the error.

"Wait here," he said. He went off and returned quickly with James Hogan, the director. Hogan came to the point quickly.

"I don't know a thing about this radio business," he smiled. "I want you to help us." That was all I wanted to hear. At last I could do something about it.

I asked for the script and saw something that gave me hot and cold chills. The writers had established a W8 rig in Montana and a W6 rig in New York, and many other technical discrepancies were evident.

Hogan was eager to cooperate. "What can we do?" he asked. I thought a minute and then recalled that when I was with a CCC camp in Michigan for three years I had been assigned W8GHA. It had not been reassigned. The locale called for a ranger's station, and this would fit in perfectly as there were a lot of them in the district.

It was too late to get a release from an actual New York rig (you can't hold up production when the overhead runs into hundreds of dollars a minute) so I suggested that they use my call letters, W6PCV, and not mention the location. This was agreed to. The W6YSO plate was also changed to W6PCV.

Right here I'd like to say that you will notice some inconsistencies. For instance, in the ranger's cabin you'll see what is apparently a kilowatt transmitter. A beautiful rig, of course, but out of all proportion to actual need. There were some smaller rigs too, but nary a receiver in sight. The prop men obligingly put one in when I called the matter to their attention. Originally, this cabin had oil lamps hanging from the ceiling, indicating a lack of electricity. I knew no ham would be able to understand how a kilowatt transmitter operated by battery. I know I couldn't. So I suggested they replace the oil lamps with electric lights, indicating a power line.

If you don't like the layouts of some of the rigs, don't blame me. They were made up in the property department before the picture went into production, to lend dramatic value to the scenes. At least it is conceivable that they could do the work they were supposed to perform, so I skipped that part.

A lot of you will recognize your QSL cards. Some of them are shown in the accompanying pictures. Originally, all of the sets were "dressed" with plain white cards lettered with an assorted alphabet. There were hundreds of them. I could just hear the hooting if they were shown on the screen. When I mentioned this to Hogan, he threw up his hands.

"How can we make real ones?" he asked. "It will hold up production too long." But

George Kearney, W6PCV, director James Hogan, and pretty Gail Patrick, star of the Paramount picture "Grand Jury Secrets." Amateur radio plays an important part in the plot of the story, and for once amateurs will be able to swallow the amateur radio sequences without need for more than a few grains of salt. At least one studio has become aware of the fact that "ham" radio operators are not in the same category as "ham" actors. The transmitter is just a "prop"; so don't examine it with too critical an eye.



when I mentioned I had several hundred from you hams all over the world and that he could use them, he calmed down. And that is why you might see your card in the picture.

I haven't attempted to tell you the story of "Grand Jury Secrets." It might spoil the picture for you, and anyway this isn't a movie magazine. But I'll have to mention that John Howard plays a reporter who is nuts about radio. He has a mobile transmitter in his car. His mother, like many another mother, is very much interested in her son's hobby. She keeps a receiver, tuned to John's rig, on all day long. And when John is ready to come home he says, "Hello, Ma, I'm coming right home. Put the chow on the table." At least that is what he was going to say if he followed the script. But of course the FCC wouldn't like that at all. So at my suggestion, they fixed the dialogue up and had him say the call letters, etc.

One scene was written so that the mother,

explaining to Gail Patrick what CQ means, tells her that it stands for "Everybody listen." Ho-hum. Well, they corrected that too, and were even kind enough to put a couple of y.l.'s into the conversation just to keep you interested.

You'll probably notice that most of the radio scenes are worked "break-in." This was necessary to keep the picture moving, as the repetition of the call letters would have been too monotonous. We hope the local R.I. will understand that *we* don't work that way.

Another scene for the ranger's cabin, towards the climax of the picture, had the ranger nonchalantly turning on his ten-meter receiver at night and getting perfect reception. The things they do in scripts! However, once in a long while it is possible, and as it was necessary for the story, I didn't object too much. You'll notice, however, that he does remark to his pet deer that it is "certainly unusual." It certainly is!



This is the ranger's cabin. Note the kilowatt transmitter. The bottle of milk is for a young deer. So the c.w. amateurs wouldn't think the ranger a "sissy," a bug key was included on the operating table.

A piece of business you will have to bear with me on is the portable high-frequency set the reporter "plants" in the jury room. You will just have to imagine that there are small batteries strong enough to give off a signal for twelve hours.

At one point of the picture they were going to have the ranger call for help by saying, "CQ . . . CQ," but you are saved a few bad minutes and instead he calls, "QRR, m'aidez, QRR, m'aidez," as it should be.

I'm going to take all of the responsibility and the credit, too, for the dramatic jury room scene where Bill Frawley rushes in with the receiver. He has brought it there so they can hear at first hand the "heavy's" conversation as he tells the reporter in the car with the mobile transmitter that he is going to kill him.

Of course, it couldn't work without an aerial but they hadn't thought of that. They hadn't remembered to bring a speaker along either, until I suggested the mother carry it. But to get back to the aerial problem—the

correct thing, of course, would be to string a wire up in the room. But it wouldn't have had much story value. They needed something dramatic. At my suggestion, one of the jury-men admits to being a bit of a ham and takes hold of the aerial binding post, at the same time grasping the hand of another jurymen. Instantly, the signals grow stronger, and as each member of the jury joins hands the hero and the villain in the car can be heard more clearly.

With the exception of the scene showing W6JYP, the semi-miraculous sequence where the ten-meter skip is still on at night, all of the sets were props. W6JYP is the real call of Bob Kelsey, who has a mobile rig in his car, and the equipment was my own. We were actually on the air the night this scene was shot and we talked to a few of the brothers around Hollywood.

Whatever fault you may find with the technical accuracies of "Grand Jury Secrets,"

[Continued on Page 89]

# Increasing Your Copying Speed

By DONALD G. REED,\* W6LCL

During the past twenty-five years it has been the pleasure of the writer to teach the Continental Morse Code to many prospective operators, and I believe that the information that has been accumulated on the subject might be of some practical value to most of the younger generation of hams.

It may come as a shock to those who know me on the air to hear that I even know the code, as for all practical purposes I deserted the key just after the World War. However, those same dots and dashes which are so hard to get well acquainted with are just as hard or harder to forget, once you have them thoroughly hammered into your system.

There have been a number of good practical methods advanced for the *ground work* of learning the code, and among the most interesting is the one called "Swing It," published in the January issue of RADIO. For beginners, this one should prove a great help (it was called "Jazz It" in '17), though those memorizing tricks may act as brakes later in the game. There is no questioning the fact that this method will be of assistance as long as it is *not carried too far*.

Once the individual characters are memorized, it will be found more advisable to lay the "memory crutches" aside and get down to the business of placing these dit dit dah dit's where they belong. They should be buried deeply in the subconscious mind, and covered with a clear picture of what they represent.

Old Mother Nature did a swell job in the interstage coupling of our brain, eyes and ears. We, as good operators, ought to learn to get the most from our equipment, whether it is in a rack and panel arrangement or in a human chassis.

It is easy to understand that an experienced operator could not possibly keep track of the individual dots and dashes comprising a letter character. What actually happens is that each set of long and short buzzes comes to mean the letter they represent. We can speed up this period of learning by impressing on the brain a *visual* picture of the letter at the same time it is coming through the phones and into

the ears. In this way a double impression is made on the memory cells of the brain, and because it is double, it will stick much easier than the single ear-born message. The sound will later suggest the mental picture of the letter, which is just what we want.

To accomplish this sound-picture condition is the simplest of tricks. All that is required is the usual key-buzzer-headset outfit we are so familiar with, plus an extra operator. This last item should be of good quality, guaranteed to pay proper attention to spacing, and capable of good speed regulation. A tape machine would be fine, if you could teach it to read, which I have never been able to do.

Suppose we call the fellow at the key the teacher, and the other member of the crew the student. All set?

Assume the usual positions, but for the moment lay aside the paper and pencil. Instead, the student will read from a duplicate newspaper the *same text the operator is sending*. It is better to have duplicate copy than to read over the teacher's shoulder, though the latter is permissible if neither has been eating fresh onions.

The teacher is to start sending at a rate just slower than the student's top speed, judged by his last test. This will allow the student to follow accurately each letter as it is transmitted. After a warming-up period of about one minute the sending speed is to be increased gradually but steadily and continued for about five minutes. An equal rest period is beneficial before the second session. Speed for the second period should be started at half way between the original starting speed and the speed used at the end of the first period. Follow the same procedure for the second and third practice periods.

At the end of the third *reading* practice period, start copying immediately, using the *same text as before*, at a speed just above the student's previous copying ability. It will be found that one session of the *reading* practice will for the time being increase the student's *copying* ability from ten to twenty per cent. The teacher should watch the student and not increase the sending speed very much above

[Continued on Page 80]

\* 2454 Lyric Ave., Los Angeles, Calif.

# FIVE-BAND

## *Coil-Switching Exciter*

By FRANK C. JONES, \* W6AJF

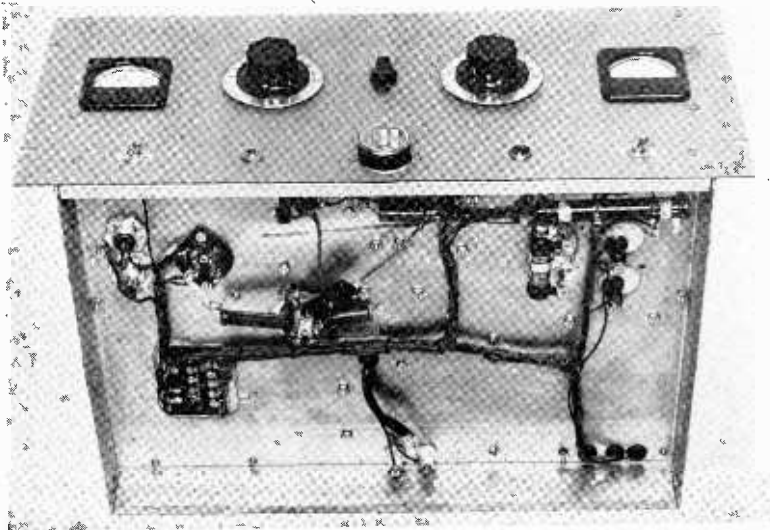
A very simple bandswitching exciter can be built around a couple of tubes without much expense or trouble in construction. Nearly all bandswitching exciters previously described have been costly affairs and as complicated to build as a modern receiver. The more simple varieties have been generally limited to three or four amateur bands. However, all five bands from 160 to 10 meters can be covered easily without using more than a four-pole three-gang rotary switch for changing all circuits in each band. Only two tuned circuits are necessary and to simplify the circuit further, the crystal socket was mounted on the front panel for quick crystal changes. 160-meter crystals may be used for 160- or 80-meter output, 80-meter crystals for 80-, 40- or 20-meter output, and 40-meter crystals for 40-, 20- or 10-meter output. If desired, a

20-meter crystal can be used for 20- and 10-meter output.

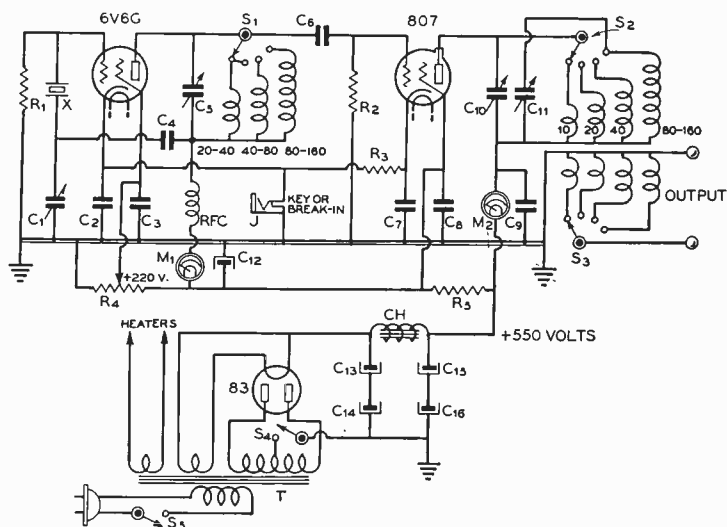
With a built-in 550-volt power supply, the exciter output varied from 24 watts on 10 meters up to 35 watts on 20 meters, 36 watts on 40 meters, 27 watts on 80 meters and 26 watts on 160 meters with the particular coupling links used in this case. An Ohmite dummy antenna and a thermomilliammeter were used to measure r.f. output. The 807 as a buffer usually gave from 7 to 10 watts more output at a given plate current than when used as a doubler. In any case, the 807 plate current was never over 90 ma.

Five-band operation was obtained by means of a split-stator condenser in the 807 plate circuit with one section connected to the coil switch and the other permanently across the 80-160-meter output coil. This gave moderately high C for 160-meter operation, though for greater output (over 25 watts) the total

\* Associate Editor, RADIO.



Bottom view of the exciter showing the relative simplicity of the under-chassis wiring. All power supply and filament leads are laced together in the cable running across the center of the chassis.



General Wiring diagram of the five-band exciter.

- |  |   |   |  |
|--|---|---|--|
| C <sub>1</sub> —560- $\mu$ fd. mica trimmer                      | C <sub>0</sub> —.006- $\mu$ fd. 1000-volt mica  | R <sub>1</sub> , R <sub>2</sub> —100,000 ohms, 1 watt                       | S <sub>1</sub> , S <sub>2</sub> —S.p.s.t. toggle switch                    |
| C <sub>2</sub> , C <sub>3</sub> —.01- $\mu$ fd. 400-volt tubular | C <sub>10</sub> , C <sub>11</sub> —70- $\mu$ fd. per section split stator, 070" spacing                   | R <sub>3</sub> —300 ohms, 10 watts  | M <sub>1</sub> —0-100 ma.  |
| C <sub>4</sub> —.002- $\mu$ fd. mica                             | C <sub>12</sub> —8- $\mu$ fd. 550-volt electrolytic   | R <sub>4</sub> —12,000 ohms, 25 watts                                       | M <sub>2</sub> —0-200 ma.  |
| C <sub>5</sub> —150- $\mu$ fd. micaidget                         | C <sub>13</sub> , C <sub>14</sub> , C <sub>15</sub> , C <sub>16</sub> —8- $\mu$ fd. 450-volt electrolytic | R <sub>5</sub> —5000 ohms, 50 watts   | J—Closed circuit jack<br>T—1000 v. c.t., 250 ma.; 5 v., 3 a., 6.3 v., 2 a. |
| C <sub>6</sub> —25- $\mu$ fd. mica                               |   | S <sub>1</sub> , S <sub>2</sub> , S <sub>3</sub> —Three-section band switch | CH—20 hy. 250 ma.  |
| C <sub>7</sub> , C <sub>8</sub> —.01- $\mu$ fd. 400-volt tubular |   |   | RFC—2.5 mh.  |

tank capacity should be considerably greater. Even at an output of 25 watts on 160 meters this maximum output did not occur at exactly greatest dip in d.c. plate current. For higher frequencies, the greatest output occurred at the usual dip in plate current of the 807.

The 807 did not require a parasitic suppressor in either the control grid or screen grid lead in the exciter illustrated in the photographs. The only trouble encountered was absorption by the 40-meter coil when operating on 10 meters. This was overcome by pulling turns off from the 40-meter coil until no "lead-pencil" arc could be drawn from the 40-meter switch contact. This condition can be secured with still enough 40-meter coil turns to resonate for 40-meter band operation with the 70- $\mu$ fd. condenser nearly fully enmeshed.

### The Crystal Oscillator

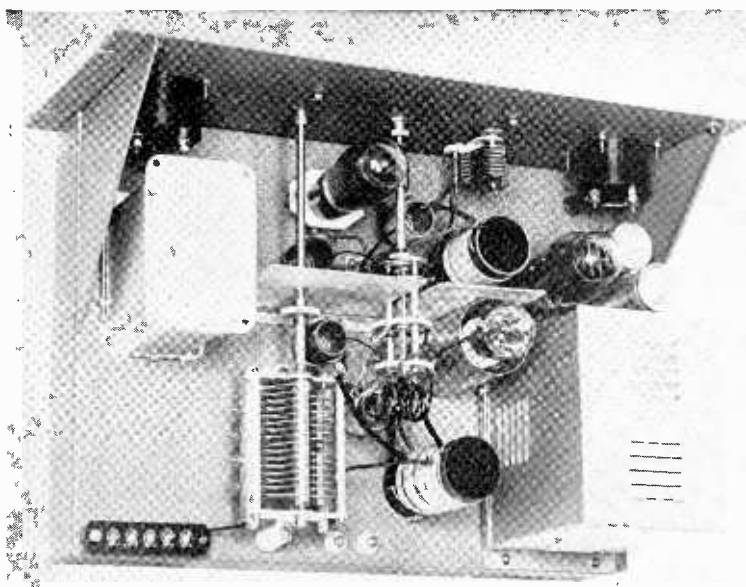
This is the "sure-fire" crystal oscillator circuit shown by the writer in RADIO several months ago. It operates with very low crystal r.f. current for high output and as long as the regeneration control condenser has large enough capacity, no spurious oscillations take

place. When used with plug-in coils and fairly heavy plate load, the regeneration condenser setting is not critical with ordinarily active crystals. However, in this exciter more care must be taken in the preliminary adjustment since both ends of the plate coils are not switched for operation on different bands.

A type 6V6G beam power tube serves as a crystal oscillator on either the fundamental or second harmonic of 160-, 80- or 40-meter crystals. The regenerative second harmonic feature requires rather careful preliminary adjustment of the grid and plate common return by-pass condenser. An adjustable mica condenser having a maximum of 560  $\mu$ fd. serves as the regeneration control. When set to approximately 500  $\mu$ fd. the oscillator will give good output from any active crystal on the fundamental or second harmonic.

### The 807 Doubler-Amplifier

The 807 does not require much grid drive even as a doubler so there is very little load on the oscillator. A 6.3-volt 150-ma. or 2-volt 60-ma. pilot lamp and loop of wire can be coupled to the oscillator coils for checking



From the top the coil switching assembly is plainly visible. The coils are grouped around the bandswitch, the higher frequency coils being placed closest to the switch terminals.

against oscillation at other than the second harmonic or fundamental of each crystal under test. If the lamp glows with uniform brilliance over all or nearly all of the oscillator tuning condenser range, it indicates too small a return condenser capacity. This regeneration control condenser is common to the plate circuit and crystal grid circuit return to ground or cathode. A readjustment of this

condenser should be made until the output from the oscillator peaks at one spot.

The oscillator plate tuning condenser should have a maximum of at least  $140\text{-}\mu\mu\text{fd.}$  in order to allow each coil to cover two bands. The coil turns are such that the lower frequency resonance or oscillation occurs with the plate condenser in at full capacity and the second harmonic resonant point of this frequency occurs near the minimum capacity setting. The 807 grid is coupled to this tank circuit through a pair of small  $50\text{-}\mu\mu\text{fd.}$  mica condensers in series to give a  $25\text{-}\mu\mu\text{fd.}$  condenser. A 300-ohm 10-watt resistor in the 807 cathode return provides enough self-bias to prevent damage to the 807 when the 6V6G is not oscillating properly.

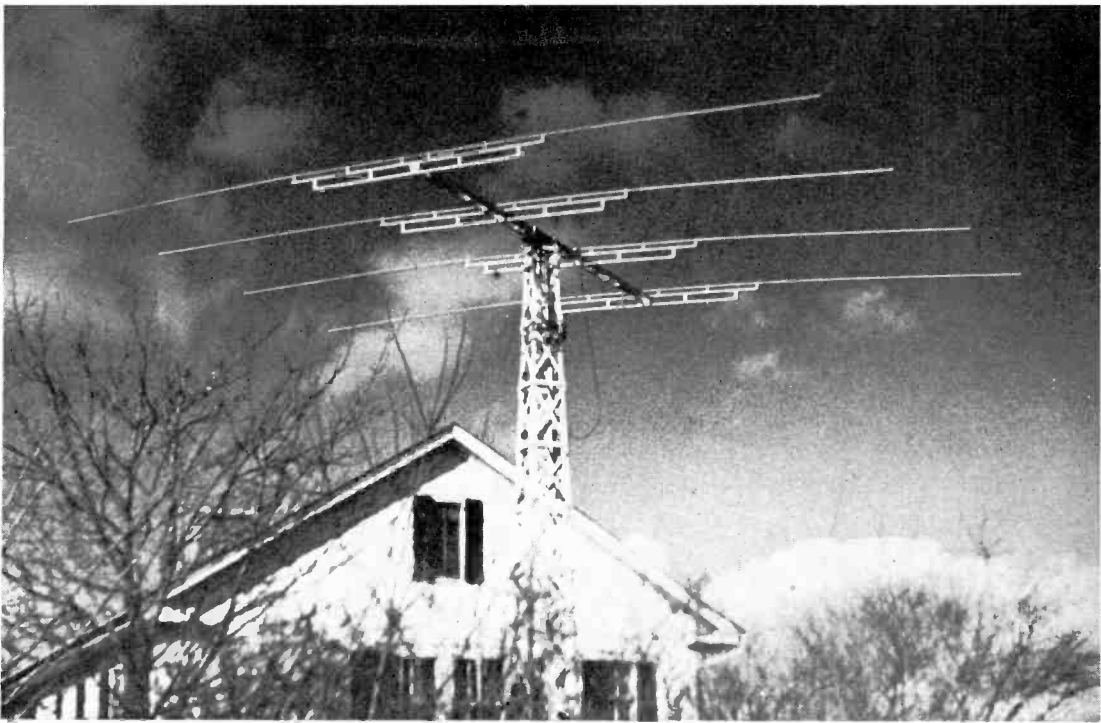
#### Power Supply

A single 1000-volt c.t. transformer furnishes power for the exciter which draws about 150 ma. under full load. The usual 250 ma. rating with choke-input filter will safely furnish 150 ma. with condenser-input filter as used in this arrangement. A single-section filter will provide sufficient filter for the 807 and the additional RC filter in the 6V6G circuit provides very pure d.c. plate supply to that tube. The 275 to 300 volts on the screen

[Continued on Page 79]

COIL TABLE		
Band	6V6G	807
10	20-meter coil used.	7 turns no. 12 enam., 1" long, $\frac{3}{4}$ " dia., 2 turn link over lower end.
20	12 turns no. 18 d.c.c., 1" long, 1" dia.	12 turns no. 16 enam., 1" long, $\frac{3}{4}$ " dia., 2 turn link over lower end.
40	20½ turns no. 22 d.c.c., 1" long, 1" dia.	18 turns no. 22 d.c.c., 1" long, 1" dia., 3 turn link over lower end.
80 and 160	35 turns no. 22 d.c.c., 1½" long, 1¾" dia.	39 turns no. 22 d.c.c., 2" long, 1¾" dia., 7 turn link $\frac{1}{8}$ " spaced from it.





# The 4-ELEMENT Rotary

By REX BASSETT\*

Much has been written this last year concerning the performance of the closely spaced multiple dipole array. It is the purpose of this article to assist the amateur who is trying to decide what type of rotary beam to install by attempting to clarify certain phases of the essential adjusting procedure, as well as by pointing out what forward gain and front-to-back ratios can be obtained from the various types of arrays when they are properly adjusted.

The following figures have been ascertained from extensive measurements made in the field. These figures show the forward gain obtained over a horizontal half-wave antenna, and the front-to-back ratios of the following type arrays:

Type	Gain	Front to Back
2 element	4 db	10 db
3 element	10 db	30 db
4 element	13 db	35 db

The above figures indicate that the respective arrays are capable of forward gains over a horizontal half-wave antenna equivalent to raising power by the number of times shown below. The figures also show that the arrays are capable of supplying front-to-back power ratios representing the ratio of radiation off the front to the radiation off the back, as follows:

Type	Multiply Power	Front-to-Back Power Ratio
2 element	2½ times	10 to 1
3 element	10 times	1000 to 1
4 element	20 times	3100 to 1

From the foregoing, it is quite apparent that the 4-element array surpasses in performance even the 3 element, which of late has attained considerable prominence. This is probably not a surprising statement inasmuch as it has been common knowledge for a number of years that up to a certain limit, the more dipoles in the array, the merrier. It can also be seen from the foregoing that any of the arrays would be considerably better than a

\* Chamberlin Bassett Research Corp., 211 Service Court, So. Bend, Ind.

simple dipole, either from a "getting out" standpoint or from the reduction of heavy interference to or from other stations.

### Mechanical Design

Mechanically, it perhaps is not possible to build a simple and economical array of greater than 4 elements without resorting to stacking them, one group above the other. It is however, a comparatively simple job to design and build a supporting structure capable of adequately holding the 4-element array in even the highest wind. A structure of this type is shown in the photograph, and consists of a 21-foot boom constructed along the general lines of the one previously described by W9HLF.<sup>1</sup> This boom is fabricated of four pieces of spruce, each 10½ feet long, which join at the center of the boom and are securely bolted to a 36-inch 4 x 4. Longitudinal bracing is accomplished by means of a number of 4" x 1½" blocks which separate the long members and are securely screwed in place.

The cross members, which are spaced every seven feet along the boom, are made of spruce and are 11 feet long by 1¼ inch thick, and are braced by a second member running parallel to the cross member and spaced 3 inches below. The elements are of special manganese aluminum alloy; are very light and rigid, and are subject to an absolute minimum of corrosion. These are supported on stand-off insulators as shown in the photograph.

### Electrical Design

The elements used in this particular array are one inch outside diameter and, for this diameter, the correct lengths for 14,200-kilocycle operation are as follows:

Radiator	.....34'
Radiator	.....34' 8"
1st director	.....32' 3"
2nd director	.....32' 3"

This array is center fed. In the above figures, the 34-foot radiator length means that each half of the antenna is exactly 17 feet long, and a space of approximately 2 inches is left open at the center between the two halves.

It has been determined that the radiation resistance, or impedance, of the close-spaced array drops considerably as the number of dipoles used is increased. Following is a list of types, showing their respective radiation resistances which represent the impedances at

the center of the radiators in each of these arrays. It is of course essential that this impedance be accurately matched with some suitable transmission line or transformation system capable of reducing a high-impedance transmission line to the correct value.

Type	Radiation Resistance
2 element	14 ohms
3 element	8 ohms
4 element	5 ohms

With any of the above arrays it is possible to raise the impedance somewhat by proper adjustment with no appreciable sacrifice in forward gain, if this is deemed desirable. However, if fairly large diameter elements are employed, and the loss resistance is held at a value so low that it does not too closely approach the radiation resistance, it is usually more desirable to adjust the array for maximum forward gain.\* When this condition is reached, the impedance will be close to the above values.

### Adjusting the Array

Any type of multiple dipole array *must* be adjusted if maximum performance is desired. This point cannot be stressed too highly. Contrary to general belief, adjusting is a very simple operation, and although it is perhaps better to adjust the array after installation in its permanent location and at the height above ground at which it will be used, if the proper procedure is followed, this operation can be performed while the assembly is resting atop a stepladder in the backyard. It will be discovered that it is seldom necessary to alter this adjustment after raising the array into place.

The array should be set up at shoulder height or so above the ground, and a horizontal half-wave antenna of bell wire, or any suitable material, should be strung at a convenient distance from the array. This antenna need not be any exact distance from the array, as long as the distance is not less than forty or fifty feet. Particularly good insulation is not required on this antenna, but it is imperative that it be tight and as rigid as possible. It must also be in the same plane as the array, and should be at about the same height above the ground.

In the center of this antenna, install a radio-frequency thermogalvanometer, and connect one half of the antenna to one side of the meter and the other half to the other side.

[Continued on Page 80]

<sup>1</sup> Moore, "Supporting the Rotary Beam," RADIO, March, 1939, p. 11.

\* This does not strictly apply to a two-element array, as the front-to-back ratio will not be particularly good under these conditions. It does apply, however, to three- and four-element affairs.

# TRANSMISSION LINES

## *As Circuit Elements*

### PART II—CONCENTRIC LINES

By E. H. CONKLIN,\* W9BNX

In any place where an inductance or capacity is required at ultra-high frequencies, transmission lines are better than common coils and condensers. Furthermore, a concentric line will give superior performance over parallel wires as to  $Q$  and  $Z_s$ , and will not produce a substantial amount of undesired radiation. Parallel wires may, of course, be enclosed in a metal pipe for shielding, but this does not appear to reduce the losses.<sup>6</sup> While concentric lines have been adapted to push-pull transmitting circuits,<sup>7</sup> they are most easily applied to single-ended circuits, and perform outstandingly in receivers where interstage coupling must be low.<sup>2, 3</sup>

If there is no radiation from a concentric line, the best ratio of outer conductor inner radius  $b$  to inner conductor outer radius  $a$  for maximum  $Q$  is 3.6, and for maximum impedance is 9.2. There has been some controversy as to whether there is radiation from a concentric line, and certainly it is a small amount if any is present. Professor Reukema, in his discussion of the problem,<sup>4</sup> makes this statement:

Consider a concentric line shorted at both ends and of such length as to be resonant, the length being assumed to extend from a circle halfway between inner and outer conductors on one shorting disc to the corresponding circle on the other shorting disc. Consider a source of high-frequency voltage to be impressed between inner and outer conductors of such frequency as to make the distance between inner and outer conductors an appreciable fraction of a quarter wavelength. The field radiated from the inner conductor induces a voltage on the inner surface of the outer tube, causing a current

to flow there lagging exactly 180 degrees behind the field which produced it and of such magnitude as to reflect completely the wave back into the inner space. But since the current induced in the outer tube by the field from the inner conductor lags 180 degrees behind the field, it lags *more* than 180 degrees behind the current in the inner conductor, since it requires a finite time for the field to travel from inner conductor to outer tube.

However, the outer tube is acting as the return conductor for the inner tube and, therefore, must carry a current *exactly* equal and opposite that carried by the inner tube, if there is to be no voltage set up between the ends of the concentric line. Since the current which flows on the inner surface of the outer tube, due to the field radiated from the inner conductor, is *not exactly equal and opposite* the current on the inner conductor, a slight voltage is set up across the ends of the concentric line, which causes a current to flow on the outer surface of the outer tube, equal to the vector difference between the currents already considered. Of course both radiated and inductive components of the field due to the current on the inner conductor must be considered, in computing the current which flows on the outer surface of the outer tube.

When the spacing between inner and outer tubes is very small compared to a quarter wavelength as is the general case except at the ultrashort wave lengths, this outer current is practically infinitesimal. Even at the ultrashort waves, the outer current is so small compared to the current which flows on the inner surface of the tube, that the energy radiated is of the order of 0.01 of 1.0 per cent of that which would be radiated if all the currents were on the outside. However, *small as it is, the energy*

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<sup>2</sup> "High Frequency Receivers—Improving Their Performance," Reber and Conklin, RADIO, January, 1938, p. 112.

<sup>3</sup> "An Improved U.H.F. Receiver," Reber and Conklin, RADIO, January, 1939, p. 17.

<sup>4</sup> "Transmission Lines at Very High Radio Frequencies," Lester E. Reukema, *Electrical Engineering*, August, 1937, p. 1002. See also discussion in February, 1938, issue.

<sup>6</sup> "A Survey of U.H.F. Measurements," L. S. Nergaard, *RCA Review*, October, 1938, p. 165.

<sup>7</sup> Hansell and Carter, *Proc. I.R.E.*, April, 1936, p. 599.

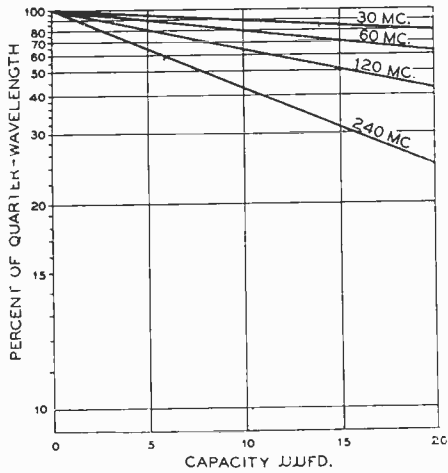


Figure 5.

Capacity required to resonate lines less than 1/4 wavelength long, for a line of 86.4 ohms surge impedance (4.22  $b/a$  ratio).

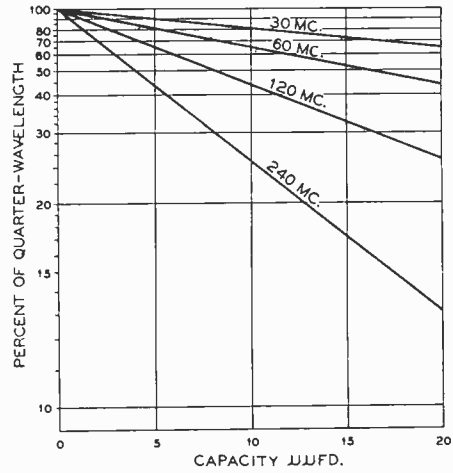


Figure 6.

Capacity required to resonate lines less than 1/4 wavelength long, for line of 159.6 ohms surge impedance (14.3  $b/a$  ratio).

radiated is by no means negligible, compared with the other (small) losses in the concentric line.

If we assume the accuracy of this contention, the optimum ratio of outer conductor inner radius to inner conductor outer radius  $b/a$  becomes 4.22 for highest  $Q$  and 14.3 for best  $Z_s$ . These figures are not substantially higher than 3.6 and 9.2 for the case of no radiation but the analysis results in there being an optimum size for best  $Q$  and  $Z_s$ . It is interesting to note that for highest impedance, such as would be desired for inter-stage coupling devices, the ratio in either event should be greater than 9, rather than 3.6, and the inner conductor size becomes relatively small.

The optimum outer conductor inner radius,  $b$ , for a line designed for best  $Q$  is  $0.0634\lambda^{0.9}$  where  $b$  and  $\lambda$  are in centimeters, and  $0.025\lambda^{0.9}$  with  $b$  expressed in inches. The best  $Q$  is then  $725\lambda^{0.4}$ . For frequency control or selectiv-

ity at amateur frequencies the design data of Table IV should be followed.

It is seen that optimum dimensions are larger than for parallel-wire lines. In most cases, practical lines will have smaller radii for economy. The values of  $Q$  obtainable are, however, much greater than for parallel wire lines.

The deviation of  $Q$  from the maximum, due to changing the conductor radius, is very similar to figures 1 and 2 for parallel-wire lines but, of course, the peak of the curve is much higher. It is seen that if both conductors are reduced and the 4.22 ratio maintained, the  $Q$  drops proportionately from the maxima given in Table IV.

By using a half wavelength concentric line shorted at both ends and fed at any intermediate point, it is possible to increase the  $Q$  by 37%. This will call for a 37% increase in conductor sizes, maintaining the same ratio.

Table IV

Optimum design for quarter-wave shorted concentric lines for maximum selectivity (max.  $Q$ )

Freq. Mc.	$b/a$	2b	2a	$Q$
		inner diameter of outer conductor (inches)	outer diameter of inner conductor (inches)	
60	4.22	13.43	3.18	8708
120	4.22	7.22	1.71	6582
240	4.22	3.86	0.92	4993

**Design for Maximum Impedance**

If the line is used for coupling out of an amplifier, the maximum impedance design given in Table V should generally be used.

The ratio of conductor sizes in this case is 14.3, still assuming that the line has some radiation resistance. The optimum outer conductor inner radius *b* in centimeters is  $0.077\lambda^{0.9}$  and in inches is  $0.0303\lambda^{0.9}$ , with  $\lambda$  in centimeters. The sending (unshorted) end impedance is then  $113,000\lambda^{0.4}$  ohms.

**Practical Lines**

The effect of the radiation resistance assumption upon the optimum *b/a* ratio is relatively small, as seen above. Until the matter is settled, it is sufficient for our purposes to use a ratio of about 4 where high Q is desired, and about 9 or larger for high impedance. Often, a ratio closer to the Q design is selected in order to have a mechanically strong inner conductor to avoid use of spacers. Inasmuch as the optimum size is relatively large, the radiation resistance assumption will have little effect in amateur apparatus where smaller diameters are commonly used.

The Q up to optimum diameter is roughly proportional to the outer conductor size. Yet lines substantially smaller than optimum will give surprising results. One receiver using an acorn r.f. stage tuned broadly with little indication of "peaking up." When the coil was removed and replaced with a 26-inch aluminum tube 1¼ inches in diameter, with a no. 12 wire for the inner conductor, signals came up three R's and sharpened up to a few dial divisions.

**Capacity Loading**

The shortening effect of a lumped capacity placed across the open end is considerably smaller on the concentric line compared with parallel wires because of the lower characteristic impedances normally encountered. The amounts of this shortening for lines with con-

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**Complete description and constructional details of the electron-coupled exciter that has been doing such a good job at W6CUH. Don't miss this article by Charles D. Perrine, Jr.**

ductor ratios of 4.22 and 14.3 are given in figures 5 and 6. When a line is shortened to 1/8 wavelength, the dimensions for the maximum Q design should be increased 9.5 per cent. Regardless of whether concentric lines radiate, these figures hold true for these ratios and, consequently, for lines of the indicated characteristic impedance. Comments made in connection with parallel wires apply here as well.

**Line Calculations**

Let us check the tuning capacity actually used in a practical receiver. The one we have in mind uses two lines 28½ inches long in the r.f. and detector stages, but with a coil in the oscillator. The tube diameters are 2 inches and 1/2 inch, the outer one having a thin wall. Neglecting wall thickness and considering the *b/a* ratio as 4, the formula

$$\left( 138 \log_{10} \frac{b}{a} \right)$$

gives a characteristic impedance of 83.1 ohms. The lines are 52.2/90ths of a quarter wave at

[Continued on Page 91]

**TABLE V**

**Design data for quarter wavelength shorted concentric lines, for maximum sending-end impedance**

Freq. Mc.	b/a	2b inner diameter of outer conductor (inches)	2a outer diameter of inner conductor (inches)	Zs (ohms)
60	14.3	32.96	2.30	1,358,000
120	14.3	17.56	1.23	1,018,000
240	14.3	9.38	0.66	778,000

# A New

# COMMUNICATION RECEIVER KIT

By M c MURDO SILVER\*

R.f. and i.f. regeneration in this new receiver give high performance with low parts cost and ease of alignment.

The use of regeneration to obtain a high order of receiver sensitivity and selectivity permits of a desirable approach to the engineering goal of obtaining the maximum in results for a minimum of cost and complexity. Ever since the high performance possibilities of the double regenerative superheterodyne known as the Jones "Super Gainer" were revealed to amateurs in 1935, the writer has been surprised that no factory-built communication receivers have utilized this idea. The reason is probably that the majority of such receivers have closely followed broadcast receiver design technique, in which regeneration is definitely out since the general public cannot be expected to use it. To amateurs, whose experience with regenerative receivers is well founded, this limitation does not apply.

Knowing what can be had from a perfectly easily operated double regenerative receiver, the writer has recently designed a communication receiver along these lines, the per-

formance of which has come up to his fondest expectations—has even exceeded them in one vitally important particular. That is in the matter of reduction of inherent circuit and tube noise. It is a known fact that overall receiver sensitivity is finally limited by tube noise due to shot effect in electron emission and by thermal agitation in input circuits (the noise made by electron movement is a supposedly solid piece of copper wire such as an antenna coil). This latter limitation is seldom reached in practice since tube noise is tremendously greater and so is usually the limiting factor. The purely empirical assumption, therefore, is that the smaller the number of tubes that must be used to obtain the desired overall sensitivity, the less will be the inherent circuit noise—the better the signal-to-noise ratio. The development of this theory with available types of tubes indicates regeneration as a prerequisite, since no small number of existing tubes will give sensitivities on the order of one microvolt absolute such as is desirable in a communication receiver, let alone permit the needed number of tuned circuits in a repeater amplifier to give necessary selectivity.

By using a regenerative first detector, regenerative i.f. amplifier, diode second detector, pentode first and beam power second audio stages, not only can plenty of sensitivity and selectivity be had, but this string of only four "tubes" as compared to the usual six or seven makes for a sizable improvement in signal-to-noise ratio. In the "Silver Super" here described the signal-to-noise ratio actually measures between 25:1 and 50:1, specifically, at an input of one microvolt absolute the signal output is 50 milliwatts, of which the noise component is between only 1 and 2 milliwatts. Such a signal-to-noise ratio makes audible many signals indeed which were heretofore lost in inherent receiver noise, usually dubbed "local noise level" instead of being recognized as what it really is, set noise.

\* Edwin I. Guthman & Co., Inc., 400 S. Peoria St., Chicago, Ill.

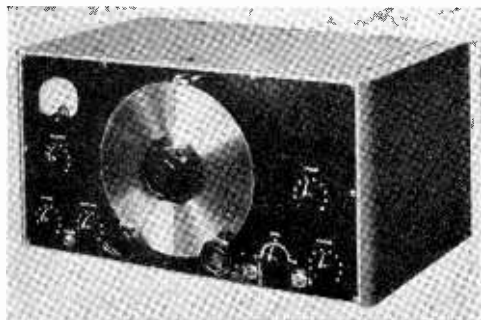
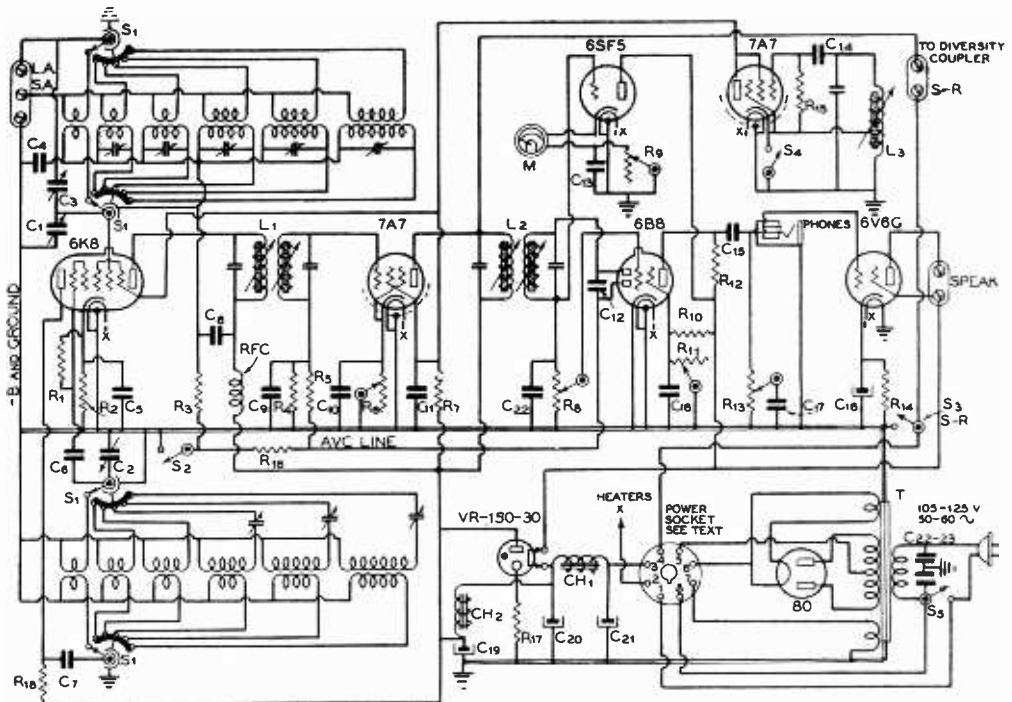


Figure 1. Front view of the "Silver Super" showing the attractive panel layout and the large, easily read german-silver dial.



General wiring diagram of the Silver Super.

- |  |  |   |   |
|--|--|---|---|
| C <sub>1</sub> , C <sub>2</sub> — 140 - $\mu$ fd., two-gang        | C <sub>10</sub> —25- $\mu$ fd. 400-volt tubular  | R <sub>7</sub> —15,000 ohms, 2 watts              | $\frac{1}{2}$ watt  |
| C <sub>3</sub> —10 $\mu$ fd. midget                                | C <sub>17</sub> —.004- $\mu$ fd. 200-volt tubular  | R <sub>8</sub> —500,000-ohm potentiometer         | R <sub>17</sub> —4000 ohms, 10 watts  |
| C <sub>4</sub> —.05- $\mu$ fd. 200-volt tubular                    | C <sub>18</sub> —40- $\mu$ fd. 25-volt electrolytic                                      | R <sub>17</sub> —2000-ohm potentiometer           | R <sub>18</sub> —20,000 ohms, 1 watt  |
| C <sub>5</sub> —0.1- $\mu$ fd. 200-volt tubular                    | C <sub>19</sub> , C <sub>20</sub> , C <sub>21</sub> —15- $\mu$ fd. 450 volt electrolytic | R <sub>10</sub> —500,000 ohms, $\frac{1}{2}$ watt | L <sub>1</sub> , L <sub>2</sub> — Permeability-tuned 455-kc. i.f. transformer             |
| C <sub>6</sub> —30- $\mu$ fd. mica                                 | C <sub>22</sub> , C <sub>23</sub> —.05- $\mu$ fd., 400-volt tubular                      | R <sub>11</sub> —500,000 - ohm potentiometer      | L <sub>3</sub> —Beat oscillator transformer   |
| C <sub>7</sub> —0.1- $\mu$ fd. 400-volt tubular                    | R <sub>1</sub> —30,000 ohms, $\frac{1}{2}$ watt  | R <sub>12</sub> —250,000 ohms, $\frac{1}{2}$ watt | T—700 v., c.t., 70 ma.; 5 v., 3 a.; 6.3 v., 2.5 a   |
| C <sub>8</sub> , C <sub>9</sub> —.05- $\mu$ fd. 200-volt tubular   | R <sub>2</sub> —175 ohms, $\frac{1}{2}$ watt   | R <sub>13</sub> —250,000 - ohm potentiometer      | CH <sub>1</sub> —15 hy., 100 ma   |
| C <sub>10</sub> , C <sub>11</sub> —0.1- $\mu$ fd. 200 volt tubular | R <sub>3</sub> —500,000 ohms, $\frac{1}{2}$ watt   | R <sub>14</sub> —325 ohms, 10 watts               | CH <sub>2</sub> —20 hy., 65 ma  |
| C <sub>12</sub> —100- $\mu$ fd. mica                               | R <sub>4</sub> , R <sub>5</sub> —250,000 ohms $\frac{1}{2}$ watt                         | R <sub>15</sub> —50,000 ohms, $\frac{1}{2}$ watt  | S <sub>1</sub> —4-section 6-position bandswitch   |
| C <sub>13</sub> —0.1- $\mu$ fd. 200-volt tubular                   | R <sub>6</sub> —10,000-ohm potentiometer   | R <sub>16</sub> —500,000 ohms,                    | S <sub>2</sub> , S <sub>3</sub> , S <sub>4</sub> , S <sub>5</sub> —S.p.s.t. toggle switch |
| C <sub>14</sub> —100- $\mu$ fd. mica                               |  |   |   |
| C <sub>15</sub> —.05- $\mu$ fd. 400-volt tubular                   |  |   |   |

When this same technique also provides continuously variable selectivity which at the turn of a knob can be adjusted to anything between the extreme width of 12 kc. and a value which gives usable single-signal c.w. reception, it becomes close to the ideal for both phone and c.w. reception. Another advantage lies in the fact that through this design technique practically all of the difficulties of home building a modern communication receiver

are eliminated and it becomes a simple matter to "align" such a receiver at home without any test oscillators or test gear whatsoever; received signals alone are sufficient when one or more i.f. transformers are factory pre-aligned.

The receiver here illustrated and diagrammed may be built from standard parts available from any jobber, or it can be had in a completely assembled Guthman kit all ready to wire. Such pre-assembly helps both

to insure proper assembly and to save for the builder the cost of factory wiring and testing. It employs a 6K8 regenerative first-detector-oscillator; regenerative 7A7 "loctal" all glass i.f. amplifier; 6B8 diode detector, a.v.c., first audio stage and new noise limiter; and 6V6G beam power tube. As accessories beside the fundamental purpose of signal amplification, a 7A7 is used as a beat oscillator, a 6SF5 single-ended pentode for R-meter operation, a VR150 automatic B-voltage regulator, and of course a power supply rectifier, in this case an 80.

The wavelength range selected as essential to present-day amateur operation was 5 through 625 meters, specifically 480 kc. through 61 Mc. Such a range in a single receiver covers every amateur band at present amenable to conventional engineering treatment, the broadcast band to regale the y.l. occasionally with dance music, and the 600-meter commercial band to delight the hearts of ex-commercial ops. hankering to hear what's going on in their old stamping grounds. Such a range automatically demanded a high L/C ratio, and with the tuning condenser value of 140  $\mu\text{fd}$ . automatically broke up into six bands each of about 2.2:1 frequency range. Each band uses individual coils, with all unused coils shorted out of the circuit and with every coil mounted directly on wave-change switch lugs for short leads.

No r.f. amplifier was considered since gain and image reactivity at the higher frequencies could not be obtained to any worthwhile degree in any simple signal-stage r.f. amplifier. Instead, first detector regeneration was employed to give image reactivity and that gain before frequency conversion so essential to swamp out detector-oscillator noise. The circuit diagram shows how this was obtained, not as a variable function, but as a fixed gain contribution.



Figure 2. Chassis layout is clean and simple with plenty of space behind it for batteries should it be desired to operate the receiver independently of the a.c. supply. It is only necessary to remove a jumpered plug and insert the battery cable to change from a.c. to battery operation.

With a 6K8 having a cathode connection common to detector and oscillator circuit, cathode regeneration could not be employed since it would involve highly undesirable detector-oscillator coupling. Straight tickler regeneration would involve both extra tickler switching operations as well as reduced high frequency range of each wave band due to the coupled tickler. So a new method was devised. An r.f. choke in the detector plate circuit provided an r.f. impedance, some of the voltage across which could be coupled back to the grid circuit. This idea is really very simple, and works out very nicely. The choke itself had to be designed to present the needed r.f. impedance over the entire range of 480 kc. to 61 Mc. In designing it several interesting facts were discovered. In appearance it is just an ordinary 10-mh. r.f. choke, except it is wound on a ceramic dowel and the coil is very narrow. The fact that it works at 5 meters as well as at 500 is due to careful proportioning of its physical size and shape, wire size and wire insulation, as well as winding pitch. The r.f. voltage across this choke is tapped off in desired amount through condenser  $C_1$  and fed back to the low potential end of the grid circuit—to the a.v.c. return. The ratio of feedback capacity,  $C_1$  to  $C_2$ , the a.v.c. by-pass condenser, determines the degree of regenerative feedback. Since high-impedance antenna primaries are employed which prevent different antenna characteristics reacting upon the first-detector grid circuit no "dead spots" occur, and this regenerative feedback may be made fixed. Thus first detector regeneration introduces no extra control, critical or otherwise, yet gives more gain and selectivity at the higher frequencies than could a non-regenerative r.f. stage. Because the regeneration sharpens tuning a manual antenna trimmer condenser knob is provided. It is not critical in setting, but does provide a way of getting the maximum out of the first detector as well as a means of eliminating five or six internal trimmer adjustments.

As assurances of high-frequency oscillator stability a VR150 automatic voltage regulator tube is used to hold plate voltage "on the nose" and a send-receive switch which cuts plate voltage to all tubes—even to the filter itself. This arrangement allows tube heaters to be run continuously at low power cost, less than 30 watts is consumed by all heaters, so that usual "warm-up" drift is entirely absent. Even the penuriously minded operator will be willing to turn on heaters an hour or two before the start of operation if by so doing warm-up drift is eliminated.



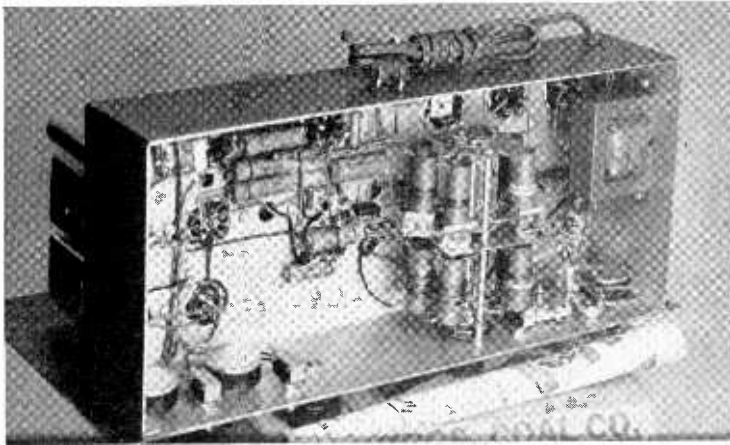


Figure 3. Separate r.f. and oscillator coils for each band mounted directly upon the terminals of the bandswitch, optimum ratio of coil size to shielding proximity, and short coil-to-tube leads all contribute to improved performance on the 28- and 56-Mc. bands.

The i.f. amplifier uses one of the new all glass 7A7 "loctal" r.f. pentodes. This tube has no base, socket pins being set right into its glass "stem," has low inter-electrode capacities and practically no lead inductance, is fully self-shielded and has higher gain than the older 6K7 or even the new single-ended 6SK7 tubes. It is fed by a high-Q permeability-tuned 455-Kc. i.f. transformer which, in using silver-plated-on-mica tuning condensers, has all the stability of an air-tuned transformer but with smaller size and higher gain. A second similar transformer couples this 7A7 to the diode second detector. Regeneration is obtained by slightly augmented grid-plate capacity at the 7A7 socket and by very high i.f. transformer coil Q. It is controlled by cathode bias variation, with actual operation in the range just below critical regeneration occurring at optimum repeater bias conditions.

And here hangs a tale. Any attempt to regenerate ordinary 455-kc. i.f. transformers results in a frequency shift of anywhere from two or three on up to 10 kc., enough to lose a signal entirely, as regeneration is varied. The remedy lies in using very loose primary-to-secondary coupling in the regenerated transformers. This also desirably increases selectivity, but reduces repeater gain. This last is of no practical consequence, however, since regeneration gives all the gain that can be used.

Actually, the i.f. amplifier is never operated in an oscillating condition, even for c.w. reception. Regeneration is used only to obtain

increased gain and selectivity; a separate beat oscillator tube is used for c.w. reception. This allows the i.f. selectivity to be made so sharp that when the beat oscillator is offset 1000 cycles so that the loudest beat of 1000 cycles is at i.f. resonance, the second audio beat (audio image) 2000 cycles is practically inaudible. Thus is virtual single-signal c.w. reception had; a bit less regeneration gives phone selectivity which is a joy and a delight in cutting through QRM.

Diode second detector and a.v.c. circuits are essentially conventional except for the splitting of a.v.c. voltage to first detector and i.f. tubes into the best proportion for maximum a.v.c. action. An a.v.c. on-off switch is of course provided. The R meter to be really useful should not be in an amplifier tube plate circuit, else it will not register on signals so weak as to be below a.v.c. delay bias. So a 6SF7 single-ended high- $\mu$  triode is used as a v.t. voltmeter to read signal voltage appearing across the diode load resistor upon the scale of the calibrated R meter in its plate circuit. A variable cathode resistor allows the initial "setting up" of meter scale for correct readings to be made.

By using a diode-pentode for second detector, etc., instead of the usual diode-triode, a noise limiter as effective as it is simple becomes possible. The pentode of the 6B8 is used as first audio amplifier, its grid being fed from the arm of the potentiometer forming the diode load. This pentode has the characteristic that its "saturation" is con-

[Continued on Page 84]

# Suggestions Regarding Close-Spaced 10-METER BEAM ANTENNAS

By MURRAY BOLEN,\* W6ABR

With practically everybody fooling with some kind of a directive radiating system, I too was bitten by the "10-meter close-spaced beam" bug. In monkeying with this type of system for ten, I have uncovered a few constructional details which are interesting enough to pass on to the brotherhood.

My first ideas came from the articles in RADIO by Gioga, Dawley, Conklin and others; since then, a lot of coffee has flowed over the lip. Most every amateur's problems on a thing like this are individual. But here follows a little general information that might help.

In the first place, bearings for the rotation of masts are a problem. If you elevate your antenna on a length of 1¼-inch water pipe, you will find that a Cadillac axle bearing, procurable at practically any automobile junk yard, fits around the pipe as though it were tooled for the purpose. One of them may also be used as a thrust bearing so that the mast may rest upon it. So, if you use 1¼-inch pipe, get two Cad bearings.

Consulting figure 1, then, with an extension bit, drill out a hole the diameter of the bearing and 1 inch deep in a piece of 4" x 4". Change bit to two-inch diameter, and drill on through. Put bearing in place in the plank and slip the whole assembly over the pipe. The 4" x 4" can be fastened to the house or to any other upright by means of six-inch lag screws. This is the upper bearing.

In figure 1B, for the bottom thrust bearing, drill out a hole the diameter of the bearing as before. Then drill on through with a half-inch hole for water drainage. Screw a narrow flange onto the threaded pipe end. Put the bearing in place and let the flange rest on the shoulder of the bearing with a half or three quarters of an inch of pipe down in the bearing. This will anchor the whole business firmly and if you screw the bottom assembly down well, you need have no fear of wind storms. Keep cup grease on the bearings and you'll find you have a very smooth and sturdy rotating mast.

\* 10510 Draper St., Los Angeles, Calif.

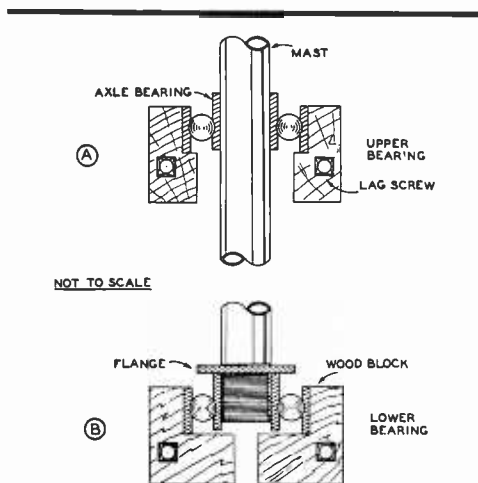


Figure 1. Showing the use of rear-axle bearings as thrust and radial load carriers in a "plumber's type" 10-meter rotary. (A) shows the axle bearing mounted in a wooden block for taking the radial load of the array. This bearing should be mounted somewhere near the top of the vertical piece of supporting pipe. (B) shows the use of a similar type of bearing to take the vertical thrust of the weight of the array.

## Slip Ring and Brush Arrangement

Most everybody using open-wire feeders has trouble with twisting feeders. Here's an adaptation of the brush-ring arrangement that makes a beam 360 degrees rotatable with noiseless contact assured. It requires a little lathe work, but the result will be well worth while.

Get 2½ inches of brass tubing about 6 inches in diameter (5⅜ inches is a standard inside diameter size) with a ¼-inch wall. With it, get about 3 feet of phosphor-bronze or hard copper tape, ¾-inch wide. Hacksaw or otherwise cut the tubing in two, making two rings each 1¼-inch wide. On a lathe, turn out a groove in each ring 3/32-inch deep and ¾-inch wide as indicated in figure 2.

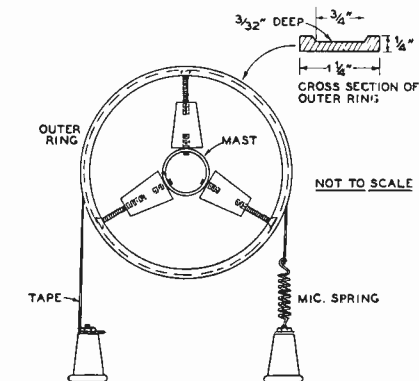


Figure 2. Drawing showing the method of construction and the method of mounting the slip rings for feed-line connection to an array designed for 360-degree rotation.

If you use 1/4-inch pipe as a mast, drill and tap the pipe so that three insulators may be screwed on—like the spokes of a wheel. Be sure to space them accurately around the circumference of the pipe. Now drill, in the center of the grooves in the rings, corresponding holes to fit the insulators. Countersink the hole for the heads of flat-head brass machine screws to screw into the insulators. You will find that if this is done accurately, the insulators do not have to be of an exact length to fill the diameter; they will draw up solidly when the rings are screwed into place. Figure 2 indicates what the assembly will look like when completed.

Of course, if you want to rotate a square wooden pole, use four insulators and adapt the rings as above.

Before putting the rings in place, be sure to drill and tap each for a machine screw, 8-32 or 6-32, on the top edge of each ring surface. These are for feeder contacts from the radiator.

With rings in place, one above the other and four to six inches apart, anchor to an insulator which is mounted solidly at a point seven or eight inches from the ring, one end of the 3/4-inch tape. Pass tape around the ring in the groove and anchor to another insulator similarly mounted; insert a small microphone spring for tension. This also is indicated in figure 2. Feeders from the shack may be connected to the insulators holding the fixed ends of the tape.

You will find you have a minimum amount of contact noise because of the great amount

of contacting surface; also, the assembly is self-cleaning and will allow continuous rotation in either direction.

### Gas-Gauge Antenna-Direction Indicating Device

Here's one of the simplest yet probably one of the best indicating devices for determining the transmitting direction of your rotating beam. It requires only three wires from the antenna to the shack and will tell you almost to a degree where your antenna is pointed. It consists of a meter, a resistor, and a dry cell.

To get the meter and resistor to match, haunt the automobile junkyard again and you will find that various automobiles of '26, '27 and '28 vintage have in them a gas gauge which consists of a panel meter and a resistor in the gas tank to go with it. Be sure to get the type meter with *three* contacts on it—and if at all possible, get the resistor from the same car. The '27 and '28 LaSalle's have this type assembly, among other makes. The three-contact meter is a balanced-coil affair as indicated in the diagram.

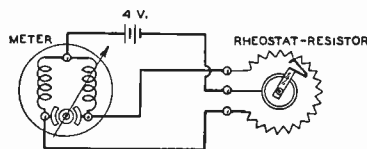


Figure 3. Method of connecting a gasoline-gauge rheostat-resistor and its associated indicating meter as a direction indicator for a rotary array.

File open the case to the resistor unit from the tank and take out the brush and resistor-rheostat affair. Bend the resistor into a complete circle and shorten the brush arm to turn inside it. The resistors are originally built to turn 270 degrees and usually are in the vicinity of 150 ohms.

Attach the reassembled unit to your mast in any way you see fit. Adjust the brush so that it contacts the resistor in the direction from center that your antenna points. Then calibrate your meter (which is in the shack) to match these cut and tried points. To calibrate, just remove the meter face and turn it over and replace. Paint on any calibration you want. It's just like shooting fish. You will find that the meter will work best on 3 to 4 1/2 volts, and you can use C batteries,

[Continued on Page 89]

# Resurrecting the D. C. Relay

By HARRY G. BURNETT, WILZ

Most of us, when we discarded storage batteries, shelved the once-popular low voltage d.c. relay. It is now difficult to find a source of supply for this type of relay in most amateur stations. This relay, as a rule, was wound with a few turns of heavy wire. Consequently, a low voltage source capable of supplying the comparatively heavy current was needed to operate it. With the storage battery passe, we had no readily available means of magnetizing the solenoid. Reflect upon the bother and expense of transforming, rectifying and filtering the a.c. at hand to provide a substitute for the battery, and it is not hard to understand why the average amateur turned to the a.c. relay as the better solution of the relay problem.

It is true that the a.c. relay is the simpler to use in modern installations. The a.c. is readily and cheaply obtainable at 115 volts, or at any lower voltage. Problems of rectification and filtering are, of course, absent.

However, there are arguments against using the a.c. relay. Here are some of them: The a.c. relay often chatters; it usually hums; and it is certain to try your patience to the breaking point when you attempt to tame it and quiet it. It is difficult to build a good one yourself, if you are trying to economize or want one for a special purpose. Buying a new a.c. relay does not solve the problem of what to do with a d.c. relay lying idle.

The smaller d.c. relays do not require a strong magnetic field from the solenoid to operate. We can reduce the current necessary by increasing the number of turns in the solenoid. This is true, you will remember, because the magnetic field produced by the relay coil is represented by  $I \times T$ . Thus, for a given magnetic effect, if we increase  $T$ , we may decrease  $I$ . Practically this means, for example, that we can remove the few turns of heavy wire from the coil of an old d.c. relay, and by rewinding with many turns of fine wire produce the same magnetic effect with a greatly reduced current. We can, thus, put old discarded "B" eliminator relays, etc., back into operation, provided that we can discover a source of d.c. capable of supplying the few milliamperes of current necessary.

Inexpensive auto horn relays or generator cut-outs may be rewound with fine wire to work on low current.

We all have "adequately filtered" d.c. power supplies. They supply several milliamperes of current to the bleeders across them, and to the r.f. and a.f. tubes they feed. The voltages supplied by these power packs are usually a bit high to apply to any relay coil directly. If there were some way of reducing this available source of voltage, our problem would be solved, and we could put our revamped relays to work.

A little thought yields the following: We can connect one side of the solenoid to the negative of our power supply and tap the other side on the bleeder at a point giving sufficient voltage to operate the relay. Care must be taken, of course, not to exceed the wattage rating of the bleeder. Again, we can insert the relay coil in series with the negative connection of the bleeder, or in series with the negative connection of the power supply to the transmitter proper. In this application, the bleeder must draw enough current to operate the relay, or the transmitting tubes enough plate and screen current to energize the relay coil. In all three cases, you will note, connection to the *negative* is indicated. This is so because of safety and insulation considerations. If the bleeder current is sufficient, connection in series with the bleeder is probably the best choice for most applications.

By judicious care in placing the relay in connection with the proper power supply, correct timing of relay action and even time delay effects can be produced.

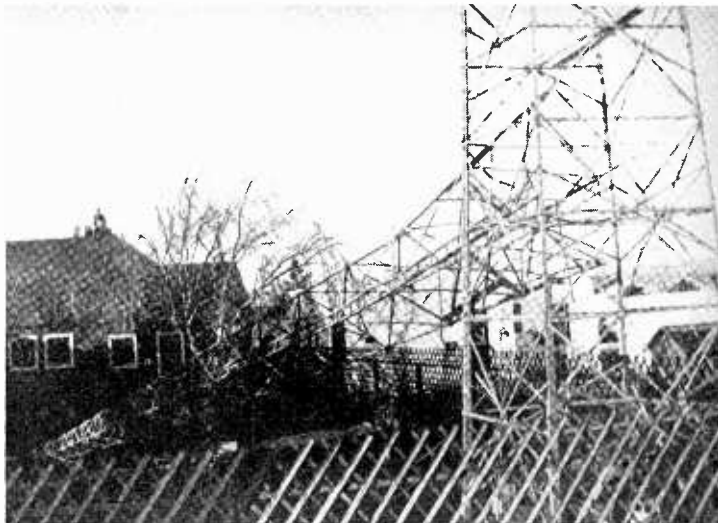
We might go on at length about possible applications for these resurrected d.c. relays. They make it easy to utilize a regulated power pack for the e.c.o., as well as the receiver; cutting the receiver B- while transmitting; disconnecting and grounding the receiving antenna when transmitting; shorting a resistance in series with the filament transformer primaries to raise filament voltages to offset poor line regulation when the transmitter is on; and a host of other labor-saving arrangements. Few are at a loss to think of ways to use a relay, so we leave the application to you. Certainly high resistance (low current) relay solenoids raise the d.c. relay from the "dead-letter" class.

\* Windsor Rd., Somerville, Mass.

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To the sorrow of many an amateur, the wind in So. Calif. occasionally ignores the Chamber of Commerce and puts on a QRO test, with the disheartening results shown here.

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# DEPARTMENTS

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- **Dx**
- **The Amateur Newcomer**
- **U. H. F.**
- **Postscripts and Announcements**
- **Yarn of the Month**
- **Scratchi**
- **Open Forum**
- **Question Box**
- **Calls Heard**
- **What's New in Radio**



# DX

## AND OVERSEAS NEWS

Herb. Becker, W6QD

Send all contributions to Radio, attention DX Editor, 7460 Beverly Blvd., Los Angeles.

As this is being written the contest is under way and yet your DX ED has to grind out the column instead of working the new ones. There just "ain't" no justice. The general opinion around here is that conditions for the first few days have been the worst in two years. The boys just sit around waiting for something to happen. The e.c.o.'s are scooting around the band with reckless abandon. Maybe I should have said "wreckless." There are good notes, bad notes, chirpy and yoopty notes . . . what an assortment. A lot of them sound as if they had been thrown together the Sunday morning after the contest began, when they discovered their one or two crystals wouldn't get to first base.

Everybody is having a grand time, however, and half the fun seems to be the little side remarks made on any one frequency the gang is concentrating upon. You may be waiting for CT1ZA along with 43 others . . . giving him a call every time he signs (or even before). When he does finally come back to you the other 42 will chime in with "Nuts" . . . "Whatta guy" . . . "I'm next" . . . etc. Probably the most common remark heard was "Get off his frequency." And no "please" either. All the favorites are in there pounding away, and a lot of dark horses are liable to creep up near the finish. I could name a flock of the boys who apparently are giving a fine account of themselves, but sure as heck if I



VQ8AS, Paul Caboche, Solomon Islands, Chagos Archipelago. Note the bank of "accumulators" under the table.

do I'll leave out someone and would hear about it sooner or later. No, sir, I'm playing safe.

A contest always brings out many comical incidents, and this one has more than its share. For example, the other night VP4ZA was causing quite a commotion on 14 Mc. He was working plenty of eastern stations but never once did he come back to any of the local W6's who were wearing out their keys calling him on 14 Mc. Yours truly couldn't figure out why none of the eastern stations were found, while QSO VP4ZA . . . that is, he couldn't until he went into a trance. Then it flashed that maybe the VP4 was on 7 Mc . . . Yes, and sure enough he was on good ol' 40. This same QD just about jarred the cat's whisker off his galena crystal in getting the rig switched to 40. He finally did it, and with the same calmness of a bride marching down the aisle. The first call landed VP4 and the mystery was solved. At least that part of it was, but the gang around town can't figure out why his signal was a couple of points louder on 20 than on 40. We wonder if his rig was on 20 and he was listening on 40. This is too much . . . you try it.

W6CUH tells a funny one. The gang was calling CR7AF . . . all on about the same frequency (of course). When they all signed and stood by there wasn't a peep out of the CR7. In that spot, however, a little signal pipes up with "Who's on his frequency?" Following this another little signal chimes in with "I am." And so they all got "nowhere" fast. Then there are always the boys in other countries who try to exchange numbers with stations in other foreign countries, such as the K5 that was heard trying to get a number out of a VK. A W3 was having a heck of a time trying to persuade a VE to kick loose with a number. The boys right now are having a fine time zooming around from

### WAZ Honor Roll (Continued)

W8NYD . . .25 . . .53	W9UYB . . .22 . . .35
W5ASG . . .25 . . .48	W6NEP . . .21 . . .53
W6PDB . . .25 . . .44	W8KWI . . .21 . . .50
W7AMQ . . .25 . . .40	W2HFM . . .21 . . .48
W6LYM . . .25 . . .39	W5BBB . . .21 . . .42
W6MXD . . .25 . . .38	W6FZL . . .21 . . .40
W6FFK . . .25 . . .36	W4MS . . .21 . . .40
YV5AK . . .24 . . .59	W60JK . . .21 . . .39
W8DBC . . .24 . . .53	W7BJS . . .21 . . .37
W4TS . . .24 . . .52	W9VYD . . .21 . . .36
W1BLO . . .24 . . .50	VE5FO . . .21 . . .35
W6LPR . . .24 . . .45	W9VXL . . .21 . . .35
W6MVK . . .24 . . .36	W6PMB . . .21 . . .30
W6MVQ . . .24 . . .32	W6PNO . . .21 . . .30
W6NCW . . .24 . . .29	CO7VP . . .20 . . .47
W6GRX . . .23 . . .43	W1KJJ . . .20 . . .47
W9ORL . . .23 . . .38	W5EDX . . .20 . . .35
W7ALZ . . .23 . . .31	W3AKX . . .20 . . .32
ON4PA . . .23	VE5FO . . .20 . . .31
W7ESK . . .23	W6LOY . . .20 . . .29
W1JCX . . .22 . . .42	W6NMI . . .20 . . .25
W1KKP . . .22 . . .40	W61WS . . .20 . . .24
	K6KMB . . .20 . . .23

### LAST MINUTE SCORES

The following claimed scores cannot be vouched for, and we can offer no assurance that they will be allowed. They are given merely to indicate what might be expected in the way of scores this year. Here they are, just as passed on to us.

XE2N	230,000	W8AU	64,500
W3CHE	183,000	W2BJ	64,000
W2UK	177,000	W6QYT	60,000
W3EMM	175,000	W3BEN	60,000
W6GRL	160,000	W5VV	57,600
W9TJ	159,372	W3EPV	55,000
ZL1MR	118,000	K4KD	53,200
W5EHM	114,500	W6CUH	53,000
W4CEN	112,000	W6GRX	53,000
W9TB	112,000	W9PCS	50,374
W8BTJ	99,000	W9CY	50,000
VK2ALU	96,000	W9TH	50,000
K4AH	95,000	W6LYM	46,000
W8LEC	86,000	W6QD	43,000
W2BHW	85,000	W6QAP	41,000
K6LKN	81,000	W6DOB	40,000
W6CXW	80,000	W6AM	36,000
W8QDU	80,000	W3KT	34,000
G6NF	70,100	W1APA	30,000
W9GRV	70,000	W7AMX	24,400
W5KC	67,000	I2JJ	23,500
LU7AZ	16,000		

one spot to another. Gee, what a difference in operating procedure since last year. Even QD zooms a little now and then . . . whenever the power leak stops. It has been off only one evening . . . the rest of the time wiping out sigs with a strength of 5 or 6. So far the power leak has scored more points than QD. Wait, what's this . . . the noise is off, see ya later.

Sunday a.m. Well, this is the last day of the battle. Oh yes, that power leak was off for a few hours and it was sweet while it lasted. Now the 10-meter band is opening up; it has been lousy all week; none of the gang have been able to do much with it. That ol' 40-meter band of mine was a lifesaver, and without it the contest would have been dull. The W6 bunch went nuts on 40, as there were a great many fine contacts made with European countries especially. Just at this minute 28 Mc. is hot as a firecracker, maybe even hotter, and the boys just don't know which one to call . . . the band is loaded with Europeans . . . loud too. Best day yet on 10.

Getting back to the roaring 40's: It seemed good to hear all of the old timers, as well as the not-so-old-timers, back on that band. I'll bet you agree. Must run along now for a while and grab off some of this 28 Mc. stuff . . . more later on the contest, towards the end of the department.

### WAZ Honor Roll

For some time you fellows have made suggestions to the effect of making the Honor Roll a bit more restricted, as it has become very large and threatens to run over a page and a half. Many ideas have been considered and we feel rather than arbitrarily set a new minimum of zones for entry into the Honor Roll, that it would be better to set a limit to the number of stations

listed. Hereafter, the Honor Roll will provide three columns for the c.w. and phone, and one column for phone only. Each column contains 90 calls; therefore there will be 270 of the highest in the c.w. and phone combined, and 90 of the phone (two way) only. In this way everyone will have a chance to "shoot" for the list, and the minimum will be automatically set. If we were to set a definite minimum of we'll say 35 zones, you can see there would be a great many of the boys dropped immediately. By this new limit, it means that the most active ones are going to remain in the Honor Roll, simply by hustling. Next month the Honor Roll will contain the 270 highest c.w. and phone, and 90 highest phone only. Remember, those in the phone section are required to "check in" with revised totals by May 10, showing standing based on two-way phone contacts only.

The 1939 DX Marathon will still contain the 50 highest c.w. and phone, and 25 highest phone only.

### Phone

W1JCX is shedding big round tears these days. All because he missed ZC6EC by a whisker. G2MF was working ZC6EC and when they finished W1JCX gave G2MF and the ZC a call. G2MF came back and said that he too had called the ZC with the hopes that he was still listening. It so happened that the QSO with G2MF was the last for ZC6EC as he was leaving Palestine. Luck was against 1JCX as they couldn't raise him and so Herb has no ZC. W6IKQ hooked VP3AA, VP4TK, VP9L, KF6DHW, KG6NVJ and OK1FZ making 32 and 50. Phil wants to know of any phone station in zone 2.

W6NCW has a couple in KF6DHW and HK3CL. W8RL got TG9BA which makes 31 and 67. W9RBI is still after them and is doing OK. W1AKY has a new country in XU8HG for no. 74. W3DRZ has 28 and 62 and is always in there plugging. Bud maintained a sked with VU2CQ for two months on 10-meter phone. His chief bit of grief is that he worked a station signing AC4UU, the Sikong Expedition in zone 23, Lake Alecnore, Tibet, in 1937 but hasn't been able to get proof.

W8QXT is quite able to bark over the mike with the consequence he has four new ones in VU2CQ, YI2BA, SV1KE and SU1CH. W6PMB is new to our tribe and uses 10 phone altogether . . . 21 zones and 30 countries. W7BVO couldn't stand it any longer . . . that is, seeing his pal W6OJ climbing up the list; so he unlimbered a bit himself and really went after them. Result: K7FST in 19, SU1WM, SU1WN, SU1JM, SU1MW, SU1RD, FB8AH, OH2OI, ES5D, I1NQ, SM7VF, KF6DHW, VP9G, VP9L. This puts Rollie up to 33 and 78. Rollie says, "Yoo-hoo, Dave."

Here's W1JCX again, can't keep him down. He finally got one in Asia . . . VU2BG was it. This makes Herb WA Con phone. Other good ones for him are K7FST, KA1FH, PK6XX, L1WY, GM3TR, SU1MR and G8MF. G6BW grabbed K7FST in zone 1, and VR6AY which



makes Ben 31 and 74. VE4SS is a new one with us and has 26 zones and 50 countries. He wonders if KC6CKM is in a different zone than K6's in T. H. The answer is "no" but it just misses the boundary of the zone by not many miles.

W6OJK located in Tucson, Arizona, has a nice rig on the air using a pair of 250TH's. The antenna is a 3-element rotary. He says that for the dxer who wants Arizona he is on 10-meter phone every day but Monday from 1600 to 1800 G.m.t. on 28,600 kc. George has 21 zones and 39 countries. F8VC contacted ES5D for his 31st zone . . . and countries are 72. G6DT has not been idle at all and sends in 6 new zones: VP3AA, U3BX, VK6FL, ZL4GM, VQ2HC, and TF3C. This gives G6DT 27 and 59. W2AZ has 38 and 106 at present with K7FST doing part of it. Frank says that KA1ME now has 37 zones. Here's a W9 with 21 and 39 . . . W9XVL. He and the x.y.l. and jr. op. were out this way in November and he claims the W6's do not have to try to sell them on California weather as they have been sold on it before. W6ITH worked KG6NVJ for a new one. Other good dx for Reg includes KF6ODC, VK9VG and HK3CL, who says his name is Mario. Also VP9L in Warwick, Bermuda. VP9L was out here a few months ago.

#### AC4YN Works W9HLF, W2CMY and W2JT

Hold your seats! It has actually happened. The first part of January W9HLF wrote us saying he had contacted AC4YN but not to publish until verified. At present we do not know if Claude Moore has his confirmation but just the other day we received a radiogram from Reg Fox stating that the only W's he had hooked were W9HLF, W2CMY and W2JT. This is very welcome news and we really hope this is the beginning so that a few more fellows can get that elusive zone. As you probably know, Moore owns that rotary beam shown in March RADIO. His rig winds up with a pair of HK354E tubes with a kw. input. While speaking of AC4YN, I can't pass our pal VK2EO . . . he also was a lucky guy to get him.

At first he didn't believe Reg was the real thing due to a different frequency that has been in use at AC4YN. However, during the dx contest VK2EO took time out to say he had received his card from AC4YN . . . and now you can't touch Dave with a ten-foot pole. The frequency that Fox seems to be using of late is around 14,300 kc. The time W9HLF worked him was 8:10 p.m., c.s.t. The dates of the contacts with W2CMY and W2JT are not at hand as yet . . . we wanted you to know this as soon as possible. HLF says that AC4YN will not work any of the gang that set their e.c.o. smack on his frequency. The message of confirmation was relayed through XU8NR and W6AOR.

#### The Brasspounders

W7GMA/W8LVV has done well with his 20 watts, and here they are: G2VF, G3BJ, G4AU, G5PN, G6KP, G8RL, K5AG, K4KD, HH4AS, ZS6BL, PA0XM, and CM6AH. Rig is a 6F6 into 802 doubler to twenty. W6MVK grabbed a new one in Y15C on 14,360. Also passes the word along that SU1WM told him all QSL's for ZC6EC and VU7BR should go to SU1SG. All will be answered when they get to their respective home QRA's.

XE2AH will soon be on the air in Tiajuana using an "ultra-ultra" rig built by W6KW. The rig, however, will only be 1 kw. W2HHF got K7FST in zone 19. Others by HHH are PK4KS, VS3AD, VS1AL, VK4HN, CR4HT, VU2AN and ZC2MA. He now has 39 and 141. W8JIN worked a station March 8 signing AC4YS who said he was unlicensed and undercover, but was located in Shigathe, Tibet. Be careful of QSL's. W3EVW added VQ2GW, PK4KS, FP8AA and CR4HT. Most of the boys have their doubt about FP8AA . . . but are hoping for the best. W8OXO and W8KKG have settled their argument regarding whose home town in West Virginia is the best. It was settled out of court.

W6BAM logs VQ4CRE and VP4ZA for new ones. W6PMV says that J6CD is on every morning between 5:30 and 7:00 a.m., p.s.t. and the frequency is 7045 kc. PK1HX is on about the

#### C. W. and PHONE

Z	C
G5BD	..33..78
VK2EO	..31..66
W9TJ	...31..56
G2FT	...31..44
W8AU	...30..61
VE4RO	..30..59
W6NLZ	..30..49
W1IED	..30..43
W4FIJ	..29..55
W5ASG	..28..62
G6CW	..28..60
W9GKS	..28..46
W8LEC	..27..41
G2IO	...26..48
W1BGC	..25..55

#### 1939 DX MARATHON

W9GKS	..25..38
W6AM	..24..56
G8JV	...24..47
W8OQF	..24..37
G3BS	...22..43
W3EPV	..22..36
W6TE	..22..36
W8OSL	..21..27
W9CWVW	..21..23
D4QET	..20..44
W1BGC	..20..36
W2BHW	..20..22
VE2EE	..17..25
W9HLZ	..17..19
W6PNO	..16..24

W8JJY	...16..24
W6ANN	..15..18
W9WCE	..14..22
W2LMN	..14..22
VE5ZM	..13..31
W2ICX	..13..13
W9XXO	..12..19

#### PHONE

G2QT	...12..12
W6ITH	..28..47
W8QXT	..27..56
W8LFE	..27..54
W9RBI	...24..37
W6AM	...8..11

W2AER	..24..30
W1AKY	..23..74
W6OCH	..23..41
W6NNR	..21..31
K7FST	..20..41
W6MZD	..20..22
F8UE	...19..43
W8NYD	..19..30
VE4SS	...17..30
W1QUD	..17..29
W8DBC	..17..23
W6QLN	..17..22
W1JNX	..15..25
W6PDB	..15..19
VE5FO	...14..16
W5EDX	..13..13
W5ASG	..10..16

same spot. W8PQK had some tough luck a while back: he lost his job and had to sell his outfit. He had to do this to keep up his car and, as he puts it, he "didn't want to lose his y.l." Everything is OK now and he is getting back on the air . . . says he thinks it's safe to do so just as long as it doesn't take too much time away from the y.l. His present rig uses a pair of 211's. He has worked a pile of nice dx, 29 zones and 76 countries. He still has the car and the y.l.

W3TR is in again with YS2LR and VP9X, XU4XA, HR7WC and ZC6EC. Al now has 37 and 108. G6WB worked VU2EU, VK4HR, VU2FX, ZL2UV, CR7AF, XU6ST, ST6KR, ZL2BD, KA1RP, K4UG, VP4TO, K4ESH, K5AC, K6QIU and K6MV. This gives John 33 and 85.

#### XU4XA Chungking, China

A letter from XU4XA was very welcome because many of the gang have wondered just where he was. Some of you may remember him, A. E. Lower, ex-XU8XA and ex-XU3XA. Quoting parts of his letter:

"Dx conditions here are good, eastern W's coming in both the mornings and the evenings (their time) but western W's are rather scarce. Europeans are also scarce here. Africans come in well after 0300 G.m.t. Eastern W's come in best from 2330 to 0230 G.m.t. on 14 Mc. Forty meters here is a flop because of local commercial QRM. I am near Chungking, in Szechuan province, 1500 miles up the Yangtze River. At present there are about 5 XU hams active: XU8NR in Shanghai, XU2AW Peking, XU7TH Kunming, Yunnan, XU6D Kweilin, and myself. AC4YN is on evenings here at about 14,292 kc., T9. XZ, PK, VU, KA and J's come through in fairly large numbers.

"I am on nearly every day from 0000 to 0400 G.m.t. usually on 14,298 kc. Doc Malcolm, ex-XU3MA, is now living permanently in Shanghai and is on the air with 18 watts as XU8MA. There are several Chinese operated stations around Kwangsi and Hunan signing XU, but don't know where they got the idea. I asked W2CMY almost every a.m. and AC4YN once a week, and

XU2AW, XU7TH and XU8NR twice a week for traffic. Receiving conditions are f.b. here, my nearest neighbor being 400 miles away, though the local Chinese commercials make up for the lack of QRM.

"The a.c. supply is very uncertain and goes to 70 volts at times in the evenings, also completely out at times, such as sked time, etc. My rig here is an RK25 oscillator, RK25 doubler, 803 PA. Receivers are two RME 69's and one HRO. Antenna is a single wire fed Hertz. I have QSL'd for every W QSO, all cards having been sent to W2CMY. Please tell the boys to send to W2CMY for their cards. Here is my list of 30 zones and 52 countries."

VK2AGJ says that after many hearbreaks and late hours he finally has 34 zones and 70 countries. All this has been on 20 meters, as Ronnie hasn't been on any other band since he came on the air in May, 1937. In three months time he has had over 50 contacts with VQ8AS. Look who's here, ol' VK2DA pops up with his 37 zones and 101 countries. TG9BA was his latest country.

W9LBB is heard from after a long time. He is still using the T20's. New ones for him are CN1AF, VQ2JC, ZD2H and VQ3HJP. Harris says that W9KG is on 80 c.w. and 10 phone most of the time. W4MR added another leg to his zepp, making a Vee beam, and worked VU2FO and VS6AO. He says maybe if he tuned it up properly he could work a few more. He now has 37 and 104. He adds that his friend W4EF has changed over a couple of receivers to use a space-charge detector. He claims it reduces the tube hiss remarkably. W4EF had it incorporated in his story in March, 1937, RADIO. W2AAL is now W4FVR in Charlotte, North Carolina. Al says he thinks the new QRA is better than his old one. He has hooked MX3A, ZD2H, YS2LR, OY3X, VQ3HJP, XZ2DY, and CR6AI since we last heard from him, and from his new spot with an antenna strung around the room he has worked XU4XA, VQ8AI, XZ2DY, FP8AA, EL2A, OQ5AV, CR7AF and others.

#### Here and There

It's good to see F8UE going up in the phone list. W8LFE said OX7ZL appeared on phone one night but he didn't sound right and didn't come from the right direction. KA1MG, Capt. J. E. McGraw, is now W7HJS and located at Fort Worden, Washington. He will be on the air shortly using a "4-25" exciter, in his new rig to drive his buffer. Final will be 211's. ON4HS is on 80-meter phone all the time and has worked all USA districts. He has 70 odd W contacts with one each with W5, W6 and W7. During one evening he contacted within an hour W1, 2, 3, 4, 5, 8 and 9 districts. W9CDT worked H17GW for a new country just a few days ago. W8SJG heard ZL2BE on 3905 kc. on the morning of February 24. W2GVZ has three new ones in CR4HT, EA9BA and FG8AA.

W6EGH reports that VP8AD told him he had been in the hospital for a while but is out and well again. VP8AD said too that he would be



A. D. Boyle, operator of ZL2VM.

J2MI, one of the best known phone stations in Japan. Notice the tube lineup and final. 2A5 crystal oscillator, 46, two 807's, two 860's, two 861's.



on the air shortly with a new rig using an 801 in the final. CM2AZ drops us a line for the first time saying he had worked TF5C which gives him 40 zones and 66 countries. W9AVV is a new dx man and is working nice dx with his 100 watts. W9CWW, still running 850 watts to his T125's, is always after them. W9VWV with 400 watts has 31 zones and is after more. W9OAAQ worked his 29th zone by getting CR7AF. He uses 250 watts. W9IEW is getting his rig on 20 phone. W9VKJ is on 7 Mc. all the time working dx skeds. These hams are all in Leavenworth, Kansas, and thanks to W9OAAQ for the info.

W1ZB is now W3HZH, W1CC is W3HXP and W1BDW is W3HWZ. These boys have all moved to Baltimore and are on the air again. Carl (W3HZH) got a break when his next door neighbor donated the use of two 60-foot sticks that had been idle in his backyard. When Carl was out on the coast last year he spent much of his spare time visiting around with the dx gang. When in Montana he saw Allan Eurich, who, you'll remember, was on the "Yankee." He is now W7HFZ. I hope they pick up their dx where they left off in W1, as they were really active brasspounders. W8AQT is up to 120 countries and is still going after them as he thinks there are more to be worked. G2UX is up a zone to 37 now and a few countries as well . . . HC1FG, HR4AF, XU8GW, VQ2PL, VQ4KTF, ZE1JT and LX1AW. He has hooked up with all districts on 28 Mc. except the W5. Guess W5BB and W5VV are not on much?

VE5RV sends a classified ad clipped from one of the Vancouver, B. C. newspapers:

**YOUNG WOMAN WISHES TO LEARN amateur wireless operating from party with ham-set, in order to obtain amateur ticket. State terms. Box 27 Province.**

Now if any of you have any ideas or terms, it's in your hands.

W6KIP gets his 39th zone in VU7BR. Also for new countries Alec has HH2ES who is Ted Esbrook, ex-OM1TB and XU8TB, KD6QLS on Midway, 7195 kc. and OQ5HR, 14,100. W6KIP has 139 countries. SP1AR adds VU7BR to make 98. He is doing a fine bit of consistent dx. W2KVA worked CT3AB who was about 7100 kc. W8QDU blew up his modulation transformer and, as he says, maybe it was a blessing as now he can do a little c.w. work. His results are two new zones and seven new countries. VQ2FJ and VU2BG are the zones and XU4XA, XU2AW, J8CA, U8IB and VS6AO a few of the countries W8QDU wants to know the QRA of U8IB.

VE2EE did a nice job last month in hauling in VP2LC, ZD4AB, VQ8AI, LX1AS, FP8AA and ZC6NX. Stan gives the QRA of ZC4AB as Care Wireless Station, Takoradi, Gold Coast. The QRA of CR4HT is Henrique Torres, Praia, Cape Verde Isles. Three new ones to our gang are VK2OQ, VK2TR and VK2AGU. G5VU is up to 33 and 81 now. He can't seem to get a card from any U9's. W6KWA has a suggestion . . . that no foreign dx station ever work anyone without at least giving one QRZ or CQ when finishing a QSO. The reason is that many times Walt finds that when a station signs over to someone about a hundred boys start calling and not a single satisfactory QSO results. As an example, he was QSO YS2LR and he told KWA that he counted 13 stations calling him while KWA was transmitting. What do you think? Anyway Walt has been active and now is up to 36 and 99.

Al Hingle, ex-W2AAL, now W4FVR, is back again with the news that he can take care of sending QSL cards to I7AA, and I7AA will check against his log and return his cards through W4FVR. Al gives the QRA of OQ5AV as: Maurice Derungs, 6, Av. Comite Urbain, Leopoldville (Kalina), Congo Belge. Also that EL2A has no cards but will be glad to send

letter of confirmation . . . if you write him first, and it might be a good idea to enclose a reply coupon. ON4AU has cards from VP7AA, G3QF, LZ1ID, U8AN and ZS3F. G5BD finds that competition stimulates his interest. It happens that his brother-in-law lives about 200 yards from him and they are both dx hounds. By the way, it looks as though G5BD heads the Marathon list this month, with G2FT right up in there. G2FT says that G8AP has a card from VP3ZA saying that he is with a roving mission and definitely on land. This blows up the report that he was a ship.

### 1939 DX Marathon

The Marathon is gaining momentum. The boys overseas are taking to it and right now it looks as though they will stay up near the top. D4QET says K7FIY was his first K7 . . . after 11 years of looking. K7FST is going to be hard to stop up there with his 20 and 41. His spot is so good that he shouldn't have much trouble snagging 'em from now on. These were worked from Alaska. W6ITH leads the phone boys with W8QXT right up in there. Keep up the good work, gang, and the recent dx contest should have boosted up your Marathon standing considerably. Remember, when reporting your Marathon score as well as the Honor Roll, be sure to keep them separated so that we won't confuse one with the other.

### More on the DX Contest

Now that the contest is over maybe we can restore ourselves to some degree of normalcy. What a madhouse it was with all those e.c.o.'s zipping around the band. The chief squawk of the fellows was that too many of them tuned zero-beat on the dx station, and usually were calling him when he was coming back to someone else. Along with that is the gripe of the few who tuned their rigs to zero-beat with the dx station and proceeded to tune up the rest of the transmitter, with the key down of course. Anyway, I guess it gave good experience copying through QRM. From reports all the gang seem to have used their band-edge frequencies very little . . . most of the work being done near the frequency of the dx station.

Without a doubt, 40 meters saved the day. 28 Mc. was not nearly as good as it has been in either of the past two years. And I really should get in another dig . . . and if I did it would be, "Don't laugh the next time I mention something about getting on 40." As I said in this column a couple of years ago . . . dx begins on 40. Some guy will pop up next year with a rotary 4 half waves in phase for 40.

W9TB says that according to his observations during the tests, W9TJ should be right up there, W8LEA and W8LEC were hitting the high spots, W2UK was always working something good, and in the 5th it looks like W5EHM or W5VV. W6GRL looks about set for the coast, with W7AMX up north, W3EMM and W3BES were also in there pitchin' and should be high. W9TB started out using a rotary for 10 and 20 and a vertical for 40. He then used the vertical as

half waves in phase for listening on 20. He found out that he couldn't hear much of anything on it so resorted to the rotary almost entirely.

YS2LR did yeoman's work on all bands. His best hour was on 7 Mc. when he contacted 32 stations. On 14 Mc. the best hour saw 26 go in the log. He said all he had to do was to finish one QSO and tune in the next station with the "pitch" control on his HRO . . . they were that close together. W4CEN and W4AH were running along at high speed and they undoubtedly have many points. W8LEC was laid up with the flu the first week-end and didn't get going until Monday. VK2EO, VK2ADE, VK2ALU were all going to town, as were ZL1MR, ZL4AO, ZL2CI, ZL4DQ and ZL1MQ. For K6's there seemed to be unusual activity with K6CGK, LKN, JPD, FAZ, PHD and PAH all doing their stuff.

J2JJ made the boys happy on 28 Mc. as there were only a couple other J's on the band . . . and then not very often. J2IX, who of course is now an x.y.l., seems to find time from her domestic duties to keep active on 7 Mc. On the west coast it was very noticeable during the first few days of the contest that few G stations were coming through. For that matter, there was a scarcity of all European stations on 20 meters. Last year there was a mob of them and everyone knocked off their quotas in no time. To me it seemed odd to hear the high-power boys out here straining everything during the middle of the week getting their G stations.

FM8AD was his consistent self as was HR4AF. On 7 Mc. XU8AM had the gang hopping for him. The VU's were few on this coast with VU2FO and VU2FX predominating. On the last afternoon VP6YB on 28 Mc. had the gang going nuts. He couldn't seem to hear any of the local gang although the band must have bulged in his face, when they would all call in unison. Out of a clear sky he did come back to a couple of San Diego district boys, W6GCX and W6GCT, and outside of that it was all east coast and W9's Tsk. We firmly believe he is a former resident of San Diego. Also on 14 Mc., ZD4AB drove the gang slightly gaga when he worked eastern W's and VE's, just any place in the band. The system of tuning near his frequency or tuning from the edge just wouldn't work. He must have just closed his eyes and picked. That's all right, though, as these things make a contest and there wouldn't be anything to talk about if you could sit right down and raise everything on the first call. I could go on at great length but we must get this into black and white, so I'll try to gather a bit more for next month.

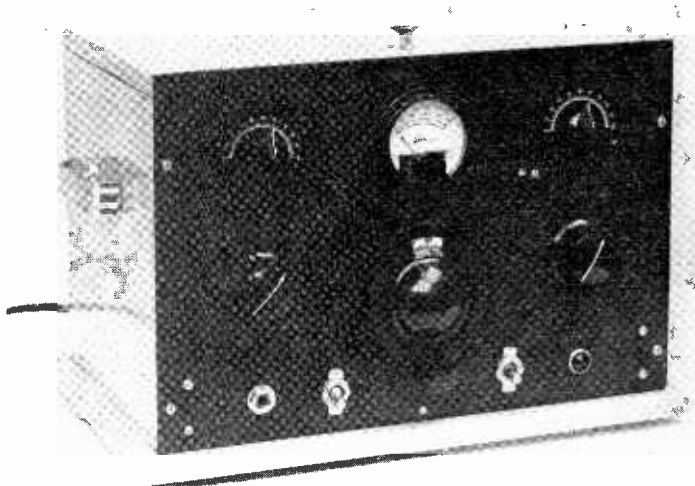
A couple of corrections . . . on the zone map in January, 1939, RADIO the Canary Isles are shown in zone 35. This of course is not true as the Canary Isles are in zone 33. The island group in zone 35 should be the Cape Verde Isles. The artist, when retouching the lettering on this small map, evidently got his zones mixed up as well as his alphabet. Anyway, the large zone map is correct . . . that's the one we'll send you for two-bits (Adv.?).

[Continued on Page 85]

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# THE AMATEUR NEWCOMER

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Front panel view of the unit showing the neatness and compactness of the layout.

## THE BAND-BOX

### *A Single-Unit Receiver and Transmitter*

By LLOYD V. BRODERSON,\* W6CLV

The mention of a combined receiver and transmitter without benefit of shielding usually will bring to mind problems of feed-back, inter-coupling, and r.f. pickup. These factors are of major importance in the design of high-power equipment but present no difficulties in the construction of low-power units. For all practical purposes a transmitter of comparatively low power may be mounted upon the same chassis as the receiver and each will still give good account of itself.

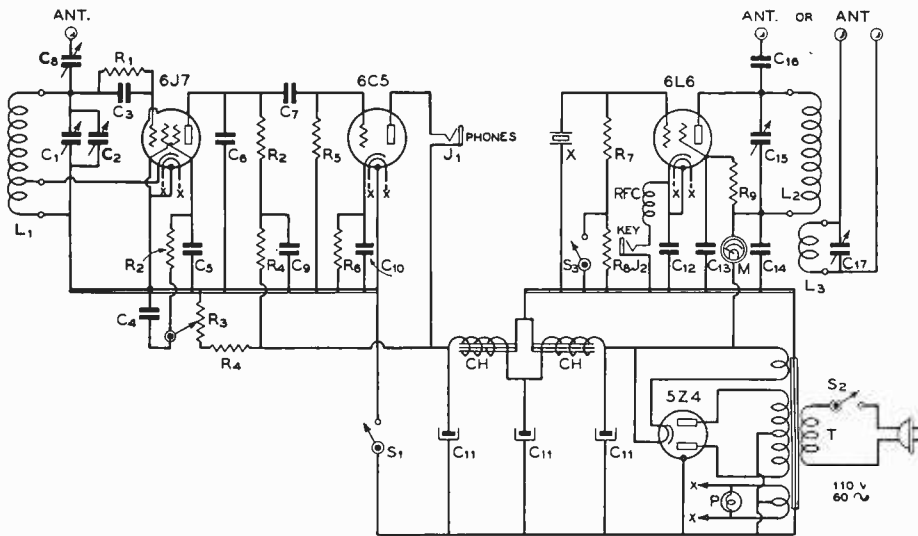
The unit here described may be constructed with ordinary woodworking tools; no metal

work is involved. Chassis supports and cabinet are of soft pine and all panelling is of masonite. Induced r.f. due to adjacent pickup is so small as to be negligible. The receiver is an efficient performer; the transmitter has reasonable power output (normal input: 22 watts) and the entire unit is operated from a single power supply. Complete, it weighs but 14 pounds—a distinct advantage should portable operation be contemplated.

#### Receiver Circuit

The receiver section is simplicity itself. A 6J7 detector with cathode regeneration is resistance coupled to a 6C5 audio stage. It is

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



Wiring diagram of receiver, transmitter and power supply.

C <sub>1</sub> —100- $\mu$ fd. midget	C <sub>11</sub> —8- $\mu$ fd. 450-volt electrolytic	R <sub>2</sub> —100,000 ohms, 2 watts	R <sub>7</sub> —10,000 ohms, 2 watts
C <sub>2</sub> —15- $\mu$ fd. midget	C <sub>12</sub> —.00015- $\mu$ d. mica	R <sub>3</sub> —50,000-ohm potentiometer	L <sub>1</sub> , L <sub>2</sub> , L <sub>3</sub> —See coil table
C <sub>3</sub> —.0001- $\mu$ fd. mica	C <sub>13</sub> —.01- $\mu$ fd. 400-volt tubular	R <sub>4</sub> —20,000 ohms, 2 watts	T—680 v. c.f., 55 ma.; 6.3 v., 1.5 a., 5 v., 2 a.
C <sub>4</sub> —0.1- $\mu$ fd. 400-volt tubular	C <sub>14</sub> —.002- $\mu$ fd. mica	R <sub>5</sub> —500,000 ohms, 2 watts	CH—10 hy., 40 ma.
C <sub>5</sub> —.01- $\mu$ fd. 400-volt tubular	C <sub>15</sub> —100- $\mu$ fd. mid- get	R <sub>6</sub> —1500 ohms, 2 watts	S <sub>1</sub> , S <sub>2</sub> , S <sub>3</sub> —S.p.s.t. toggle
C <sub>6</sub> —.0001- $\mu$ fd. mica	C <sub>16</sub> —.002- $\mu$ fd. mica	R <sub>7</sub> —15,000 ohms, 2 watts	J <sub>1</sub> , J <sub>2</sub> —Open-circuit jack
C <sub>7</sub> —.01- $\mu$ fd. 400-volt tubular	C <sub>17</sub> —100- $\mu$ fd. mid- get	R <sub>8</sub> —8500 ohms, 2 watts	RFC—2.1-mhy. choke
C <sub>8</sub> —35- $\mu$ fd. mica trimmer	R <sub>1</sub> —5 megohms, 1/2 watt		M—0-100 ma.
C <sub>9</sub> , C <sub>10</sub> —0.5- $\mu$ fd. 400-volt tubular			

a tried and proven circuit and retains some excellent features even in this day of more elaborately designed receivers. Should the builder so desire, the 500,000-ohm fixed resistor in the grid of the audio stage may be replaced by a midget-type volume control. This may be mounted on the front panel wherever convenient.

### Transmitter Circuit

The transmitter portion consists of a 6L6 (metal type) regenerative crystal oscillator with provision for fundamental and harmonic operation. Relatively high efficiency with low r.f. crystal current and its ability to be heavily loaded are its outstanding characteristics. No troublesome keying problems will be encountered and the usual attendant "bugs" have been quite conspicuous by their absence.

A glance at the power supply portion shows no radical departure from customary practice.

Two filter chokes combined with three 8- $\mu$ fd. filter condensers adequately filter the d.c. The transmitter positive terminal is taken directly from the rectifier filament thereby enabling the full rectified output to be applied to the plate of the 6L6 tube. A single-pole switch in the negative lead disconnects the receiver during transmission periods. It may, however, be left closed should break-in operation be desired.

### Construction

The layout diagrams and photographs clearly show the location of all components above the chassis. The front panel is finished in black crackle and holds the following controls: from left to right at the top portion are the regeneration control, transmitter plate milliammeter and transmitter antenna coupling condenser. A bandset condenser and the vernier tuning and plate tank condensers occupy the center portion. The lower panel space is



Rear view of the combined receiver-transmitter.

occupied by the phone jack, negative lead switch, a.c. line switch and the pilot light.

The masonite chassis, also finished in black crackle, holds all the necessary sockets in addition to the power transformer. Their positions may be somewhat modified to meet individual requirements but the layout diagram in general should be followed as closely as possible.

Equipment already on hand and frequent visits to the proverbial "junk box" will no doubt yield a good portion of the needed material. Wafer type sockets may be used to advantage but a good low-loss socket is advisable for receiver coils and the 6L6 tube. The diagram as shown is the best all around solution for parts placement and the resultant short leads are well worth a little time and effort. The end pieces supporting the chassis are also of soft pine, sanded, and finished with two coats of grey enamel.

The rear terminal strip completes the assembly. Upon this are mounted the feed-through insulators, crystal doubling switch, keying jack and the outlet for an a.c. line cord.

### Wiring

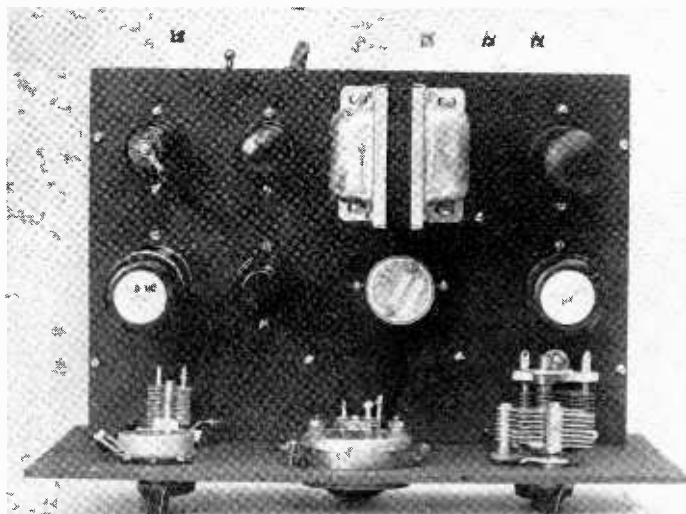
As no shielding whatsoever is employed, a few suggestions regarding the wiring of each section will nullify any chance of stray coupling. The two filter chokes are mounted directly underneath the power transformer; the same mounting bolts that hold the transformer also hold the chokes. As the 5Z4 rectifier tube is directly opposite these parts, the major portion of the power supply wiring is very compact. The three 8- $\mu$ fd. filter condensers are mounted as close to the transformer-choke assembly as possible. Midget

### Coil Specifications

Receiver:	3.5-Mc. band—28 turns, slightly spaced. Cathode tap two turns up from the grounded end.
	7.0-Mc. band—14 turns, slightly spaced. Cathode tap one turn up from the grounded end.
	14.0-Mc. band—8 turns, spaced to cover a winding length of $1\frac{3}{4}$ ". Cathode tap $1\frac{1}{2}$ turns up from the grounded end.
Transmitter:	3.5-Mc. band—31 turns, close wound. Antenna coil: 12 turns close wound.
	7.0-Mc. band—15 turns, slightly spaced. Antenna coil: 8 turns, close wound.
	14.0-Mc. band—7 turns, spaced to cover a winding length of $1\frac{1}{2}$ ". Antenna coil: 4 turns, close wound.

Transmitter plate and antenna coils wound on same form. Spacing between coils is approximately  $\frac{3}{16}$ ".

Coils for both receiver and transmitter are wound with no. 20 enam. wire on  $\frac{1}{2}$ " dia. forms.



Looking down on the sub-chassis of the complete unit. Although the placement of components can be seen fairly clearly from the photograph, the layout drawing accompanying the article will allow the placement to be exactly duplicated.

type paper condensers of the ratings specified may be used to conserve space. The remaining components may be placed wherever convenient. It will be found that because of the layout each section, transmitter, receiver and power supply, will have the majority of its wiring in its respective area. Heater and pilot light leads are twisted.

The grid leak and grid condenser connecting to the cap of the 6J7 should be located as near to this point as possible. In no case should any attempt be made to mount these parts beneath the chassis. The extra length of lead necessary for this would enable a.c. hum pickup to become objectionable.

All receiver negative leads terminate to one connection on the switch SW<sub>1</sub>; those of the transmitter go to the remaining contact. Should these leads inadvertently be connected together before reaching this point a continuous ground will be established rendering the switch inoperative. Insofar as possible the greater portion of the ground leads should terminate at some predetermined point. Receiver grounds in this model are connected to the ground side of the receiver coil; those from the transmitter go to the rear right bolt holding the transformer. All tube shields are grounded as well as transformer and filter choke cases.

The receiver antenna lead terminating at the standoff insulator on the rear strip should not parallel those antenna leads from the transmitter for any great length. Rotor connections on all variable condensers are "pig-tailed"—nothing can be more exasperating than an erratic wiping contact. The remainder of the wiring will be quite simple and if the

foregoing is given more than casual attention, no trouble will result.

#### Power Supply

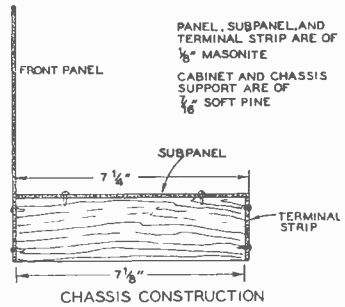
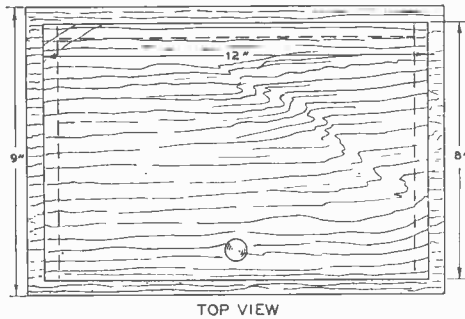
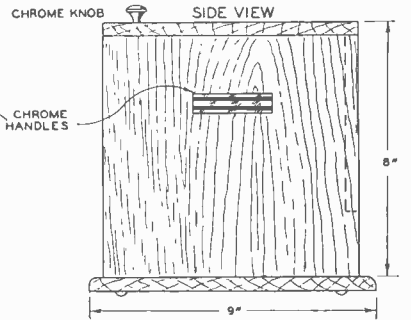
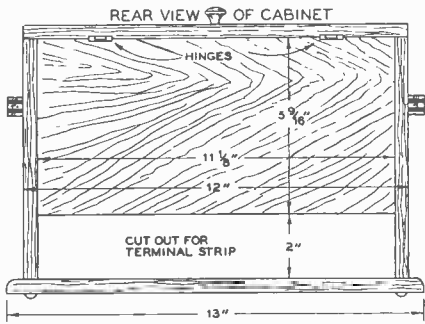
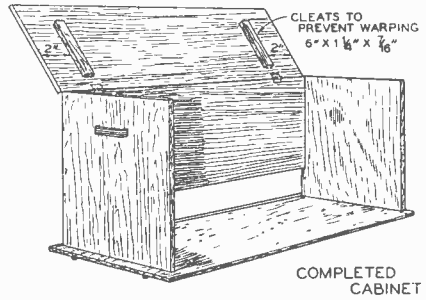
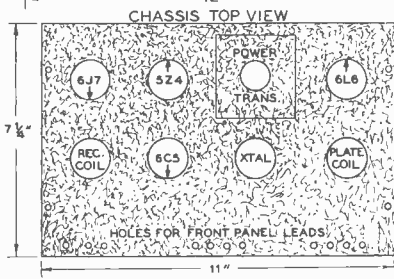
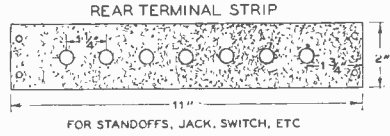
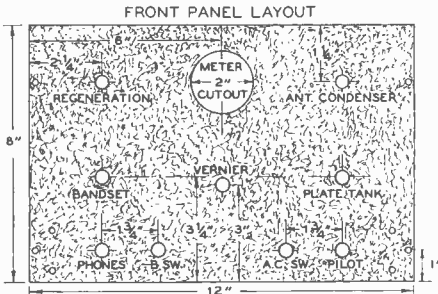
The transformer specified delivers 680 volts center tapped at 55 ma. In addition there is a 5-volt 2-ampere winding and a 6.3-volt, 1.5-ampere winding. Any transformer having the above ratings may be used if it is borne in mind that the 6.3-volt winding furnishes heater current to all tubes except the rectifier and therefore should not be rated at less than 1.5 amps. A 20-watt, 25,000-ohm bleeder resistor may be incorporated, if desired, purely as a precautionary measure. However, the filter condensers operate well within their ratings and the bleeder really is not necessary.

#### Coupling Methods

Two of the more common methods of coupling an antenna to the plate tank coil of the transmitter are shown. The builder may omit the one not adaptable to his requirements. Should portable operation at some future time be contemplated it would be advisable to incorporate both systems. The antenna coil may be connected to any system employing two-wire feed, such as a zepp or a twisted-pair non-resonant line. Should the antenna be of such design that additional capacity is required to establish resonance, a fixed mica condenser of .00015  $\mu$ fd. may be shunted across the .0001- $\mu$ fd. variable thereby extending its capacity range to .00025  $\mu$ fd. The connection from the hot end of the plate coil is well adapted as coupling to end-fed

[Continued on Page 83]





Layout drawings of cabinet, sub-chassis and placement of components.

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# U. H. F. . . .

By E. H. CONKLIN,\* W9BNX

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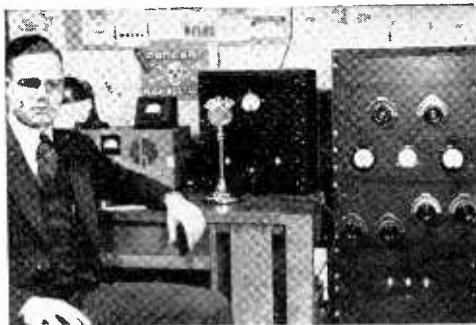
## 56 MC.

Perhaps we are taking liberties with the facts or getting the cart before the horse by mentioning that there was a severe ionosphere storm from noon on February 24 to 8 a.m. February 26, eastern time. Another started at 10 p.m. March 3, ending at 2 p.m. March 4. The third occurred between 1 and 6 a.m. March 6. Displays of Aurora Borealis were reported at various points on the 24th. At any rate, the peculiar action of amateur bands is worth noting, particularly the unusual 56-Mc. dx.

In Johnsonville near Albany, N. Y., W2KLZ was listening on 28 Mc. at 2:30 p.m. February 24 and heard several W1 and W2 stations coming through with strong signals, but fluttering rapidly. Shifting to "five," he struck a dx signal around 58 Mc. with the same identifying flutter, then found another station on the low end of the band. These were heard all afternoon well enough to have copied keying but the modulation, if there was any, was made inaudible by the flutter. At 5 p.m. he gave up calling CQ dx on "five" and went up to the 80-meter band where signals were fading deeply and rapidly. At 7:30 there were more carriers on 56 Mc. and at last W8VO in Akron replied to a CQ with code. W8SLU near Pontiac, Michigan, was heard at about 8:25 p.m., and both sides of a contact between W8RV (Buffalo) and W8VO were logged. A peculiar effect was that dx signals averaged about the same level for long periods of time. W8VO built up gradually and then slowly faded out at 9:30.

W8VO heard the band open up at around 7 p.m., apparently for the 1st, 2d, 3d, 8th and 9th districts. At first, stations had a clean c.w. note and then a mushy modulation gradually set in, with many good crystal stations like W2AMJ, W2KLZ, W8RV and W8SLU

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W9ZJB, Kansas City, Missouri.

spreading out to between 175 and 300 kc. wide. \* Not one word of phone could be understood, and both c.w. and i.c.w. sounded alike. The modulation seemed to be above 7 kc. and created a loud racket in the receiver. Ordinarily the receiver is only 25 kc. broad. Stations within 50 miles were the same as dx except louder. There was no periodical fade except the modulation present on all signals. A strong local oscillator would not heterodyne any of the signals. Altogether, 29 carriers were heard up to 58.5 Mc. before the mushy signals appeared all over the dial. Contacts were made with W2KLZ, W2AMJ (New Jersey), W1KAF (KTF?), W8SLU. Some W3's were heard, one call sounding like "W3GOK." With bad fading, the dx went out shortly after 9 p.m.

Commercial stations on 2930 and 3105 kc. were at times out of commission due to 10 to 25 cycle modulation on their carriers, and several times from QRM of unknown origin. Reports indicated that even the 160-meter band was subject to flutter, but the amplitude was less than on higher frequencies. W8VO reported slight effects of the same sort on 56 Mc. on December 28, January 3 and 8, and on February 3.

W8RV says that VO was R6 to 9 in Buffalo and Niagara Falls but, oddly, the quality of phone was bad and code was necessary to make a contact. At the time, RV's antenna was nearly at right angles to VO; he uses a four-section vertical W8JK quite similar to the one at W9CLH. He heard W2AMJ about R4 during the contact with VO.

In Glenview, outside of Chicago, W9VHG heard all eastern and nearby districts on 28 Mc. in the afternoon and expected something to happen on "five." After dark, signals had a peculiar hollow sound, with a great deal of hum and noise, making them hard to understand. At 7 p.m. central time, 56 Mc. started to come through, and both sides of the W8RV-VO contact were heard on a horizontal 10-meter antenna. VO was R7 and RV was R3 but both covered wide bands more

like modulated oscillator signals. W5BEN/9 saw the Aurora display that night and learned via 28-Mc. contacts that it was visible in England and New Zealand also. W9QDA in Chicago heard 28-Mc. signals from Indianapolis, and from Springfield, Illinois. Chicago stations were heard in Milwaukee.

In Akron, W8LVV heard VO's work and mentioned that 14 Mc. was in bad shape, W2 and W9 stations sounding as if they were using 25-cycle power supplies; W6's came through all afternoon but only G2VF from Europe. On 80, the Ohio relay net faded out around seven o'clock which gave him the idea of listening on five meters.

According to a 10-meter report, GM6RG finally worked W3GSV, R9 plus both ways, after midnight in Scotland. It might have been the first day since August that GM6RG failed to make a contact with a W.

Frank Lester, W2AMJ, observed that VO's signals were of the "around the corner" type on the 24th, with none of the characteristic fading that accompanies dx signals. He thought that VO was operating portable. VO was heard and called by W1KTF and W1EYM on code but signals were starting to drop out. There were still plenty of other carriers coming through at AMJ but apparently with no modulation on them. VO's voice had a considerably lower apparent percentage modulation than i.c.w., in addition to being badly scrambled. Practically all 10- and 20-meter harmonics had a peculiar combination howl and roar on the carrier with various degrees of voice modulation distortion. All of the 20-meter harmonics were considerably worse in this respect than 10-meter harmonics. The Aurora was quite pronounced, and its strength was directly related to VO's signals so it seems quite possible that it was responsible for this transmission (there may have been no "skip," though, unless it was between Albany and New York).

W2AMJ and W1EYM had been observing the peculiar noise accompanying carriers, and found it to a minor degree several times earlier in February. EYM noticed one night that it seemed to shift around, with signals from different directions apparently taking on the peculiar sound.

On March 3, AMJ worked W1KTF. The peculiar carrier noise seemed to develop toward the end of the contact, and VO's signals again came in both at AMJ and EYM for about ten minutes around nine o'clock, much weaker this time. The moon was too bright to permit observing Aurora, if there was any.

On March 1, W8VO heard the band loaded with mushy phones that seemed to be W2's

and W3's. On the third, he heard W2KLZ clear enough to copy on code but fading at half-minute intervals was bad. At times signals were as loud as on the 24th but mushed up more than ever. Carriers were clear on a long horizontal wire but too weak to copy modulation. W8CIR could only find one carrier and failed to identify it.

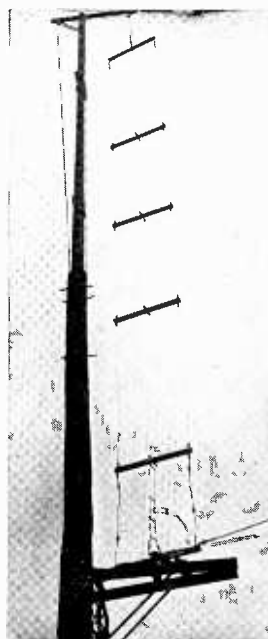
The same condition was reported during the evening by W2KLZ who heard loud mushy carriers and a network program (52 Mc.).

One odd thing about all this is that all distances out to some 400 miles appeared to come in simultaneously with no skip except possibly between W2KLZ and W2AMJ-W1EYM-W1KTF.

### February 22 Relay

After working W8CVQ in Kalamazoo from W9CLH in Elgin both morning and evening on January 1, we thought something would come of the February 22 relay. The day in Wheaton started out at zero degrees, and the sky was that deep blue which generally indicates no bending of five-meter signals. Hearing nothing but Lake Bluff, Wilmette and Chicago signals, plus one unidentified but steady carrier around 58.5 Mc., we were reduced to ragchews.

It later came out that CVQ had trans-



W8RV's four-section vertical 8JK on 56 Mc.



WIHXE, who has received confirmation of 56-Mc. reception of C5ML.

mitter trouble and did not get on until late. He heard a call from W8IUD in Wyandotte, south of Detroit, and a carrier on W9CLH's frequency satisfactory for c.w. operation—but someone had taken home the key at W9CLH and it was phone or else! CVQ heard several more unidentified phones before closing up. In spite of the bad dx weather, it was apparent that c.w. signals could have been put from Elgin, Ill., to Detroit, Mich., with the one relay. CVQ worked W8SLU beyond Pontiac, IUD, and heard MDA on phone in Ann Arbor two nights before, with rather low power at these stations. IUD could copy only c.w. through auto QRM. MDA said that CVQ's strength on the 22nd was only enough for c.w.

North of Detroit, W8SLU has been doing good work, contacting both CVQ and VO two nights before the relay, hearing CIR (in Pittsburgh—a good long haul, especially in winter!) and QKI in Ashtabula. A message from W9LCH could not be handed to VO before signals faded out, VO having been busy with CIR while conditions were good. SLU puts 100 watts on HK24's on phone, 150 watts c.w., using a W8JK antenna 45 feet high. Receiver is a Hallicrafters 5-10.

From Akron, W8VO reports a blizzard with heavy snow static making reception impossible until late afternoon when QKI in Ashtabula was raised. The latter had not been able to make contacts. SLU in Michigan had come through for nearly two hours on the 20th, but VO was tied up with CIR and made the contact when phone had gone out and even c.w. was weak.

In Toronto, VE3ADO was able to give a message to W8NOR in North Tonawanda, across the lake, but it died at POL in Buffalo without getting to Erie, Pa., or Pittsburgh due to the unusually low signal level. The week before, W8RV had tried unsuccessfully to work into Erie, although he had little trouble getting across to Toronto. W8PK could only work AGU and PLQ on the 22nd.

W3RL says that W8RDC at Romney, West

Va., may put a 100-watt rig in a filling station on Alleghany Front Mountain, to break the gap in the southern route. RL passed a message through GMZ and HDC to HI in Baltimore, where reports cease.

W2MO was able to get 650 watts on the air, with 300 watts to the antenna, and worked W3's and W1's on the 22nd. Messages from W3BZJ originating at Wilmington, Del., and from W3BYF at Allentown, were relayed. W1KTF EYM, W3BYF BZJ HOH AXR FVR GJU comprised all the signals that were heard.

W5CSU/1 and W1JDO didn't even hear any signals outside of the Boston area.

### Miscellany

W8CVQ's new acorn receiver is so sensitive that he is having trouble with harmonic QRM even from the 160-meter band. He finds that the 600th harmonic of a 100-kc. oscillator in the college lab. can be picked up.

Robbie, W4EDD, reports via 28 Mc. that he has a five-element rotary, a half-kw. transmitter, and several good receivers ready for the May-August dx.

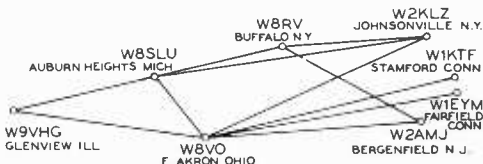
W9ZJB is all set with a crystal-controlled phone, beam antenna, and new 5-10 receiver. He says that UIZ in Leavenworth is getting into Kansas City with the new 65-watt transmitter, and worked SMM for the first two-way.

Activity in the New York metropolitan area has picked up, according to W2KDB.

A u.h.f. banquet in Buffalo on February 25 was attended by W8AGU-BO-QKI-GBK-LMK-OLB and VE3ADO. Tests starting on March 13 were arranged.

W4DRZ in Fort Lauderdale, Florida, now has 100 watts on five meters and is working regular schedules with W4EDD near Miami, both ends being R9 all the time. He is in a good position for contacts during the summer dx.

We used to hear from W3HI and W3WA around Baltimore until they sent us a story about helping at a regatta. The story was set in type, left out of one issue because of



February 24 56-Mc. DX contacts.

space, and the type was not moved east when we changed printers. So it wasn't our fault. And they can't be as peeved at the Editor as we are for having left out that December 56-Mc. dx story which was supposed to have missed the deadline for one issue, and its omission from the next was never explained to us. There was really a lot of good dx that day, but only the barest mention appeared in this column because the best of the story went into the separate, and unpublished, article.

W8RV sends us a copy of our 56-Mc. column sent by facsimile transmission. We have received the funny paper from W9CLH that way, too.

The active Connecticut stations, according to W1IJ, are W1KTF EYM BRL KPN KQC JLK IXP BKO KJT KLJ LJA LFS HDF KJC LLL KEE IPV ADZ. Almost sounds as if the band isn't dead up that way.

The Washington gang are more active now, says W3RL, with W3HDC AWM DBC GMZ ADQ on the air.

The preliminary results of the R.S.G.B. 56-Mc. dx contest indicate that W9NY's forty two-way c.w. contacts over 200 miles will be tops.

Perhaps our face should be red. Last June W1HXE heard "CQ dx CQ dx de G5ML" on 56 Mc. We pointed out that W5ML was being reported that day, but now HXE turns up with a confirmation card. Oh well, British stations aren't supposed to call "CQ." HXE sent us a copy of the *News* of his club, which indicates that W1LGY LGG LEA LCC are active again.

#### Frequencies

Judging from the following list of frequencies, the most jammed part of the 56-Mc. band is likely to be just above 57 Mc., resulting from use of 28.5-Mc. phone band crystals. Another concentration is at the low frequency edge.

W8QDU/8	56,016	W8MSK	57,020
W8JLQ	56,020	W9ZHB	57,020
W8MST	56,032	W8QDU	57,032
W8BIQ	56,040	W9ZJB	57,048
W6OIN/6	56,052	W9QCY	57,048
W6RR	56,056	W3GMZ	57,240
W8OPO	56,080	W2KLZ	57,350
W3HDC	56,120	W9ZJB	57,664
W9FEN	56,216	W3RL	57,964
W2ETN	56,216	W2JCY	58,000
W1LFI	56,488	W8CVQ	58,020
W8JHW	56,720	W8IUD	58,108
W9IEZ	56,720	W1JFF	58,656
W8NOR	56,960	W9ZJB	58,960
W8VO	57,010	W3AWM	59,344
W3DYE	57,012	W8DPN	59,950
W2AMJ	57,015		



56-Mc. contact QSL's on the wall at W9ZJB.

From the Merrimack Valley Amateur Radio Club *News* we cop this little tidbit:

#### SIGNAL SEARCHING

By Jerry LeRoy, W1LSN

We up in New Hampshire do listen to hear  
Some action and voices to bring us good cheer.  
Since the first of December, the year just gone  
past,

The 5-meter band sounds like it's been gassed.  
Our pure stable signals, delightful to hear,  
Don't bring us the ragchews, now classed as so  
dear.

The boys who all voted "the law should be  
changed"

Must all be confined, or lying in chains.  
So we'll keep right on listening—Lo! What can  
that be?

Sure nuff 'tis the carrier of 1ERT.  
He's calling SI, the boy of Revere.

There's one or two others, not mentioned within,  
Standing by on 5 meters, a QSO to begin.  
Calling CQ and CQ, times goes by the hours—  
Better call up the greenhouse and order the  
flowers.

What! A signal we hear? Nope, it's gone to our  
head,

That 5-meter band sure nuff has gone dead.  
So we'll just carry on and work those whom we  
may

And hope that 5 meters will have a new day.

#### 112 MC.

There seems to be no lack of interest in  
2½ meters, and if the seasonal factor is like  
"five," there should be plenty of activity dur-  
ing the late spring and summer.

W1DVI in Holyoke, Mass., is getting ready  
to go on the band. W5CSU/1 says that about  
fifteen Boston stations are in regular operation.

[Continued on Page 93]

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# POSTSCRIPTS...

*and Announcements*

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## FCC Amateur Convictions

Attention of the amateur fraternity is called to the fact that the FCC is dropping its somewhat lenient policy of previous years with regard to amateur infractions of the regulations and is meting out punishment in proportion to the seriousness of the violation. On February 20, 1939, the FCC announced its action in the case of the following alleged violations of the Communications Act of 1934, as amended. The Commission further ordered that all these parties be given fifteen days from receipt of this order to make application for hearing. If the application for hearing is not made the orders become immediately effective.

Harold J. Collins, Dayton, Ohio—The Commission *suspended for six months* the Amateur Radio Operator's License of Harold J. Collins because said operator is alleged to have taken the examination for amateur operator's license under the name of Isrel H. Snyder for the purpose of obtaining for Mr. Snyder an amateur operator license.

Martin F. Clarke, St. Paul, Minnesota—The Commission *suspended for six months* the Amateur Radio Operator's License of Martin F. Clarke because said operator is alleged to have communicated with an unlicensed radio station, failed to keep an accurate log, and failed to notify the Commission of portable radio operation in violation of Rule 387.

Chester Orville Bishop, Zillah, Washington—The Commission *suspended for three months* the Amateur Radio Operator's License of Chester Orville Bishop because said operator is alleged to have operated an amateur station on frequencies for which his license was not valid.

## Re February Cover Photograph

For those readers who may have been intrigued by the intricate looking device which made the cover photograph for the February RADIO, further information on the material may be found in two articles by Grote Reber which have appeared in recent issues of

*Communications*. The first, "Electric Resonance Chambers," appeared in the December issue, page 5. The second, "Electromagnetic Horns," appears in the February, 1939, issue of the same magazine, page 13.

## 51,000 Licensed Amateurs in U. S.

The FCC recently announced that there are slightly over 51,000 licensed amateur radio operators in the United States at the present time. Since quite a few amateurs own more than one station, the number of licensed stations is slightly above this figure. Small wonder that the QRM situation is becoming increasingly acute.

The FCC announcement also made note of the fact that there are more than a thousand "shut-in" amateurs and more than a hundred operators who are blind. The blind operators most frequently take their examinations in Braille. The tests are then sent to the Library of Congress for transcription from whence they are sent to the FCC for rating. The blind operators take the same code test in sending and receiving as other applicants.

## Re "Electrical Multi-Measurements"

Several errors inadvertently crept into the article "Electrical Multi-Measurements" as it appeared in the March issue of RADIO. Two of the errors appeared in the circuit diagram, figure 5, on page 27. 1. The common terminal of the voltage resistors should be connected to the movable member of switch  $S_2$ . 2. The connection to the stationary member of switch  $S_1$  should be connected to the wire which it is shown passing over in this same wiring diagram.

On page 27, second column, the text states that the entire resistance of the L.O. circuit should total exactly 20 ohms. It should be 30 ohms. Also, the equation on page 29:  $L = (0.388)/I$  should be  $L = (0.318)/I$ . And the one on the same page which reads:  $C = (26.6)/I$  should be  $C = (22.1)/I$ .

## 56 Mc. DX Field Day

QST joins with us in announcing a series of dx periods on each Saturday and Sunday in May, special efforts to be made at 9:00 a.m. to noon Central time and 5:00 p.m. to 8:00 p.m. Central time on these dates. It is suggested that frequent calls be made, going over the band carefully for dx; and that contacts during the above periods be made short to permit covering all possible contacts. Emphasis should be placed on calling and signing with c.w. to squeeze an extra 100 miles of dx out of present equipment.

Report your work for publication; comments received by E. H. Conklin, W9BNX, Wheaton, Illinois, up to May 10 will appear in the July u.h.f. column.

# YARN *of the* MONTH

## BAYING AROUND THE BAY ON 63 Mc.

As nearly everyone knows, the construction of one of the world's greatest bridges was facilitated with the use of ultra-high-frequency radiotelephones. All piers, shore bases and floating equipment were interconnected by u.h.f. sets.

Of the several thousand connected with the project who used the equipment, very few knew anything about radio and the balance cared much less. This gave rise to many amusing incidents, a few of which will be recounted:

One morning the chief engineer went over to the equipment on his power cruiser to call his office. The air was found to be in use. The surveyors on the triangulation stations had very little to do except when making actual readings on pier sights. So they were occupying the air as follows:

"North triangulation station calling island station."

"Island station answering; go ahead, Bill."

"Say, Jack, have you a copy of this morning's Chronicle? If so, turn to page eighteen and on number fourteen vertical give me a five-letter word meaning 'to run'."

"Okay, Bill, just a minute. Etc."

One of the 63-Mc. antennas was erected on top of a large shed on a pier platform. This shed roof was an excellent spot to place a large sign to advertise to passing ferry boat passengers where they might get bridge piers built and by whom. To illuminate this sign a series of pipe standards was lined up. All these pipes happened to be a half-wave of the antenna length and were spaced so as to make a perfect series of parasitic reflectors. Much directivity of the signal was noted, in the wrong direction! The situation was carefully explained to the Boss Electrician, who sent Butch, a helper, out to the pier armed with a hacksaw and a folding rule. Butch carefully measured and cut a foot off each pipe, then surveying the antenna, carefully lopped a foot off it also!

A report came in one day that one of the stations had very low modulation but only when a certain foreman was in charge. An investigator was sent out to snoop into the matter. His report: "Since the loudspeaker is used for signalling, Johannsen when throwing the switch to transmit would lean over the edge of the table and holler at the speaker. The handset microphone, being hung on the wall, would get only a fraction of the normal input."

Speaking of handsets, they served a very useful purpose when a hammer was not handy. Many handsets were used for driving nails, cracking nuts (both human and edible) and general pounding on the walls. Never a one broke unless it just accidentally fell from the table less than three feet to a carpeted floor. Then at least a dozen pieces could be picked up.

To show why spoken communication should be carefully written down when a message is handled, we recount this one. Pier seven called into the wrong office and requested a message be relayed to a warehouse via a boat. This meant the officeman would try to remember the message, shout it to another person who would deliver it in person to the warehouse. The original message was, "Pier seven wants to know when the bolts will be sent out today." As finally delivered, "Pier seven wants several bales of hay." Yes, several bales of hay actually were purchased and sent out to the pier.

It was reported that a certain pier could not be reached late at night to get the hourly reports. Work was actually suspended, only a watchman being on the pier. A boat trip caught the fellow by surprise. What a funny sight he made. He was kneeling on the table, a screwdriver in one hand, pliers in the other, flashlight between his teeth and the set half apart. Only explanation was, "Just trying to

*[Continued on Page 89]*

By D. REGINALD TIBBETTS, W6ITH



Pine Junct., U. S. A.

Dear Hon. Ed.

Sakes goodness alive, hon. ed., what you think? Scratchi are temporary inmate of Pine Junct. City Hospital, where are cooperating from infernal injuries receive in auto accident. Scratchi are get so absorb in working 10 meter mobile rig in car that forget to pay attentions to such minor details as curve in road, also truck coming in opposite direction. Blooey. Scratchi are wake up calling "CQ 10 meters" with half of selfs in plaster casting, and pretty nurse taking pulse reading.

While Scratchi are lye in bed for repairs, are get acquainted with fellow who are very smart gentlefellow indeed. He are a grate explorer he tell me and have bin everyplaces. We are get along fine, and get to be very friendly until he discover I are the fellow who run in to him. You see, hon. ed., he are the truck driver, and are slightly soar about getting both truck and selfs smashed to peaces, especially the latter. Whooey, he are madder as a wet hen.

So Scratchi are not visit this fellow any more, on account of he get so mad when see me that doctor are say that he are likely to throw a fit, on account of cannot get loose from ropes which are got him tied up from ceiling and oh, boy, hon. ed. What that fellow are threaten to do to me if could get hisself loose.

Well, Scratchi are not got anybody to visit now, so are just keep company with selfs, and lye here and think what a fine fellow I are. Also are get some slick idears which might interest you hon. ed. One are how to raise stations on 10 meters. All a fellow have to do when want to raise somebody are put a telephone mike on rig and say "Portable mobile W6— in the 6th district calling CQ." Are positively garantee hon. ed. that will get four times as many replys using this system. To keep from telling a lye, hon. ed., you can walk around room holding mike in hand while talking.

Also, Scratchi are got grate idear for a beam antenna what are not need rotation, are

very directive and sharp, and good for all directions at the same time. Scratchi have it figger out that if can put up a very sharp diamond right at the North Pole and aim it due south, it will have tremendous power gain and hit everyplaces at same time, because everyplace in world are south from antenna, and therefore rite in line with the beam. Have not quite figger out how to adapt the idear so antenna can be used the same way at other locations than North Pole, as are very cold at the North Pole and too far away to put a ham shack or run remotely control or feeder wires. But are working on that now, and expect to have the problem licked before get out of this place, provided the truck driver are not get well first. He are very anxious to see me just as soon as they will let him loose.

Respectively yours,

HASHAFISTI SCRATCHI

## NEW CATALOGS

The latest edition of the RCA Receiving Tube Characteristics Chart 1275-B, dated February, 1939, is just off the press. The chart is published in the form of a 5½-inch by 8½-inch booklet comprising 12 pages. The booklet gives characteristics data on 191 RCA tubes including glass, glass-octal, GT, and metal types in numerical-alphabetical sequence. Socket connections with RMA designations are shown at the end of the booklet.

All readers may obtain a copy of the booklet from their RCA tube distributor, or on request from Commercial Engineering Section, RCA Manufacturing Co., Inc., Harrison, New Jersey.

The Spring-Summer edition of their transformer catalog, no. 400-CX, is announced by the Thordarson Electric Mfg. Co., 500 W. Huron Street, Chicago, Ill. Several new transformers are included for the serviceman, public-address engineer, and the amateur. Copies may be obtained free of charge from any Thordarson distributor or direct from the factory.

The Hammarlund Manufacturing Company, Inc., 424 W. 33rd St., New York City, announces a 1939 second edition catalog. This new and complete 20-page catalog contains many items which have recently been added to the Hammarlund line. Among these are variable condensers of improved design, transmitting foundation units, and other new and interesting components for both transmitting and receiving. Complete technical details, mechanical as well as electrical, are given for the various parts. This catalog will be mailed without charge to anyone requesting it.



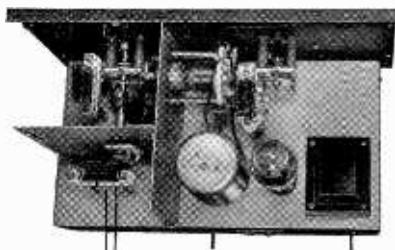
What's New . . . .

## IN RADIO

### New Tubes

Mention was made in the March issue of the fact that a new series of tubes, designated as the GT series, was being manufactured by RCA. The new tubes have short tubular envelopes and octal bases but are not necessarily single-ended as are the new S series tubes. At present there are available in the 6.3-volt classification the following types: 6A8-GT, 6K7-GT, 6Q7-GT, 6F5-GT, and 6J5-GT. In addition there are a 12A8-GT, a 12K7-GT, and a 12Q7-GT available in the 12-volt series and a beam-power amplifier and full-wave rectifier in both the 25-volt and the new 35-volt series. The characteristic letter and element number (such as the "K7" of the 6K7-GT) indicate the tubes with which they correspond in the conventional series.

### New 5-10 Meter Converter Kit



The Wholesale Radio Service Co., Inc. has announced a kit-form converter which is being produced by the Lafayette Radio Corporation. The converter kit, which is designed for five- and ten-meter operation, employs many of the design features of the converters described in the December and January issues of RADIO. Frank Lester, W2AMJ, is responsible for the design of the unit.

The kit employs one of the new 1853 ultra-high-frequency amplifier tubes in the tuned r.f. stage, a 6K8-GT combined mixer and oscillator and an 80 rectifier. The r.f. and converter stages are gang-tuned but a separate tuning control is provided for the oscillator to avoid the complications of critical alignment.

The kit provides all necessary parts including a copper-plated punch chassis and drilled crackle cabinet. Coils are of the plug-in type and are wound by the builder; coils for ranges other than the 5- and 10-meter bands may thus be made up as desired.

### The Skyrider 23

The Hallicrafters have announced a new receiver for amateur communications use which incorporates many new and very worthwhile design features. The new receiver utilizes a total of eleven tubes and is priced to sell in the medium price range.

All the tubes in the r.f. and i.f. sections are of the new highly-efficient single-ended metal type. A 6SK7 is used in the r.f., a 6SA7 is used as mixer with a separate 6SJ7 oscillator feeding it, and two 6SK7's are used as i.f. amplifiers. The other tubes are: second detector-first audio, 6SQ7; a.v.c. amplifier, 6B8; output audio, 6F6G; beat oscillator, 6SJ7; noise limiter, 6N7; and rectifier, 80.

Frequency stability throughout the receiver is greatly improved through a new design principle: compensation of drift in tuned circuits caused by temperature change through the use of condensers with equal and opposite temperature coefficients to those of the inductances in the circuit. Thus the intermediate-frequency and crystal-filter transformers are permeability tuned and are resonated by fixed condensers with opposite temperature drifts to those of the inductances. The crystal filter is completely shielded and is provided with a six-position variable-selectivity switch.

The full frequency range from 540 kc. to 34 Mc. is covered in four wavebands. In addition, full coverage bandspread tuning is available from 3.5 to 4.0 Mc., 7.0 to 7.3 Mc., 14.0 to 14.4 Mc., and 28.0 to 32.0 Mc. These latter tuning ranges are selected by separate positions on the waveband switch. Additional features of the receiver are: crystal filter on 455 kc., improved noise limiter using 6N7 tube, signal-strength meter calibrated both in arbitrary units and decibels, separate permanent-magnet speaker in cabinet of matching

[Continued on Page 81]

## The Open Forum

Philadelphia, Pa.

Sirs:

During the last three years I have redistributed 618 lbs. of QSL cards that were rescued from the dead letter office. I am in the Philly Fire Dept. and as I have lots of time on my hands (I'm pilot of our fire boat) I spent two seats of pants getting the correct QTH's for these cards.

Wondering why I didn't get a QSL from a choice dx station who promised to QSL, I wandered into the Central P. O. one day and asked about misdirected QSL cards. The clerk said that during his time there had been "quite a few" received and sent to the dead letter office. He said if I could convince them I was a responsible person that I could probably get them and help the P. O. (and the hams) by putting the correct QTH's on them.

When I informed them I was a city employee they were satisfied as to my integrity, and shipped me the works, 17 bags! The stamps were from 121 countries, and nearly all the zones.

I don't expect anything in return, but I hope that if you receive a card stamped "rerouted by W3AZT" that you will at least appreciate it. Boy, what a job!

Christie Urback, W3AZT

## Question Box

*Would you recommend replacing my two-element rotatable array with one of the three-element type? My chief worry is whether the results will be worth the cost and labor involved in making the change.*

Making predictions on the suitability or operation of antennas is a risky procedure. Quite often a well designed and carefully constructed antenna will give very poor results, while a mess of haywire poorly constructed and inefficiently fed will turn out to be superior to anything previously tried. One classic example of this is the vertical antenna which, from a purely theoretical standpoint, should be ideal for high-frequency dx work. However, in most cases the vertical turns out to be a very poor antenna. But occasionally we find a location where the vertical justifies its theoretical background and outperforms all other types of antennas. It would seem, therefore, that beside the obvious considerations of local ground conditions and proximity of elevated objects there are other intangible factors which influence the operation of antennas.

These intangible factors make accurate antenna prognostications practically impossible. However, in your case you may expect the following benefits from the three-element array: Increase in front-to-back and front-to-side signal ratios (these are of importance principally in receiving); slight increase in signal strength to the front due entirely to the antenna's horizontal directional properties; and, usually, a somewhat greater increase in signal strength due to a lower angle of radiation (this increase varies from time to time depending upon ionospheric conditions and the distance over which communication is being attempted).

Against these advantages must be weighed the following disadvantages which the three-element array has in comparison with the two-element one: Greater difficulty in making tuning adjustments; complication of the supporting and rotating mechanism; and lowered radiation resistance. The latter causes the array's effectiveness to be more dependent upon operating frequency, due to greater Q (more selective as to frequency). It also makes the mechanical and electrical details of the feed system more complicated, as the current and voltage (and therefore the losses) are greater in such a system. Beside these disadvantages you also have the problem of building a suitable supporting structure for the elements of the three-element array.

If the above mentioned advantages seem to outweigh the disadvantages in your particular case, the three-element array should be tried by all means. If, however, the disadvantages appear too great and the two-element array is giving reasonably satisfactory results it would seem that the best thing to do would be to continue to use it.

*Which gives best results on a plate-modulated stage: grid leak bias, cathode bias, or fixed bias? I refer of course to fidelity.*

While it depends upon many factors, especially upon the presence of distortion from some cause such as regeneration, etc., it has been found that grid leak bias ordinarily produces the best linearity in a class-C stage. This results from the fact that as the plate voltage is raised (as during modulation) and the increased plate current starts to rob the grid of some of its grid current, the bias decreases slightly (due to less current through the grid leak) and tends to maintain the same value of grid current. This compensating effect has to take place at the modulating (audio) frequency, and therefore the grid by-pass condenser (if used) should not be larger than about .004  $\mu$ fd. max. in the average transmitter.

If desired, approximately the same effect may be obtained by running fixed bias equal to cutoff (to protect the tube in case of excitation failure) and grid leak bias equal to twice cutoff. This gives a total of three times cutoff, two-thirds of which is "compensated."

### Correction

The dimensions given on page 59 of the April issue for a 2.5-meter dipole are in error. Those given are for  $1\frac{1}{4}$  meters. For  $2\frac{1}{2}$  meters, multiply the dimensions given by two.

# The RADIO Antenna Handbook

## 1. FUNDAMENTALS Characteristics and Considerations

Frequency (Kilocycles)	Wavelength (Feet)	Wavelength (Meters)
1000	300	91.4
2000	150	45.7
3000	100	30.5
4000	75	22.9
5000	60	18.3
6000	50	15.2
7000	43	13.1
8000	38	11.6
9000	33	10.1
10000	30	9.1

## 3. FEEDING THE ANTENNA

**Characteristics and Considerations**  
 Small percentage of the total energy is reflected in an antenna system as compared to the reflecting system.

**Characteristics**  
 When the antenna system is connected to a load, the impedance of the antenna system will vary with the frequency of the radiation. It is necessary to check across the antenna for one of the half-wave sections if the antenna is operated.

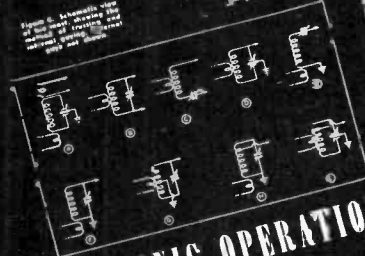
## 4. TRANSMISSION LINES and Feed Systems



## 2. CHOOSING AN ANTENNA

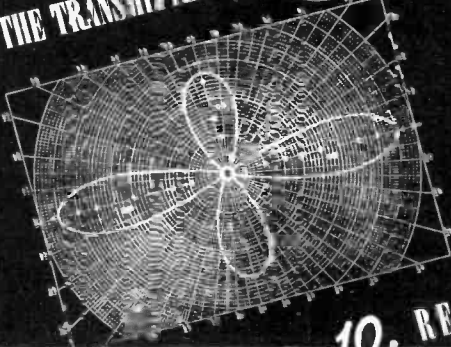
**THE SOUTH BEARING BEAM**  
 Four dipoles can be formed into the shape of a square or in figure 20 to produce a multiple radiation that has characteristics similar to the "Loop" if the dipoles are spaced in a circle. The theoretical radiation pattern is shown in figure 21. The actual radiation pattern is shown in figure 22. The same principle can be applied to any other shape.

Approximate values are given in the diagram in terms of efficiency. The diagram is for a beam antenna. The actual values can be obtained by following the same principle.



## 5. HARMONIC OPERATION

## 11. SUPPORTING THE ANTENNA



## 7. DIRECTIVE PROPERTIES OF ANTENNAS

## 8. DIRECTABLE ARRAYS

## 9. U.H.F. ANTENNAS

## 10. RECEIVING ANTENNAS

SEVENTY-FIVE CENTS IN U.S.A. ELSEWHERE, 85c or 3s. 6d. Canadian postal notes and British postal orders acceptable

Improved Converter Design

[Continued from Page 16]

Tuning Up

If the units have been wired properly, no difficulty should be encountered in getting them to operate properly with a wide variety of auto receivers. It is merely necessary to set the auto-receiver's dial to some point around 1500 kc. and, after adjusting the output transformer trimmer for maximum noise or hiss, align the high-frequency stages in the converter. The oscillator padder should be set so that the low-frequency end of the band falls at about 5 on the dial of the three-tube converter or at approximately 30 on the dial of the four-tube model. After the band has been thus located on the dial it is only necessary

to align the mixer and/or r.f. trimmers for maximum signal strength and then to check the setting of the output transformer trimmer; the converter is then ready for use. It also may be of advantage to re-trim the auto set to peak its sensitivity in the vicinity of 1500 kc. The set's operation throughout the balance of the broadcast band will be affected but slightly.

It will be found that the converter will operate satisfactorily with the oscillator padder condenser set at either of two values. Although both of these settings of the padder condenser are very nearly full capacity, one setting will place the oscillator 1500 kc. higher than the detector and the other will allow the oscillator to operate 1500 kc. lower in frequency.

It has been found that there will be very little difference in the sensitivity of the converter whether the oscillator is on the high or the low side. However, accurate tracking between the oscillator and the r.f. and mixer will only take place when the oscillator is on the *high-frequency* side of the mixer. This, of course, will take place when the oscillator padder condenser is at the *lower* capacity setting which gives tuning of the ten-meter band.

When the oscillator is on this side of the mixer the tracking is very close over about 90 per cent of the dial. Since the ten-meter band only covers about 75 per cent of the dial the tracking over the band is excellent.

Possible Improvements

Although the four-tube unit operates very satisfactorily and is extremely sensitive, whenever any instrument is completed it is foreseen where possible improvements or alterations could be made. One possible variation would be to include an 1853 tube as r.f. stage instead of the 6SK7, with the grid bias for this tube being obtained from the a.v.c. bus of the auto receiver. However, unless some provision for a.v.c. is incorporated, it is not advised that the higher gain type of tube be substituted for the type shown. As the unit now stands its sensitivity is so high that a normal 28-Mc. signal arrives at the input of the auto set with the same strength as the average broadcast station located five or ten miles away. If the sensitivity is increased much beyond this the converter will have a tendency to overload the auto receiver with resultant cross modulation and splatting. This was proven in laboratory tests. However, if some a.v.c. provision is made to reduce the gain of the preselector stage when a very strong signal is being received, a tube of the 1853 type may be used.

For list of parts used in both the three- and four-tube converters, refer to Buyer's Guide, page 96.



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Ask Your Jobber . . .

If he handles the AEROVOX complete line, he can supply these quality units. Ask for latest catalog . . . or write us direct.



**100-Watt Transmitter**  
*[Continued from Page 20]*

The first position switches the meter into the grid circuit of the amplifier. The third position shows plate current of the amplifier, and the fifth position connects the meter to the exciter meter switch. The latter is usually set to measure the current of the exciter stage that is driving the final. Thus, the final amplifier switch is the only one generally used during operation. The 100-ohm, 2-watt resistors for the plate and grid circuits of the amplifier are mounted directly on the switch as can be seen in the photograph.

**Tuning the Transmitter**

Tuning up the transmitter is really simple. Adjust all exciter stages for minimum plate current with no load. Then with the 80-meter grid coil in the amplifier and no plate or screen voltage applied to the 814 or RK47, adjust the amplifier grid circuit for maximum grid current. Then adjust the position of the link coil for proper value of grid current. Allow about 12 ma. grid current with no amplifier plate load. Next, switch the meter back to the oscillator plate circuit and readjust the oscillator for minimum current. Repeat this

operation on the 40-, 20-, and 10-meter bands.

Always check the plate current of the particular 6L6 being used as a driver for the 814 or RK47. If the plate current of that 6L6 should be higher when the key of the final amplifier is open than when it is closed, readjust the grid circuit of the final so that this condition is overcome. After all stages have been properly aligned with the amplifier coupled to them, there will be no need for further adjustment. The 814 or RK47, of course, should be loaded to the maximum plate current specified by the manufacturer.

On the air the finished transmitter puts out a very clean and steady signal. The 100 watts output will permit contacts all over the world under ordinary conditions. For greater power, a high-powered final amplifier can be added to this transmitter and the input may then be run as high as the maximum legal input.

See Buyer's Guide, page 96, for parts list.

●

Those modernistic tables with the chrome plated pipe frames and shiny black slab tops make a very decorative and functional operating table. If the tubular framing is made of standard-size conduit all the wiring can be pulled through the pipe with inlet and outlet boxes and switches at convenient spots.



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**STANDARD TRANSFORMER CORPORATION**

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**Band-Edge Frequency Spotter**

[Continued from Page 30]

whether he is just inside the band or just outside it. It is only necessary to *increase* the capacity of the oscillator trimmer condenser enough to cause a very slight change in the beat note between the standard and the incoming signal. Increasing the capacity of this condenser will lower the frequency of the spot point until it is just below 7000 kc. Hence, if the beat note between this harmonic and the c.w. station *increases* in frequency, he is inside the band; if it decreases or drops to zero beat he is outside the band. A similar procedure can always be used to determine whether a station that is very close to a 50-kc. point from the spotter is just to one side or just to the other. Of course it will always be necessary to reset the oscillator by the calibrating station in the b.c. band whenever the oscillator trimmer has been changed.

The warm-up time of the unit is very short, a matter of five minutes or so, due to a great extent to the very high value of capacity in the 50-kilocycle oscillator tank. Once the oscillator has been set it will not drift more than a few cycles on the broadcast band (less than 100 cycles on ten meters) in many hours of continuous operation. However, each time the unit is placed into operation from a cold start it will be best to check the setting of the oscillator trimmer condenser after allowing five minutes or so for warm up.

See Buyer's Guide, page 96, for parts list.

**Conquering the Q**

[Continued from Page 33]

frequency. When a split-stator type condenser is used, this is the net capacity of the sections in series.

**Q in Receivers**

The Q factor, though very important in receiver design, does not concern the amateur here as much as in the transmitter. Due to modern methods of manufacture, the amateur has very little control over Q in respect to receivers. In transmitters we saw that  $Z = X^2/R$  and also that  $Q = X/R$ . From this we can see that  $Z = X \times Q$ . In other words the voltage developed across a parallel resonant circuit becomes proportional to the Q. It then becomes apparent that Q can become a measure of the gain of a circuit as well as a measure of selectivity. To the newcomer this should explain why it is always recommended to wind homemade receiver coils of large size wire. The more inductance we are able to get with the minimum resistance, the greater will be the Q and the more gain and selectivity the circuit will have.

On first examination some of the Q formulas seem to contradict themselves. From  $Q = X/R$  it would seem that the larger the inductance, the greater the Q would become. The formula  $Q = Z/X$  seems to indicate that the smaller the inductance or the larger the capacity, the larger the Q.

Each holds true in its own place. It can be said that for circuits delivering power into a load that must maintain a constant value of impedance, the larger the C possible the greater the Q if the impedance is kept the same value for all values of C. This can apply to the power stages in a transmitter.

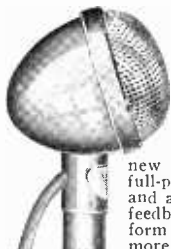
On the other hand for circuits which do not have to maintain a constant impedance, where circuit gain and the voltage developed across the impedance are the prime factors, the greater the impedance, that is, the greater the L (as long as its resistance is kept low) and the less C, the greater the Q factor.

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See page 98 for latest offers.

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**Five-Band Coil-Switching Exciter**

*{Continued from Page 40}*

of the 807 is also correct for the 6V6G plate circuit. From 200 to 250 volts on the 6V6G screen is ample. Individual cathode current measuring jacks can be used in place of individual plate circuit milliammeters if cost is an important consideration.

**The Coil-Switching Arrangement**

The coil data are listed in the accompanying table and the placement of the various coils is illustrated in the top view photograph. The 10-meter coil is self-supporting with one end soldered to the insulated split-stator condenser rotor and the other to the correct coil-switch tap. The gang switch for 10-meter operation connects in the 20-40-meter oscillator coil and a 40- or 20-meter crystal should be plugged into the front panel socket. The 20-meter final position cuts in the same 20-40-meter oscillator coil and an 80-, 40- or 20-meter crystal can be used. The 40-meter final position cuts in a 40-80-meter oscillator coil and a 160-, 80- or 40-meter crystal can be plugged into the front panel socket. The remaining switch position cuts in the 80-160-meter coils with the 80- or 75-meter output at near minimum settings of the condensers and the 160-meter band toward maximum capacity.

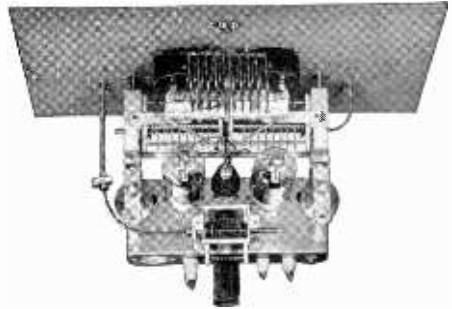
The chassis is 12" x 17" x 2" with a 19" x 7" front panel. An aluminum shield 8" x 5" was placed between the 807 and 6V6G stages. The isolantite coil switch was mounted on small bracket near the large aluminum shield which in turn was mounted 5" behind the front panel. The two tuning condensers are insulated from the metal chassis and front panel. The link output, 110 a.c. and various voltages were brought out to through-insulators and a terminal strip at the rear of the chassis for test or connection to other units.

In a practical test this exciter drove 60 ma. of grid current to an unloaded HK354 final amplifier through a 5000-ohm grid leak. This was fully equivalent to the drive obtained from the regular 809 triode buffer stage, 6L6G and 6A6 exciter in that particular transmitter. The 807 plate current runs at 60 to 90 ma. depending on the load drawn from it and whether it is acting as a buffer amplifier or doubler. The oscillator plate current runs from 20 to 40 ma. over the whole range with various makes and types of crystals.

See Buyer's Guide, page 96, for parts list.

**SAVE MONEY — SUBSCRIBE!!**  
See Page 91

**THE "BPA-500"**  
**RADIO FREQUENCY AMPLIFIER**

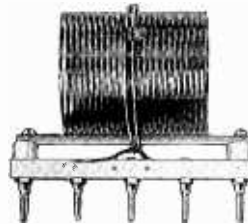


This is the efficient "Semi-Skeleton" Amplifier described in the March 1939, issue of "RADIO" on Page 40.

Easily constructed, it admirably fills the need for a medium power R.F. final which will **REALLY PERK** even on 5 meters. In addition, it is equally as efficient with inputs from 75 to 500 watts. See one at your BUD distributor

BPA-500 Kit ..... \$24.00 Net  
(Complete except Tubes, Coils, Meters)  
BPA-500S Kit ..... 3.60 Net  
(Only Panel, Semi-chassis, Brackets)

**AIR-WOUND TRANSMITTER COILS**



**500 WATT RATING**  
—  
**5 to 160 METERS**  
**INCLUSIVE**  
—

Coil supports of fire-resistant plastic are firmly cemented to turns.

Ceramic insulation is Alsimag 196. Designed for correct L-C ratio for phone as well as CW. Coils have individual links. This series used in the BPA-500 Amplifier. Priced from \$1.65 to \$2.70 Net.

See us at the National Radio Parts Trade Show, Stevens Hotel, Chicago, Ill., June 14 to 17, 1939—Booth 402, 404, Marconi Blvd.

**BUD RADIO, INC.**  
5205 Cedar Ave. Dept. R59  
**CLEVELAND, OHIO**

**Increasing Your Copying Speed**

[Continued from Page 37]

the copying ability of the student, as this brings about a condition of confusion and is more injurious than beneficial.

The reference to the quality of the teacher for this or any other type of operating is not to be overlooked. In handling traffic, nothing is more important than clean-cut spacing and regular length dashes. Without good spacing no operator can ever expect to be copied correctly, and it is good spacing that makes speed possible. It is far easier to copy a good fist at thirty words per than a poor one at fifteen.

So if you are the teacher, remember to key cleanly and evenly. When it comes your turn to be on the receiving end you will appreciate the difference.

●

## Just A Decade Ago

Arrangement between United States and Canada authorizing the exchange of messages between private experimental radio stations becomes effective.

The 866 rectifier tube introduced.

The Pensacola, Fla., Chamber of Commerce enlisted the aid of amateur radio when storms cut off communication between Pensacola and the outside world.

First Australian-Japanese two-way ten-meter QSO. (VK5HG and J2BY).

Byrd party at Little America, Antarctica in communication with every U. S. call area and several foreign countries.

MacMillan sailed from Wiscasset, Maine, in the schooner *Bowdoin*, equipped with short-wave radio for communication from Northern Labrador.

The Chicago Tribune's plane *'Untin Bowler* left Chicago on a proposed Arctic flight, signing the call KHEJ and contacting amateur stations. The plane was later torn from its moorings at Port Burwell and was carried to sea by the rough waters. Its crew escaped.

Col. Claire Foster's epochal article *Rocking the Boat* published in QST.

Maximum power permitted amateur stations in India, ten watts.

Niagara Falls Power Co. in touch with Lockport and Buffalo by way of amateur radio when sleet and snow snapped their telephone lines.

American stations rebroadcast European programs for the first time, Christmas Day.

**The 4-Element Rotary**

[Continued from Page 42]

You now have the best field-strength meter for this purpose that it is possible to obtain. Erroneous measurements will be virtually eliminated by reason of the fact that the field-strength measuring will be done only on horizontally polarized energy. Electronic field-strength meters using short vertical antennas are not suitable for this job, and it is better not to use them.

Now, with the reflector side of the array facing the field strength antenna, and with both the reflector and outside director opened at the center, and with about 25 watts of power being fed to the radiator, begin adjusting the length of the inside director until the *lowest* possible current reading is obtained in the field-strength antenna. Next, in turn, adjust the lengths of the outside director and reflector until this current is still *lower* and until the *lowest possible* reading is obtained in the field-strength antenna. Now rotate the array through 180° to a point where the outside director faces the field-strength antenna. It is usually well to check the previous adjustment by then slightly readjusting the directors and reflector to a point where the *highest possible* current is indicated at the center of the field-strength antenna. It will usually be ascertained that this last adjustment exactly coincides with the previous one, and that you were right the first time.

Wasn't so tough, was it? Just a few simple rules to follow, and perhaps the hardest part of the whole thing is in finding the thermogalvanometer. However, one of the local gang can always be depended upon to have one kicking around and, if not, you can always try the local broadcasting station. They will generally lend you one for a long enough time to make your adjustments inasmuch as this rarely takes longer than twenty minutes after completing the mechanical work.

●

### FINAL DISCOUNT

Inasmuch as the ham is able to build a death-dealing power supply at 40% "off," it would seem logical he also apply for the same discount from his favorite undertaker if the present wholesale disregard of safety measures continues.



### UNIVERSAL 5MM.

All purpose microphone including amateurs, p.a., schools, stage, etc. Beautiful in appearance. Small in size. Superlative in performance. High fidelity reproduction voice and music. Incl. locking plug and 25 ft. cable. Direct to grid or any desired impedance. In De Luxe package at your jobbers now.

**UNIVERSAL MICROPHONE CO. LTD.**  
424 Warren Lane, Inglewood, Calif., U. S. A.



**What's New**  
[Continued from Page 73]

design, and positioning of panel controls for ease of operating and fatigue-free tuning.

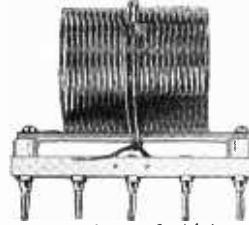
**NEW DYNAMIC MIKE**

A new microphone of the dynamic type in the popular priced field has been recently released by the American Microphone Co., Inc. This moving coil microphone has a high output level, approximately -45 db, and several interesting features. The microphone is tiltable, making it possible to use the microphone in a horizontal position for non-directional pickup, or tilted for voice work. The frequency response of the microphone when in a horizontal position is essentially flat. With the microphone tilted, the face of the instrument acts as a baffle and produces a response characteristic rising with frequency. The latter response curve is especially desirable for voice work, giving crisp, clean articulation.

Both low and high impedance models are offered. The former type is recommended where the microphone is remote from the amplifier. Further information is available from the American Microphone Co., Inc., 1915 S. Western Ave., Los Angeles, Calif.

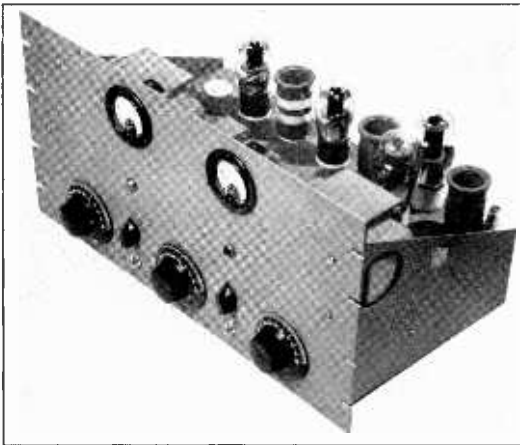
**NEW TRANSMITTER COILS**

Bud Radio, Inc., has recently announced a new series of air-wound tank coils suitable for use in radio-frequency amplifiers operating with inputs up to 500 watts and for frequencies between 1.7 and 60 Mc.



These coils are constructed of enameled copper wire firmly cemented on three fire-resistant plastic locking strips, and this winding is supported on a heavy ceramic bar of Alsimag 196. Each coil has its own link at the center of the coil, and all hardware parts are brass. Sufficiently large wire has been used in these coils to insure freedom from heating when operated within their rating, and each coil fits the same standard plug-in mounting base having a distance of 5" between the outside hole centers.

A new four-page folder describing this and other items recently announced may be secured by writing to Bud Radio, Inc., 5205 Cedar Ave., Cleveland, Ohio.



All chassis and panels are punched and drilled. The Panel, Brackets, and Meters are additional features. A special cabinet is also available for those desiring the "Bi-Push" in one complete unit. The above are finished in gray. KITS include tubes, and all components are of nationally known lines.

NEW IMPROVED "Bi-Push" and Power Supply  
(With chassis and tubes) Less meters .....KIT \$45.00  
PANEL, punched for meters and all controls and  
with 2 pilot lights ..... 3.00  
SPECIAL BRACKETS (per pair) ..... 1.50  
STREAMLINE CABINET (front panel blank) ..... 5.50

*Write for Bulletins on other units*

## THE IMPROVED BI-PUSH 45 WATTS

**MORE OUTPUT** is obtained from the new IMPROVED "Bi-Push" Exciter due to its shorter leads and better layout.

**TUNING . . . FRONT and REAR** is a valuable feature, especially when rack-mounted. Condenser shafts extend through front and back drops of the chassis.

**BAND CHANGING** is easier due to more accessibility to coils. This is possible because power supply is mounted at the front of the chassis.

The NEW IMPROVED "Bi-Push" exciter is fundamentally the same as originally described by the Editor of Radio.

# RADIO-TELEVISION SUPPLY CO.

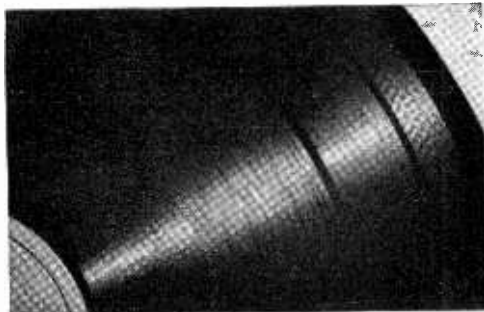
1701 So. Grand Ave.

*"Where Ham Spirit Prevails"*

Los Angeles, Calif.

**CONSTANT VELOCITY TONE RECORD**

Universal Microphone Co., Ltd., Inglewood, Cal., has announced a new Universal Constant Velocity Record. The new record will establish a definite standard for the interpretation of light patterns and volume levels and will put an end to various and sundry arguments with regard to the relation between light patterns and frequency response.



The new Universal record is a standard 12-inch pressing recorded at 78 r.p.m. with the recording in three parts. The first run consists of a glide frequency recording from 50 to 10,000 cycles with breaks at 100, 200, 300, 400, 500, 1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000 and 10,000 cycles.

During the breaks, a voice announces the frequency. With a background reference level of zero, the run from 50 to 200 cycles is at plus 7 db; the run from 200 to 500 is at plus 14 and the remainder up to 10,000 cycles is at plus 21 db.

The second run is a 1000-cycle note in steps of 2 db from plus 8 to plus 18, with silent breaks between steps in order to facilitate measurement of background level. The width of these steps can be measured lineally, and such measurement used for checking other recordings.

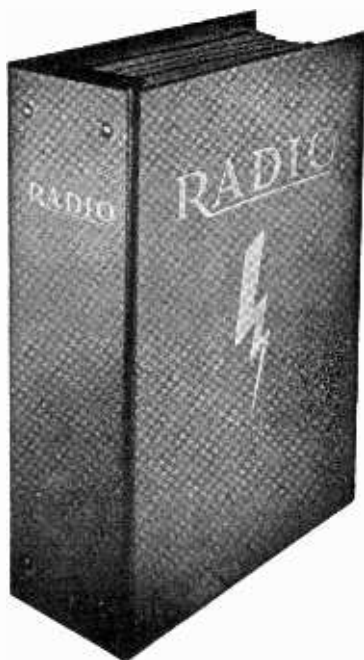
The final run is a 400-cycle note at a level of plus 18 db, zero reference being the background level of the record when using a standard-point playback needle.

The new Universal Constant Velocity Record is useful for calibrating pickups, checking turntable speeds, or for testing playback channels in laboratories, colleges and schools, studios, and broadcast stations. It can also be used in lieu of an audio oscillator where the expense of such an instrument would make its use prohibitive.

**Lucite**

The new DuPont plastic called *Lucite*, which has received much publicity because of its ability to persuade light rays to travel other than in a straight line, will find many uses around the amateur station. It is an excellent u.h.f. insulation, the power factor being as good as anything we have seen. The material is relatively inexpensive, and easily worked with ordinary shop tools. While it is a thermo-plastic and like Victron and celluloid will not stand much heat without becoming soft, this property makes it easy to bend and form into desired shapes merely by heating it.

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**RADIO, Ltd.**

7460 Beverly Blvd.

Los Angeles

California

**The Amateur Newcomer**  
*[Continued from Page 64]*

antennas or to any single-wire feed line. The fact that a perfect impedance match is seldom obtained by this method is offset by its utility.

**Operating Data**

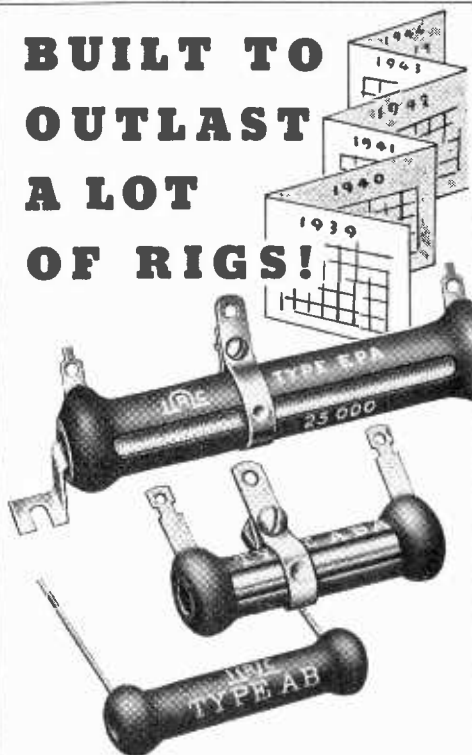
**Receiver:** Coils wound as specified will hit the amateur bands when the bandset condenser plates are approximately half meshed. The 15- $\mu$ fd. variable vernier enables more than 60 dial divisions of spread to be obtained. It is more than likely that a little pruning will be necessary. This can best be accomplished by spreading the end turns on the coil rather than by removing a turn. With a plate voltage of 250, regeneration will occur with the control about one-third on. If regeneration is too harsh the cathode tap may be moved a fraction of a turn nearer the ground end of the coil. A 5-megohm grid leak is satisfactory for all frequencies and no experimenting with this value is necessary.

**Transmitter:** For fundamental 3.5-Mc. operation the coil and crystal for this frequency is inserted and the switch SW<sub>2</sub> closed. With antenna disconnected plate current will dip to approximately 20 ma. Coupled to a suitable antenna this oscillator may be loaded to 75 ma. at which point a power input of 22 watts is obtained. Plate voltage under load is 300. For 7.0-Mc. operation employing the same crystal, the 7.0-Mc. coil is inserted and SW<sub>2</sub> opened. A calibrated monitor or other frequency indicating device is necessary at this point. With antenna again disconnected, the plate tank tuning condenser is rotated until the second harmonic is heard. This will be evidenced by a sharp drop in plate current. Loading is similar to that for fundamental operation. Should a glass type 6L6 be used as the oscillator tube, additional capacity will be required between plate and cathode. This may be a small padder condenser of about 8  $\mu$ fd. connected at the tube socket.

**Cabinet Construction**

For those who plan to duplicate the cabinet illustrated, the construction diagrams are self-explanatory. Soft Oregon pine, 7/16 inch thick, is used throughout. Assembly is relatively easy, all parts being nailed together with one-inch finishing nails, sunk and puttied. Two coats of grey enamel are required for a glossy finish. Rubber feet fastened to the base prevent slipping; cleats across the inside cover discourage warping. A large assortment of chrome handles and knobs for finishing the cabinet may be obtained at any hardware store. Removing four wood screws from the front panel will enable the entire panel and chassis assembly to be slipped out with ease. See Buyer's Guide, page 96, for parts list.

**BUILT TO  
OUTLAST  
A LOT  
OF RIGS!**



**T**ubes and circuits change, but power supplies go on forever. It pays to use rugged resistors because they never become obsolete. Long after this year's hook-up has been dismantled, and yesterday's overloads shaken off and forgotten, your IRC Power Wire Wound Resistors will be looking for new worlds to conquer.

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**Cement Coated**

**POWER**

**WIRE WOUND**

**RESISTORS**

**New Communication Receiver Kit**

*[Continued from Page 49]*

trolled by its screen voltage; the peak strength of the signal it can pass is governed by its screen voltage. Nothing is easier than to provide a screen voltage rheostat with the result that screen voltage can be set so that the pentode will just pass as loud a signal as may be tuned in, but no more. Thus it cannot pass noise crashes louder than signal. The net result of this limiting action is to allow noise to be held down to no louder than signal; in operation this sounds as though noise had been practically eliminated.

The headphone jack is in the 6B8 plate circuit, after the tone and volume controls. This provides good audio discrimination against heavy low-frequency noise since the high pentode plate resistance in effect "tunes" the phones so that they don't respond to the low tones which are useless for either c.w. or intelligible phone reception. The lows are there on the speaker, however, where they belong for music reception. The 6V6 audio stage is perfectly conventional.

The power supply is worthy of comment because it allows either battery or a.c. operation of the same receiver—portable or fixed operation in one set. An 8-pin socket with

a dummy strapped across (for a.c. operation) plug allows the power circuits to be broken by pulling out the dummy plug. This opens the rectifier B+ lead and the heater circuit, to which batteries, or a 6-volt battery and vibrator or generator B supply, can be connected by another plug. It also brings out to this plug the send-receive switch and the on-off switch, so that both function on either a.c. or battery operation. Plenty of space is left in the back of the set cabinet for a vibrator or generator B supply—even for a complete dry battery supply setup—not to mention for one of the writer's recently announced "Diversity Couplers."

Upon the premise that no communication receiver is any better than the controllability of its operating functions, front panel control has been made quite complete. The large satin-chromium tuning dial is 7¾" in diameter with six accurately calibrated wavebands occupying 324 degrees of its circumference. The high-frequency-band dial calibrations are at the outside where the effective dial scale length is greatest, 21⅞" to be exact. Around this outer dial edge is a 500-division scale which is directly readable to one part in 5000 against the 0-10 decimal indicator scale. This, plus the great effective dial scale length, provides what might be called "spread band"

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258 Broadway New York City

## RADIO

tuning in that each frequency range is unusually widely spread out for a main dial. For those desiring it an 0-200 division, 4" diameter bandspread dial is available which is driven from the main dial shaft through a 12:1 positive, no-backlash, gear train. Easily mounted and with its bandspread dial "peeking out" at the upper right of the main dial, it gives over eleven feet of dial scale for each 2.2:1 frequency band. Dial drive is direct through the center knob for fast band skipping, or through the 15:1 vernier action which is actuated by the large knob to the lower right. Other controls are, top left, down and across to right: noise limiter, tone, headphone jack, antenna trimmer, send-receive, wave-change, vernier tuning, a.v.c. on-off audio gain, b.f.o. on-off, i.f. gain and selectivity. Also, at top right on the panel is the b.f.o. pitch control which is tuned by movement of a powdered r.f. iron core inside the b.f.o. inductance. The panel is finished in silver on etched black, and in its grey enamel steel cabinet with hinged cover the set presents a very pleasing and commercial looking appearance.

See Buyer's Guide, page 96, for parts list.

### DX

[Continued from Page 60]

On the first page of the DX section for April there is a picture of the station K6LKN. It was labeled K6KLN, so when you work Dave please remember his call is K6LKN. Hope that clears things up.

### Frequency List

There is no frequency list for this month because you probably know them all after going through the contest. Next month will bring the rare ones out again and at that time we will toss their frequencies at you as fast as we get 'em. The day after the contest I took my smelling salts and went out and read the service power meter. From now on I probably will be working for the Edison Company. The extra large "breeze" that blew around here about a week before the contest raised the deuce with a lot of antennas . . . especially the rotary type. All the parts houses ran out of wire, insulators and rods for radiators. They didn't seem to mind the "blow."

Had a visit from W9EGU so I guess my quota of nines was filled because two others were hooked during the contest without much trouble. Speaking of visitors . . . the shack of QD looked like "homecoming" during the whole week of the contest. I never knew there were so many hams not in the contest. During that week 35 visitors were "entertained" . . . if you get what I mean. Conditions were bad on the air for them, so they thought we should have a gathering. One listen at my pet power leak and they agreed it matched theirs . . . so we all sat around and swapped "yarns." Anyway, 'twas fun. Ur nr ok my nr 599282 . . . it's got me.

## Active

An active crystal is easily excited; it snaps into oscillation rapidly, faithfully follows keying, and has a high Q. All B5 40-meter Crystals have a high relative activity because they are accurately cut, precision lapped, individually finished to rigorous performance standards, and mounted in a correctly designed holder.

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Each B5 40-meter Unit is calibrated by reference to a primary standard of frequency. The measured value is stamped on the holder nameplate and is guaranteed to be correct within .03% in any standard oscillator circuit. Precise calibration assures frequency accuracy—low drift insures frequency stability.

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Rigid manufacturing standards and careful inspections are applied during every processing operation. As a final check for perfect crystal quality and the ability to withstand adverse operating conditions, each crystal is subjected to an exacting overload test. Dependable performance is built into B5 40-meter Crystal Units.



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- 5—Universal, Steel Mounting Strap—Allows mounting unit in any position.

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2590 Neil Ave., Apt. B., Columbus, Ohio  
(Nov. 1938-Feb. 20, 1939)

(7 Mc.)

CM—2RV; 6DV; 6DH; 6AC; 7AD; 8CH; 8JK; C02LL (phone); CT1GG; FA3AW; HB9D1; H13C; H18H (phone); HPIX; HK5JD; K5AM; K5AG; K6—0ES; ORA; QHL; PUS; QB; PATM; T12AS (phone); T12BC; T15RC (phone); VK—2CL; 3EM; 3K; 4NY; 5GW; VULT; VP2SC; XE—1BW; 1EP; 1CQ (phone); 2CN; 2FA; 2JK (phone); 2JX (phone); 3AD; 3AX (phone); 3X (phone); ZL—1C1; 2MM.

(Feb. 20-28 1939)

CM—6AD; 2DD; 8RR; CN8MI; K6PUP; K6DVK; VK—2ACG; 4HY; 6WZ; XELD3; XE3AF.

David F. Lewis, W21YO  
27 Avondale St.  
Valley Stream, L. I., N. Y.

(14 Mc. CW)

CN1AA-7; CR—6A1-6; 7AD-4; 7AF-4; 7AG-7; 7AS-6; 7AW-5; 7BC-4; 7BT-6; EL2A-7; FB8AB-6; F18AC-7; FQ8AB-5; FR8VX-5; FUBAA-7; G8D0-7; G8MF-6; I7AA-5; J2—JJ-8; KG-8; KN-5; MI-5; NK-8; XA-5; J3—CG-5; J2—JJ-8; FK-6; FZ-6; J5CC-7; JS—CA-6; CD-7; CG-8; DF-7; FJ-6; AA-6; AF-5; AP-6; CW-4; DL-6; ER-6; FG-7; RP-6; KA1—AA-6; KA8ED-3; K7—ERZ-6; ETS-6; FNE-6; SP-5; KA4LH-6; KA8ED-3; K7—ERZ-6; ETS-6; FNE-6; FRU-6; FST-6; FST/Siberia-7; GRF-6; LZ-8; PA-7; Q05AQ-8; Q05AV-7; OX70U-7; OY4C-6; OY4D-6; P1JBV-8; PK1—B0-7; MF-3; RI-8; TM-5; TT-7; VX-5; PK3AA-5; PK3EM-4; PK4K0-7; PK4KS-7; PK6XX-6; ST—2CM-6; 2LR-5; 6KR-5; TAA-7; TF3C-7; TF5C-8; TF5M-7; TG9AS-7; UG—AN-7; SE-6; ST-5; WB-6; UK81A-6; U81B-7; U9—AB-6; AC-6; AV-7; AW-7; MF-7; MI-6; ML-6; MN-4; VK—4HN-4; 9BW-6; 9VG-6; VP8AD-7; VQ—2GW-7; 2JC-6; 2MI-7; 2HJP-6; 4CR1-8; 4KSL-6; 4RHL-7; 8AB-5; 8A1-7; VR5CD-6; VS—1AK-4; 2AE-6; 2AD-5; 6AG-5; 6AH-8; 6A0-7; 6BE-6; 6BG-6; 7RF-7; VU2—AN-5; BG-8; EB-6; ED-7; EU-6; FH-4; FO-7; FS-7; FX-7; JM-5; LK-6; VU7FY-4; XU—2AW-8; 2JN-6; 2C-7; 4XA-8; 6D-6; 7CK-7; 7CW-6; 8DM-5; 8HM-5; 8NA-5; 8NR-8; 9WW-6; XZ2—DY-8; JB-7; LZ-5; Y12BA-9; ZC6AQ-6; ZC6EC-6; ZD2H-6; ZD4AB-7; ZPLAX-7.

(14 Mc. phone)

FB8AH-8; PK—LRI-8; 4KS-7; 6XX-5; VR6AY-7; VS7RF-7; VU2CQ-7; VU2FX-5; ZX2DY-8.

Bob Everhard  
"Belle Vue", Nelson Park,  
St. Margarets-at-Cliffe,  
North Dover, Kent, England.  
(Jan. 10-Feb. 10, 1939)

(1.7 Mc. phone)

W1—BES; BB; KUW; KSM; KKR; BNO; W2EJW; W3DQ; W4BJZ; W80LR/3; GW2BG; G—2P0; 2GD; 2KT; 2LZ; 2AX; 3SI; 30A; 30J; 5VT; 5ZQ; 5MP; 5H0; 6PA; 6ST; 6NN; 3WC.

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NC-80-X	117.00	18.30	12.86	8.75
HQ-120	123.00	19.60	13.47	9.16
SX-16, speaker	149.50	22.60	16.53	11.25
RME-69	152.38	24.10	16.78	11.41
RME-70	138.60	21.10	15.31	10.41

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## RADIO

### (3.5 Mc. phone)

W1—IFD; DOA; CNY; BNO; IWG; AAH; ADM; AW; DRL; FOF; JXV; FMP; W2—FLX; MW; GOQ; DKS; HNP; JZX; CET; ASR; HS; EOA; HNA; AOG; HQB; OR; W3—DOG; FAM; AHS; EWW; GPM; FTU; JC; GKJ; EOZ; BIN; AXR; GGW; DQ; CEI; AWU; EOP; W4—BAZ; BPG; CCM; CYV; DLK; W5—GPS; LIQ; BOZ; REI; NNJ; CHU; AQ; JOE; CDU; KDX; CNA; JLN; RH; GWH; W9—WXL; MM; BBU; VE—ILR; LCR; 1R; 1G; 2KX; 2GH.

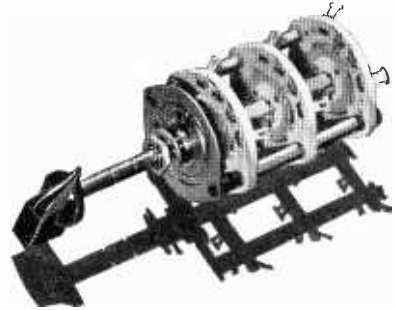
### (14 Mc. phone)

VU2—CQ; FQ; CA; ZS1—BL; B0; AX; T; K; ZS2—J; X; AZ; AV; AQ; ZS5—CS; CO; J; BS; CL; CA; CJ; Q; BE; ZS4—L; H; PK—2AY; 6JD; ZS6—DY; DU; DL; EB; EO; H; A; CJ; FB; CT; BA; CU; XZ2—DX; DY; EX; FBS—AD; AM; AF; ZEJJA; ZEJJU; ZOGEC; CRTAU.

### (28 Mc. phone)

W1—DQK; LQC; FVO; KZU; WR; WV; IXP; KUD; DIK; LMB; JIR; KTF; IS; CKV; LFX; AWZ; EZS; AJS; LEU; CND; JAR; CGM; BGJ; EUG; W2—KVD; IDV; LMW; ADI; JCY; JQX; FQK; IAL; KPX; AIH; AHX; LTO; BMK; IYX; EUR; HGU; LKG; HSC; LAH; DMJ; GXZ; AMM; AMJ; KHR; JSJ; IKV; FGB; KAX; HVQ; LIR; W3—ALK; AKX; GXZ; VO; PC; HQJ; AXU; GSV; CAD; HOH; CWG; GSK; GNN; EOZ; CHO; EMM; FII; FFG; AFH; W4—YC; FWA; EJQ; DXM; EEB; EEE; CYV; EJC; AZB; FX; FRF; ASE; FIJ; CYU; DV; MV; DEO; FBH; EDQ; DEK; FSE; AEI; DRZ; EBM; CLK; BCR; EXF; W5—FUA; ZA; HOH; DUK; DYW; GYM; EB; DAD; HDK; CFU; BEN; EEL; GJF; WR; CCU; GSY; GWZ; AJG; YJ; EKf; GBS; ASG; CYX; FPD; GPB; ERV; GZK; BSK; EYZ; FEJ; FFW; AYH; W6—OJK; POZ; NIO; OR; PKK; LNI; AU; NYD; NLS; NNR; MBD; PBD; PDB; W7—ABK; ACD; EAI; BJS; W8—RRR; GHX; GLW; AFQ; KYY; PGV; PKQ; RUV; YX; RLT; RXY; FHQ; CMW; ODH; SRB; LMW; REU; JFC; MLR; QGZ; JLW; PYO; OUZ; NAT; QXV; OPB; QL; CJM; CKY; PK; AVB; ETJ; HCR; RXJ; NML; CBX; CIR; LQK; DST; NYU; HEC; NXF; NOH; GSC; EDX; HHZ; FXM; AEM; QGW; LHX; MMS; OON; NKA; IHM; NK; LAC; GFL; MID; DUH; CHQ; ILR; OXY; DLD; SIM; DJJ; IAU; POP; PYP; TQ; MZM; FID; JBD; JBX; RK; HMS; QKI; FAR; LUQ; JHW; RKR; RIS; SGX; IY; PUK.

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Sketch at right shows how the 162C can be used to make a simple "Turret" assembly.



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- Especially suited for Beam Antennas

This sturdy Rf relay is designed for Antenna Change-over, Multi-band Transmitter Tank Switching and 60 cycle Power Switching. No chatter. For 110 volt AC. Very reasonably priced at \$9 net.

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WRITE DEPT. Q FOR GORDON CATALOG

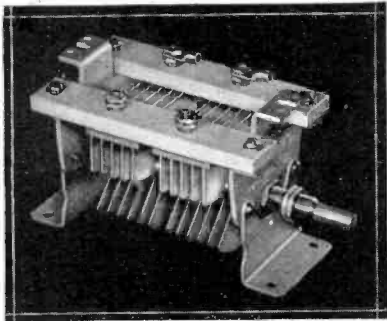


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# ★ A NEW ULTRA HIGH FREQUENCY DUAL Transmitting Condenser

This popular "N" series is now augmented by the new type NT-50-GD, shown here with a pair of the new "M" mounting feet.



NT-50-GD  
(Protected by U. S. Pat. No. 1626391)

The wide popularity of our type NP-35-ND for diathermy machines, ultra high frequency oscillators and P.P. amplifiers, has indicated its versatility, and we are flattered by its universal acceptance.

A dual 50 mmfd. unit has been requested, capable of operating in a push pull class "C" amplifier, 100% plate modulated, using such tubes as a pair of T-20's etc.

SPECIFICATIONS ARE AS FOLLOWS:

### TYPE NT-50-GD

Frame—Same as NP-35-ND.  
Capacity—7.50 mmfd. per section.  
Airgap—.070"—3000 volts peak.  
Plates — Buffed and polished — rounded edges.

LIST PRICE ..... \$6.00 each  
AMATEUR NET PRICE \$3.60 each

Above prices are less mounting brackets shown in illustration.

Oh yes, those type "M" brackets shown, which make for short lead layouts for "N" or MIDWAY condensers, are put up individually in envelopes with screws and lock washers for 20c list each, 12c net each to amateurs.

See these at your nearest dealer or write for further information.

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## RADIO

### THE DAY OFF

By DOROTHY JOHNSTON, MRS. W6CME

Saturday night: Husband announces tomorrow is his day off and how about sleeping late and going somewhere for the day. Suggestion greeted by shouts of joy from family.

7:00 p.m.: Husband goes into radio room to listen to the boys on ten.

12:00: Still listening.

Sunday 7:00 a.m.: Wife awakened by loud bumps on roof. Thinks the Marines have landed. Realizes it's the o.m. putting up the 10-meter beam he's been talking about.

8:00 to 11:30: Wife tries to do housework between holding wires, passing up insulators, hammer, nails, etc.

12:15: Wife, finishing breakfast dishes, greeted by shouts of "Let's eat."

1:00 to 2:00: More noises on roof.

3:00: O.M. decides to give a CQ and try out new beam

4:00: Still trying!

5:00: Ditto.

6:00: Wife gets reproachful looks and suggestions of steak for dinner.

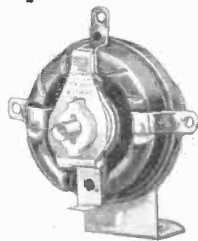
8:00: Wife says "good night" very coldly and retires to bedroom to start 1183-page novel. Husband looks blank and wonders if all women are as lacking in sense of humor as is his wife.

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Here's instant, easy, flick-of-the-wrist band switching for rigs up to 1 K.W., with really low-loss efficiency. With these Ohmite Band - Change - Switches, band changing may be provided in all stages of the transmitter and "ganged" for complete front-of-panel control. Ample size for heavy duty. Ohmite all-porcelain vitreous enamel construction insures long dependable service.



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RHEOSTATS • RESISTORS • TAP SWITCHES



**You're in the Movies Now**

[Continued from Page 36]

please remember that we did our best. Story value had to be considered above all else, and the people who know nothing about amateur radio are regrettably in the majority. James Hogan, the director, and Paramount, which produced the picture, cooperated to the limit of their ability.

If you have any "beefs," please write to me. If you liked the way it was handled you might write to Paramount studios and tell them. They'd probably like to know their efforts in your behalf were appreciated.

**Suggestion Regarding Beam Antennas**

[Continued from Page 51]

as the thing draws only a few ma. Direction finding is a cinch, and calibration will never change.

In case the meter doesn't allow enough scale to satisfy you, here's an additional trick. Mount the meter in an old alarm clock case—or something similar—and paint the glass black except through where the scale will be read. Glue onto the original needle a small broom straw, previously dipped in ink, and you can have as much scale as you like. Be sure to allow a little overlap of the straw at the bottom of the needle for counterbalance; this type meter has no counterbalance spring. The arrangement worked 100 per cent for the writer, and it's the most sure fire gadget of its kind I've seen.

**Yarn of the Month**

[Continued from Page 71]

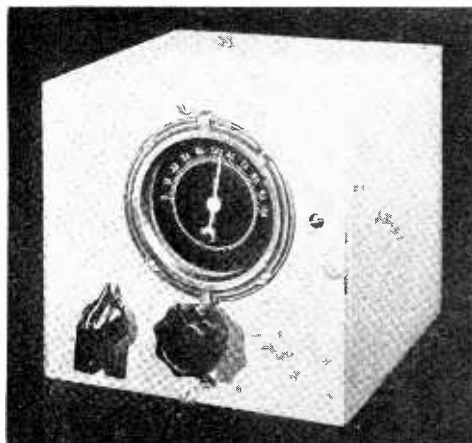
get some music." Funny thing was he actually had a local lid rebroadcasting on five meters.

When construction was nearly finished and one of the pier fenders caught fire from a rivet dropped from above, the fire spread like a flash, mainly due to creosoted piling and a stiff wind. A loyal electrician ran into the radio office shack and tore loose the transmitters. He ran with one under each arm to the edge of the fender under the pier and hollered for a passing tug to pick him up. Before the tug could get to him the fire had swept around to where he was standing. He held tightly to the equipment until his pants caught fire and then dove into the bay. Needless to say he came up but the equipment did not. He was given a medal, greenback variety, by the radio department. Not for attempting to save the equipment, but because it was fully covered by insurance! You see, the fire didn't quite reach the radio office.

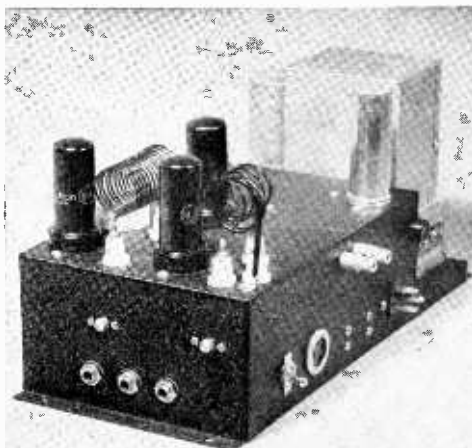
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Radio Supply presents sensational new Mobile Equipment for ten meter operation in "X" Kit Form.

**"GONSETT CONVERTER"**



"XCI" complete kit .....	\$10.63
6J8G tube .....	1.35
<b>Total .....</b>	<b>\$11.98</b>
Wired and tested .....	5.00
<b>Complete ready to operate .....</b>	<b>\$16.98</b>




"XM1" complete kit .....	\$18.50
Tubes for same .....	3.15
Mallory Vibropak .....	11.10
<b>Total .....</b>	<b>\$32.75</b>
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*big Catalog*  
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**RADIO**

**TEN METER**  
*Comment*

During the past winter there have been some differences in the manner that ten meters has acted. While Chicago stations heard the east coast (about 725 miles to New York) occasionally around noon last year, this time some stations have been rather consistent early in the morning. Even Detroit has been heard at W9QDA with regularity, particularly W8QDU, both distances often being heard with a "thump-thump" fade. Echoes have not been uncommon, possibly the result of a direct and round-the-world signal.

W8PK in Rochester, New York, says that he often hears several W2's in the morning on ten meters, notably W2JCK and W2KHR, who are the same ones reported by W9QDA. W1CND also came through several times in the morning.

With the widespread interest in 28 Mc., and plenty of room for phone, particularly at the high-frequency end, a good deal of ground-wave dx has been carried on after the band goes dead. One hundred mile signals generally are superior to those on 56 Mc., according to W9ZHB and W9BBU in Illinois. Possibly this is due in part to the better receivers and transmitters in use. This tendency may yet give five meters a lot of competition in future years, and might be encouraged in order to keep active stations on the air during that part of the sunspot cycle when winter dx, summer work to South America, and summer 300-1200 mile sporadic communication will be at a minimum.

There still is severe phone QRM right at 28.5 Mc. and complaint on this score has been heard, particularly from foreign stations. Moving to a frequency above 29 Mc. is thought to result in a smaller percentage of successful calls, but should be a good place for the stations calling CQ, and possibly for working after contact is established.

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**C. F. CANNON CO.**  
SPRINGWATER, N. Y.

**Transmission Lines as Circuit Elements**

[Continued from Page 45]

60 Mc., or 52.2 electrical degrees long. The impedance, 83.1 ohms, times the *tangent* of 52.2 degrees gives an inductive reactance of 107 ohms. Solving for the capacity at 60 Mc., in the formula  $1/(2\pi fC)$ , the necessary capacitive reactance is found to be given by a condenser of 25  $\mu\mu\text{fd}$ .

Actually, the receiver uses 20- $\mu\mu\text{fd}$  condensers. With RCA 954 acorn tubes adding some 7  $\mu\mu\text{fd}$ , making a total of 27  $\mu\mu\text{fd}$ ., the receiver will tune to about 55 Mc. Thus it is seen that tuned circuit calculations are not only fairly simple, but remarkably accurate.

**Superheterodyne Tracking**

To be sure, oscillator tracking in a superheterodyne can be avoided by having a separate control. It is no particular problem on 56 Mc. to track coil-tuned stages because they are so broad; with concentric lines as tuned circuits, somewhat more care is desirable.

The largest circuit capacity in a converter with one r.f. stage will be found across the line that couples the r.f. to the detector because this line has both a grid and a plate

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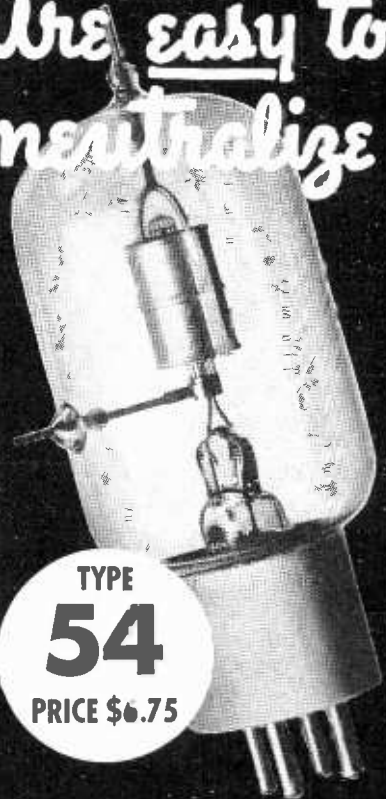
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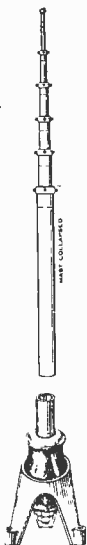
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connected across it. The r.f. stage can be tracked easily by adding a capacity to replace the plate of a tube. This can be a piece of metal soldered to the end of the inner conductor, having a suitable capacity to the chassis.

The oscillator can use an ordinary coil instead of a line, and with a little cut-and-try, the circuit can be tracked with the detector and r.f. over one amateur band. If another concentric line is available, it might as well be used to obtain greater oscillator stability, though it is hardly necessary to go into inconvenient mechanical arrangements in order to tap the tube down on the oscillator line. With transmission lines as resonant circuits, one can accurately calculate the circuit constants and control both the line length and conductor ratio to obtain accurate tracking; the most convenient setup, however, is an oscillator line of the same length and conductor sizes as in the other circuits.

In this case, an intermediate frequency below a megacycle probably will cause no difficulty at all if it is possible to rotate the oscillator condenser in respect to the other condensers, and to adjust a padder. Low intermediate frequencies, however, sometimes make it difficult to obtain good gain from high mutual conductance mixer tubes. At high intermediate frequencies the oscillator is offset so far that the dial settings for the edges of the band are not the same as for the other circuits. A higher oscillator frequency will require less capacity to reach the edge of the band, and a slower change in capacity to track over the band. This can be obtained with a condenser together with a parallel padder, as in broadcast practice, or using a smaller tuning condenser. Likewise, an oscillator frequency below the signal frequency will require more capacity to get to the band edge and a faster increase in capacity to track in the band with the r.f. and detector. This can be obtained with a condenser having more plates than in the detector or r.f., and possibly a padder as well. Changing the ratio of conductor sizes or line length in the oscillator may permit quite good tracking without a tuning condenser different from those in other stages.

**Transmitters**

Concentric lines can be used in transmitters to replace chokes, by-pass condensers and tuned circuits. Transmitters at very high frequencies will be more efficient when coils are replaced with such lines, and the shielding will be improved. The most convenient arrangement results from use of single-ended stages with pentode or beam tetrode tubes not requiring an out-of-phase voltage for neutralization.

## RADIO

### Concentric Line Equations

At high radio frequencies, the equations for concentric line constants are unchanged from those for power frequencies:

$$L_o = 2 \log_e \frac{b}{a} \times 10^{-9} \text{ henries per cm.}$$

$$C_o = \frac{1.111 \times 10^{-12}}{2 \log_e \frac{b}{a}} \text{ farads per cm.}$$

$$Z_o = 60 \log_e \frac{b}{a} = 138.15 \log_{10} \frac{b}{a} \text{ ohms.}$$

The method of calculating the shortening necessary to obtain resonance with a given capacity is the same as for the parallel wire line, the only difference being the characteristic impedance of the line.

### U.H.F.

[Continued from Page 69]

W1IGO and W1HXE are about ready to warm things up around Lawrence.

112-Mc. contacts have finally been established by W2KDB, located at South Ozone Park, N. Y. He says that the Queens County stations are W2BFW DGJ IMZ KDB KOR LHI LIM LUW. Around Bronx and Yonkers, W2CUZ JBO BRO ITF HYG IFB are reported active.

W2JBO in the Bronx has had good reports in contacts with W2JRG (Scarsdale—8 miles) and W2JTF/2. JBO puts 50 watts into a pair of 10's, having cut his 56-Mc. coils down from five to three turns (and landed on 80 Mc.?). He urges others to get on 2½ with revised modulated oscillators now accumulating dust.

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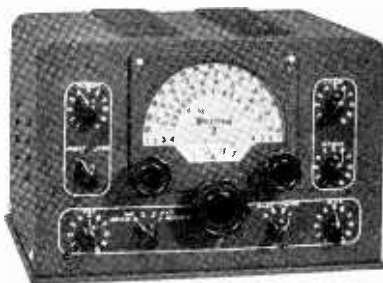


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Los Angeles, Calif.

## RADIO

In Milwaukee, W9ZGD is still going. W9GSP now has a transmitter. W9KOL at Port Washington, 23 miles north is about ready to provide a little better dx for the Milwaukee boys. W9YYY/9 who reported a Californian a few years ago on 2½ said it was not a harmonic or a reradiated signal because the frequency was announced.

W6LJS in Santa Rosa, California, seems to find plenty of stations to work, with W6KIN KPA QIO also active. He uses 25 watts into an RK34. They find the separate quench superregen using pentode detectors to be the most sensitive outside of resistance-coupled superheterodynes. LJS has worked Sebastopol, seven miles away, both with his home rig and with a transceiver using only 150 volts on the plates; 2½ seems to work as well as 56 Mc. He and KIN have been reported R8 by KIW fourteen miles away, located behind hills.

## NOW . . . AUTOMATIC VOLTAGE REGULATION



too!

Many hundreds of the new GUTHMAN U10 Frequency Meter-Monitors are today enabling their owners to comply with the law requiring regular transmitter frequency measurement, and to "pre-spot" new QSO's so they can be tuned in again during receiver warm-up periods without customary annoying fishing. To mention but two cases out of many, WCFL's W9FI uses a U10 to check its ultra high frequency transmitter, while W6USA at the Golden Gate Exposition uses a U10 to check frequency of its five transmitters.

But now the U10 is further improved by inclusion of socket for a VR90 automatic voltage regulator tube, which does a nice job of compensating for voltage changes when transmitter is keyed or modulated and both are on the same (usually heavily loaded) power line. This automatic voltage regulation provision is now included at no extra charge, and full data on how to incorporate it into U10's now in use can be had for a postcard giving serial number. (Address Dep't R5). The same card will also bring free six individual large size calibration curves for all amateur bands from 5 thru 160 meters.

And thanks a lot for the FB response on the new GUTHMAN U17 Communication Receiver Kit . . . we've been flooded with inquiries and are glad to advise that U17's are now on display at all GUTHMAN jobbers.



28 MC. NOTES

There has been a great deal of short skip ten-meter work this past winter, between distances of 150 and 800 miles or so. Chicago-New York and Chicago-Detroit signals in the early morning will serve as examples.

W9ZJB in Kansas City says that around six p.m., mixed in with signals from VK, ZL and K6, he has heard W9VHR and W9QHO in Omaha about 175 miles from Kansas City. Also, he hears W9QAQ in Council Bluffs, W9TIO, W9TIQ, W9ROQ and W5's in Tulsa and Fort Worth. Their signal strength is not over R6 and with a deep, rapid fade like 56 Mc. (Possibly the "bump-bump" fade heard on the Chicago-Detroit-New York signals.) With the beam swung on them they cannot be heard, but with the ends pointed at them they are audible. This has happened almost every night in January and February.

If this type of dx is "long ground wave" like 56 Mc., it suggests that the 28-Mc. band won't be so very dead when it closes down for the usual summer or winter skip, and further indicates that similar equipment on 56 Mc. may produce very much the same distances.

Reports

Don't forget to send your u.h.f. reports, comments, etc., to E. H. Conklin, W9BNX, 512 N. Main St., Wheaton, Illinois.

"SCOTCH TAPE" LABELS

From C. L. Lindberg, W8PH, comes a suggestion for an ingenious method of making nameplates for use under meters, jacks, switches, etc., on the transmitter or at the control position. He has been using them for some time at his home station and has also used them for temporary markers for relays, terminal blocks, etc., at WKBN, Youngstown, Ohio.

They are made by typing the desired information (Grid Current, Plate Voltage, Antenna Tuning, etc.) on a piece of paper of the desired color and then cutting the paper to size. The labels are then placed on the transmitter panel under their appropriate meters, dials, etc., and covered with a piece of Scotch cellulose tape (transparent gummed cellophane tape). The tape is trimmed down to leave about a 1/16-inch border around the label. This will be ample to stick the label to the panel.

These labels are waterproof, cheap, and can be made and mounted in a few moments. Also, if desired, the labels may be removed and replaced by more appropriate ones should the transmitter be changed or should the functions of the various meters or dials be changed.

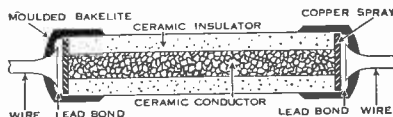


YOU WOULDN'T USE A FIRE HOSE TO WATER THE PLANT

Nor does it make sense to replace a small resistor with a LARGE one. In fact, most resistors in radio sets actually carry less than 1/4 watt load. It is changes resulting from high chassis temperature and humidity that actually cause breakdown . . . not overload. Replacements of the same material, but in larger sizes are no sure remedy.

TYPE 710, rating 1/2 watt, size 1/8 x 5/8 inch. List price 60c for five.

TYPE 714, rating 1 watt, size 1/4 x 1 inch. List price \$1.00 for five.



Center ceramic core, and ceramic jacket fired together to form a single shockproof unit. Pure copper covers resistor end for wire lead contact.

OLD MAN CENTRALAB

SCYS: You'll have one gosh awful time getting anything but perfect performance with Centralab Volume Controls, Fixed Resistors, and Wave Change Switches.



See the CENTRALAB display at the 1939 National Radio Parts Trade Show—June 14 to 17, Stevens Hotel, Chicago.

**Centralab**  
CRL  
**AXIAL LEAD RESISTORS**  
 Div. of Globe-Union, Inc.  
 Milwaukee, Wis.

# 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.

### IMPROVED CONVERTER DESIGN

Page 9

#### Three-Tube Converter

C<sub>1</sub>—Cardwell ZR-10-AS  
C<sub>2</sub>—Cardwell ZR-15-AS  
C<sub>3</sub>—Hammarlund MEX  
C<sub>4</sub>—Hammarlund APC-75  
C<sub>5</sub>—Solar MW-1216  
C<sub>6</sub>, C<sub>7</sub>—Solar MP-4143  
C<sub>8</sub>, C<sub>9</sub>, C<sub>11</sub>—Solar S-0238  
C<sub>10</sub>—Solar DT-879  
R<sub>1</sub>, R<sub>2</sub>, R<sub>7</sub>—I.R.C. BT-1/2  
R<sub>3</sub>—Ohmite Brown Devil  
S<sub>1</sub>—Mallory-Yaxley 3242-J  
Tubes—RCA  
Dial—Crowe 120

#### Four-Tube Converter

C<sub>1</sub>, C<sub>2</sub>—Bud 1641  
C<sub>3</sub>—Bud 1642  
C<sub>4</sub>, C<sub>5</sub>—Hammarlund MEX  
C<sub>6</sub>—Bud 1673  
C<sub>7</sub>, C<sub>8</sub>, C<sub>9</sub>, C<sub>10</sub>, C<sub>11</sub>—Solar MP-4143  
C<sub>12</sub>, C<sub>14</sub>, C<sub>15</sub>—Solar S-0238  
C<sub>13</sub>—Solar MW-1216  
R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub>, R<sub>7</sub>—I.R.C. BT-1  
R<sub>6</sub>—Ohmite Brown Devil  
L<sub>1</sub>—Rebuilt Meissner 16-8096  
S<sub>1</sub>—Mallory-Yaxley 3242-J  
Tubes—RCA  
Dial—Crowe 123-M

### SHUART BANDSWITCHING TRANSMITTER

Page 17

C<sub>1</sub>—Cornell-Dubilier type 4,  
C<sub>2</sub>—Cornell-Dubilier type 1W  
C<sub>3</sub>—Cornell-Dubilier type 1W  
C<sub>4</sub>—Cornell-Dubilier type 4,  
C<sub>5</sub>—Hammarlund MC-100-S  
C<sub>6</sub>—Cornell-Dubilier type 4,  
C<sub>7</sub>—Hammarlund MTC-100-B  
R<sub>1</sub>—I.R.C. BT-1  
R<sub>2</sub>—I.R.C. AB,  
R<sub>3</sub>—I.R.C. BT-2  
R<sub>4</sub>—I.R.C. BT-2,  
R<sub>5</sub>—I.R.C. AB  
T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>—Hammarlund ETU tank  
circuits for 10, 20, 40 and 80 meters

### RFC—Hammarlund CHX

X—Biiley LD-2 crystal  
Amplifier grid coils wound on Hammarlund XP-53 forms  
All components and chassis available as a kit from Hammarlund Mfg. Co.

### DAWLEY FREQUENCY SPOTTER

Page 26

C<sub>1</sub>, C<sub>2</sub>—Hammarlund Star SM-100  
C<sub>3</sub>—Cornell-Dubilier or Solar silvered mica  
C<sub>4</sub>, C<sub>5</sub>—Solar type MW  
C<sub>6</sub>, C<sub>7</sub>—Solar type MP "Domino"  
C<sub>8</sub>, C<sub>9</sub>, C<sub>10</sub>—Solar type MW  
C<sub>11</sub>, C<sub>12</sub>—Solar type MP "Domino"  
C<sub>13</sub>—Solar type MW  
C<sub>14</sub>, C<sub>15</sub>—Solar D-820 electrolytic  
R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>—I.R.C. BT-1 and BT-2  
R<sub>5</sub>, R<sub>6</sub>—Ohmite Brown Devil  
S<sub>1</sub>—Centralab 1465 switch  
L<sub>1</sub>—Meissner 17-6753 b.f.o. coil  
T<sub>1</sub>—Thordarson T-13R11

### JONES FIVE-BAND EXCITER

Page 38

C<sub>1</sub>—Mallory-Yaxley CTX-956  
C<sub>2</sub>, C<sub>3</sub>, C<sub>7</sub>, C<sub>8</sub>—Mallory-Yaxley TP  
C<sub>4</sub>—Solar MW-1233  
C<sub>5</sub>—Bud 907  
C<sub>6</sub>—Solar MW-1206  
C<sub>9</sub>—Solar MP-4111  
C<sub>10</sub>, C<sub>11</sub>—Cardwell MT-70-GD  
C<sub>12</sub>—Mallory-Yaxley HS-893  
C<sub>13</sub>, C<sub>14</sub>, C<sub>15</sub>, C<sub>16</sub>—Mallory-Yaxley M2-753  
R<sub>1</sub>, R<sub>2</sub>—Centralab 516  
R<sub>3</sub>—Ohmite Brown Devil  
R<sub>4</sub>—Ohmite 0386  
R<sub>5</sub>—Ohmite 0578  
S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub>—Mallory-Yaxley 163-C  
RFC—Bud 920  
Chassis—Bud 663  
Panel—Bud 1253  
Chassis Brackets—Bud 1266  
Dials—Bud 163

[Continued on Next Page]



**SILVER COMMUNICATIONS RECEIVER**

Page 46

All components available as a kit from  
E. I. Guthman Co.

**BRODERSON NEWCOMER'S  
TRANSMITTER-RECEIVER**

Page 61

- C<sub>1</sub>—Hammarlund HF-100
- C<sub>2</sub>—Hammarlund HF-15
- C<sub>3</sub>, C<sub>6</sub>, C<sub>12</sub>, C<sub>14</sub>, C<sub>15</sub>—Cornell-Dubilier  
type 3L
- C<sub>4</sub>, C<sub>5</sub>, C<sub>7</sub>, C<sub>9</sub>, C<sub>10</sub>, C<sub>13</sub>—Cornell-Dubilier  
type 3L
- C<sub>8</sub>—Hammarlund EC-35
- C<sub>11</sub>—Cornell-Dubilier type JR-508
- C<sub>13</sub>—Hammarlund MC-100M
- C<sub>17</sub>—Hammarlund Star SM-100
- R<sub>1</sub>—I.R.C. BT 1/2
- R<sub>2</sub>—I.R.C. BT2
- R<sub>3</sub>—Yaxley K12 control
- R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub>, R<sub>8</sub>, R<sub>9</sub>—I.R.C. BT2
- Coil forms—Hammarland Isolantite type  
CF-4
- RFC—Hammarland CHX
- Crystal—Bliley LD-2 or B-5
- CH—Thordarson T13C27
- Jack—Yaxley "A1" midget
- Pilot light bracket—Yaxley 330

**ODE TO A HAM WHO HAS GONE ON PHONE**

By ERIC ADAMS, VE3ALG

Another C.W. station has vanished,  
No longer will Tommy his faithful key tap,  
Just for a band full of phone-hash he left us,  
To have on his desk a mike, and to yap.

He never again will hear dashes and dots  
As he searches the band for a weak, feeble  
sound.  
Ah, there he has found it! A heterodyned  
mumble,  
Such is the life of the simple phone-hound.

They talk all the day about subjects quite  
screwey,  
Shout "hi" many times, though it sounds aw-  
fully dumb,  
And finish by screaming out, "Seventy-three's,  
Has my carrier got any hum?"

They don't work DX, 'cause the DX is brainy  
And doesn't waste time putting voice on  
the air.  
So all they can do when they're on 20 meters,  
Is to get very much in CW hair.

Phones spend lots of money for much extra  
junk  
And add to their racks a new panel.  
Then if they are lucky, they're heard several  
blocks,  
Providing they have a clear channel.



## DON'T LET IT GET YOU DOWN!

Of course you read the best periodicals covering your own special branch of the Radio field.

But what of the other twenty-nine magazines which cover the other ninety per cent of the increasingly fascinating world of Radio? To be well acquainted with important progress in all these fields would help you to know and enjoy your own specialty even more than you do today.

Today, thanks to Radio Technical Digest, you can keep up-to-the-minute on everything that's happening in radio (except broadcast and entertainment), without spending a fortune in time and money.

Between the covers of this concise, well-written digest, is the technical world at a glance! The outstanding articles of the month in both foreign and domestic publications are reprinted or condensed; others reviewed in thumb nail sketches.

## RADIO TECHNICAL DIGEST

BIMONTHLY

Two years, \$2.50

Overseas, \$3.00

7460 Beverly Blvd.

Los Angeles, Calif.

# The Marketplace

## Classified Advertising

RECONDITIONED guaranteed receivers. Practically all models cheap. Shipped on ten days trial. Terms. List free. W9ARA. Butler, Missouri.

AMATEUR RADIO LICENSES. COMPLETE TRAINING IN CODE AND THEORY. DAY AND EVENING CLASSES IN NEW YORK. ALSO HOME STUDY COURSES. HUNDREDS OF LICENSED STUDENTS ON THE AIR. AMERICAN RADIO INSTITUTE. 1123 BROADWAY, NEW YORK.

YOUR sigs rcvd hr. phone CQ's, etc. on guaranteed phonograph records, special 35c. Brown's Radio Laboratory, Dolgeville, New York.

LISTEN for High Frequency Broadcast Station, W9XA, 26,450 Kilocycles, Kansas City, Missouri.

W6KX QSL's now offer silver letters on thin black card with white backs. Keith LaBar, 1123 North Bronson, Hollywood, California.

MAKE an offer on 125 watt, 160 meter plate modulated rig. Dope given on request. W9JQC, Kewaunee, Wisconsin.

MOBILE CONVERTER described in this issue, three tube model, \$13.50 less tubes. Shipped express collect. One only. Radio, Ltd. 7460 Beverly Blvd., Los Angeles, California.

FOR SALE—Closing station in this call area. 450 watt phone-cw transmitter, rack and panel job complete with all accessories \$250 FOB. National HRO, 1938 Model, \$150 FOB. Write for details. W6NCW, Captain F. A. Rudolph, Hamilton Field, California.

FOR SALE—Breting "14" built September 1937 in best condition. Also 6 foot baffle stained and waxed. Take best offer. G. M. Ziegler, Patton, California.

ANY size metal case made for that new portable or mobile transmitter. R. H. Lynch, 970 Camulos, Los Angeles, California.

WANT: Old spark equipment, transformers, quenched gaps, etc., also old large power tubes, such as 851, etc. W5KD, 215 N.W. 19 Street, Oklahoma City.

MOVING: Must sell 250 watt transmitter and Tobe receiver in writing desk cabinet \$125.00. W7FYS, 818 Spring Street, Pullman, Washington.

WANTED complete rig priced right. HEMPstead 7111, Los Angeles, R. W. Smiley.

CRYSTALS AIRMAILED 160A—80X—40X \$1.95. 40AT \$2.75. Complete line 100Kc. to 18 Megacycles—Write. C.O.D.'s accepted. COMMERCIAL CRYSTALS QUOTED. C-W Mfg. Co. 1170 Esperanza, Los Angeles.

CRYSTALS IN HOLDERS; 40X \$1.60; 160-80A \$1.25. Any Frequency. C.O.D.'s accepted. Pacific Laboratories 344 Fetterly, Los Angeles.

SELL 1937 Skybuddy, \$13. Write. Glenn Hastings, R.F.D. 5, Box 378, Bessemer, Alabama.

WANTED used SW3 less power supply. Accept best offer. Joe Baker, 15715 Marlin, Van Nuys, California.

COMPACT Phone Transmitter described in March 1939 issue of RADIO complete with tubes and mike \$200.00. 900 watts if 35T's replaced with 250TL's. No other changes necessary. Crystals for 75, 40, and 20 meters. Coils for 75 and 20 meters. J. T. Goode, 153 Syracuse Walk, Long Beach, California.

DYNAMOTOR, sell or swap. Westinghouse 12 volts input, 400 volts 80 ma. output. A-1 condition. \$4. W9IVU, Princeton, Illinois.

COLLINS 45A, 160-80 to 10, 150 watts, RME 69 panel \$350.00 cash. W60A0, 1107 Lincoln Ave., Alameda, California.

SELF-STARTING electric world time clock. Just the thing for DX hounds, \$7.50. W8JYJ, Cy Jenks, Ypsilanti, Michigan.

BLILEY, Hallicrafter, Astatic, Johnson, Kenyon, Sprague, Bud. Triplett, etc. Try us first. Lakeland Radio Supply, Angola, Indiana.

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

QSL's—Samples, Brownie, W3CJ1, 523 North Tenth Street, Allentown, Pennsylvania.

ANSWER factory quotes promptly on solutions for your radio problems. Robert Kruse, Guilford, Connecticut.

FOR sale QST magazines 1916-1934. Robert Kruse, Guilford, Connecticut.

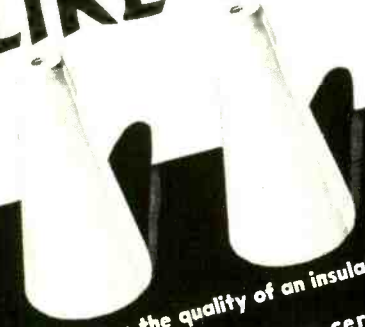
## Advertising Index

Aerovox Corporation . . . . .	76	Mallory & Co., P. R. . . . .	87
American Microphone Co., Inc. . . . .	93	Meissner Manufacturing Co. . . . .	7
Bliley Electric Company . . . . .	85	Ohmite Manufacturing Co. . . . .	88
Breting Radio Mfg. Co. . . . .	93	Premax Products . . . . .	92
Bud Radio, Inc. . . . .	79	Radio Amateur Call Book . . . . .	92
Burstein-Applebee Co. . . . .	78	RADIO <i>Antenna Handbook</i> . . . . .	75
Cannon Company, C. F. . . . .	90	RADIO <i>Binder</i> . . . . .	82
Cardwell Manufacturing Corp., The Allen D. . . . .	88	RADIO <i>Handbook</i> . . . . .	94
Centralab . . . . .	95	RADIO <i>Technical Digest</i> . . . . .	97
Cornell-Dubilier Electric Corp. . . . .	86	RCA Manufacturing Co., Inc. . . . .	Cover IV
Eitel-McCullough, Inc. . . . .	Cover III	Radio Supply Co. . . . .	89
General Rotary Antenna Co. . . . .	86	Radio Television Supply Co. . . . .	81
Gordon Specialties Co. . . . .	87	Solar Manufacturing Co. . . . .	90
Guthman & Co., Edwin I. . . . .	94	Standard Transformer Corporation . . . . .	77
Hammarlund Manufacturing Co., Inc. . . . .	5	Taylor Tubes, Inc. . . . .	Cover II
Harrison Radio Co. . . . .	86	Thordarson Electric Mfg. Co. . . . .	3
Heintz and Kaufman, Ltd. . . . .	91	Turner Co., The . . . . .	78
International Resistance Co. . . . .	83	United Catalogue Publishers, Inc. . . . .	84
		Universal Microphone Co., Inc. . . . .	80
		Wholesale Radio Service Co., Inc. . . . .	90

Two ceramic insulators

# ALIKE IN APPEARANCE

...but in performance  
there's a vast difference

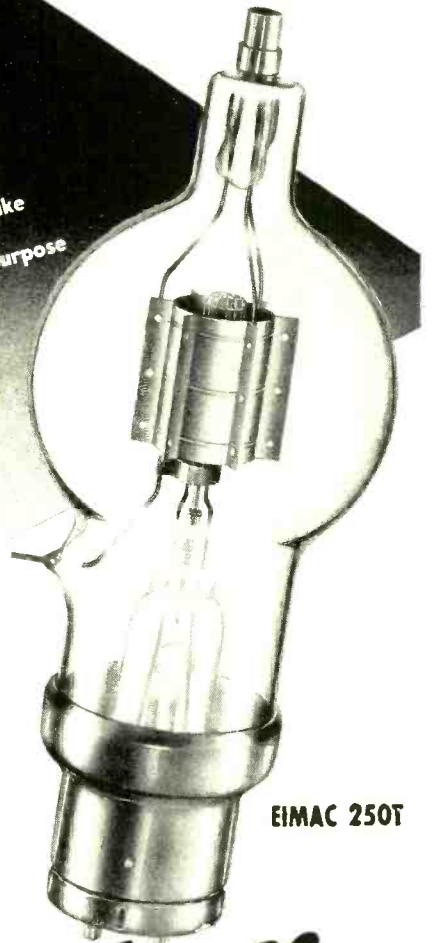


You can't judge the quality of an insulator by its appearance. The older type ceramics are not capable of withstanding Ultra high frequencies such as found in R.F. circuits yet they look exactly like the newer types which are necessary for this purpose

When Eimac tubes first appeared on the market, their unusual design features were rather unique. The odd shaped, crystal-clear bulb, cylindrical elements, new non-sag filament support, wide spacing of grid and plate leads—all were "ear-marks" of the Eimac tube. But there were other features (not visible) which became apparent only when the tubes were put into service. Low inter-electrode capacities, increased electrical efficiency, complete freedom from tube failures caused by gas released internally and ability to withstand momentary overloads as much as 400% to 600% without damage—these are the hidden capabilities which are responsible for Eimac's vastly superior performance.

Eimac tubes are no longer unique in appearance because the purely physical details have been adopted by others (a fitting testimonial of superiority) but they are *still* unique in their most important feature—namely; **OUTSTANDING PERFORMANCE.**

Install Eimac tubes in your transmitter and step into rank with the world's leading radio engineers. See your dealer or write for complete data.



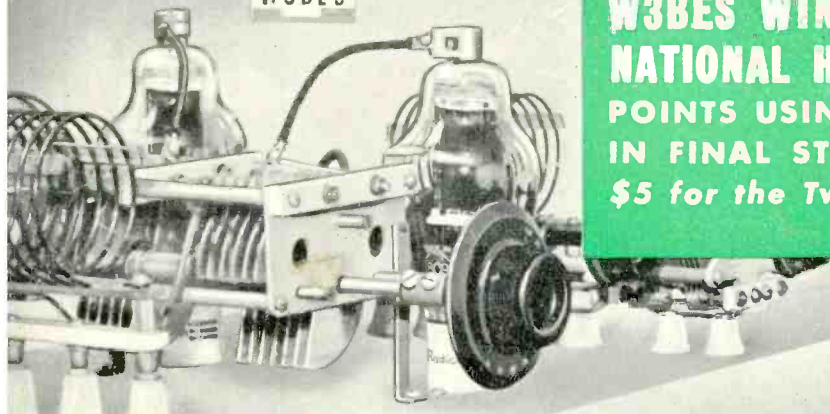
EIMAC 250T

**Eimac**  
TUBES

EITEL-McCULLOUGH, INC.  
SAN BRUNO, CALIFORNIA

W3BES

**W3BES WINS 9th SWEEPSTAKE NATIONAL HIGH...ROLLS UP 84,000 POINTS USING PAIR OF RCA-809'S IN FINAL STAGE...at Total Cost of \$5 for the Two!**



**WIN, PLACE and SHOW with RCA's**

Here is the W3BES Sweepstake Record:

- 1936—Ran 3rd using RCA-852's with 1,000 watts.
- 1937—Ran 2nd using RCA-809's with 100 watts.
- 1938—First place—with the same 809's!

*Proving*

**A RIG NEED NOT BE COSTLY TO COME IN**

*A Winner!*

Jerry Mathis of Philadelphia's well-known Frankford Radio Club *knows* tubes! He knows them as an amateur of long standing — as a prize winner in many important amateur events. Small wonder then, that, for his own 100-watt entry in the Ninth A.R.R.L. Sweepstakes, Jerry chose a pair of RCA 809's for the final amplifier stage and drove them with a third 809.

These tubes were almost two years old. He had bought the first three delivered to a Philadelphia RCA distributor and had used them hard ever since. They had brought him in second in the 1937 Sweepstakes. During the DX Contests, he blush-

ingly admits to having built them up temporarily to 500 watts input instead of their rated 150 watts input. Yet these battered old 809's continued to come through in their own big way.

During the 40 hours of the 1938 contest, Jerry's W3BES worked 502 stations, or an average of better than 12.5 per hour. To be exact, his total score was 84,001.25 points — a record that tells its own story of honest-to-goodness results from inexpensive equipment. Says Jerry: "An investment in RCA 809's will give you a final amplifier stage that can't be beat at anywhere near the price!"

*RCA presents the Magic Key every Sunday, 2 to 3 P.M., E.S.T., on the NBC Blue Network*



RCA-809  
**\$250**  
Amateur Net



**Radio Tubes**

**FIRST IN METAL, FOREMOST IN GLASS, FINEST IN PERFORMANCE**

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