RADIO

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THE WORLDWIDE TECHNICAL AUTHORITY • OF AMATEUR • SHORT WAVE AND EXPERIMENTAL RADIO •

This Month:

Inductive Neutralization and Tuning
Remote Switching of Matching Stubs
A T-200 Grid Modulated Transmitter
An Improved "Conversion" Type Exciter

1938 will see considerable activity on the 56-60 megacycle band. The F.C.C. has recently issued its orders and placed definite assignments. Note that it will be imperative to operate **within the band.** Television broadcasts are on the left, Government assigned frequencies on the right, and we amateurs are in between. The rules have been made; now we must play the game according to the rules!

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RADIO

In this issue "Radio" presents:

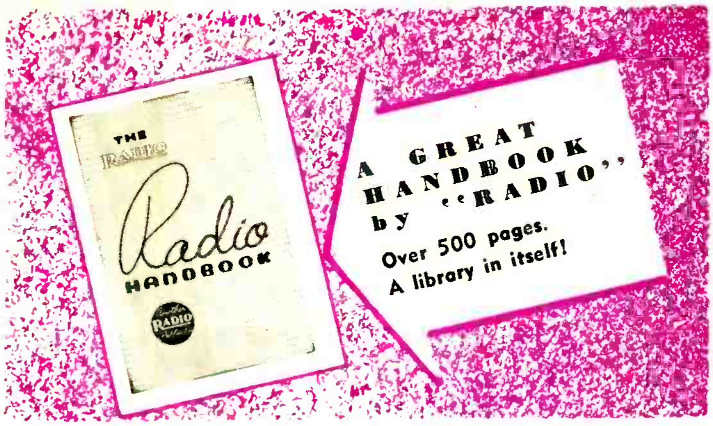
ARTICLES

MISCELLANEOUS FEATURES

DEPARTMENTS

THE WORLDWIDE TECHNICAL AUTHORITY OF AMATEUR, SHORTWAVE, AND EXPERIMENTAL RADIO

One of the most important pieces of information in the 1938 catalog of "RADIO" publications.



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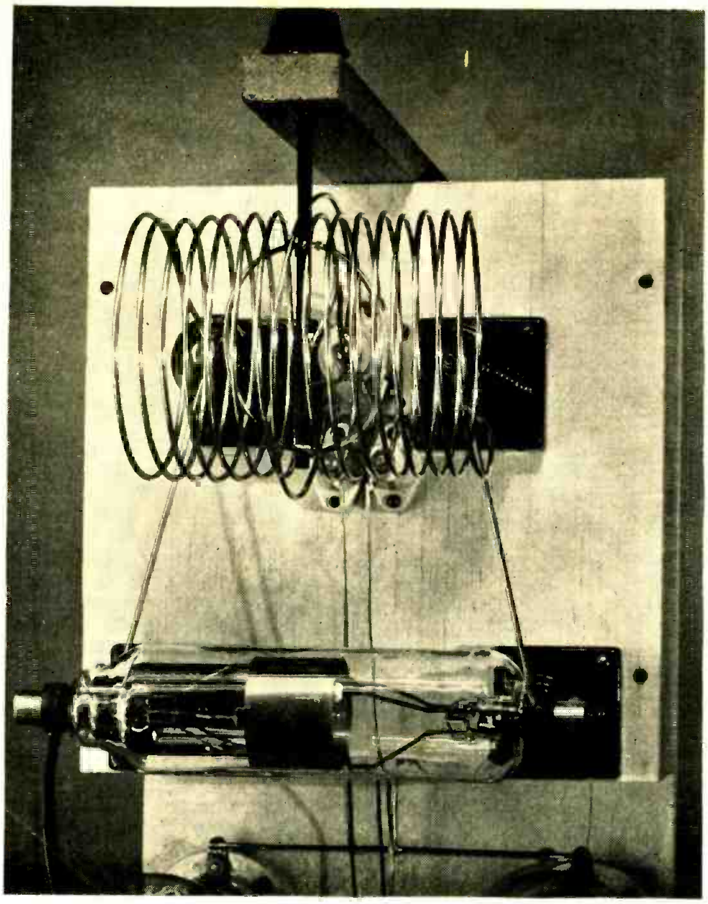


Something Different . . . . .

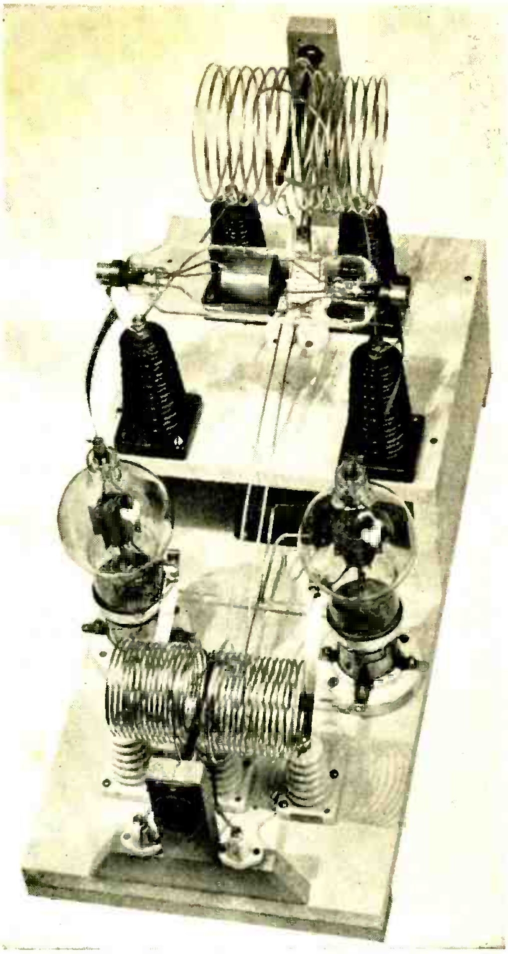
The business end of W6CUH's fixed-capacity final. The "tube" is a high-voltage fixed tank condenser. The link is part of the neutrolizing circuit and the shorted loop resonates the plate circuit. Details about the fixed-capacity final will be found in the story starting on the opposite page.

FIXED-CAPACITY FINAL

Loop-tuned Link-neutralized

By

CHARLES D. PERRINE, Jr.*
W6CUH



Link neutralizing — no tuning condensers — no by-passes. This revolutionary 1938 amplifier hits a new high in simplicity and economy. The one condenser is a small, fixed, vacuum affair capable of withstanding 40,000 volts. The only other parts are two coils, three links, two tuning loops, and two 250TH's. The saving in condenser costs actually pays for one 250TH.

Link neutralization is a highly practical application of inductive neutralization. Just as link coupling improved and simplified interstage coupling in transmitters, so does link neutralizing improve the inductive type. Collins and Craft[1] first applied inductive neutralizing to amateur work by directly coupling the plate and grid coils of an amplifier in reverse phase so as to neutralize the feedback through the tube. They point out the big disadvantage of such a system: that neutralization changes with frequency. This is true for conventional capacity tuning of plate and grid circuits, but *not* for *inductive* tuning. Referring to the skeleton amplifier circuit in figure 1, let K represent the coefficient of coupling between L_1 and L_2 introduced by links L_3.

Then for neutralization:

$$K = \omega^2 \sqrt{L_1 L_2 C_{gp}}$$

where $\omega = 2\pi f$ and f is the frequency in cycles per second, C_{gp} the grid plate capacity of the tube, and L_1 and L_2 the inductance of the two coils.

But, using the resonance equation $\omega^2 = \frac{1}{LC}$, ω is eliminated from the expression for K:

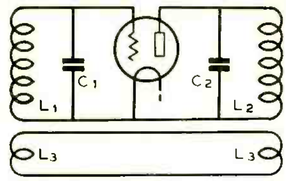
Thus $$K = \frac{C_{gp}}{\sqrt{C_1 C_2}}$$

Hence K, and neutralization, become inde-

*421 25th St., Hermosa Beach, Calif.
[1]A. A. Collins and L. M. Craft, "Inductive Neutralization of R.F. Amplifiers", *QST*, July, 1936.

FIGURE 1

Fundamental Circuit



pendent of frequency if C_1 and C_2 remain fixed and all tuning is done by varying L_1 and L_2.

Thus inductive tuning not only nails down the neutralizing adjustment but obviates the use of variable tank condensers. The actual variation of inductance is obtained by rotating a single shorted turn inside the tank, a stunt borrowed from broadcast practice. The effect of the shorted turn is to vary the coil by approximately one turn. This is more than sufficient to cover any ham band, with the possible exception of 160 meters (where it has not yet been tested). With a low resistance silver-plated or silver wire "flipper" loop, the losses in it are very low. Contrasted to condenser tuning, there are no voltage limitations to inductive tuning.

The Vacuum Tank Condenser

The use of inductive tuning immediately makes possible the use of a fixed vacuum condenser for the tank capacity. With a good vacuum, ridiculously small spacings can be used to increase capacity and reduce physical dimensions. The condenser used in the new amplifier is a somewhat experimental model made to order by Eimac. With no precedent to follow, the voltage ratings of the condenser were necessarily made high.

The condenser consists of two 750T plate stems end to end as pictured in the photograph. Two concentric tantalum cylinders supported from the opposite ends of the condenser form the plates. The capacity turned out to be a little higher than expected, 30 μμfd., but not excessive for the contemplated frequency of 7 Mc. Due to the use of tantalum, the vacuum improves with age. The gap between electrodes is only 1/16", but as much as 40,000 volts of r.f. failed to cause a trace of arcing or ionization. The leads to the electrodes are good for at least 60 amps. Losses are nil as the only insulation is Nonex and vacuum. 30 μμfd., 40,000 volts, and 60 amps. in a 2¼"x 8" condenser show just what can be done in a vacuum.

The complete circuit of the experimental amplifier is shown in figure 2. Note the two new circuit symbols devised for the tuning loops and vacuum condenser C. The grid tank capacity is the grid-filament capacity of the 250TH's. The resulting high L/C ratio is permissible because the push pull operation keeps harmonics down. Some "Q" is coupled into the grid tank from the preceding driver plate tank. The link L_6 does the work of neutralizing by feeding back to the grid tank sufficient out-of-phase power to neutralize the capacitive feedback. As in the past, push pull is used because it reduces harmonics and is balanced to ground, though unbalances with respect to ground do not appreciably affect link neutralization. The only balance important is that of the load on the tubes, which is controlled by the antenna coupling. An unbalanced load will cause one tube to run hotter than the other.

Construction

The photographs show clearly the constructional details of the amplifier. The breadboard is 12"x24" with a 5" platform at one end to bring the plate tank on a level with the tube tops. The filament transformer is located under this platform. Complete symmetry of layout is important and has been carried out in the placement of all parts. Power leads are brought out to terminals on the end of the baseboard below the plate tank. Wiring is done with no. 10 silver plated wire.

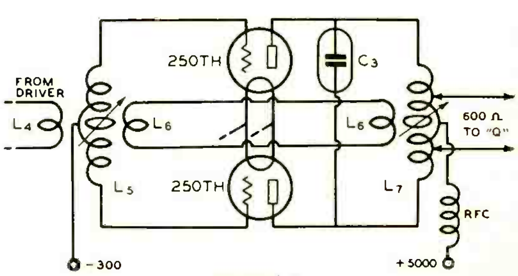


FIGURE 2

The complete circuit of the 7 Mc. push pull amplifier.

C—30 μμfd. 40,000-volt vacuum type (see text).
L_4, L_6—1 turn, silver-plated no. 10 wire.
L_5—35 turns, 3" diam., 6" long, silver-plated no. 10 wire.
L_7—15 turns, 4½" diam., 5" long, silver-plated no. 10 wire.
Tuning loops—One shorted turn, silver plated no. 10 wire.
RFC—High frequency r.f. choke, 500 ma.

The grid tank is on a level with the grids of the tubes. The exciting and neutralizing links are coupled to the center of the coil with just enough separation to pass the ¼" bakelite shaft that carries the rotatable, silver-plated tuning loop inside the tank. The bearing for the bakelite shaft is a midget open circuit phone jack; the sleeve provides the bearing and the spring the necessary friction to prevent free rotation. This jack is mounted at the coil-center level on a piece of bakelite attached to the top of a wooden upright. Provided with a suitable knob, this 25-cent tuning set-up tunes as smoothly as the best.

The grid and plate leads to the tubes are made of thin ½" copper strip. It is a recognized fact that the braid usually used is a poor r.f. conductor at high frequencies. The copper strip is not only better in this respect, but also helps appreciably in cooling the tube terminals and seals.

The platform carries the entire plate tank. The vacuum condenser is supported on two insulators by short no. 12 wire leads and two large size grid clips. It must be sufficiently in the clear as any objects near its middle might cause a puncture by arcing through the glass. The plate coil is self-supporting and arranged for a good shape (form) factor. The plate tuning loop is mounted and controlled just as in the grid circuit. The neutralizing link L_6 is placed around the center of the plate coil. The link line joining the two neutralizing links is made of two parallel no. 10 wires that can be seen running down the center of the amplifier between the tubes. The polarity of the link must, of course, be correct; otherwise it would accentuate the feedback. Proper polarity follows a simple rule: If the tanks are wound in the same direction, the links are also in the same direction and connected in parallel (no crossover) by the link line.

Adjustment

Neutralization of the amplifier is simplified because only one neutralizing adjustment is made, that of the neutralizing link. First apply excitation with the plate voltage off,—and increase it until 200 ma. of grid current flows. Then adjust the coupling of the neutralizing link (can be done either at plate or grid ends, or both) until the grid current remains unchanged as the plate is tuned through resonance. The point of complete neutralization is quite broad. And neutralization is really complete; a sensitive light coupled to the plate tank shows no trace of r.f. As a final acid test of neutralization and stability, the amplifier was operated as a class B linear with approximately cut-off bias and excitation removed with no sign of self-oscillation with tanks both in and out of tune.

Plate tuning is just as in any condenser-tuned rig. The antenna coupling should preferably be balanced, such as the Q feed shown. But even a badly adjusted, end-fed antenna can be coupled on to one side of the tank without bothering neutralization, though the tube loading will be unbalanced and the tubes will not heat evenly.

Advantages

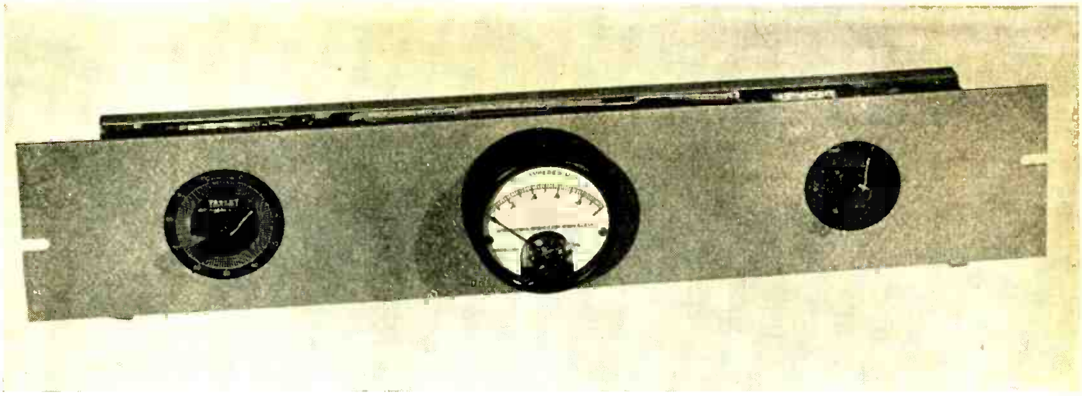
Operating advantages of this amplifier over the old type are many. For the c.w. man, it will withstand full plate voltage with the load removed (at 5000 volts this produces an 8" arc when drawn with an insulated pipe wrench). To the phone man it means no further worry about modulation peaks, as even 1/32" electrode spacing is good for at least 20,000 volts in a good vacuum.

The inductive tuning of the grid circuit and the resulting low-C produce a very broadly-tuned circuit when loaded by the low impedance grids of the 250TH's, broad enough to cover 200 kc. at 7 Mc. without retuning with less than 10% change in grid current. And as the only condenser in the amplifier is sealed in glass, dust and moisture can never make it flash over.

The amplifier described above is just one application of link neutralization. It can be used wherever neutralization is required with a great simplification of circuits. Even with capacity tuning it will be constant enough to cover about a 1% frequency change. Doing away with split tanks in single-ended stages (required for capacity neutralizing) will make band switching much easier.

Link neutralizing was applied to a single-ended 250TL amplifier on 14 Mc. and gave more complete neutralization than the old capacity neutralization. Another case was a 6L6 to be operated as an amplifier instead of as a doubler, thus requiring neutralization. It took only a moment to run a link between the grid and plate coils to neutralize the tube perfectly without any further change in the original circuit.

The foregoing is the result of two weeks of hurried tests; hence plenty remains to be done. Prospects are very good that small vacuum condensers will soon be available on the market. It is all something new to work with, and should result in revolutionary new amplifier layouts. More data and construction details will appear in an early issue.



An Improved Type VOLUME INDICATOR

By RAY L. DAWLEY,* W6DHG

Great progress has been made in recent years in the improvement of the volume indicator. The old biased-detector type of indicator as used a few years ago has been so thoroughly improved upon that to watch one of the older ones after a person has become accustomed to the present type would be very misleading as to the average program level and the strength of the peaks. The modern copper-oxide high-speed indicator is so much superior in the indication of the proper amplitude of peaks and the average program level that it is difficult to improve upon it in this respect.

But the present high-speed v.i.'s are rather tiring to watch due to their continual indication of every little peak in the speech or music that is being measured. The little pointer is so continually "on the go" that the eyes soon become strained from trying to follow its movement. For this reason many mixers and operators are inclined to favor the slower-speed indicators that do not indicate peaks so well but do indicate average program level.

To alleviate this difficulty, designers have suggested the use of a meter that would follow the *envelope* of the highest of the peaks but would not indicate every minor peak that comes along. Such a meter is very much easier to read, is not nearly so tiring, and still gives an indication of every important peak that travels through the system.

A few of the manufacturers have placed such meters upon the market. All operate upon the same general principle: the use of an audio amplifier to feed a peak rectifier which works into an RC network of appropriate time constant. There is then a continuously-indicating vacuum-tube voltmeter that measures the voltage across the RC network. The meter to be described is of that type.

Such a meter can very easily be made and installed upon an amateur transmitter, public address amplifier, or program line to give an accurate indication of every peak as well as the average level.

Electrical Design

The circuit diagram shows the simple circuit of the meter. A 6C5 tube, with a 100,000-ohm input circuit, forms the first stage. The tube acts as a voltage amplifier to bring up the low voltage from the speech line to a value which will operate the succeeding rectifier and v.t. voltmeter. Due to the use of the high-resistance potentiometer, R_1, the insertion loss incurred by placing this meter across a speech line is practically negligible. Also, due to the high-resistance input, the meter may be efficiently operated from a line having any common impedance, 50, 200, 500, 1000 ohms, etc. If

*Technical Editor, RADIO.

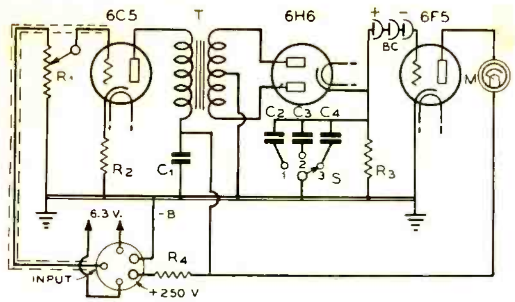


Figure 1

C$_1$—8 μfd. 450-volt electrolytic
C$_2$—.01 μfd. 400-volt tubular
C$_3$—.05 μfd. 400-volt tubular
C$_4$—.25 μfd. 400-volt tubular
R$_1$—100,000-ohm potentiometer
R$_2$—2000 ohms, 1 watt
R$_3$—1 megohm, 1 watt
R$_4$—10,000 ohms, 1 watt
T—Midget 3:1 p.p. input audio
BC—3 bias cells in series
S—Time-constant switch
M—0-5 d.c. milliammeter

it is desired to calibrate the meter accurately, this input resistance may be a step-by-step potentiometer with a definite loss for each step, say a total loss of 30 db taken in 3-db steps.

The meter is quite sensitive with the input circuit shown. Actually, a voltage of about 0.5 volts is all that is required at the input to drive the meter to full scale; this is with the potentiometer R$_1$ wide open. This corresponds to a sensitivity of about -10 db for full scale across a 500-ohm line. The sensitivity, of course, is higher for a higher-impedance line and lower for a lower-impedance one.

The 6H6 Rectifier

The 6C5 tube works, through a midget push-pull input transformer, into the two plates of a 6H6 connected as a full-wave rectifier. The center tap of the transformer is grounded and the cathode circuit of the rectifier works into an RC network which determines the time constant of the meter (neglecting, of course, the time constant of the meter movement.) A tap switch, S, is provided to change the time constant as desired or as conditions warrant.

With the switch in position (1), the smallest condenser is in the circuit and the time constant is very short, in the vicinity of .01 second. In position (2), the time constant is considerably longer, about .05 second. This would be the position of the switch most generally used. In the third position the largest condenser is in use resulting in the longest time constant, about .25 second. In all positions the up-take is rapid and approximately the same; the time constant of the filter determines how slowly the meter returns to the average position after a peak has passed.

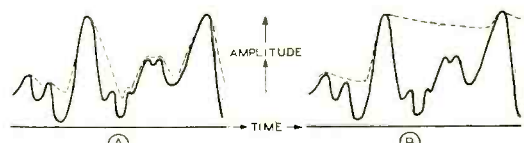
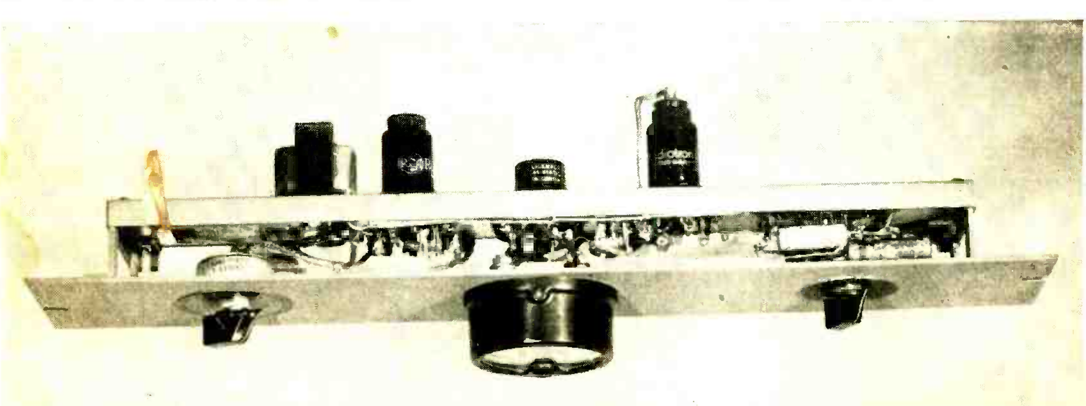


FIGURE 2

In figure 2 is shown a comparison of the operation of a meter of this type and of a standard high-speed v.i. meter of the copper-oxide type when operating on a complex audio wave. The dotted line in figure 2 (A) shows how the needle of the conventional type is continually "on the go", indicating every minor peak as well as the major ones. This is the type of movement that is so tiring to the eyes. (B) indicates the operation of the meter described in this article on the same waveform. The major peaks are shown just as clearly but none of the minor ones are indicated. The slope of the dotted line (the movement of the needle plotted against time) is determined by

[*Continued on Page 90*]



Improved
CONVERSION EXCITER

To make the best use of our present congested amateur bands, it is necessary to be able to change frequency within the band at will. Self-excited oscillators require extreme care in construction if they are to be used for frequency control on the higher frequencies. However, a low frequency, self-excited oscillator can be made very stable when the stability is considered in terms of cycles rather than a percentage. By heterodyning a variable frequency, self-excited oscillator working in the region of 100-400 kc. against a high frequency quartz crystal oscillator, it is possible to take advantage of both the stability of the crystal and the variable frequency feature of the self-excited oscillator.

The frequencies are mixed in much the same manner as in a superheterodyne in order to get the resultant frequency. This was more fully explained in the original conversion exciter article which appeared in the June, 1936, issue of RADIO and in the follow-up article which appeared the next month.

While the exciter described in the original article was a big step in the right direction, it has been possible to simplify and so improve the original version that almost any amateur who has had experience in transmitter construction can get one going with little difficulty. The circuit as originally shown was primarily an experimental one; the exciter was built up in order to test the theory upon which the operation is based. The following exciter is suggested for amateurs desirous of building a practical model. —EDITOR.

***By* C. M. WEAGANT,* W7GAE**

The completed exciter with power supply.

After many months of experimenting with the conversion exciter idea, an exciter was finally evolved which was sure-fire and completely free of bugs. The circuit is fundamentally the same as that of the original conversion exciter described in RADIO, but many minor modifications greatly improve the performance and eliminate some of the disadvantages possessed by the original circuit.

The unit may be used either as a frequency meter of high accuracy, as a straight crystal oscillator or as a variable frequency exciter. The mechanical layout is illustrated in the accompanying photographs. The exciter shown is quite compact. The unit would be undoubtedly easier to construct if built on a slightly larger chassis and cabinet.

Shielding between the various stages is necessary in order to minimize stray coupling, the latter being responsible for erratic operation.

The low frequency oscillator is connected as a triode in order to make the plate impedance low and to simplify the circuit. Injector grids of the 6L7 tubes are connected in push-pull. The selectivity of the plate circuit of the 6L7 tubes prevents the "image" (unwanted heterodyne) frequency from passing through and appearing in the output circuit. The control grids of the 6L7 tubes are connected in parallel and driven from the high frequency oscillator.

The high frequency oscillator is of the Pierce type and has no tuned circuits. It will oscillate with any good crystal if the setting of the small mica trimmer condenser from cathode to ground is correct.

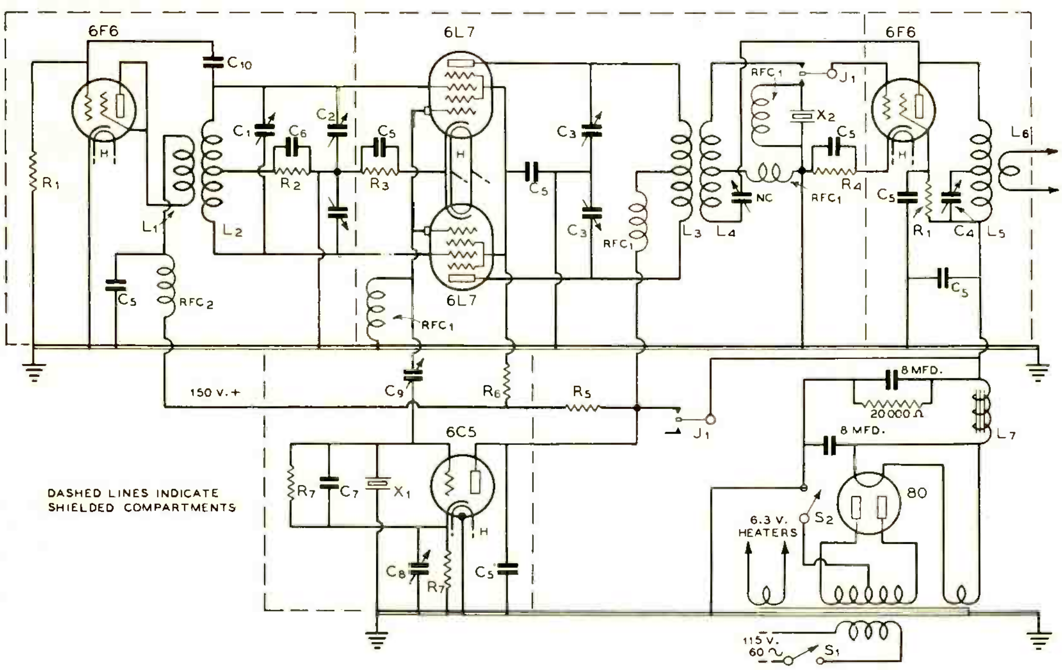
The i.f. coil primary must be pruned down to make the low frequency oscillator more stable and prevent harmonic output and beat notes. It is necessary to remove approximately 45 feet of wire from the primary. The primary should then be moved up close to the secondary, as tight coupling is required when this much

*4110 N. E. Fremont St., Portland, Ore.

wire is removed. This may be accomplished by melting the wax with the point of a small soldering iron placed in the hollow tube which supports the coils. The primary should be moved up close to the secondary while the wax is hot and held in position until the wax solidifies.

To determine when sufficient wire has been removed from the primary, measure the negative grid voltage across R_2 when the exciter is in operation. It should measure between 10 and 12 volts negative. The more wire removed the lower this voltage will be. If the low frequency oscillator does not oscillate, reverse the primary. Oscillation is indicated by a voltage drop across R_1 or by the existence of the second harmonic as heard by a broadcast receiver.

The padder C_1 across the i.f. coil should be set for the desired frequency with C_2 set for zero capacity. The padder across the primary may be left set at low capacity or it may be disconnected. If a very low frequency is desired for the low frequency oscillator, the padder across the primary may be connected in parallel with C_1 across the secondary. The condenser C_2 is the main tuning condenser used to change frequency. It is controlled by a large vernier



C_1—100 μμfd. padder condenser
C_2, C_3—350 μμfd. per section, 2-gang b.c.l. condensers
C_4—100 μμfd. midget padder condenser
C_5—.002 μfd. mica condenser
C_6—.006 μfd. mica
C_7—.00005 μfd. mica
C_8, C_9—3-30 μμfd. mica trimmer
C_{10}—.0001 μfd. mica
NC — Midget neutralizing condenser
RFC_1—2½ mh. r.f. choke
RFC_2—5 mh. r.f. choke
X_1 — Conversion crystal near 3920 kc.
X_2—Conversion crystal near 3592 kc.
T_1 — Power transformer, 700 v. c.t., 70 ma., and filaments
J_1—D.p.d.t. switch (anti-capacity) to change from straight crystal oscillator to conversion circuit
S_1, S_2 — S.p.s.t. toggle switch
L_1—Primary of ST-465-CT i.f. transformer with 45 feet of wire removed and primary closely coupled to secondary (see text)
L_2—Secondary of ST-465-CT i.f. transformer
L_3—28 turns of no. 18 enam. on 1½" coil form (for 80 m. crystal)
L_4—24 turns of no. 30 dsc interwound with L_3 and center-tapped
L_5—42 turns of no. 18 enam. with C_4 tapped 22 turns from cold end
L_6—1-turn link coil on bottom of L_5
L_7—15 hy. 75 ma. filter choke
R_1—30,000 ohms, 2 watts
R_2—50,000 ohms, 1 watt
R_3—300 ohms, 1 watt
R_4—400 ohms, 10-watt wire-wound
R_5—5000 ohms, 10-watt wire-wound
R_6—6000 ohms, 1 watt
R_7—60,000 ohms, 1 watt

Top view. The main tuning condenser is hidden by the output condenser directly above and in front of it in the photo.

dial on the front panel. The output condenser C_3 is tuned by the small dial on the front panel, and when once set for the middle of the band covered by a crystal, it does not require resetting for operation anywhere within this range.

Unity coupling is used between the 6L7's and the 6F6 neutralized buffer for the sake of simplicity. The 6F6 has sufficient output to drive a 25-watt buffer or doubler in the transmitter, yet does not have so much output that it blocks the receiver when used as a monitor or frequency meter. It is important that the 6F6 buffer does not self-oscillate, as this will cause many frequencies (birdies) in the output and probably get you a pink ticket.

Neutralization may be checked by placing a pick-up loop and dial light over L_5. No indication should be secured when the crystal is removed, regardless of the setting of the tuning condenser. If it lights at any setting of the tuning condensers, the 6F6 is not perfectly neutralized. The neutralizing condenser requires very little capacity. If desired, about an inch of twisted hook-up wire can be used and trimmed or untwisted until the tube does not self-oscillate.

The exciter may be thrown from the conversion circuit to a straight crystal oscillator by means of the switch on the front panel. This disconnects the plate voltage from all of the tubes except the 6F6 buffer tube and connects the crystal to the control grid of the 6F6, making it a conventional pentode crystal oscillator.

C_4 is mounted inside the coil form and tapped across but one-half of L_5. It is tuned for maximum output at the center of the band, and then does not require resetting for operation anywhere in the band.

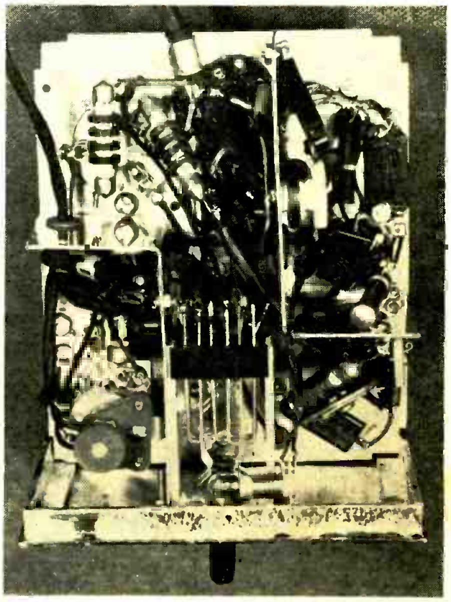
The output of the exciter should light a 6.3-volt, 0.25-amp. dial lamp to full brilliancy, either as a straight oscillator or as a conversion exciter. By replacing the crystal of an existing oscillator with a small coil and trimmer condenser, it is possible to link couple this exciter to a transmitter with no other changes in the transmitter.

The power supply is conventional and is built in a separate unit.

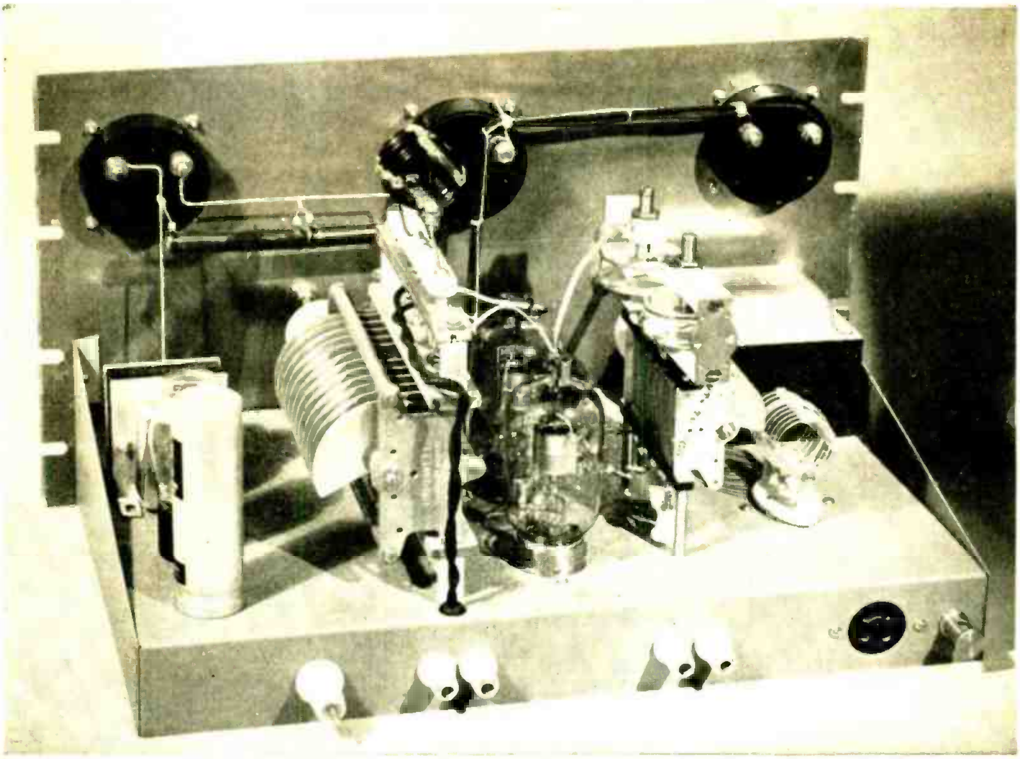
The main tuning dial should be precision built if a high degree of accuracy is desired. This is of especial importance when working fairly close to the edge of a band. The dial may be calibrated directly in kilocycles if desired, or a tuning chart may be made up so that the unit may be used either as a frequency meter or as an exciter.

The writer uses only two crystals to work

[*Continued on Page 95*]



Beneath the sub-panel is the change-over switch and all the resistors and r.f. chokes.



Looking down on the amplifier from the rear. The small 10-meter coils illustrated have a good form factor and small field, giving efficiency on 10 meters comparable to that obtained on 20 meters.

400-WATT HK-54 AMPLIFIER

of neat and efficient design

***By* FAUST R. GONSETT,* W6VR**

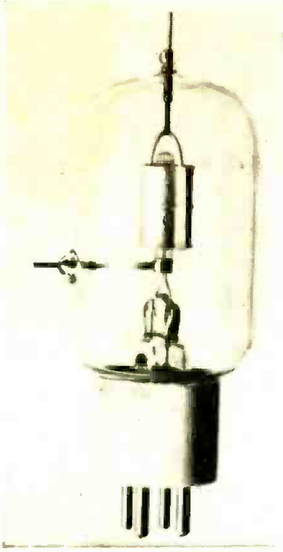
Illustrated in the accompanying photographs is a push-pull final amplifier designed to run at 400 watts input, plate modulated on 10 and 20 meter phone. Besides utilizing a pair of the new HK-54 Gammatrons, it possesses interesting mechanical features, the layout being such that plate, grid, and neutralizing leads are all less than a couple of inches long.

Actually the input on 20 meters was run up to over 600 watts on phone without signs of distress, but such operation demands that the tubes be run in excess of their ratings. While such operation is possible, it is not to be encouraged.

*Laboratorian, RADIO.

The amplifier is built upon a standard 19-inch relay rack panel and chassis, the panel being of duralumin and the chassis of cadmium plated steel. The black, square-case meters, and the black, wheel-type control knobs present a striking appearance against the satin finish duralumin panel.

As the circuit of the amplifier is strictly conventional, the wiring diagram is not given. A word might be said, however, about the method of bias. A small bias pack is built right on the chassis. This consists of a small b.c.l. power transformer, 300 volts each side of c.t. at about 75 ma., an 80 rectifier, and an 8 μfd. electrolytic as filter. This small amount of filter is



● The newest addition to the HK family, the HK-54, is the "walking image" of its big brother, the HK354-D. The new tube draws 5 amps, at 5 volts, has a μ of 27.

sufficient because the grids of the 54's are driven to saturation, and are, therefore, insensitive to ripple modulation. Also, because of the method of deriving bias from the pack, most of the bias is generated by the grid current rather than the pack itself. A small .004 μfd. mica condenser should be shunted across the electrolytic condenser right at its terminals to protect it from r.f. It is also important that the condenser have a grounded metal case. Electrolytics deteriorate quickly if much r.f. gets at the "goo", and the one used here is only a few inches from the hot stuff.

Shunted across the voltage delivered by the bias pack is a 7500-ohm, 100-watt resistor with a slider. The bias is derived from the slider tap, and the tap adjusted so that the bias developed is between three and four times cutoff when approximately 50-60 ma. of grid current is flowing. When excitation is removed, the bias will drop considerably, but it still will be sufficient to cut off the plate current to the 54's, thus protecting them and also allowing oscillator keying if c.w. is used.

Because of the heavy current drawn by the filaments of the 54's (10 amps for the pair), the filament transformer was mounted on the chassis to avoid long leads and voltage drop. The husky filament transformer may be seen in the rear view photo to the back and extreme right.

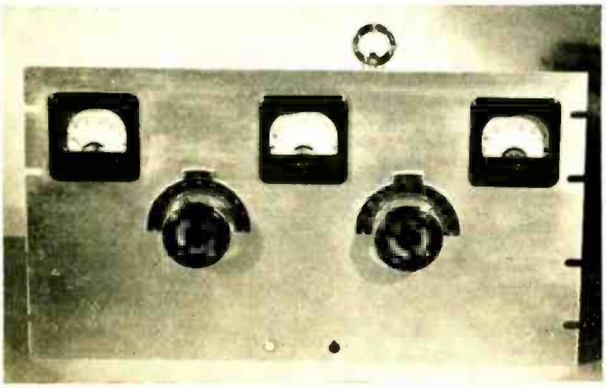
By mounting the plate coil socket (jack strip) directly on the plate tank condenser and the neutralizing condensers directly on the grid condenser as shown, very short leads result. The longest r.f. leads in the amplifier, those from the grid condenser to the grid coil, are only three inches long.

The frame of the plate tank condenser is insulated from ground but bypassed to ground by means of a high voltage mica condenser. This permits the use of closer spacing in the condenser without danger of arc-over. The condenser is driven by means of an extension shaft which is insulated from the condenser with an insulated coupling.

Coupling from the final tank is by means of a link, the latter being an integral part of the plug-in plate coil. The twisted pair from the link terminals on the coil jack strip may be seen running down the back of the plate condenser. It terminates in the jack type stand-off insulators directly below.

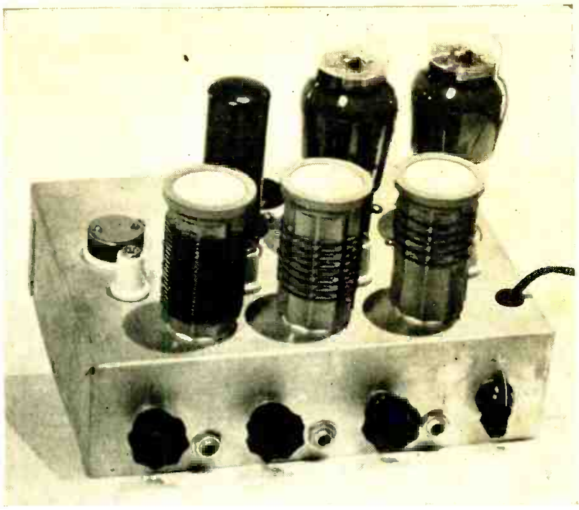
The 54's are mounted in "sunken sockets"; the porcelain base, metal shell 866 type are

[*Continued on Page 85*]



● The black, square case meters and wheel-type control knobs are especially attractive against the satin finish, duralumin panel.

Simple, Flexible
15-20 Watts . . . .



That's the Foolproof
DYNAPUSH EXCITER

By W. W. SMITH,* W6BCX

●

What with all the new fangled exciters that have been described in the last three or four years, it is somewhat surprising to note the number of "die hards" still using 47 oscillators and 46 doublers to get down to the frequency they want. There must be a reason; so we determined to get to the bottom of things forthwith by proceeding to question an amateur who continues to use the same 2A5 oscillator and 46 doublers he hooked up over four years ago.

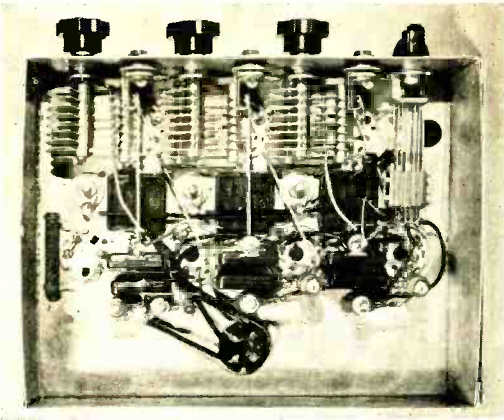
"Well, the front end of my rig may not have regeneration, degeneration, touch tuning, free wheeling, bi-tet, or tri-push, but on the other hand neither has it any bugs or parasites. The crystal current is low, the output is sufficient for the purpose, and when I turn things on everything perks right off. The same can be said for some of the newer exciters when constructed right, but for hams like myself who have a knack for running into bugs, the newer exciters are somewhat a bugaboo. They may work and they may not."

There was the answer: Simplicity, freedom from "bugs", and foolproof operation. The old straight pentode oscillator and string of high μ triode doublers *did* have many desirable attributes. How about bringing the arrangement up to date with newer tubes to constitute an exciter that would appeal both to the old timer with a tender spot in his heart for the "good old circuits" and the newcomer who has not sufficient technical knowledge and experience to build one of the many trick exciters without borrowing a lot of grief?

When the idea took shape, the result was the exciter illustrated. It must be conceded that this "1932 exciter" cannot be used for spraying paint, grinding valves, or making ice cubes. But when it comes to delivering excitation, it is just about the simplest, most foolproof and sure-fire arrangement one can build. The crystal current is low, it is completely free from parasitics and self-oscillation, it is not critical of construction or adjustment, and the keying is such as to bring joy to the heart of any c.w. man.

Because of its very simplicity, the fundamental circuit is somewhat flexible as to the tube complement. The exciter may be built with inexpensive components and used with 6L6-G's in the second two stages to keep the price down.

*Editor, RADIO.



Underchassis view of the exciter, illustrating arrangement of components.

This is the version illustrated in the photograph. It will deliver approximately 25 watts at the crystal frequency, and about 20 watts from the doubler stages except on 10 meters. On 10 meters the output falls off to about 12-14 watts.

By substituting an isolantite base 6L6-G (RK-49) in the last stage, along with an isolantite insulated midget condenser and a ceramic coil form for the 10-meter coil, the output on 10 meters will compare more favorably with that obtainable from the doublers on lower frequencies.

By utilizing a pair of 809 tubes as doublers in place of the 6L6-G and RK-49, the output will approximate 25 watts on all bands down to and including 10 meters, provided ceramic insulation is used in the last stage. The only change in constants required for 809's is the substitution of a 10,000 resistor for the 5000-ohm one at R_5. It is also preferable to use a higher range tuning milliammeter, though not absolutely necessary .

The Oscillator

A 6L6 is used in a straightforward "pentode type" crystal oscillator circuit. (The beam forming plates can be considered as the equivalent of the usual pentode grounded-suppressor element.) While the plate voltage is fairly high, the crystal current even at 40 meters is not excessive for the following reasons: First, the screen voltage is kept at a rather low value. Second, the feedback capacity between grid and plate circuits is kept down to a value just sufficient to provide stable oscillation on all bands. The capacity between the "hot" side of the oscillator grid circuit and the output circuit in the usual 6L6 oscillator is considerably more than is needed for active oscillation even on the lower frequencies, inasmuch as the internal grid-plate capacity alone of the 6L6 is sufficient for 40- and 80-meter operation, and almost sufficient for 160-meter operation. Very little additional feedback capacity is therefore required, much less than is present in an unshielded breadboard oscillator.

This excess of feedback can be reduced in several ways. It can be reduced by partial neutralization, but this complicates the circuit. It can be greatly reduced by shielding completely the input (grid) circuit from the plate tank circuit. It can be reduced considerably by shielding just the tube itself. Thus, by utilizing a metal type 6L6 and grounding the shell, the crystal current will be reduced considerably with a 40-meter crystal, yet the output will remain practically unaffected. By connecting the shell direct to *cathode* instead of to ground, there is a very slight neutralization effect in addition to the shielding effect, the remaining feedback being just about the desired degree for optimum operation on all bands with low crystal current on the highest frequency band.*

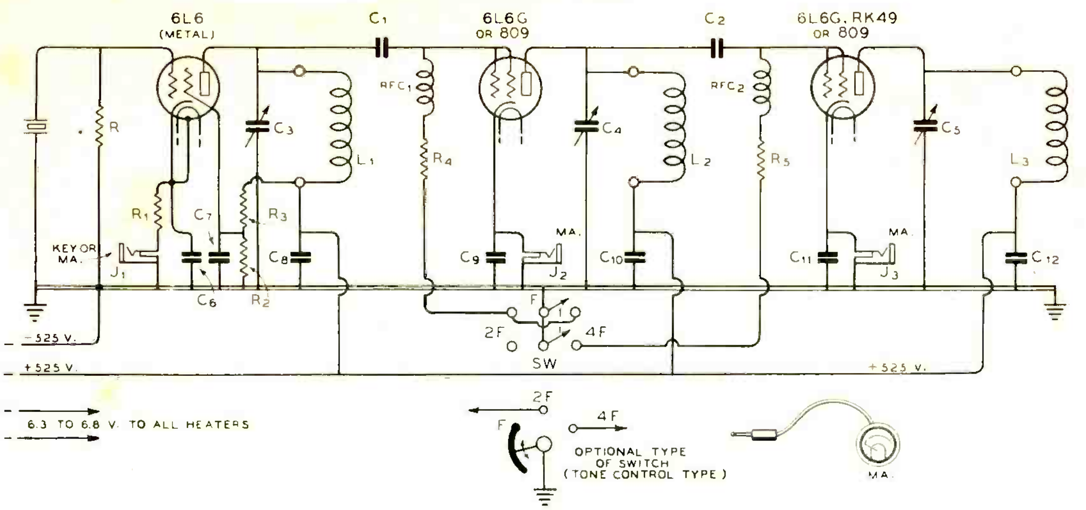
This oscillator either drives the following stage or delivers approximately 25 watts, with only about 65 ma. of crystal current for a 40-meter crystal (less for lower frequencies). With the load completely removed (no external load and the grid of the following stage open), the crystal current is somewhat higher, but not dangerously so.

To keep the crystal current at a minimum, the oscillator should be constructed on a metal chassis, with the grid leads (to crystal and gridleak) as short and direct as possible. It makes a difference in the r.f. crystal current of about 10 ma. when the crystal is reversed in the socket with the type holder illustrated in the photograph. The crystal current is lowest when the exposed, heat-radiating electrode is connected to ground instead of to grid. The reason for this will be obvious from the previous explanation of capacity feedback, the capacity in this case being between the "hot" end of the plate coil and the top, exposed crystal holder electrode, both being located above the chassis.

The Doublers

Those who have experienced trouble with operation of 6L6 tubes as screen-grid doublers due to a tendency toward parasitics and self-

*J. M. Wolfskill, "Operating Notes on Crystal Oscillators," *QST,* February, 1937.



GENERAL WIRING DIAGRAM OF THE "DYNAPUSH"

C_1—100 μμfd., mica
C_2—.006 μfd., mica
C_3, C_4, C_5—50 μμfd. double spaced midgets
C_6 to C_{12}—.006 μfd., mica
R—50,000-ohm 1-watt carbon
R_1—300 ohms, 10 watts
R_2—20,000 ohms, 10 watts
R_3—15,000 ohms, 10 watts
R_4—10,000 ohms, 10 watts
R_5—5000 ohms, 10 watts (10,000 ohms if 809's are used)
SW—D. P. D. T. switch with "center off" position, or a three position "tone control" switch (see text)
J_1, J_2, J_3—Closed circuit jacks
MA—0-150 ma. d.c. milliammeter (0-200 if 809's are used)
RFC_1—2.5 mh. r.f. choke (8 mh. if 160-meter crystal is to be used)
RFC_2—2.5 mh. r.f. choke

oscillation will be gratified with the extremely stable operation of the tubes when used as here illustrated. When used as dual-grid triodes, the transconductance is reduced enough that parasitics and self-oscillation (doubling) cannot be sustained. The very high μ of the tubes when used as dual-grid triodes makes them well-suited for use as doublers, besides obviating the necessity for either fixed or cathode bias. The output when used in the high μ triode connection is not quite as great as when used in the pentode (tetrode) connection at the same plate voltage, and somewhat more excitation is required; however, as used here the question of excitation is of no consequence, and the slight reduction in output is more than justified from the standpoint of trouble-free, foolproof operation. Also, the total number of circuit components is reduced when the tubes are used as triodes, an incidental advantage.

The foregoing also applies to the RK-49, inasmuch as this tube is essentially a 6L6-G with a 6-prong Isolantite base.

Using 809's

The use of 809's as doublers will necessitate running the plate leads up through the chassis to the top cap connections. This will increase the length of the plate leads, but because the internal plate-filament capacity of an 809 is considerably lower than that of a 6L6-G, the tuning condensers will resonate with about the same capacity.

The μ of an 809 is somewhat lower than that of a 6L6-G connected as a high μ triode, but is still very high (50). The "resting" plate current (no excitation) is somewhat higher, but this actually is an advantage, as it makes the load on the power supply (and consequently the oscillator voltage) more uniform when the doubler stages are cut in and out. They will easily stand 550 volts with no bias, and consequently oscillator keying is perfectly feasible the same as with 6L6-G's.

The Power Supply

The power supply should deliver from 500 to 550 volts under load and possess *good regulation*. For 6L6-G doublers, it should have a capacity of at least 200 ma., and for 809's a capacity of 250 ma. For c.w. work or for driving a plate-modulated class C amplifier, an 83 rectifier and simple, single-section choke input filter consisting of a husky choke and 8 μfd. of

COIL TABLE

160 Meters	70t. 1½" dia., no. 22 enam. close wound
80 Meters	34t. 1½" dia., no. 22 d.c.c. close wound
40 Meters	20t. 1½" dia., no. 18 enam. spaced 2"
20 Meters	9t. 1½" dia., no. 18 enam. spaced 1½"
10 Meters	4½t. 1½" dia. spaced 1¼" or 6t. 1⅛" dia. spaced 1½" no. 18 enam.

600-working volt condenser may be utilized. Where the unit is used to drive a grid-modulated amplifier, a filter consisting of an input (swinging) choke, 4 μfd., smoothing choke, and 4 μfd. should be used.

If 809's are used, it should be borne in mind when picking a filament transformer that these tubes draw 2.5 amperes apiece on the filaments.

Construction Notes

The method used for connecting the tank circuits permits mounting the tuning condensers directly to the metal chassis. However, the r.f. resistance of an iron chassis is not particularly low, and inasmuch as circulating tank current can be quite high, it is inadvisable to rely upon the chassis for a return for one side of the tank circuit. A common ground bus of heavy copper wire should be run the length of the chassis and grounds made to this bus from the rotors of the three tuning condensers, the ground bus in turn being grounded to the chassis at two or three points. The leads to C_8, C_{10}, and C_{12} should likewise be of heavy copper wire and made directly to the ground bus with as short leads as possible.

If the exciter is to be used with a 160-meter crystal, RFC_1 should be made about 8 mh. instead of 2.5 mh., as the latter does not offer sufficiently high impedance at 160 meters.

The band switch, for cutting out unused doubler stages, may consist either of a d.p.d.t. switch having a "center off" position, or of a three-position "tone control" type shorting switch. Besides being somewhat less expensive, the latter has the advantage of reading in rotation for 1, 2, and 4 times fundamental crystal frequency output respectively.

Not commonly available at amateur supply houses, these tone control switches can be obtained in a pinch from a Philco distributor. The most common type is used as a switch to mount on an auto radio speaker, the mounting bracket constituting the connection for one side of the switch. This works out fine, as for our purpose the arm of the switch would be grounded to the chassis anyhow. The switch may have any number of points so long as it has at least two points (three positions); unused points may be left floating.

The Coils

Only 5 coils are required to cover all bands from 10 to 160 meters, one coil for each band to be covered. The coils are easily constructed, as there are no taps or jumper connections to make. The approximate number of turns for each band are given in the coil table. Some alteration may be required in each particular instance to get some of the coils to work both in the oscillator and doubler positions with the tuning condensers specified.

Operation: Tuning Up

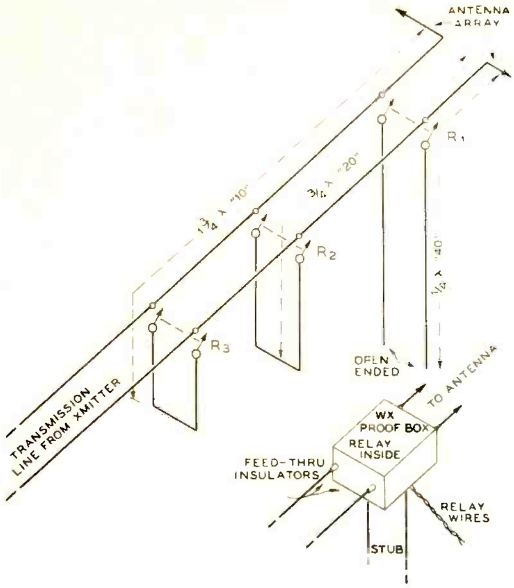
With progressively smaller coils in the exciter along with a crystal to correspond to the lowest frequency coil, the coupling link is placed over the coil of the frequency desired. Several mechanical arrangements for facilitating the changing of the link from one coil to another are possible. In the unit shown, the link is plugged into two of the jack type stand-off insulators alongside the coils. These jacks are wired so that the r.f. output is connected to the output line regardless of which pair of jacks is used for supporting the link. This cuts down the 10-meter output very slightly (due to the "floating" wires tied to the link line), but simplifies changing of the link. The simplest method, however, is to terminate a piece of twisted lamp cord in a three-turn link and place the link over the proper coil. This method also has the least amount of loss.

If one neglects to throw the band switch, nothing disastrous happens. The output will either be nil or considerably reduced, depending upon the position of the switch. There is no danger of blown tubes or crystals.

The grid current to the doubler stages runs rather high, due to the high μ of the triode doublers. This results in a cathode current reading substantially in excess of the plate current. The cathode current for the tubes when working will run about 60 ma. for the oscillator and about 85 ma. for the doublers. The

[*Continued on Page 84*]

MATCHING STUBS *with remote switching*



By

B. K. WILLOUGHBY*

W9NTW-OHK

Now that antenna arrays are being designed and used for more than one amateur frequency band, it is about time to suggest a practical method of shifting the radio-frequency transmission line without having to run out and clip it on a different stub each time a change is made in the frequency band. Of course, this is not necessary where a zepp-type feeder system or other tuned-type feeder system is used, for then the tuning is usually done inside the shack. However, the use of such feeder systems with antenna arrays is fast disappearing, especially where we are dealing with the higher frequencies.

This switching system has been designed for use with a two-wire untuned line, but adaptations of this system may also be used with the twisted-pair and the concentric-cable types of feed lines.

Before the feeder system is attached to the antenna array, it will be necessary to determine how the feeders will be built. If the feed line is to consist of two no. 12 wires spaced 6 inches, then the matching stubs must also be of that size wire and of that spacing. Probably the best system would use heavy wire (6, 8, or 10) spaced the separation of the poles of the antenna relays or switches which are used for the stub switching.

The best way to start the construction of the feed system is to make up a length of transmission line considerably longer than will be needed to run from the shack to the antenna itself. One end of it should be attached to the antenna array at the proper point of feed; then the various stubs can be cut from the length of transmission line.

Application to the Flat-Top Beam

Suppose this feed system is to be used to couple the transmission line to one of the Kraus flat-top beams as described most recently in the December RADIO. The array itself is designed as a "two element" affair for 14-Mc. operation and comprises four half-wave wires on this band. However, the beam will also work quite well on 7 and 28 Mc., in addition to the band for which it was designed, so our feed system should be designed to couple the transmission line to the array on all three of these bands.

In this particular case, when feeding this array on 7 Mc., it will have to be fed current at the point where feeders connect to the array. For this reason, a shorted ½-wave matching stub or an open-ended ¼-wave stub will have to be used. The latter is used in this case. However, on the other two bands the array will be fed voltage.

Tuning

Cut the transmission line off about 35 feet from the point of attachment to the array (assuming that the array is of such dimensions that it will tune approximately to the desired frequency without too much compensation in the stub). Shock excite the array on 7 Mc. and resonate the antenna and *open-ended* stub by judiciously cutting the stub to resonance as noted by maximum current at the point of connection of the stub to the array, or by any other

*21½ West Main Street, Marshalltown, Iowa.

means. Then attach the remainder of the transmission line a short distance below the point of connection of the stub to the array. Vary the position of the point of connection until all standing waves are removed from the transmission line. The proper procedure for making these adjustments has been frequently discussed in recent issues of RADIO.

When the system is working properly as a matching stub and untuned transmission line on 40, cut off the stub from the point of connection of the transmission line to the stub. The schematic diagram indicates where this break should be made. In this break insert a normally-open, radio-frequency-type relay.

Now, when this relay is closed, the whole arrangement acts as a quarter-wave, open-ended stub transformer which couples the transmission line to the antenna array. With the relay open, there is just an untuned transmission line running to the center of the array.

Adjusting for 14 Mc.

The system is now ready for adjustment on 14 Mc. The line which runs directly to the antenna array (with the 40-meter relay open) is cut at some odd multiple of a quarter wave on 20. In this particular case the feeders should be cut about 50 feet from the array. This will give a three-quarter wave matching transformer for 14 Mc. when the shorting stub is adjusted. This stub is operated as a shorted line and is resonated as such in contrast to the open line as used on 7 Mc. Then the transmission line is re-connected and adjusted for the minimum standing waves as before. Then the connection between the transmission line and the bottom of the stub is broken as before and another normally-open relay is inserted.

Ten Meters

The same procedure is followed for ten meters as was used in adjusting the system on 20. In this particular case it is probable that the stub had best be cut to about 58 feet and the shorting bar inserted and resonated. This will give a total stub length of seven quarter-wavelengths at 28 Mc. The adjustments and connections are made as before.

Controls

When completed, it is only necessary to throw the proper switch in the shack to close the relay for the band in which operation is desired. The array is then automatically tuned to resonance in this band. Excellent use of this system could be made in a multi-band, electrically bandswitching transmitter. As the band is changed electrically, the antenna system is resonated for operation on the desired band.

One wire on the relays can best be made common; one wire apiece will be required for the other sides of the three relays, making a total of four wires in all. These relays should be enclosed in weather-proof, spider-proof boxes, the wires carrying r.f. entering and leaving by means of feed-through insulators.

●

Free Wheeling "Q" Spacers

Charles D. Perrine, Jr., W6CUH, sometimes known as "Chuck", phoned us frantically upon receiving his January RADIO to enlighten us with the following important correction regarding the spacers he uses for his four-wire "Q" matching section. He informs us that his wife contends they are iced tea coasters, and *not* beer coasters.

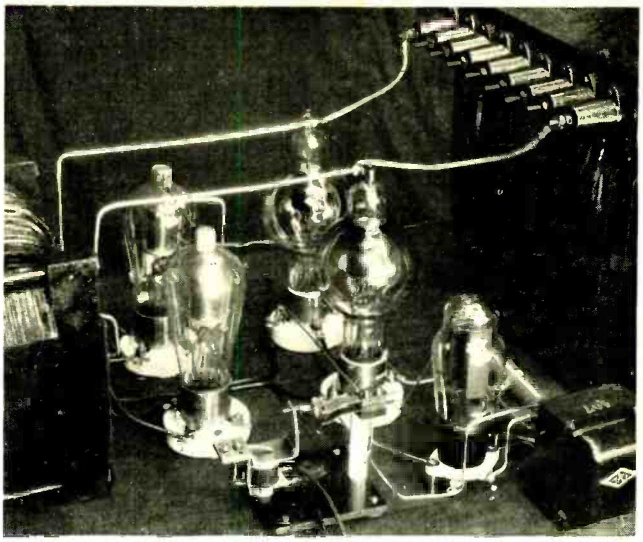
Charlie added that when buying them one should take precautions to get the correct type of material. It seems that some are made from bakelite, while others are made of a plastic that has much better insulation qualities than bakelite; the bakelite ones show up rather poorly at the high frequencies. The plastic ones can easily be identified; they are translucent, while the bakelite ones are not.

The spacers should be oriented so that they will not collect water when it rains. If for any reason that is not done, a small hole should be drilled in the center to allow water to drain out. The wires of the matching section can be secured to the spacers by means of short "serving wires" a few inches long. This method is much simpler than using screws or clamps, and just as satisfactory. Incidentally it is simpler to drill four holes around the edge of the coasters and insert the *serving wires* through the holes than it is to thread the coasters along the four wires of the matching section.

●

Ionosphere Notes

During December and late November, the National Bureau of Standards reported ionosphere storms on November 18, December 5 and 23. High daytime absorption occurred on the following days in December: 13, 14, 15, 16, 19, 20, 21, 23, 24, and 27. If your log shows unusual conditions on these days, you may be interested.



A pair of the new KY21's doing their stuff in a bridge circuit at W6QD.

KEYING---*with Grid-Controlled Rectifiers*

One of the biggest problems confronting the high-power c.w. man is that of keying. Where one husky power supply delivers a kilowatt or so to the final amplifier, plus a few odd watts to the buffer-driver, the task of keying assumes considerable proportions. Primary keying is perhaps the better of the commonly-used methods, though it is by no means entirely satisfactory. The keying relay in a high-powered transmitter utilizing primary keying is of necessity quite a majestic affair, usually resembling a small pile driver or trip hammer. And even so the occasional "slugging" of the line (which occurs whenever the keying relay catches the charging current at the wrong part of the cycle) causes bad blinking of lights on the same line circuit, and sometimes the relay contacts will stick in spite of their size.

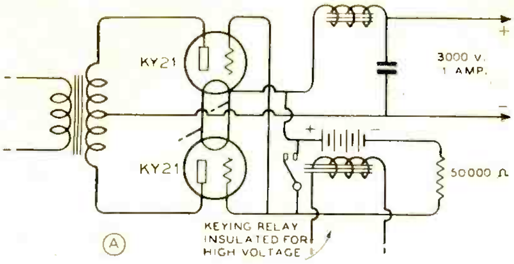
Perhaps the best method of primary keying shown to date is that using fixed bias on the final amplifier, no bleeder on the final-amplifier power supply, and a separate, primary-keyed power supply using but little filter to feed the driver stage. The ripple modulation from the driver stage is largely "wiped out" in the final amplifier due to the fact that the grid of the last stage is driven to saturation and ample filter is used on the final amplifier. A full description and explanation of this system was given by Burnett, W1LZ, in the March, 1937 issue. In an early issue will be described still another method of improved primary keying.

Grid-Controlled-Rectifier Keying

However, by the incorporation of grid-controlled rectifiers in our high-voltage power supply, we can enjoy keying that has practically all the advantages of primary keying with none of the disadvantages. The only drawback of this type of keying as compared to primary keying is that of the small amount of additional equipment needed and the additional expense of the special rectifiers. However, one type of grid controlled rectifier that is particularly adapted to the power supply of a high-power amateur transmitter is priced quite reasonably, and they can be incorporated in a transmitter with but few additional parts required. This newly-released rectifier has been given the designation KY21.

Ratings

With choke input a pair of these tubes will deliver a maximum of 3000 volts at 1 amp., in addition to providing an excellent means of keying. Thus a maximum of 3 kilowatts is available without exceeding the manufacturer's ratings. About 200 volts is required to cut off the rectifiers at the maximum rated voltage, correspondingly less bias being required for



less plate voltage. A pair of these tubes draw 20 amperes at 2.5 volts.

Inasmuch as no power is required to "block" the grids, there is little sparking at the relay contacts. And because the keying is ahead of the power supply filter, the wave train or keying envelope is "rounded" enough that clicks and keying impacts are eliminated. In fact, it is important that no more filter be used than is required to give a good T-9 note, inasmuch as excessive filter will introduce lag and put "tails" on the keying. The optimum ratio and amounts of inductance and capacity in the filter will be determined by the load on the filter (plate voltage divided by plate current). With high plate voltage and low plate current (high impedance load) more inductance and less capacity should be used, and vice versa.

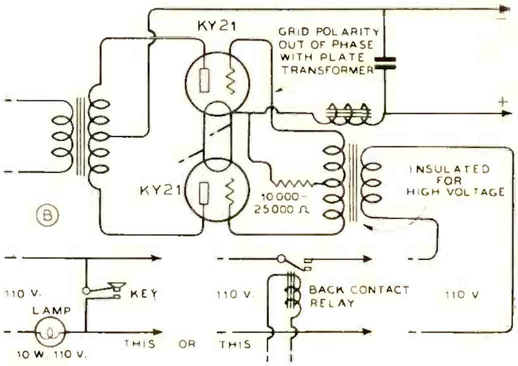
Control Circuits

Of the large number of possible circuit combinations, four of the most practical are illustrated. The circuit illustrated at "A" is perhaps the simplest and most trouble-free, but has the disadvantage of requiring bias batteries. The relay contacts handle little power, but must be insulated from ground for the high voltage.

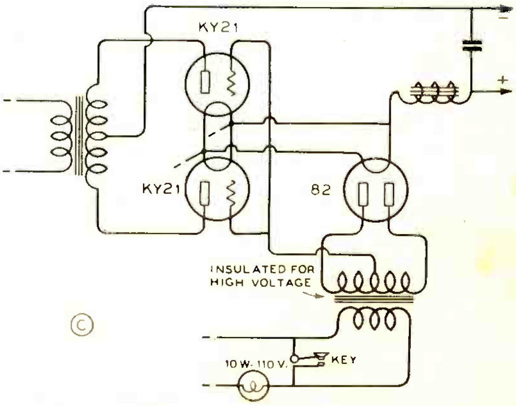
At "B" is shown the simplest method not requiring batteries. If used as shown, the bias transformer must be insulated for the full plate voltage (secondary to both primary and case). One way to avoid this and make possible the use of a small b.c.l. transformer would be to connect a 2.5-volt filament winding across the rectifier filaments, using this for the primary and letting the regular 110-volt primary "float". The 2.5-volt winding would be keyed with a relay insulated for the full plate voltage. It is apparent that *either* the relay *or* the bias transformer must be insulated for the peak voltage delivered by the secondary of the plate transformer, regardless of what system is used: B, C, or D.

System "C", utilizing a small auxiliary rectifier, keeps the power supply rectifiers from drawing grid current—somewhat of an advantage over the system illustrated in "B". Also, it is unnecessary with this system to experiment to get the correct polarity on the bias transformer, as is the case with "B".

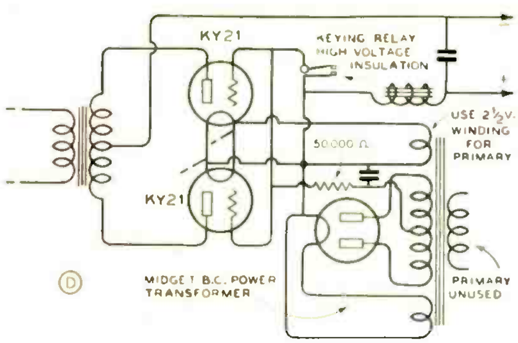
The arrangement shown at "D" is similar to that of "C" except that it permits the use of a regular b.c.l. transformer for the bias trans-



former, inasmuch as it need not be insulated for high voltage. However, the transformer case should be insulated from ground if mounted on a metal chassis. This precaution also holds for arrangement "B" if modified to use 2.5 volts off the rectifier filament winding for the primary instead of the 110 volts as illustrated in the drawing. When used in this way (regular primary "floating") there is no high potential between windings, but the whole transformer is "hot" to ground by the full plate voltage. Unfortunately, b.c.l. transformers were not designed to withstand 3000 or 4000 volts r.m.s., either between windings or to the case. The system illustrated at "D" requires a keying relay insulated for the full plate voltage between contacts and ground.



If the arrangement at "D" is used, the b.c.l. transformer should have a 2.5-volt winding rated at not less than 8 amperes (preferably more). A transformer with two 2.5-volt windings should be connected with the two 2.5-volt windings in parallel (with due regard to polarity). The sum of the ratings for the two windings should be at least 8 amperes.



If a b.c.l. transformer is available but it has too light a 2.5-volt winding, arrangement "D" can still be used by utilizing an 82 rectifier instead of an 80. The 82 rectifier would be connected directly across the 2.5-volt winding as at "C". With this arrangement the b.c.l. transformer is not called upon to carry the rectifier filament power, and more current can be drawn from the high voltage winding without exceeding the current rating of the 2.5 (in this case the primary) winding.

Bridge Rectification

If bridge rectification is used, only two of the four rectifiers need be of the grid-controlled type. However, the required bias voltage will be twice that for a full wave circuit delivering the same output voltage. The grid voltage is never critical, the only requirement is that it be sufficient to cut off the rectifiers at the plate voltage used.

Other uses for these grid-controlled rectifiers will be apparent from the suggestions given above. From time to time we will show circuits for using the tubes in various control arrangements. It must be remembered, however, that the tubes will only operate as control devices when working on a.c. Once the current has started to flow, the grid no longer has the ability to stop the flow. The grid can only keep the mercury vapor from breaking down in the first place until the critical ratio of plate-to-grid potential is approached. Past this point, the vapor breaks down, and full space current flows.

By placing a bias on the controlling element, when operating on a.c., the point on the a.c. cycle at which the vapor breaks down may be adjusted. Through this feature the tubes may be operated, to a limited extent, as voltage and power control devices.

•

Plate Modulation of Beam Tetrodes

We have received several inquiries regarding high-level modulation of RK-39's and 807's. It seems that in one place the amateur reads that the screen must be modulated along with the plate, and then somewhere else he reads that it is possible to get good quality by modulating the plate alone. Perhaps the following will shed a little light on the subject of modulating the new beam tubes.

If the screen voltage is derived from a dropping resistor (*not* a divider) that is bypassed for r.f. but not a.f., it is possible to secure quite good modulation up to about 90% by applying modulation only to the plate, provided that the screen voltage and excitation are first run up as high as the tube will stand safely. Under these conditions the screen tends to "modulate itself" to an extent, the screen voltage varying over the audio cycle as a result of the screen impedance increasing with plate voltage, and decreasing with a decrease in plate voltage.

This "parasitic modulation" of the screen voltage is not at as high a percentage as the modulation applied to the plate. By using a series dropping resistor as noted above and connecting it to the "business end" of the secondary of the modulation transformer, the screen voltage can be made to follow the envelope of the plate voltage more closely. With this latter system, it is possible to obtain high-percentage, good-quality modulation with less screen input and grid excitation. Offsetting this is the fact that a little more audio power is required to modulate both plate and screen than is required to modulate the plate alone.

THE WORM TURNS COLD

Effect of good, poor, and indifferent ground on the efficiency and radiation of both horizontal and vertical antennas. Further notes on ground screens and radials.

Since Norman McLaughlin's (W6GEG) "Worm Warming" article was published in the July, 1937, issue of RADIO, letters have been received from points throughout the country telling of the improvement gained by putting a lot of radial wires into the ground below the antenna. It appears that there has been little consideration in our ranks of the importance of ground systems since "spark" days.

The function of the earth in radio transmission can be divided into several types. First, waves are reflected from its surface at a point that may be close to, or somewhat removed from, the transmitting antenna. The point of reflection depends upon the height of the antenna, the contour of the terrain, and the vertical angle of radiation under consideration. If one's location is fixed in the local geography, there is but little that can be done about this reflection except to raise the antenna or change its polarization.

Close to the antenna there are conduction and dielectric losses, which represent the second type, and the ones with which this discussion is mainly concerned.

When using a quarter-wave vertical antenna and a ground, the antenna current is generally measured with a meter placed in the antenna circuit close to the ground connection. Looking at this meter, it is not at all difficult to picture the flow of current into the ground. Now if this current flows through a resistor, or if the ground itself presents some resistance, there will definitely be a power loss in the form of heat. Improving the ground connection, therefore, provides a definite means of reducing the loss of antenna power, increasing radiated power.

It is of interest to know just what constitutes a good ground[1]. If few wires are laid in the ground, it has been found that the current quickly leaves the wires and passes into the earth. As the number of radial wires is increased, current will be found at greater distances from the antenna. A saturation point appears to be reached for about 120 radial wires at least 4/10 wavelength long.

If the antenna is shorter than a quarter wavelength—not uncommon on our lower frequency bands—the antenna current is higher and consequently the power lost in the resistive soil will be greater. The importance of a good ground with short radiators is therefore quite obvious. With a suitable buried radial system, even very short antennas can be expected to give upwards of 90% of the efficiency of a quarter-wave antenna used with the same ground system.

But, if shorter wavelengths are used, at which a half-wave vertical is practical, why not cut out this conduction loss by eliminating the ground current with center feed? It sounds good, but one should not neglect to consider the fact that the antenna still has capacity to the ground through which some current will be flowing, and an electrostatic field will be present. A few nearby trees and houses should be expected to cause some dielectric loss if they are in the electrostatic field, but what about all that poor dielectric *below* the antenna? Here we have rid ourselves of the current flowing into a ground connection, only to create a stronger electrostatic field which brings about another kind of loss. But earth covered with a highly conducting radial ground system will improve this situation materially. With the earth neither a perfect conductor nor a perfect dielectric, we must overlook neither of these deficiencies.

Horizontal Antennas

What of the horizontal antenna? It requires no current flow into a ground connection, is balanced to ground, and both high voltage ends are raised up in the air. Fine, but is it really up in the air a half wavelength or more so that the soil will not be in a strong field? Perhaps all 14 Mc. and many 7 Mc. antennas are up in the air a half-wavelength, but practically no 3.5 or 1.7 Mc amateur antennas are more than a quarter-wavelength high, not

[1] E. H. Conklin, "Ground Systems for Efficiency," RADIO, December, 1937.

to mention a half-wavelength high. So, even in the case of a horizontal antenna, there can be serious ground losses which can use up a lot of power in heat if the soil is not screened with wire.

Location and Attenuation

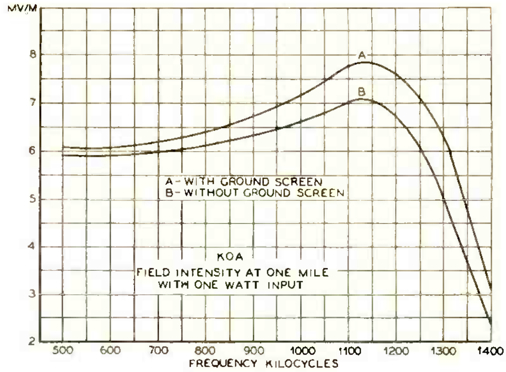
Is it enough just to put power into the local atmosphere that will deflect a field strength meter materially? Getting power out in the form of radiation truly is important, but it is also necessary to keep it there while it is traveling to distant points. A ten per cent improvement in field strength is fine, but if one can reduce the *rate* at which this field strength decreases at greater distance from the transmitter location, considerably more will be gained than just a few per cent. This dying-out of the signal strength more rapidly than is theoretically necessary, is called excessive *attenuation*. An engineer who studied the location of transmitters in a state police net told us of one transmitter placed in a convenient police station. While there was plenty of power locally, the transmitter just didn't cover its assigned area. Moving it a few miles away and installing a suitable antenna and ground system cured the trouble. The outfit began to "poke out" as it should. The average amateur cannot always move a few miles away, but he can quite often put in a good buried ground or a counterpoise.

F.C.C. Comments

We quote below some comments made by the F.C.C. in addition to those mentioned in McLaughlin's article:

"A review of the antenna systems employed by broadcast stations reveals that there are now many antennas in use with a radiating efficiency that does not comply with the requirements of good engineering practice. In many cases a material improvement in the coverage of the station could be accomplished by erecting an efficient radiating system. This increase in coverage may be more than could be accomplished by doubling the power.

"Except for the reduction of shadows, locating the antenna on a building does not necessarily increase the efficiency . . . To obtain the maximum efficiency of which any antenna is capable, a good ground or counterpoise system must be employed . . . At the present state of the art, it appears that, where a vertical radiator is employed, the ground system should consist of radial wires at least $\frac{1}{4}$-wavelength long. There should be as many of these radials as



Improvement obtained by use of ground screen.

practicable and in no event less than 70. These wires should be buried only deep enough to provide mechanical protection (not greater than 12 inches). However, they should not be permitted to rest on the surface. In many cases a counterpoise or combination counterpoise and ground system may be superior to a ground, especially where a good ground cannot be obtained."

When an antenna is mounted on a building, it is often advisable to cover the building with a counterpoise in order to reduce the electrostatic field in the building, thus reducing dielectric losses.

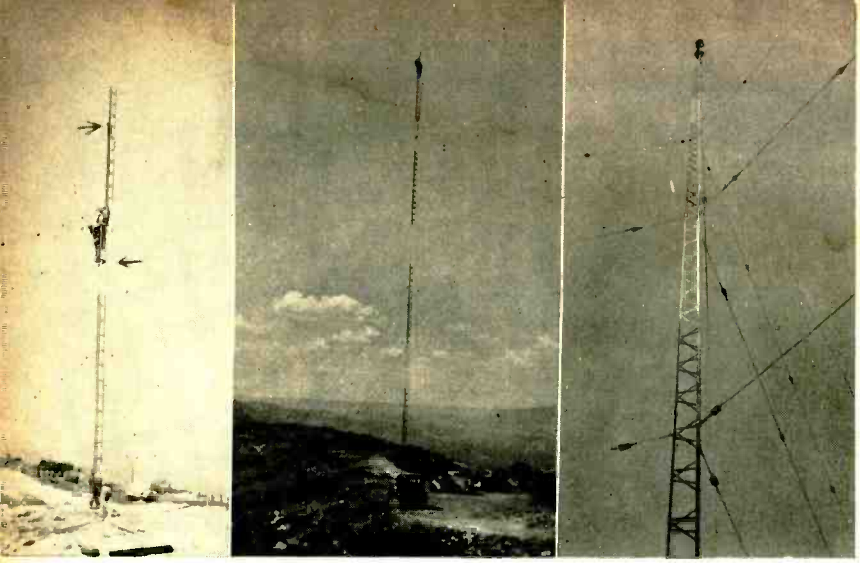
When both a ground and a counterpoise are used, it is often best not to connect the two together to be used as a ground, but to tap both on the antenna coupling coil at different points. These adjustments can be made with the aid of an r.f. meter in the antenna lead, and a field strength meter located a few hundred feet from the antenna system.

"Ground Screens"

Where a ground system considered nearly ideal is not used, a "ground screen" has often proved helpful. This can effectively be a counterpoise or ground, but is much the same as using many short radial wires if no additional ground system is employed. The following comments on ground screens appeared in the *RCA Review* and in RADIO DIGEST (September, 1937) in an article by Raymond F. Guy:

"Where there is high base voltage on a tower, the reduction of dielectric losses in the earth merits careful consideration. These losses are the result of heating of the earth between the lower part of the antenna and the

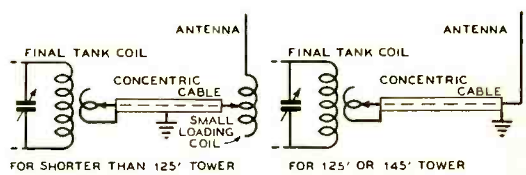
[*Continued on Page 84*]



To the left, raising the third 20-foot section of the mast. The top and bottom of derrick pole, used in raising the 20-foot sections, are indicated by the arrows. In the center is shown the completed mast, 147 feet up. To the right, looking up toward the top showing the guying arrangement.

147-FT. STEEL MAST . . . *Only $85*

By R. T. SAMPSON,* W6OFU



THE CABLE COUPLES THE SAME AS TWISTED PAIR IN LINK-COUPLED CIRCUITS

The use of vertical antennas has become standard practice for broadcast stations operating within a few kilocycles of the amateur 160-meter band, but little has been said on the subject in amateur circles. The writer has used a quarter-wavelength vertical tower as an antenna, coupled to a good radial ground system, on 160-meter phone. From the results, he believes it to be superior to any other type for non-directional work due to its low angle of radiation.

Vertical antennas used for broadcast work must meet several requirements and many cost thousands of dollars. The one recently installed at KCRJ in Jerome, Arizona, has met all the requirements at a material cost of about $85. It took three men two days to erect it. It measures 147 feet high, and is a three-legged, uniform cross-section, guyed mast. This type of tower is made in twenty-foot sections for Win-chargers. It is purchased unassembled and is terminated in a five-foot stub so that heights of 25, 45, 65, etc., feet are available. All necessary hardware and guy wire are included with the tower material.

The Insulated Base

The base is made of three wall-switch insulators mounted on a concrete block, with a piece of boiler plate bolted on them for the tower to rest on. The guy wire anchors are cubes of concrete three feet on a side, located 100 feet (or about two-thirds of the tower height) from the base.

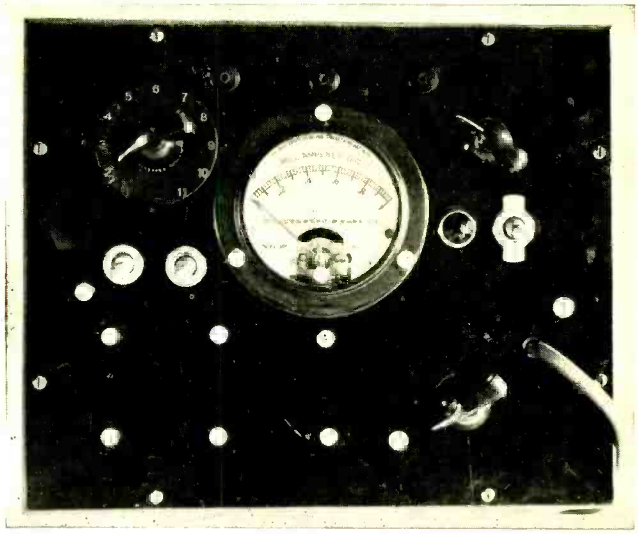
Assembling and Raising

Antennas up to 105 feet in height may be assembled and painted on the ground and raised in one piece with a gin pole, or over a house or barn roof as discussed in the Nov., 1937, issue of Radio. If greater heights are wanted,

[*Continued on Page 86*]

*Chief Engineer, KCRJ, Jerome, Arizona.

An Amateur's VACUUM-TUBE VOLTMETER



By
LLOYD W. ROOT*
W9EHD, W9HA

During the past few years quite an assortment of vacuum-tube voltmeters, taken from a large number of sources, have been built by the writer. Each one has been subsequently torn down for the parts that it contained. Then the next was built, each time with the hope that "this one" would fill the bill and become a permanent piece of equipment. Finally a completely satisfactory one was evolved. The one to be described is the result of that development.

The Specifications

In designing this meter it was desired to have an a.c.-operated affair that would measure both a.c. and d.c., that would use a 0-1 d.c. milliammeter for an indicator, that would require only one volt for full-scale deflection and would be linear over its full scale, thus making charts and re-calibration unnecessary. Quite a little bill for one meter to fill.

Selecting the Tube

The first job in the design was to run a series of plate current-grid bias curves on all the tubes that might be suitable for the purpose. From these curves the limits of linearity of the various tubes can be determined. Since an 0-1 milliammeter is to be used, and the maximum sensitivity desired is one volt full scale, it would be desirable to find a tube whose E_g-I_p curve showed a plate current change of one ma. or more for a grid voltage change of one volt.

*906 W. Oklahoma Street, Appleton, Wisconsin.

Tubes such as the 1B5 and the 55 looked inviting because of the included rectifier elements, but these, among others, tested unsatisfactory. Tests upon the 6R7 and 6Q7 showed that these would both answer to the requirements; however, the 6Q7 was somewhat better. So the meter was designed around this tube.

Figure 1 shows the fundamental circuit of the meter. It will be seen that the a.c. voltage to be measured is half-wave rectified and filtered by the diodes of the tube. The voltage peaks then are applied as extra negative bias on the grid of the triode amplifier. The resulting change in plate current causes an unbalance in the meter bridge circuit with a corresponding indication on the meter. With the proper choice of initial grid bias so as to insure operation on the straight portion of the E_g-I_p curve, and also in the selection of proper bridge balance resistors, the milliammeter will indicate exactly one ma. for an applied peak potential of one volt a.c. or d.c. With the necessary resistors for voltage dividing, almost any reasonable potential may be measured. But since high potentials are usually associated with relatively high power, the ordinary low-resistance voltmeters can be used. Therefore a maximum scale of 500 peak volts for the v.t. voltmeter was decided upon.

Voltage Multipliers

Figure 2 shows two methods of voltage dividing which may be used. The values given in the table provide ranges of 1, 10, 100 and

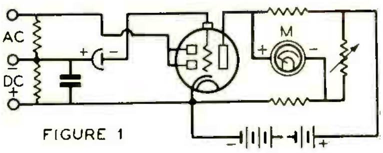


FIGURE 1

500 volts full scale. With circuit A the meter has a constant impedance of 100,000 ohms per volt while with circuit B the impedance ranges from 2000 ohms per volt on the 500 volt tap to 1 megohm on the 1 volt position. The use of circuit B simplifies the filter required, but the meter becomes somewhat too sensitive to stray electric fields if values of resistance larger than those specified are used.

The writer has always felt that any piece of apparatus worth building at all is worth building well, so considerable care was taken to select resistors that were as nearly exact as possible. Most experimenters are familiar with the measurement of low resistances but a few words in regard to the measurement of high resistance might be in order.

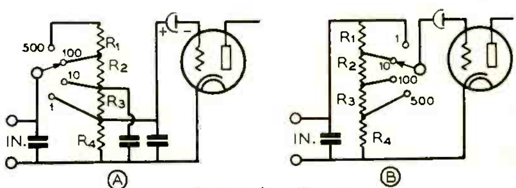
Resistance Measurement

Almost any standard text[1] may be consulted for a measuring arrangement, the circuit shown in figure 3 being a modification of a standard method for measuring leakage resistance of cable insulation. Referring to the diagram, by having the standard resistance R at least 1000 times as large as Q and the galvanometer resistance small as compared to R, the approximation $X = \frac{I_2}{I_1} \frac{P R}{Q}$ gives results which are correct to one-tenth of one per cent. Suggested values of P, Q and R are 10,000, 100 and 100,000 ohms, respectively.

A small 22.5- or 45-volt B battery may be used to supply current for resistances from one to ten megohms while 90 volts or so may be necessary for resistors up to 100 megohms. For most accurate results the sensitivity of the galvanometer used should be at least equal to the resistance being measured. Reflecting wall galvanometers having a sensitivity of 100 megs. or more are ideal but sensitivities as low as one meg. can be tolerated if extreme accuracy is not desired. In the writer's case the standard was a Leeds & Northrup 1/10 meg. box, and the galvanometer had a sensitivity of 109 megs.; about 15 volts of dry cells were used on the circuit shown.

[1]*Electrical Measurements,* Carhart and Patterson.

Figure 4 shows the circuit diagram of the completed instrument while the photographs of the front and back indicate fairly well the method of mounting the various items. The bias cell is mounted on a short isolantite pillar as near the grid cap of the 6Q7 tube as is possible. All resistors used in the voltage divider are grouped closely around the selector switch. The .9 meg. resistor is composed of a .5 meg. and a .4 meg. in series, the 9 meg. of a 5 meg. and a 4 meg. and the 40 meg. of two 20 meg. resistors. In the writer's instrument, additional



	A	B
R1	40 MEG.	900,000 OHMS
R2	9 "	90,000 "
R3	.9 "	8,000 "
R4	.1 "	2,000 "

FIGURE 2

resistors were added so that with extra points on the selector switch and an extra d.p.d.t. toggle switch the meter could be used as a voltmeter for ranges of 1, 10, 100 and 500 volts d.c. with 1000 ohms per volt. This slight additional expense is well worth the trouble since it broadens the scope of the meter. The circuit diagram does not show these extra resistors since the individual's preference can be followed here.

The entire unit is mounted in a walnut cabinet, 4″x6″x8″, having a one-quarter inch formica front panel. Installation of the unit in a

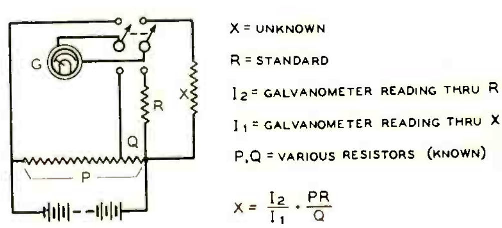
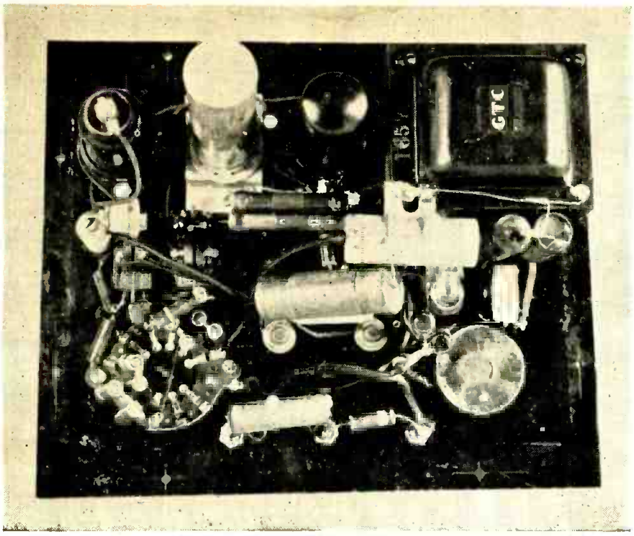


FIGURE 3

metal box is to be highly recommended. A shield around the meter will greatly assist in reducing interference from stray electrical pick-up.

Adjustment and Calibration

To adjust the instrument, throw switch SW_1 to the left and set R_{11} so that the 0-1 ma. meter reads exactly half scale (250 volts) being careful to allow sufficient leeway on R_{12} for higher



and lower line voltage. This can best be assured by setting R_{12} at about half value provided the line voltage at the time is around 115 to 120 volts. For best filtering, R_{11} ought not be less than 5000 ohms so that it may be necessary in some cases to add an extra condenser C_0 of about 1 μfd. across the input to R_{11}. In the writer's case this was not necessary, 6000 ohms at R_{11} being sufficient. Since the meter requires one-half milliampere from the power supply with switch SW_1 to the left, the potential applied to the bridge circuit when switch SW_1 is flipped to the right will be from three to four volts more than that indicated by the meter with the switch in the first position.

While SW_1 is to the right, set the input selector switch on the one-volt tap, bring the meter needle to zero by balancing the bridge with resistor R_7 and apply one volt d.c. to the d.c. input terminals. The 0-1 milliammeter should read exactly one ma. If it does not, juggling the values of R_6, R_8 and R_9 will accomplish the desired result. It is not necessary to spend a great deal of time in trying various values for R_6, R_8 and R_9. When the milliammeter reads within a few per cent of full-scale it may be brought to exactly full-scale by a final adjustment of either R_{11} or R_{12}, after which the reading of the milliammeter with SW_1 flipped to the left may be noted.

The meter will then be in calibration at any future time by setting the line rheostat to the milliammeter reading as noted above. A check of the other switch voltage positions may be made and will be found to be exact if care has been taken to provide accurately measured resistors for the multiplier. The meter is then ready for use, reading peak volts both a.c. and d.c.

The use of a line rheostat to "set" the instrument has worked out very satisfactorily. In the event that some experimenters may wish to add automatic voltage control to the unit, circuits having this feature[2] may be incorporated. The additional expense is hardly worth the trouble except where long time measurements are to be made. As initially described, the cost of all apparatus including the milliammeter should be considerably less than half that of the commercial article, with the advantages of greater sensitivity and larger range. The writer will be glad to answer any inquiries regarding the construction or operation of the voltmeter. It is felt that a v.t. voltmeter should be a part of the equipment of every experienced experimenter.

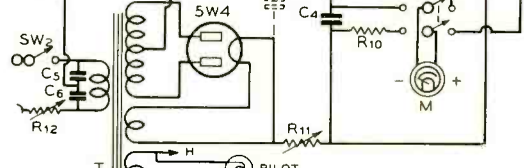


FIGURE 4

C_0—See text
C_1—.02 μfd. 600-volt tubular
C_2—.25 μfd. 200-volt tubular
C_3—0.5 μfd. 200-volt tubular
C_4—12 μfd. 450-volt elect.
C_5—0.1 μfd. 400-volt tubular
R_1—40 megohms, 1 watt
R_2—9 megohms, 1 watt
R_3—900,000 ohms, 1 watt
R_4—100,000 ohms, 1 watt
R_5—1.0 megohm, 1 watt
R_6—50,000 ohms, 2 watts
R_7—10,000-ohm rheostat
R_8—5000 ohms, 1 watt
R_9—10,000 ohms, 1 watt
R_{10}—500,000 ohms, 1 watt
R_{11}—10,000 ohms, 20-watt semi-fixed
R_{12}—50-100 ohm, 5-10 watt line-control rheostat
T—Midget receiver trans.
BC—Mallory bias cell
SW_1—D.p.d.t. toggle switch
SW_2—S.p.s.t. toggle switch
M—0-1 milliammeter

[2] "Voltage Stabilization," RADIO, Dec. 1937, p. 20. "Automatic Voltage Regulators," *QST*, August, 1937.

Ham Hints . . .

By GEORGE F. MARKS

Chromium Polish

So much chromium is now being used in radio sets and panels that it is well to know that this finish may be polished. The only materials required are absorbent cotton or soft cloth, alcohol, and ordinary lamp black.

A wad of cotton or the cloth is moistened in the alcohol and pressed into the lamp black. The chromium is then polished by rubbing the lamp black adhering to the cotton briskly over its surface. The mixture dries almost instantly and may be wiped off with another wad of cotton.

The alcohol serves merely to moisten the lamp black to a paste and make it stick to the cotton. The mixture cleans and polishes very quickly and cannot scratch the chromium surface. It polishes nickel-work just as effectively as it does chromium.

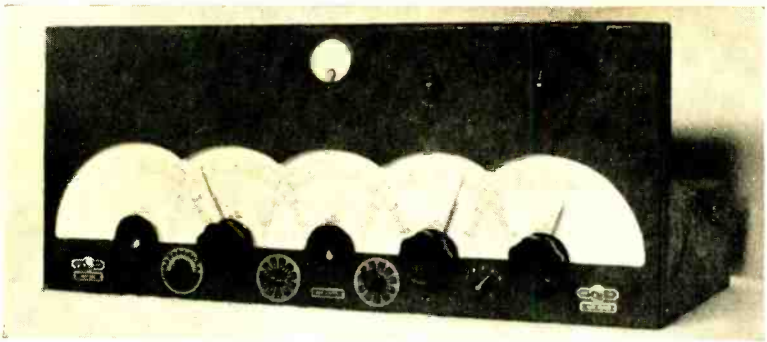
•

Liquid Soldering Flux

A chemical action that is frequently set up between ordinary soldering flux and metal tends, after a time, to cause the introduction of resistance at the joint. This action is particularly harmful where the connecting metal surfaces are quite small, as in radio and other delicate electrical work. The possibility of this chemical action may be lessened by swabbing the joint with alcohol as quickly after the soldering flux is used as possible. But even that is not a certain precaution.

The slow chemical deterioration of the connection does not take place when rosin is used as the flux, and for that reason rosin-core solder is used almost exclusively for all fine soldering work. But since often too much rosin runs onto the connection being soldered and must be scraped away if a neat joint is to be made, a liquid rosin soldering flux such as described here will be found extremely convenient.

This liquid flux is formed by adding rosin to denatured alcohol until no more will dissolve, thus creating a saturated solution. After the joint to be soldered has been carefully cleaned, it is painted with this alcohol-rosin solution, using a small paint brush. The joint may be soldered easily then if a clean and well-tinned soldering iron is used. This solution should be kept in a tightly-corked jar when not in use to prevent evaporation. Since the alcohol is used up more quickly than the rosin, a little alcohol should be added occasionally as needed to dissolved lumps. This flux is not only extremely easy to use but it is economical, since inexpensive solid wire solder is used with it.



FIVE BANDS—*Individually Tuned*

By G. R. LEACH,* W8NPJ

In designing the receiver which I am about to describe, I had several things in mind which the receiver must do before it would be satisfactory for my use.

1st—It must be selective.
2nd—The sensitivity must be good on all bands.
3rd—The noise level must be low.
4th—The tuning units should be such that the dial covers only the amateur band.
5th—The band-spread should be great enough to make logging a station easy.

With these and other things bothering me, I started accumulating data; very few articles escaped my reading. This idea in this article and that idea in that article appealed to me and were used. Most all of the circuit features have been tried out by others and found to give satisfactory results; hence, really all that is new in this article is the arrangement and the particular combination of the various tried units.

After considering coil changing and band switching and all the grief that is associated with each, I decided I would do something a little different and build a receiver with a separate tuning unit for each band, switching only the antenna leads, the positive battery lead and the plate lead from the first detector. This would permit building all coils for their particular band and would make it possible to peak each band without disturbing any other band.

Layout

So out came the drafting board, and a full-sized sketch was made. Too large—so another sketch, then another and finally the layout as you see it here was devised. If you will notice the layout, you will see that the first and second audio, beat oscillator, second detector, third, second and first intermediates are arranged across the rear of the chassis, while the r.f. stage, first detector and oscillator for each band are arranged across the front on the chassis. This makes short leads possible and places the tuning units in their proper sequence. With such a layout, it is possible to install the intermediate, second detector and audio units and either of the five bands initially and add the other bands as funds and desire demand. In the photos, I show only the 10-, 20- and 80-meter bands equipped, leaving out the 40- and 160-meter bands. These will be added at a later date.

Circuit Description

The r.f. stage, first detector and oscillator tuning unit and tubes are individual to each band and, once adjusted for the band, can be let alone, as they are not affected by the tuning units of either of the other bands.

R.F. Stage

This r.f. circuit is regenerative, and so long as it is kept properly shielded, will work very efficiently on any band. The 50,000-ohm potentiometer which controls the screen voltage is common to all five r.f. tubes and works about the same for each. It may be necessary to change the number of turns on the antenna coil to match your particular antenna, but a little

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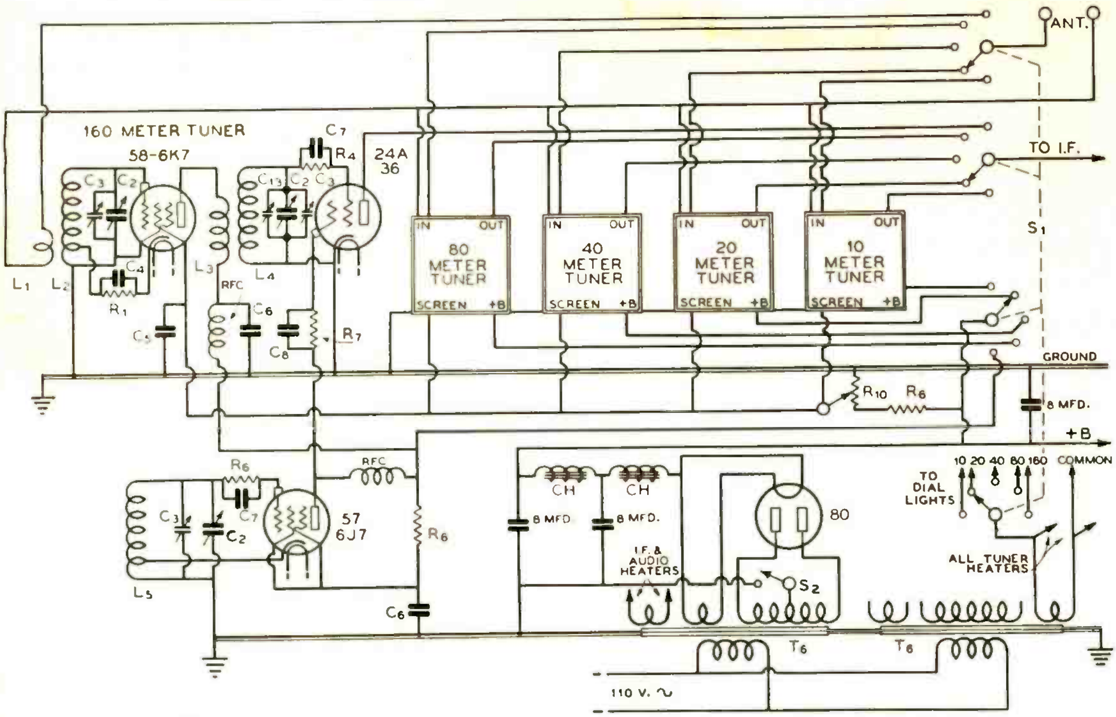


C_1—Trimmer condenser across input coils on 14- and 28-Mc. bands. 100 µµfd. air padder condenser.
C_2—20 µµfd. per section, 3-gang bandspread condensers
C_3—100 µµfd. air padder condensers
C_4—.002 µfd. mica
C_5—0.1 µfd. 400-volt tubular
C_6—.01 µfd. mica
C_7—.0001 µfd. mica
C_8—.00005 µfd. mica
C_9—Crystal-filter series condenser (not numbered on diagram) 35 µµfd. mica trimmer
C_{10}—10 µfd. 25 volt electrolytic
C_{12}—0.5 µfd. 400-volt electrolytic
C_{13}—20 µµfd. midget variable
C_{14}—Twisted wire coupling
R_1—300 ohms, ½ watt
R_2—25,000 ohms, ½ watt
R_3—400 ohms, 1 watt
R_4—500,000 ohms, ½ watt

cut and try on this and you will be able to satisfy even yourself.

Detector and Oscillator

The first detector and oscillator circuit described by Mr. R. M. Barnes, W4EF, in the March issue of RADIO for 1937, was found to be just what I wanted, and the credit for this feature must be passed on to him. It does just what he says it will do, and, although I have not tried it on five meters, it works very fine on all the other bands. The space charged detector, as he says in his article, gives ideal coupling conditions from the oscillator and permits grid leak detection, which seems superior on weak signals.

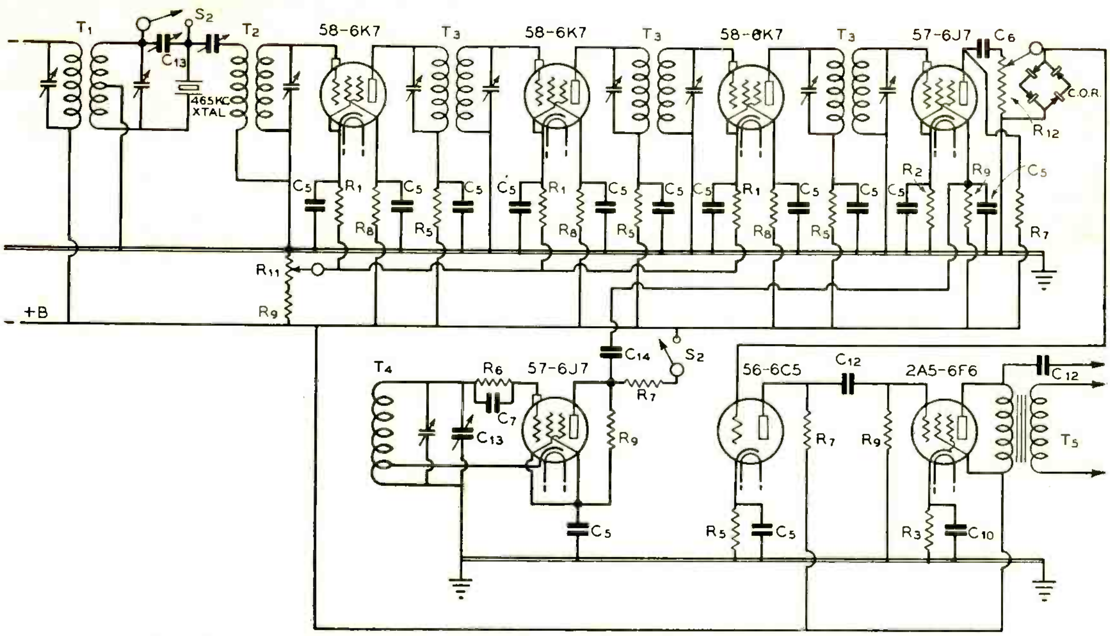
However, I did find that shielding of the coils, resistors and by-pass condensers improved its stability. A standard 3-gang condenser, 20 µµfd. per section, with one stator plate removed from each gang, is used for band-spread. This eliminates any backlash between condensers.

Intermediate Frequency Amplifier

In laying out the chassis, provision was made for a crystal filter unit, but, so far, I have had so much success with the selectivity obtained from the ultra-selective intermediate coils that I have not put in the crystal filter. I have the 465-kc. crystal, but use it only in an oscillator to line up the intermediates. Some day when I haven't anything to do, I intend to put in the crystal just to see what effect it will have on the rest of the receiver.

Three i.f. stages were used, and while perhaps some of you may think this is too much gain, there was a reason for it, as will be shown later. All grid and plate leads, by-pass condensers and resistors for each stage are shielded. The circuit of the intermediate stages is standard, and, although the usual automatic volume control is not shown, it could be added with very little effort. Personally, I did not consider it desirable on this receiver.

SCHEMATIC OF THE FIVE-BAND RECEIVER



R_5—5000 ohms, 1 watt
R_6—50,000 ohms, ½ watt
R_7—100,000 ohms, ½ watt
R_8—20,000 ohms, 1 watt
R_9—250,000 ohms, 1 watt
R_{10}—50,000-ohm wire-wound potentiometer
R_{11}—25,000-ohm wire-wound potentiometer
R_{12}—100,000-ohm potentiometer
$T_{1, 2, 3}$—465 kc. intermediate transformers (See Buyer's Guide)
T_4—Rewound half of any 465-kc. transformer
T_6—Power transformer
T_5—Pentode-to-voice coil output transformer
RFC—2.5 mh., 125 ma. pie-wound choke
S_1—Four-gang, 5-position switch
S_2—Toggle switches
C.O.R.—Small copper-oxide rectifier used as volume limiter

2nd Detector, Beat Oscillator, Audio Stages

These stages are conventional, and most any type that suits your fancy can be used. Some will like one type, while others like some other type, so far be it from me even to suggest anything special. The circuit shows what I like and am using, but if any of you care to offer something better, just drop me a line and I will appreciate your suggestion.

The only thing different about this combination is the noise reducing unit connected between the second detector and the first audio stage. This unit is a small copper-oxide rectifier so connected that it knocks off the peaks of all noise surges. While it also reduces the output considerably, I have compensated for such losses by the addition of an extra i.f. stage, and the results are well worth the effort. The usual tube hiss and set noises are completely eliminated and the interfering outside noises are greatly reduced.

Chassis

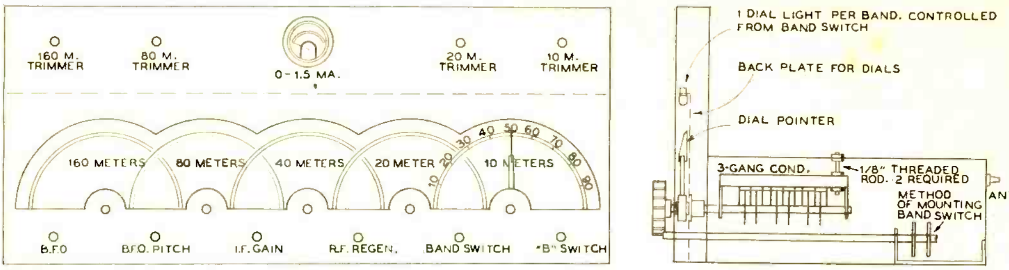
The chassis is 14″x28″x5″ high. While this seems large at first, it really isn't very much larger than some commercial receivers. The height is necessary in order to mount the tuning condensers directly under their associated coils.

Front Panel

The front panel is 28¼″ long and 12″ high with all edges turned over 1½″. The cutout for the five dials is as shown in the sketch, and the various dimensions are also shown.

The arrangement of the knobs on the front is as follows, reading from left to right on the lower row:

No. 1—Switch for beat oscillator.
No. 2—Beat oscillator note control.
No. 3—I.f. gain control.
No. 4—Pre-selector regeneration control.
No. 5—Five-point switch for switching plate leads from various bands to i.f. stage.
No. 6—On and off switch for plate supply.



Detail of front panel of the receiver showing the various trimmers and controls. To the right, the method of mounting the 3-gang tuning condensers and the bandswitch.

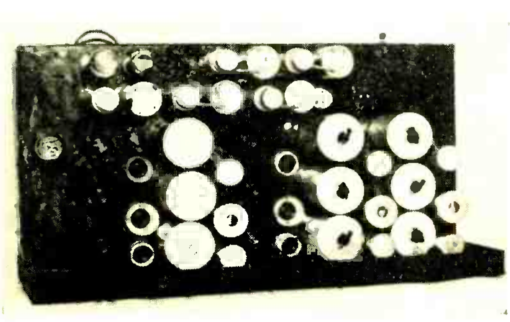
Dials

The dials are homemade, and I wouldn't trade them for any other that I know. Each dial arc is 6½" in diameter, and, although they slightly overlap at the ends, it will be found that there is no inconvenience from this. A large dial makes logging stations easy, important for amateur work. A Crowe planetary drive is used with a large Crowe knob, while the pointer is made from a ⅛" round brass rod with a flat strip about 1½" long soldered at the point and a 6/32 thread on the other end for screwing into the larger of the two small knobs which come with the planetary drive. This combination makes an ideal arrangement. Perfectly smooth action without backlash is obtained; this is extremely important on the higher frequency bands.

Shielding

Complete shielding is essential in this receiver; ample shielding material has been used both above and below deck. The coils are shielded with the usual 3" aluminum shield, with the band-set condensers mounted in the top of the shield with the coil. This keeps the leads short, as well as shielding them. The connections to the grid caps of the r.f. and oscillator tubes are brought out at the top of the coil shield and into the tube shield, allowing only ¾" of wire to be exposed. It has been unnecessary to shield these short lengths. Grid condensers and resistors are located in the cap of the tube shield.

The resistances and condensers under the chassis have also been shielded, and, while this is not absolutely necessary, I have found it worth while. A 2" tube shield cut down for this purpose was used; fasten them under the same bolts which hold the tube shields on the upper part of the chassis. The leads to the grids of the i.f. tubes are shielded.



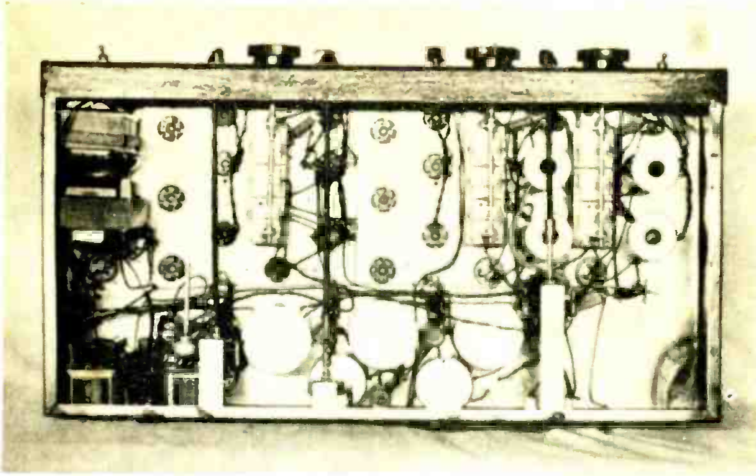
Top view of the completed receiver.

Power Supply

Due to the number of tubes which have their filaments lighted at all times when the set is on, I employed two filament transformers, as the drain would be a little too great for one of standard type. However, if your transformer will handle the load, it would be foolish to use a second one. I keep all tubes hot so that when I want to change to a different band, I do not have to wait for them to heat.

The plate supply is the usual receiver type, well filtered. I use two chokes and three 8 μfd. condensers, and they seem to do the work in great shape, as there are practically no set noises.

Inasmuch as the plate supply is cut off the tubes which are not in use, there is no drain on the high-voltage supply above that of a normal 10-tube receiver. There is a switch for turning the receiver on and off, mounted on the



Bottom view of the chassis. The tuning condensers for the three tuners that have been completed can be seen.

desk, so consequently the photos do not show this switch.

Tubes

I have used 2½-volt glass tubes in this set, but I see no reason why any of the various newer tubes would not do just as well. I had the tubes and transformers on hand, and since they worked as well as any of the newer types, I continued to use them.

Grounding

In my estimation, grounding is one of the most important things to watch. Being a crank on that, I naturally have selected material for the chassis that can be soldered. A common ground of no. 12 copper wire has been run the full length of the chassis and soldered to the chassis every 4½". This wire was placed between the intermediate stages and the different tuning units, thus permitting each unit to be grounded at a common point.

Wiring and Testing

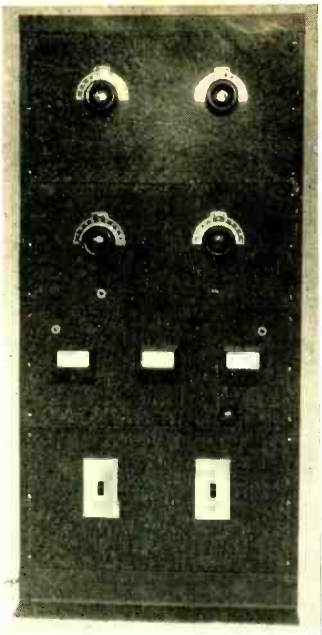
In order to keep any of the r.f. from going astray, resistors, by-pass condensers and r.f. chokes were mounted as close to the source of r.f. as possible. Of course, this is common knowledge to most of you, but there are those attempting to build a receiver who may appre-

[*Continued on Page 82*]

COIL TABLE

Band	10 Meters	20 Meters	40 Meters	80 Meters	160 Meters
Form Diameter	1¼"	1¼"	1½"	1½"	1½"
Preselector L_1 L_2	3 turns close-wound 4 turns spaced to ⅝"	4 turns close-wound 7 turns spaced to ¾"	5 turns close-wound 12 turns spaced to 1"	10 turns close-wound 28 turns close-wound	12 turns close-wound 60 turns close-wound
Cathode tap from gnd. end	¾ turn	¾ turn	1 turn	2 turns	4 turns
1st detector L_3 L_4	Each 4 turns interwound to cover ⅝"	Each 7 turns interwound to cover ¾"	10 turns 12 turns (interwound to 1")	12 turns 23 turns (interwound)	20 turns 51 turns
Oscillator L_5	4 turns spaced to ⅝"	7 turns spaced to ¾"	12 turns spaced to 1"	25 turns close-wound	48 turns close-wound
Cathode tap from gnd. tap	1½ turns	2 turns	3 turns	4 turns	6 turns

Values given above are approximate and will be subject to considerable variation. Specifications for 10, 20 and 40-meter bands are taken from those of the receiver of R. M. Barnes in the March, 1937 RADIO.



An Economical Phone and C.W. TRANSMITTER

By FRANK C. JONES,* W6AJF

The medium or low μ tubes are slightly superior to high μ tubes when used in a grid-modulated radio frequency amplifier. However, high μ tubes can be used with excellent results and the quality of modulation is such that it will compare with a plate-modulated phone when it is properly adjusted. These adjustments are very simply and easily made and do not require continual readjustment as most amateurs seem to believe.

The two important adjustments in any ordinary grid-modulated phone are the antenna coupling and r.f. grid excitation. The antenna coupling should be greater than for plate-modulated or c.w. class C amplifiers. A simple rule is to increase the antenna coupling a little beyond the point of maximum antenna or feeder r.f. current for any one value of d.c. grid current in the r.f. stage which is to be modulated. *Modulation linearity and good voice quality cannot be obtained without heavy antenna loading.* The other important adjustment is the grid excitation which should be low enough so that *little or no d.c. grid current* flows when the microphone is not being energized.

The transmitter shown in the circuit diagram and photographs was designed for c.w. grid modulation on the 10- and 20-meter bands. It could be used on 40 and 75 meters but would require a larger capacity tank tuning condenser in the final amplifier for 160-meter operation. The carrier output on phone runs pretty close to 150 watts and on c.w. about 400 watts.

The output depends upon the plate supply voltage which runs about 1500 volts in the transmitter shown. Any plate supply of from 1500 to 2000 volts is suitable for tubes such as the HK354 or T-200 in ordinary grid-modulated systems.

A Pierce crystal oscillator arrangement was used in order to obtain sufficient grid drive on 10 meters with only two doubler stages and two tuned circuits. A 6C5 triode has the crystal connected between grid and plate in an ultra-audion oscillator circuit. A 75-μμfd. mica condenser is connected from grid to cathode in order to provide the correct amount of grid excitation to the 6C5 when the crystal is connected from grid to plate. The crystal acts as the tuned oscillator circuit with shunt d.c. plate supply through an ordinary radio frequency choke. This eliminates the need of a tuned circuit such as is generally used in most triode, tetrode or pentode tube crystal oscillators. The tuned plate circuit in most crystal oscillators is used primarily for control of r.f. feedback to the crystal and can be eliminated where high r.f. output is not needed.

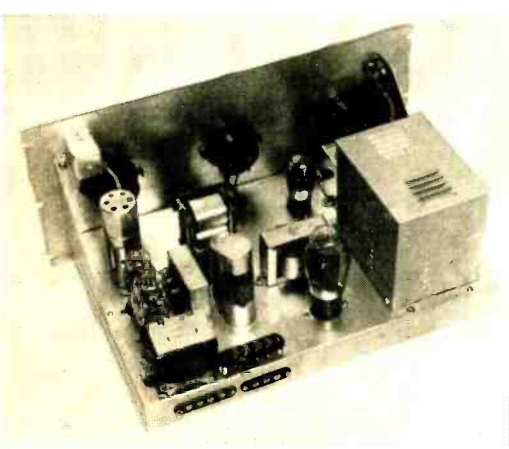
The crystal r.f. current in an ordinary grid leak triode crystal oscillator will be excessive if the plate voltage is more than 250 to 300 volts.

The 6C5 crystal oscillator used in this transmitter operates at a plate voltage of about 275 volts with low crystal current. The oscillator provides sufficient output to drive a 6L6G doubler and to light up a small neon bulb when testing the circuit for oscillation. The 6C5 plate current runs between 10 and 15 ma. and it is obtained from the 6L6G screen supply

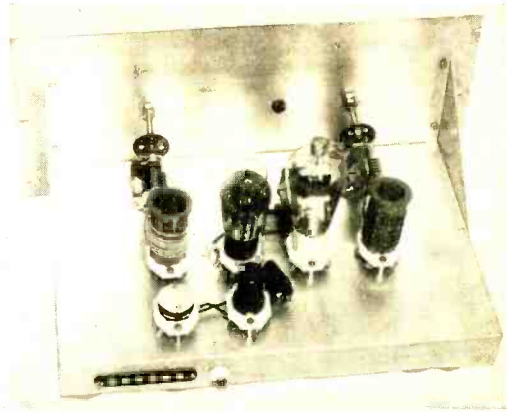
*Engineering Editor, RADIO.

which in turn is obtained from the 500-volt plate supply. The 10,000-ohm resistor and 50,000-ohm bleeder drop the 500 volts to about 275 for normal operation when connected to the 6L6G screen and 6C5 plate circuits. The 0.5-μfd. condenser connected across the 50,000-ohm resistor acts as an extra hum filter condenser in conjunction with the 10,000 resistor. This provides the third section of hum filter for the plate supply to the crystal oscillator, which is generally needed when the set is to be used on 10 meters. The frequency doublers always increase any slight frequency modulation present in a crystal oscillator with the result that some transmitters have an r.a.c. carrier in the 10-meter band even though having a pure d.c. characteristic when used on 40 or 80 meters. The 10,000-ohm series resistor also adds protection to the crystal, preventing surges when keying the cathode circuit for c.w. or for phone break-in operation.

The 6L6G is made slightly regenerative in order to obtain high output on 20 meters with either a 40- or 80-meter crystal in the 6C5 circuit. A .00015-μfd. (150 μμfd.) mica condenser is connected from cathode to chassis ground at the tube socket and a 300-ohm wire wound resistor is connected in series with the cathode and keying circuit. This small by-pass (.01 μfd. is the more commonly used value) results in regeneration at the frequency of the tuned plate circuit, which in this transmitter is always tuned to 20 meters for either 10- or 20-meter band operation. This regeneration is necessary when the 6L6G is used as a quadrupler with an 80-meter crystal, and is beneficial even when doubling from a 40-meter crystal.



The speech amplifier-modulator.



The exciter portion of the r.f. section.

The 6L6G doubler drives a neutralized T-20 buffer or doubler which in turn drives the final amplifier. The 500-volt plate supply is used for both the 6L6G and T-20 stages as well as for the complete audio channel. An 807 tube could be used for the 6L6G at 500 volts plate supply; however, the 6L6G seems to stand the overload satisfactorily as a doubler. Part of this voltage is used as bias voltage drop across the 300-ohm resistor and key-click filter choke resistance.

The T-20 uses a combination of cathode bias and grid leak bias. The 200-ohm cathode resistor provides sufficient self bias to protect the tube in case of crystal excitation failure. The main bias is provided by a 15,000-ohm grid leak which, at a d.c. grid current of 10 ma., furnishes bias of about 6 times cut-off. This gives good efficiency when the T-20 is used as a doubler for 10-meter output. The T-20 buffer output on 20 meters is sufficient to drive 40 ma. of grid current into the final amplifier for c.w. operation. The complete exciter is keyed in the cathode or center-tap lead through a key click filter. This consists of a 2-henry low resistance iron-cored choke coil in series with the key and an external ½-μfd. 400-volt condenser and 400-ohm 10-watt resistor connected directly across the key at the operating table position. This simple key-click filter removes key-clicks and allows break-in operation, since the final amplifier is operated with fixed bias equal to at least 1.4 times cut-off.

A d.p.d.t. toggle switch connects a milliammeter into the T-20 center tap lead, or into the 6C5-6L6G cathode lead. The connection shown automatically connects the other stage on through past the meter circuit so that only the cathode current to the T-20, or to the 6L6G-6C5, is measured at one time. It is possible to read the "unloaded" grid current to the T-20 stage with this same meter by disconnecting the 500-volt plate supply from the T-20. A s.p.s.t. toggle switch opens or closes the plate supply lead in order to facilitate neutralizing adjustments on the T-20 stage.

Link coupling of one turn at each end of the twisted pair around the T-20 plate coil and T-200 grid coil supplies sufficient coupling between these circuits. A 25- or 40-watt mazda lamp may be coupled to the 10-meter coil or the 20-meter grid coil for phone operation only. The r.f. leads in the final amplifier are very short and the type and arrangement of parts allows neutralization even on 10 meters with a single-ended amplifier. A small amount of regeneration was intentionally added by means of a 50-μμfd. 5000-volt mica condenser connected between the coil centertap and the rotor of the split-stator tank condenser.

This 50-μμfd. condenser has the effect of making the final amplifier slightly regenerative so that the d.c. grid current is nearly as high under plate voltage and antenna load as with no plate voltage applied. For example, the grid current drops from 50 ma. down to 40 ma. under load and 20 meter c.w., as against a drop to 20 ma. without the 50-μμfd. condenser. A larger value can be used on 20 meters but will cause instability on 10 meters. The stage is still neutralized and may be used for phone operation without removing the 50-μμfd. condenser. The capacity, if any, which can be connected from coil center tap to the rotor of the split stator condenser will depend upon the type of tube, lengths of r.f. leads, type of tuning condenser and frequency band of operation. Sometimes capacity as high as .002 μfd. can be added to a 40- or 20-meter c.w. transmitter to double the d.c. grid current under load, resulting in an increase of r.f. output into the antenna with less tube plate heating.

The speech amplifier and modulator consists of three receiving type tubes with the result that the cost for phone operation is at a minimum. Excellent quality can be obtained even with a 2A5 or 42 pentode modulator, since it is operated into a fixed 4000-ohm load resistor. The variable, modulated grid load is effectively in shunt to this 4000-ohm resistor. The vari-

Key to Schematic on Facing Page

R. F. SECTION

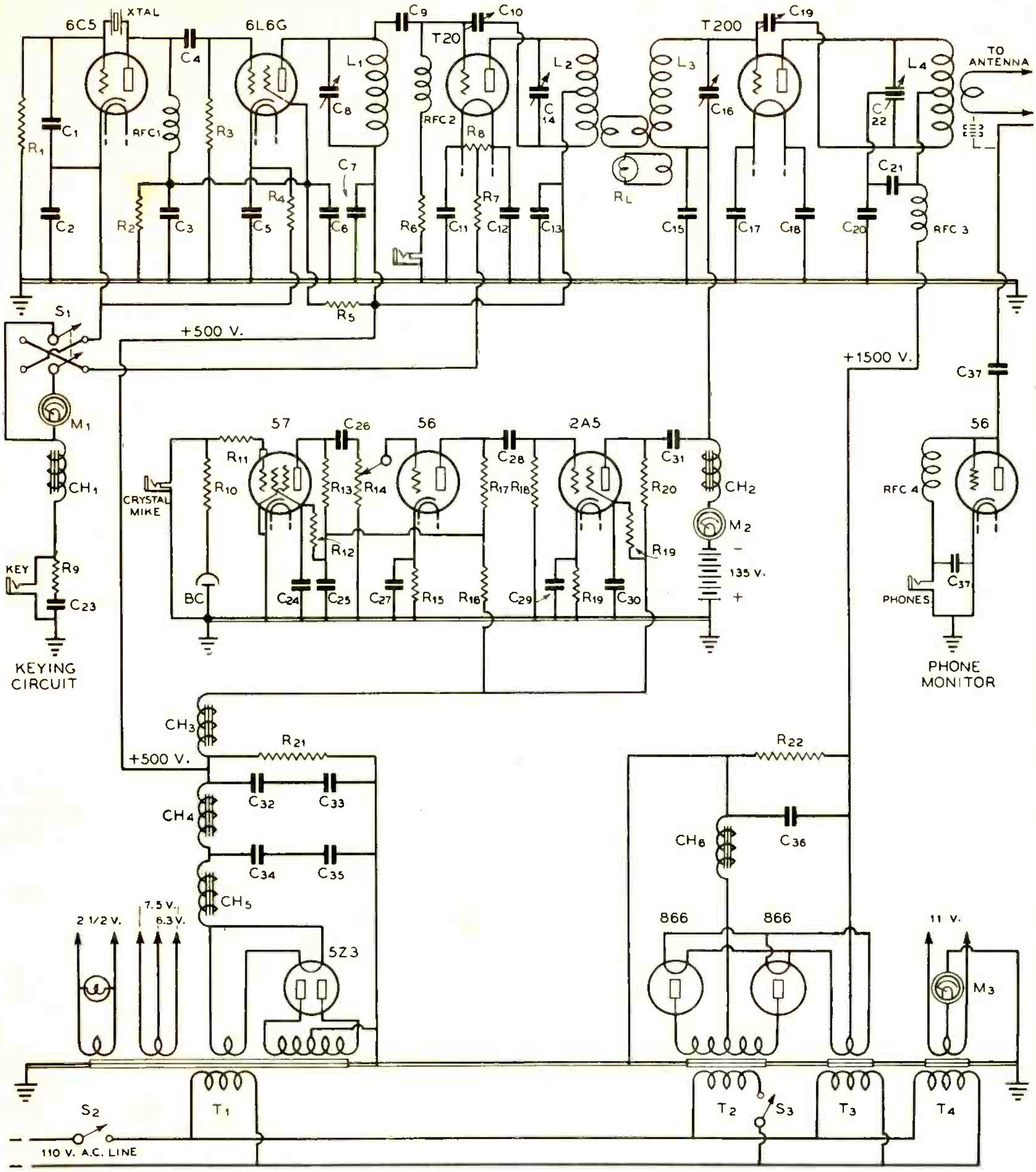
R_1—25,000 ohms, 1 watt carbon
R_2—50,000 ohms, 2 watts
R_3—100,000 ohms, 1 watt carbon
R_4—300 ohms, 10 watts
R_5—10,000 ohms, 10 watts
R_6—15,000 ohms, 10 watts
R_7—200 ohms, 10 watts
R_8—30 ohms, c.t., 10 watts
R_9—400 ohms, 1 watt
C_1—75 μμfd., mica
C_2—.01 μfd. mica
C_3—0.5 μfd. 400 volt paper
C_4—.0001 μfd. mica
C_5—.00015 μfd. mica
C_6—.01 μfd. mica
C_7—.006 μfd. mica
C_8—50 μμfd. midget
C_9—50 μμfd. mica
C_{10}—10 μμfd. double spaced
C_{11}—.001 μfd. mica
C_{12}—.001 μfd. mica
C_{13}—.006 μfd. mica
C_{14}—35 μμfd. double spaced
C_{15}—.002 μfd. mica
C_{16}—35 μμfd. double spaced
C_{17}—.001 μfd. mica
C_{18}—.001 μfd. mica
C_{19}—12 μμfd., 6000-volt spacing
C_{20}—.002 μfd., 5000 v. mica
C_{21}—5000 v. mica, try 50 μμfd. (see text)
C_{22}—40 μμfd. per section, 6500 volts
C_{23}—0.5 μfd., 400 volts
M_1—0-100 ma. d.c.
CH_1—2 hy., 100 ma.
RFC_1—2.5 mh., 100 ma.
RFC_2—2.5 mh., 100 ma.
RFC_3—2.5 mh., 500 ma.

AUDIO SECTION

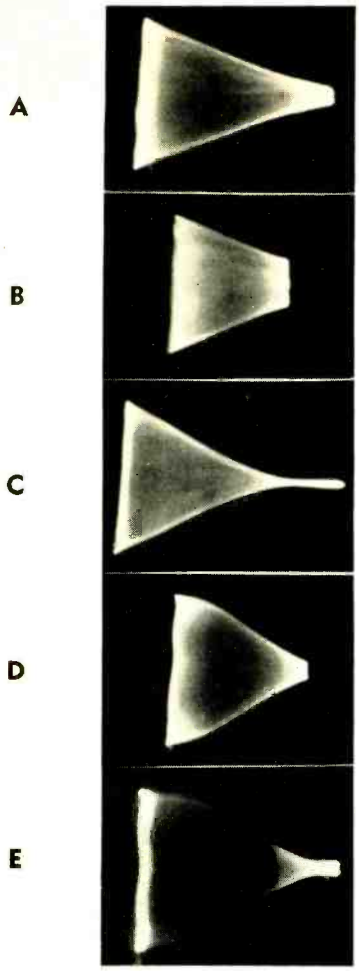
R_{10}—1 meg., 1 watt
R_{11}—25,000 ohms, ½ watt
R_{12}—2 meg., ½ watt
R_{13}—250,000 ohms, 1 watt
R_{14}—½ meg. tapered pot.
R_{15}—2000 ohms, 1 watt
R_{16}—25,000 ohms, 5 watts
R_{17}—100,000 ohms, 1 watt
R_{18}—½ meg., ½ watt
R_{19}—400 ohms, 2 watts
R_{20}—4000 ohms, 10 watts
C_{24}—0.1 μfd., 400 volts
C_{25}—0.5 μfd., 400 volts
C_{26}—.01 μfd., 400 volts
C_{27}—1 μfd., 200 volts
C_{28}—.01 μfd., 400 volts
C_{29}—10 μfd. 25 v. electrolytic
C_{30}—4 μfd. 450 v. electrolytic
C_{31}—1 μfd., 600 volts
C_{37}—.001 μfd.
BC—Bias cell
CH_2—30 hy., 50 ma.
M_2—0-50 ma. d.c.
RFC_4—2.5 mh. or more

POWER SUPPLIES

T_1—1200 volts c.t., 200 ma., and filament windings shown
T_2—3500 volts c.t., 300 ma.
T_3—2.5 volts, 10 amps., 5000 v. insulation
T_4—11 volts, 5 amps
CH_3—30 hy., 50 ma.
CH_4—12 hy., 200 ma.
CH_5—200 ma. swinging choke
CH_6—20 hy., 350 ma.
C_{32}, C_{35}—8 μfd. 450 volt electrolytics
C_{36}—4 μfd., 2000 volts
R_{21}—25,000 ohms, 50 watts
R_{22}—100,000 ohms, 100 watts
M_3—0-500 ma. d.c.
Note: An 8 μfd. electrolytic should be connected from the top of CH_3 to ground.



Schematic Diagram of the Jones Transmitter



(A) **Normal operation, 150-watt carrier.**
(B) **Undermodulation. Insufficient audio excitation.**
(C) **Overmodulation. Excessive audio input.**
(D) **Distortion. Excessive r.f. grid excitation.**
(E) **Overmodulation and distortion. Insufficient antenna loading.**

able load usually ranges from 7500 ohms on up to higher values in this particular transmitter. The resultant modulator load runs from about 2500 to 4000 ohms, which causes no appreciable distortion as far as voice quality is concerned.

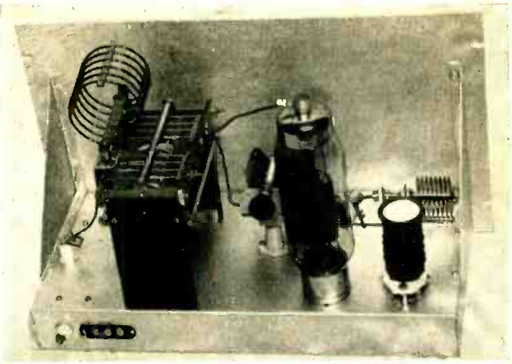
A 57 pentode high gain speech amplifier tube drives a 56 which is resistance coupled to the 2A5 modulator. The audio channel has additional filter in the form of a 30-henry 650-ohm choke and 2-μfd. 600-volt by-pass condenser. The two speech amplifier stages have an additional hum and "motor-boating" filter in the shape of a 25,000-ohm resistor and 0.5-μfd. condenser. The 4000-ohm 2A5 plate resistor drops the d.c. plate supply to a little over 300 volts at the plate of the 2A5. A 35,000-ohm resistor drops the 2A5 screen supply voltage to about 250 volts and a 0.1 μfd. by-pass condenser shunts the audio frequencies to ground for normal operation of the 2A5 tube.

The T-200 grid circuit is connected to the modulator plate through a 1-μfd. 600-volt condenser in order to receive audio voltage excitation for grid modulation. A small 30-henry choke provides a d.c. path for the grid current without short circuiting any audio power. It has a low enough d.c. resistance; so no appreciable grid bias change results during modulation kicks of d.c. grid current. Medium or small sized B batteries furnish sufficient grid bias (135 volts) for c.w. and phone operation with a T-200 tube with 1500-volt plate supply.

Two plate voltage transformers, one of 600 volts at 200 ma. (each side) and another of about 1750 volts at 300 ma. will supply all necessary plate power supplies for the transmitter. A single section of filter consisting of a 20-henry 300-ma. choke and 4-μfd. 2000-volt condenser provides enough filter action for c.w. and grid-modulated phone. The 20-henry filter choke was used in preference to a swinging choke in order to have better hum filtering action. A 100,000-ohm bleeder, and choke input to the filter, maintains the plate voltage supply constant enough for exciter keying.

A 56 tube connected as a diode, with an r.f. choke and phone jack, offers a simple, built-in phone monitor. The plate lead, of insulated wire, is run up to a location near the antenna feeder or feeders in order to pick up enough r.f. energy to give a good strong audio signal response in a headset plugged into the phone jack. This monitor can be used to check for best grid excitation and proper antenna loading as evidenced by good voice quality when modulating. A flashlight lamp, thermocouple-meter in the antenna feeders or field strength meter should be available for checking antenna coupling.

The audio peak voltage required for full modulation is about 115 volts when the carrier output was set at 150 watts, and 175 volts for



● (Right) The T-200 final amplifier. (Below) The power supply deck.

nearly 200-watt carrier. The voice quality was not as good as the higher output level and the tube plate became a dull red in color after a few minutes' operation.

Oscilloscope pictures taken show good linearity up to modulation levels of over 90%, as can be seen by the nearly perfect triangle at "A."

This type of grid modulation is not purely efficiency modulation, but is a combination of power supply release and efficiency modulation. The d.c. plate current will kick up 10 or 20 ma. when modulating; however, there is practically no carrier shift unless the set is modulated far in excess of 90%.

Construction Notes

The transmitter was built in standard relay rack construction in a rack 42½ inches high. The chassis are 11"x17"x1¾" and are fastened to the front panels by means of machine screws in front and by means of triangular shaped end brackets. The top and bottom front panels are 10½"x19" and the two middle panels are 8¾" x19". The photographs illustrate the layout of parts.

The 10-meter final plate coil consists of 6 turns of no. 10 enamelled wire, center tapped on a 2¾" diameter wound 2 turns per inch. The 20-meter coil consists of 10 turns of no. 10 wire, center-tapped on a 2½" diameter wound 4 turns per inch. The 20-meter 6L6G coil consists of 7½ turns no. 20 d.c.c. wire on a 1½" diam. form 1¼" long. The 20-meter coil for the T-20 consists of 11 turns no. 16 enamelled 1¼" diam. center tapped, 1⅛" long. The 20-meter final grid coil consists of 8 turns of no. 16 enamelled on 1½" diameter 1⅛" long. The two 10-meter coils were wound on 1½" diameter forms to cover a length of 1½" with no. 16 enameled wire. The T-20 coil consists of 6 turns, center tapped, for 10 meters and the grid coil consists of 3½ turns.

Operating Notes

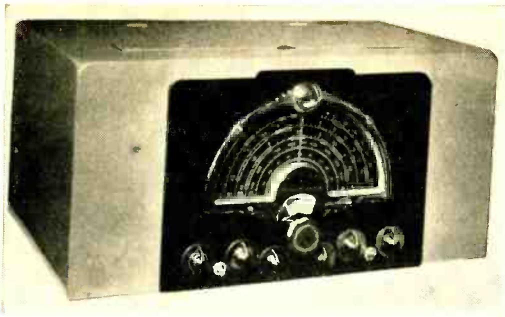
The T-20 plate supply switch should be turned off until the crystal oscillator has been checked for oscillation with a neon bulb and the 6L6G tube circuit tuned to resonance. This will be shown by a dip in cathode current to about 60 ma. When the meter switch is thrown over to the T-20 position, the grid current will be between 15 and 20 ma., since no plate voltage is applied. The T-20 can then be neutralized with the 20-meter plate coil in place. Link coupling this circuit to the final grid and application of plate voltage to the T-20 will cause from 30 to 50 grid ma. to flow in the next stage when the circuits are in tune and the coupling link adjusted correctly. It is allowable to run as high as 90 or 100 ma. cathode current into the T-20 under load at the plate voltage used here, since the meter reads the sum of grid and plate current.

The final amplifier can then be neutralized with a neon bulb or lamp and a turn of wire, or it may be neutralized by observation of the grid current meter.

The antenna can be link coupled to the final through an outside tuned circuit, inductively coupled or coupled by a one- or two-turn loop

[*Continued on Page 80*]

Razor-Sharp Phone SELECTIVITY



In recent years the necessity for increased selectivity in communication receivers has resulted in the concentration of attention upon the tremendous benefits to be had from quartz crystal filter circuits. Properly designed and operated, such circuits can provide substantially the maximum of selectivity which may be successfully used in c.w. telegraph reception. Since in i.f. amplifiers employing crystal filters the major portion of adjacent signal selectivity is provided by the crystal, little attention has been paid to the associated coupling transformers in terms of improving their selectivity, over ordinary broadcast receiver technique. Hence, the problem of selectivity adequate to voice reception is about where it was several years ago, while the number of amateur phone stations in operation has so greatly increased as to require drastic improvement.

Quartz crystal filter circuits for phone reception leave much indeed to be desired. It is in practice impossible to broaden the extremely sharp selectivity curve of a 400 or 500 kc. crystal to the degree necessary for intelligible voice reception without serious volume loss due to curve dissymmetry. A 465 kc. series-connected quartz crystal filter passes voice modulation on its skirts—far "down" from its sharp nose.

Upon page 66 of the January, 1938, issue of RADIO is most briefly described the result of recent work calculated to provide i.f. amplifiers for superheterodyne receivers capable of the order of selectivity needed today for voice reception in the amateur bands. The curve herewith shows the results obtained from a total of six 472-kc. tuned circuits cascaded in a two-stage i.f. amplifier. The rather startling maximum selectivity depicted in curve A is not the result of complicated circuits, but is the product of the simple and straightforward elimination of losses in conventional i.f. coupling transformers and in their associated tubes.

Curve A shows an intelligence-admitting "nose" 3 kc. wide, with a "drop" of 60 db. in a range of 3½ kc. immediately outside this "nose". The 3000-cycle admitted band provides good voice intelligibility, while the extraordinarily steep "skirts" give a degree of interference rejection which is nicely able to drop nearby heterodyne interference "down the drain", particularly if tuning is shifted very slightly off a desired signal toward the side opposite the QRM. The skirt steepness is sufficient to give good single-signal c.w. reception using a 2000-cycle beat note instead of the more common 1000 cycles. The unwanted audio "image" is then 4 kc. away, and is so far down the skirt as to provide an audio image ratio of about 1000 to 1, or 60 db.

From the foregoing it may be correctly surmised that the new communication receiver herein illustrated and described has been designed primarily for selective voice reception, but it also shows up well on c.w. reception. This receiver is known as the McMurdo Silver "14-15" because it uses 14 tubes with its 10" Jensen-Silver speaker or 15 tubes with its optional 15" speaker. Housed in a substantial steel shielding case 20" long, 13" deep, and 9¼" high, it presents a very attractive appearance through the contrast of its polished chromium escutcheons on black Micarta panel set off by a case finished in "British Post Office" gray enamel. This attractive finish is a smooth enamel and does not catch dust. It may be wiped clean, or washed with soap and water.

Four tuning bands covering 540 to 32,000 kc. take in everything but the 5-meter band.

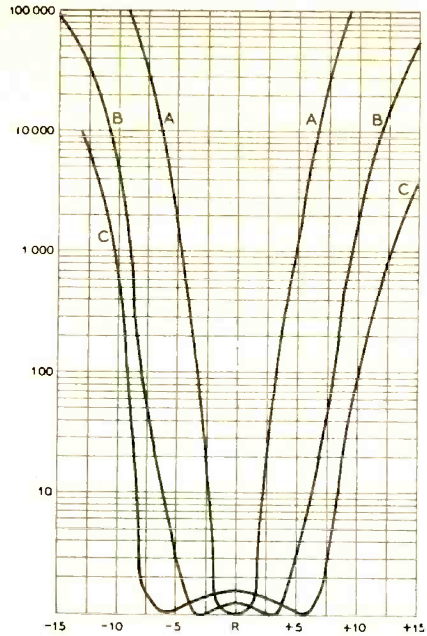
The stage of tuned r.f. amplification is somewhat unconventional in that by judicious use of ordinarily bothersome stray coupling capacity an increasing amount of stable regeneration is introduced upon increasingly shorter wavelengths, thereby getting out of this single stage the maximum in gain and image selectivity. The signal-to-noise ratio is high even at fractional microvolt absolute sensitivity. Sensitivity is excellent from 540 to 32,000 kc. The high sensitivity on 10 meters is especially helpful.

A 6L7 detector-converter tube is used, coupled to a voltage- and temperature-stabilized 6J7 electron-coupled oscillator.

Following the converter are two 6K7's in the two stage, variable band width i.f. amplifier producing the selectivity curves illustrated. Through six permeability-tuned circuits, each of extremely high Q, and permanently fixed coupling circuits varied by the ganged switches shown in each i.f. grid circuit, the three selectivity choices are instantly available. It is thus possible to broaden the "14-15" for signals of questionable stability, for standby operation and for high-fidelity broadcast reception.

The full selectivity contribution of all six tuned i.f. circuits is obtained by discarding the usual low resistance diode second detector in favor of the new infinite impedance (inverse feedback) detector. This greatly improves selectivity by not ruining the last two out of the six tuned i.f. circuits, and provides better tone quality through the greater percentage-modulation capabilities of this detector as contrasted with the older diode detectors.

The tuned and amplified a.v.c. system uses a 6K7 amplifier driven from the second i.f. grid, and with its broad, permeability-tuned i.f. transformer, provides an a.v.c. selectivity desirably broad in terms of preventing input tube over-load on channels immediately adjacent to powerful signals—quite an important item if *actual* selectivity is to be that provided by the i.f. circuits. One diode of a 6H6 provides a.v.c. voltage for r.f., first detector and first i.f. tubes, with less a.v.c. voltage applied to the second i.f. amplifier in consideration of the stronger signals it handles. The second diode of the 6H6 actuates the 6G5 "magic eye" tuning indicator tube, which through its graduated window may be used as a satisfactory R-meter. (A better R-meter would be an 0-10 milliammeter in the 2d i.f. plate return.) One 6J5 tube is used as second detector, a second as beat oscillator. The pitch is variable from the front panel through adjustment of the iron core of the b.f.o. transformer. Still another 6J5 is used as first audio driver stage.



Unlike most communication receivers that give little thought to audio quality, the audio amplifier of the "14-15" has been designed to give truly realistic music and voice reproduction limited only by the operator's choice of selectivity as set by the selectivity knob position. Two 6L6 beam power tubes are used in class A prime (AB_1) to develop 20 watts output at negligible harmonic distortion.

Having a good audio system, it would be foolish to waste it only upon radio reception; so a fourth position of the selectivity knob cuts the audio input over to a pair of tip jacks on the chassis rear. Into these may be plugged a crystal phono-pickup, and of much more interest to amateurs, a carbon microphone input transformer or a suitable pre-amplifier for low-level mike operation. Output is either to the speaker or is available through a separate 5000-ohm secondary on the output transformer. From this 5000-ohm secondary twenty watts of audio power are available to modulate a 40-watt class C transmitter stage or to drive a bigger modulator for larger transmitters.

The power supply is interesting in that it uses one or two 5Z3 rectifiers depending upon whether the buyer selects a 10" or 15" speaker. One husky choke and one section of the speaker field in conjunction with three 25 μfd. wet electrolytic condensers provide a high de-

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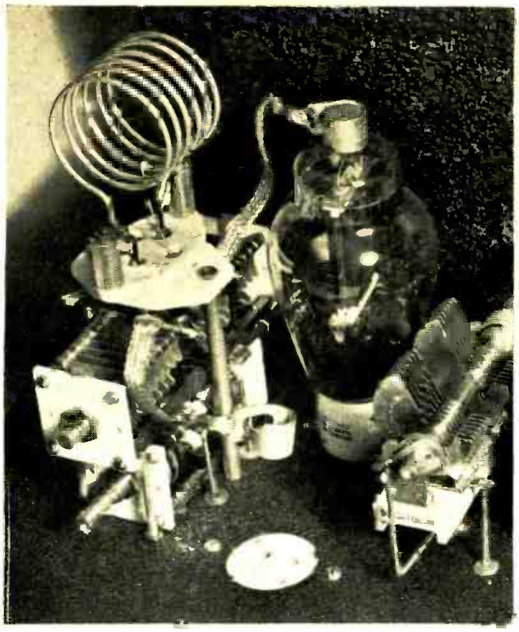
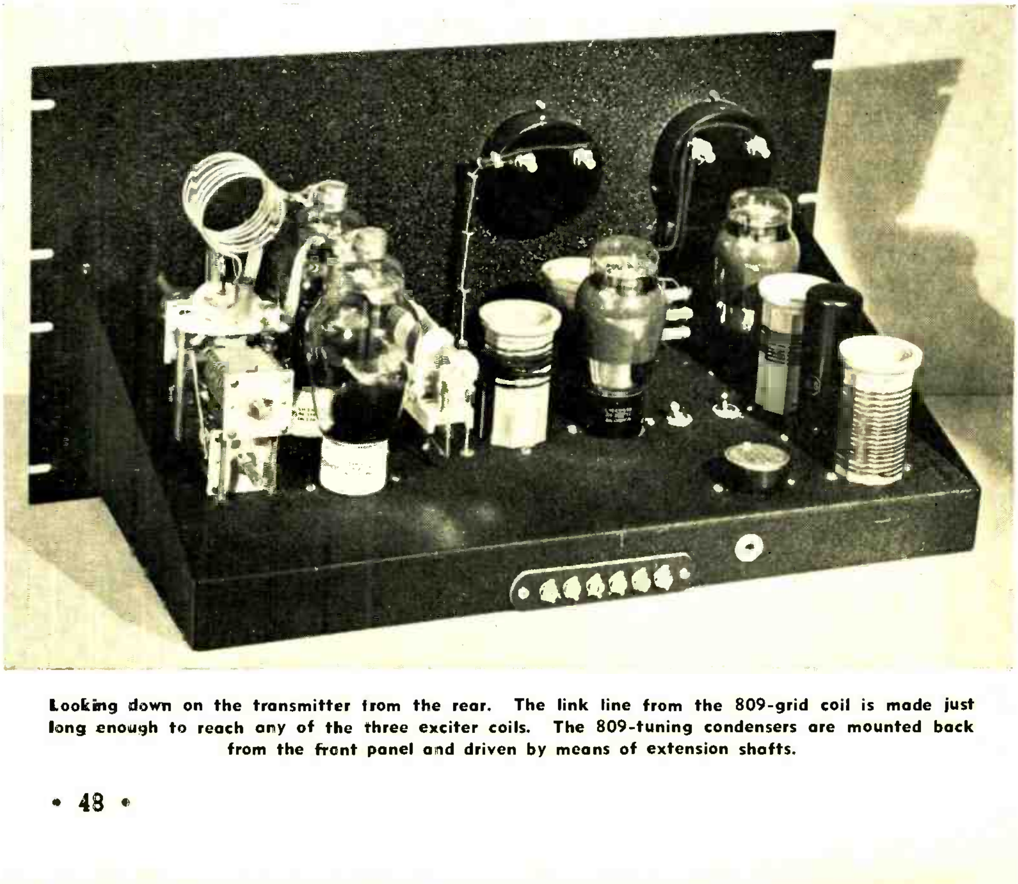


PUSH-PULL 809'S

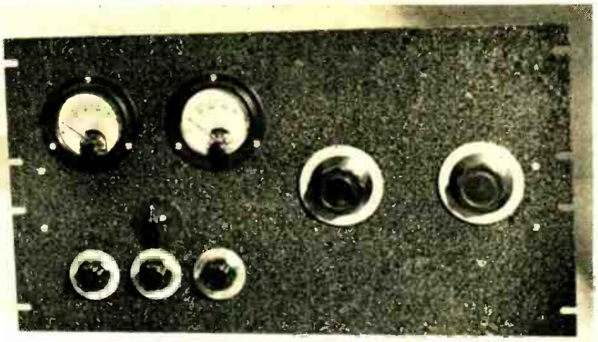
Illustrated in the photographs is a 150-watt phone-c.w. transmitter utilizing the "Dyna-push", a three-tube exciter described on page 19 of this issue. Calling attention to the fact that the exciter was ideally suited for driving a pair of 809's to 150 watts or more input on either phone or c.w. proved to be a boomerang. The temptation to build such a combination as an integral unit was just too great to resist. The result was a highly satisfactory phone or c.w. transmitter giving lots of watts per dollar with a minimum of constructional difficulties and "bugs".

Inasmuch as the exciter portion is identical with the one described as noted above (except for mechanical layout), the wiring diagram is not repeated. The mechanical layout can be observed from the accompanying photographs. Since the circuit of the push-pull final amplifier is strictly conventional, neither was it deemed necessary to show a wiring diagram of this portion of the circuit. Values of the various



Looking down on the transmitter from the rear. The link line from the 809-grid coil is made just long enough to reach any of the three exciter coils. The 809-tuning condensers are mounted back from the front panel and driven by means of extension shafts.

Driven by the "Dynapush"



The front view of the 100-125 watt phone-c.w. transmitter presents a pleasing appearance.

By B. A. ONTIVEROS,* W6FFF

components can be obtained from the buyer's guide on page 96.

By utilizing a 2500-ohm grid leak in series with two 4.5-volt "C" batteries, it is possible to run 900 volts on the 809's with oscillator keying. This amount of fixed bias will cause the plate current to drop to a very low value when the excitation is removed, provided parasitics are not present. No trouble should be experienced from the latter, however, if the mechanical layout illustrated is followed closely.

The 2500-ohm grid leak and 9 volts of C battery are also correct for phone operation, though it is advisable to drop the plate voltage to about 750 volts with plate modulation. On 10 meters a further reduction in plate voltage to about 650 volts would be safest, though not absolutely necessary if tuning up is done carefully at reduced plate voltage before full voltage is applied.

Two power supplies are required, one of 525 volts for the exciter portion as described in the article on the exciter, and one of about 900 volts for the 809's. The latter should be capable of delivering 200 ma. and should have means for dropping the voltage slightly when working phone.

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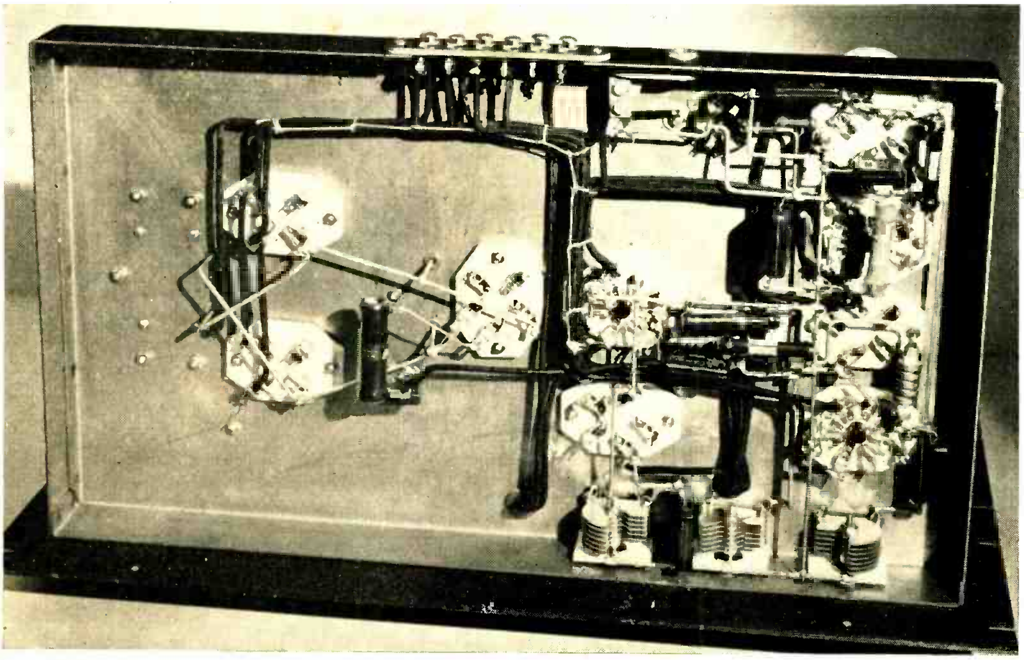
*Technical Department, RADIO.



Under chassis view. The three 50-μμfd. exciter tuning condensers have a .030" air gap. The closer spaced type (.020" gap) tend to arc over when mounted directly on the metal panel as illustrated here.

A HAM BAND SUPERHET

1500-kc. Intermediates

By RAYMOND P. ADAMS*

The operating efficiency of the writer's "10-Meter Phone Station Receiver" (RADIO, Nov., 1937), (which had been subject, by the way, to considerable test and application and with other than 28-Mc. coils installed), has indicated the practicality of 1500 kc. as an intermediate frequency and prompted the use of a channel of this value in the low-drain 10-20-30-40-80-meter band tuner to be described in this article.

The 10-meter job in original form, however, had its limitations and was open to considerable improvement. Some reconstruction and a few wiring changes proved several things: first, that a 1500 kc. i.f. channel does not afford the gain and selectivity to which we are accustomed unless at least three well-designed stages are used. Four stages are really needed, for that matter, where the second detector is a diode. Second, that metal r.f. tubes might well be replaced by glass equivalents, which have lower effective interelectrode capacitance. Third, that a remote cut-off first i.f. amplifier isn't exactly the best bet for weak signal reception. Fourth, that much superhet noise may be directly attributed to the h.f. oscillator and that some means of manually controlling oscillator output is desirable. Fifth, that the r.f. tuning condenser stator leads should tap down on the coil windings, that the loading capacities be removed, and the inductances be wound to more precise limits—all to effect a more favorable L/C ratio. Sixth, that the conventional b.f.o. and crystal filter refinements—eliminated in the 10-meter receiver for reasons of economy—are almost imperative in any job to be used for communications purposes. Naturally, we applied a number of these findings in the design and construction of the present job.

An Objective

We had a pretty clear cut idea of just what we were after from the first. For one thing, the new super was to incorporate no r.f. stage but was to be designed for alternative antenna or external preselector input to the first detector. Also, it was to feature both optimum signal sensitivity and optimum conversion in the mixer, minimum interaction between signal and h.f.o circuits, automatic gain control, variable h.f.o. output, and, above all, good selectivity and maximum usable gain in the i.f. channel. With all of this, it must lend itself to alternative battery, vibrator-type, or a.c.-pack powering, must work with good operating efficiency at a power potential of no more than 135 volts, and must draw no more than 40 ma. of B and 1.5 amperes of A. Quite an order, no doubt, but we have filled the bill pretty well,

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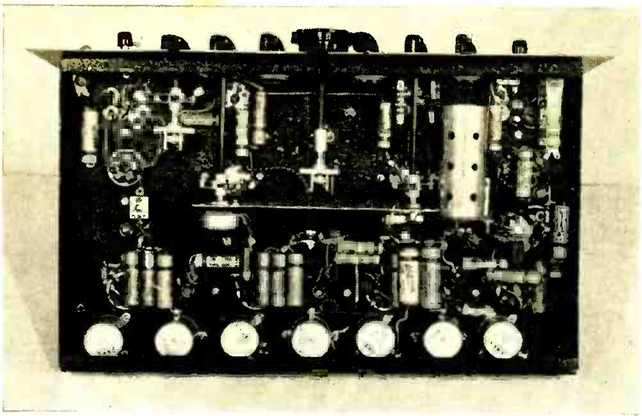


• Under-chassis view of the receiver. The b.f.o. tube can be seen, mounted horizontally, in the upper right-hand part of the chassis.

even if we're not exactly sure that we've found the best of all possible mixer set-ups.

General Description

The "front end" consists of the conventional mixer, with separate oscillator, and, as we have said, is designed for either antenna or external preselector feed. The 1500 kc. intermediate channel of course makes the use of the receiver without r.f. preselection entirely practical, as the image is removed 3000 kc. from the desired signal.

The i.f. channel, using Alignaire (air-trimmed) 1500-kc. components, consists of a link filter stage, a first stage using a sharp cut-off 6J7 for weak signal amplification, and three stages of remote-cutoff, a.v.c.-controlled pentodes working into a diode rectifier. The use of shielded chokes in screen and plate leads to the tubes and the proper choice of limiting bias have completely stabilized these i.f. circuits.

A diode second detector, of course, acts as a low impedance load across the output i.f. transformer; last stage gain is accordingly not very high. A grid bias, plate, or infinite-impedance detector would probably increase the overall channel efficiency, make a fourth i.f. stage unnecessary—but would call for just as many tubes as we have worked into the lab model if a.v.c. is desired. More on this later, however.

The high-μ triode section of the detector tube is our one and only a.f. amplifier, and provides more than ample audio for headset reception. The b.f.o. tube is a separate triode, mounted, by the way, below chassis.

The complete job is built up on a standard 10"x17" chassis, assembled into a similarly standard and readily available metal cabinet—and we do like that new grey wrinkle finish.

The tuning eye, a 6N5, works on 135 volts, is a worthwhile refinement, but isn't exactly an R meter. Either a 5 ma. milliammeter in one of the controlled i.f. cathode circuits or a suitable milliammeter in the second-detector cathode circuit (where plate detection is used) would give a better signal strength indication.

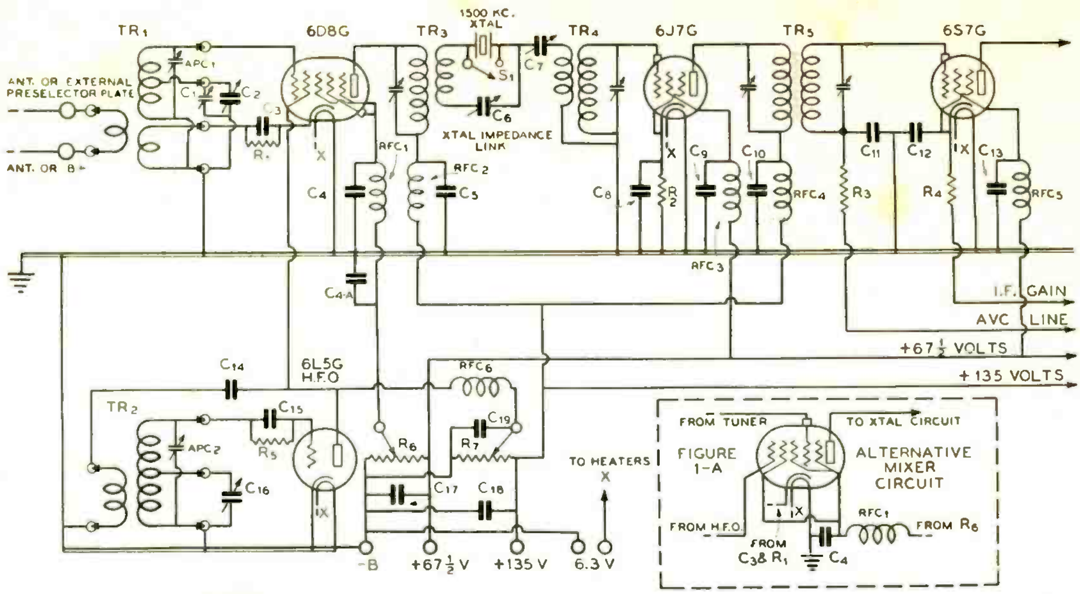
The Tuning System

Both detector and oscillator coils are factory-wound Hammarlunds, three winding, six prong form type, slightly rebuilt to text specifications. In the lab. model, all except the 10-meter coils are equipped with APC trimmers, to facilitate band spotting. The use of the loading capacities in the oscillator forms is recommended —and suggested for the detector forms to simplify alignment.

The Mixer Circuit

We tried one mixer set-up after another, using a pentagrid converter, with separate triode oscillator. The simplest circuit affording good conversion gain with minimum interaction is shown in figure 1-A, and this one is recommended where an external preselector is to be used. The circuit given in the main drawing affords good signal-input sensitivity, however, and does a good job on 10 meters. Somewhat like the "trick" Jeppesen layout (page 61—April, 1937, RADIO), it places the signal on the no. 1 grid and the oscillator output on the no. 2 grid and ties the normal signal input grid to screen.

The use of R_7 as a means of manually controlling oscillator output has much to be recommended, as is our employment of a screen supply potentiometer for the mixer. Whether regeneration in the signal circuit is to be used



C_1—15 μμfd. midget trimmer
C_2, C_{16}—35 μμfd. per section, two-gang variable condenser
C_3, C_4—.05 μfd. 400-volt tubular
C_{4A}, C_5—0.1 μfd. 400-volt tubular
C_6—15 μμfd. midget trimmer
C_7—3-30 μμfd. mica trimmer
C_8, C_9—0.1 μfd. 400-volt tubular
C_{10}, C_{11}—.05 μfd. 400-volt tubular
C_{12}, C_{13}—0.1 μfd. 400-volt tubular
C_{14}—.001 μfd. mica
C_{15}—.00025 μfd. mica
C_{16}, C_2—35 μμfd. per section, two-gang variable condenser
C_{17}, C_{18}—.25 μfd. 400-volt tubular
C_{19}—.05 μfd. 400-volt tubular
C_{20}—0.1 μfd. 400-volt tubular
C_{22}—.05 μfd. 400-volt tubular
C_{23}, C_{24}, C_{25}—0.1 μfd. 400-volt tubular
C_{26}—.05 μfd. 400-volt tubular
C_{27}, C_{28}, C_{29}—0.1 μfd. 400-volt tubular
C_{30}, C_{31}—.00025 μfd. mica
C_{32}—0.1 μfd. 400-volt tubular
C_{33}—10 μfd. 25-volt electrolytic

or not, an adjustment of these controls can and will effectively aid in pulling up a weak sgnal out of oscillator noise level.

We have already discussed the intermediate amplifier in some detail. We shall simply note here that the crystal-filter circuit is of the relatively low impedance link type, providing a proper match down to one of the new 1500 kc. crystals and up to the first i.f. tube grid. Also, either the four-stage layout with diode detection or the alternative three-stage affair with infinite impedance or plate detection and separate a.v.c. channel will give quite satisfactory results.

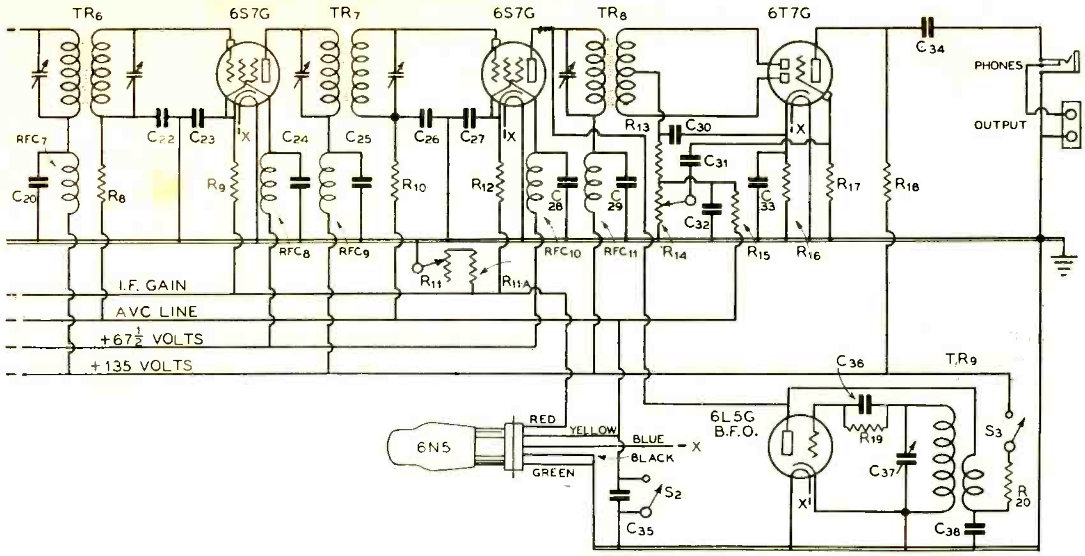
If the infinite impedance or grid leak or plate-type second-detector is to be used, by the way, do not use TR_8 as a coupling between the final i.f. stage and this detector, but employ a standard double-tuned output job. The center-tapped i.f. can be used in the separate a.v.c. circuit for push-pull diode feed.

If no automatic control is desired, economy does suggest the three-stage i.f. channel (6J7-6S7-6S7) and the use of other than diode detection. In such a case, TR_8, and the additional 6S7G may be eliminated from the scene entirely, and an additional triode employed as audio frequency amplifier (replacing the 6T7G). The magic eye indicator would likewise be omitted.

The large number of tubes used in the complete receiver would require a filament current drain not altogether consistent with the low B drain effected where the B plus potential was reduced to 135 and the screen supply to 67.5. This suggested the idea of employing .15-ampere tubes in all circuits except the first i.f., which called for a 6J7 (there being no .15 amp. equivalent). Quite excellent results have been obtained with the new, low-drain tubes.

As mixer, we employed a 6D8G—the .15 ampere equivalent of the 6A8. It worked well, but of course a separate oscillator is used to drive it.

H.f.o. and b.f.o. triodes are 6L5G's—similar to 6C5's. Second and third, and the optional fourth, i.f. pentodes are 6S7G's—remote cutoff tubes with an amplification factor of 850 at 135 volts plate and 67.5 screen voltage.



C_{34}, C_{35}—.05 µfd. 400-volt tubular
C_{36}—.00025 µfd. mica
C_{37}—Trimmer in b.f.o. coil
C_{38}—0.1 µfd. 400-volt tubular
Note—All tubular condensers listed as 400-volt may be 200-volt condensers providing the maximum voltage to be used on the receiver will not exceed 180 volts.

R_1—400 ohms, ½ watt
R_2—500 ohms, ½ watt
R_3—250,000 ohms, ½ watt
R_4—500 ohms, ½ watt
R_5—50,000 ohms, ½ watt
R_6, R_7—100,000-ohm potentiometer
R_8—250,000 ohms, ½ watt
R_9—500 ohms, ½ watt
R_{10}—250,000 ohms, ½ watt
R_{11}—12,000-ohm potentiometer

R_{11A}—Resistor on R_{11}
R_{12}—500 ohms, ½ watt
R_{13}—50,000 ohms, ½ watt
R_{14}—500,000-ohm potentiometer
R_{15}—250,000 ohms, ½ watt
R_{16}—2500 ohms, ½ watt
R_{17}—500,000 ohms, ½ watt
R_{18}—250,000 ohms, ½ watt
R_{19}—50,000 ohms, ½ watt

R_{20}—30,000 ohms, ½ watt
APC_1, APC_2—Air padder trimmer condensers—140 µµfd. for osc., smaller for detector circuits
Coils—See text and Buyer's Guide
I.f. transformers—See Buyer's Guide
S_1—Crystal switch, s.p.s.t.
S_2—A.v.c. switch, s.p.s.t.
S_3—B.f.o. switch, s.p.s.t.

The second detector, a 6T7G, is a conventional diode-triode.

In the lab. model, seven of these .15 ampere tubes are employed, together with the one .3 amp. 6J7. (One of the seven is the optional eye indicator-type 6N5). Total filament drain for the whole receiver is thereby made extremely low—only 1.35 amps. as compared to the 2.4 amp. requirement of a similar but standard-filament tube layout. Total B drain is similarly down, the average value being something less than 35 ma. at full gain.

We will forego the usual details on set construction and the presentation of layout drawings referring specifically to the laboratory model. It will be sufficient, we think, to indicate simply a suggested arrangement of components and list a few pointers which will or should facilitate anything like duplication of the initial design.

1. The Alignaire-trimmed i.f. transformers are rather bulky, hence they do not leave any too much space on a standard 10"x17" chassis for other than mixer, h.f.o., i.f., and second-detector tubes. The b.f.o. triode is positioned below chassis for this reason.

2. A two-inch-high chassis is recommended if it is to be used with the specified cabinet, which is the largest standard one made by Hadley. In assembling chassis and panel together, by the way, it might be a good policy not to rely entirely on the securing nuts for the various controls, as we have done, but to depend for support upon a couple of sturdy angles. In any event, the lower edge of the chassis front drop should be raised about ⅝-inch above the lower edge of the panel, to provide for ample clearance when the assembly is installed in the cabinet proper.

3. The i.f. components along the rear length of the chassis should be brought back from the down-drop bend sufficiently far to permit the installation of antenna, output, and power-lead terminal strips and binding posts at the indicated positions. There would not be sufficient clearance between chassis and rear cabinet wall to permit installation of these items on the rear chassis drop—unless, of course, a much narrower pan were employed.

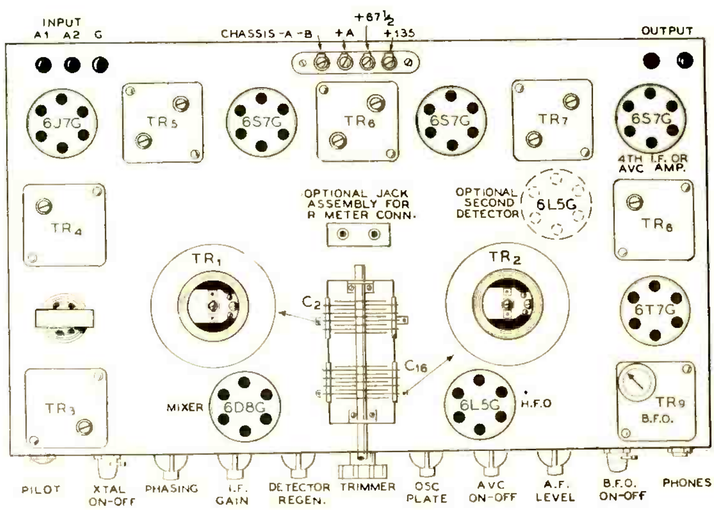
4. The various i.f. chokes are lined up along the rear of the chassis and serve as convenient ties for B plus and screen connections. In our circuit diagram, we indicate the use of such chokes in each and every stage; actually, we have, in the laboratory model, substituted filter resistors at one or two points where it was convenient.

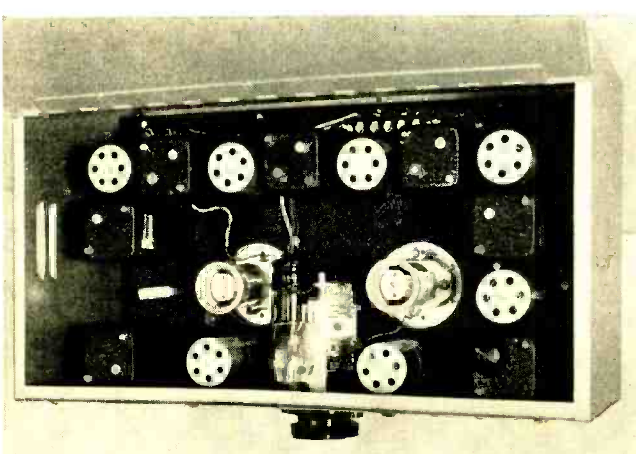
5. The a.v.c. on-off switch and the i.f. manual gain control are mounted on a partition below chassis. All other controls are assembled on the front drop and the front panel. A minimum of shielding is indicated. If the recommended layout is carefully followed, there should be little or no necessity for boxing off the b.f.o. and crystal filter "downstairs" groups of components.

6. The dial is located at a suitable point on the front panel and the band-spreading two-gang tuning condenser elevated until its shaft lines up accurately with the control hub. A rather large hole at dial center and in the front panel will be imperative, as the hub set screw which secures dial to condenser shaft sets in close to the control mechanism and isn't the easiest thing in the world to get at.

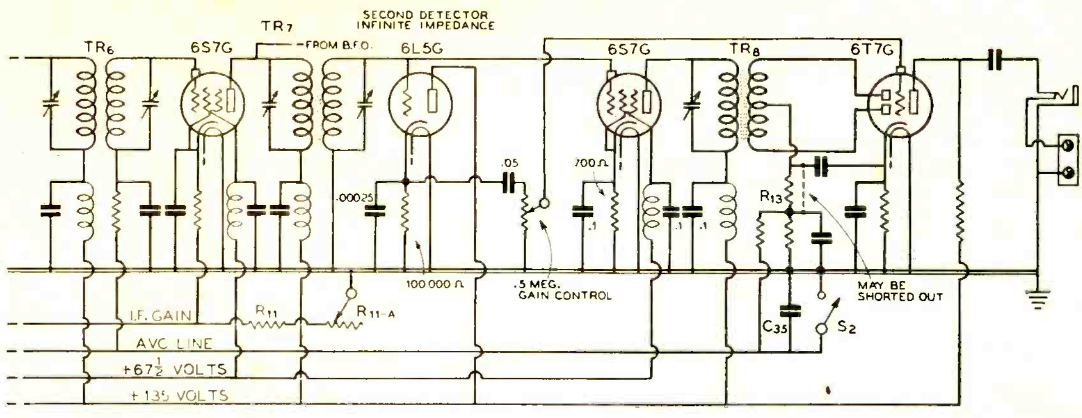
7. Oscillator coils are rebuilt to this extent: the winding at the base of the forms is removed and one of the associated prongs used as a terminal for spreader condenser tapping. A lead is brought from this terminal to the tuned section of the inductor, the tie being temporarily made well along toward the grid end. The APC trimmer is connected across the tuned winding following its insertion into the form. The socket for oscillator coils is so connected that the returns for the two interspaced windings tie together to chassis-ground—with the high side of the feedback winding leading out to the plate blocking condenser.

8. Detector coils call for a little more reconstruction. One end of the winding at the bottom of the form is removed from its associated prong and tied to the return lead for the tuned winding. The opened prong is then used for the tap connection between the tunable winding and the detector-circuit band-spreading condenser stator lug. The winding at the bottom





• Top view of the completed receiver is shown at the left, while above is the schematic diagram of the chassis layout in which the various components are identified and their placement shown.



Alternative intermediate amplifier, a.v.c., and audio amplifier for use with an infinite-impedance second detector. R and C values are the same as for the other circuit.

of the form is to be used as a cathode feedback coil and should of course be cut down to a very few turns—the exact number to be determined later with the set in operation. If APC trimming is desired, the tank connects across the tuned or secondary winding. If a more favorable L/C ratio is desired, the APC's should of course not be used and the grid winding should be increased by a number of turns sufficient to bring up the inductance to resonate at the desired frequency.

9. Equipped with 140 μμfd. APC tanks, the oscillator coils will tune over a sufficiently wide range to permit the use of HFO units wound for higher frequency coverage than the detector inductors with which they are to be associated. The no. 61 manufactured coil, for instance, tuning from 17 to 41 meters and acting as detector coil at 14 Mc. with minimum tank, would work well with a no. 60 oscillator coil tuning from 10 to 20 meters; the oscillator coil could be loaded up to provide for high C here. Some difficulties in effecting tracking throughout the manually tunable range (dial range, that is) might be experienced, due to totally dissimilar frequency-capacity ratios in the tuned circuits, but tracking *is* possible through careful tapping of band-spreader stator leads down on the coil windings.

Adjustments

B plus voltages of 135 for plates and 67.5 for screens should first be supplied the tuner, the i.f. gain opened wide, and the various circuits adjusted for proper operation at these potentials. The specified cathode resistors for all but a.v.c.-controlled i.f. tubes have values affording suitable grid-bias voltages. The cathode resistors for the 6S7G's are slightly lower than rated value, and with a.v.c. off and the gain potentiometer still adjusted for maximum gain, R_{11a}, which is a wire-wound bias limiting resistor supplied with the potentiometer, should be itself adjusted until the bias reading at the individual 6S7G cathodes is — 3 volts.

The i.f. circuits should now be roughly adjusted to 1500 kc., the crystal set up in an external oscillating assembly, and these circuits readjusted (with crystal switch in the "off" position) to exactly crystal frequency. With the crystal replaced in its receiver socket, the job is or should be ready for service once the r.f. coils have been adjusted for both proper spotting of ham bands and suitable frequency spread.

Band spotting, as we have previously indicated, is effected through an adjustment of the APC trimmers installed within the coil forms. Tracking and band spread is made possible through proper tapping of the tuning condenser stator leads down on coil windings.

Input Circuit Notes

We use the winding interspacing between detector coil turns as antenna coil. It should be noted that while the use of this winding will be fairly satisfactory whether a preselector is used or not, it does effect considerable coupling when the antenna connects directly to it; it is suggested, therefore, that unless an external r.f. stage is to be added—in which case the interwound winding will be ideal as a plate coil

[*Continued on Page 81*]

Showing the motor-driven rotating head before being hoisted up the telephone pole which supports the 20-meter installation at W4DRD. An ohmmeter-type direction indicator is part of the control box at the operating position.

Let's Whip the

***By* E. H. CONKLIN,* W9FM**

When the rotating head is placed atop the pole and the radiators are attached, the installation looks like this.

The thought of erecting a rotary beam antenna has probably entered the mind of almost every ham interested in the 14 Mc. and higher frequency bands. On 14 Mc., the system usually involves a massive structure, though the "gondola" of Kraus or the "box kite" of Roberts, described in RADIO during the past several months, appears to be at least a partial solution of the problem. Yet, thought of getting the necessary telephone pole or tower, raising it with the array mounted at its top, or even building a drive mechanism, discourages many from ever starting the job. Most certainly, anything that will make the task more easy is welcome.

The Heart of the System

A simple mechanical arrangement is now possible using the recently available[1] copper-plated, highly tempered steel tubes, which can be supported solely at one end even though a quarter-wavelength long. They are tapered to give added strength at the supported end, and weigh only 2½ pounds for the 17-foot length. They appear to be able to stand considerable wind, holding out horizontally with very little bend. Using a pair of them, it is possible to mount a twenty-meter horizontal antenna from a single point. With a ⅛-wavelength crosspiece on a tower, a rotary flat-top beam, useful on 20 and 10 meters, can be built with a minimum of construction difficulty.

[1]General Rotary Antenna Company, Coral Gables, Florida.

Application to the Flat-Top Beam

It has been pointed out that two elements spaced a half-wavelength, fed in phase, will give a 3 decibel gain, thus effectively doubling the transmitter power. The same antennas fed 180 degrees out-of-phase will produce a slightly lower gain. When they are brought closer to each other, the radiation from each antenna causes an induced current to flow in the other—which explains the heavy current flowing in two-wire feeders—and a point is reached where radiation caused by this induced current more than makes up for the loss in gain due to the close spacing, the radiated power in the favored direction then reaching a maximum.

Application to "Compact Yagi"

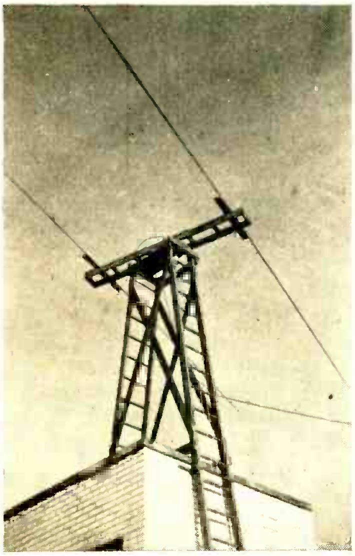
The theory is by no means confined to two wires 180 degrees out-of-phase. This phasing, as used in the Kraus flat-top beam, was suggested only because a phase difference of 180 degrees is so easily obtained simply by reversing the feeder connections between the doublets. Other phasings will produce other patterns, and can be obtained in a "driven" array by the use of connected stubs or other phase-

*Associate Editor of RADIO.

TWENTY-METER ROTARY

changing schemes. Perhaps the most simple means of getting phase relationships other than zero or 180 degrees is by operating one doublet as a parasitic element—a reflector or a director —adjusting the phase by changing the length. This is the scheme suggested by the makers of the steel tubes mentioned above, and used by Roberts in his article in RADIO for January.

With perfect adjustment, a maximum gain of 5.6 decibels, representing the field strength that would be produced by 3.6 times as much power, should be obtainable. In fact, a somewhat greater gain is possible if both a reflector and a director, each spaced only 1/10-wavelength from the antenna, are used.



The 20-meter installation at W2IVW uses rope and pulleys for rotation.

The Standard Arrangement

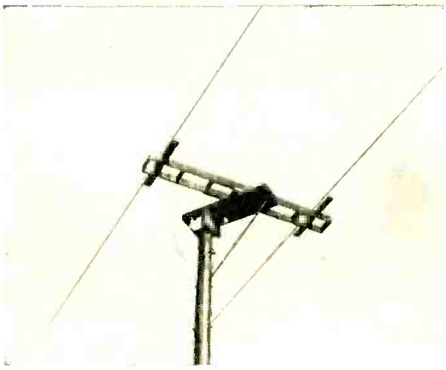
The arrangement for which the steel tubes were originally designed, involves the use of one driven antenna, fed at its center by a flexible transmission line coupled through an auto transformer, and one parasitic director. The line is not properly matched if it is connected directly into the center of the antenna, because the antenna presents to it an impedance quite a bit below 72 ohms.

During the work of determining the proper adjustment, a series of patterns was measured, using a fixed receiver 350 feet away from a rotary antenna. The antenna was mounted on a substantial tower provided with a cat-walk to enable an assistant to make adjustments quickly and to read the meters which were temporarily placed in the feed line and antenna.

The received signal was observed on the "R" meter of an RME-69 receiver. This meter has a scale labeled in decibels, its reading being noted for different antenna arrangements and positions. A short horizontal antenna, which remained unchanged throughout the tests, was used for receiving.

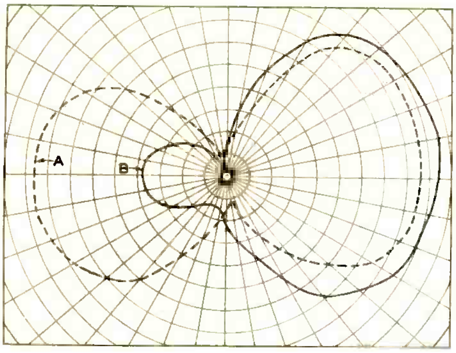
Calculated comparative signal intensity curves, in volts per meter, were also obtained by making a rough calibration of the receiver. This was done by varying the power delivered to a simple doublet antenna, and noting the antenna current and receiver meter reading, since the received signal intensity voltage is proportional to the antenna current. The radiated power is proportional to the square of this voltage ratio.

The antenna alone provided the expected "figure-8" bi-directional pattern, while the use of the director enabled adjustment to reduce back-end radiation (or pick-up when receiving).

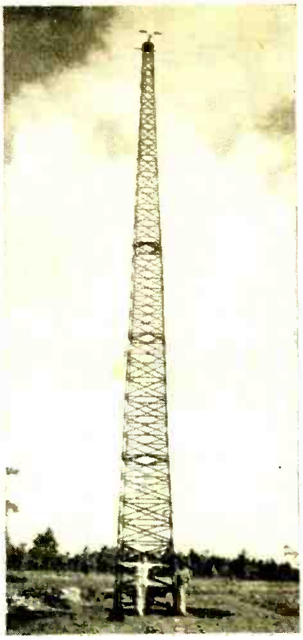


The W5FIY 20-meter installation shows how simply the rotating head can be mounted for rope rotation.

Field patterns of antennas taken nearby are not strictly representative of what happens at a distance, largely because the effective radiation leaves the transmitting site at an angle above the horizontal. The measured ground pattern for a nearby doublet appears sharper



Measured radiation pattern of the radiator and close-spaced director combination as compared to the pattern of the radiator used alone. The slightly "lop sided" shape is a result of a small amount of transmitter radiation. The actual gain as provided by the director when measured at a distant point is considerably greater than the nearby ground pattern plotted above. This is explained by the effect of the director on the vertical angle of radiation.



The 10-meter motor driven installation at W4DLH is mounted atop a 70-foot tower.

than when actually used in communication because of this fact. The flat-top family of beams, however, tends to cancel high angle radiation, and measured ground patterns are therefore more reliable.

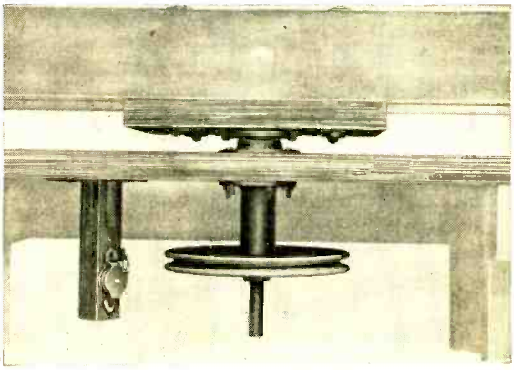
Radiation Pattern

Above we show the measured pattern for the antenna alone as it was rotated. It was slightly eccentric due in part, probably, to the off-center method of rotation. We also show the pattern for the antenna system when the director has been added. This particular pattern is the one referred to by Roberts as that resulting from the use of a director, though it does in this case show an irregularity to one side where it fails to drop to zero as would the theoretical pattern.

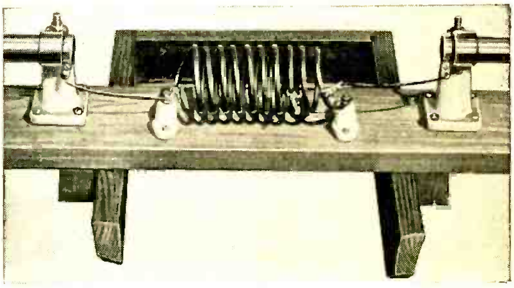
He points out that some adjustment of director—or reflector—length will alter the front-to-rear ratio. With these tubes the adjustment of length, if desired, can be made at the center of the parasitic element, lengthening or shortening it without actually sawing up the tubes, though normally the tubes are supplied the proper length for the center of the band.

Using this type of antenna, the radiation to the side and at very high vertical angles is sub-

[Continued on Page 81]



Section of rotating head with belt guard removed and cross beam on top.

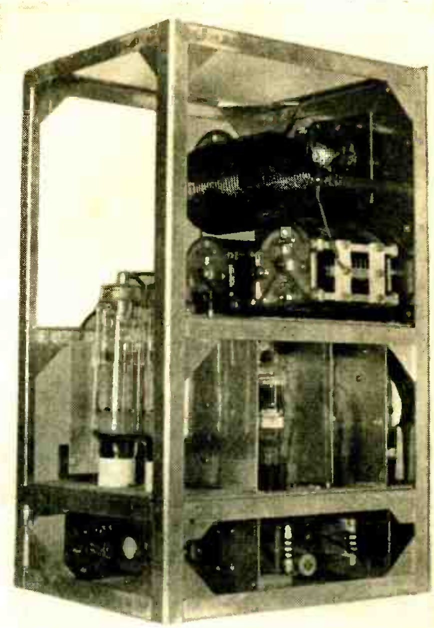


The driven radiator is split to allow insertion of an impedance matching transformer in order to match 72-ohm twisted cable to the 13-ohm (approximately) radiation resistance.

BAND-SWITCHING

Phone and C.w. with RK20's

By DEAN S. YOUNG,* W1MP, W3FZ



Rear-quarter view of the rig. One of the two RK20's shows, as well as the compartments for the 6A6 and RK25. The large coil and condensers are part of the output and antenna coupling.

One of the joys of amateur radio is the construction of the apparatus we "hams" are privileged to own and operate. With all-wave communications receivers advanced to the stage where a twist of the dial and the turning of a switch puts us on any desired frequency, we fully sympathize with the fellow who, while attempting a rapid QSY, gets his fingers across the "hot stuff" and lets out a lusty "damn!"

Most all of us, at one time or another, have seriously considered band-switching for the rig, but have given it up as being too expensive, too complicated, or just too much of a job to tackle.

Band-switching, simplicity in design, low cost of parts, multi-band operation, crystal control, c.w. or phone with either break-in or "push to talk", no neutralizing worries and rapid QSY are the main features of the rig herein described.

The tube line-up starts with a 6A6 crystal oscillator which feeds an RK25 buffer doubler stage; this in turn drives a pair of RK20's, (operating in parallel) to a full rated input of approximately two hundred watts on c.w. and around seventy-five watts on suppressor modulated phone.

A π network feeds the antenna directly from the tank circuit of the RK20's. With fair efficiency, a phone carrier power of twenty-five to thirty watts and a c.w. carrier power of between one hundred ten and one hundred twenty-five watts can be pumped into the sky wire.

The rig is compact, simple to operate, and all controls are on the front panel. But suppose we start from the beginning.

Construction of the Rack

Although other materials might be substituted in many places, the entire rack is constructed of aluminum for the definite purpose of isolating the input and output circuits of each stage. The rig is very well shielded for one very definite reason: An improperly shielded pentode can develop more "bugs" than Carter has pills.

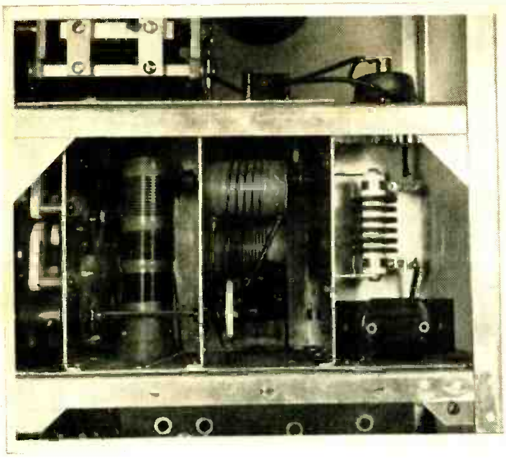
Aluminum rivets are used throughout. In using these rivets, it is always best to countersink the hole, then flatten out the rivet end. This makes a permanent job and allows the panels to mount flush against the case. Flathead screws can be used, but they will, and do, loosen up unless lock washers are used under the nut.

The four uprights must be mounted to the end and cross pieces by not less than two rivets or screws at each point where the frame is fastened together. Two-by-two triangular pieces of aluminum, three for each corner, greatly simplify the fastening of the frame. The cross pieces may also be mounted by use of these triangular braces.

Chassis and Shields

The base plate for the sockets, etc., should be laid off and drilled before the mounting is done. Care must be taken to insure that the frame is square and that the cross pieces are

*1924 N.W. 37th Street, Washington, D. C.



Side view. The 3-section coil is for the crystal oscillator tank. Next to it are the coils for the RK25 tank and the ganged switches.

parallel. If all is in order, mount the base plate.

The vertical shields should then be temporarily mounted and marked. It is a simple matter to drill the front panel. Lay out the second shield holes by centering them with the front panel hole, and then finish up the holes for the shafts that run from the rear. This applies to both top and bottom sections. After this drilling and aligning has been finished, the amplifier base plate should be drilled and mounted on the cross pieces and tops of the vertical shields. If everything fits properly, the base plates, panel and shields should be dismantled preparatory to mounting the parts.

Before going into further detail it is necessary to realize that a box 10″x12″x20″ is not very large. When you stop to think about all the parts, coils and tubes that must be mounted into this small space, it is readily understood why certain types of chokes and condensers (both fixed and variable) are specified.

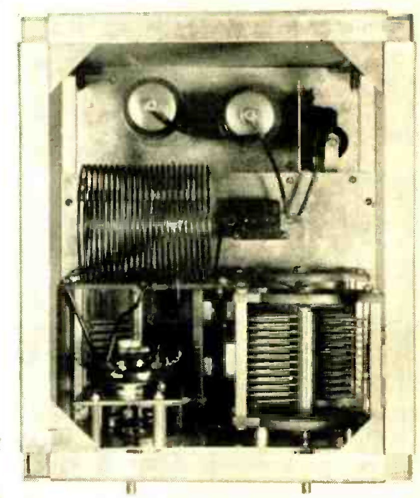
The Circuit

Another point that must not be overlooked is the fact that a pet version of standardized circuits may work, but perhaps not as well as those called for in this article. The electrical design is straightforward and simple to follow and there is no necessity of risking the many kinds of peculiar oscillations that pentodes can so easily produce.

It is standard construction procedure to start at the oscillator and work forward; so let's get started on the building of this rig. The crystal oscillator uses a 6A6 with the plates and grids tied in parallel. The crystal current is fairly low due to the r.f.c. directly across the crystal and use of cathode bias. The crystals are mounted behind the front panel and a single-pole eleven-throw isolantite switch selects the one for any desired frequency.

"Break-In" by Oscillator Keying

Keying is accomplished by opening the cathode of the oscillator tube. Of course, when the key is open there is no signal emitted by the transmitter, so, we have break-in. It is a good idea to use shielded "mike" cable for key leads, and to ground the shield (in the cable) to the frame of the transmitter. Somehow the neighbors will seem a great deal more friendly.



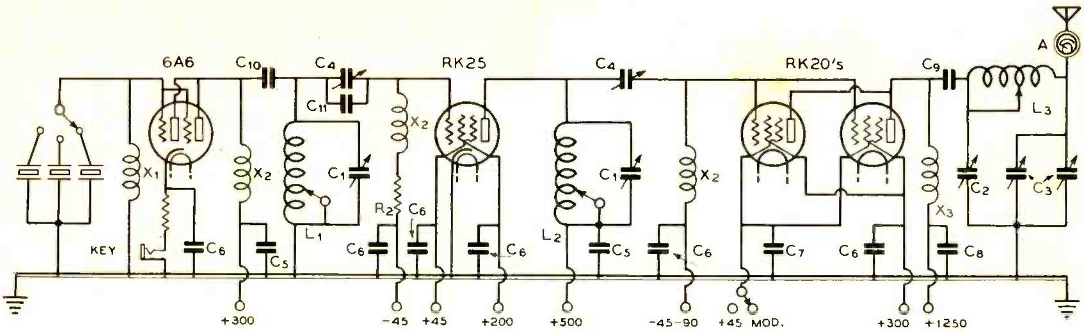
Top view of the rig. At the left lower corner is visible the band-switch for the final tank circuit.

The Oscillator

The oscillator coil form is of 1½-inch synthane tubing. It is mounted in a vertical position by a plug in the base which is drilled and tapped for a screw that comes up through the base plate.

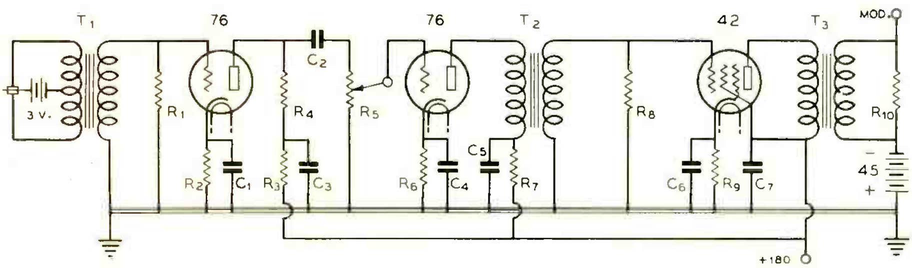
The coil is wound in three sections and with three sizes of wire. All windings are in the same direction and they are connected together in series. The connections between the coils are brought out to the tap switch.

The 7-Mc. coil (first section) is wound with 13 turns of no. 14 enamel wire and, when



R.F. SECTION

C_1—100 μμfd. midget condenser
C_2—100 μμfd midget condenser
C_3—225 μμfd. 3000-volt condenser
C_4—75 μμfd. midget condenser
C_5—.02 μfd. 1000-volt mica
C_6—.01 μfd. 1000-volt mica
C_7—.00015 μfd. 1000-volt mica
C_8—.01 μfd. 2500-volt mica
C_9—.002 μfd. 2500-volt mica
C_{10}—.005 μfd. 1000-volt mica
C_{11}—.00005 μfd. 1000-volt mica
R_1—Cathode resistor on 6A6. 600 ohms, 10 watts
R_2—10,000 ohms, 2 watts
X_1—2½ mh., 125 ma. r.f. choke
X_2—8 mh., 125 ma. r.f. choke
X_3—2½ mh., 500 ma. r.f. choke
Coils—See text
A—Antenna ammeter



MODULATOR SECTION

C_1—10 μfd. 25-volt electrolytic
C_2—0.1 μfd. 400-volt tubular
C_3—4 μfd. 450-volt electrolytic
C_4—10 μfd. 25-volt electrolytic
C_5—4 μfd. 450-volt electrolytic
C_6—10 μfd. 25-volt electrolytic
C_7—0.1 μfd. 400-volt tubular
R_1—100,000 ohms, 1 watt
R_2—2000 ohms, 1 watt
R_3—10,000 ohms, 1 watt
R_4—50,000 ohms, 1 watt
R_5—500,000-ohm potentiometer
R_6—2000 ohms, 1 watt
R_7—10,000 ohms, 1 watt
R_8—100,000 ohms, ½ watt
R_9—500 ohms, 3 watts
R_{10}—15,000 ohms, 3 watts
T_1—Mike-to-grid transformer
T_2—3:1 interstage transformer
T_3—1:1 output to suppressor grid transformer

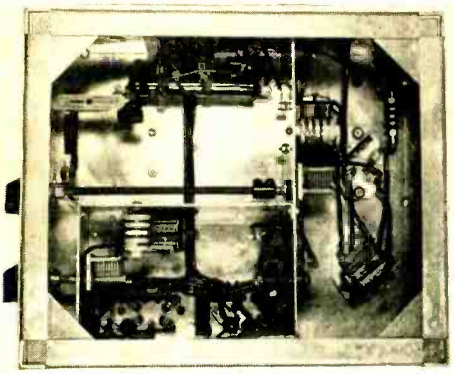
tuned with 50 μμfd., has a "Q" of 300. The second section is wound with 17 turns of no. 20 enamel and when used in series with the 7-Mc. coil it gives a resultant "Q" of 225 at 3.5 Mc. The third section is close wound with no. 28 enamel wire and with all three coils in series we have a "Q" of 175 at 1.8 Mc.

It is important that a good grade of synthane or isolantite be used if loss in the coil is to be kept at a minimum. Coil dope may be used, but be sure that it is low loss, and of best quality.

Now, if we had used no. 22 enamel wire spaced and tapped off for each frequency, we would have very poor "Q" and possibly our coils would heat up and cause us to have unstable operation. If larger wire were used, the coil could not be mounted in the small space allowed. As it is, we have space of at least one-half of the coil diameter between the coil and the shield.

The switch, being single-pole four-throw, shorts out any section of the coil that is not in use. The tuning condenser and switch mount directly on the front shield. All resistors, sockets, condensers and chokes mount below the base. By looking at the photograph it will be seen that the fixed condensers are stacked by running screws through the mounting holes and bolting them to the base. The plate r.f.c. is mounted with a 6-32 screw which runs through the sub-panel shield and screws into the hole in the choke form which was left open after the brackets were removed.

The buffer grid excitation condenser is insulated from and mounted to the front of the



The bottom of the rig. Shielding compartments aid greatly in stabilizing the performance.

sub-panel shield. Wiring should be direct and the leads should be made as short and direct as possible. The wire from the oscillator grid to the crystal switch should be run through over-sized spaghetti to minimize capacity to ground; this also applies to the wires running from the crystal switch to the various crystals. It would be advisable at this stage to test the oscillator on all bands to make sure that all coils resonate properly. It must be remembered that as the circuit is loaded, variations in tuning will be noticed. If the inductance of the coils is correct, each band should occupy approximately seventy-five degrees of the dial.

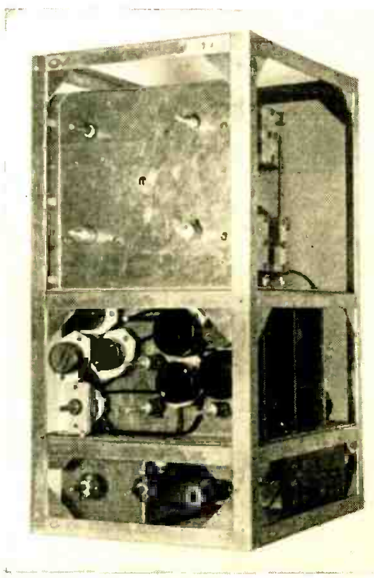
The Buffer

Having heard a lot about 6L6's, I decided to try one as a buffer. After four full evenings of tuning, changing components, and trying different arrangements, I discreetly accepted defeat.

Beam power tubes are without a doubt as fine a doubler tube as I have ever encountered, but as a capacity coupled single ended *buffer* amplifier, they are too critical in adjustment for a transmitter of this type.

A type RK25 was substituted; it proved satisfactory in every respect. An 802 would, of course, give identical results. Being shielded this stage requires no external neutralization. The circuit employs series feed to the plate of the tube, and a combination of battery and grid-leak bias. Positive voltage is applied to the suppressor at all times! The rotor of the tuning condenser, contrary to general practice when series feed is used, is connected to ground by mounting it directly upon the interstage shield partition. This gives the effect of having two condensers in series to tune the tank coil and simplifies mounting by eliminating the necessity of insulating the rotor from ground.

In some circuits where a pentode tube is biased by a grid leak alone, means of varying the grid excitation is not provided; a grid leak will bias a tube in direct proportion to the amount of excitation available. Since a combination of battery and grid-leak bias is used in our circuit, this rule holds true only to a certain extent. For that reason a variable condenser is connected in parallel with the fixed grid excitation capacitor. In this way constant input to the buffer grid can be maintained despite wide variations in the output of the oscillator. Coil switching in this stage can be done two ways, the simplest method being a duplicate of the system used in the crystal oscillator. If frequencies above 14 Mc. are to be used, individual coils for the higher frequency bands would give slightly higher efficiency.



The front view shows the placement of the crystals and operating controls. A front panel with knobs for the various controls is placed over the unit.

Both methods were tested, and with the exception of higher Q in the individual high frequency coils, little difference was noticed up to 14 Mc.

High voltage leads are doubly insulated by encasing them in spaghetti tubing and by passing them through rubber grommets at all points

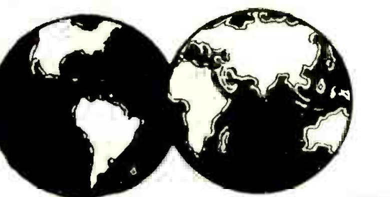
[Continued on Page 87]

—W6NJI

DEPARTMENTS

- **Dx**
- **Yarn of the Month**
- **Question Box**
- **Postscripts and Announcements**
- **56 Megacycles**
- **Open Forum**
- **Calls Heard**
- **New Books**

DX



HERB. BECKER, W6QD

Readers are invited to send monthly contributions for publication in these columns direct to Mr. Becker, 1117 West 45th Street, Los Angeles, Calif.

This is "open season" for the dx men. Open season, because this is the time of year that all the boys usually pop out with denials that they are going into the dx contest. Last year you will remember that all the fellows—or I should say most of them—came out with, "Oh, I might get on for a while, but I can't hope to run up any score."

However, this year the boys seem to have discarded all of these stories (they know that no one would believe 'em anyway) and are boldly stating, "Sure, I'm getting into the contest with both feet and am going to run up a new high score." In QSO's with many W hams they openly admit it . . . and that's the spirit they should have.

I don't believe conditions will be as good as last year, but that should make it just that much more fun. The 10 and 20 meter bands have really folded up during the past month or so, but according to past years and data on hand the first part of March should find things on the "up" again.

This next contest should not only help to add more countries to your totals but increase your zones, too. With all of these quick frequency and band change exciters and transmitters being brought out during the past year it is going to be pretty tough to follow a fellow around. With a flip of a switch some of these boys are going to be able to jump from one band to another without leaving the operating desk. As far as frequency changing is concerned, there are plenty of fellows who are using from four to twenty crystals, and with a lot of them being variable crystal units, it's going to be one grand hop, skip and jump.

While speaking of improvements in rigs, etc., I'd like to call your attention to the new final amplifier by W6CUH described in this issue of RADIO. This is sort of a radical departure from the average ham layout, and it really gives food for thought in future rebuilding. There is also another story which I think will be of interest to most of the dx men. It is about the new KY-21 keying tubes. They are grid-controlled rectifiers, and by looking over the article I think you will readily realize the possibilities of them. No more sticking relays as in primary keying. All the better to work the W9's . . . and speaking of the nines, I'll have to work 'em fast and furious after the crack W1JPE made about WAN (Worked All Nines). That one was OK but the one about his having to "push the mike aside to get at the key" is slightly exaggerated. Here is the true story:

When By was out here he noticed the "mike" on the corner of the desk. I told him that now we could put the rig on phone for him. He hemmed and hawed around for a while and finally broke down in the usual modest Goodman style: "No, you see, Herb, every time I get on phone all I can raise is y.l.'s."

"Well, what the deuce is wrong with that?" inquires Becker.

W1JPE replies, "Oh, shucks, I see enough y.l.'s back home."

Barbara please note; Hartford papers please copy.

The "Handle" for Phone Men

Now that we are awarding the "upholstered key" to a c.w. man each month, I think it fitting and proper that we award something to the phone men. So, with this in mind I believe the most appropriate thing to award would be a "handle". This is really brought about by the increasing number of phone men who start their QSO's by saying, "Well, the handle here is Elmer", or "OK on your handle, Oscar, the handle on this end is Yutch," and so on into the night. If we had a high-class wood carver on the staff we could turn out a real "handle", but we possess no such talent so will have to wait.

However, this month the "handle" goes to W6LYM, Norol Evans. Reason, during the past month he has given his "handle" more times than any other. At least a number of reports from all angles would indicate such. And to think he *used* to be a good c.w. man. Who'll get it next month? Watch out.

A Bit from England

G6QX has been giving 40 a whirl and has worked all W districts except the 5th, 6th, and 7th. Also VE2ZL, U9 and best of all, K6EO, which was the first K6-G QSO on 40 for both of them. Bob says that the W sigs were not as strong as he has heard them before, however. On 28 Mc. he hooked two

D3DAH ready for a spin.

good ones in K4EJC and FM8AD. Another one that sounds good to me is his contact with an LX in Luxembourg on 80. Bob says he was QSO G2ZQ and John said he hadn't been doing much lately. Peter, G2PL, is active on 40 around 0800 G.m.t. and has been knocking over some nice stuff. Jack Clarricoats, G6CL, was presented with an NC-101X at the annual general meeting of the RSGB, December 29th. Jack is very popular among the British hams. And now they will have to watch out or Jack will snag all the dx away from them. G6QX has just worked his 2222d W station and still needs Nevada, New Mexico and Mississippi. G6RB has been on 28 Mc. for the past few months and has done some swell work including ZE, VU, VK, PK, LU and a whole flock of W6's . . . but very rarely a W7. How come??? G6RB finds that he has cards for 38 zones, which is a very good percentage. Also says that he thinks VK5KO is the most consistent VK on ten, as he has heard him every Sunday since September and had QSO's on 8 week-ends.

Here's a word from o.m. Mayer, K4KD, in Porto Rico. Mayer says, "After putting my 35T on 40 I knocked off some east coasters in the evening and the next a.m. I fell out of the hay and guess who answered my CQ? No less than our ole friend W7AMX. Nice QSO as far as it went, but it didn't go far. When the "HI" stations (in Dominican Republic) got their fones warmed up on 40 it was all over. A QSO with D3DSR was finished the same way."

K4KD says he will be on 40 a great deal this winter and his frequencies are 7038 and 7140 kc. He finishes by adding that all the W7's must be Scotchmen as he has spent dollars trying to get a QSL from one of them but n.d.

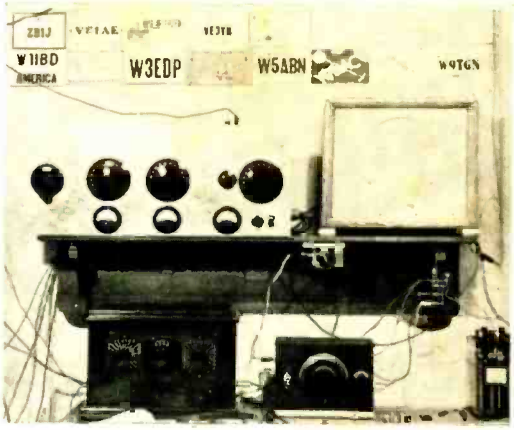
W8MPD is a new one to our list with 30 zones and 66 countries. W4EPT worked YI2RJ in Iraq, 14,351 kc. on Jan. 4th. 4EPT also kept a sked with VP1AA every a.m. and worked him with any kind of a rig from a T20 down to a 6F6. Frequency of VP1AA when on 40 is 7000 or 7400 kc. That's a good spot . . . 7400 kc. W2AAL kicks through with some info. . . . that FR8VX comes through best around 7 p.m. and in the mornings around 10 to 11 e.s.t. New stations for 2AAL are U9ML, ES5D, TF2C, J2JJ, K7FST, TF5C, JX5KS, OX2ZA. Now has 104 countries.

W8JSU is all for 40 meter dx. He has been hearing FP8PX, UT3AC, YS1FM, ZE1JI, PK1MF and VP2LA plus the usual Europeans, VK's, and South Americans. ON4AU and F8EO are two of the most consistent. W8JSU has never run over 50 watts to his T20 and only lacks Asia for his WAC . . . also he has heard 96 countries on 40.

Need Virgin Islands?

Pat Jessup, W2GVZ, comes through with the dope that K4AAN is on 7298 kc. quite frequently. The fact there are not very many K4's on makes it a hard place to work.

W6GCT informs me that a good new country for the fone boys is represented by ZS3F on 14,090 kc. W6MVQ adds three countries during the past month . . . SP1HH, LA7I, VO3X. W1AVB worked OQ5AE on c.w. OQ5AE was using his old rig powered with a gas engine. W1AVB is using an attic antenna with 200 watts into a 100TH and has hooked ZS, ZE, ZT, ZU, FQ8, FY8, and a flock of others . . . Oh, yes, TBA1 gave him his QTH as Paris, France.



The rig at D3DAH

W3EXB made a fast WAC for himself using only 60 watts. On 14 Mc. he worked VQ8AS, VU2FH, YV1AK, VK6KV, W5FYS and on 28 Mc. OK1FF. Time was 1 hour and 35 minutes.

VP3THE Headed Home

Those of you who have not worked VP3THE will probably not get an opportunity to contact him unless he changes his mind and goes back. January 12 or 13 was his last day on the air and he really crowded the contacts in on the last few days. Evidently they decided to leave a little previous to what they first expected and Bill Hungerford was good enough to jam in the QSO's thereby giving hundreds of fellows a country which they might not have received for some time.

W2IOP sold his rig on December 25th and is now building a new one with 100TH's in it. He says can't run more than a few hundred watts due to his a.c. house line of no. 14. Anyway, Larry says that 20 has been foul for the past month or so and he has been up on 40. Here is some of the stuff he has worked on 7 Mc.: G8CZ, G5DQ, G6VQ, VO4BA, EI8B, G5FA, ZL3FP, G8RL, K7CHB, CT1ET, G6XJ, F3JR, F3IB, G5XP, K6OPL, F8GS, ZL2BD, ZL2UV, VK4CW, VS4CS, FA8PW, OK1BC, I1EC, PA0GN, PA0UN, G6WY, G8HK, K6CGK, G8FF, G5IU, J2NA, D3CDM, G6YR, LU5BL, VP2LA, PY2CR, K6OVN. W2IOP says that OK1BC will soon be on 56 Mc. so there will be something for the 5-meter dxers. Larry sizes up the 40-meter time table something like this:

Times for 7 Mc. Dx in the Mornings

1:00 to 4:00 a.m. for Europeans
2:00 to 7:30 a.m. for VK, ZL, K6, K7, K4, etc.
12:30 to 8:00 a.m. for Central America
3:00 to 5:00 a.m. for Asia
12:00 to 8:00 a.m. for South America

W4MR is now using a pair of 100TH's on 10 and 20, and his antennas are "Q" types . . . three half waves. Alva claims these are darn good general coverage antennas but is going to put up some more directional type in the near future for the test. W4MR

MORE ADDITIONS FOR YOUR FREQUENCY LIST

K6OKH	3550	G5IU	7155	I7EY	14000
VP1AA	7000-7400	G6ZO	7155	G8MF	14080
ZS1AN	7015	D3CDK	7150	XS3F	14090 fone-cw
OK1CX	7020	OE6OK	7160	SP1HH	14145
ON4HC	7020	OK1XA	7170	ST6KR	14156
D4NXR	7015	U2NE	7170	LA7I	14260
HA8D	7015	K7AOE	7175	VS6AO	14300
G5YH	7020	D3CFH	7160	VR4AD	14310
K7GOM	7015	D4QET	7165	YI2RJ	14350
ZB1P	7030	OK1CX	7165	VO3X	14415
VP4AA	7030	SP1KM	7150	HH4AS	14415
LU5AN	7045	HA2L	7055		
HA8R	7055	CT1JU	7030		
SM6SO	7065	VP5PD	7040		
K7EWZ	7060	EA2U	7295	**28 Mc. Fone**	
G8PT	7075	K4AAN	7298		
VP6LN	7100	I1ER	7300	VP9R	28220
K7ERZ	7130			HI7G	28150
D4HCF	7125	**14 Mc.**		VP6YB	28230
G8PQ	7125			YV5AA	28300
I1EC	7145	VE5LD	13380	K4EZR	28600

worked CN1CR in Tangier on 14,415 kc.

For some time Keat Crockett, W9KG-W9ALV, has been doing most of his good dx on his W9ALV call in Weston, Mo. His W9KG outfit was at K.C. However, 9ALV has been turned in for cancellation so from this point forth all of Keat's work will naturally be done on W9KG, with the station address, Box 164, Weston, Mo. W9KG has been doing a good "spot" of dx lately including HRO who says he is ex-HR7WC and ex-HR1TC in Honduras, FI8AC, HS1BJ, VS6AG, CR7AW, OX2QY, PY1AZ, VP4CF in Trinidad, U9MN, OX2ZA, ZB2A in Gibraltar, ES5D, VP6FO in Barbados, and YL2CG. Keat says that 40 has some life to it too.

W3EMM says he is starting the year 1938 out right by bringing his zones up to date. On phone he has 28 and his total is 37 and by 1958 he expects to reach the 40th zone, hi. W1DKD has been on 7 Mc. and here are a few of the stations worked with his 808 running 200 watts: CT1QF, CT1RR, D4DYL, G8QC, GM6IZ, HA2L, I1TKM, PA0AZ, and OXYE (a ship QTH 19 deg. N. 49 deg. W.) For the fellows who want the mailing QRA of OXYE . . . "Wireless Operator, Amadesen Nordkap, Cobowring & Co., 17 Battery Place, New York City." W8KNP informs us that EA2U comes through on 7295 kc. and I1ER at 7300. Heard ZX4M on 14,400; he wonders if this is Sarawak.

Eric Trebilcock and the ZL-VK Contest

Here's BERS 195, Eric Trebilcock again. In the recent ZL-VK contest he heard 100 stations in 29 countries. Eric's standing now is 145 countries and 38 zones, and on phone 47 countries and 26 zones. A new record for his HAC was made on November 29th when he heard all six of 'em in 8 minutes . . . YV5AA, J2JJ, W2JHW, ZB1J, FB8AH, VK4QA. Recently, VK3EO and VK5UK dropped in to see Eric, who is now located away up in VK8, and they had a swell visit. VK3EO was on leave from the navy and 5UK is flying a transport plane across the VK wilds into VK8. Incidentally, out of the 145 countries BERS 195 has heard he has received 117 QSL's which is a good number.

G6GH recently hooked his first VK6 and FQ8 which brings his zones up to 37. New countries added are VP5, HH, CN1, VR4AD. G6GH was the first G contact for VR4AD. W8IQB sends in a bunch of 40-meter dx he has heard and worked; these will be found in the frequency list. W9UQT has been holding 38 zones in the bag and I guess he was afraid to spring 'em loose before, as he is a new one to this section. His countries are 97.

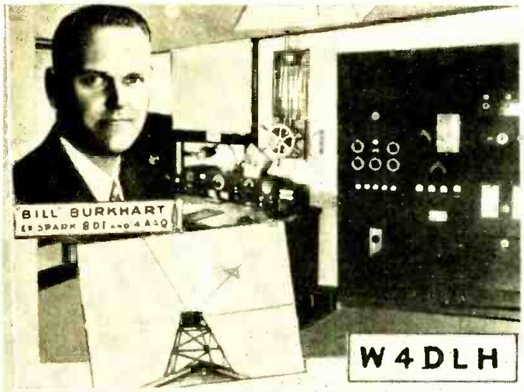
W6OCH, Larry Barton has added 2 zones and now totals 30 and 63 . . . all on phone, of course. Larry has just built himself a new home in San Leandro which is near Oakland, California. Needless to say, he picked out a good radio location. In about a month you can expect to hear OCH on plenty and with a brand new wallop, too, I assure you.

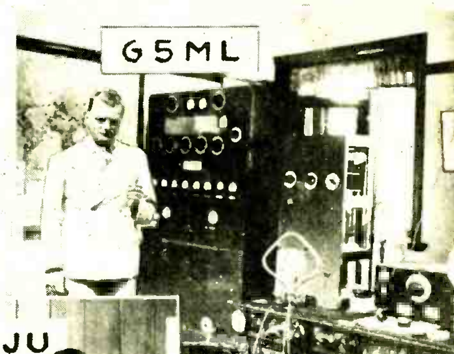
A Contest Tip—Stay in the Band

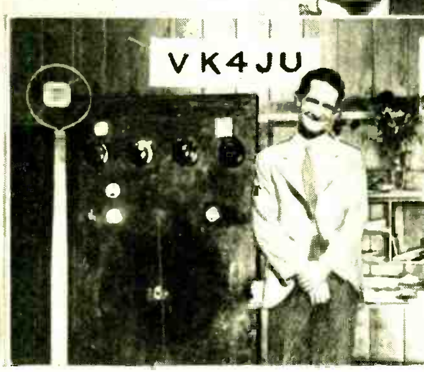
Don't forget, fellows, that in this coming dx contest if you contact a dx station who is out of the band you are disqualified as well as he. Naturally the same applies if you are out of the band. It will not pay to take a chance. Inasmuch as most of the W gang will be parked near the edges of the bands most of the time, a suggestion to encourage the foreign dx stations to get further into the band should be worthwhile. I would say that if most of the boys in other countries who are in the contest would get in at least 50 kc. from the edges, it would get them out from under 90 per cent of the heavy W QRM. It might be well to suggest this to various foreign stations before the contest. For example, on 14 Mc. if the gang in other countries would stay between 14,050 and 14,150 kc., and on the other end of 20 between 14,350 and 14,250 kc., I think it would do a great deal of good. It's pretty tough to know that there is some elusive dx station under that whole pile of W QRM around 14,396 kc. and that you can't do a thing about it. Another thing that would help would be to have all the USA fellows keep their frequencies between 14,250 to 14,275 and then from 14,350 to 14,400, allowing the intervening 75 kc. for strictly a dx band for the foreign boys. Of course, the W's won't stick to this; there will always be some guy who will plop right in the middle of the 75 kc. But still it would be a good idea. If this plan had the mutual backing of the gang, it would not only popularize the 25 kc. next to the phone band, but it would place a definite spot in

W. A. C. Round Table

Participants who made a new record on January 4, 1938, of W.A.C. on phone in 3 minutes and 20 seconds.







These are the same stations which made a record W.A.C. in January of last year, as described in RADIO at time.

which we could look for dx. The same thing would also apply to the low frequency side 14,150 to 14,125 and from 14,050 to 14,000 kc. It's something to think about.

K6CGK's Trip to Japan

A while back, K6CGK took a trip to Japan. He has been kind enough to write a nice letter with a a lot of information about the boys he visited while there—a lot of them old timers whom we'll remember. The following is from the letter of Katashi Nose, K6CGK:

"Every J station that I worked would invariably ask me when I was coming on a visit to Japan. So I finally packed my grip and sailed for the land of O'Sock Me.

"I went to the ship's 'shack' to send a message to J2MI, but found I was short of cash. Evidently the message got there, however, as when I arrived in Yokohama there were J2MI and J2LU with QSL cards pinned on them. A cab was hired and we sped through a sea of bicycles, all on the left side of the road. After a visit with them I said CUL and shot down to Osaka and the J3 district where I hunted for J3CR. An hour and a half was spent searching through the crooked streets and it left me none the wiser as to the location of his shack. Just as I turned around to go back, lo and behold, there was a huge sign "J3CR" tacked on the gate . . . . plain as daylight, and I had been past there just before. J3CR wasn't home but his yf said that Kyozo was busy 'putting together battleships at the docks and didn't have much time to pound brass.'

"Another search brought out J3FJ and his hidden transmitter which was under lock and key from the RI. He uses a pair of Telefunken equivalents of

"WAZ" HONOR ROLL

Station	Zones	Countries
G2ZQ	40	136
ON4AU	40	
W8CRA	39	135
W6CXW	39	132
W6ADP	39	127
W6GRL	39	119
W6HX	39	111
ON4FE	39	110
W6FZY	39	101
G6VP	39	
W8BTI	39	
W7BB	39	
W3SI	39	
W3ANH	39	
G6WY	39	
W4DHZ	39	
W6CUH	39	128
W8OSL	39	113
W8BKP	38	132
W1BUX	38	120
G5BJ	38	120
W8DFH	38	119
W1CC	38	108
W2GW	38	104
W2GTZ	38	115
W9ALV	38	102
W6AM	38	101
W8LEC	38	100
W2AAL	38	104
W9UQT	38	97
W5BB	38	91
VE4RO	38	85
W9VDQ	38	79
W2GT	38	95
XE1BT	38	69
G6RB	38	
W9TJ	38	
G5YH	38	
W8HWE	38	
W8ZY	37	114
W1ZB	37	124
G2LB	37	111
W6KIP	37	118
W6QD	37	111
W8DWV	37	109
W7AMX	37	115
W6GAL	37	106
W9PTC	37	103
W8KPB	37	100
W6LYM	37	100
W6FZL	37	99
W9AJA	37	99
ZL2CI	37	97
W8OQF	37	97
W2HHF	37	95
W7BYW	37	93
W8AU	37	92
W9KG	37	91
W3EXB	37	90
G6GH	37	89
W6GCB	37	81
W2BSR	37	
W2GWE	37	
G6NJ	37	
W2DTB	37	
W3EMM	37	
LY1J	37	
W4AH	37	
W6VB	37	
W2GVZ	36	103
W9AFN	36	105
ON4EY	36	97
W5VV	36	96
ZL1HY	36	95
W6BAM	36	97
W9KA	36	92
W6KWA	36	90
W6FZL	36	95
G2UX	36	83
W4AJX	36	
W8KKG	36	
W9ARL	36	
W3EDP	36	
W2OA	36	
W6KBD	36	
VK3EO	36	101
U1AD	36	
W9CWW	36	71
W2BJ	35	105
W8CJJ	35	98
W3EVW	35	97
W2BXA	35	98
W1AQT	35	96
W9EF	35	94
ON4FQ	35	92
ON4FT	35	92
W1GDY	35	89
W3AYS	35	85
W6FKZ	35	83
W6ITH	35	78
G6QX	35	75
W6DOB	35	95
W9UBB	35	71
K6AKP	35	63
W6NHC	35	
W6GRX	35	
W2AIW	35	
W3BBB	35	
W2IOP	35	
W9PK	34	
W8AAT	34	
W6TI	34	
W8CNZ	34	
W8BSF	34	94
W3EVT	34	90
LU7AZ	34	89
VE2EE	34	87
ON4SS	34	80
W3GAU	34	86
W6HEW	34	86
W8EUY	34	84
W6GHU	34	83
W6LHN	34	71
W8JK	34	
W3EGO	34	
W2FAR	34	
W1RY	33	92
W9LQ	33	84
W3TR	33	80
G2IO	33	76
W7AYO	33	73
W6LCF	33	71
VE4LX	33	69
OK2HX	33	66
W8LDR	33	
K6JPD	33	
W6LDJ	33	
W9LBB	33	
W5AFX	33	
ON4TA	33	
G6CL	33	
VK2VQ	32	99
ON4VU	32	86
W6JBO	32	81
W9FLH	32	80
ON4NC	32	79
W3CIC	32	75
W6AX	32	74
W3GAP	32	70
W6JMR	32	70
W6KZL	32	67
W9DEI	32	66
W6KRM	32	62
W6MHH	32	62
W6DIO	32	
W8HYC	32	
W8BTK	32	
W5EHM	32	
OK1AW	31	86
W8HGA	31	83
W9LW	31	82
W6LEE	31	57
W6IES	31	57
K6CGK	31	54
W3DCG	31	
W5CUJ	31	
W6HXU	31	
I1TKM	31	
W4MR	31	92
W5KC	30	81
W4DCZ	30	80
W6DRE	30	78
W3UVA	30	76
W6GNZ	30	73
W2WC	30	72
W6CEM	30	69
W4DTR	30	68
W8MPD	30	66
W9PGS	30	63
W6KEV	30	58
W8PHD	30	57
W6LCA	30	46
W6JJA	30	
W8MAH	30	
W7AVL	30	
W8DED	30	
W9IWE	30	
W1APU	30	
W3RT	30	

PHONE

Station	Zones	Countries
W6ITH	33	57
W6LLQ	31	68
W6AM	31	
W4AH	31	
W6OCH	30	63
W4DSY	30	
W6NNR	29	58
W6MLG	29	55
W3EMM	28	
W9ARA	27	53
W3FAM	27	55
W9BBU	27	45
W2HUQ	27	
W5DBD	27	
W9NLP	26	48
VE2EE	26	53
W6BGH	26	
W9TIZ	25	36
VK2ABG	25	
W3SI	25	
W1BLO	24	50
W2IUV	24	41
W6FTU	24	35
W8JK	24	
W9NLP	24	
VE5OT	24	
W9QI	24	
W6AAR	23	
W2IXY	23	63
W7AO	22	
XE1BT	22	
W2HCE	21	51
W6MVK	21	22
W6GCT	21	30
W7ALZ	21	25
YV5AK	20	45
W5ASG	20	38
W8QDU	20	33
W1COJ	20	
W6GRX	20	

If you have worked 30 or more zones and are ready to produce confirmation on demand, send in your score of zones and official countries on a post-card.

Phone stations need work but 20 zones, but stations must be raised on phone. Stations worked may be either c.w. or phone.

Revision and additions to the honor roll will be made every other month.

203A's, with '20 watts' input. J3CT was looked up, only to find that he had given up hamming to squint at meters at the local power company. His poor wife chased halfway across Osaka trying to find an American dish for me, only to find out later that I could have gotten by alright on 'rice and tea,' hi. J2CC and J2DA were also in Osaka and going to school.

"A trip north to Tokyo and J2 was enjoyed as I attended the JARL meeting where everybody from J2GW to J2NS was there. I was induced to make some sort of a speech, and at the conclusion I was asked whether it was in English or Japanese. Hi. J2GX, exJ1DO, was there, and Taroh said that he is operating a commercial station and much preferred it to ham operating. J2GW made a standing invitation to visit his shack. Miss Chiyono Sugita Suzuki, J2IX, ex-J1DN, decided that two could live as cheaply as one, so was married some time ago. J2HI, ex-J1EE, came into town the first time in months, to attend this meeting, and said he was about ready to come back on the air. I met and shook hands with the J2's present who were NG, NS, NA, LC, IA, IS, LU, MB, HZ, KS, ME, NR and W6NGO, also on a visit.

"I took advantage of the hospitality of J2MI and made his shack my headquarters. The phone rig at

[Continued on Page 92]

YARN *of the* MONTH

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HAYWIRE AND HOW

Didja ever have a yen to build a kilowatt? Didja ever fall for one of these here now smooth how-to-build-it articles adorned with pictures of a fancy-looking rack and panel? What they don't tell ya is that it is the equivalent of a term in the workhouse, three to six months at hard labor.

First of all, I look on ham radio as a communication hobby. Darned if I expect to be a carpenter, mechanic, painter, electrician, steeplejack, and ditchdigger as well. I want to be on the air, first, last and all the time, and I bitterly begrudge the time, effort and grief essential to building a high-power panel job. It is only when the itch for more power or the latest circuit overcomes an inherent aversion for work that I break down and start buying up Vesey Street. (Ever carry a 40-pound transformer half a mile in minus zero wx?)

Now I have conscientious scruples against such things as sawing in a straight line, using a template, right angle corners, straight leads, etc.; in short, anything conducive to a neat appearance. Fortunately, I am cursed with a Station Engineer (profuse apologies to all engineers) who worships the great gods of Neatness and Symmetry. I am an utter pagan who would just as soon (and prefers) to mount every possible hunk of junk at least a half inch off center or out of line.

Now about that kilowatt job. It was a tossup as to who suffered most: me, under the domination of the Station Engineer* who demanded strict conformance to appearance and efficiency; or the S. E. himself, who frequently verged on mental unbalance as a result of my tendency towards haywire. We built this Frankenstein in his garage and mebbe that wasn't a smart idea. Yeah, considering the time I dropped the blow torch and spread burning alcohol over his wooden floor and the other time when I drilled 27 holes through one of the shelves and on through his floor as well, I guess that was a wise idea. Incidentally, you wouldn't think that I could burn up part of the wooden rack before it was even finished, but I did that with my lil blowtorch on a stubborn copper tubing joint.

The time I really gave him high blood pressure was when I drilled a hole through my nice shiny panel and mounted a Bradleyohm about five inches out of line with the meters and dials. He had to threaten me with a hammer to force me to put in concealed wiring and once I unwillingly did a neat wiring job under the coercion of a hot soldering iron at my neck. (He often looked at me like I was some sort of worm and kept muttering something about "Rube Goldberg contraptions.")

He has had faults, though. One of 'em was disintegrating insulators. I'll bet he used 117 standoffs. One out of every five did not crunch. He had a mania for that last extra twist that spells CRACK and a high mortality rate. Then, too, he helped me wind the copper tubing tank coil around the clothespole; you know, the one that we had to saw off the top to get the coil off of. Then, too, neon tubes don't have enough glue on 'em. Whenever he comes into the shack, I jot down a note to buy two more, before he even touches 'em. One day I hid 'em and so he maintained his perfect record by dropping my Trimm fones instead.

His greatest exploit was the time the buffer tank coil wound on celluloid exploded and shot flames two feet high up through the rig. Me, I jumped for the extinguisher, but him, he just blew it out. He literally blew out ten square inches of blazing celluloid—and dislodged a condenser as well.

Well, after building the rig twice, once when I mounted each piece and once when he took it off and put it on straight, we tried to make it work. However, the stupid morons who write handbooks only put in three pages or so on trouble shooting. (You can't shoot trouble;

*W2CMY.

By J. P. Jessup, W2GVZ

ya gotta sneak up on it and smother it with kindness.) Wot we need is a 500-page supplement entitled, "Dumb Mistakes Ya Probably Made".

Nothing I ever built ever worked the first time—or the second. (Sometimes not the fifth.) I only leave out one wire in a hundred, which is a swell average, but not good enough. Once I wired both leads to the same condenser plate. The S. E. had a fainting spell the time I wired two power transformers in series by mistake. Once I found him holding his head in his hands and absolutely incoherent. At my approach, he waved a heavy wrench. Just a blob of solder in the variable condenser. Also, transposing the grids in a pentode is commonplace with me. Why doesn't somebody re-name those dern elements?

Well, anyway, it finally worked and since then we went through the agony twice again. (Three rigs is easier than band-switching.) When we tested out the second rig, it was cuckoo altogether. Now it works—now it doesn't—there she perks—naw she ain't, etc., with clocklike precision at three-second intervals. After ten hours of diddling, the S. E. suddenly screams and, for no reason at all, knocks me cold. When I came to, I found a note which said, "You blithering lid, where did you get that blinker socket you are using as the main input socket?"

Just in passing, order an extra portion of boiling oil for the author of the antenna article who blithely and casually says, "Sink the butt of the pole 5 to 6 feet in the ground." Last summer I put up an un-guyed 40-foot vertical and as I lay face down on the ground holding on to the end of a 4-foot shovel and trying to chisel out another inch beyond the four feet, I prayed fervently that sometime, somewhere, someday, I would meet that guy in a nice dark alley.

Well, come September, I started the fall rebuilding on all three rigs (completed on New Year's day). Among many things, I wanted xtal keying and, being smitten by the appeal of the tin bottles, that meant new oscillator stages. The first one was a dud. So I ripped her out and built up an 802 oscillator. ND. So I went back to the original 47 and 841 as before, only to find out then that the connection on the bias bleeder of the next tube was loose and that the next tube had been completely cut off all that time. Got tin bottle perking two hours after end of SS contest.

The second rig worked first crack. Suspiciously, I started using it and, sure enuf, a carbon plate bottle soon got white hot. The tank coil (a boughten job) had come unsoldered.

The third rig was treated to a new RK-20 driver stage, as well as the iron xtal kicker. I'm telling you, in my more or less misguided 16 years in this craziest of all pastimes, I never saw the beat of it. The first dash gave 10 mils excitation on the RK-20. The next dash gave 3 mils. The next five bangs on the brass gave 15 mils, and, believe it or not, on the next dash, the meter went off scale backwards. Right then and there I debated long and earnestly whether to (1) Use an axe, (2) Appeal to the F. C. C. or (3) Become a missionary.

The test set reported everything OK. And so it was, if I didn't look at that dizzy meter. Here is wot I had done. After carefully insulating the excitation lead right up to the socket, I had jammed the chimney tube shield down hard on the lead and bolted it fast. As I was saying, I hate to do construction work, because I always pull something new and dumber than before. I solemnly swear on a stack of handbooks not to change another wire—anyway not until next Tuesday.

Question Box

The grid current on my final amplifier has been behaving erratically of late, and in the course of hunting the difficulty the subject of how the grid current SHOULD *behave has come up. Should the current go up or down when the plate voltage is applied to an amplifier, and should it go up or down when the amplifier is modulated for phone work?*

The grid current on a properly-neutralized, properly-excited and properly-loaded amplifier should go down from 20 to 35% when the plate voltage is applied. Any serious deviation from this means that there is something at fault or out of adjustment in the stage. If the current goes *down* more than this, it would indicate that the amplifier is under-excited, too heavily loaded, or degenerative. If the current goes *up* when the plate voltage is applied, this is almost always a sign of regeneration or lack of neutralization.

The average grid current on a plate-modulated class-C amplifier should remain substantially constant under modulation. If it moves more than a small per cent (and you are sure the stage is not being over-modulated), this is also one of the conditions mentioned in the paragraph above, or it may be an indication of a weak tube, an overloaded modulator stage, or a too-heavily by-passed grid return.

POSTSCRIPTS...

and Announcements

Assistant Wanted

It is expected that there will soon be open a position as an editorial assistant on RADIO'S staff. Applications will be carefully considered from those meeting the qualifications below.

Applicant should be able to show a "bent" toward editorial or writing work and have a bit of experience along that line; it is not necessary that such experience be professional, nor is it necessary that your previous writings be on radio topics. If possible, submit samples. Experience on a school or college publication will count.

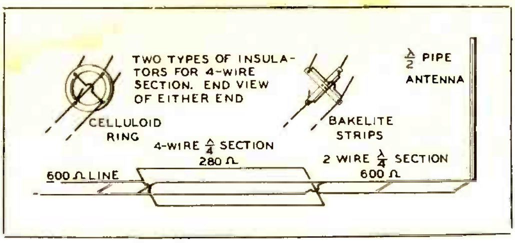
Applicant should be a radio amateur with sufficient personal experience in construction of amateur equipment to be familiar with "standard" transmitters, receivers, etc., together with approximate constants, considerations affecting layout, and like items.

Applications from a considerable distance will be considered only if supported by unusually strong evidence of the applicant's qualifications for the work, as we do not wish to ask anyone to travel far on a mere chance that he may prove acceptable.

Salary for the first three months will be about minimum required for living in this vicinity; for that reason, preference will be given to a single man, all other things being equal. Salary thereafter will depend entirely on your adaptation to our requirements.

Applicants whose applications appear most promising will be asked to submit an article or two for possible publication and as a sample of their work. These, if accepted for publication, will be paid for at our regular rates. A manuscript or two may be sent applicants to see how they would revise it for publication.

Applicant should have a fair degree of proficiency at the typewriter, though no great speed is required. Applicant's English should be good but not fancy, and reasonably accurate use of punctuation will be necessary.



RADIO'S Vertical Antenna

In the description of the method of feed for the vertical antenna as used at RADIO'S lab., which began on page 40 on the Jan. RADIO, mention was made of the various sections of line used to give the impedance transformations.

Evidently many of the amateurs that were interested in this feed system were somewhat baffled by the use of the two cascaded line sections. In response to requests for a diagram illustrating the actual connection of this feed arrangement, we are showing one above.

The diagram is self-explanatory as to construction, although a reference to the previously mentioned article in the January issue will clear any doubts as to the method of operation of the system.

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HIES

Tch, tch, is our face red. Our radioddity in the December issue stating that there was no English word that used all the dot letters exclusively really brought an avalanche of corrections.

To quote from just one of the many letters and cards, this one from W5EOW:

"I think you are passing up the verb 'hies', the present perfect of the infinitive 'to hie' meaning to hasten or to move. This form has been used by no less an authority than Shakespere in his Macbeth, 'And hies her to her cave in darkness.' "

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HANDBOOK Error

It has been called to our attention that there appears an error in the circuit diagram, figure 24, at the bottom of page 330 in the new 1938 RADIO HANDBOOK. The circuit shows a class B modulator using a pair of 35T's. In the diagram the grid and the plates of the tubes are reversed. What are shown as the plates should be the two grids and vice versa. The modulator would undoubtedly operate much more efficiently with the input going to the grids and the output being taken from the plate circuit.

56 Mc. . . .

Dx Tests in Progress

By* E. H. CONKLIN

As this reaches you, the five-meter international dx tests mentioned in the January issue will be in progress. We have received a number of letters from various stations promising participation, and have written to quite a few dx stations urging them to participate. Details of the test were published last month but are reviewed here in case you missed them:

The tests will continue through February 27, being mainly on Saturdays and Sundays. We have asked everyone to concentrate on the hour of 10:00 to 11:00 a.m. Eastern time for Europe and Africa, and at 4:00 p.m. your local time for South America and Oceania. U.S.A. stations listen during the first fifteen minutes, transmit during the second fifteen, etc. The hours of the tests should be extended if possible.

Newfoundland Stations on 56 Mc.

Some Newfoundland stations are just about within the maximum single skip distance from points in Great Britain, and may have a better chance of working across the Atlantic than U.S. stations. Clarence Mitchell, VO1W, district representative of VO1, will stir up interest in five-meter dx, and promises at least one transmitter and two receivers active during the dx tests. These stations will probably split the schedule so as to work U.S. or other dx stations, whichever are heard.

OK1AA On Regularly

We have received a card from Al. Weirauch, OK1AW, giving the transmission schedules of OK1AA in Czechoslovakia. A 50-watt crystal-controlled transmitter is used on 56.0 Mc. Transmission is on phone and i.c.w. Thursdays from 16:30 to 18:00 G.m.t.; on c.w. Saturdays between 14:00 and 16:00; and on Sundays, phone from 13:00 to 14:00, but c.w. only between 14:00 and 17:00.

Milwaukee Stations Active

W9SO and W9OUB, who room together in Milwaukee, are using a bilateral folded Bruce array, with eight quarter-wave elements, beamed north-south. Input is 75 watts to a pair of 809's in the final of the long-lines m.o.p.a. rig. This transmitter will be automatically keyed during the January and February dx tests.

W9SLF puts 100 watts into a pair of T-20's. He uses a half-wavelength antenna now but is working on a directional job. His crystal multiplies to 57.3 Mc.

At W9ANA, about 200 watts are fed to a pair of 50T's with provision for increasing the input during the January and February tests. He uses an eight-element unidirectional array, now pointed south. He promises to average two hours of activity daily. He feeds his final 500-cycle energy, through a homemade automatic keying device. His frequency is 56.936 Mc.

We also hear that W9NY is active, using a pair of 801's on 56.012, manually keyed c.w., feeding a phased pair of vertical half-wave elements.

Ionosphere Data

Conditions fell off somewhat during the middle of December after very high frequency F_2 layer reflections were recorded by the National Bureau of Standards in November. By December 22, however, conditions were back to levels where 56-Mc. dx signals had a real chance of getting some place. Here are the critical frequencies and layer virtual heights, both in kilometers, for the Wednesday noons in December, as provided by the Bureau:

Dec.	Normal Incidence Critical Frequency E layer	Normal Incidence Critical Frequency F_2 layer	Virtual Heights E layer	Virtual Heights F_2 layer
1	3160	14,700	120	240
8	3150	12,300	130	240
15	3320	12,200	120	230
22	3350	14,100	120	240
29	3320	11,800	120	230

No Sporadic-E Layer

Last month we reported several items of five-meter dx. One of these was the reception of a W1 call in Cincinnati. The W1 reported had not been on the air. Checking with ionosphere records, the National Bureau of Standards reports as follows:

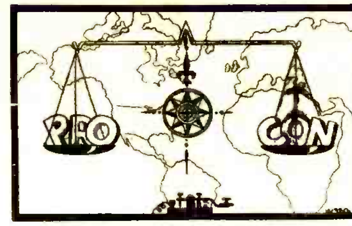
"On none of these days were sporadic-E reflections observed at Washington which would account for the transmissions. The F_2 layer critical frequencies have not been high

[*Continued on Page 83*]

*Associate Editor, RADIO.

The . . .

OPEN FORUM



Philadelphia, Pa.

Sirs:

All this business of changing the power limitation to 5 kw. so the boys with dough can put on more "umph" and work more stuff is a lotta hooey. Fooey.

And all this talk of restricting hams to 100 watts or so in order to give everyone an "even break" regardless of finances and to keep a few QRO stations from QRMing the band so nobody else can work anything is also uncalled for.

The first is okay if you have the necessary mazuma to put on the 5 kw. The second is f.b. if you can't spare the necessary rocks to go QRO. But neither is going to make everybody happy. Neither is the answer to the problem. What is the answer? Here it is right here.

All we need to do is to observe the following self-imposed restrictions in regards to use of frequencies. No splitting up the bands, relegating the foreigners to a "dx" portion, just common sense use of the proper frequency for the distance to be worked. No cluttering up the dx bands with cross-town 500-watt ragchews on 20 meters. No needless calling of stations 2500 miles away on 160 meters, messing up the band with a kilowatt when there is only one chance in 100 of raising the fellow. Eliminate all this superfluous QRM and the low power boys wouldn't have to holler for power restrictions to reduce the QRM; the high power boys wouldn't have to beller for still more power in order to blast their sigs through.

Here is the system in a nutshell. It would be to our mutual advantage to abide by it, but there are always enough heretics and non-conformists to gum up such a plan when it is not made mandatory. But heaven forbid any government regulations in this direction, even if for the general good. Better that it be a self-imposed plan; perhaps by blacklisting the chiselers we could make it stick. Sanction by the A.R.R.L. would probably be a big help in putting the thing over.

It goes like this:

Air Line Distance	Day	Night
	PHONE	
0-25 Miles	56 Mc.	56 Mc.
25-250	4.0	1.7
Over 250	14 & 28	4 & 14
	C. W.	
0-25	1.7	1.7
25-250	3.5 & 7	1.7 & 3.5
Over 250	7 & 14 & 28	3.5 & 7 & 14

"WALLY" WALLACE.

●

La Seyne, France

Sirs:

Stations in phone should repeat often the code word when they call dx stations, because when you don't understand well the english, it is very difficult to answer when he have not take the call well.

ROGER MENC, F8SI

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Southington, Conn.

Sirs:

Why is it a lot of the fellows every now and then will ask for more restrictions? Quite often you hear a request for a certain frequency for light power, one for low power, one for dx, and so on *ad infinitum*.

To me it indicates two things, both of which are harmful to ham radio, as it is now understood. First, it indicates something savoring of weakness, lack of ingenuity, a "looking to mamma to help baby" etc. Amateur radio men are supposed to work out their own problems. They have done so in the past; they'll continue to do so in the future. But there seems to be an increasing number of the "spoon-fed" variety who cry for help as soon as someone QRM's them or something else happens.

[*Continued on Page 94*]

Numeral suffix indicates "R" strength. Send Calls Heard to Calls Heard Editor, not to Los Angeles.*

Eric W. Trebilcock, BERS-195, Telegraph Office, Darwin, North Australia.
Oct. 1937

(7 Mc.)

W—5FCV; 6AWY; 6JHC; 6KHU; 6LNS 60EJ; 7DC; 9DIR; 9JX8; AU1AU; CR7AC; CR7AU; CR7RC; D3BMP; J2CH; J2MI; J2OV; J7CJ; J8CF; J8CG; J8CH; K6JFV; K6MOJ; K6ONF; K6OVN;K 6PEJ; K6OXT; K6OWQ. — **KA** 1AX; 1CM; 1HR; 1PK; 1SL; 1TS; 6PX; 9NP; 9WB; 9WX; PK1BL; PK6PA; SM5VQ; VR1AM; VU7FY; XU7CK; XU8DO; XU8VW; XU8WT; XU9KA; XL1BR; ZL1JF; ZL3BJ; ZL3GU; ZL3ID; ZL3JD; ZL4FW. — **ZS** 1BA; 1BD; 1L; 2E; 2G; 2X; 4A; 4Q; 5AG; 5AN; 5AQ; 6AM; 6BB; 6BC. — **ZU** 1Z; 2M; 5AC; 5AQ; 6AM; 6AR; 6P; 6U; ZT1A; ZT2Q; ZT2U; ZT5F.

(14 Mc.)

During VK/ZL 1937 Contest

W—1JLT; 1LZ; 2GTZ; 3GKM; 4CBY; 4CDE; 4DCZ; 4DOC; 5CVW; 5FMV; 5QL; 5JC; 5VV; 6BAZ; 6CXW; 6DRE; 6FZL; 6GCX; 6MVK; 6MVQ; 6NKY; 6QD; 7DVY; 8ANB; 8BTI; 8CUO; 8DFH; 8NJP; 8OE; 8QQE; 8ZY; 9AEH; 9ARL; 9DIR; 9FS; 9TB; 9TSV; 9VLQ; 9VWL; 9WTW. D4NRF; D4SNP; FI8AC; HA8C; HS1BJ; G?MA; G5VU; G6XL; G6WY; GM6NX; J2MI; J2NF; J8CD; K5AG; K6BNR; K6GQF; K6JPD; K6OJG; K6SO; KA1CS; KA1DL; KA1FM; KA1SL; KA1SP; KA7EC; LU1CA; LU5AN; NY1AE; OA4J; ON4SS; PA0AZ; PA0UN; PK1BX; PK1RL; PK1MF; VE4RO; VQ3FAR; VQ8AF; VQ8AS; VR4OC; VS2AE; VS6AG; VS7MB; VU7FY; XE1AA; XE1AM; XU6SW; XU8CZ; XU8HM; XU8TT; XU8VC; ZE1JI; ZS2X; ZS5U; ZU6C.

(14 Mc. phone)
Oct. 1937

CE1AC; K6BNR; KZYL; KA1BH; KA1HS; KA1LY; PK1GL; PK3WI; VS2AK; VU2BG; ZZ2DY; ZE1JR.

(14 Mc.)

W—1AXA; 1CAB; 1CH; 1DUJ; 1DUK; 1GBO; 1HVO; 1HWB; 1HXW; 1JZI; 1KIV; 1LZ; 2AAL; 2CMY; 2DPA; 2DTB; 2EWD; 2GSA; 2GVR; 2JOZ; 2JVU; 2JZF; 2KGY; 2KHI; 2KAH; 3FQP; 3FWY; 3FYB; 3NF; 3PW; 4CBY; 4EAK; 8BTI; 8CUO; 8DFH; 8FCV; 8MCY; 8MTY; 8NLD; 8OE; 8OFO; 8OQF; 8QDU; 8ZY 9UQT. CR7AJ; CR7AU; CR7AW; D3BMP; F8EO; FB8AB; FI8AC; FM8AD; F58VX; G2NN; G2XN; G2YL; G6DL; G6RH; G8AW; G8FZ; G8IP; GM2JF; HO2U; HS1BJ; J2CN; J2JJ; J2KO; J2ICD; K4RJ; K4EMG; K6CGK; K6OJG; KA1CS; KA1SL; KA7EC; LU1CA; LX1AS; OA4J; OE7JH; ON4GW; PA0AZ; PK3WI; VE3FB; VE3QH; VQ4KTC; VQ8AS; VS6AZ; VS7JW; VU2AE; VU2DR; XU3XN; XU8HM; XU8RL; XU8VC; YI2BA; ZE1JG; ZE1JI; ZE1JZ; ZL1FT; ZL1HY; ZL2GN; ZL2IW; ZLKY; ZL4DQ; ZSL1Z; ZS2P; ZS7W; ZT2Z; ZU2J; ZU5AG; ZU6AC; ZU6AF; ZU6V.

●

A. W. Hingle, W2AAL, 625 Ramapo Avenue, Pompton Lakes, N. J.
Oct., 1937

(14 Mc.)

CT1PX; D3CRF; F3LG; F8AT; **G**—2NN; 2XW; 5AN; 5CM; 5HZ; 5LP; 6GN; 6Q ; 8IP; 8NY; 8PC; 8TC. GM5WT; GM8AT; GM8FT; HB9AY; HH4AS; HR5AK; J8CF; K7KD; KA1AX; LU3EV; ON4HF; ON4PV; U6ST; UK3AA; VE5SW; VK3RB; VK2TC; VK3PH; VK4JU; VK4JX; VK6MW; VU2FH; YV2CU; ZS1B; ZS2P; ZS4E; ZS5T; ZU5AQ; ZU6E.

Alec G. Binnie, ZL129 Seddon Ave., Waihi, Auckland Province, New Zealand.
Oct. 25 to Nov. 11, 1937.

(14 Mc. phone)

W—1FD; 1FQE; 1KKM; 1KKP; 2AZ; 2HS; 2JEB; 2JKQ; 3AHR; 3EKO; 3EO; 6CNQ; 6CQG; 6CQI; 6DAW; 6DDP; 6EQI; 6FGU; 6GTC; 6HOW; 6HX; 6IDV; 6IDX; 6LEN; 6LI; 8AVD; 8FHE; 8HDT; 8HFU; 8JOE; 8KBJ; 8LEX; 8QCF; 9BCQ; 9DNP; 9DTP; 9ELX; 9GFQ; 9ITS; 9JIE; 9MDF; 9TIZ. CE1AI; CE1AO; CT1DV; CX3BL; G5RV; HH5PPA; J2MI; **K6**—BNR; JPD; KMB; LKN; MTE; MTV; MZQ; OJI; OQE. KA1BH; KA1CS; KA1HS; LU2HI; LU2EE; LU4NB; LU5FG; LU7BK; NY2AE; OA4AI; VE4FI; VE4MO; VE5OT; VE9BW; VS6AB; XU8RV.

(28 Mc. phone)
W—1AEP; 3AKX; 5AKZ; 5DJS; 5FAC; 5HOZ; 6CKR; 6KZR; 6OSP; 6PBD; 8JL; 9TTB; 9ZMS.

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Bob Everard, "Oakdene", Lower Sherring Road, Sawbridgeworth, Herts, England.

Oct. 18 to Nov. 18, 1937

(14 Mc. phone)
W—5DVM; 5JC; 6AL; 6AM; 6AQK; 6BAW; 6BAY; 6BFC; 6BKY; 6CQI; 6CUU; 6FT; 6GCT; 6ISH; 6IXJ; 6NNR; 6NKX; 6OAJ; 7EGV; 7ETN; 7FQU. CN8AD; CN8AE; CN8AM; CN8AU; CT2AB; CX1AA; CX1AH; CX2AK; CX3BL; FB8AF; FB8AH FT4AG; HH2N; TT5PA; K4ENY; K6BAZ; K6BNR; K6NJQ; K7FBE; KA1ME; KA1JR; KA1YL; LU5PZ; LU7AG; LU9BV; LU9IEX; PY1GO; PY7AI; VE3AEL; VE3QR; VE4CIV; VE4OK; VE5OT; VK2AP; VK2AZ; VK2VV; VK2XU; VO2N; VO6JQ; VQ4CRE; VS1AF; VS1DI; VS2AK; VS2AO; VU2TI; VU2UC; VU3KX; VU3MR; VU3ZZ; VV4AE; VV4AO; VV5ABQ; VV5AK; ZZ2EZ; ZE1JA; ZT2B; ZT3F; ZT5S; ZT6AL; ZU6C; ZU6N; ZU6P.

(28 Mc. phone)

W—1AA; 1ABS; 1ADM; 1AEP; 1AIQ; 1AJZ; 1ARB; 1AUT; 1BBX; 1BJC; 1BQQ; 1CAA; 1CCZ; 1CJL; 1COA; 1DPJ; 1DQK; 1DTJ; 1EER; 1ELR; 1EWF; 1FMQ; 1FNL; 1FZA; 1GJZ; 1GWK; 1GX; 1GYA; 1HFV; 1HHU; 1HMH; 1IAV; 1IFD; 1IPA; 1IWV; 1IXR; 1IYT; 1JCI; 1JT; 1JRZ; 1JXU; 1KJJ; 1KKL; 1KNB; 1KPP; 1KQF; 1KSA; 1KTF; 1TW; 2AHX; 2AMF; 2AMJ; 2AOG; 2AYS; 2BBI; 2DC; 2DOY; 2DOZ; 2DVU; 2DVV; 2DYR; 2FCZ; 2FWK; 2GFH; 2GH; 2GOQ; 2GUM; 2HEM; 2HNN; 2HPZ; 2HYJ; 2IAI; 2IEU; 2IJU; 2INX; 2IVO; 2IXY; 2JCY; 2JIH; 2JNP; 2JOC; 2JQJ; 2JQX; 2JXZ; 2KAP; 2KDQ; 2KHX; 2KPK; 2UK; 3AAY; 3AIR; 3AKZ; 3AUC; 3BIW; 3BYF; 3CBT; 3CYK; 3DYV; 3EDP; 3EQ; 3EUNA; 3FAR; 3FAY; 3FKK; 3FMQ; 4FQW; 3FVA; 3FXU; 3GEX; 3GHS; 3GIO; 3GIZ; 3GPM; 3GSV; 3GTL; 3GZN; 3PC; 3WA; **W**—4AHH; 4AP; 4AUU; 4AZB; 4BJU; 4BYY; 4CPB; 4CYU; 4DID; 4DPD; 4DRZ; 4DXN; 4EBM; 4EC; 4ECI; 4EDD; 4EEV; 4EF; 4EKR; 4EMV; 4EPO; 4EQN; 4ERH; 4ETF; 4FQ; 4FT; 4FX; 4GB; 4PD; 4TL; 4YC; 5AKZ; 5ALK; 5BCU; 5BQD; 5CQJ; 5EB; 5ECT; 5EGU; 5EHM; 5EIH; 5EMC; 5EQF; 5ESI; 5FDE; 5FHJ; 5FNH; 5FPD; 5FZB; 5GCE; 5GHW; 5GKZ; 5GLW; 5GQU; 5QQ; 5ZA; 5ZS; 6AK; 6AQK; 6BDQ; 6BHO; 6CDO; 6CKR; 6CUU; 6ERT; 6GCO; 6GCX; 6GUQ; 6HBL; 6HX; 6ITH; 6JJU; 6LLA; 6LUB; 6LWN; 6MBQ; 6MEZ; 6MPS; 6MSQ; 6MYO; 6NAP; 6NIX; 6NLJ; 6NLP; 6NLS; 6NX; 6OSH; 6OZC; 6OZH; 6PBD; 6SE; 7CKZ; 7CPY; 7DVY; 7EKA; 7EMP; 7FDL; 7GGG; 7NY; 8ADB; 8ANO; 8BDO; 8BIQ; 8BSM; 8BTO; 8CFD; 8CHB; 8CHQ; 8CJM; 8CLS; 8CNA; 8CPC; 8CUY; 8DH; 8DIG; 8DLU; 8DW; 8EBP; 8EBS; 8EPC; 8EUK; 8FOC; 8FSA; 8FXM; 8FYC; 8GFL; 8GLY; 8GWZ; 8HCR; 8HEQ; 8HHH; 8HHZ; 8HSP; 8IHM; 8ISC; 8IWG; 8JFC; 8JLQ; 8JLW; 8KPH; 8KQ; 8KQQ; 8KYY; 8LGO; 8LJ; 8MAT; 8MEY; 8MID; 8MNJ; 8MSH; 8MYI; 8NHP; 8NK; 8NOH; 8NWO; 8NYD; 8NYU; 8OAE; 8OLY; 8OPO; 8OSX; 8OTK; 8OTV; 8OUT; 8OYC; 8PFN; 8PHB; 8PK; 8PLT; 8POL; 8PPY; 8PTN; 8PWA; 8QBO; 8QGZ; 8QKI; 8QRV; 8QUI; 8QUR; 8QXY; 9AAG; 9AGO;

*George Walker, Assistant Editor of RADIO, Box 355, Winston-Salem, N. C., U.S.A.

9ARK; 9AZE; 9BBR; 9BBU; 9BHT; 9BLL; 9BMX; 9BQY; 9BU; 9CCI; 9CET; 9CJJ; 9CLH; 9CON; 9DDF; 9DHO; 9DKA; 9DKK; 9DLU; 9DN; 9ECO; 9EKD; 9EW; 9FRE; 9GEG; 9GIC; 9GPC; 9HDU; 9HDZ; 9IAG; 9IIX; 9IXI; 9JBO; 9JHY; 9JIL; 9ING; 9KNZ; 9KPD; 9LQ; 9LQT; DLSZ; 9LUW; 9LXQ; DLXX; 9MDF; 9MIL; 9NKX; 9OKH; 9OS; 9PBY; 9PGS; 9PNU; 9PQH; 9PUY; 9RBM; 9ROQ; 9RRC; 9RUK; 9SBU; 9SNB; 9SQE; 9TFY; 9TGN; 9TII; 9TIO; 9TLQ; 9TNY; 9TTB; 9TTU; 9UEI; 9UEL; 9UIA; 9UIZ; 9UJB; 9USI; 9UWV; 9UYD; 9VGO; 9VMV; 9VUJ; 9VVC; 9WBX; 9WC; 9WFF; 9WIP; 9WIQ; 9WOA; 9WOI; 9WOU; 9WXT; 9WZO; 9YHQ; 9YIM; 9YLV; 9YON; 9YRX; 9YXS; 9ZHB; 9ZMS; 9ZNA; 9ZOR.

●

William D. Wadsworth, VE5RE, 1506 Cedar Avenue, Trail, B. C., Can.
Sept. 7 to Oct. 7, 1937

(14 Mc. phone)

CO2WW; HH5PA; PK1RR; VK2HF; VK3XJ; VO8YB; VP9R; YI2BA.

(28 Mc. phone)

ZU6P.

(14 Mc.)

ES5C; ES7D; G6BS; 6GCQ; GM2JF; HB9BD; J2CC; J2KJ; J5CC; J5CV; J8CF; K6OQV; K7COI; LU4BH; LU5AN; LU9AX; OH7NI; ON4AU; ON4DM; ON4NW; OZ4H; OZ8A; PK1MF; PY2CW; SV2C; VE5LD; VK2AEZ; VK2BZ; VK2VQ; VK2ZW; VK5JU; VK5WR; VK6SA; VP5PZ; V2IAS; VR5CD; VS3AE; VS4CS; VS7AG; XE1AA; XE1AG; XE1AM; ZL2GS; ZT1Z; ZT6AT.

(28 Mc.)

FR8VX; ON4JZ; ZT1Z.

March 20 to Oct. 7, 1937
Heard Regularly

(14 Mc. phone)

CO2WW; CO2WZ; CO8MA; G2BH; G6LK; HH5PA; HI5X; HP1A; KA1ME; K6LJV; K6MVV; K6NTV; K6OQE; PK1RR; PY1FR; PY2BA; VK2HF; VK3XJ; VK4LW; VO8YB; VP5PZ; VP6YB; VP9R; YI2BA.

(28 Mc. phone)

K4EPO; VP5PZ; ZU6P.

(7 Mc.)

CM2BK; CM7AB; **K**—4DUZ; 4EGZ; 6BHL; 6CGK; 6CK; 6CRW; 6DV; 6IJH; 6ILT; 6EXP; 6KCK; 6KPF; 6LBH; 6LKN; 6LMU; 6MAW; 6MBT; 6MEM; 6MTE; 6MTH; 6MOJ; 6NIY; 6NJV; *NXD; 6OCL; 6OES; 6OGD; 6OHX; 6OJG; 6OKR; 6OLX; 6ONF; 6PAH; 6PAL; 6PAS; 6PDQ; 6SO; 7BNW; 7BOK; 7COI; 7DYF; 7EMV; 7DAA; 7ENA; 7EQF; 7FAK; 7FNE; 7FRU; 7FSX; 7GDL; 7GLL; KA1HR; KA1PK; KA1PT; OK2FF; VK2QI; VK3BH; VK3BR; VP1WB; VP2LA; XE2B; XE2CN; XE2FG; XE2GJ; XE2HC; XE2TH; ZL2BF; XL2BV.

(14 Mc.)

CM—2AD; 2AF; 2AG; 2AZ; 2FA; 2OP; 2RZ; 7AB; 7AI; 7LR. **D**—3BMP; 3BXK; 3CUR; 3DSR; 3FZI; 3GKR; 4PCU; 4QET; 4YLL; ES5C; ES7D. **F**—3CX; 3KH; 8AC; 8AI; 8EB; 8EF; 8EO; 8FC; 8IG; 8IZ; 8PT; 8PZ; 8RR; FA8BG. **G**—2BK; 2DC; 2DF; 2DL; 2KU; 2LB; 2LK; 2PL; 2OB; 2TR; 2XW; 5GS; 5IU; 5JF; 5LI; 5LY; 5OJ; 5SO; 5UX; 5WP; 5YU; 5YV; 6BS; 6DT; 6DX; 6FQ; 6GH; 6HG; 6NF; 6QS; 6RA; 6RH; 6UF; 6VQ; 6WY; 6YU; 6ZO; 8HH; 8HN; 8IP; 8IS; GI5WD; GM2JF; GM5ST; GM6IZ; GM6XI; GM8RJ; HA8D; HB9BD; HC1JW; HH3N; HK4EA; HR1AA. **J** — 2BD; 2CC; 2JJ; 2JR; 2KJ; 2LU; 2MU; 2NG; 2NQ; 2NS; 2OC; 2OZ; 3CR; 3FJ; 5CC; 5CV; 6DP; 6DU; 7CR; 8CF. **K** — 4CVV; 4DUZ; 4EJF; 4EVC; 4RJ; 4UG; 5AA; 5AE; 5AG; 6AJA; 6AKP; 6BHL; 6BNR; 6BUX; 6CGK; 6COG; 6DTR; 6DV; 6FAZ; 6HOO; 6LBH; 6MAW; 6MTW; 6MV; 6MVV; 6MXM; 6NXD; 6NZC; 6OES; 6OJG; 6OJI; 6OLX; 6ONF; 6OPJ; 6OQV; 6SO; 6TE; 7BGO; 7BZX; 7COI; 7EVM; 7FAK; 7FYI.

(14 Mc.)

KA1ER; KA1ME; KA1MM; KA1SO; LU1HK; LU1HK; LU4BH; LU4DJD; LU5AN; LU6JB; LY1J; LY1S; NY1AE; OA4AQ; OA4Q; OE?AH; OE6DK; OH5NF; OH5NR; OH5OD; OH7N1; OK2HX; OK?OF. **ON** — 4AU; 4DM; 4DX; 4FE; 4FQ; 4FT; 4GK; 4HX; 4NC; 4NW; 4RX; 4VU; OZ2H; OZ2M; OZ4H; OZ7TI; OZ8A.

PA — EA; FLX; HC; GN; KV; OO; SD; VB; WV. PK1MF; PK1MJ; PK1RI; PK3BM; PY2AC; PY2CW; PY2DC; PY2HQ; PY2KX; SM5SC; SM6PA; SP1HH; SV2C; TF2A; TF3AG; VE5AAY; VE5LD. **VK** — 2ADE; 2AEA; 2AEZ; 2ACN; 2BR; 2BZ; 2CI; 2DA; 2DG; 2DK; 2GM; 2IZ; 2LD; 2LP; 2NQ; 2OQ; 2QL; 2QP; 2RK; 2R; 2SK; 2TI; 2TT; 2UF; 2UU; 2UY; 2VQ; 2VW; 2XJ; 3EO; 3GC; 3IW; 3LY; 3NG; 3OC; 3QJ; 3QK; 3UH; 3VF; 3VU; 3WP; 3WU; 3WY; 3XP; 3ZR; 3ZZ; 4CG; 4DO; 4EL; 4ER; 4GF; 4GK; 4KX; 4RF; 4RM; 4RY; 4SD; 4UR; 4WU; 4YL; 5FM; 5HG; 5HM; 5HR; 5JC; 5JU; 5JT; 5LL; 5LN; 5ML; 5PS; 5WK; 5WR; 5XB; 6FL; 6OQ; 6SA; 7LC; VO8ARE; VP2CD; VP2TG; VP5PZ; VP9K; V28AS; VR5CD; VS2AK; VS3AE; VS6AG. **XE** —1AA; 1AG; 1AM; 1BA; 1BC; 1CM; 1DD; 1LM; 3AC; 3Y; XU8LR; XU8VX; YV5AQ; YL2CD. **ZL** — 1DM; 1DV; 1FE; 1LY; 1MQ; 2BX; 2CT; 2DS; 2MO; 2QM; 2SX; 3AQ; 3FL. ZS1AN; ZS2X; ZT1Z; ZT6AT.

(28 Mc.)

FR8VX; ON4JZ; ZT1Z.

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Donald W. Morgan, 2CBG, Grange Road, Kenton, Middlesex, Eng.
Sept. 1 to Oct. 1, 1937

(14 Mc.)

W — 1ANU; 1BGW; 1CBZ; 1CH; 1FFD; 1FQV; 1IOR; 1JCF; 1JKO; 1JMT; 1KHE; 1KOF; 1LQ; 1WV; 2CTO; 2CTX, 2CYC; 2GW; 2GWC; 2GWF; 2HKP; 2HQA; 2IYO; 2PP; 2ZC; 3AXR; 3BQO; 3BVD; 3CVK; 3EPV; 3EXB; 3GGE; 4AIR; 4DG; 8JBL; 8KOL; CN8AR; CR7RB; CT1OR; CT1PX; CX1AJ; CX2BK. **D** — 3FBN; 3FDF; 4ATT; 4CPV; 4DIP; 4GKF; 4FRF; 4GZK; 4OAP; 4OIP; 42NM;4VZI; ES1C; ES5C; ES5D; ES7D; F3EB; FM8AD; FM8GT; FM8LC. **G** — 2BY; 2GO; 2IM; 2UV; 5FG; 5ZS; 6CJ; 6CL; 8FZ; 8IF; 8MH; 8NO; 8UI; HA2B; HA2P; HA5H; HA7P; HA8H; HB9BX; HB9DX; HB9K; HB9XU; I1GA; I1KN; I1LT; LA3I; LA4A; LA4K; LA6A; LA7A; LA7J; LA7U;

[*Continued on Page 91*]

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NEW BOOKS

AND REVIEWS of CATALOGS

[*Books submitted to the Review Editor will be carefully considered for review in these columns, but without obligation. Those considered suitable to its field will also be reviewed in* Radio Digest.]

A new handbook for radio servicemen, compiled in "question and answer" form, has just been announced by the publishers. Originally planned by the Institute of Radio Servicemen, the handbook offers a complete digest of essential data of interest to the serviceman.

Question and Answers Handbook includes nineteen sections, each covering a phase of radio servicing. Among the subjects discussed are: basic theory, superheterodynes, auto radio, public address, power supply units, etc. The Handbook contains almost 3500 questions and quite thoroughly covers those problems that confront the Serviceman. The book is available from the Allied Radio Corporation, Chicago.

Razor-Sharp Phone Selectivity

[*Continued from Page 47*]

gree of filtering output, thereby deriving additional field excitation, acting as a bleeder, and also as a screen voltage divider.

Controls are, left to right, volume-on-off, a.v.c.-manual, selectivity, manual gain tuning, b.o. pitch, wave band, send-receive, and bass tone. The selectivity knob provides treble tone control, and the new-to-communication-receivers bass tone control allows one to cut out noise in the low audio frequency range not essential to intelligibility. It will give when desired enough "umph" to satisfy the most rabid bass lover in music reproduction.

The dial has five scales, the innermost graduated 0-100 degrees, and the remaining four accurately calibrated for the four tuning ranges. Its knife-edge, anti-paralax pointer directly attached to the gang condenser shaft is driven through a no-backlash 16:1 gear reduction. The dial, three inches in diameter and graduated 0-200 degrees, gives over 8 feet of dial length to each wave-band, an average of 21.2 dial division per inch for all five amateur bands—or, for the similarly averaged 10, 20, 40, 80, and 160-meter amateur bands, 5.26 for each dial division of 3/64" width. Fine tuning is automatically provided at an 80:1 ratio through the single tuning knob, which after one revolution in either direction at 80-1 ratio, automatically shifts to 16:1 "fast" ratio to let the operator quickly get over to the next band.

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Push-Pull 809's

[*Continued from Page 49*]

Because of the widely varying load the exciter imposes upon its source of plate voltage, it is not feasible to use one 900-volt supply with a dropping resistor to feed the exciter portion. The exciter requires a separate power supply possessing good regulation.

The two toggle switches used when changing bands may be seen in the rear view of the whole transmitter, between the two 6L6-G's. Incidentally, an RK49 may be substituted for the second 6L6-G to give slightly more 10-meter excitation to the 809 stage.

By means of the selector switch mounted directly below and between the two meters, the left hand meter (0-100 ma. d.c.) can be used to read cathode current to any of the first three tubes or for reading grid current to the 809 stage. 50-ohm carbon resistors are wired in series with these various circuits, and the meter

switched across the resistor in whatever circuit it is desired to read current. A 300-ma. meter is permanently wired in the plate circuit of the 809's.

The grid leak in the 809 stage serves satisfactorily as an r.f. choke. A 250 or 500 ma. r.f. choke is used to feed the center of the plate coil. Adding a regular grid choke merely encourages a low frequency parasitic; hence none is used.

The illustration of the final tank circuit should be studied carefully. The short leads resulting from this arrangement contribute largely towards the high efficiency obtained at 10 meters. The coil socket is mounted directly above the double-spaced midget split-stator tank tuning condenser, while directly below the tank condenser is the ganged neutralizing condenser (two-section but rotors insulated from each other). The tank condenser shown provides sufficient "Q" on 10, 20, and 40 meters, but a larger condenser would be preferable for the lower frequency bands. The neutralizing condenser is mounted to be adjustable from the back, rather than from the front panel, inasmuch as the neutralizing adjustment holds for all bands when once correctly made.

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Economical Phone-C.W. Transmitter

[*Continued from Page 45*]

to a twisted pair feeder and doublet antenna. A 500- or 600-ohm non-resonant feeder (one or two wire) can be similarly coupled to the plate coil by means of from one to three turns of heavy rubber insulated wire wound directly over the center of the plate coil. The number of turns can be varied to change antenna coupling and degree of loading.

For grid modulation on either 10 or 20 meters, the antenna coupling was increased until 200 ma. (at least 175) of plate current flows with a grid current of 4 ma. The plate current will be about 150 ma. at ½ ma. grid current, and any value of from zero up to nearly 5 ma. of grid current can be used with good voice quality. The grid current kicks up to somewhat over 5 ma. on speech. Excessive grid current provides a stronger carrier but reduces the percentage modulation and increases distortion. The resting efficiency for 20-meter phone operation is nearly 50% and over 90% modulation can be obtained with excellent quality—*if the antenna loading is sufficient.*

On 20-meter c.w., the following meter readings were obtained: 6G5-6L6G cathode, 60 to 70 ma.; T-20 grid, 10 ma.; T-20 cathode, 80 to 85 ma.; final grid, 40 ma., and T-200 cathode, 350 ma. The antenna coupling was such as to pull 325 to 350 ma. on 20-meter c.w. Ten-meter c.w. operation gave the following readings: 6L6G, 60 ma.; T-20 cathode, 90 ma.; final grid, 20 ma., and final cathode, 300 ma. at resonance.

A Ham-Band Superhet

[*Continued from Page 55*]

for that stage—the number of turns be cut down to optimum.

Regeneration

If the detector circuit oscillates at any setting of the input selectivity control, too much regeneration is of course implied. The number of turns in the cathode winding should be cut down until with the mixed screen at full 67.5v. potential, a "just below the point of oscillation" condition is indicated.

Performance

The receiver really does perform. Gain and selectivity are everything that they should be. With regeneration in the detector stage, the input-signal selectivity is really satisfactory—and of course there is no image problem due to the use of the high i.f. Output is more than sufficient to overload the headphones off one's head, the signal-to-noise ratio can be made quite acceptable with a judicial setting of the various controls, the bands can be spread over the dial face completely, and, last but not least, the job lends itself to any type of power supply. It really "goes to town" when tied up to 135 volts of B battery.

Let's Whip the 20-Meter Rotary

[*Continued from Page 58*]

stantially reduced. A front-to-back comparison gave as much as a 14 decibel difference, equivalent to 2-1/3 R points on the meter as calebrated by RME.

Installation Methods

The installation of this system is not difficult. The steel tube elements are fastened in clamps, mounted on insulated screwed to short wood members. The latter are placed across the ends of a larger wooden cross beam which is made slightly longer than 1/10-wavelength and arranged at its center to pivot at the top of the mast. Due to the light weight of the structure, the whole rotating portion can be assembled and carried up the mast, or can be raised with the mast, inasmuch as it weighs only about 35 pounds.

By locating the bearing on a "bracket," a horizontal piece of wood fastened at the side of the masthead, there is plenty of room to arrange a commutator through which to feed the antenna, if it is desired to eliminate loose feeders and enable continuous rotation of the antenna.

A rope-driven arrangement of this type mounted at the top of a ladder mast, as used at W2IVW, is shown in the accompanying picture. A similar job, using a standard motor drive and gear reduction, mounted on an ordinary telephone pole ten inches in diameter at the bottom and seven at the top, is in use at W4DRD. Another illustration of the application of the steel tube elements appears in the picture of W4DLH's tower. These serve to show how simple the rotating part of the antenna is with this type of construction.

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Five Bands—Individually Tuned

[*Continued from Page 39*]

ciate the tip. As for the wiring, I have kept the leads as short as possible, sacrificing neatness to do it. The wiring from the plate of the first detector to the first i.f. coil is a little long due to its being routed through the switch, but it has not caused any serious trouble.

With the wiring complete and the set ready for test, the fun begins. As a rule, I turn on the power and if anything starts to smoke, I call in the fire department. However, with the power on and only the rectifier tube in its socket, I measure each connection at each socket with a voltmeter—you can usually pick up the majority of the bugs in this manner. Be sure to see that there is no high voltage on either filament lead. This test often pays dividends.

If the voltages are all correct, put in the audio and i.f. tubes and line up the i.f. transformers with a 465-kc. oscillator. Next, put in the r.f. first detector and oscillator tube in one of the bands, preferably the 80- or 40-meter band, turn the band set condensers to about 50% capacity and turn on the transmitter oscillator. With the band-spread condenser set on 50, adjust the oscillator band-set condenser to the loudest point (one of the two points may be the better) ; next, tune the first detector band-set condenser to its loudest point with both gain control and regeneration control backed off. Next, the r.f. band-set condenser should be set to its loudest point and then the transmitter oscillator turned off. Tune in a fairly loud signal and touch up the first detector and r.f. band-set condenser. Then, repeat on a weak signal and you should be ready to tackle the next band. Of course, this testing is done with an antenna connected.

Tuning up the 10-meter band is quite critical, but don't give up too quickly because when you get it properly adjusted, it really works and you will be well satisfied with it.

A trimmer condenser was used on the first detector on the 10- and 20-meter bands. This is not absolutely necessary, but it helps to clear up a weak signal.

Conclusion

The receiver has been in use for quite sometime, and the more I use it, the more I am sold on its operation. I can get at all the controls and tuning features without even looking under the deck. If I get an idea that it is not properly tuned or the i.f.'s are off or something should be changed, I am not reluctant to make the change as I would be if it were a commercial job. The cost is much lower than that for any good commercial receiver and I believe its performance is equal to any that I have heard.

If I had it to do over again, there is only one thing that I would change. I would paint the chassis before I assembled the equipment on it, as painting around the tube sockets, etc., was one nasty job.

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56 Megacycles

[*Continued from Page 72*]

enough to account for 56 Mc. transmission. However, it would seem that the transmissions reported by W3GLV, Leesburg, Va., on October 18 at 42 Mc., and during the first week in November at frequencies from 41.5 to 52 Mc., were F_2-layer transmissions. This conclusion would also apply to the transmissions heard by G6DH in London on November 1, if the transmissions were over a daylight path."

Of course, the reception of W8HQC in Buffalo by E. C. Hatch in West Medford, Mass., which was verified, might still have been a localized sporadic-E condition, or perhaps more likely, low-atmosphere bending of the type Ross Hull has mentioned.

[*Continued on Page 86*]

Foolproof Dynopush-Exciter

[*Continued from Page 22*]

actual plate current drawn by the doublers will of course be somewhat less than the value as read by the cathode meter.

Keying

The exciter may be keyed in any one of the three cathode jacks. For break-in operation, the key would obviously be inserted in the oscillator jack. Keying of the oscillator is very clean and free of "yoops."

Capabilities

This exciter may be used as a low power transmitter to deliver 15 to 25 watts directly to an antenna. It will excite a c.w. amplifier to 250 watts input with good efficiency. It will drive a plate-modulated class C amplifier to 150 watts input if the class C amplifier uses modern tubes with a high transconductance. The output of the exciter is sufficient to excite a grid-modulated stage to from 200 to 400 watts input, depending upon the degree of efficiency desired.

The exciter is ideally suited for driving an amplifier consisting of a pair of T-20's or 809's to 150 watts input on either phone or c.w. In fact, such a transmitter is described elsewhere in this issue. The amateur whose finances will not permit construction of the whole transmitter at once can build the exciter as described here and use it to get on the air, adding the push pull amplifier when the condition of the pocketbook permits.

The Worm Turns Cold

[*Continued from Page 29*]

actual ground wires which customarily are buried. High base capacity should introduce very little loss, but interposition of the earth may introduce considerable loss which, fortunately, can be rather easily reduced.

"The first application of the ground screen and the quantitative measurements of the reduction of losses on broadcast frequencies was at station KOA, Denver, Colo., 1934. Those tests consisted of making measurements of field intensity at one-mile distance with constant power input, over the broadcast spectrum, without a ground screen. The entire performance was then repeated with a ground screen in position. This entailed making painstaking measurements of antenna resistance and reactance over the broadcast spectrum under each condition since the antenna input power could not have been determined without them. The screen consisted of galvanized iron fencing of approximately ¾-inch mesh, 50 feet square. An equal improvement obtained by increasing the power of this station would have cost over $30,000 whereas the ground screen cost approximately $300."

If it costs one per cent as much to improve the radiating system as to increase the power, for the same result, isn't it worth serious thought? If you are using a vertical antenna on any frequency, or a horizontal antenna that is within about a half-wavelength above the ground, start looking for a good deal on second-hand wire.

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400-Watt HK-54 Amplifier

[*Continued from Page 18*]

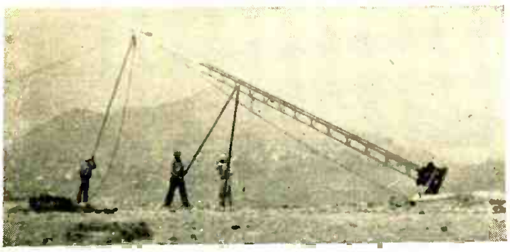
mounted below the chassis with the shell protruding. This explains the "underslung" appearance of the 54's.

The three meters on the front panel read plate current, grid current, and filament voltage, and are permanently wired in their respective circuits.

Characteristics on the type 54 were given in last month's RADIO.

147-Ft. Steel Mast

[*Continued from Page 30*]



then each section is raised and guyed separately using a 20-foot "shooting gin pole" of three-inch iron pine to raise the sections. This gin pole has a hook on the bottom which rests on a cross member of the tower about six feet below the top of the erected portion. It is tied to the tower with a rope. A rope and pulley attached to the top of this pole are used to raise the section to be added. Two men work at the top and one remains on the ground.

The KRCJ tower was guyed at each 20-foot section while being raised. After the permanent guys were attached to the anchors through turnbuckles and adjusted, the extra guys were cut loose.

The ground system, to meet F.C.C. requirements, has 80 buried radial wires each 190 feet long. These are covered with soil but are hardly one foot deep.

Any standard type of coupling can be used at the base of the mast.

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56 Megacycles

[*Continued from Page 83*]

Old Stuff

For historical purposes, W9PWU in Colorado sent us details of reception and QSO's with Illinois, Indiana and Michigan stations that took place on July 4, 1936. Several stations at each end were successful. So don't think that *all* dx takes place between Chicago and New England!

Frequencies

Here are a few more crystal frequencies for the records:

	Mc.
OK1AA	56.00
W9PWU-QCX	57.310, 58.080, 56.850
W9SLF	57.3
W9ANA	56.936
W9NY	56.012

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Bandswitching

[*Continued from Page 62*]

where they run through the base plate. The plate lead of the buffer stage connects directly to the "high" side of the tank coil by passing through an isolantite feed-through insulator. This substitution was made to keep r.f. losses at a minimum.

The amplifier excitation condenser is mounted through grommets in the same manner as the buffer excitation condenser. One thing, it is advisable to mount and wire completely the grid circuit of the final amplifier before testing the buffer-doubler stage. Then too, it will be found that simulating actual "under load" conditions during tests will greatly facilitate resonating the coils.

Checking for Parasitics

A simple test for feedback or parasitic oscillation is to apply voltage to both the oscillator and buffer, open the key, and touch the plates of the tubes with a small neon bulb. With "key up" conditions there should be no indication of r.f. regardless of the setting of any of the tuning condensers. This test is an important one, and applies to all stages of the transmitter. Should you discover that there *is* a stray bug running loose, it can probably be traced to an improper choice of by-pass condensers, a long by-pass lead, a resonant choke, improper screen voltage, or lack of bias.

Now, if everything is in proper working order, the amplifier base may be mounted to the frame. The sub-panel (for the amplifier) is mounted behind the front panel using ½" bushings to hold it in such a position as to allow sufficient clearance for bolts, shaft extensions, etc., that connect to the condensers and the band switch. A pair of 804's or RK-20A's in parallel are used in the final stage.

A good look at the photographs will show that the amplifier band switch is mounted on a synthane strip, which is fastened to the panel by threaded bars. Experience has shown that, although the shaft of this switch is insulated from the contacts, high r.f. voltages *can* arc over! By mounting the switch away from the panel and by insulating the shaft with a flexible coupling, the danger of a "flash over" is eliminated and circuit capacity is kept at a minimum.

Since the plate antenna circuit tunes against ground, it is not necessary to insulate the variable condensers. For this reason, they mount directly to the sub-panel. However, the mounting bolts should not be considered as sufficient ground return; all connections to the frame should be electrically bonded.

The Final Tank Circuit

The air-wound tank inductance is supported at one end by a ¾" dia. synthane rod which fastens to the panel, and by the variable condenser at the other. Leads to the band switch should be heavy tinned copper or copper wire, and—keep 'em short! The chart shows the proper points to tap the coil but with different antennas these points will vary slightly.

The wiring of the final should be encased in spaghetti at all high voltage points with the exception of wires carrying r.f.; these should be left bare. May I suggest that you use a flexible lead to the plate clips of the RK20's; this wire should preferably be bare copper. When heavy wire is used to make such a connection, there is danger of breaking the plate cap loose from the glass bulb.

The matching network used in the transmitter acts as an impedance device which, when properly adjusted, effects an impedance match between the tube and the antenna. Should this adjustment be incorrect, harmonics are allowed to travel a low-resistance path into the antenna.

Calculating the "Pi" Network

In order to assure a proper match, both the inductance and capacitance should be carefully calculated by the following formula:

R_1 = Plate impedance
R_2 = Antenna impedance

X_a = Reactance of plate tuning condenser
X_b = Reactance of plate tank coil less 10% of value
X_c = Reactance of antenna tuning condenser
A = Factor

$$X_b = \sqrt{(R_1)\ (R_2)} \text{ less } 10\%$$

$$A = \sqrt{(R_1)\ (R_2) - (X_b)^2}$$

$$X_a = \frac{(R_1)\ (R_2)}{R_1 + A}$$

$$X_c = \frac{(R_1)\ (R_2)}{R_2 + A}$$

The values X_a, X_b and X_c are now ready to be interpolated into values of inductance or capacity as the case may be; these values depend, of course, upon the frequency selected. The following sample problem may be of aid.

Antenna impedance = 70 Ohms
Plate impedance = 6000 Ohms
Frequency = 3.5 Mc.
$\sqrt{6000 \times 70}$ = 650 = Reactance of plate inductance
Subtract 10% (65); let us say X_b = 600 ohms.
$\sqrt{6000 \times 70 - (600)^2}$ = 245 = factor or A

$$X_a = \frac{(6000)\ (600)}{6000 + 245} = 578 \text{ ohms} = 80$$

μμfd. at 3.5 Mc.

$$X_c = \frac{(70)\ (600)}{(70) + (245)} = 133 \text{ ohms} = 350$$

μμfd. at 3.5 Mc.
X_b = 600 ohms or an inductance of 28 μh. at 3.5 Mc.

Information regarding the correct number of turns, spacing, etc., for a certain inductance together with formulae for changing reactance into values of capacity or inductance at a certain frequency can be found in your radio handbook. Do not under any circumstances attempt to substitute incorrect values in your antenna network!

Tuning the Coupler

A common error in tuning this type of coupler is allowing the plate resonating condenser to have more capacity than the loading condensers. Another and more serious mistake is in attempting to "soup her up" to a point where tubes are over-loaded. In doing this the entire circuit is improperly operated and by setting the condensers at a point where the tube "draws mills" a mismatch is accentuated.

It will be found that at the point of maximum output, both loading and resonating condensers should indicate resonance in the plate current, and if changed, will cause the plate current to rise. This is the proper operating point!

An antenna ammeter (0 — 1½) should prove a great help in making your adjustments. And another tip—if the r.f. current is not very high, do not get the idea that your rig isn't working properly. With a voltage fed antenna this is a normal condition.

And speaking of antennas—this coupler system can be made to match into a large number of different antennas, provided the coil is large enough and has enough taps to resonate properly the circuit.

The Modulator

When phone operation is desired, the "c.w.—phone" switch cuts off the positive suppressor voltage and connects the speech equipment and the —45-volt B battery. Only a small amount of audio power is needed to modulate fully the transmitter; for this reason very little speech equipment is needed.

It would be well to use a separate power supply for the speech equipment which could be arranged so that when the "phone" switch is connected, the supply is "on." The plate current on the final should remain constant at all times during modulation.

Power Supply

The power supply is standard and uses no trick circuits. Except for the necessity of good regulation and low hum level there is little to be stressed. It will be noticed that batteries are used for bias. This type of supply was selected because it affords good regulation and seldom fails.

In conclusion, should you run into trouble in the construction or testing of your rig, a self-addressed stamped envelope enclosed with the "dope" on your trouble will bring you all the information I can give. In the meantime, keep an ear tuned to the low end of the 20, 40, 75, and 80 meter bands where the rig is used nightly. I'll be QSO'ing you!

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Improved Volume Indicator

[*Continued from Page 13*]

the time constant of the RC filter in the 6H6 cathode lead. The different time constants, as selected by the switch, S, determine the different slopes and consequently how far the meter will return between successive strong peaks of a definite frequency or separation.

The Vacuum-Tube Voltmeter

A 6F5, operating with a fixed minimum bias is used as a v.t. voltmeter to indicate on the milliammeter M the voltage across resistor R_3. The meter M may be calibrated in db, in percentage modulation, or in any other convenient units. The calibration of the meter, of course, must be left to the individual constructor.

A 0-5 d.c. milliammeter was used in the unit shown in the photographs. A lower or slightly higher-range meter may be used; the calibration for each meter can be made accordingly.

The three bias cells in series furnish about 3.3 volts of negative bias to the grid of the 6F5. This bias is just about sufficient to stop the flow of plate current to the 6F5 with an applied plate potential of about 250 volts. If the meter does not drop completely to zero, a slight adjustment of the instrument will bring the needle to zero on the scale.

Power Supply

The meter is designed for use with an external power supply. Any supply capable of delivering 250 volts at 5-10 ma. and 6.3 volts at about 1 ampere will be satisfactory. This small amount of power can ordinarily be taken from the power supply of the speech amplifier. The drain of the unit of course increases a certain amount as the plate current of the 6F5 swings up with an incoming signal. However, the resistor R_4 and the condenser C_1 will keep any short-period fluctuations from being fed back into the power supply and vice versa.

Construction

The complete meter is mounted upon a "two-unit" standard panel. That is, the panel is 3½" high and 19" wide with standard drilling at the ends. The indicating instrument and the time-constant and volume controls are mounted upon the front panel. The three tubes, the input transformer, and the various components are mounted upon a small, vertically-mounted chassis that is bolted to the back of the panel.

The details as to parts mounting and placement can be obtained from the photographs. The mechanical construction of the panel and chassis can also be clearly seen. The power supply and input circuit leads are brought out to a 5-prong socket mounted upon the chassis.

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Calls Heard

[*Continued from Page 76*]

LU4DJ; LY1SL; OH1NP; OH3NK; OH5NV; OH5OA; OH6NN; OK1GD; OK1KX; OK1OM; OK2PN; OK2RR; OK2ZA; OK3VA; ON4XF; OZ1F; OZ1L; OZ1L; OZ2AK; OZ3D; OZ7E; PZ0DB; PZ0KV; PZ0RJ; PY1AL; PY2AL; PY2BM; PY2BA; PY2HQ; PY2KK; PY2ZN. **SM** — 5GM; 5OH; 5TI; 5VJ; 5VU; 5WD; 5WL; 5ZL; 6VX; 6WL; SP1EW; SP1HA; SP1LM; ST1CM; ST2LX; SU1SG; SV1CX; SV1RX; U1AB; U1AI; U1CT; U1QT; U2NC; UK1CC; VE1EP; VE1HG; VE3AU; VE3FB; YM4AE; YR5AK; YR5CF; YR5ML; YR5RC; YT7KP; YU7AY; YU7DM.

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Charles R. Bickford, W1JMH, Montague Street, Lake Pleasant, Mass.

Nov. 1937.

CM — 2AK; 2JH; 6AD; 7FR; 7RR; 8AI; 8AQ; 8AR; 8AS. CT1PC; F8IZ; F8NY; F8ZW; G2UQ; G5NE; G6UX; G6YR; HI6O; K6GOM; K61BH; K6NFU; K6OHX; K6PAS; K6PDQ; K7FZD; PY1BR; VO5KLA; VK2QP; VK3DT; VK3IR; VK5HG; VK5RF; XE1D; XE2AD; ZE2GD; ZE3AD; ZE3B; ZL2BV.

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Alois Weirauch, OK1AW, Mestec Kralove, 9, Czechoslovakia.

Sept., 1937

(28 Mc. phone)

W — 1ADM; 1AXA; 1COA; 1DQK; 2BHY; 2GSD; 2HN; 4DAZ; 4DYY; 4IBM; 8ANO; 8KYY; 9INC; PA0FB.

(14 Mc.)

W — 1CH; 1DZE; 1LZ; 2FZI; 3GNY; 4CYU; 4DYV; 5BB; 9FS; 9TSV; K5AA; K5EVC; LU4LSH; PK1BO; PY2AJ; VQ3FAR; VU2AM; VU2FH.

(28 Mc.)

W — 1XP; 2AGW; 2AWN; 3AUC; 3ENX; 3EXB; 3GPS; 4MR; 7AMX; 8CLS; 8JFC; 8QUL; 9BAC; 9FPB; 9SHE; VK5HG; VU2CQ.

•

H. F. Rawls, W6DRE, 80 W. Lewis Ave., Phoenix, Ariz.

Oct., 1937

(14 Mc. phone)

CN7AG; CR7AE: CR7AW; CR7AY; D3AOK; EI5F; EI6G; FB8AB; FB8AD; FB8AE; FT4OG; FY9Z; HH3L; J2OV; J2OZ; J5CC; J5GF; J8CF; KA1AX; KA1ER; KA1SL; KA1YL; KA7EF; LU3HK; LU5AN; OH5NF; OK2PM; OK3DZ; OK6HO; ON4AN; PAOCE; PK1BO; PK1MF; PK1RI; PK3BM; PK3LC; PK4MK; PY8AH; SU1CH; SV1RX; TF2Y; U1AD; U3FB; U5AN; VQ3FAR; VQ4CRI; VK8AS; VS3AE; VS6AE; VS6AL; XU8RL; XZ2OY; YI2BA; YK7AA; YR5CU; YV5AP; ZE1JB; ZE1JG; ZE1JI; ZE1JO.

ZS — 1AH; 1AL; 1AN; 1AV; 1B; 1D; 1G; 2G; 2X; 2Y; 3F; 4A; 4F; 4U; 5AB; 5AG; 5AH; 5T; 5Z; 6H; 6K; 6W. **ZT** — 2Q; 2U; 2Z; 5P; 6AK; 6AL; 6AU; 6F| **ZU** — 1C; 1L; 1T; 2B; 2D; 2F; 5AQ; 5D; 5J; 6AJ; 6AL; 6AN; 6B.

(28 Mc.)

CM2OP; CM2XF; CM7AB; CT1KH; D4RVC; EI5F; EI6G; F3KH; F8BS; F8EO; F8NS; F8RR; FM8AA; **G** — 2DC; 2DH; 2GC; 2TK; 2XC; 5BJ; 5LI; 6CL; 6OH; 6QB; 6RB; 6WY; HK3AL; LU6AX; LU7AZ; K5AG K5AY; OA2MV; ON4FE; ON4HC; ON4VU; PAOGN; PAOPN; VK2UD; VK3BQ; VK3YP; VK5KO; VO1N; ZE1JU; ZL1HY; ZL2FX; ZS1AH; ZS2J.

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Dx

[*Continued from Page 68*]

J2MI consists of a grid modulated 210 with an 861 linear amplifier. The wire that was strung around the room served a double purpose as a clothesline and a counterpoise. Oh yes, J2KJ with his three 852's in parallel looked mighty nice with '20 watts' input. He uses a huge super termed 'the battleship.'

"A 20-hour train ride brought me to the J5 district. I forgot my callbook and J5CC, J5CE and J5CL were sought in vain. I spent the night in that city, however, and set up my portable receiver. 20 was tried and CXW, QD, and DOB were heard, including a few east coast boys, but the terrific signals of the Europeans drowned them all out.

"The J4's were so widely scattered that I could not locate any of them. I was in Japan exactly three months and was getting a little anxious to get home to see if the heap would still perk. I left from the same dock where I landed and once again I shook hands with J2MI and said farewell midst a sea of colored tape.

"When I arrived home I sent out CQ CQ CQ CQ de K6CGK, and it was a laugh when J3FI came back, and said, 'Glad to see you, hope to see you in person soon.' He had not known I had been three months in his country."

Incidentally, K6CGK is one of the most versatile of the K6's. He's on everything from 5 to 160, both phone and c.w.; you're just liable to hear him anywhere.

W2HNI heard K6OKR on the 3.5-Mc. band calling CQ December 10th about 3:37 p.m. e.s.t. W2HNI gave him a call with his 40 watts but had no luck. However, three minutes later he heard K6OKR calling W2IJU but guess IJU didn't click either as the K6 went right into another CQ. His frequency was about 3550 kc.

New ones for W3GAU—SV1RX, CR7AW, OX2QY, FR8VX, VU2FH, VU2AU, ES5D, TF5C, VP4TJ, VE5ACS, VS6AG, YV5AP, U4AL, VO6J, HK3AL, VP7NC, TBA1, ???, VU2JP, VU2AN, VU7ON, VQ8AS, VP6MY. Zones for W3GAU now are 34 with 86 countries.

The "leather-upholstered key" this month goes to W2GVZ. The reason—Pat sent in five separate dx reports for the past month. This is really a swell idea because it gets the news off your chest before you forget it. Anyway, W2GVZ now has 36 zones and 103 countries. New zone was VE5LD who was on 13380 kc. Shhhhh!!! Another good one for him was ZB2A in Gibraltar, 14280 T8. This was on December 19; W2BHW also got him. Well that's that; now GVZ can pound his upholstered key a little harder.

W8DWV worked a new one, G8MF in the Channel Islands, 14060. He also got his card from ZN1B in Bechuanaland, which was reported in detail in December RADIO. ZN1B is also ZS6M when not in that country. Another new one for Francis is FR8VX—which brings his total up to 37 and 109.

W3FAM has been doing some very nice fone work, especially for a W3. Recent contacts with two way fone are J2MI, KA1ME, YL2BC, HC1FG, OZ3U, K7FBE, VK6MW, ZU6P, ZS6AJ. He has some sort of a 14-Mc. beam antenna and now rates 27 zones and 55 countries.

After chasing ZB1H for 3 years W6BAM landed him last month. Another new one for him was VO3X. W2GVX has been on 40 quite a bit lately and reports that there were plenty of Europeans but none that were especially rare. He says that OK1BC was working W's by the dozen and he was using a rotary beam supported on four towers.

W7ALZ has discovered that he worked VK6FO on 14-Mc. fone some time ago so that boosts his zones on fone to 21. W7ALZ also says that conditions are picking up as EI2L and GM6NW were both coming through around noon during the latter part of December. Dorothy Hall, W2IXY, hooked up with ZL2BI, 14200, and FB8AF, 14140 kc. Not many ZL's on 14-Mc. fone. W2IXY now has 23 and 63, all on two-way fone.

W8EUY, a New Contributor

W8EUY is a new one to our list—he has 34 zones and 84 countries, all done with 500 watts to a 150T. He says that on December 5th he QSO'd a station signing YI2BA on 7140 kc. and asked him why his signal sounded so different from his 20-meter sig. YI2BA said that it was his new rig for 7 Mc. and crystal controlled. Time of QSO was 5:50 a.m. e.s.t. W8EUY doesn't quite know if this guy was a phoney or nix. Who does, and don't all speak at once. I'll stick my neck out but I think the guy is OK. The latest for W8EUY is that eternal three, HS1BJ, OX2QY and FR8VX.

Don't tell anybody, but W2BMX is quite an artist himself when it comes to phone, and I think the other rascal is W8SG. Here's another call for 40 meters, W3BGD. and a few recent ones are LU5AN, ZS1AN, ON4HC, ZB1P, OK1CX and ZS1CX. Says most of the stuff comes through from 0100 to 0700 G.m.t. This, of course, will be interesting to the eastern hams.

It is understood from reliable sources that around March first all amateurs in the Union of South Africa will use the one prefix, "ZS". In other words, there will be no more ZT and ZU calls. This may necessitate some new calls to avoid duplication. When more definite information is available, we will let you know what the score is.

Wedding Bells for Dx Man

Yes sir, you could have knocked us over with a feather. That world-famous brasspounder, W6CXW, has went and done it. Ol' Henry broke down and admitted he was married . . . and to make matters worse (or maybe it's better) he said he has been married for three months. So, fellows, congratulations are in order . . . but lay off the wisecracks. Henry says there's nothing like married life. When asked if he was going into the contest this year he said, "No not really to run up a score, just to look for new countries." In a package he was carrying there were four variable gap crystals scattered throughout the band. You figure the rest. This department extends its congratulations . . . whether he goes in the contest or not.

New Country List

Many compliments have been received already on the new list of countries published in last month's RADIO. You should check your present totals against the new list. Don't be afraid; you will without a doubt gain a few. Corrections in both your zone and country list and bring your total up to date. Recent visitors at W6QD were W9DFY, VE4LX, W8CBF and VK3UN. W9DFY was on a flight with TWA; VE4LX and family are in town for a couple of months; W8CBF, a friend of W8LEC's, has been buzzing around Hollywood, I think, and VK3UN was on his way to London for a couple of years. He is an officer in the Australian army. I hope you all noticed that new W9—it boosts my average. Say fellows, when you send in some calls of good dx worked, *please* list their frequency or frequencies so that we may compile them into the frequency list.

Before shutting off this mill I want those who sent greeting cards to know they were appreciated by the xyl and the om. And then, too, there were a few who remembered that it was just a year ago, January 1, 1937, that the xyl and I took the fatal plunge. For their congrats, many thanks too. What a day!!! What a year!!!

I still can't get over W6CXW . . . married. We'll see how he holds up in this coming contest. I'll let you in on another secret, or it *was* a secret until now, wedding bells are starting to ring for G2ZQ, John Hunter. On April 2nd they will be ringing so loud and hard that they will bounce on him, and poor John won't know what hit him. Ah me! Yes sir, G2ZQ, *after* the contest, April 2nd . . . Boom!!!

Quick Watson, the needle—I hear a W9.

Open Forum

[*Continued from Page 73*]

Now does that sound like a real amateur? As one ham remarked recently, we have ultra receivers, transmitters, antennae, test equipment, and theory for only a snap of the finger. Yet there is more complaining than in the days of the spark gap and crystal detector.

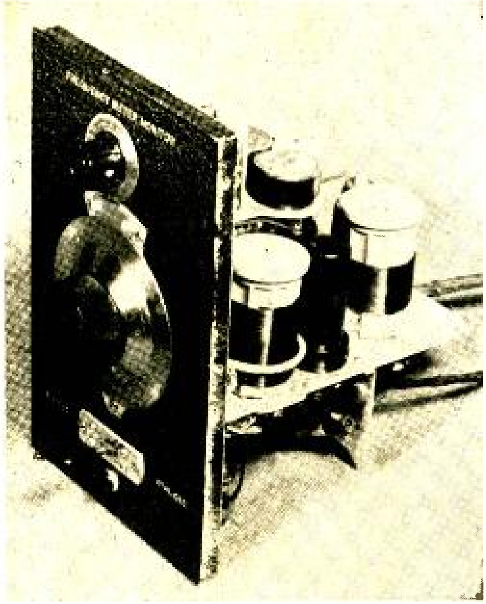
Asking for more outside control (government regulation) is not going to help. Here we are having all we can do in the face of world greed to hold our pitifully small allotment of frequencies and yet some moronic hams keep crying for more restrictions! The only restrictions needed are those for nonsensical operating. This can only come from the ham fraternity itself. Constant checking of the careless operator by other hams will result in his operating his station more intelligently from necessity. This should be self-evident to all.

Let's stop acting like a lot of babies and do some intelligent constructive work. Every ham should pull together so far as presenting a united front to the outside world is concerned, regardless of petty likes or dislikes for this fellow or that, this organization or that, this magazine or that. Fighting among ourselves is healthy sign. But, for goodness sake, let's keep the moans and groans in our own family and work out our problems in our own way!

K. A. FICHTHORN, W1BGJ

Improved Conversion Exciter

[Continued from Page 16]



phone on any band, either straight crystal control or variable frequency. C.w. may be had on any band using variable frequency. The jack on the front panel may be thrown from crystal control to variable frequency, or vice versa, without even turning off the transmitter.

One crystal used by the writer has a frequency of 3919 kilocycles, and the other has a frequency of 3562 kilocycles. With proper setting of the padder C_1, the low frequency oscillator will cover from approximately 250 to 385 kc. Any frequency between these may be either subtracted or added to the frequency of the 80 meter crystals used. This gives a range of 135 continuous variation kc. at 80 meters with one crystal, besides the fundamental frequency of the crystal. Thus the 3562 kc. crystal gives either 3562 kc. operation or any frequency between 3812 kc. (3562 plus 250) and 3947 kc. (3562 plus 385). The 3919 kc. crystal gives either 3919 kc. fundamental operation or any frequency between 3534 kc. and 3669 kc.

When doubling down to higher frequency bands, the coverage will be 270 kc. at 40 meters, 540 kc. at 20 meters, etc. The stability even at 10 meter is such when using conversion that it will invariably be mistaken for straight crystal. The low frequency oscillator should, of course, be protected from drastic temperature changes and line voltage fluctuations.

It is strongly advised that one tune up his transmitter with straight crystal control first and become familiar with where the various tuning condensers resonate before attempting to use the conversion circuit. If this is not done, it is possible (though not very probable) that one might get on the wrong image and thus be way out of the band.

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.

FOOLPROOF DYNAPUSH EXCITER

10-watt resistors—Ohmite
RFC_1—Hammarlund CHX
RFC_2—Hammarlund CHX (2.1 mh.) or Hammarlund CH8 (8 mh. for 160 m.)
C_3, C_4, C_5—Hammarlund SM-50-X ("Star")
Mica condensers—Aerovox type 1450
Coil Forms—Hammarlund XP-53; 10-meter form preferably CF-5-M
Switch—Centralab no. 1461 tone switch or Yaxley no. 60 jack switch
Jacks—Yaxley type 702

IMPROVED VOLUME INDICATOR

C_1—Aerovox PBS-5 8 μfd.
$C_{2, 3, 4}$—Cornell-Dubilier "Dwarf-Tigers"
R_1—Yaxley L control
$R_{2, 3, 4}$—Aerovox 1 watt
S—Yaxley 1316 switch
BC—Mallory bias cells

FIVE BANDS—INDIVIDUALLY TUNED

C_2—Bud 3-gang bandspread condenser
T_1—Coto CI-51 intermediate
T_2—Coto CI-52 intermediate
T_3—Coto CI-50 intermediate

Don't Forget

RADIO'S QSL CARD CONTEST

Prizes:
First: Taylor 814
Second: 4 μfd. oil-filled 600-working-volt condenser

Closing date: Feb. 28, 1938.

Rules: See page 165 of Jan., 1938, RADIO.
Send cards to RADIO, *c/o Contest Editor, 7460 Beverly Blvd., Los Angeles*

BAND-SWITCHING

R.F. by-pass condensers—Cornell-Dubilier type 4
C_1—Hammarlund MC100M
C_2—Hammarlund TC100B
C_3—Hammarlund TC225B
C_4—Hammarlund MC75M

A HAM BAND SUPERHET

Fixed tubular condensers—Aerovox
Resistors—Half-watt Continental Insulated
R_{11}—Yaxley H-12
R_6, R_7—Yaxley L
R_{14}—Yaxley N
R.f. Transformers—Two each, Hammarlund 60, 61, 62 and 63, rebuilt to specifications.
TR_3, TR_4—Meissner 8182 crystal link
$TR_{5, 6, 7}$—Meissner 8093 throughout or type 8093 1st and second with 8097 output to infinite-impedance detector.
TR_8—Meissner 8176
TR_9—Meissner 8174
Crystal—Bliley or Monitor 1500 kc. mounted crystal
Tuning condenser, C_2C_{16}—Hammarlund MCD35SX
C_1, C_6—Hammarlund HF-15
$RFC_{1, 6}$—Hammarlund CH-X
All other r.f. chokes—Hammarlund CH-10-S
S_1, S_2, S_3—Yaxley 10
Tubes—National Union 0.15-ampere designs

400-WATT HK-54 AMPLIFIER

Grid condenser—Cardwell MT-70-GD
Plate tank condenser—Cardwell XG-50-KD
Coils and jack strip—Decker Mfg. Co.
Neutralizing condensers—Hammarlund N-10
Transformers—Inca J-34 and C-65

PUSH-PULL 809'S

Exciter Portion (Refer to Dynapush Diagram)

C_3, C_4, C_5—Cardwell ZR-50-AS (.03" air gap)
Sockets—Hammarlund isolantite
Mica condensers—Aerovox 145[illegible]
Dials—Crowe

Push-Pull Amplifier

Grid condenser—Hammarlund MC[illegible]M
Plate condenser—Cardwell ET-[illegible] (use larger capacity for 80 and 160 m.)
Neutralizing condenser—Car[illegible]DI, reassembled with slightly les[illegible]ease maximum capacity to abo[illegible]
Plate coil—Decker M[illegible]
Dials—Bud Mfg C[illegible]

The Marketplace

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

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

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

(d) No display permitted except capitals.

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

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

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

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

(i) We reserve the right to reject part or all of any ad without assigning reasons therefor. Rates and conditions are subject to change without notice.

FBXA complete, FB preselector, fifteen coils, $50.00; W6MYK, Tucson, Arizona.

FOR Sale: New 803 at $20.00. J. K. Robertson, 608 No. Gardner St., Hollywood, Calif.

WANTED: Set of used ten meter coils for FB7A. Write W2DTE.

FOR Sale: slightly used pair of 35T's, Sylvania 841, and RCA 807. Any reasonable offers considered, W6MSM, Acampo, Cal.

FOR Sale at *sacrifice price*: 1 kilowatt modern rack and panel transmitter with Class B modulator, in two compact units, all first class condition. W6NKP, 214 North Bailey St., Los Angeles.

WRITE us your requirements for racks, panels, chassis, specials, etc. We can save you money. R. H. Lynch, 970 Camulos, Los Angeles, Calif.

STANDARD FREQUENCY EQUIPMENT. Oscillator-Temperature control, Quartz bar. Three Multivibrators, One 224-L Wavemeter, One 384 oscillator with coils and rack. Price $550.00. L. M. Clausing, 5509½ Lincoln Ave., Chicago.

HIGH-Voltage Oil Condensers. Working voltage 4000, Capacity 1½ mfds. 17" high, 13½" long, 6" wide. $6.00 each. Robinson, 5507 Lincoln Ave., Chicago, Illinois.

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

CRYSTALS: X-cut, 160-80, ± two kilocycles $1.75. Spot frequency $2.50. Three small, 80 meter blanks, including carborundum and grinding instructions $1.20. Uptown Radio Shop, 1833 Elm St., Cincinnati, Ohio.

DOUGLAS Universal Class B Transformers—Match all tubes—Formerly W8UD audio's—50 watts audio $4.95 pair—100 watts audio $7.75 pair. Postpaid. Guaranteed. For details write W9IXR, WEYERHAEUSER, WISCONSIN.

QSL's—SWL's: New Rainbo effects! Samples! Fritz, 455 Mason Ave., Joliet, Illinois.

CRYSTALS: Those unbeatable Eidson "T9" X-cut 40 and 80 meters, $1.60. very close frequency supplied, fully guaranteed. "T9" ceramic holders $1.10, prices postpaid. COD's accepted. Eidson's, Temple, Texas.

QSL's. 300 one-color cards $1.00. Samples. 2143 Indiana Ave., Columbus, Ohio.

2500 V.CT.—400 Ma. Transformers $9.00. Also guaranteed plate and filament transformers designed to your specifications. Request prices. Michigan Electrical Laboratory, Muskegon, Mich.

BARGAIN: 100-watt, 160-meter phone transmitter and Denton receiver $70.00. W9UJP, Churubusco, Indiana.

FREE: 75c gift to RADIO or *QST* subscribers! W8DED, Holland, Michigan.

FABERADIO, after years of successful manufacturing still sells "Y" 160 and 80 meter crystals for 75c each. More than 4000 users are satisfied. "X" cut $2.25. "A" cut $2.75. Molded holders $1.00. Variable frequency holders $4.95. Commercial crystals a specialty. FABERADIO, Sandwich, Illinois.

METER Repair—Accurate and dependable service. Standard types of meters repaired in 24 hours. Repairs priced so that anyone can afford them. Write for price quotations. Braden Engineering Company, 305 Park Drive, Dayton, Ohio.

RADIO Engineering, broadcasting, aviation and police radio, servicing, marine and Morse telegraphy taught thoroughly. All expenses low. Catalog free. Dodge's Institute, Polk Street, Valparaiso, Ind.

FOR Sale: W. E. 1 kw. trans., 700A oscillator, water-cooled tubes, power amplifier, 8 h.p. motors, hi-voltage mica condensers, RCA 40C, 5000-volt meter, ampere-hour meter and much more. Ray Moore, W6ARX, 1627 North Alvarado, Los Angeles, Calif.

SOME of the answers to my advertisement in the January issue about stamps were destroyed by fire. If you answered and did not receive a reply, please answer again as I have lots of fine equipment to trade for stamps, W6KAT, La Canada, Calif.

METERS repaired, Ham's prices, W9GIN, 2829 Cypress, Kansas City, Mo.

110-VOLT AC generator, 200 watts, $14. 600 watts, $24.50. Katolight, Mankato, Minn.

RADIO will pay you for acceptable articles about your pet antenna, amplifier, transmitter, or receiver. Write 7460 Beverly Blvd., Los Angeles, for details.

ART work and cut for your QSL, $4.75 up. W6KX prints the best QSL's! Keith LaBar, 1123 N. Bronson, Hollywood, Calif.

INDEX TO ADVERTISERS

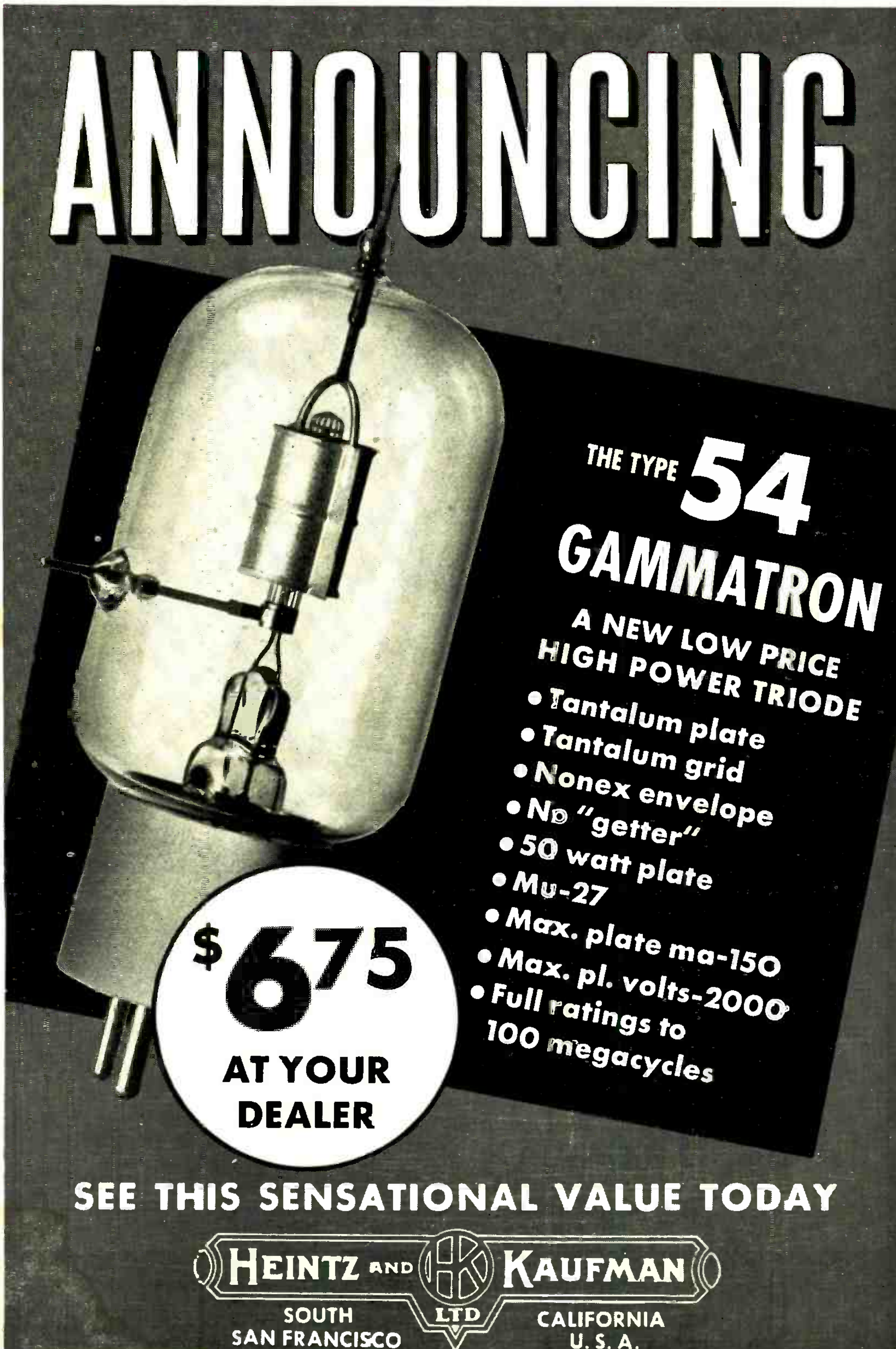
Callbook Clippings

We are receiving more complaints from amateurs who have sent in twenty-five cents to a "clipping service" in response to the following "bait":

"Dear *Sir:* Your name has appeared published in a recent *Radio Publication* having a circulation of approximately *universal.* Return this form to us, together with your remittance of 25c (in coin) and we shall be pleased to immediately forward clipping of same."

It seems to us that twenty-five cents is rather a high price to pay for a small clipping from the Radio Amateur Call Book.

In our estimation the whole book at $1.25 is a much better investment.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THE TYPE 54
GAMMATRON
A NEW LOW PRICE
HIGH POWER TRIODE
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• Tantalum grid
• Nonex envelope
• No "getter"
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• Mu-27
• Max. plate ma-150
• Max. pl. volts-2000
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100 megacycles
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Boosts Performance, Cuts Cost of Transmitting Tubes

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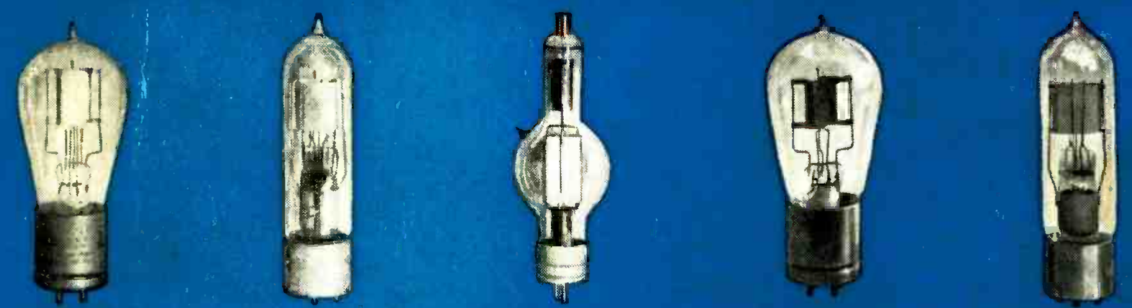
RCA pioneered the development and sale of transmitting tubes in 1921. Since then, RCA has greatly increased performance capabilities of these tubes, thereby insuring greater sales, which have consistently lowered price levels!

★ 1921 ★

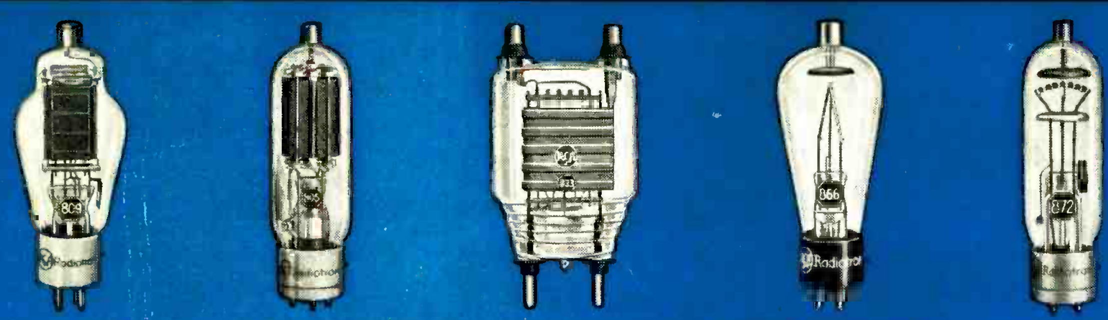
These transmitting tubes were developed and sold by RCA.



UV-202	UV-203	UV-204	UV-216—DC Output:	UV-217—DC Output:
"5 watter"	"50 watter"	"250 watter"	20 watts at 350 volts	150 watts at 1000 volts
$8.00	$30.00	$110.00	$7.50	$26.50

★ 1938 ★

These RCA transmitting tubes give better performance at lower cost.



RCA-809	RCA-805	RCA-833	RCA-866—DC Output:	RCA-872—DC Output:
Plate Input* 75 watts	Plate Input* 315 watts	Plate Input* 1250 watts	550 watts at 2300 volts	2980 watts at 2300 volts
$2.50	$13.50	$85.00	$1.50	$14.00

*Class C Telegraph Service

RCA presents the "Magic Key" every Sunday, 2 to 3 p. m., E. S. T., on the NBC Blue Network

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FIRST IN METAL
FOREMOST IN GLASS
FINEST IN PERFORMANCE

RCA MANUFACTURING CO., INC., CAMDEN, NEW JERSEY
A Service of the Radio Corporation of America

RADIO

ESTABLISHED 1917

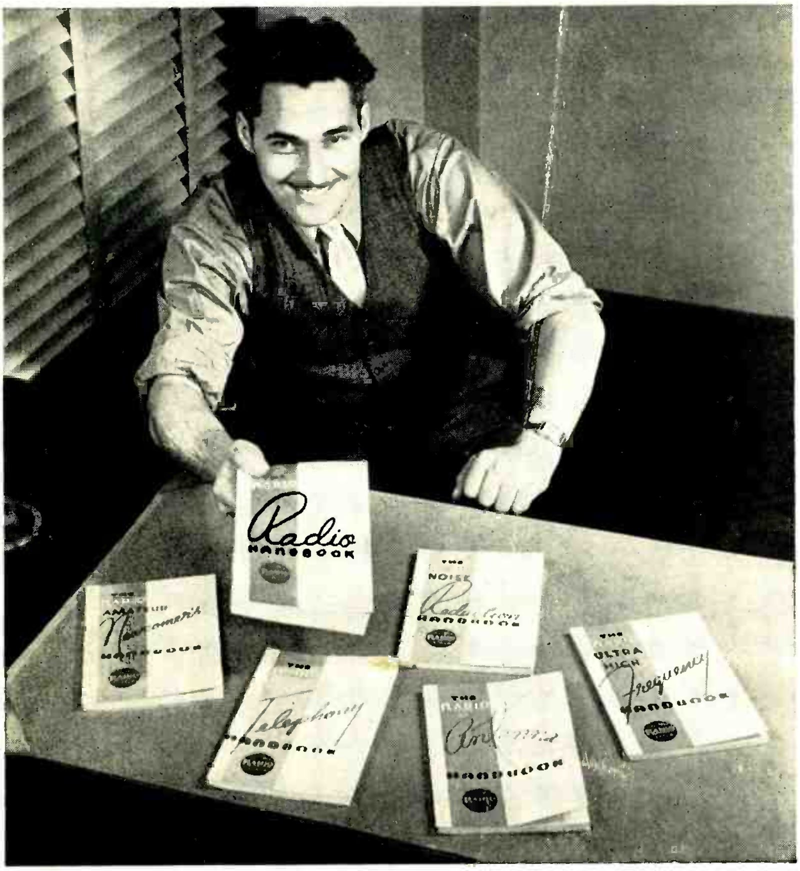
MAY, 1938 W8RHB 30c in U.S.A. and Canada
1/8 in the United Kingdom; 2/- in Australasia No. 229 ®

THE WORLDWIDE TECHNICAL AUTHORITY • OF AMATEUR • SHORT WAVE AND EXPERIMENTAL RADIO •

This Month:

A Diversity Receiver for 20-Meter Phone
The "Flextal" Simplified Conversion Exciter
A Five-Meter "Super Gainer" Receiver
A Modern-Design 500-Watt Modulator

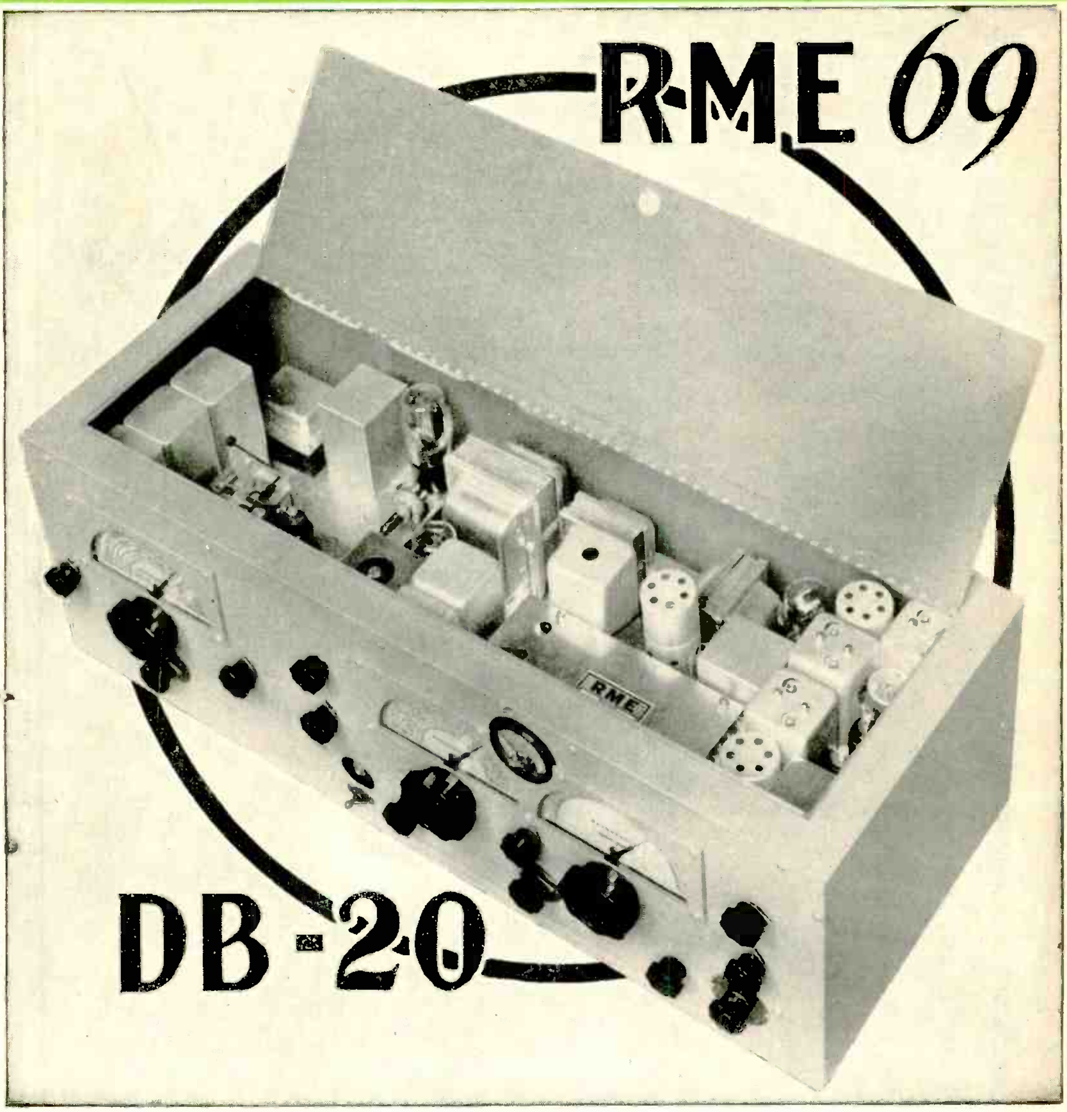
Let us remind you . . .



- that the 1938 RADIO HANDBOOK is still the best buy of the year at $1.50 (in continental U.S.A. Elsewhere, $1.65 or 7s.).
- that no other book has as much hitherto unpublished material . . . nor so much information between two covers.
- that no ham shack is complete without it.
- and that you can get it from your local radio parts dealer, news stand or directly from us at:

RADIO LIMITED TECHNICAL PUBLISHERS · 7460 BEVERLY BLVD. · LOS ANGELES

COMMUNICATION



AFTER THE NOVELTY WEARS OFF AMATEUR RADIO BECOMES A HABIT

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With thousands on the air making their daily schedules, working DX contests, carrying on in emergencies, it has become a habit for an amateur to say: "For receiver, I'm using an RME-69, OM", and many add "with a DB-20 pre-selector". This combination is now available in a single cabinet, either with or without antenna change-over switch and noise suppressor.

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306 FIRST AVENUE **PEORIA, ILLINOIS, U.S.A.**

RADIO

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Phone: CHickering 4-6218

Chicago Office:
3618 No. Bernard Street
Phone: JUNiper 5575

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1. *Radiooddities, Strays*, and the like may be sent to Rufus P. Turner[3].
2. Calls Heard may be sent to George Walker[2]; also dx news and station descriptions from eastern America and from transatlantic countries.
3. Advertising inquiries may be directed to our nearest office, but all copy and cuts should be sent direct to Los Angeles.

Unusable, unsolicited manuscripts will be destroyed unless accompanied by a stamped, addressed envelope.

[1] 512 N. Main St., Wheaton, Illinois.
[2] Box 355, Winston-Salem. North Carolina.
[3] 106 Chilton Street, Cambridge, Massachusetts.

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RADIO, *Entered as second-class matter. Published at 7460 Beverly Boulevard, Los Angeles, Calif.*

Radio, May, 1938 No. 229

RADIO is published ten times yearly (including enlarged special annual number) about the middle of the month preceding its date; August and September issues are omitted. Published by

RADIO LIMITED TECHNICAL PUBLISHERS 7460 BEVERLY BOULEVARD LOS ANGELES

IF YOU MOVE, notify us in advance: We cannot replace copies sent to your old address.

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ENTERED as second-class matter February 6, 1936 at the postoffice at Los Angeles, California, under the Act of March 3, 1879. Registered for transmission by post as a newspaper at the G.P.O., Wellington, New Zealand.

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★

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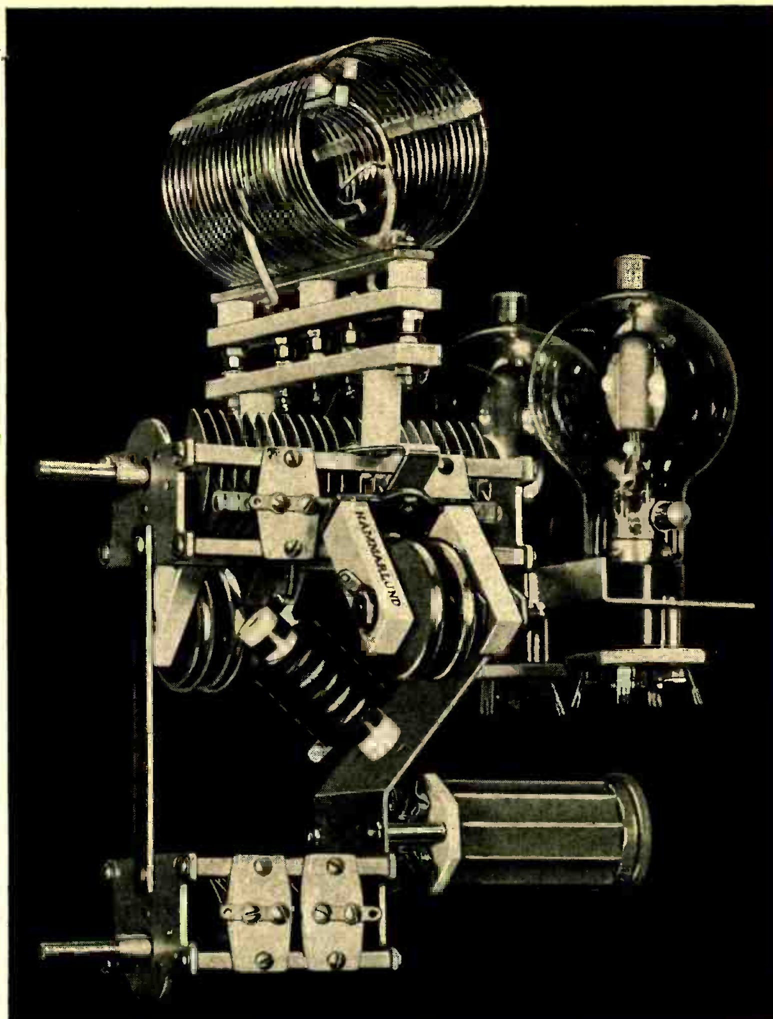

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PRECISION PRODUCTS FOR BETTER RADIO

HAMMARLUND

May • 1938 Number 229

RADIO

In this issue "Radio" presents:

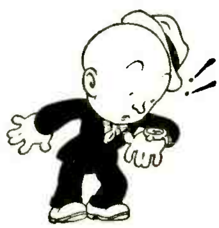
ARTICLES

MISCELLANEOUS FEATURES

DEPARTMENTS

THE WORLDWIDE TECHNICAL AUTHORITY OF AMATEUR, SHORTWAVE, AND EXPERIMENTAL RADIO

TIME



and radio

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RADIO DIGEST

7460 Beverly Boulevard, Los Angeles

INDEX TO ADVERTISERS

Introducing 2 NEW Hallicrafters Receivers . .

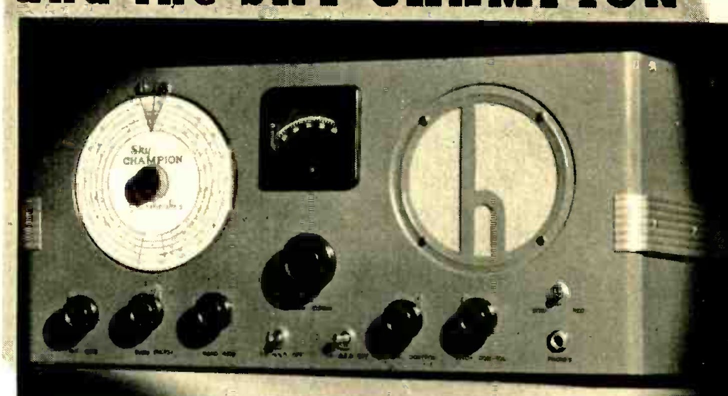
the SKY BUDDY

Only an organization with the facilities, experience and resources of the Hallicrafters could build a practical communications receiver to sell at this low price. The 1938 SKY BUDDY covers everything on the air from 18.5 MC to 545 KC, including the 20, 40, 80 and 160 meter amateur bands, regular broadcast, police, aviation, foreign short wave, and government services. It's an amateur's receiver in every respect—an AC set of conventional power transformer construction, and built of highest quality material and parts throughout. Sensitivity and selectivity are comparable only to receivers selling at many times its modest price. Any amateur or critical short wave listener will be delighted at its fine performance—it has all the painstaking, careful engineering of the better Hallicrafters receivers. See the New 1938 SKY BUDDY at your Hallicrafters dealer today.

Amateur's Net Price Including Speaker and Tubes **$29.50**

- 5 Tubes
- 3 Bands
- Complete Coverage 18.5 MC to 545 KC
- Built-In Speaker
- Separate Band Spread Dial
- Easily adapted for battery operation
- All necessary controls

and the SKY CHAMPION



At no time previously, has the Amateur or Short Wave Listener with a limited purse been offered so much in a communications receiver for so little in price. The SKY CHAMPION is an 8-Tube, AC superheterodyne with Pre-Selection, complete coverage from 44 MC (6.8 meters) to the top of the broadcast band, Built-in Speaker, every essential control for amateur reception and a Band Spread better than A. R. R. L. Handbook recommendations. In Sensitivity, Selectivity and all around performance, the SKY CHAMPION equals and betters receivers selling at double its price. It's a true Hallicrafters receiver—incorporating only the finest of parts, and the most careful and painstaking engineering and workmanship.

See the New Sky Champion at your Hallicrafters dealer today or write for complete information.

Amateur's Net Price Including Speaker and Tubes **$49.50**

- 8 Tubes
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- 4 Bands
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- Separate Band Spread Dial
- Individual coils for each band
- Every essential control for efficient amateur reception

A champion endorses the SKY CHAMPION. Mr. T. R. McElroy, Famous World's Champion Code Operator says: "Congratulations on the SKY CHAMPION! It's got performance you can't get for twice the money elsewhere!"

All Hallicrafters Receivers Available at Liberal Time Payments

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2611 Indiana Avenue, Chicago, U. S. A. • Cable Address: "Hallicraft" Chicago

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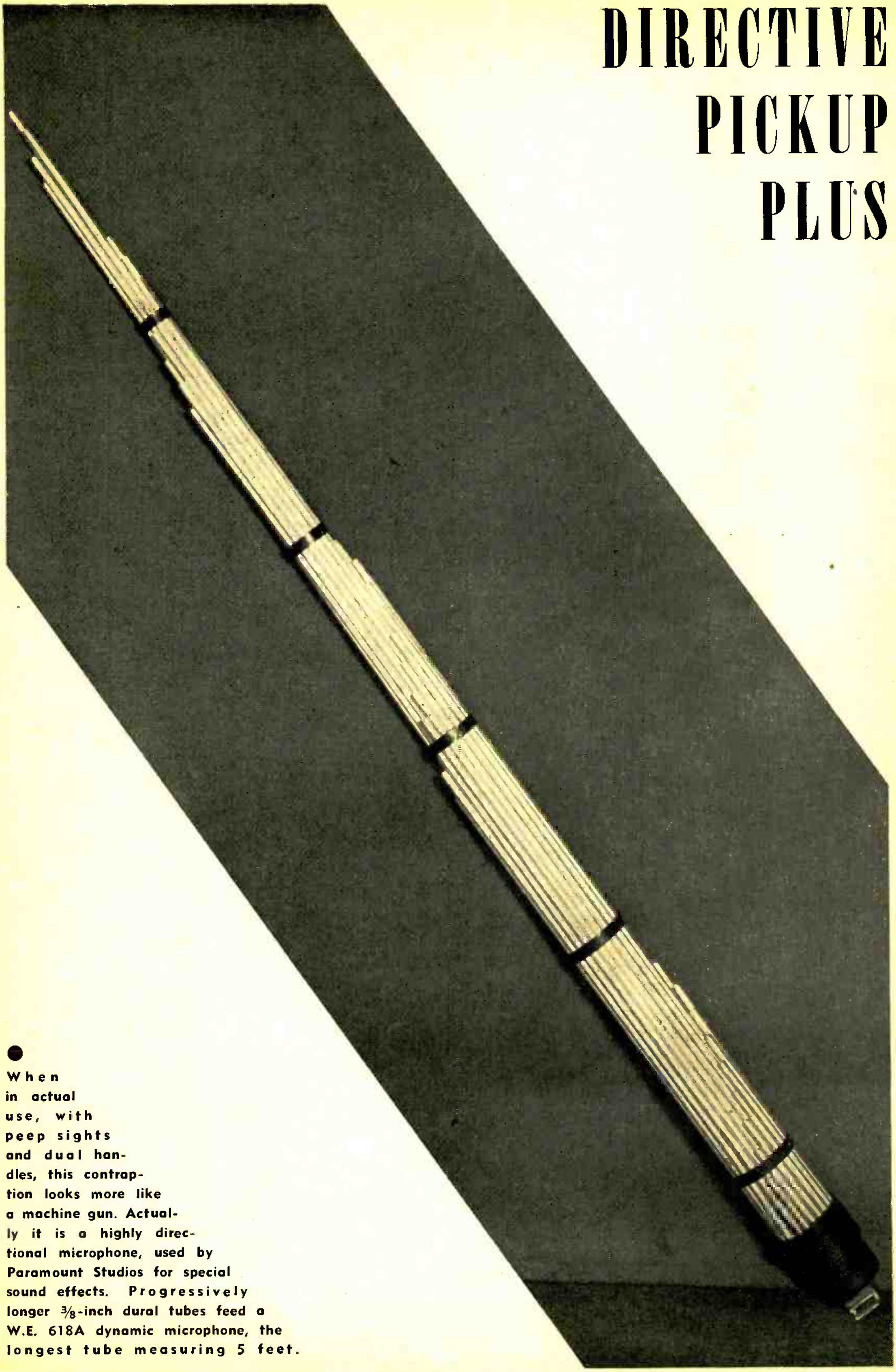
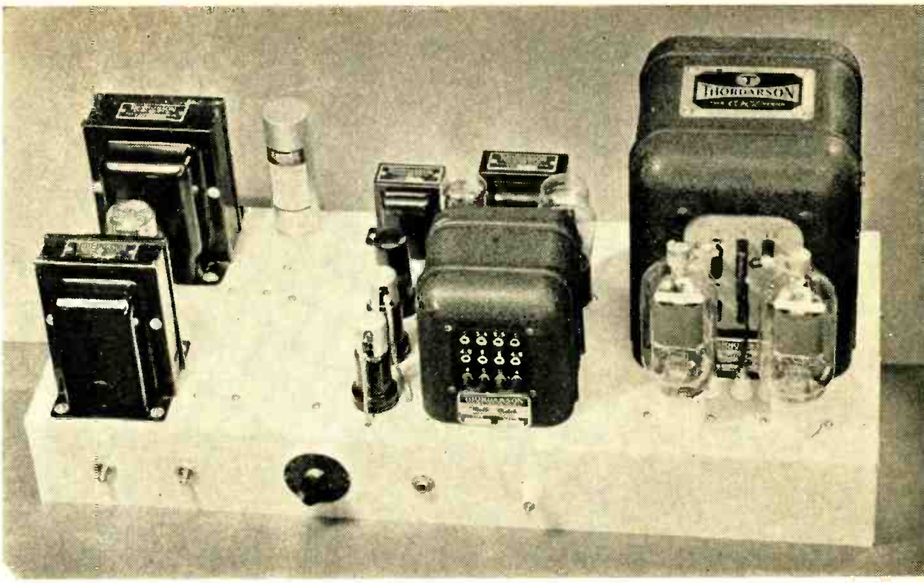
DIRECTIVE PICKUP PLUS



When in actual use, with peep sights and dual handles, this contraption looks more like a machine gun. Actually it is a highly directional microphone, used by Paramount Studios for special sound effects. Progressively longer ⅜-inch dural tubes feed a W.E. 618A dynamic microphone, the longest tube measuring 5 feet.

● The complete modulator as built upon a 24"x10"x3" chassis.



A SPEECH-MODULATOR

of Modern Design

● *By* RAY L. DAWLEY,* W6DHG

In recent months a number of improved tubes, improved circuit arrangements and new ideas have been published concerning high-level modulators and modulation systems. With these new thoughts in mind it was not a particularly difficult task to design and build a modern-design speech amplifier-modulator to incorporate them.

A.M.C.

First, and perhaps most important of the improved ideas that have been publicized in recent months concerning modulation systems is automatic modulation control[1]. A number of other methods of controlling the peak amplitude of the voltage have been suggested but the one advocated by Waller seems to incorporate the largest number of desirable points. This arrangement *does* effectively hold the modulation percentage below 100% regardless of the modulation waveform, the response characteristics of the complete amplifier and modulator or of its power-handling capabilities. Also, as has been mentioned before in connection with modulation-percentage limiting devices, the actual effective modulation percentage is raised. The gain on the amplifier may be turned up to a higher level than would be possible without a.m.c. Then, due to the limiting characteristics of the circuit, the gain of the amplifier will be raised for low-level voice passages and reduced to an amount which will prevent overmodulation on the high-level ones. All in all, a.m.c. is decidedly a feature to be incorporated in any speech amplifier-modulator of modern design.

Degenerative Feedback

It has been proven by Nalley[2] that degenerative feedback between the grids of the class-B tubes and their drivers in a class-B modulator exerts a definite improvement in the quality of output of the modulator through a reduction in harmonic generation. Hence, feedback between the class-B grids and their drivers has

*Technical Editor, RADIO.

[1] "Automatic Modulation Control," Waller. RADIO, March, 1938, p. 21.

[2] "Negative Feedback Applied to Class-B Audio," Nalley. RADIO, July, 1937, p. 54.

been used in this modulator. The improvement in quality was easily noticeable in a listening test made upon the modulator when it was operating with and without feedback. Of course a portion of the distortion that was apparent when the modulator was operating without feedback was caused by the use of beam tetrodes as drivers for the class-B stage. But when the feedback was cut into the circuit the distortion was considerably lower than that experienced when using low-μ triodes as drivers in the conventional arrangement.

Modulation Capability

Another idea taken into consideration in the design of the amplifier-modulator was that of obtaining the maximum peak power output from the modulator tubes. In an article that appeared in the April RADIO[3] Douglas Fortune, W9UVC, analyzed the now commonly known fact that more class-C input can be modulated 100% by voice waveforms with a certain complement of tubes than can be modulated by a sine wave. His analysis mentioned the fact that an audio amplifier will modulate a class-C input numerically equal to its *peak* audio output. It is well known that the peak power contained in a sine wave is twice its average power. The peak power contained in an ordinary speech waveform is from three to four times its average power. So if we design the class-B amplifier stage so that it is capable of a high ratio of peak-to-average power output, it will be capable of modulating considerably more input to the class-C stage.

It is possible to obtain a high ratio of peak-to-average power from a class-B modulator by working the class-B tubes into a somewhat lower than average plate load impedance, and by proper design of the driver stage. Through these design principles, the modulator described, although only capable of an output of about 175 *average* watts at the plate voltage recommended (1000 volts) it is capable of a *peak* output of approximately 500 watts at this same voltage—and consequently is capable of modulating 100% by voice an input of 500 watts to the class-C stage.

Mechanical Construction

The combined speech amplifier-class-B modulator with the associated power supply for the speech amplifier, is built upon one 24"x10"x3" metal chassis. All the mounting holes for the equipment and the sockets were drilled first. Then the top side of the chassis was painted with aluminum gray lacquer. The under side of the chassis was not painted; the plated cadmium finish on this side facilitated the grounding of the various components.

The power supply for the speech stages is mounted along the left hand side of the chassis. Then there are mounted, in a row, the 6J7 first audio stage, the 6L7 a.m.c. amplifier and the 6F6 last audio. Then, in the next row, in front is the multi-tap driver transformer for the class-B stage, then the two 6V6 drivers, and in back, the coupling transformer between the 6F6 and the two 6V6G's. On the right hand end of the chassis are mounted the two TZ40 modulators and their associated class-B output transformer.

Looking at the front of the chassis can be seen at the extreme right, the on-off switch for all filaments and for the plate supply for the speech amplifier. The plate supply for the TZ40's is controlled at the transmitter proper. The next switch is the on-off switch for the a.m.c. circuit. Then comes the gain control, the microphone input jack and the binding post for connection to the a.m.c. peak rectifier.

The under-chassis view is practically self-explanatory. At the extreme right end of the chassis is the 7.5-volt filament transformer for the TZ40's and to the left of the center of the chassis are mounted the resistor plates. Only the upper one can be seen as the two are mounted one above the other.

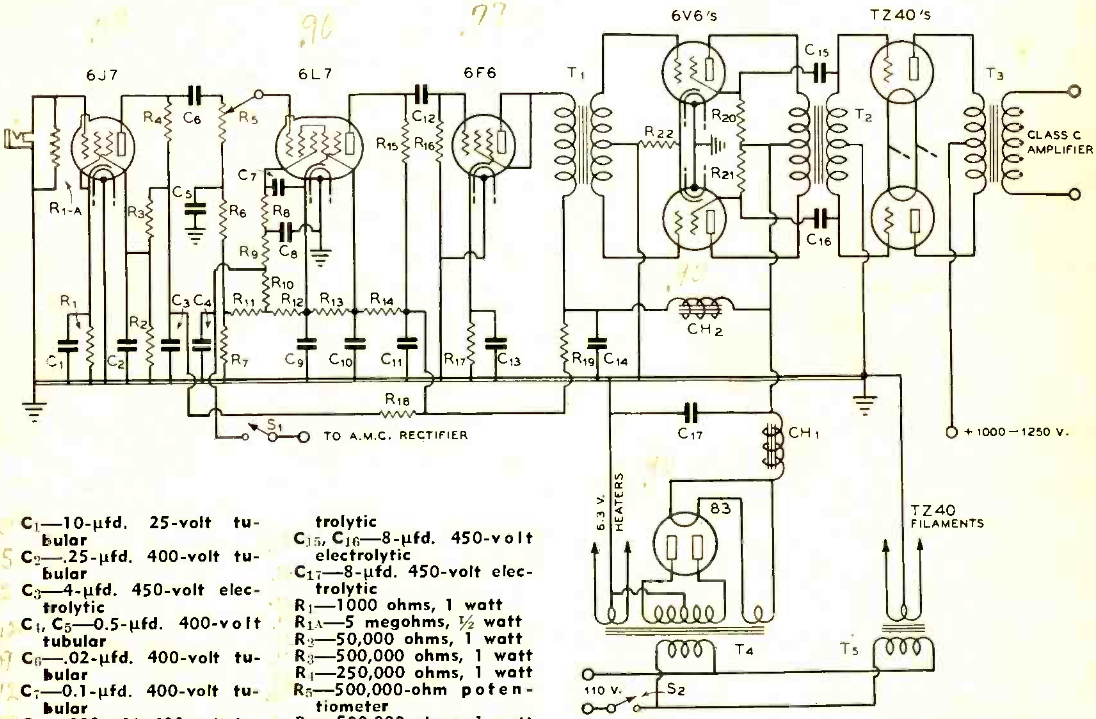
Electrical Design

The speech amplifier uses a 6J7 metal tube connected as a high-gain pentode in the input. The circuit is conventional and the tube is designed to operate from a diaphragm-type crystal microphone. The closed circuit jack on the input of the amplifier is shielded by a small metal can to eliminate any possibility of coupling between the output of the amplifier and the input circuit. Since the large metal spring of the jack is at grid potential it was deemed desirable to shield it from the output circuit of the 6V6G's and from the a.m.c. lead which also runs very close to the jack.

The 6L7 A.M.C. Stage

The second stage of the amplifier—the a.m.c. stage—utilizes a 6L7 tube and is connected essentially the same as the analogous stage in the amplifier described by Waller[1]. The 500,000-

[3] "More Speech Power from Class-B Modulators," Fortune. RADIO, April, 1938, p. 49.



C_1—10-μfd. 25-volt tubular
C_2—.25-μfd. 400-volt tubular
C_3—4-μfd. 450-volt electrolytic
C_4, C_5—0.5-μfd. 400-volt tubular
C_6—.02-μfd. 400-volt tubular
C_7—0.1-μfd. 400-volt tubular
C_8—.002-μfd. 400-volt tubular
C_9—8-μfd. 450-volt electrolytic
C_{10}—0.5-μfd. 400-volt tubular
C_{11}—8-μfd. 450-volt electrolytic
C_{12}—.05-μfd. 400-volt tubular
C_{13}—10-μfd. 25-volt tubular
C_{14}—8-μfd. 450-volt electrolytic
C_{15}, C_{16}—8-μfd. 450-volt electrolytic
C_{17}—8-μfd. 450-volt electrolytic
R_1—1000 ohms, 1 watt
R_{1A}—5 megohms, ½ watt
R_2—50,000 ohms, 1 watt
R_3—500,000 ohms, 1 watt
R_4—250,000 ohms, 1 watt
R_5—500,000-ohm potentiometer
R_6—500,000 ohms, 1 watt
R_7—4500 ohms, 5 watts
R_8—1 megohm, 1 watt
R_9—100,000 ohms, 1 watt
R_{10}—500,000 ohms, 1 watt
R_{11}—350 ohms, 1 watt
R_{12}—150 ohms, 1 watt
R_{13}—5000 ohms, 5 watts
R_{14}—7500 ohms, 5 watts
R_{15}—100,000 ohms, 1 watt
R_{16}—100,000 ohms, 1 watt
R_{17}—750 ohms, 10 watts
R_{18}—10,000 ohms, 5 watts
R_{19}—2000 ohms, 5 watts
R_{20}, R_{21}—5000 ohms, 3 watts
R_{22}—300 ohms, 10 watts
T_1—Triode power tube to p.p. power tube driver transformer
T_2—Multi-match class-B input transformer
T_3—Multi-match class-B output (300 watt)
T_4—745 c.t., 145 ma.; 5 v., 3 a.; 6.3 v., 4.5 a.
T_5—7.5 volts, 4 amperes
CH_1—10-hy., 150-ma. filter choke
CH_2—10-hy., 65-ma. filter choke
S_1—A.m.c. on-off switch
S_2—110-v. a.c. switch

ohm volume control is placed between the plate circuit of the 6J7 and the control grid of the 6L7. It is important that this potentiometer be of the insulated-shaft type since the entire 6L7 circuit operates considerably above ground potential. A complete description of this circuit and of its operation was given in the article previously referred to. One slight change has been made in the RC filter in the injector-grid circuit of the 6L7. It was found that the return-to-normal time constant of the network was, under certain conditions, slightly too long. Changing the value of the condenser from the injector grid to ground from 0.5 μfd. to 0.1 μfd. sufficiently lowered the constant of the network. Aside from this quicker return to normal after an unusually strong signal has passed, the operation of the 6L7 is the same as the one used by Waller.

The 879 reverse peak rectifier should be connected in the conventional manner; the plate of the tube should be connected directly to the a.m.c. binding post on the amplifier, and the filament of the tube should be connected to the lead that goes to the plates of the modulated class-C amplifier. The filament should be lighted from a 2.5-volt filament transformer that is adequately insulated for twice the average plate voltage of the modulated amplifier plus 1000 volts. Also, it is often a good idea to remove the negative peak rectifier as far as conveniently possible both from the speech amplifier and from the class-C final.

Since the injection grid of the 6L7 a.m.c. amplifier is 70 to 90 volts above ground potential (the whole a.m.c. stage is, as mentioned before, at this potential above ground) the 879 peak rectifier will begin to operate when the plate voltage on the class-C amplifier becomes less than 70 or 90 volts, whatever the case may be. Then, as the modulator tends to drive the plate voltage lower than this the gain on the speech amplifier will be reduced as the injector-grid bias on the 6L7 becomes negative. As this negative bias is increased, the signal output of the modulator is reduced. The final result: the output voltage of the modulator is reduced to an amount that will not cut the negative-peak plate voltage on the class-C stage to zero; consequently, there is no overmodulation. And, the gain on the speech amplifier may be run up to an amount which will permit a higher average voice level from the transmitter without any chance of overmodulation under any case. When the resulting signal is heard over the air, the transmitter seems to be modulated at a much higher percentage although there is no tendency toward overmodulation splatter or hash.

The next stage, a 6F6, is connected as a low-μ triode and is transformer coupled to the grids of the 6V6G's used as drivers. The 6F6 is triode connected for two reasons: first, since there is ample gain obtained for any ordinary condition of operation from the cascaded 6J7 and 6L7, the low-μ of the triode-connected 6F6 serves only to step up the power output of the 6L7 to the amount needed by the 6V6G's without greatly increasing the gain; and second, a power triode in this position will have somewhat less distortion than either a pentode or a low-level triode such as a 6C5. The coupling transformer between the plate of the 6F6 is designed to carry the plate current of the 6F6 without saturation of the core. It is designed with a step-down ratio to feed the grids of a pair of power tetrodes or triodes.

The 6V6G Drivers

A pair of 6V6's or 6V6G's are connected as tetrodes with degenerative feedback coupled into their screen circuits. This method of connection for the 6V6G's adapts them very well as drivers for the TZ40's since the plate impedance of the tubes is very considerably lowered by this method of connection.

Beam tetrodes when connected in the conventional manner are not particularly well suited as drivers for a class-B stage unless a considerable amount of swamping is used. The high plate resistance of the tubes in the conventional method of connection causes a large drop in output voltage when any increase in load is placed upon them. But by connecting them in this manner two important advantages are accrued. First, the two resistors, R_{20} and R_{21}, act as swamping resistors for the grid circuit of the TZ40's. Second, since feedback is introduced into the 6V6's, their gain is raised or lowered from the operating value by an amount depending upon the conditions of drive to the modulator.

Operation of the Feedback Circuit

An explanation of the operation of this arrangement for obtaining negative feedback should be of interest. First, if the screen potential is maintained at a constant value with respect to the audio voltage, the tubes will operate as conventional tetrodes with high gain and high plate resistance. Then, if the screens are connected to the plates of their respective tubes, the screens will swing back and forth at an audio voltage of the same phase and magnitude as that of the plates. The tubes then operate as conventional triodes with low gain and low plate resistance, but *without* the ability of adjusting their gain to conform to varying conditions of load. Now, by connecting the screens to a source of voltage of the same *phase* as the plates but of different magnitude (the correct driver transformer ratio is 4 to 1, step down), the gain of the tubes will be reduced to some value between that obtained with tetrode connection and that obtained with triode connection. In other words, with the tubes connected as shown, they will be operating under conditions between those of tetrode and triode operation.

Now, with this thought in mind, consider what happens during an audio cycle when the 6V6G's are driving the TZ40's. As the audio voltage increases, the grids of the TZ40's start to draw grid current and the loading across the secondary of the driver transformer increases. Ordinarily this increased loading would lower the voltage appearing across the winding but another condition comes into play. As this voltage tends to decrease due to increased loading, the amount of voltage that is being fed back to the screens of the 6V6G's tends to decrease. But, as the feedback voltage tends to decrease, the gain of the 6V6G's tends to increase and thus tends to counteract the condition and hold the voltage up to the value that would be obtained if there were no non-linear loading on the secondary.

Thus the use of this system of degenerative feedback greatly reduces any tendency toward distortion in the place where distortion most commonly occurs in a class-B modulator: in the tubes and in the driver transformer.

However, when first placing the amplifier in operation, it is very important that the screens be connected to the proper side of the class-B modulation transformer secondary. The only way of finding out which side is the proper one is to connect up the amplifier and try it out. If you have, by some queer trick of fate (the odds are 1 to 1), connected the proper screens to the proper grid circuits everything will be lovely. If not, the amplifier will leave no doubt in your mind; it will oscillate quite vigorously and with much gusto at about 500 cycles. It is a fine idea not to have the plate voltage on the TZ40's when this test is made—something is liable to flash over. If the 6V6G's do oscillate, reverse the connections between the screen grid coupling condensers and the class-B grids and the correct phase relation between the screen and plate voltages will be obtained.

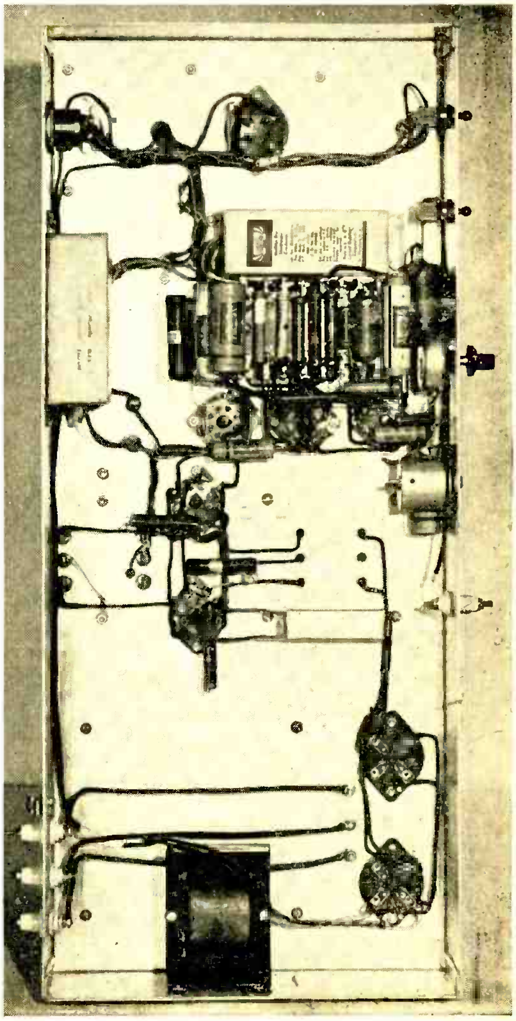
The TZ40 Class-B Stage

The TZ40's operate with zero bias under the conditions recommended by the manufacturers. The standing plate current on the two tubes is approximately 45 ma. with an applied plate voltage of 1000 volts. It will be somewhat higher, in the vicinity of 60 ma., if the full rated plate voltage of 1250 volts is used. Since these values of standing plate current require an appreciable amount of plate dissipation from the tubes, a small amount of grid bias will lower the plate current under no-signal conditions by a considerable amount. It would only be necessary to connect a 4½-volt "C" battery between the center tap of the driver transformer for the 1000-volt conditions; a pair of 4½-volt batteries in series to give 9 volts would be best for 1250-volt operation.

For maximum peak power output from the TZ40's, that is for the adjustment which will modulate the greatest class-C input with voice, the plate-to-plate load impedance for the 1000-volt conditions would be 5100 ohms. Under these conditions of operation the complete modulator would be capable of 100% modulating an input of 500 watts to the class-C stage; the plate current on the TZ40's should kick up to 200 to 250 ma. under normal modulation.

For maximum peak modulating capabilities at 1250 volts the plate-to-plate load value should be 7400 ohms; the unit would be capable of fully modulating 600 watts input and the plate current would kick up to 175 to 225 ma. under full modulation.

If it is desired to operate the class-B stage under the conventional conditions for maximum *sine-wave* audio output, the plate-to-plate load resistance would be 6800 ohms under the 1000-volt conditions; the power output would be 175 rated watts and the plate current would drive up to 250 to 275 ma. on peaks.



In this view, the modulator is standing on end. By comparison with the circuit diagram, placement of parts can be easily figured out.

Band Leader, W2AD

● The candid camera caught Andy Sannella in a moment of great exuberance while conducting his orchestra during a C.B.S. broadcast. (In addition to leading a dance band, W2AD plays several instruments and is one of the best of the electric guitar performers.) He works up as much enthusiasm for amateur radio, in which he has been interested for about 10 years. W2AD started out with a transmitter using a pair of 852's in the final. Now, with a kilowatt phone and c.w. rig, he operates usually on 20 meters, but also likes to hear what the boys are doing on 40, 75, and 160.

Movie Actor, W6OSP

● Movie-going hams have heard Donald Grayson sing in Columbia's musical westerns, as well as talk over the air on 10-meter phone. Before the films found the tenor-voiced radioman, W6OSP was violinist with Henry Busse's orchestra, Harry Sosnick and Johnnie Hamp, here and abroad. W6OSP has had his call about a year now . . . before that, he traveled around so much that nothing but a portable would have done.

Tennis Star, W5VV

● Wilmer Allison, the long-legged Texan on the left, is a champion in two fields: radio and tennis. In spite of a world championship in tennis, he says he is most proud of winning the 1937 dx contest for the fifth district! His tennis titles include: American champion in singles, doubles and mixed doubles, world's champion in doubles, and national intercollegiate champion in singles. He started hamming back in 1919 with the call 5TC, but let the hobby slide until he finished college and received the call W5VV. He's been on the air consistently since then—usually 10- and 20 meter phone and c.w. During his annual tennis trips around the world, he visits fellow radio hams and manages to maintain skeds with W5BB, his brother-in-law.

"It takes all kinds . . ."

Almost every profession and trade in the world will be found among those who are amateur radio operators. Here are representatives from five different activities: radio industry, sports, journalism, motion pictures, entertainment.

Editor

• Jack Clarricoats, G6CL and R.S.G.B. secretary, wonders whether he should make another w.a.c. and w.b.e. or try to snag Nevada, Wyoming and South Dakota for his w.a.s. "Clarry" edits the "T. & R. Bulletin" and "A Guide to Amateur Radio", knows about 2000 of the 3200 R.S.G.B. members, invariably carries a black notebook full of facts and figures pertaining to ham radio, enjoys talking extempore, expects to see at least one of his three youngsters with a call one of these days.

N. A. B. Man

• N.A.B. refers to the fact that Herb Hollister, W9DRD, is on the executive committee of the National Association of Broadcasters board of directors. W9DRD will be remembered by old timers as the maker of many of the first quartz plates used in amateur transmitters. To everyone, he is the man who now general manages KANS Broadcasting Co.

After the "SK"

By **ERIC T. LEDIN,* W6MUF**

Among the "Q" signals one of the most common is undoubtedly QSL. How it started nobody knows. That it will not end is quite certain. Without benefit of commercialism the custom has become universal among amateurs. Although occasionally a feeble complaint is heard, the growing stack of cards or the spreading "wallpaper" continues to be for many of us the focal point of sleepless hours.

That there are hams so blase as to be bored with foreign cards is hard to believe. At the present time there are roughly 100,000 unclaimed cards in the nine W QSL Bureaus. Visualizing this "mint" in relation to the meagre accumulation on my own desk has speedily deflated the ego.

Curiously, in thirteen years, I have yet to meet a ham who does not hold his QSL's in high esteem. To me they are the top rewards for achievement. They are indisputable proof of accomplishment. No apologies for haywire when XU's and OZ's line the walls. The personality at the other end of the contact is not complete until his card arrives.

It is true that international dx is now taken for granted and contacts rare enough to demand proof are scarce. Naively though, and perhaps with a tincture of sour grapes, I aver that the ten-zone ham is still in the majority. It is to us then, that a survey of what goes on in the QSL Bureaus is a revelation.

During the year 1937 well over 300,000 cards were handled by the nine Bureaus in the United States. Add to this the much greater number of cards exchanged direct, plus those handled by VE and other Bureaus throughout the world and the figure deserves a gasp. Almost all foreign countries now maintain this service, and local QSL's are redistributed in large packets to other Bureaus throughout the world.

It was in 1932 that the idea of the QSL Bureaus originated. Prior to this time cards had been distributed from A.R.R.L. headquarters in Hartford, but for various reasons it became necessary to discontinue the service. Herman Schmidt (W2AEN) of Bronx, New York, took over the first amateur QSL Bureau, and was shortly succeeded by Henry Yahnel (W2SN) who still holds the second district appointment. The experiment was a success in this district, and shortly appointments were made in the other eight districts and Canada.

As an example of the increasing popularity of the QSL card, in 1933, 10,174 cards were handled in the second district and by 1937 the number had increased to 35,716.

The increase is general in all districts. In the eighth, cards have increased by 15,000 in the last two years and so far, 1938 is far ahead of 1937. The number of envelopes handled has likewise increased about five times in as many years, but the chief problem has always been and still is—how to inveigle addressees into collecting their loot. As a general rule about 50% of the cards find envelopes and are promptly forwarded. Of the remainder only about 20% eventually reach the owners.

A number of methods of ridding the files have been tried. It seems that without exception, the sight of all these rare cards has inspired the various managers to rack their brains and raid the bank in philanthropic efforts at distribution with uninspiring results. One-sixty phone, eighty-meter c.w. nets, and printed notices have been tried. W5DKR sent out 2,000 notices and received replies from about one-third. W3CZE has tried the same stunt but is still swamped with unclaimed cards. W2SN printed up 2,000 cards and received about 50% replies.

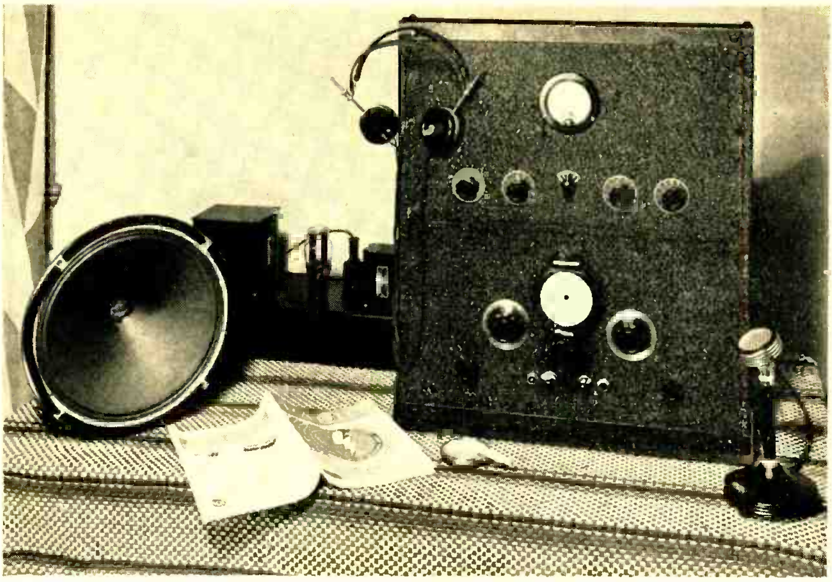
As is to be expected, about fifty stations in each district lead the list and corner the quantities, but in one district alone there are now 30,000 cards on hand which belong to some 5500 different stations. Cards are on hand which date back to 1929. In January of this year, W1GBY received a consignment from Belgian Congo covering QSO's made in 1934.

As an average, twenty-five to fifty parcels of mail are received daily at each Bureau and in several instances as high as four thousand

[*Continued on Page 77*]

*244 Excelsior Lane, Sausalito, Calif.

• If desired, the receiver can be altered to accommodate another set of coils for 10-meter phone.



A DIVERSITY RECEIVER

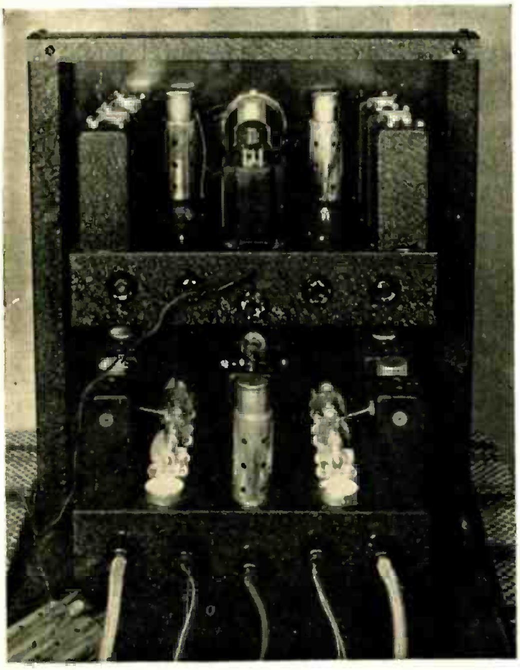
for 20-Meter Phone

By **RAYMOND P. ADAMS***

A diversity receiver featuring all-band coverage, single dial control, and metering for full visual indication of gain balance, signal conditions in each channel, and combined output, might be a pretty nice thing to have in the shack and might be as impressive in its operation as in its appearance. But we're somewhat doubtful if any such set-up would be within the financial and constructional reach of the average amateur.

There's not only the enormous cost of the many required parts to consider—there's the question of whether or not some of these components may be conveniently acquired. And then, another consideration, of what practical worth to the amateur is diversity reception on the broadcast band, 160 meters, and other low-frequency signals? If a diversity job is built primarily to eliminate fading 'phones, and if fading is particularly troublesome on say 14 Mc., why an immense, expensive, complex rig which has comparatively little functional value except on these higher frequencies? As a diversity receiver performs best when fed by directional receiving antennas, one spaced to take the valley as the other takes the peak of a fade, and cut to approximate wavelength, what sort of signal collectors would we require to get good diversity action on all bands? How about the antennas for 160-meter reception? Just think of them—spaced the necessary two wavelengths or more. The only practical diversity installation for amateur use would be one built for service on some one or two specific bands,

*1717 No. Bronson Ave., Hollywood, Calif.



● Back view of the receiver proper. The two i.f. channels, second detectors, and the 6B5 power stage are mounted upon the upper chassis while the two r.f. channels and the h.f. oscillator are on the lower one. The two mixer tubes have been removed from the bottom chassis to show the ganged r.f. tuning condensers. The inter-connecting power and i.f. cables also have been removed for the sake of clearness.

preferably in the higher frequency range. The most logical band is 14 Mc., with perhaps 28 Mc. added as the occasion demands. It is possible that a special receiver might be designed for 3.9-Mc. phone—the receiver to be described might even be adapted to it—but that would be another design problem and possibly can be covered at a later date.

The receiver to be described is strictly a 20-meter phone band affair, although it could be altered slightly to accommodate another set of coils for 10-meter phone. The circuit is simple, straightforward and understandable; actually it is very similar to the conventional common high-frequency superhet layout and uses conventional tubes. The two channels are physically and electrically symmetrical, entirely free of cross-coupling and individually stable. The receiver is built upon a two-deck rack with the r.f. parts on the lower and the i.f. and a.f. components on the upper chassis; the power supply is a separate external unit. The main dial tunes the common h.f. oscillator and affords full-scale band spread. R.f. tuning is direct-drive controlled, separately, for each channel.

Layout

On the upper panel are the "R" meter, the diversity switch, the audio and tone controls, and the gain-balance controls for the i.f. circuits. On the lower are the tuning dials to which we have already referred, the r.f. gain control, the common i.f. gain control, pilot indicator lights for each channel, and switches for communications on-off and break-in. Layout for the two chassis is for the most part symmetrical; i.f. transformer cans have the same dimensions as the r.f. shield boxes, the same positions and the same physical relation to associated stage tubes. R.f. stages move back from the lower front panel toward the rear of the bottom chassis; i.f. stages are in line forward, from the rear of the uppermost base toward the upper panel. The 6J7 h.f. oscillator lies between the two 6L7 mixers, directly beneath the output transformer, which is in a horizontal line with the 6B5, 6C5 driver, and R meter (the meter is positioned between the two diode-triode second detectors).

This has been found to be a thoroughly practical layout permitting short-lead wiring with good isolation between stages and a logical sequence of connections between them. The only long leads are those between the chassis, and the only important long ones, those between the 6L7 plates and the input i.f. transformers. But these latter leads have been carefully shielded to reduce the possibility of any bad effects resulting from their length.

The R.F. Circuits

As the two input channels are symmetrical and identical, anything said in description of one is applicable to the other. We shall therefore simply discuss the r.f. circuits as though they were only one channel—the other channel is the same conventional receiver.

Two r.f. stages have been used to afford good r.f. preselection and gain. One stage, with regeneration, will do the trick almost as well but would involve the use of some sort of feedback control and would be more difficult to align properly. The first of these departs from conventionality slightly through its incorporation of a 6J7G, which is neither manually nor automatically gain controlled, and which performs slightly better with weak signal inputs than the remote cut-off "K". The second stage employs a 6S7G, with a.v.c., though a 6K7G may be substituted if filament drain is of no great concern. Small 2.1-mh. pie-wound r.f. chokes have been placed in each of the two plate circuits and the screen circuits are de-coupled with 5,000-ohm resistors.

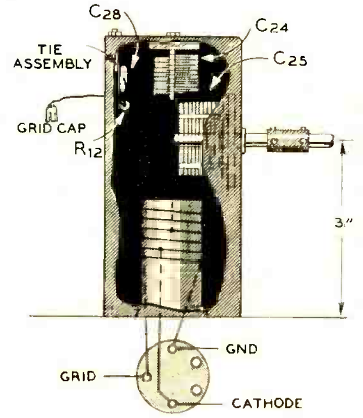
The mixer is the usual 6L7—probably the only tube available to us which provides maximum isolation between two detector circuits working in diversity channels and fed by one common h.f. oscillator. Operating with rather high screen voltage obtained through a dropping resistor from B plus and neither automatically nor manually gain controlled, this tube does its usual excellent job of conversion. We suggest the use of the straight metal type 6L7, due to its efficient self-shielding even though glass tubes may be used elsewhere in the set. A change from a glass 6L7G to a metal one in the receiver shown completely eliminated any tendency toward instability.

The H.F. Oscillator Circuit

The high-frequency oscillator circuit employs a 6J7 in a high-C e.c. hookup, and provides ample output for dual mixer excitation. The coupling condensers have been brought down to 25 μμfd. in value and tie between the mixer injector grids and the oscillator cathode.

R.F. and H.F.O. Coils

All r.f. coils are wound on small isolantite plug-in forms and are specifically for 14-Mc. phone. The L_2, L_4, and L_6 windings are wound



Internal arrangement of the high-frequency oscillator shield can. The main tuning control is the one entering the can from the right.

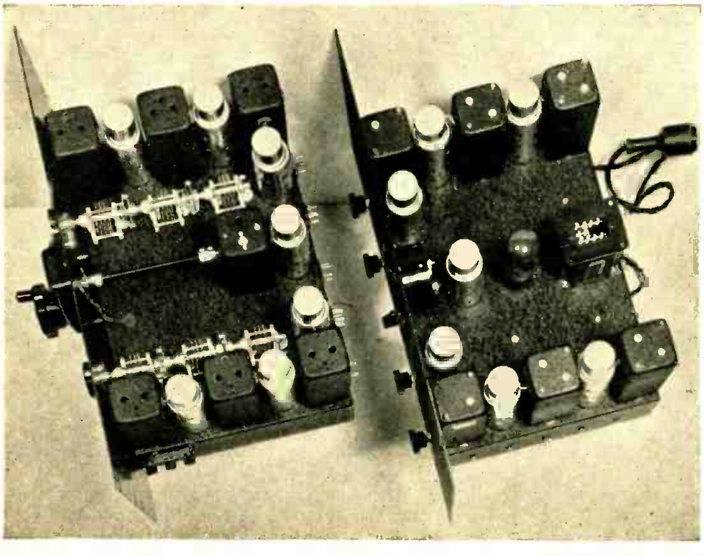
to precise limits and spot pretty close to the high frequency end of the 14-Mc. band, to minimize the necessity for much tank capacity. L_3 and L_5 are interwound with L_4 and L_6.

L_7, the oscillator coil, employs relatively few turns for high-C operation and is tapped for both cathode feedback and bandspread.

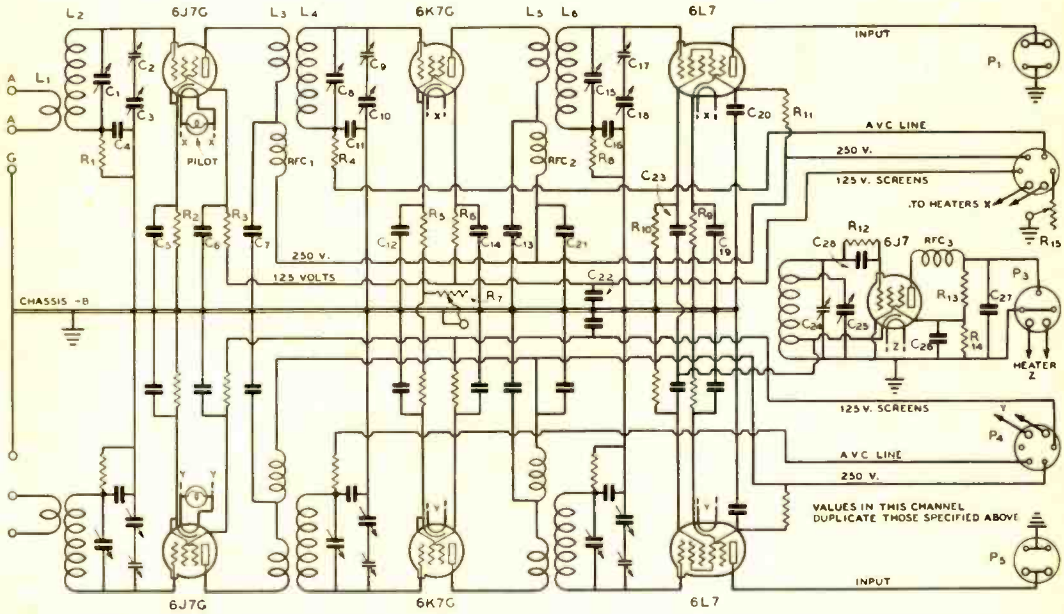
Should it be desired to use the receiver on bands other than 14-Mc. phone, appropriate plug-in coils of similar design may be used.

R.F.-H.F.O. Tuning

The r.f. tank condensers (C_1, C_8 and C_{15}) are 25-μμfd. APC air trimmers, mounted, by the way, below chassis and on the coil socket terminals. They might very well go inside the



● Top view of the two chassis; the r.f. and h.f.o. chassis on the left and the i.f., audio and "R" meter chassis on the right. The various r.f. coils are contained in the shields along each side of the r.f. chassis as shown on the left. The h.f.o. tube and tank circuit are placed in the center of this chassis; the extension shaft going from this shield can to the front panel is the main tuning control.



Complete wiring diagram of the two-channel diversity receiver. The two r.f. channels and the h.f.o. are shown above; the i.f. amplifiers, second detectors and the audio channels are shown on the opposite page.

All values given for the upper channel are duplicated in the lower one.

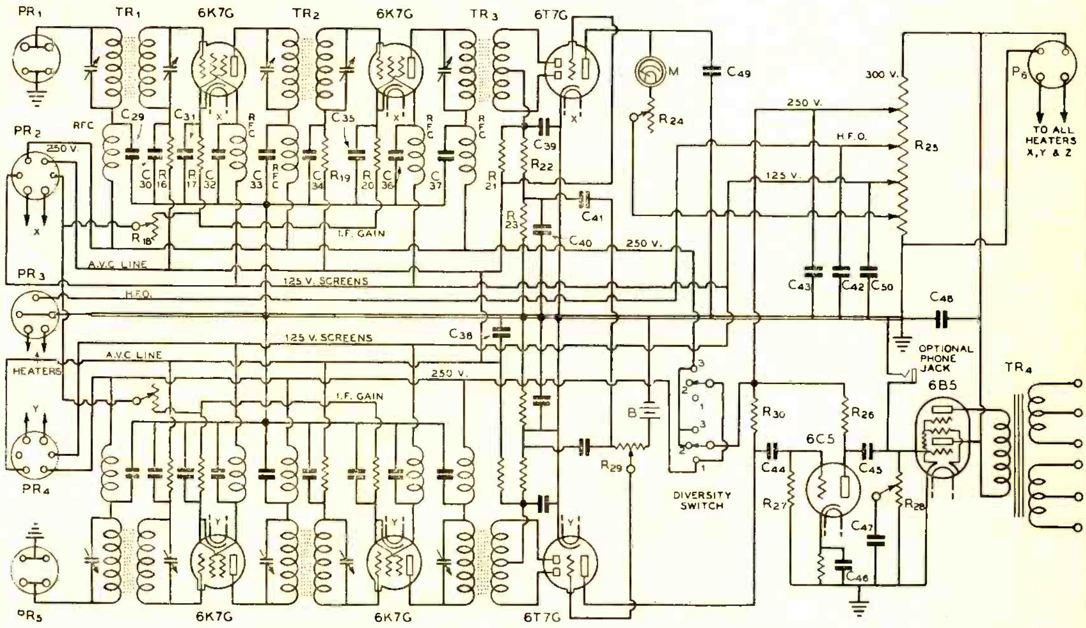
C_1—25-μμfd. r.f. tank condenser
C_2—3-30 μμfd. spread-set trimmers.
C_3—20-μμfd. tuning condenser
C_4, C_5, C_6—.05-μfd. 200-volt tubulars
C_7—.05-μfd. 400-volt tubular
C_8—25-μμfd. r.f. tank condenser
C_9—3-30 μμfd. spread-set trimmer
C_{10}—20-μμfd. tuning condenser
C_{11}, C_{12}, C_{13}, C_{14}—.05-μfd. 400-volt tubulars
C_{15}—25-μμfd. r.f. tank condenser
C_{16}—.05-μfd. 200-volt tubular
C_{17}—3-30 μμfd. spread-set trimmer
C_{18}—20-μμfd. tuning condenser
C_{19}—.05-μfd. 200-volt tubular
C_{20}—0.1-μfd. 400-volt tubular
C_{21}, C_{22}—0.1 μfd. 400-volt tubulars
C_{23}—.000025-μfd. mica condensers
C_{24}—100-μμfd. oscillator tank
C_{25}—15-μμfd. oscillator bandspread
C_{26}, C_{27}—.05-μfd. 400-volt tubulars
C_{28}—.0001-μfd. mica
R_1—100,000 ohms, ½ watt
R_2—1000 ohms, 1 watt
R_3—5000 ohms, ½ watt
R_4—100,000 ohms, ½ watt
R_5—300 ohms, 1 watt
R_6—5000 ohms, ½ watt
R_7—15,000-ohm potentiometer
R_8—100,000 ohms, ½ watt
R_9—600 ohms, 1 watt
R_{10}—50,000 ohms, ½ watt
R_{11}—15,000 ohms, 1 watt
R_{12}—50,000 ohms, ½ watt
R_{13}—100,000 ohms, ½ watt
R_{14}—50,000 ohms, ½ watt
R_{15}—15,000-ohm potentiometer
Coils—See coil table
$RFC_{1, 2, 3}$—2.1 mh., 125-ma. chokes
Plugs—See text

coil shield-cans for more convenient adjustment. C_3, C_{10}, and C_{18} are the ganged r.f. tuning condensers, each 20 μμfd. in capacity. These latter condensers could, of course, bridge directly across L_2, L_4, and L_6, to give about twenty divisions of bandspread; they could be cut down physically through the removal of plates to effect a somewhat greater spread, or they could tap down on the windings for the same purpose. But we have employed series capacities (C_2, C_9, and C_{17}—all 3-30 μμfd. MEX trimmers) so that we might both conveniently adjust the spread to any desired amount and align this spreading accurately, stage by stage.

The 6J7G, in our job, is not regenerative. But, nevertheless, changes in antenna load will upset the first stage alignment to some extent. And, although we haven't yet done it, we plan to substitute—and suggest that the individual builder should do the same—a front-panel-mounted variable condenser for the APC at C_1 to compensate conveniently for these changes in load.

C_{24}, the oscillator-circuit tank condenser, should be about .0001 μfd. in value. It is an adjustable APC mounted either below chassis on the coil socket terminals or in the coil can.

C_{25}, the oscillator tuning condenser, is mounted in the can; it is of 15 μμfd. in capacity (maximum), and when tapped down on L_7 3½ turns from the grid end of the winding,



C_{29}—0.1-µfd. 400-volt tubular
C_{30}—.05-µfd. 200-volt tubular
C_{31}, C_{32}, C_{33}—0.1-µfd. 400-volt tubular
C_{34}—.05-µfd. 200-volt tubular
C_{35}, C_{36}, C_{37}—0.1-µfd. 400-volt tubular
C_{38}—.05-µfd. 200-volt tubular
C_{39}, C_{40}—.0001-µfd. mica
C_{41}—.05-µfd. 200-volt tubular
C_{42}, C_{43}—0.1-µfd. 400-volt tubular
C_{44}, C_{45}—.05-µfd. 400-volt tubular
C_{46}—25-µfd. 25-volt tubular
C_{47}—.05-µfd. 200-volt tubular
C_{48}—8-µfd. 450-volt electrolytic
C_{49}, C_{50}—0.1-µfd. 400-volt tubular
R_{16}—100,000 ohms, ½ watt
R_{17}—300 ohms, 1 watt
R_{18}—5000-ohm potentiometer
R_{19}—100,000 ohms, ½ watt
R_{20}—300 ohms, 1 watt
R_{21}—1-megohm, ½ watt
R_{22}—50,000 ohms, ½ watt
R_{23}—250,000 ohms, ½ watt
R_{24}—250,000-ohm potentiometer
R_{25}—30,000-ohm 75-watt voltage divider
R_{26}—50,000 ohms, ½ watt
R_{27}—500,000 ohms, ½ watt
R_{28}, R_{29}—500,000-ohm potentiometers
R_{30}—250,000 ohms, 1 watt
R_{31}—(Number omitted from diagram; cathode resistor for 6C5) 5000 ohms, 1 watt
RFC—16-mh. shielded r.f. chokes
M—0-1 d.c. milliammeter
TR_1—456-kc. input i.f. trans.
TR_2—456-kc. interstage i.f. trans.
TR_3—456-kc. single-tuned diode-input i.f. trans.
TR_4—Output transformer, 7000 ohms to line and v.c.
Receptacle plugs—See text
B—Midget 3-volt "C" battery

will afford approximately 100 degrees of spread for the phone section of the 20-meter band.

Front Panel Gain Controls

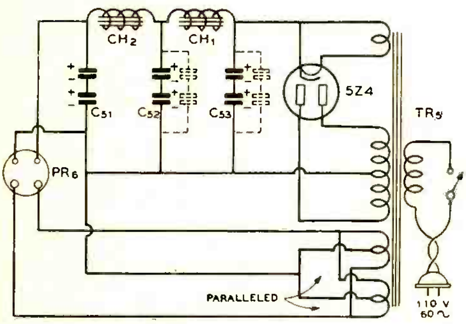
R_7 is the r.f. gain control, adjusting the effective sensitivity of both channels simultaneously. This control varies the conductance of second stage tubes only as the 6J7's work wide open at all times. R_{15} is the i.f. gain control, has nothing to do with the r.f. circuits, and has simply been positioned on the lower panel for convenience of adjustment.

Connections to the I.F.-A.F. Section

$P_{1, 2, 3, 4, 5}$ are all male receptacles. P_1 and P_5 are for mixer output, P_2 for power and a.v.c. connection to one channel and for i.f. gain connection (from R_{18} and R_{18A}) to R_{15}, P_3 for h.f.o. power, P_4 for second channel power and a.v.c. $PR_{1, 2, 3, 4, 5}$ are female receptacles on the "upstairs" chassis and, of course, are related to the P items on the lower. Short lengths of cable, with plug terminations, connect the two sections together between all but P_1 and PR_1 receptacles. The mixer-to-TR_1 leads are single wires, similarly plug terminated, but run through low-C shielded tubing for reasons which have been given.

The I.F. Circuits

Each i.f. channel uses two stages, tubes being 6S7G's or 6K7G's. (They have similar characteristics and simply differ in filament drain.) Both stages are manually and automatically controlled, individually (to assist in channel-balance) by means of the R_{18} and R_{18A} and collectively by means of R_{15}. All screen and plate circuits are very carefully by-passed and r.f.-choke filtered. Cathodes are, similarly, in-



Circuit diagram of the heavy-duty external power supply. The choke, the power transformer and the speaker field all must be able to carry the 165-ma. average drain of the receiver.

C_{51}, C_{52}, C_{53}—Each two 16-μfd. 450-volt electrolytics in series
CH_1—15-hy, 210-ohm, 165-ma. filter choke
CH_2—1000-ohm heavy-duty speaker field to carry 165-ma.
TR_5—425 volts, 165 ma.; 5 volts, 3 amps.; 6.3 volts, 6 amp.
PR_6—Receptacle plug from receiver proper

dividually by-passed, with each stage bias limited.

TR_1 and TR_2 are conventional i.f. transformers for 456 kc. input and interstage service. TR_3, on the other hand, is a single tuned, c.t.-secondary item designed for a.v.c. or noise-suppressor channel diode feed. All these components are Ferrocart (iron-cored) jobs, Alignaire (air) trimmed.

The Second Detector and A.V.C. Circuits

We have used 6T7G (150-ma. filament) tubes as second detectors rather than the 6H6's which the reader might have expected us to employ, and simply so that the overall number of tubes required for the diversity set-up might be cut down to minimum. These tubes, like the equivalent 6Q7's which may be substituted for them, are duo-diode high-mu triodes.

The a.v.c. voltage develops across the R_{22}, R_{23} diode load (total—300,000 ohms) from TR_3 center top to chassis-ground. The total control voltage (R_{21} filtered) for the one channel is impressed in parallel with the voltage developed by the other since the a.v.c. lines are connected together. Thus the channel receiving the strongest signal and producing the strongest a.v.c. voltage, takes control of both channels of the receiver.

The "R" Meter

We use but one meter for visual signal level indication. The meter is in the plate circuit of the triode section of one of the 6T7's, is a one-ma. affair and reads backwards. It should and will eventually be worked into a bridge layout for forward reading but it does a good enough job in its present connection. R_{24} limits the plate current to 1 ma. full deflection (about 135 volts at the plate of the T does the trick).

The Diversity Switch

A two-pole three-way switch, wired so that the B plus connection to the individual channels may be made or broken, permits the use of either channel independently or both channels together and in diversity. It is a very desirable refinement, but we now think that it should have a few more poles so that screen voltage leads will make or break with plate voltage leads and so that when either channel is switched out of service some sort of bleeder will be switched in to compensate for the change in drain on the power supply.

The Audio Circuits

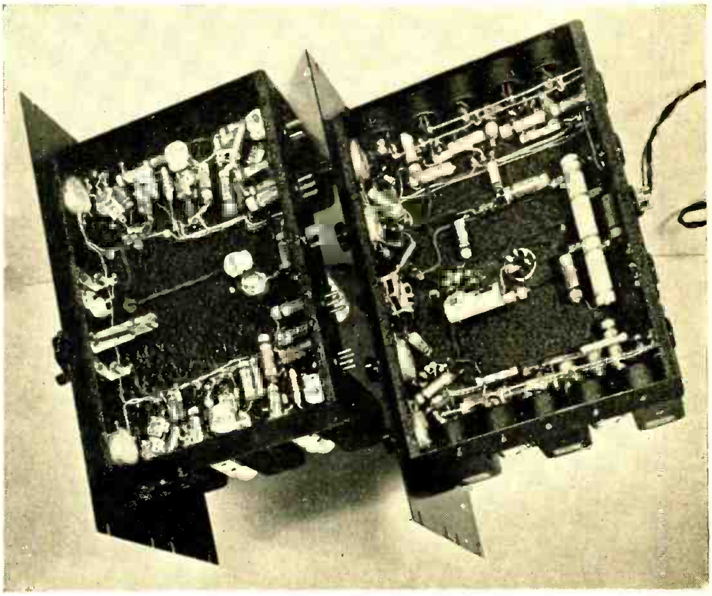
Audio frequency outputs from both second detectors add arithmetically in the grid load resistor of the triode section of the second 6T7G (or 6Q7G), and thus combined are amplified by this tube, by the succeeding 6L5 or 6C5 driver, and by the 6B5 output stage. The 6B5 is well suited to this use but of course a 6F6, a 6L6, a 6V6 or a 42 could be substituted.

Noise Silencers

It will be seen, by looking at the circuit diagram, that there is no noise silencing arrangement incorporated into the circuit. One has not been included since neither the "hole-punching" or "amplitude-limiting" type will operate satisfactorily on the i.f. or audio input circuits of a diversity receiver. However, one of the audio-amplifier amplitude-limiting types might be used in the plate circuit of the 6C5/6J5 audio stage. But the candid opinion of a number of people who have had experience with silencers of this type is that they are scarcely worth the trouble of their installation although they are effective in reducing certain types of local interference..

Power Supply

The power transformer selected for use in this receiver must have quite healthy ratings. It must supply, in the very first place, 4 to 6 amperes at 6.3 volts for filaments—enough to



● **The bottom view of the two units shows the sub-panel wiring of the high-frequency unit at the left and that of the i.f. audio section at the right.**

permit actually the use of .3 amp tubes throughout the line-up if we wish. The high voltage should be rated at about 425 each side at 160 to 170 ma. Under conditions of full receiver B drain and with condenser input in the filter system, the output at the high side of our voltage divider is 300, indicating a drop across CH_1 and the speaker field CH_2 of 125 volts. A heavy-duty speaker is of course necessary, and C_{52} and C_{53} should both be series-parallel electrolytics to assure against breakdown.

The voltage divider is under the r.f.-a.f. chassis and is tapped as follows: full voltage for the 6B5, 250 volts for the plates for all other (except h.f.o. and v.t.v.m.) tubes, about 200 volts for h.f.o. plate, about 135 volts for the v.t.v.m. circuit and slightly more than 100 volts for screens.

Construction

Our photographs should adequately point out correct parts placement on the two chassis. So long as the usual wiring precautions are taken and our layout recommendations are borne in mind, there's no reason why construction should be a difficult business.

All coils (r.f. and h.f.o.) are wound on small plug-in forms and are shielded by individual cans. R.f. cans are drilled on one side to pass the leads from coils to tube grid caps. The oscillator unit, on the other hand, must be subjected to considerable mechanical and wiring attention. The APC condenser (if it is not to go below chassis) must be installed in the top of the box, along with a tie point on which are mounted the grid leak and condenser. A hole for the grid-cap connection from tie point to 6J7 must be made in the side and the HF-15 condenser must be mounted on the front surface and in such a way that its shaft will line up properly with the main tuning dial with which it is coupled. Then all these items must be wired and leads brought down for tap and grid connection to the coil.

With the coils built we may proceed with the construction of the r.f. assembly, the i.f.-a.f. layout, the power supply, and the plug-terminated cables for connection between units. We have found, by the way, that the securing nuts for the various controls will hold chassis and panels together quite securely; no supporting arms should be necessary.

In wiring up the three units, the usual practices should be observed, particularly for the r.f. and i.f. sections. Keep leads short and direct and bring all returns for each stage to one chassis point. Remember that there must be no cross coupling between channels, follow the circuit diagram carefully, and don't stint on the use of tie-points.

Check-Up and Alignment

With the wiring and inter-section cabling carefully checked, the diversity switch in posi-

COIL SPECIFICATIONS FOR 14-Mc. PHONE

Radio-frequency coils: L_3, L_5—10 turns interwound with L_4, L_6 of 12¾ turns, all spaced to one inch.

Antenna coil: L_1—6 turns, close wound; L_2—12¾ turns, spaced to one inch.

Oscillator coil: L_7—6¾ turns, spaced. Cathode tap at 1¾ turns from ground end; bandspread tap at 2½ turns from grid end for 20 divisions of 20-meter phone bandspread, 3½ turns from grid for full dial spread.

tion three for two-channel operation, and the power unit turned on, adjust the sliders on the voltage divider until proper plate and screen potentials are read with all gain controls on full. Check full-gain cathode potentials (−3 for all r.f. and i.f. tubes), readjusting the screen-supply tap until proper limiting voltages are obtained. Vary the adjustment of one or more of the controls with a voltmeter across the B-plus line; if the B voltage shifts to any great extent, indicating poor regulation, remove the C_{53} input filter condenser. Fairly good regulation is quite imperative in a diversity receiver.

With the P_1-to-PR_1 and P_5-to-PR_5 mixer output connectors in place, align both i.f. channels to exactly 456 kc. It is quite important that both i.f. channels be aligned to exactly the same frequency.

Tighten up C_2, C_9, and C_{17} until fully closed, set the ganged r.f. condensers at zero dial reading, and, with the APC tanks, align the r.f. circuits to spot at some frequency slightly higher than the high frequency 20-meter band limit (with antennas connected if the C_1 condensers are not panel mounted). Use the same frequency for the alignment of both channels.

The series trimmers may now be opened up to give maximum desired r.f. bandspread, as the ganged condensers are varied from minimum to maximum, and to afford accurate tracking. Or they may be left "as is" to give about forty divisions of spread over the band.

C_{24}, in the oscillator circuit, is adjusted until with the main tuning dial indicating minimum C_{25} capacity, the desired high frequency oscillator limit is reached. Proper tapping for C_{25} will then bring about a spread meeting individual requirements. If the 6J7 oscillates at more than one frequency, by the way, reduce its plate potential by adjusting the slider on the voltage divider. If it does not produce enough output for optimum dual-mixer conversion, increase the plate potential, or place the cathode tap slightly higher on the coil winding.

Operation

The two antennas should be fairly well separated—by two wavelengths at least. Balanced transmission-line feed is of course suggested between the antennas and the two inputs. Collectors may be directional or non-directional, parallel to each other, at right angles to each other in the horizontal plane, or in a vertical-horizontal relation. The important thing is to have them so situated that the best possible diversity action will result. Remember, the further apart the antennas are placed, the greater will be the effective diversification; the more chance we will have of having a signal at its peak at one antenna when at the depth of its fade at the other. Remember, too, that there is polarity as well as space diversification in the fade, and that the antennas—particularly if they cannot be well separated—should logically not be in the same polarization plane.

If the antennas are directional, by the way, and their collective effectiveness multi-directional, then the assembly has a dual applications value. It not only operates in diversity when we want to hold one particular signal to minimum effective fade, but it provides for optimum pickup conditions when we are scanning the band for CQ's or for a reply to one of our own, working very much as though we were using a single aerial of practically no directional characteristics.

When adjusting the receiver for diversity reception, the gain conditions, channel against channel, should be in approximate balance. Controls R_{18} and R_{18A} are simply varied until a non-fading signal gives the very same R-meter reading when the one set of ganged r.f. condensers is thrown well out of alignment and the other adjusted for maximum level as it does when this input tuning condition is reversed. If both inputs are now brought into

[*Continued on Page 78*]

An Inexpensive Way to

DETERMINE TRANSMITTER OUTPUT

By K. CROMWELL,* VE4KD

Nearly every amateur station is able to determine the input to the final stage but few are able to measure the power output with any degree of accuracy. A method used by some to determine the power output is to use a bank of lamps as dummy load and then by a comparative system to determine the amount of power that was being dissipated by these lamps.

This method is shown schematically in figure 1. A tank circuit, tuned to the operating frequency, is coupled, either by a link or inductively, to the final stage. Then a lamp or lamps are tapped across enough of the turns of this external tank circuit to load the transmitter to normal operating conditions. A photronic cell, at a fixed distance from the lamps, is then used to determine their brilliancy. Then, with the cell and the lamps in the same positions, the lamps are connected to the 110-volt a.c. line. A voltage regulator, either a variable resistor or a tapped autotransformer such as the variac, is then used to light the lamps to the same brilliancy (determined by noting the reading of the photronic cell and its meter) as they had when they were operating from the transmitter. The power being dissipated by the lamps is then determined by noting the current flowing through them and the voltage across them. The product of this voltage and current gives the output of the transmitter directly.

But photronic cells, sensitive meters to go with them, a.c. voltmeters and ammeters, and tapped transformers such as the variac are expensive. Since they were above the budget of this station, one of the principles of photometry was used to achieve the same result.

The Simplified System

The operation of this system of photometrically determining the approximate output power of a transmitter is based upon the fact that

*1668 Dufferin St., Windsor, Ont., Canada.

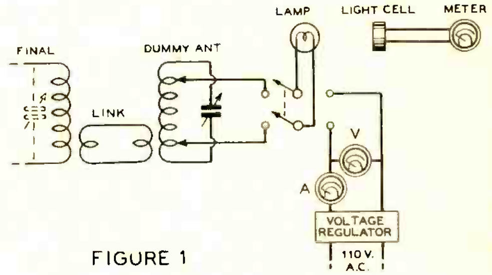


FIGURE 1

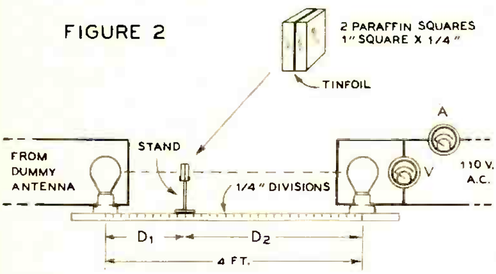
translucent materials will integrate the amount of light intensity arriving at their surface and will glow by an amount dependent upon this intensity. Hence, since this is a method of measuring *light* energy and not power directly, it must be assumed that the lamp banks concerned are both operating at the same relative efficiency as far as the conversion of r.f. energy into light energy is concerned. This condition will be approximately met when the two lamp banks are operating at nearly the same brilliancy. When this condition is met, this method of measuring power is quite accurate. But even when it is not met precisely the method will give reasonably accurate results.

The Procedure

Upon a wooden board, approximately 5 feet long, is nailed or bolted a yardstick and another section of one 1-ft. long making a total measuring-stick length of four feet. Then at one end, one or more lamp sockets are mounted so that their centers are lined up with the 4-ft. mark; at the other end of the measuring stick are placed one or more lamp sockets also lined up with their centers exactly at the zero mark of the stick. One set of lamps is connected to the transmitter to act as the dummy antenna; the other set is connected to the 110-volt a.c. line and preferably with an ammeter in series with them and a voltmeter across them. The set-up is graphically indicated in figure 2.

Next comes the device which replaces the photronic cell. Procure a block of paraffin wax, the kind commonly used as a seal for jelly jars. Cut two pieces from the block 3/8" thick and 1-inch square. Next cut a piece of tinfoil (it is important that it is equally bright on both sides) 1-inch square. Gently heat one side of each of the wax squares and press them together on opposite sides of the tinfoil. Then pare down the wax until each side is exactly 1/4-inch thick. The next operation is to make a

FIGURE 2



stand from thin sheet metal to hold the wax-and-tinfoil square. This stand should be of such a height that the centers of the two lamps or sets of lamps are lined up with the center of the square, figure 2.

To use the equipment, tune up the rig with enough lamps at one end of the board to take the full output of the transmitter at approximately full brilliancy. Then light up approximately the same amount of lamps at the other end of the board directly from the 110-volt line. Now vary the wax square back and forth between the two sets of lamps until the two sides of the square glow with the same brilliancy. Now determine the power input to the lamp or set of lamps that are operating from the 110-volt line either by taking the product of the line voltmeter and the ammeter in series with them, or by approximating their input from their wattage ratings.

Then the power that is being dissipated in the dummy-antenna set of lamps can be determined from the formula:

$$W_1 = (D_1/D_2)^2 \times W_2$$

where W_1 is the power in the dummy lamp load, D_1 is distance of first lamp from wax, D_2 is distance of second lamp from wax, and W_2 is the a.c. line input to the second lamp.

Practical Example

Suppose we have a transmitter with a pair of 809's in the final stage running at an input of 150 watts. Since the efficiency of the final stage will be approximately 65%, there will be about 100 watts to be dissipated in the dummy load. Consequently it would be best to place a 100-watt lamp in the socket as the load. Then, either a 50-watt or 100-watt lamp may be placed in the other end and operated from the a.c. line. The transmitter is tuned up to the dummy load, the a.c. is turned on in the lamps at the other end and the wax block is moved back and forth until the glow on each side of the tinfoil is the same.

The distances D_1 and D_2 are measured and the wattage input to the lamps that are running from the a.c. line is either measured or approximated. They are found to be: D_1, the distance from the dummy lamp to the block of paraffin, 25"; D_2, the distance from the other lamp to the paraffin, 23"; and W_2, the wattage input to the a.c.-line lamp, 100 watts. Substituting these in the above formula:

$$W_1 = (25/23)^2 \times 100 = 118 \text{ watts}$$

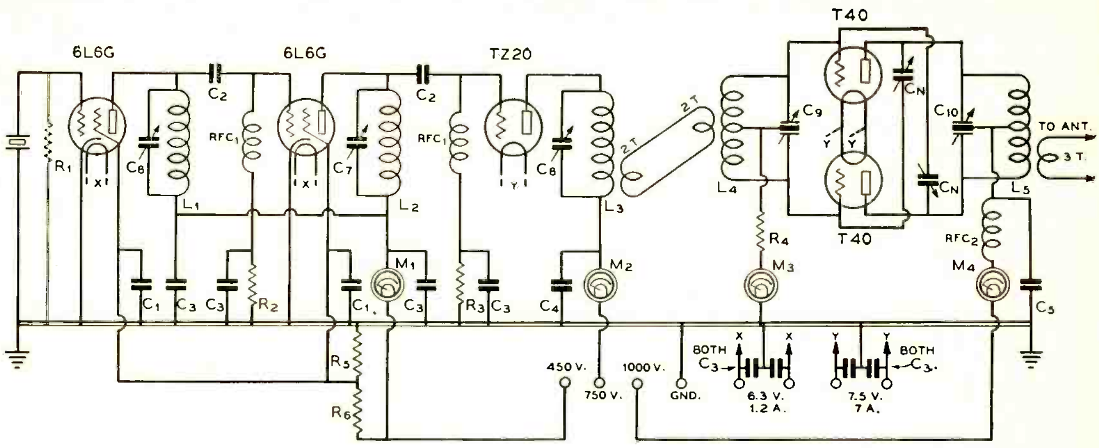
Thus the output of the transmitter into the dummy load is 118 watts. Of course, as mentioned before, this method of measurement is subject to some error since the conversion efficiency of the lamps will vary considerably depending upon their brilliance. The method is quite accurate enough for ordinary determinations, however.

Pick-ups . . .

Have you ever noticed that the VE phones use the names of our States in spelling? Wonder how many W hams know the names of the Canadian provinces as well.

WLW engineers tore their hair for a month to get a pistol-shot sound effect. It seems that the real McCoy does not sound like itself when broadcast.

From a story in *American* magazine: "Her warm loveliness, electric and enigmatic, was like a throbbing radio signal — an exciting 'C.Q.', clearing a short-wave channel from her to me."



C_1—.01-μfd. 600-volt tubular
C_2—.00025-μfd. mica
C_3—.002-μfd. molded-bakelite paper 600-volt
C_4—.002-μfd. molded-bakelite paper 1000-volt
C_5—.002-μfd. 2500-volt mica
C_6—50-μμfd. midget variable
C_7—35-μμfd. midget variable
C_8—50-μμfd., 4000-volt variable
C_9—50 μμfd. per section split stator
C_{10}—100 μμfd. per section, 4000-volt split stator
CN—Low-minimum neutralizing condensers
R_1—100,000 ohms, 1 watt
R_2—20,000 ohms, 5 watts
R_3—25,000 ohms, 5 watts
R_4—3000 ohms, 20 watts
Coils—See text
Meters—See text
RFC_1—2½-mh., 125-ma. chokes
RFC_2—2½-mh., 500-ma. r.f. choke

A Foolproof 10-METER RIG *Using T-40's*

By A. S. BAUMANN,* W4AEI

Here is a foolproof 10-meter 250-watt transmitter using the new T-40 tubes. It is a straight forward circuit using a 6L6G 40-meter crystal oscillator, a 6L6G doubler to 20 meters, TZ20 doubler to 10 meters and the T40's in the final. It was built for G. F. Steele, for use in his station, W4EGJ, at Norcross, Ga.

As seen in the accompanying photographs, this is built on one standard rack and panel unit. The chassis is 11"x 17"x 3", the panel is 19"x 12½". Reading from left to right the meters are: plate current for the oscillator and 1st doubler, 0-150 ma.; plate current for the 2nd doubler, 0-150 ma.; grid current for final, 0-100 ma., and plate current for final, 0-500 ma. These are all standard 2" meters.

I have found, from experience, that it is difficult to get maximum efficiency from an all-band transmitter, using plug-in coils or band switching, when operating on the high-frequency bands. This is probably due to the losses in the coil and socket contacts and losses in the coil forms themselves. Another problem with all-band operation is the "Q" of the circuit. Naturally for 160-meter or 80-meter operation, the tank condensers must have large capacity for proper operation, whereas in the minimum capacities these same condensers are decidedly too high for 20 or 10 meters.

Building a transmitter for one-band operation, especially on very high frequencies, makes it a simple matter to get maximum efficiency, because the proper "Q" in each of the tank circuits can be obtained without difficulty.

Coil Specifications

The coils are all wound on a 1" form and then removed and doped with Duco cement to make them self-supporting. The oscillator coil consists of 26 turns no. 16 enameled single cotton and is close wound. First doubler coil to 20 meters, 20 turns no. 14 enameled and

*568 Winton Ter. N. E., Atlanta, Ga.

spaced the diameter of the wire. Second doubler, 12 turns no. 14 enameled spaced about one and a half times the diameter of the wire. Both final grid and plate coils are wound with no. 12 enameled, 12 turns each and spaced equal to twice the diameter of the wire. All coils are self-supporting as has been mentioned above.

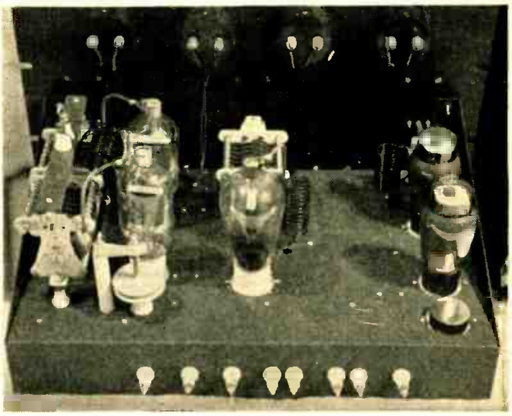
Parts in each circuit are arranged in order to make each lead as direct and short as possible. Tank coils are soldered directly onto the condensers in each case. Each circuit has its individual ground return direct to the chassis. The grounds are not bonded with a common bus at any point to reduce the chance for intercoupling. The ground stand-off on the rear of the chassis is connected by a bus to the center of the chassis. This reduces any tendency for interstage regeneration due to stray circulating ground currents.

Power Supplies

Two power supplies are used; one is a 450-volt 150-ma. supply for the two 6L6G tubes and the other is a 1000-volt 500-ma. supply for the final and doubler. The voltage for the TZ20 power doubler is obtained through a 3000-ohm 75-watt dropping resistor from the 1000-volt supply. This puts about 750 volts on the plate of this tube.

The normal current readings for this rig when operating are: oscillator and 1st doubler 47 ma., 2nd doubler 75 ma., final grid 50 ma., and the final 35 ma. unloaded. The final loaded plate current, of course, will vary due to loading and type of antenna used.

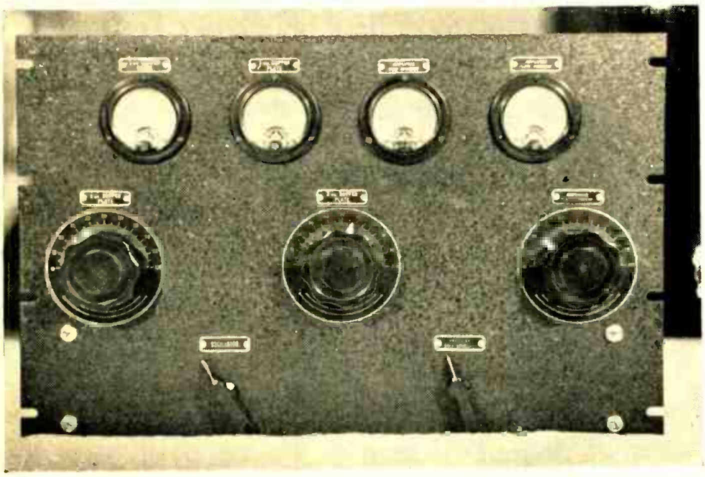
The antenna used on this transmitter is the conventional 4 half-waves in phase with a quarter-wave matching stub. The transmission line to the antenna is fed by means of a three turn pick-up coil loosely coupled to the final tank. The final is normally loaded to 230 ma. at 1000 volts. But the T40's are very easily capable of taking 300 watts input and have been operated at this input for tests.



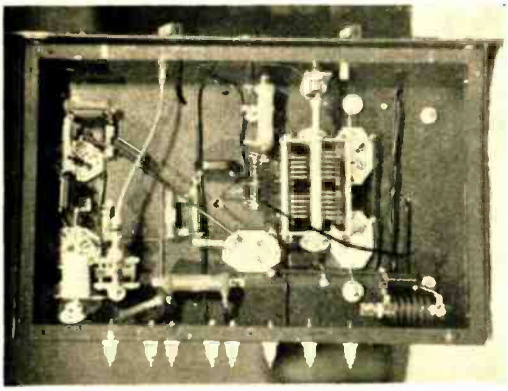
Back view shows layout of the parts in the 10-meter transmitter.

The modulator uses a pair of 6L6G's in class B (triode connected) with about 500 volts on the plates. They do a very nice job of modulating 230 watts input and do so with very little effort.

This unit is later going to be mounted in a standard 6-foot relay rack with two other complete r.f. units, one on 160-meter phone and the other on 20-meter c.w. and phone. Also in this same rack will be the power supplies and modulator. There will be a simple voltage switching arrangement which can be controlled remotely by relays. This will give instantan-



• The transmitter is built on one standard rack and panel unit. Front view of the rig is shown here.



Parts in each circuit are arranged so as to make each lead as direct and short as possible.

eous band switching without losses due to plug-in coils or switches in r.f. sections. Naturally the efficiency should be very good on all bands.

At first this seems to be rather an expensive way to get all-band operation in one transmitter, but with medium-power tubes as efficient and as inexpensive as they are today, one can get a fairly high-powered rig at minimum cost.

•

Noise Damping

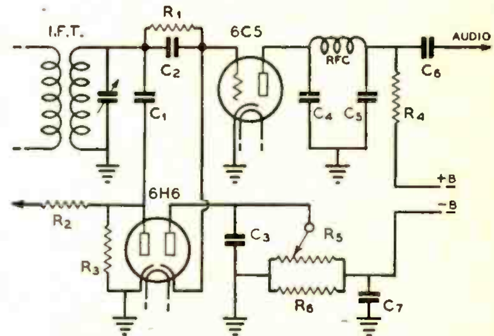
AND A.V.C. WITH GRID-LEAK DETECTION

Ordinarily, when someone mentions a grid-leak detection for the second detector in a superhet you think, "Yes, that should be swell, especially as far as sensitivity is concerned, but what about a.v.c. and some type of noise damping?" And there the discussion stops.

But O. H. Mills, W8NED, in designing a new five- and ten-meter superheterodyne, decided that grid-leak detection would give a worthwhile increase in weak-signal sensitivity and so figured out a method of applying a.v.c. and noise limiting to the grid-leak detector as used in his receiver.

The circuit is shown in the accompanying circuit diagram. It is quite simple, one diode of the 6H6 acts as a carrier rectifier to supply the a.v.c. voltage to the preceding stages, and the other one, reverse connected, acts as a noise limiter. It should be very simple to install such an arrangement in an existing superhet; W8NED states that due to the simplicity of the circuit there are very few, if any, "bugs" to iron out. He also states that the circuit gives as good results on phone signals as on c.w. reception. That does sound encouraging.

The circuit does, however, have one disadvantage. The setting of the noise suppression potentiometer, R_5, is correct for signals of only one level. This potentiometer must be re-adjusted when signals of a much different level are being received. However, due to the



C_1—.00005-μfd. mica
C_2—.00025-μfd. mica
C_3—1.0-μfd. tubular
C_4, C_5—.0005-μfd. mica
C_6—0.1-μfd. tubular
C_7—10-μfd. 50-volt electrolytic
R_1, R_2, R_3—1.0 megohm, ½-watt
R_4—100,000 ohms, 1 watt
R_5—10,000-ohm potentiometer
R_6—500 ohms, 10 watt
IFT—Diode-input i.f. transformer
RFC—10-mh. r.f. choke
Note—There should be enough current flowing through R_6 to develop a voltage of 25 volts across it.

a.v.c. action of the receiver, the variations in signal level, especially when receiving phone signals, should not be particularly great.

The detector tube, shown as a 6C5 in this particular diagram, can be almost any other small triode or pentode as long as it is connected for grid-leak detection.

It should be noted that the negative B supply is not grounded.

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Here and There . . .

Miss Nelly Corry, G2YL, has made another trip to the West Indies, stopping at Miami, Florida. Welcome, Nelly, but why make the Southern California Chamber of Commerce fret?

•

VE2AJ, located one-thousand miles from the ocean, still is five-hundred miles nearer Liverpool, England, than W2AJ.

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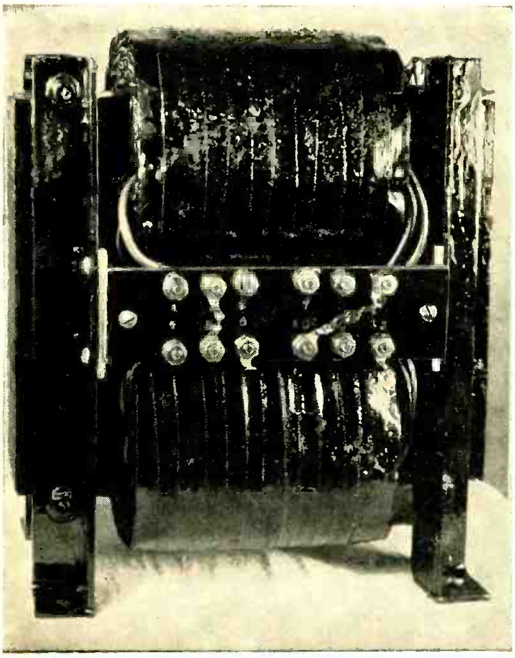
What a governmental coincidence—*Woodrow Wilson*, W3BOX, is located in Federalsburg, Md.

MODULATION-TRANSFORMER DESIGN

By **LLOYD W. ROOT,* W9HA-W9EHD**

This discussion is not intended to be the ultimate in either the theoretical or the practical aspect of transformer design but it is hoped that it will perhaps point the way to a more complete understanding of some of the more puzzling features of transformer characteristics. It is one thing to design a straight power transformer carrying only alternating currents and quite another when one or more windings of the transformer must also carry direct current.

Most experimenters are familiar with the much abused formula for determining the number of turns to be used on a given power transformer but perhaps are not so well acquainted with other formulas dealing with magnetic quantities so that a brief review of those most used might be in order. In this presentation the similarity between the simple electric current and magnetic formulas will be apparent.



A representative 300-watt modulation transformer made from the design data given herein.

Indeed, the equation dealing with magnetic reluctance might be termed the "Ohm's Law" of magnetic circuits.

Laws of Magnetic Circuits

In practical terms the unit of magnetic field strength is the Gauss. It is one line of magnetic force per square centimeter and produces a force of one dyne (approximately .001 gram) on a unit magnetic pole. A current of electricity passing through a coil of wire produces a magnetic field at the center of the coil which is directly proportional to the current strength, the number of turns of wire, the material on which the coil is wound and inversely to the radius of the coil. For a torus or a coil surrounding a closed magnetic path (as would be the case of a transformer carrying direct current),

$$H_0 = \frac{4\pi NI}{10L} \text{ where}$$

H_0 = direct current magneto-motive-force (MMF) in Gilberts per centimeter (Oersteds)

N = number of turns in winding

I = current strength in amperes

L = length of magnetic circuit in centimeters

One Gilbert per cm. produces one Gauss or one line of force per square cm. of cross-sectional area in a vacuum while in a substance of permeability mu (μ) there will be produced mu lines per sq. cm. That is,

$B = \mu H$ where

B = flux density in Gausses (lines per sq. cm.),

μ = magnetic permeability,

H = magnetic field strength.

The reciprocal of the permeability is called the reluctivity. Thus, $V = 1/\mu$. The magnetic drop across any path is known as the magneto-

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There has been far too little material published in the various radio magazines concerning the proper design of high-level audio transformers, especially those where the secondary must carry the class-C plate current along with the audio current. In this informative article, Mr. Root gives a complete discussion of the conditions existing within a transformer carrying d.c. plate current along with audio, the mathematics necessary for taking into consideration these conditions in making the design, and a number of practical examples for using these formulas in the design of class-B output transformers for high-power use.

It should be pointed out that it will usually be less expensive to purchase complete factory-made transformers for power levels of 100 watts or less; but for high power uses, where special consideration must be made in the design, it is often advantageous to be able to design and have built or build a transformer to the exact specifications of the transmitter.

motive-force (MMF) and is equal to the product of the magnetic potential gradient and the length of path, MMF = H L. The reluctance of any magnetic path equals the product of the reluctivity and path length divided by the cross-sectional area of the path, R = VL/A. When the magnetic path is not homogeneous, that is, consists of more than one kind of material (such as iron plus air), the total path reluctance is the sum of the separate path reluctances. The permeability of a magnetic material is not a constant quantity, however, but varies over rather wide limits depending upon the degree of magnetization. Figure 1 shows the relationship between the permeability of a sample of silicon steel and the magnetizing force. For most common transformer iron the permeability reaches a maximum value of from 5000 to 7000 for magnetic flux densities of from 5000 to 7000 Gausses.[1]

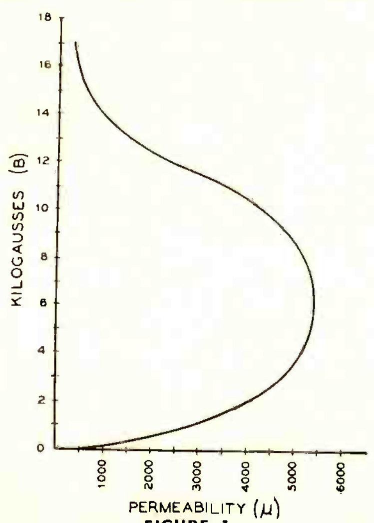


FIGURE 1

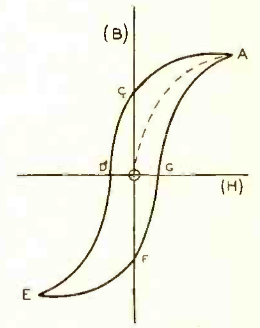


FIGURE 2

If the flux density in a given sample of iron is observed while it is carried through one magnetization cycle, results as shown in figure 2 will be obtained. Starting at point O on the curve, the flux density (B) increases as the magnetic field (H) is increased, until eventually a point is reached where the flux density no longer increases with increased field. At this point the iron is said to be saturated, saturation occurring at from 10,000 to 15,000 lines per sq. cm. (63,000 to 94,000 lines per sq. in.). If, at point A on the curve, the field is diminished, the flux in the iron will not fall back along line AO but along AC. When H = O, it will be found that B = OC and that a negative field will have to be applied of mag-

[1] "Magnetic Core Materials Practice," Allegheny Steel Company, Brackenridge, Pa.

Watts loss/lb. at 10000 Gauss	Freq. in c.p.s.	Watts loss/lb. at 60 cycles	Gauss
.4	25	.08	2000
.7	40	.25	4000
1.2	60	.5	6000
1.6	80	.8	8000
4.0	133	1.2	10000
		1.3	10500
		1.65	12000
		2.2	14000
		2.5	15000

FIGURE 3

nitude OD to bring B to zero. The amount of this negative field that has to be applied is called the coercive force and it is proportional to the "hardness" or retentivity of the iron. Permanent magnets having high retentivity are desirable for certain purposes but for transformers, curves showing low coercive forces are to be preferred.

Figure 2 shows the complete cycle of magnetization, commonly called a hysteresis curve, the area ACDEFGA being indicative of the hysteresis loss of the iron sample under test. Magnetic materials also suffer "eddy current" loss which is due to the flow of transverse alternating currents in the core caused by changing flux through it. It can be minimized by laminating the core material, common laminae being from 15 to 25 mils (thousandths of an inch) thick. Both eddy current and hysteresis losses are usually combined and called iron loss in designing transformers. Iron losses increase with increasing magnetization and frequency as shown in the tables of figure 3 based on 26-gauge electric steel (0.0187″ thick, 0.75 lbs. per sq. ft.).

There are two types of cores which are generally available for use in transformers, the core-type and the shell-type. (See figure 4.) The core-type is used by those desiring to cut out their own laminae, while the shell-type is used by those fortunate enough to possess the expensive punches and dies needed or by those able to obtain burned out transformers having the requisite E-shaped laminae. The shell-type gives a more compact design since all windings are on the center leg, while with the core-type the windings are usually split, half going on each of the long legs. The average full-load efficiencies of a representative group of small transformers is shown in figure 5.[2]

When a transformer winding must carry a relatively large direct-current along with the induced alternating-current, the core becomes magnetized by a fairly heavy polarizing magneto-motive-force which establishes a unidirectional magnetic flux (B_o) upon which is superimposed an alternating flux (B_{ac}).[3]

$$(1) \quad B_{ac} = \frac{10^8 E}{\pi\sqrt{2} N A K F} \text{Gauss}$$

$$(2) \quad B_o = \frac{4 \pi N I \mu}{10 L} \text{Gauss}$$

Where, E = r.m.s. alternating voltage across winding
N = number of turns in winding
A = cross-sectional area of core in sq. cm.
F = frequency in cycles per second
K = stacking factor = W/V g,

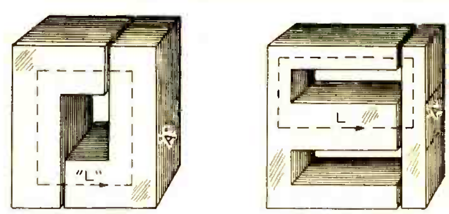


FIGURE 4

where W = core weight in grams
V = core volume in cc.
g = sp. gravity of core material (7.5-7.7)

(K = .94 for butt-joint core
.88 for 100% interleaved laminae)
I = direct-current in amperes
μ = magnetic permeability
L = length of magnetic circuit in cm.

The actual value of the alternating current permeability (μ_{ac}) of the core material simultaneously subjected to alternating and direct magnetization can be presented through the

[2]"Standard Handbook for Electrical Engineers," McGraw Hill Book Co.

[3]"Alternating Current Phenomena," C. P. Steinmetz.

medium of incremental permeability curves which show the value of (μ) to be lower for larger values of H_0 and, what is most important, "that core materials having the highest values of μ_{ac} when unpolarized are subject to the greatest reduction in the a.c. permeability by a given value of H_0". The introduction of an air-gap into the path of the magnetic core will reduce the degree of direct magnetization established, and, even though the reluctance of the core path to a.c. magnetization is increased by the air-gap, there may be an actual increase in the effective inductance of the reactor as a result of the introduction of the air-gap."[1] Thus it may be of particular advantage to use a poorer grade of silicon steel in a transformer designed to carry direct-current.

The direct-current magneto-motive-force consists of the drop across the reluctance of the iron path plus the drop across the reluctance of the air-gap,[4]

$$MMF = H_1 l_1 + H_2 l_2$$

H_1 = Magnetic potential gradient in iron,
H_2 = Magnetic potential gradient in air,
l_1 = Length of magnetic circuit through iron,
l_2 = Length of magnetic circuit through air.

In air, the magnetic flux density is numerically equal to the magnetizing force, or $H_2 = B_0$. Thus, the above equation becomes

$$(3) \quad MMF = H_1 l_1 + B_0 l_2$$

KVA Capacity	Efficiency Full-Load	Weight Lbs.
.050	89%	3-4
.10	90	8
.15	91	14
.25	92	20
.375	93	30
.50	94	40
1.0	95	70

FIGURE 5

The two unknowns are H_1 and B_0, the relation between which is given on the B-H curve for the particular iron involved. Without attempting to show exact relationships, imagine the solid curve in figure 6 to represent the B-H curve of a silicon-steel sample.

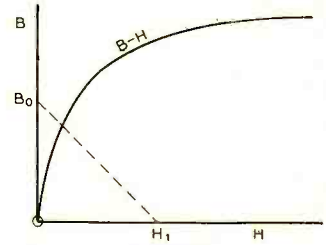


FIGURE 6

Equation (3), above, will be recognized as the equation of a straight line and if plotted on the same axes as figure 6 will intersect the vertical axis of the B-H curve at a point corresponding to H_1 = zero and $B_0 = MMF/l_2$, and also will intersect the horizontal axis at a point corresponding to B_0 = zero and $H_1 = MMF/l_1$. For a given set of conditions the total MMF is known, being equal to $(4\pi NI)/10$ Gilberts, so that both B_0 and H_1 can be computed and the dotted line shown in figure 6 drawn. Thus, the vertical coordinate of the point of intersection of the straight line (3) with the B-H curve determines the value of the d.c. flux density in the core under the conditions as given and the horizontal coordinate gives the magnetic potential gradient in the iron part of the magnetic circuit. It is then possible, knowing H_1 and the value of B at the intersection of (3) with the B-H curve (OC), to make use of incremental permeability curves to determine the apparent (not the a.c.) permeability of the iron under the given operating conditions. It will be found that while the a.c. permeability of the iron under the given conditions may be as high as 5000 to 8000, the apparent permeability has dropped to as low as 150-300 when the core is subjected to a strong direct polarization. Examination of magnetic path reluctance formulas reveals the clue to the method of increasing the apparent permeability (μ_a) for the purpose of increasing the effective inductance of the transformer winding and thus improving the bass-note response. Using the same symbols and terminology as above, the reluctance of the iron path

$$R_1 = V_{ac}\, l_1/A,$$

while the reluctance of the air path

[4] "The Magnetic Circuit," Karapetoff.

$R_2 = l_2/A$ (The reluctivity of air being unity).

The total path reluctance is then

$$R_1 + R_2 = V_{ac} \frac{l_1}{l_1 + l_2} + \frac{l_2}{l_1 + l_2}$$

Since, in most cases, the length of the air-gap seldom exceeds 1% of the iron path, $\frac{l_1}{l_1 + l_2}$ is practically unity and $\frac{l_2}{l_1 + l_2} = \frac{l_2}{l_1}$ (approximately) so that

$$(4) \quad V_a = V_{ac} + \frac{l_2}{l_1}.$$

In other words, in most practical cases, the apparent reluctivity is equal to the sum of the a.c. reluctivity and the ratio of the length of the air-gap to the length of the mean iron path.

Substituting $\frac{1}{\mu_{ac}}$ for V_{ac} and $\frac{1}{\mu_a}$ for V_a in equation (4),

$$\frac{1}{\mu_a} = \frac{1}{\mu_{ac}} + \frac{l_2}{l_1} \text{ or,}$$

$$(5) \quad l_2 = \frac{l_1 (\mu_{ac} - \mu_a)}{\mu_a \mu_{ac}}.$$

Introduction of Air Gap

From equation (5), it is seen that it is possible to effect as much of a change in the permeability of the iron as necessary for best results in the completed transformer. Thus, if $\mu_{ac} = 5500$ and it is desired to have $\mu_a = 400$, the total air-gap should be 0.0023 l_1 cm. Instead of interleaving the transformer laminae, one should provide for a butt-joint to be filled with some non-magnetic material such as fiber, micanite, etc. This can easily be done with most shell-types of cores but is somewhat more difficult with the core-type unless one uses four gaps. Figure 4 suggests a way in which two gaps may be provided in the core-type. The same scheme could, of course, be extended to provide only one gap. In both types of core shown, the gap between the two sections of core should be half the calculated amount since there are effectively two gaps. By the introduction of an air-gap into the magnetic circuit of a poor transformer, one may compensate to some extent for limitations imposed when the unit was manufactured. The bass-response will tend to be increased by such a procedure. It should not be assumed, however, that the use of an air-gap provides a cure-all for core and winding faults.

Some rather interesting conclusions may be drawn by juggling equations (1) and (2), above. If we agree that for flux densities under 14,000 Gauss no serious error is involved in assuming that a sine-wave alternating voltage applied to the transformer winding will produce a sine-wave flux variation in the core material, we may let $B_o + B_{ac} = 14{,}000$. Then, replacing B_o and B_{ac} with their equivalents,

$$\frac{4 \pi I \mu N}{10 L} + \frac{10^8 E}{4.442 K F A N} = 14{,}000$$

For clarity set $\frac{10^8 E}{4.442 K F} = \Theta_1$ and $\frac{4 \pi I \mu}{10 L} = \Theta_2$

Then $$\frac{\Theta_1}{A N} + \Theta_2 N = 14{,}000$$

or $$(6) \quad A \Theta_2 N^2 - 14{,}000 A N + \Theta_1 = 0$$

Equation (6) may be solved for maxima and minima by differential calculus or by use of the quadratic formula, either method resulting in the same solution. If we apply the quadratic formula and solve for N,

$$(7)\quad N = \frac{7000 \pm \sqrt{49 \times 10^6 - (\Theta_1\ \Theta_2)/A}}{\Theta_2}$$

There is obviously no real solution for N if $\frac{\Theta_1\ \Theta_2}{A}$ is greater than 49×10^6. On the other hand if $\frac{\Theta_1\ \Theta_2}{A} = 49 \times 10^6$ i.e.,

(8) $A = \Theta_1\,\Theta_2/49 \times 10^6$ sq. cm., there will be two coincident solutions for N. Thus

(9) $N = 7000/\Theta_2$ turns. By now inserting the values of Θ_1 and Θ_2 and assuming the stacking factor K to be .94 (butt-joint), we have

(10) $A = .61406\ \mu\ I\ E/L\ F$ sq. cm.

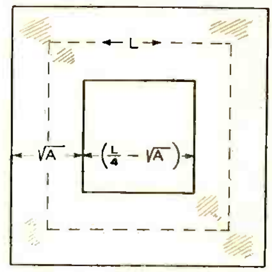
(11) $N = 5570.4\ L/\mu\ I$ turns.

Equations (10) and (11) present what seem like rather contradictory facts, but it must be remembered that the two equations go hand in hand—one is meaningless without the other. As a further check it will be noticed that by eliminating L between the two equations we obtain $N = \frac{3420.6\ E}{A\ F}$ turns, which is perfectly logical. For actual transformer design these equations may be still further simplified by assuming values for μ and F. At least one manufacturer supplies a choice of two modulation transformers, one based on a response of 70 cycles, the other on 35 cycles. The average amateur interested in good intelligible speech could very well use 100 cycles as the basis for computation, but if he is partial to high quality low-note response, he might wish to use F=70.

Permeability Factor

We have avoided dealing with the permeability factor (μ) as long as possible since it is such an extremely variable quantity. From actual experience it may be concluded that values of μ_a ranging from 250 to 500 will prove satisfactory. If some chosen value of μ_a does not lend itself to a satisfactory design

FIGURE 7



for a given available core, the value may be changed slightly to fit the desired conditions and allowance made in the air-gap according to equation (5). Allowing μ_a to be 400 and setting F = 70 in equations (10) and (11),

$$(12)\quad A = \frac{3.51\ E\ I}{L}\ \text{sq. cm.}$$

$$(13)\quad N = \frac{13.93\ L}{I}\ \text{turns.}$$

When one has on hand core punchings of certain definite size, the length (L) of the magnetic path is pre-determined and the problem resolves itself into stacking the laminae sufficiently deep to obtain the required cross-sectional area. Dimensioning new laminae, however, is somewhat more difficult, but here again there are obviously certain limits. It would appear possible to have a very small cross-sectional area and a long magnetic path or vice versa, resulting in a long, slender core or a short, fat one, but for best efficiency the ratio of L to A should be from 1.5 to 3 (L in cm., A in sq. cm.).

Equations (12) and (13) above can be derived in another way by re-stating equations (1) and (2) thus

$$\text{From (1)},\quad N = \frac{10^8\ E}{\pi\sqrt{2}\ K\ F\ B_{ac}\ A}$$

$$\text{and from (2)},\quad N = \frac{10\ B_o\ L}{4\ \pi\ I\ \mu}$$

If we imagine that we are dealing with the secondary winding of the modulation transformer across the terminals of which is induced an r.m.s. audio potential E while the winding is carrying the class-C plate current I, then obviously the latter two equations refer to the same N. Eliminating N from these two equations, setting $B_0 = B_{ac} = 7000$, $\mu = 400$ and $F = 70$, we have $A\,L = 3.509\,E\,I$, which is the same result as obtained above in equation (12).

Moreover, equation (2) results in $N = (13.926L)/I$. [Same result as (13).] For ease in further computation, let us use the constants appearing in equations (12) and (13), above, to the nearest decimal, thus

$$(12)\quad L = 3.5\ E\,I/A$$

$$(13)\quad N = 14\ L/I.$$

Now if we could find some other relationship involving the three unknowns L, A and N, it would be possible to design a transformer starting from "scratch". For the purpose of calculation, suppose the core cross-section to be square and that the outline of the core itself is a square as shown in figure 7. Then the winding "window" will be a square having an area of

$(L/4 - \sqrt{A})^2$ sq. cm.,
L = magnetic path length around center of core (Cm.),
A = area of cross-section of core legs. (Sq. cm.).

Let us further suppose that the turns ratio between total primary and total secondary is to be 1 to 1.2. If the number of turns of wire on the secondary be N, the number of turns on the primary will then be N/1.2. If the outside diameter of the wire used on the secondary is d_1, there will be $1/d_1$ turns per unit length or $(1/d_1)^2$ turns per unit of cross-sectional window area. The space required by the secondary turns will then be $N(d_1)^2$. Similarly, if the diameter of the wire used on the primary is d_2, the window area needed by the primary will be $N\,d_2^2/1.2$. Thus, the total window space needed for both windings is

$$N\left(d_1^2 + \frac{d_2^2}{1.2}\right).$$

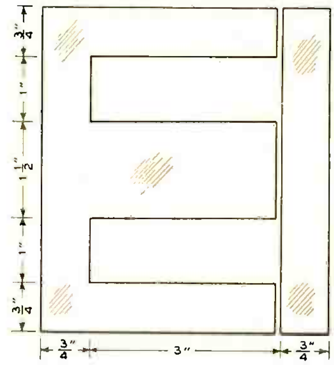


FIGURE 8

For ordinary transformers an allowance of an extra thirty per cent is usually made for insulation but for class-B modulation transformers from eighty to one hundred per cent is not too much. Equating the window area to twice the space required by the wire, we have

$$(14)\quad \left(\frac{L}{4} - \sqrt{A}\right)^2 = 2\,N\left(d_1^2 + \frac{d_2^2}{1.2}\right)$$

From (12), (13) and (14) it is possible to solve for any of the three unknowns, but the work is simplified somewhat if we solve for A, since it usually has the smallest numerical value. Eliminating L from (12) and (13), (15) $N = 49\ E/A$. Substituting (12) and (15) into (14),

$$\left(\frac{.875\ E\,I}{A} - \sqrt{A}\right)^2 = \frac{98\ E}{A}\left(d_1^2 + \frac{d_2^2}{1.2}\right)$$

Simplifying and rearranging terms in descending powers of A,

$$(16)\quad A^3 + 2\sqrt{98\,E\left(d_1^2 + \frac{d_2^2}{1.2}\right)}\ A^2 + 98\ E\left(d_1^2 + \frac{d_2^2}{1.2}\right) A - (.875\,E\,I)^2 = 0$$

This cubic has only one positive solution for A and may be solved using Horner's Approximation, reference to which may be had in most any standard mathematics text. Knowing A it is then possible to use equations (12) and (15) to find L and N, respectively.

Let us carry through the design of two transformers, one of 100 watts audio handling capacity (to modulate 200 watts input to the class-C amplifier), the other of 250 watts audio capacity. Let us suppose that we have E-shaped punchings available of the size and shape shown in figure 8, which we intend to use for the 100-watt transformer and that we propose designing the 250-watt transformer right from "scratch" using core-type laminae. In both cases there are two things to be decided upon before any design can be started — the maximum r.m.s. voltage to be developed by either primary or secondary and the maximum steady d.c. class-C plate current to be used. As a rule the highest r.m.s. voltage will appear across the modulation transformer secondary, especially if zero-bias modulator tubes are used on the primary. If the low- or medium-mu modulator tubes are used with their attendant high plate voltages, the maximum r.m.s. audio voltage will appear across the total primary winding. In special cases where restricted design is desired one may easily determine which winding requires the greater number of turns of wire. The square root of the product of recommended modulator plate to plate load and audio power output equals the r.m.s. audio voltage developed across the primary, while the secondary r.m.s. voltage will be equal to the class-C plate voltage divided by the square root of 2. Thus,

$$E_p = \sqrt{W\ R_L}$$

$$E_s = \frac{E_b}{\sqrt{2}}$$

where E_p = r.m.s. audio voltage developed from plate to plate of modulator tubes

W = rated audio watts output from pair of modulators

R_L = recommended plate to plate load resistance for modulators

E_s = r.m.s. audio voltage developed across secondary of modulation transformer

E_b = class-C amplifier d.c. plate volts.

Watts Audio	R.M.S. Audio Volts	D.C. Class-C Plate Current
100	1000	.15 amps
175	1500	.20
250	1750	.25
350	2000	.35
500	2500	.50

FIGURE 9

The maximum class-C plate current contemplated should next be noted. Figure 9 shows the maximum r.m.s. audio voltage to be expected as well as the class-C plate current for a group of representative modulators. These values will fit practically all cases found in amateur practice and make the design of a "universal" modulation transformer possible.

Recalling our two design problems and referring to figure 9, the 100-watt transformer will have a maximum r.m.s. audio voltage of 1000 volts on the secondary N turns and will carry a class-C plate current of .15 ampere. Thus, in equations (12) and (13), E = 1000 and I = .15. From figure 8 we determine the length of the magnetic path to be L = 30 cm. Substituting these values in (12) and (13) we have

$$A = \frac{3.5 \times 1000 \times .15}{30} = 17.5 \text{ sq. cm.}$$

$$N = \frac{14 \times 30}{.15} = 2800 \text{ turns.}$$

Since A = 17.5 sq. cm. = 2.71 sq. inches, the given laminae must be stacked to a depth of 2.71/1.5 = 1.8 inches. We have already assumed that the primary to secondary turns ratio is to be 1 to 1.2 so that the number of turns on the primary will be N/1.2 = 2334 (approx.). The wire sizes are determined from the total amounts of current they will be called upon to handle. Since the audio r.m.s. voltage on the secondary is 1000 at 100 watts, the audio current will be 100/1000 = 0.1 ampere. The total current carried by the secondary wire is then .15 + .1 = .25 amperes. At 1000 circular mils (CM) per ampere this would require no. 26 wire. The primary wire size should be chosen to carry 1.2 times the secondary current or 0.30 amperes, corresponding to size 25 wire. This combination will be found extremely conservative in operating ratings since the audio currents do not flow continuously. As a matter of fact, in case the core window space does not

[*Continued on Page 79*]

An Economical Cathode-Ray

MODULATION INDICATOR

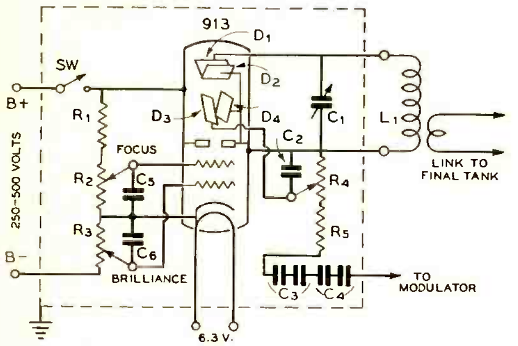


FIGURE 1

C_1 and L_1—Tuned to transmitter frequency
C_2—.0001-µfd. 600-volt tubular
C_3—2 0.1-µfd. 600-volt tubulars in series
C_4—2 0.1-µfd. 600-volt tubulars in series
C_5, C_6—.002-µfd. 400-volt tubulars
R_1—150,000 ohms, 1 watt
R_2—50,000-ohm potentiometer
R_3—25,000-ohm potentiometer
R_4—200,000-ohm potentiometer
R_5—800,000 ohms, 1 watt
SW—S.p.s.t. toggle switch
The insulation on L_1 should be adequate for 500 volts.

By
H. F. FOLKERTS*
W2HFZ

A very simple, economical cathode-ray-tube modulation indicator is shown in figure 1. The principle of operation or the idea itself is not original, but this particular arrangement, considering its performance, is more compact, simple, and inexpensive than similar devices which have previously been described.

No saw-tooth circuit, synchronizing circuit, deflection amplifiers, or additional power supply is required. The unit consists essentially of a 913 cathode-ray tube with a few resistors and condensers. It can be constructed and mounted in a metal box at a cost slightly higher than the price of the cathode-ray tube itself. The exact cost depends upon the contents of the "junk" box.

The power supply may be any of those used in the transmitter or receiver capable of supplying about 250 to 500 volts, since the additional current drain on this supply is in the order of only a few milliamperes. The higher the voltage, providing it is not over 500 volts, the greater will be the detail in the resulting pattern. Naturally, the power supply voltage should be reasonably free from ripple. A separate filament transformer or filament winding is essential to prevent short circuiting the bias supply of the cathode-ray tube. If a separate filament transformer is used, it should be placed far enough away from the cathode-ray tube to prevent beam deflection by the magnetic field. The iron shell of the 913 tube, however, reduces this possibility greatly.

Regarding the 913 tube, the constructor should bear in mind that the negative side of his power supply is usually grounded, whereas the shell of the cathode-ray tube must be positive. Thus, the shell should be carefully insulated from ground by bakelite tubing or by some other suitable means. A piece of bakelite tubing about two inches longer than the tube itself is to be preferred, since the extended portion helps shield the screen from the room light (and from inquiring fingers).

Adjustment

The adjustment of this unit is very simple and may be completed in a few moments. After the heaters have warmed up, close the switch (SW) and adjust R_2 for the proper focus and then R_3 for suitable brilliance. With no deflection voltages applied as yet, the resulting pattern should be a luminous spot at the center of the screen. The switch (SW) should not be closed until the heater of the 913 tube and the cathode of the rectifier have reached operating temperature. Failure to exercise this care, especially at low anode voltages, may result in a negatively charged screen which will not fluoresce properly. This charged-screen condition is due to a low-velocity electron beam. Another preventive measure would be to adjust the bias control R_3 for maximum bias before the heater supply has been turned on.

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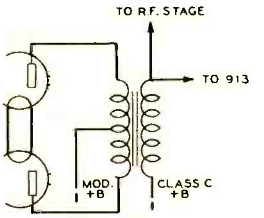


FIGURE 2

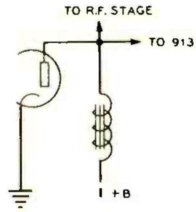


FIGURE 3

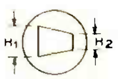


FIGURE 4


FIGURE 5


FIGURE 6

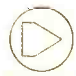


FIGURE 7

Next, by means of a tuned pick-up coil and twisted-pair transmission leads, unmodulated r.f. voltage from the final tank or antenna circuit is coupled to plates D_1 and D_2. This coupling is varied until the electron beam in the cathode-ray tube traces a vertical line approximately one-half the diameter of the tube screen. The audio modulating voltage is then coupled to plates D_3 and D_4 as shown in the diagram. Proper precautions should be taken by the constructor to insulate the r.f. leads from ground to prevent shorts or possible shock, since they are at high potential. The transmitter is now modulated with a convenient tone, such as that from an audio oscillator, and resistor R_4 varied until the horizontal dimensions of the pattern are approximately ¾ of the diameter of the tube screen. That's all there is!

The purpose of C_4 is merely to increase the voltage breakdown point of coupling condenser C_3 and should be necessary only where the d.c. plate voltage to the final r.f. stage is greater than 650 volts. With C_4 in series with C_3 this unit may be used on transmitters employing 1250 volts on the plate of the final r.f. stage. C_2 should be mounted directly at the socket of the 913 tube and serves as an r.f. by-pass condenser. Without this condenser, the r.f. energy "floating" around the unit might be sufficient to deflect the electron beam horizontally, resulting in a distorted pattern. Condensers C_5 and C_6 likewise serve as r.f. by-pass condensers, preventing defocusing and pattern distortion. Using the voltage and wattage ratings shown for all parts in this circuit, the amateur can measure percentage modulation on any transmitter having up to 1250 volts applied to the plate of the final r.f. stage.

Figures 2 and 3 indicate the proper method of connecting the modulator to the 913 tube. Regardless of whether the transmitter is grid, screen, suppressor, or plate modulated, the connections shown still apply. If a class-B r.f. stage follows the modulated stage, the link circuit should be coupled to the output of the class-B stage.

Interpretotion of Figures

To determine the exact modulation percentage, as in figure 4, substitute the maximum and minimum vertical dimensions of the pattern in the formula:

$$\%\ \text{Modulation} = \frac{H_1 - H_2}{H_1 + H_2} \times (100).$$

From this equation it is obvious that the pattern resulting from a 100% modulated carrier is a true isosceles triangle, as shown by figure 5.

If the transmitter has been improperly adjusted or modulated, various other patterns will result when modulation is attempted. Two of these patterns are shown in figures 6 and 7. Figure 6 indicates that the modulated carrier voltage has reached zero before the modulating voltage has reached its peak value on the negative portion of the a.f. cycle. To put it more clearly, overmodulation has taken place. Figure 7 indicates that the modulated carrier voltage does not continually increase with a corresponding increase in the positive half cycle of the audio modulating voltage. This condition may be due to insufficient r.f. grid excitation, poor regulation of a common r.f. and modulator power supply, or low emission r.f. tubes. Various other possible patterns and their causes are explained in detail in the article "Let's See," by Jay C. Boyd, in the April issue of RADIO; 1938 RADIO *Handbook; R/9* for September and November, 1935; *QST* for March and April, 1934; "RCA Cathode-Ray Tubes and Allied Types," and Rider's "The Cathode-Ray Tube at Work."

The author wishes to thank Melvin A. Lewis (W2HEJ) for his cooperation in the use of his amateur radio station.

●

Kunio Shiba, J2HJ, died in April, 1936. Just recently, his brother, Baron Masao Shiba, sent us a copy of a 172-page memorial book edited by friends, including J2IS. The book contains reproduced articles, copies of his 28 Mc. w.a.c. cards in color, and other material. In all it is quite an unusual memorial, and one which impresses the reader with the value of amateur radio in international friendship.

A Five-Meter

SUPER GAINER RECEIVER

A five-meter superheterodyne receiver suitable for c.w. or phone reception in the u.h.f. region and incorporating a simple and new noise-limiting circuit.

By FRANK C. JONES,* W6AJF

Line-stabilized and crystal-controlled transmitters in the u.h.f. region have made it possible to use fairly selective superheterodyne receivers with as much success as on the lower frequencies. A good noise limiter system to suppress automobile ignition interference makes this type of receiver considerably more desirable than a super-regenerative type because of better selectivity. A superheterodyne receiver can easily be made which is less subject to auto ignition QRM than in the case of a good super-regenerative receiver. The latter has an objectionable hiss which is not present in the superheterodyne receiver. The main disadvantage of the superheterodyne heretofore has been the large number of tubes and the complicated circuits required. The set illustrated here has only three tubes in the radio receiver proper and an extra tube for noise limiting or suppression.

The Circuit

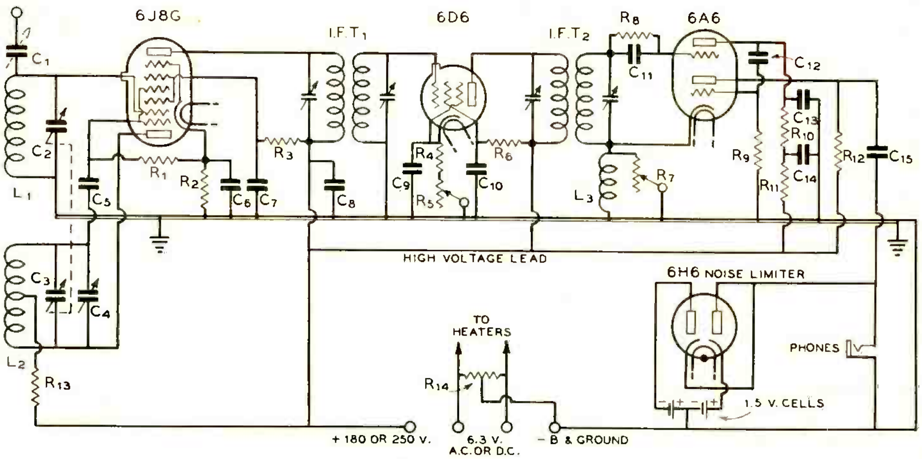
The circuit utilizes a new hexode converter tube, the 6J8G, which is apparently far superior to any previous tubes or combinations of tubes such as the 6A8 or 6L7-6C5 detector-oscillator systems. Electron mixing takes place through an extra grid connected inside of the tube to the oscillator triode section of the 6J8G. This triode has a high transconductance and oscillates vigorously even below five meters in the circuit shown. The oscillator circuit requires a tuning condenser which isn't grounded or by-passed to ground for u.h.f. operation. This is easily accomplished by mounting this condenser on a small porcelain stand-off insulator and connecting the rotor to the dial and detector tuning condenser through insulated shaft couplings. A high-C oscillator circuit gives good frequency stability and can be made to track easily with the low-C detector circuit for single dial tuning. Good oscillator stability is especially needed for c.w. reception of long distance 5-meter signals. These signals occasionally reach long distances when the ionized air layers are such as to reflect these very high frequencies back to earth.

Regeneration in the detector circuit was tried by tapping the cathode lead to a point near the grounded end of the detector tuned circuit. Variable screen voltage was obtained through a potentiometer but little benefit seemed to result—possibly due to the oscillator circuit arrangement. The sensitivity was so much greater than expected with the circuit shown that additional regeneration was left out. An i.f. sensitivity control was needed due to overloading from any nearby 5-meter phone station signals.

One stage of 1600 kc. i.f. was sufficient since a regenerative second detector adds to the gain and selectivity in the intermediate-frequency amplifier. A 6A6 acts as a regenerative second detector and one stage of audio amplification as in the super-gainer receivers illustrated in various editions of the RADIO *Handbook*. The 6A6 has two triodes, one of which acts as a grid-leak detector connected to the second 1600 kc. i.f. transformer. Regeneration, or oscillation for c.w. reception, is controlled by a 1000-ohm variable resistor connected across a cathode r.f. coil. This coil consists of approximately 40 turns of small wire such as no. 28 d.s.c. jumble wound on a ½"-diameter porcelain or bakelite rod. It is not coupled to the i.f. transformer but is mounted underneath the chassis near the 6A6 tube socket. The best number of turns depends upon the type of i.f. transformer and degree of coupling. Loose coupling between the coils of the second i.f. transformer is best for smooth control of regeneration by means of the cathode circuit.

The second triode in the 6A6 is resistance coupled to the detector and to the headphones.

*Engineering Editor, RADIO.



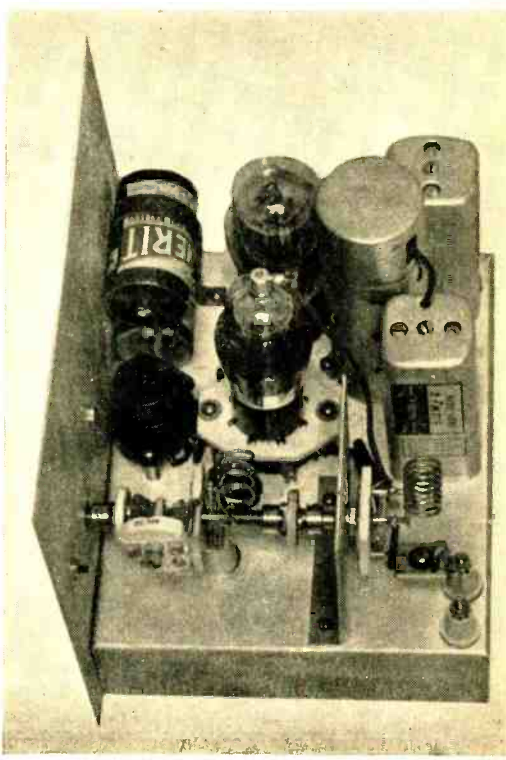
C_1—3-30-μμfd. coupling condenser
C_2—8-μμfd. tuning condenser. Revamped 15-μμfd. midget
C_3—15-μμfd. midget tuning
C_4—50-μμfd. osc. tank condenser
C_5—.0001-μfd. mica coupling
C_6, C_7—.005-μfd. mica by-pass
C_8, C_9—0.1-μfd. 400-volt tubular
C_{10}—.01-μfd. mica by-pass
C_{11}—.0001-μfd. mica coupling
C_{12}—.01-μfd. 400-volt tubular
C_{13}—.002-μfd. 400-volt tubular
C_{14}—0.5-μfd. 400-volt tubular
C_{15}—.25-μfd. 400-volt tubular
R_1—50,000 ohms, ½ watt
R_2—300 ohms, ½ watt
R_3—100,000 ohms, ½ watt
R_4—300 ohms, ½ watt
R_5—50,000-ohm rheostat
R_6—100,000 ohms, ½ watt
R_7—1000-ohm rheostat
R_8—5 megohms, ½ watt
R_9—500,000 ohms, ½ watt
R_{10}—50,000 ohms, ½ watt
R_{11}—20,000 ohms, ½ watt
R_{12}—50,000 ohms, ½ watt
R_{13}—25,000 ohms, ½ watt
R_{14}—50-ohm c.t. resistor
$IFT_{1,2}$—Midget 1600-kc. iron-core i.f. transformer
L_1, L_2—See text
L_3—40 turns, ½" dia., no. 28 d.s.c. jumble wound

The plate circuit of the second detector has an RC filter, an extra condenser and resistor, in order to reduce hum and any possible motorboating trouble. A second audio stage consisting of a high-gain interstage audio transformer and a pentode amplifier tube can be added for loudspeaker output.

Noise Limiting

The new noise-limiting circuit is of particular interest because it can be added to any short-wave or u.h.f. receiver. It is very effective in leveling off the terrific popping or crackling of auto ignition noise. Weak phone signals can clearly be understood through very bad auto ignition interference.

This limiter has a 6H6 twin diode connected in push-pull across the audio amplifier. The plate of one diode connects to the ungrounded end of the headphones and the cathode of the other diode to this same point. The remaining cathode and opposite plate connect through bias delay batteries to the grounded side of the headphones. A negative bias of 1½ volts is applied to each diode plate to act as a delay voltage in order not to attenuate the desired phone or c.w. signals. However, the ignition noise voltage may be as high as 10



or 15 volts on peaks and the limiter levels these off, in fact short circuits the output for the short duration of the noise-voltage peak. These noise peaks, in a receiver that isn't too selective, have a very short period and the receiver output can be automatically short-circuited for a 1/1000 to 1/100 of a second without appreciably affecting the audio quality on phone reception.

The push-pull diode circuit is necessary in order to short-circuit both positive and negative a.f. noise peaks. A single diode would only suppress approximately half of the noise. Whenever a noise peak develops more than 1½ volts (either positive or negative) one diode or the other begins to conduct and acts as a short circuit of fairly low resistance across the headphones. The delay voltage can be made any value; however, two small 1½-volt dry cells connected as shown provide about optimum delay voltage for average headphone reception. This type of noise limiter in any of its several possible forms has proven to be extremely effective. The simplicity of the circuit and ease with which it can be applied to any audio amplifier should make it very popular.

In adapting it to any audio amplifier, it should never be connected across a transformer, choke or pair of phones which has d.c. plate current flowing through the winding. The phones, choke or transformer should be isolated from d.c. as shown in this circuit. The relatively low d.c. resistance of the phones or transformer acts as a current path for the diode return circuit. The delay bias limits the noise voltage to the same approximate level as that of a moderate signal which means that the noise is no longer objectionable.

Other Tube Combinations

Other tube combinations may be used in the five-meter receiver illustrated here. A 6K7 or 6K7G may be substituted for the 6D6 i.f. stage. A 6N7 metal tube usually has a little less hum level than a 6A6 or 6N7G in the second detector-audio circuit due to its better shielding. Any two triodes connected as diodes can be substituted for the 6H6 noise limiter, but the 6H6 is so compact that it is highly recommended. There seems to be no present substitute for the new 6J8G hexode mixer tube.

The receiver was built on a 14-ga. aluminum chassis 6"x8"x1¾" with 12-ga. front panel 7"x8½". A vernier or slow motion dial is necessary and it must be insulated from the oscillator tuning condenser which it drives. The latter is mounted on a porcelain insulator and the detector tuning condenser is mounted on a 3"x3" 14-ga. aluminum bracket which acts as a shield between the oscillator and detector coils and condensers. The 6J8G tube is mounted up above the chassis on a porcelain socket in order to have short r.f. leads to the triode oscillator section. The 6D6 is shielded and the 6A6 should also be shielded. The 6H6 was mounted above the chassis simply because it was added to the receiver at a later date. Ordinary iron-cored air or mica-tuned i.f. transformers are satisfactory.

Single-Dial Control

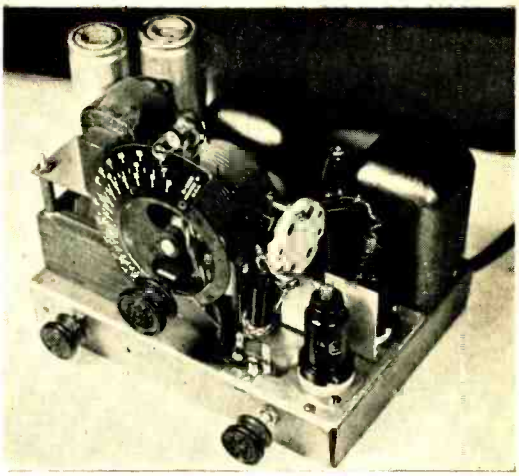
Two Hammarlund type HF-15 condensers were ganged for single-dial tuning control. An ordinary ⅝"-long brass spacer tube was carefully soldered to the shaft nubbin at the rear of the oscillator tuning condenser. This must be "sweated" on carefully with a soldering iron as too much heat will loosen the rotor plates. This hollow shaft extension can be easily soldered on over the nubbin by clamping the front end of the condenser shaft in a vise and holding the brass sleeve in line with a pair of pliers and a steady hand. The shaft extension provides a ¼"-diameter shaft for the rear insulated coupling and also spaces the tuning condensers farther apart. The rear or detector tuning condenser has one rotor and one stator plate removed, leaving only three plates. This leaves a tuning condenser with a maximum capacity of about 8 μμfd. The oscillator condenser has a maximum capacity of about 17 μμfd. and by choosing the proper coils and oscillator trimmer condenser, the two circuits can be made to track 1600 kc. apart. A 50-μμfd. midget condenser set at about three-quarters of its full capacity acts as a fixed "tank" condenser across the oscillator coil and provides a high-C oscillator circuit. The detector has no trimmer condenser as it should have as low C-to-L ratio as possible for maximum signal sensitivity. The oscillator should always be tuned to 1600 kc. higher in frequency than the detector.

Coils

The coils are soldered to the tuning condenser terminals. The oscillator coil has 4 turns of no. 14 wire wound on ½" diameter and the turns spaced enough to make the coil about ¾" long. The coil is center-tapped and the resistor is soldered directly to the coil with a lead about ⅜" long since this resistor must also serve as an r.f. choke in the oscillator circuit. The trimmer condenser is soldered to the

[*Continued on Page 85*]

This is a re-built commercially-manufactured converter from a few years back, but it can also be constructed either from the junk box or new parts.



A 28-Mc. Converter

***By* RUSSELL H. FRANKE*, W8GNJ**

The writer, having been bitten by the species of radio bug known as u.h.f., recently spent several sleepless nights trying to decide whether to tear down a perfectly good nine-tube super and rebuild it for 28 Mc. and higher or build a u.h.f. converter to hook on ahead of this already proven, but decidedly low-frequency, receiver.

There was only one way to decide. The family pocketbook was carefully emptied into the center of a large sheet and its contents as carefully counted, but alas! there was not even one cent among the few that was willing to leave its companions and be a martyr to the most worthy cause.

The case seemed hopeless and one was likened to a person cast upon a desert island without food or drink. But after this period of extreme dejection had passed, a new thought began to dawn! There was plenty of junk lying around so why not put together a converter and just see what it would do, if anything, without the fancy trimmings and high class insulation that are usually associated with high frequency equipment?

Something to Start on

A hasty inventory of the top layer on the top shelf disclosed a shortwave converter which had been designed for use with a standard b.c. receiver and which was sold very widely throughout the U.S. by one of the leading mail order houses a few years ago. This contained its own power supply and produced an intermediate frequency of about 1000 kilocycles.

This seemed to be a good beginning so it was completely dismantled and was found to yield many parts that were later to be useful. As the power supply was of the conventional type and occupied but a small amount of space, little was changed here except to rewind the filament winding of the transformer for 6.3 volts, it being originally designed for 2.5. This, however, was merely a time consuming chore and required but little skill. Since the two small metal electrolytics which, in the photos, are clearly visible just above the transformer, were only 6 µfd. each, another 8 µfd. section was added which accounts for the extra unit which may be seen beneath the chassis. The old reliable type 80 was retained as the rectifier as there seemed to be no reason why anything different should be used.

The Tuned Circuits

The problem of suitable tuned circuits next presented itself. It was decided to use the two-gang condenser which originally tuned the unit;

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hence, some means had to be devised to reduce the capacity and also to give a reasonable degree of spread to the amateur band.

The idea of series condensers seemed fairly good and so a dual intermediate transformer trimmer was hooked into the circuit with one section in series with each section of the variable. This turned out to be very effective as it not only gave the necessary reduction in capacity and an acceptable band spread but it also provided a very nice adjustment for tracking the oscillator properly. It has been said that this tracking is not important at these frequencies but on the contrary it was found to be quite necessary in this case.

As it was only desired to use the unit on ten meters, some very sturdy coils were wound with 20 turns of no. 14 wire on a one-half inch form with no spacing between turns. The coils were then soldered right into the circuit. The oscillator coil is tapped about one third of the length from the cold end, this being not at all critical. The cold ends of both coils and also the two spring rotor contacts of the variable condensers were brought to a common ground. All of the high-frequency by-pass condensers were also brought to this point. This bonding was found to be very important since at this high frequency stray circuits are easily formed when the chassis or the shielding forms a part of one of the tuned circuits.

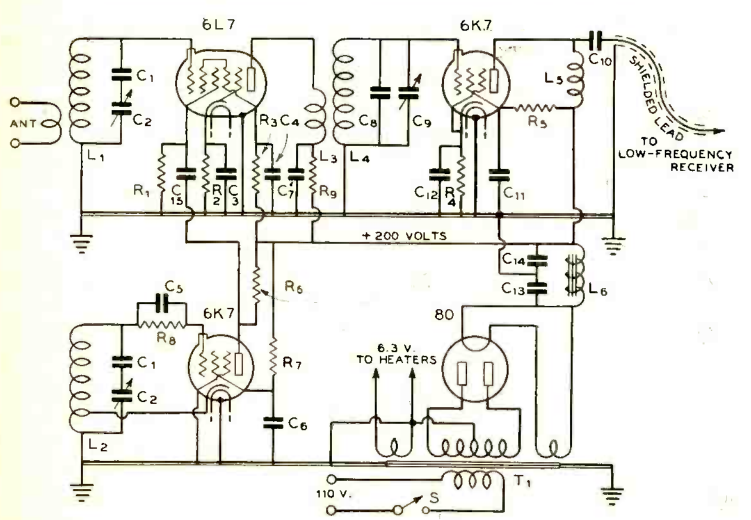
A 6L7 was chosen as the mixer tube because of its good reputation as such and a 6K7 was used as the oscillator because one happened to be handy. This combination proved to be a wise choice as the coupling can easily be controlled between the two stages because of the complete isolation of each tube from its tuned circuits. While this coupling is not at all critical, a capacity of about .0001 µfd. seemed to be best in this case. Probably a fixed mica condenser of this value could as well be used instead of the variable padder which may be seen at the upper right in the bottom view of the chassis.

At this point it might be well to mention that if a metal panel is not used on the unit, as was the case here, the oscillator stage must be placed well back on the chassis to prevent body-capacity effects when tuning. This is the reason for the small shield between the mixer and oscillator tubes. Another reason is that it helps to isolate the two circuits.

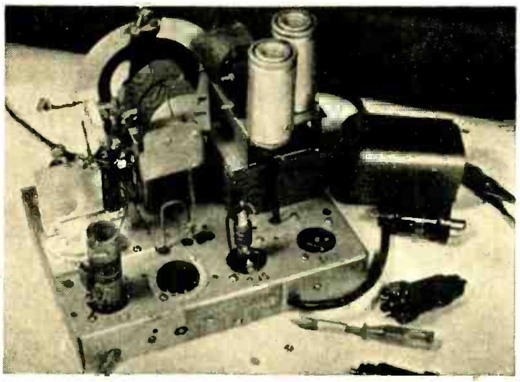
Reason For an I.F. Tube

The failing of most superhet converters lies in the fact that the output is usually taken directly from the plate circuit of the mixer tube and fed into a very uncertain load depending on the input arrangement of the receiver with which it is being used. More for this reason than for anything else, an i.f. amplifier was used as a coupling stage and was found to be well worth

SCHEMATIC DESIGN OF THE 28-MEGACYCLE CONVERTER



C_1, C_2—Tuning condensers, see text
C_3, C_4—.01-µfd. 400-volt tubulars
C_5—.0001-µfd. mica
C_6, C_7—.01-µfd. 400-volt tubular
C_8—.0001-µfd. mica
C_9—Small trimmer condenser
C_{10}—0.1-µfd. 400-volt tubular
C_{11}, C_{12}—.01-µfd. 400-volt tubular
C_{13}—6-µfd. 450-volt electrolytic
C_{14}—14-µfd. 450-volt electrolytic
C_{15}—.0001-µfd. mica
R_1—50,000 ohms, ½ watt
R_2—400 ohms, 1 watt
R_3—5000 ohms, 1 watt
R_4—300 ohms, 1 watt
R_5—100,000 ohms, 1 watt
R_6—50,000 ohms, 1 watt
R_7—100,000 ohms, 1 watt
R_8—50,000 ohms, 1 watt
R_9—5000 ohms, 1 watt
T_1—Power transformer from old unit rewound for 6.3-volt fils.
Coils—See text
L_5—2.5-mh. r.f. choke
L_6—20-hy. 50-ma. filter choke
S—A.c. line switch



Almost everything may be seen in this view. The uncovered i.f. transformer is at the left foreground.

the few extra parts it takes. The conventional 6K7 fills the bill perfectly.

The coupling transformer between the mixer and the i.f. tube is merely an old interstage coil from a midget t.r.f. b.c. receiver with a few turns removed from the secondary and shunted with a small .0001-μfd. condenser and a variable trimmer for the purpose of dodging any strong broadcast signals that might get into the circuit. This transformer, with the shield cans removed, shows very clearly in the photo.

Choice of an I. F.

An i.f. of 2000 kc. was chosen for two reasons. First, it gives complete freedom from image interference. Second, because in the set-up used here it is very desirable occasionally to stand by on the high frequency end of the 160-phone band at the same time that the receiver is being used on ten and this i.f. makes this conveniently possible without the necessity for two complete receivers. The low-frequency receiver can be tuned to as low as 1900 kc. without materially affecting the operation of the converter even though its i.f. stage is permanently tuned to 2000 kc.

It was originally intended to provide a tuned output transformer in the plate of the 6K7 i.f. tube which accounts for the second copper shield can at the rear center of the chassis, but in the usual haste to get the thing working to see what it would do, r.f. choke and condenser output were used instead and the results were so satisfactory that the coupling system has not been changed. Possibly a tuned coupling transformer at this point and better high-frequency parts would improve the operation of the unit considerably, but that is doubtful because it really gives excellent results. Ten-meter phone stations have been heard from all over the world with tremendous volume and good consistency when using either an all-wave table-model b.c. receiver or the ham-made 9-tube super in conjunction with the converter.

Noise Level and Antennas

When the converter was first put into operation, the noise level and auto ignition racket seemed to be quite high. An ordinary b.c. antenna was being used and so a regular 10-meter doublet with a two-wire low-impedance twisted line was tried. The improvement was positively amazing! Signals came up to R7 out of an apparently dead band and those that were R8 or 9 before were so loud that the volume control would not completely cut them off.

Perhaps the writer is overly enthusiastic about this performance as it is the first experience of any consequence with a 10-meter converter. However, the unit operates so much better than several standard all-wave communications receivers with which it was compared, that it is felt that we really have something to crow about—considering the junk that was used in its construction.

The writer wishes to give a great amount of credit to W8NFM who did much to hasten the design and construction of the above very successful converter.

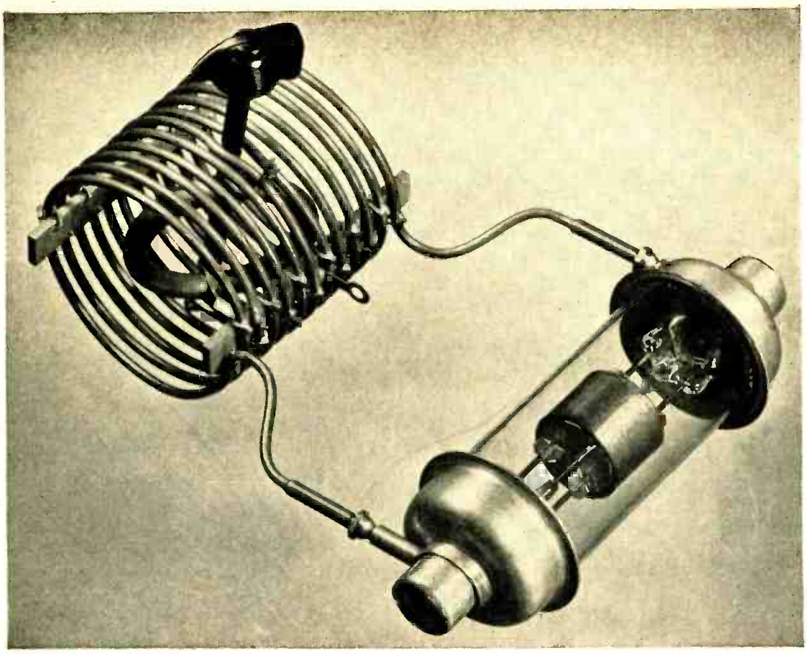
Ten Years Ago
. . . IN MAY

The yacht "Carnegie," signing WSBS, leaves Newport News, Va. for Plymouth, England, on the first leg of a projected three-and-a-half-year world cruise. L. A. Jones ships as operator.

W9AFA most consistent May contact for the "Bowdoin," WNP, frozen in at the North Pole.

W. D. Terrell, chief of the radio division, department of commerce, congratulates Twin City Vigilance committee on its outstanding work in cleaning up b.c.l. QRM.

Objections raised to the use of amateur calls for obvious commercial communications by the "New York Times" (2UO) and the "San Francisco Examiner" (6ARD). Pressure brought to bear results in the two newspapers taking out limited commercial licenses.



VACUUM CONDENSERS

for Fixed-Capacity Finals

In the article on inductive tuning by Chas. D. Perrine, Jr. in the February issue, mention was made of the fact that small vacuum tank condensers would soon be commercially available. We have been informed by the manufacturer that within a very short time condensers similar to that shown in the accompanying photograph will be offered on the market.

Tentative specifications call for four sizes: 6½, 12, 25, and 50 μμfd. for 10, 20, 40, and 80 meters respectively. Two 50-μμfd. units may be paralleled for 160-meter operation. The "Q" represented by these values is about optimum for high-power operation with tubes normally used by amateurs, and this works out very nicely inasmuch as the use of these condensers will probably be confined to amplifiers of 500 watts and over.

The condensers are all the same size physically, and fit into heavy cartridge fuse clips, which can be mounted on ceramic insulators having a long leakage path.

Because of the small spacing between electrodes, the static stress is sufficient at d.c. potentials of over 9000 volts to drag electrons from the negative electrode even though cold. However, at radio frequencies the condenser will stand any potential that will not arc between the outside corona shields (3½-inch spacing) or more than 30,000 peak volts. In common tank circuits, where no d.c. appears *across* the tank condenser, the condensers will easily withstand 4000 volts on a plate-modulated amplifier or 5500 volts on c.w.

The fact that one of the vacuum tank condensers cannot be used in a "split stator" arrangement is no drawback in a push-pull amplifier which uses a *split grid condenser with grounded rotor.* Inspection of high-power push-pull amplifiers in recent issues of RADIO will in many instances show the rotor of the plate tank condenser to be "floating" instead of connected to ground. Such an arrangement actually has several advantages if the *load on the two tubes is not unbalanced.*

On the higher-frequency bands a single, heavy, shorted turn may be rotated within the tank coil to vary the resonant frequency over the band. This, of course, requires that the coil be initially "pruned" to just the right amount of inductance, because it is possible to

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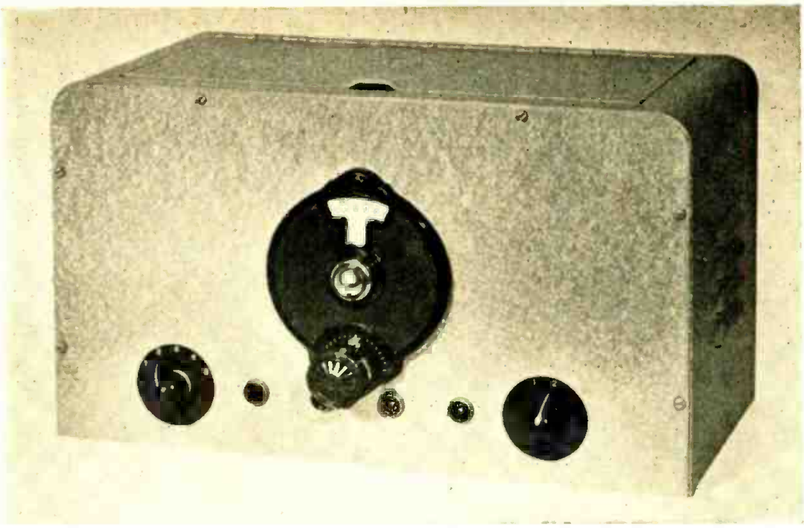


THE "FLEXTAL" EXCITER

By **LEIGH NORTON,* W6CEM**

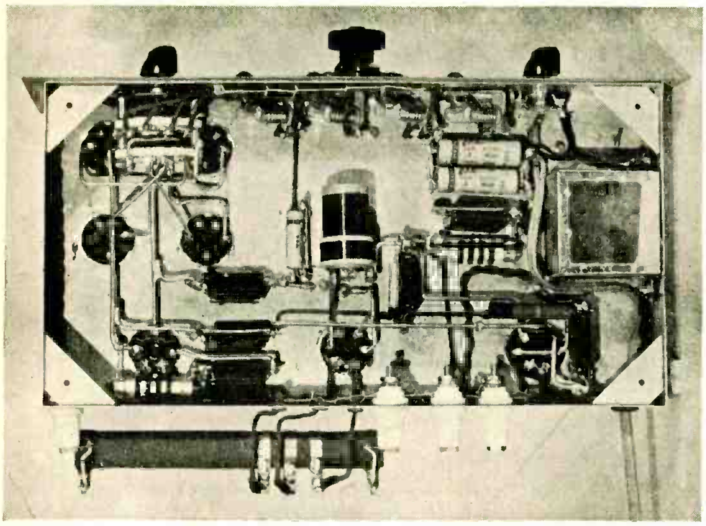
One of the results of the recent dx contest which will not appear in the logs of the contestants was the discovery by numerous operators that operation could have been far more enjoyable and much more productive if some sort of continuously variable frequency control had been employed. It was disheartening, to say the least, to listen to some choice dx station making one contact after another while his receiver stayed tuned to a frequency about 5 kc. from the new crystal purchased just before the contest to "get down in the band a ways." To provide a shining example of "locking the stable after the horse was stolen," it was decided, after the contest was over, to see what could be done to enable W6CEM to be placed *anywhere* in the 7, 14 and 28 Mc. bands.

Three solutions to the problem presented themselves. A large supply of variable crystals would do the job, but to cover the c.w. section of the 14 Mc. band at least twelve crystal units would be necessary. For complete coverage of both 7 and 14 Mc. no less than 24 would be required. The cost of these crystal units made this solution highly impractical in the writer's case.

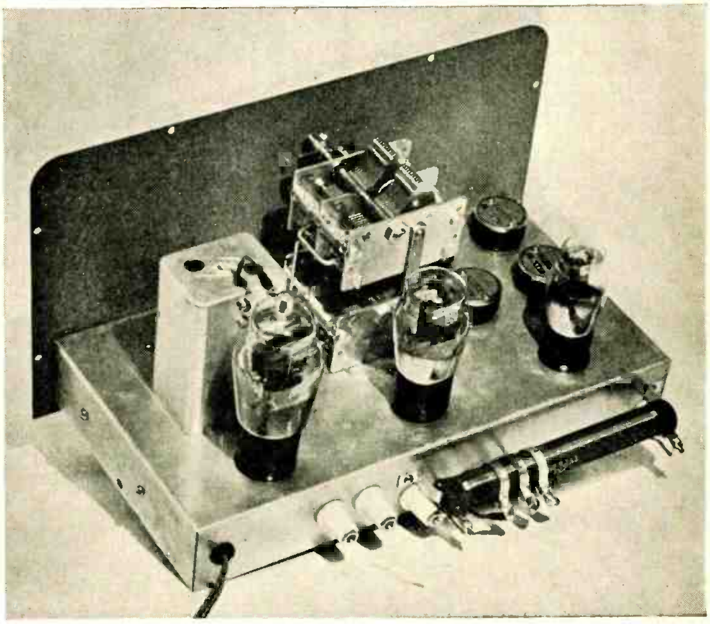
*921 Maltman Avenue, Los Angeles.

Another method was to replace the present crystal stage with a self-controlled oscillator of the electron coupled type. The electron-coupled oscillator, however, leaves much to be desired in the way of stability, quality of signal, and simple foolproof construction. To be really stable, an electron-coupled oscillator should be operated at a very low power level, making several buffer stages necessary to bring its output up to the level of the average crystal oscillator. The theoretical high degree of voltage-frequency compensation obtainable in this type of oscillator requires critical and interlocking adjustments of screen voltage, plate voltage, and excitation. Even when an elaborate voltage regulated power supply is used, its operation is not always entirely satisfactory. These disadvantages ruled out the electron-coupled oscillator principally from a standpoint of simplicity and ruggedness.

The third solution to the problem was to follow in the footsteps of W6BC and W7GAE and attack the variable frequency control problem from the frequency conversion angle. In this type of control unit, a variable output frequency is obtained by mixing the output of a variable low-frequency oscillator with that of a relatively high-frequency crystal oscillator. The output is taken from the plate circuit of a



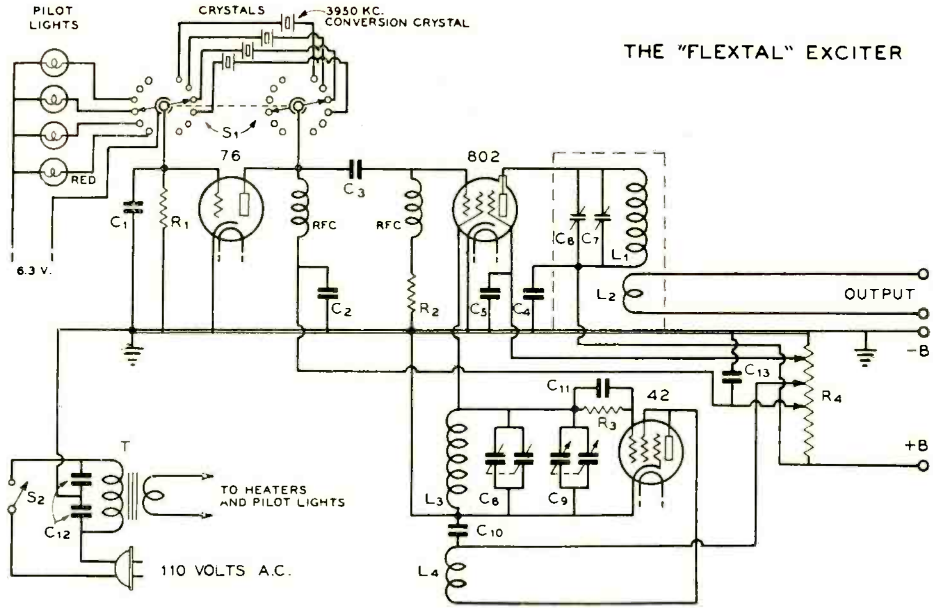
• In this bottom view the pilot lights may be seen at the top, the crystal switch top left, the low-frequency coil at the center, and at right center, the filament transformer.



• The tubes from left to right are 802 mixer, 42 l.f. oscillator and 76 crystal oscillator. The voltage divider is outside-mounted to avoid heating effects on the stability.

mixer stage which may be tuned to either the sum or difference of the two applied frequencies.

The theoretical frequency stability obtainable from this type of unit is very high. To provide a highly exaggerated example: If a 3600-kc. self-controlled oscillator had a 1% frequency shift due to a certain change in plate voltage, the change in frequency would amount to 36 kc. Comparing this shift with that of a conversion unit, assuming a similar set of conditions as applied to a low-frequency oscillator on 350 kc. which is mixed with a crystal oscillator on 3950 kc. to obtain the same 3600-kc. output frequency, we find that the same voltage change would have a negligible effect on the 3950-kc. crystal oscillator and would cause a frequency change of but 3.5 kc. in the 350 kc. oscillator. Since the output frequency is simply the difference between these frequencies (the l.f. and crystal oscillators), the shift in resultant frequency would only be that of the low frequency oscillator, or 3.5 kc. The conversion



- C_1—.0001-µfd. mica
- C_2, C_3, C_4, C_5—.002-µfd. mica
- C_6, C_7—25 µµfd. each, in tank unit
- C_8, C_9—2-gang b.c.l. condensers, 350 to 365 µµfd. per section
- C_{10}—.01-µfd. 400-volt tubular
- C_{11}—.0005-µfd. mica.
- C_{12}—0.1-µfd. 400-volt tubular
- C_{13}—4-µfd. 450-volt electrolytic
- R_1—50,000 ohms, 1 watt
- R_2—3000 ohms, 2 watt
- R_3—30,000 ohms, 1 watt
- R_4—25,000-ohms 100-watt voltage divider
- L_1—48 turns no. 22 enam. close wound on 1" dia. form
- L_2—8 turns no. 22 enam. wound over cold end of L_1 and insulated from it by strips of celluloid
- L_3, L_4—Broadcast receiver coil, see text
- S_1—4-pole, 2-gang 6-position tap switch
- S_2—110-volt a.c. on-off switch
- T—6.3-volt 3 amp. filament transformer

unit is, therefore, inherently over 1000% more stable than the self-controlled oscillator, regardless of the actual percentage of frequency change considered.

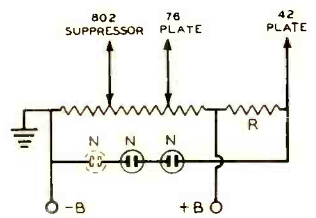
In at least two other ways the conversion unit has a definite advantage in regard to stability over the self-controlled oscillator. A certain amount of compensating action is provided by the high frequency crystal oscillator itself. This will be discussed later in connection with the choice of crystal frequency. The effect of changes in element spacing due to tube heating again shows the conversion unit to be definitely superior.

All in all, the conversion unit presents a very rosy picture as to inherent frequency stability from a theoretical standpoint. This theory is well borne out in practice; listeners are unable to notice any difference between conventional crystal control and control by the conversion unit.

With the conversion type frequency control showing such marked theoretical advantages it was decided to see what could be done to simplify its utilization.

It was decided that to provide a really satisfactory frequency control the following requirements must be met: (1) It must be stable to the highest possible degree; (2) it must have a reasonable amount of output—enough to excite the rig in place of the present crystal stage; (3) it must be inexpensive to construct. Parts must be easily obtainable through the usual channels; (4) it must be of simple design, with no critical adjustments or "tricky" circuits; (5) it must be flexible—operate either as a conversion unit or straight crystal oscillator and buffer merely by selecting the proper crystal with a tap switch.

The aforementioned theoretical advantages seemed to satisfy requirement (1); so with the other four requirements firmly in mind and the ever present junk box close at hand the prob-



Voltage Stabilization Circuit

R—5000 to 15,000 ohms, 10 watts
N—2-watt neon lamps

lem was attacked in earnest. The unit to be described is the result of many hours spent in trying various combinations of coils, resistors, condensers, and tubes. It resembles its predecessor of the junk box in circuit and operation only, a new set of parts having replaced the time worn ones used in the original model.

Several of the local ham fraternity with a bent toward coining words who have built similar units or seen them in operation have dubbed it the "Flextal" exciter. "Flextal" is fairly descriptive of the unit's operation; so "Flextal" it remains.

The "Flextal" conversion exciter is probably far from the ultimate in frequency control. No piece of radio equipment worthy of the name should ever be considered as not subject to improvement. However, it does answer all the requirements originally set up. It provides an abundance of extremely stable, easily obtainable, low cost r.f., the frequency of which is controllable by "a twist of the wrist".

The "Flextal" consists essentially of a crystal oscillator, a pentode amplifier, and a low frequency oscillator modulating the pentode stage, which thence becomes the "mixer". As the heart of this type of unit is the mixer stage, it was decided to employ the largest moderate-voltage tube that could be used. The only practical tube proved to be the 802; it has effective shielding and a sufficient number of elements to handle the job—not perfectly, but adequately.

Two simple methods of modulation, or injection, suggested themselves. Either screen or suppressor modulation could be used. Of the two, screen modulation proved to be the more satisfactory, giving slightly greater conversion output, and having the distinct advantage of being much less critical in adjustment.

The 802 is used as a straight single-ended mixer, in contrast to the balanced modulator used in previous units of this type. This proved to be no disadvantage, in spite of the fact that three frequencies appear in the output tank: (1) the crystal frequency, (2) the sum of the crystal and the low frequency, and, (3) the difference between the crystal and the low frequency. These three are easily separable by the use of a moderate value of C in the tank circuit. In practice, with the 802 plate circuit tuned to the desired peak, it is impossible to get enough energy through on the two unwanted frequencies to be measurable on the grid of the stage following the "Flextal" unit. The screen of the 802 is directly connected to the "hot" end of the low frequency oscillator tank circuit. This places it at ground potential for d.c. and also at ground for *high frequency* r.f. due to the by-passing effect of the high-capacity oscillator tank condenser.

The crystal oscillator is a simple Pierce affair, used because of its simplicity and because of the fact that it will operate with crystals of widely differing frequencies, there being no tuned circuits.

The low frequency oscillator uses a 42, triode connected. The 42 was selected because of its ruggedness and large power handling capability (allowing it to "loaf" at low voltages) and its wide element spacing. This choice has been fully justified; the 42 leaves nothing to be desired in output and frequency stability.

The choice of a frequency for the low frequency oscillator involves several considerations. An output range from the "Flextal" unit of from 3500 to 3650 kc. will provide complete coverage of the 7 and 14 Mc. bands and the c.w. section of the 28 Mc. band together with the most-used portion of the 28 Mc. phone band. To achieve a 3500- to 3650-kc. output range, the low frequency oscillator must have a range of 150 kc. In order to keep the l.f. oscillator out of the 465-kc. i.f. amplifier in the neighbors' b.c. sets, it should tune no higher than 450 kc. A frequency range of from 300 to 450 kc. seems to be the logical answer.

An "interstage" broadcast coil tuned by a regular four-section b.c. condenser with its sections in parallel will cover from approximately 250 to 750 kc. By splitting the condenser in two parts and using two paralleled sections for padding, or band setting, and two for tuning, it is possible to obtain a spread of approximately 75 divisions on an ordinary 100-division dial for the 300 to 450 kc. range.

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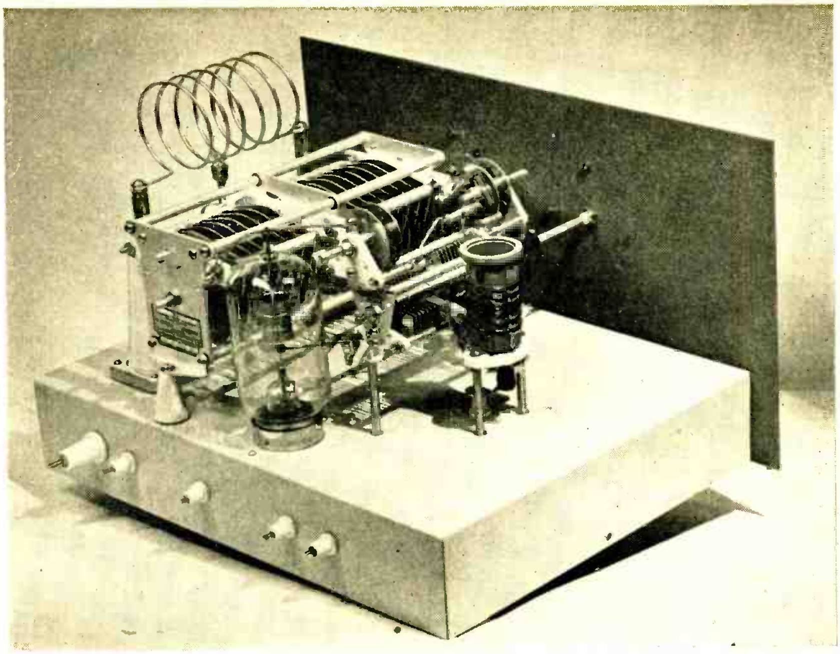


A Neat H.F. KW. AMPLIFIER

By FAUST R. GONSETT,* W6VR

The problem of laying out a kilowatt amplifier so as to have short leads and take up but little space is a rather difficult one because of the necessarily large size of the components. The problem is a strictly mechanical one, and not insurmountable. By shoving parts around in different positions and combinations it is usually possible to hit upon one that permits of a very compact and efficient layout. One such arrangement of a kilowatt amplifier is illustrated in the accompanying photographs. It takes up but little room, and r.f. leads are all less than two inches long; in fact the average length is about one inch.

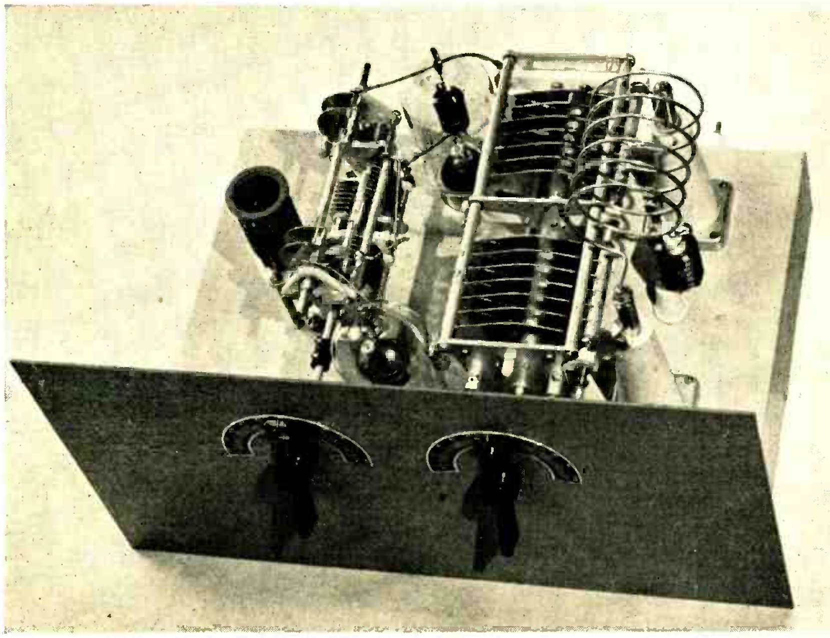
The amplifier consists of standard, readily available components, including a pair of the new HK-254 Gammatrons. The short leads are accomplished by "underslinging" the HK-254's and mounting the other components either on ceramic standoff insulators or on brass rods or bushings of such heights that lead lengths are kept to a minimum.

*Laboratorian, RADIO.

The amplifier is constructed on a standard rack size panel and chassis, the panel measuring 19x10½ inches and the chassis 17x13x3 inches. If used in a rack, especially one with a dust cover, a narrow "meter panel" with a cut-out and snap-on door can be used above the amplifier panel to reach the coils from the front of the transmitter.

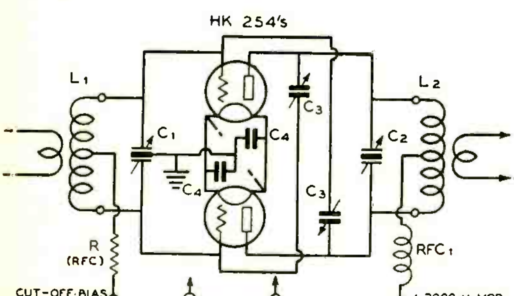
The two variable condensers are so placed that the shaft holes divide the front panel into three equal sections. The appearance would probably be improved slightly if the condensers were spaced a little wider apart, but this would require longer r.f. leads and would place the plate tank coil too close to the dust cover if one is used.

The "50-watt" sockets for the HK-254's are supported below the chassis by means of one-inch bushings. This puts the grid and plate leads at just the right height. The grid condenser and coil socket are both raised from the chassis by means of 2¼-inch brass rods or bushings. This permits short leads and places the shaft of the grid condenser at the same



height as the plate condenser if the latter is supported on the 1½-inch ceramic cones shown in the illustration.

Because the rotor of the grid tank condenser is grounded, the shaft coupling need not be of the insulated type. However, the rotor of the plate tank condenser is left "floating" in order to increase the allowable plate voltage, and an insulated shaft coupling is therefore required. It will be necessary to saw the rather long shaft of the plate tank condenser in order to accommodate placement of the insulated coupling between the condenser and front panel.



L_1, L_2—See coil table
C_1—100 µµfd. per section, 2000 volt spacing
C_2—100 µµfd. per section, 7000 volt spacing
C_3—5 or 6 µµfd. max. 7500 volt spacing
C_4—.002 µfd., 500 volt mica
R—400-ohm 10-watt resistor
RFC_1—2.5 mh. 500 ma. r.f. choke

The 7000-volts-per-section plate tank condenser allows the use of 2000 volts with plate modulation or 3000 volts on c.w. Thus it is possible to run 1 kw. input on c.w. or 800 watts on phone without exceeding the 200 ma. per tube rating on the HK-254's. If sufficient audio power is available, trouble may be experienced with arcing of the neutralizing condensers on occasional (unintentional) peaks of overmodulation. This is easily remedied by placing in series with each lead from plate to neutralizing condenser a 100-µµfd. 5000-volt mica fixed condenser.

No bias provision is made in the amplifier itself. It is desirable to use fixed bias equal to cutoff (1/25th the plate voltage) and a grid leak for the balance. A 3500-ohm 100-watt grid leak with adjustable slider connected so as to short out part of the resistor may be considered as part of the bias unit rather than part of the transmitter. The slider should be adjusted so that 80-ma. grid current flows when maximum driver output is being obtained. While more drive will permit greater efficiency, 50 watts output from the driver will be sufficient for phone operation and about 30 watts will be sufficient for c.w. operation. More drive permits the use of higher bias, which results in slightly greater efficiency. Regardless of the amount of drive available, the grid leak should be adjusted to allow 80 ma. of grid current.

COIL TABLE			
Band	Turns	L_1 Length	L_2 Length
10 M	6 T	1½"	4"
20 M	12 T	2"	5"
40 M	24 T	2"	5"
All L_1 are 1½" dia.; all L_2 are 2½" dia.			

The 400-ohm 10-watt resistor in the grid lead is used as an r.f. choke rather than to provide bias, the small amount of bias resulting from the voltage drop being incidental. A regular r.f. choke used at this point might resonate with the r.f. choke in the plate circuit and cause a bad, low-frequency parasitic oscillation. There is little r.f. voltage present, and the 400-ohm resistor serves the purpose nicely.

The filament transformer should be capable of putting out nearly six volts and have an adjustable primary if it is not placed on the chassis, and heavy wire (no. 10) used for the connecting leads. There is room on the chassis for such a transformer, however, and its inclusion will make it unnecessary to allow for the voltage drop in long filament leads. If the amplifier is to be used in a rack, the transformer should be mounted towards the front panel to minimize the pull on the panel and chassis.

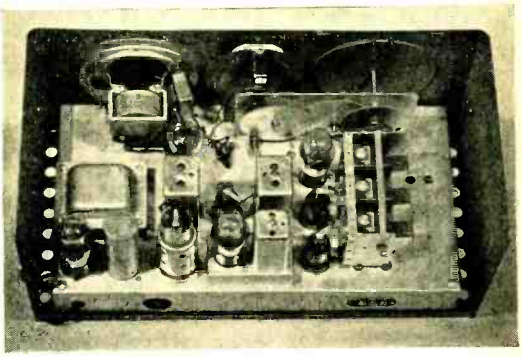
The Coils

The coils are supported on large, jack-type stand-off insulators with heavy jacks and plugs spaced 6½". The 10- and 20-meter plate coils are wound from no. 8 bare or enameled wire and are self-supporting. The 40-meter plate coil is wound of no. 12 wire, and supported by means of celluloid strips held in place with Duco cement. If no. 8 wire is not available, no. 10 may be used for the 10- and 20-meter coils, though the coils will "shimmy" a bit. If bare wire is used, it should be shined first with steel wool and then painted with Duco cement or clear lacquer after the coils are wound. No. 18 enameled is used for the grid coils.

The approximate dimensions for the coils are given in the table. The turns should be squeezed together or pulled apart a bit as the case may be until the coils resonate with the condensers nearly out on 10 meters, about half way meshed on 20 meters, and nearly all the way meshed on 40 meters. It is possible to get the unloaded minimum plate current lower by using lower "C" in the plate tank, but the "Q" will not be sufficient for proper operation when the amplifier is loaded. If the amplifier is to be used only on c.w., one extra turn may be used on 10 meters and two extra turns may be used on the 20-meter coil.

The Tubes

The HK-254's, newest addition to the Gammatron line, are rated (each) at 100-watts plate dissipation, 40-ma. maximum grid current, and 200-ma. maximum plate current. The μ is 25, the interelectrode capacities very low, and the tubes require a standard 50-watt socket.



A New Receiver

A new Hallicrafters communications receiver has been received at RADIO's laboratory. It is in the medium-low price range and possesses most of the features found on expensive "precision" receivers. A descendant of the familiar "Sky Chief", the new "Sky Champion" is an eight-tube superheterodyne covering the range of 545 kc. to 44 Mc. in four bands. The dial is similar to those used on the more expensive Hallicrafters receivers last year, rather than the b.c.l. airplane-type found on the Sky Chief. Possessing a high degree of bandspread, the receiver tunes very nicely over the amateur bands.

Eight tubes are used as follows: 6K7 r.f. (preselector), 6L7 first detector, 6J5-G h.f. oscillator, 6K7 intermediate frequency amplifier, 6Q7-G second detector and a.v.c., 6J5-G beat oscillator, 6F6-G audio amplifier, and 80 rectifier. The use of a preselector stage and separate beat and h.f. oscillator tubes contributes much toward the excellent operation of the receiver. The use of 455 kc. (free channel) for the in-

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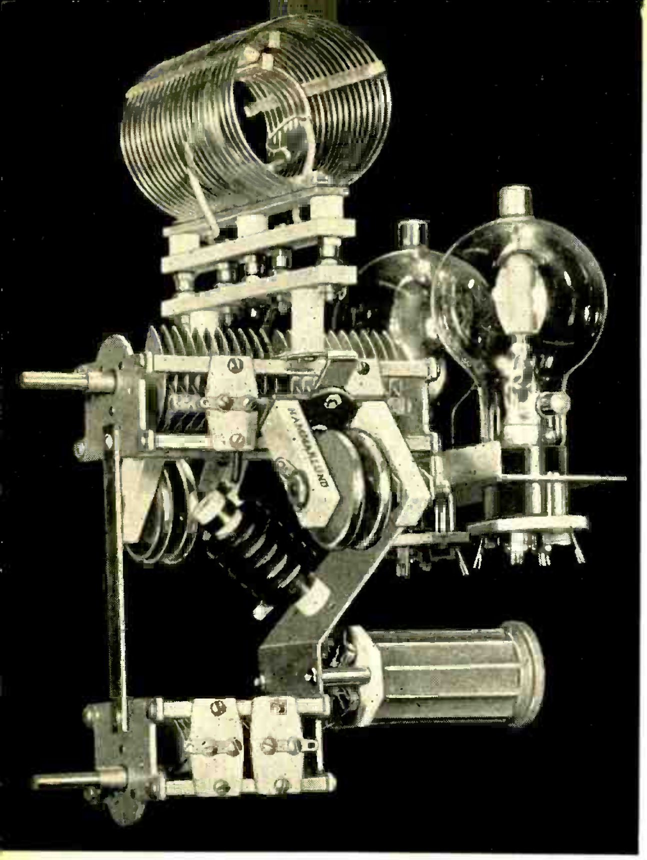

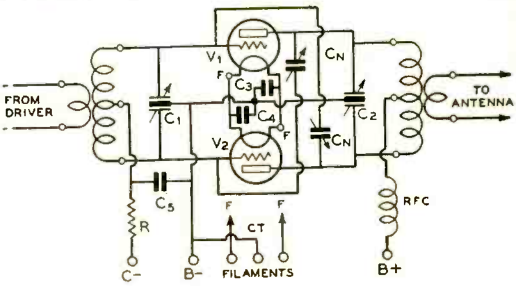

C_1—100 μμfd. per section, 1000-volt spacing
C_2—100 μμfd. per section, 3000-volt spacing
C_3,C_4—.001 μfd. mica
C_5—.001 μfd. (optional). Try with and without
C_N—2-10 μμfd. neutralizing condensers
R—Appropriate gridleak for tubes used
V_1V_2—See text
RFC—2½ mh., 500-ma. r.f. choke

"UNIT-CONSTRUCTION" *Final Amplifier*

The majority of medium-power amateur rigs being constructed at the present time are using a pair of tubes of the 35T, 808, 54 or T55 class operating as a push-pull amplifier with 150 to 500 watts input. A number of excellent layout arrangements have been shown in past issue of RADIO. But all these involve considerable mechanical construction, and in some cases considerable reassembling is necessary before the various components will fit together in the prescribed manner. Also, they were either breadboard mounted with its attendant disadvantages, or they were panel and sub-chassis mounted with its necessarily large mounting space requirements.

Some sort of unit construction for the entire final stage would be very desirable to those desiring to build a compact and efficient final stage. Such an arrangement, one involving little labor for assembly, is shown in the accompanying photograph and circuit diagram.

The arrangement is very rigid, is compact and self-contained, and features very short interconnecting leads between the various tube elements and the tank and neutralizing circuits. This is conducive to the elimination of parasitics and to high efficiency on the higher frequencies. Also, due to the unusually short neutralizing leads, neutralization is quite easily and completely obtained regardless of frequency.

Much time has been spent in the design and arrangement of this unit. All parts associated with the amplifier proper are joined together with brackets of various shapes. This hardware is available, if desired, in kit form and the only tools necessary for assembling and wiring are a screw-driver and a soldering iron. When finished, it is a self-supporting unit which can be bolted to the panel with the mounting screws furnished with the variable condensers; no chassis is necessary.

Mounted upon the two side bars of the large variable condenser are the two brackets which

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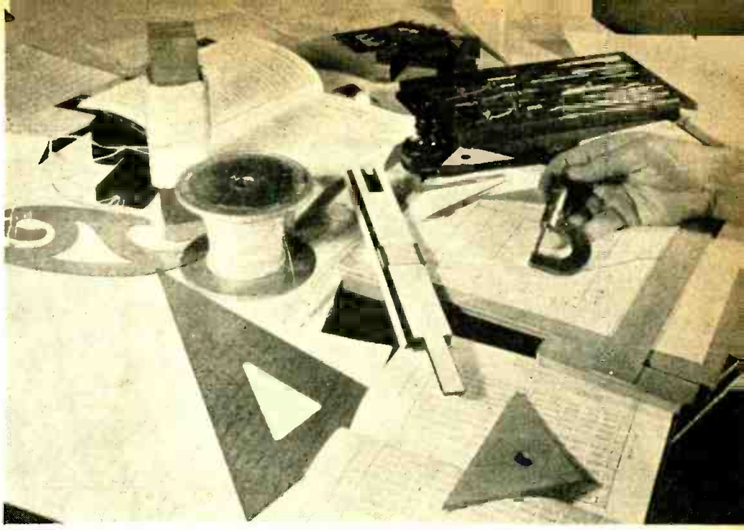


W9HA - W9EHD

DEPARTMENTS

- **Dx**
- **Open Forum**
- **Postscripts and Announcements**
- **56 Megacycles**
- **Yarn of the Month**

DX

HERB. BECKER, W6QD

Readers are invited to send monthly contributions for publication in these columns direct to Mr. Becker, 1117 West 45th Street, Los Angeles, Calif.

I thought the dx contests were over. However, one wouldn't think so the way the mail has been pouring in. Here we are, living the contest all over again . . . it makes me sleepy and tired to think about it. Anyway, I guess both the c.w. and phone portions were a huge success. I believe the phone boys got a little tougher break on conditions than the c.w. gang did during their nine-day stretch. However, the following paragraphs will bring out a surprise or two. Here's the first one.

W2UK Scores Again
176,000 C.W. . . . 68,000 Phone

This fellow Tommy "In-the-bushes" Thomas, W2UK to you, finally found an adding machine that would cover his score. I can imagine poor Tommy after running up 176 grand needing a few weeks to recuperate. W2UK made 329 contacts in 76 different countries and had a multiplier of 179, using the 10-, 20-, 40-, and 80-meter bands. That's what I call going places. There is more to Tommy's success than we probably imagine because only a short time ago he stepped off that well-known plank and now has an x.y.l. Our operative no. 1492 tells us that Tommy's "better half" kept the coffee pot sizzling the last few days of the contest, and supplied him with extra heavy toothpicks to prop his eyes open. A double congratulation to you, Tommy: one for joining the benedicts and the other for that string of points in the contest.

The transmitter at W2UK seemed to be instilled with the spirit of scoring points, so when the phone contest began, Matty Rehm, W2HNY took over the driver's seat and proceeded to run up about 68,000 points. Although not the highest, it was mighty good. Matty made 296 contacts in 54 countries with a multiplier of 78.

W6GRL Repeats in Phone Contest
82,000 points

W6GRL, who has been known as one of the best c.w. dx men in the business, upset all pre-season dope, formulas, or what have you, by entering the phone dx contest. He not only entered it but scored more points than any other west coast station, much to everyone's surprise including his own.

Before going further I should tell you that Doc Stuart turned his station over to Dave Evans for the phone contest, "just to see what he could do on phone". Doc spent his "two-bits worth" in the c.w. contest and had to get busy again yanking molars. Anyway, almost over night a perfectly good c.w. station turns into a first-class phone station. As far as we can determine this is the first time any station on the Pacific coast has been "tops" in both the c.w. and phone contests in the same year. W6GRL made 318 contacts in 56 countries with a multiplier of 87. To refresh your memory GRL scored 140,000 points in the c.w. brawl.

Here are a few other phone scores that have trickled through, although they seem to have a flavor of W6: W9ARA, 80,000; W2UK, 68,000; W3GCR, 50,000; W6ITH, 51,240; W9YGC, 45,000; VK2GU, 42,000; W6OCH, 37,700; W6CQI, 57,000; W2JMI, 30,000; W6AM, 29,000; W6NNR, 18,000; W6GRX, 17,000; W6GCX, 14,478; W9QI, 12,267; W6QD, 105; W4CYU, 96,000; W3ANH, 56,000; W2DC, 100,000; W3EMM, 98,000.

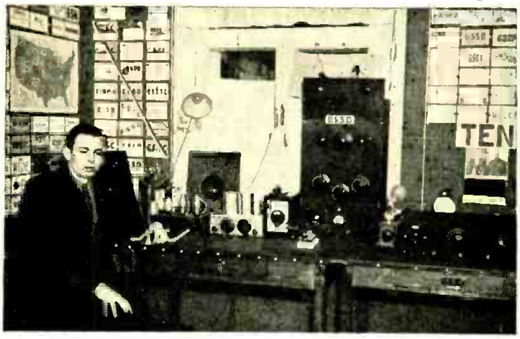
Here are a few more scores from the c.w. marathon: GI6TK, 81,000; G6NF, 91,784; W1ME, 65,670; W2BJ, 40,300; W4ELQ, 44,226. Others who probably have swell scores are W3ANH, W3PC, CO2JJ, W4DSY, W4AH, J2MI, VS6AG, YR5AA, KA1ZL, KA1ME. 10-meter phone brought out such stations as OK1FF, ES5D, I1TKM, SP2LM, FA8IH, VP3NV, TG9AA. More c.w. scores are W3EMM, 156,000; G6WY, 75,000; G6QX, 57,700.

VK2ADE made 104,000 on c.w.—probably the highest score ever made by a VK in any contest.

W9CVL, looking at the whole thing from a Kansan's viewpoint, thinks the phone boys got the best break in conditions, that there were plenty of variable crystals or e.c. units used, and that they should tune up on dummy antennas. Milt also passes along the word that VR6AY (have you ever heard of him?) worked his first G station on March 27th. It was G2TR on 20, of course. W6OCH nabbed 7 new countries out of the phone 'test: YR5AA, VR6AY, K6BAZ, PA0UN, EI6G, GM6RG, VU2LL. All of those are darn good contacts but it just so happens that K6BAZ, who is on Howland Island all right, cannot be considered as a country, at least not yet. For you fellows who have been counting Howland and Baker . . . just take a slant at the Official Country List and you will notice that they are not there. W9QI got himself three new zones out of it, FB8AH, SV1KE, and KA1ME. This makes 28 zones but don't know how many countries.

W6ITH worked K6BAZ, ES7X, and YR5AA on 28 Mc., K6CGK, K7PQ, XE2HN on 1.8 Mc., and K6CGK, K7PQ, XE2FY, K6LKN, K4SA, K7DWH on 3.9 Mc. K7PQ and K6CGK were contacted on four bands. Hal Palin, W9YGC, upped his zones two and now has 29. His best catches in the "mike derby" were VR6AY, J2MI, J2NF, KA1ZL, KA1ME, KA1CS, OZ5BW, SP1DC, ES5D, CN8MU, LA1F, PK3DG, PK2AY, CE1AH and on 28 Mc., VU2CQ. His score, 45,000. It took a lot of warbling to haul in that bunch of points in Indiana.

W1HKK of Boston writes that he hopes the following dx he has worked on phone meets with the approval of a c.w. man . . . hi. It does and here it is: SU2TW, YR5AA, YR5CF, I1IT, VR6AY, ZS3F, ZE1JR, OZ9Q, YI2BA, VK5BF, FA3HC, EA9AH. He wants us to know he actually has a card from YI2BA. His rig is p.p. RK20's with 200 watts input and two beam antennas. Now W8QDU pops up with his new stuff: KA1ZL, ES5D, YR5AA, FA3HC, YN1OP. Zones now 22 and 47 countries for him. W9JOL is using a Vee beam on 28 Mc.



ES5D Estonia
K. Kallemaa, Operator

which is 248 feet long on each leg, fed with Q bars and a 600-ohm line. His transmitter ends up with a pair of T125's running around 500-watts input. During a recent QSO he had with VK5QR, the VK told him he was using only 7.5 watts. His little rig was a 6D6 osc. and a 6L6 final with 190 volts on the plate.

Mutiny on the Bounty

Is there anyone who hasn't heard VR6AY? Is there anyone who wants to work him? Well . . . I was just a wonderin', thasall. You certainly hear all sorts of stories about VR6AY; that he won't answer unless you're in the family, or unless a sked can be cooked up by someone "in on the ground floor" with nightly contacts, etc., etc.

Then, too, there is his side of it. For the first few days he was on the air and was overly anxious to contact his home QTH, every time he would blast out a call for a certain W1— station, well, the whole band would be filled with the gang calling him from every district, both phone and c.w. Imagine the possibility of VR6AY picking out this W1 from that mob. Anyway this went on night after night so I guess he finally got pretty well disgusted.

On the other hand, how was the poor dx man to know the importance and personal "tie-up" of VR6AY's call to the W1 district. It's about even anyway you look at it. Ol' Lou Bellem, W1BES, is usually at the mike or key, and he really did give plenty of the boys a new country, for which they should be grateful. I was glad to see Lou get on c.w. and give that gang a break, too.

Chatter

Now for a little c.w. chatter from here, there, and up yonder. First I might mention that you had better get ready to dig for this news, because there's a lot of it and it's going to be squeezed down. If I didn't it would fill the book and we would have to change the name from Radio to "*Dx*". Boss says 'twould never do.

We are glad to see Lindy, W2BHW, shoot us a line. In the contest he got 103 grand, has worked 38 zones and 122 countries, rig uses a T200 in the final with from 500 to 850 watts input. His receiver is an HRO, antenna is a Yagi with three reflectors and two directors, other antennas include a Vee and a couple of zepps. Lindy did all those points without getting on 80 meters . . . purty good I'd say.

Another new one is W2HVM with his 30 and 74. Says he's been after that 30th zone for a long time. W2GTZ now has 124 countries by getting VR6AY and K6TE. Wilmer Allison, W5VV, says the contest is over and he and the x.y.l. are speaking again. Also that queer ringing sensation has left his ears, and the light meter has stopped whirring.

W6DRE in Arizona was running 100 watts to an 808 but after about 24 hours he QRO'd to an old 852. W6DRE has a house trailer that he runs around in, so whenever he decides to put up new antennas he drives out in the wide open spaces outside of Phoenix, puts up a rhombic, a couple of Vee's and then sets his "shack" right in the middle of it all. Tough part is getting near a power line with any kind of regulation.

Another W9, this time W9PK, is never lonesome. At W9PK he has W9TOK 150 feet way 300 watts, W9PST 3 blocks 500 watts, W9UKU 4 blocks 300 watts, W9UIG 6 blocks 750 watts, W9TKN 4 blocks 400 watts, and W9TRH 6 blocks with 600 watts to say nothing of others just a little farther away. Real sport in a dx contest. Aw heck, why don't ya go back to spark and put 'em all to bed.

W8PCU put up a beam from January Radio, got on the air for 13 hours, 28-Mc. c.w. and worked 41 stations in 22 countries. W8LAC made his w.a.c. on phone by getting VU2CQ on 10 meters, and now has 25 zones and 64 countries. W9PGS has 32 and 77 with these as new for him: FT4AG, HH4AS, VP9L, GM6NX, FY8Q, CT2BO, YN1AA, HI2BA, FM8AD, YT7MT, FB8AB, CN8AV, VP6YB, and CR7AC. W9WCE says he worked nine new countries during March.

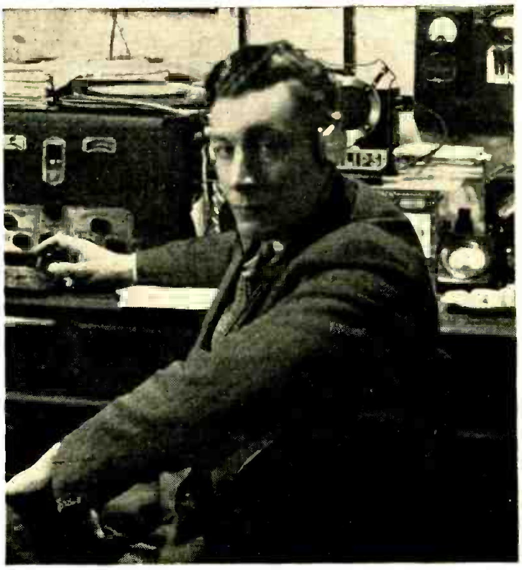
Most of us have heard or worked ZB1H in Malta, but few of us have seen a picture of his station. We are presenting also a description of ZB1H.

ES5C Estonia
R. W. Paide, Operator

ZB1H, Malta

ZB1H is owned and operated by E. Montanaro Gauci. Although Mr. Gauci has been interested in radio since the early days of broadcasting, ZB1H wasn't licensed until 1935. The station is operated mostly on 14 Mc. as this band has been found to be the best for dx. The power input is normally 250 watts but can be increased to 400 watts by throwing a switch. The lineup of the rig is as follows: 47 c.c. oscillator, 46 doubler, RK20 second doubler, and two Ediswan ES501 in push-pull for the final amplifier. The second doubler is used as a p.a. when operating on 7 Mc. The antenna is a full wave Windom. Inasmuch as ZB1H is located in a residential district, the erection of antennas becomes quite a problem.

Two power packs are used: one of 450 volts for the exciter, and the other 1500 volts for the 2nd doubler and p.a. Rectifiers are 5Z3 and two 866A's. Two receivers are used, a PR-16 and a home-built job which is invariably used when on c.w. The PR-16 is used when on phone. The modulator consists of four RK31's in p.p. parallel, and the mike is a double-button Phillips. In Malta a separate license is required to work phone and the applicant must have at least one year of experience on c.w. ZB1H was the first station authorized to work phone.



ZB1H—E. Montanaro Gauci

That old timer OK1AW adds another one to his standing and now registers at 33 zones and 90 countries. Alois is building a new rig and when it is finished we hope to be able to show you what it looks like. Bob Everard of SWL fame in England has a total of 1788 verifications of phone reception and over 1600 of these are more than 3000 miles in distance. You will remember in this column a couple of months ago mention was made of VK3UN on his way to England. Well, he arrived OK—in fact he has already made plans to get on the air very shortly. Of course he will need a ticket first. Magee is with the Royal Signal Mess, and who should he bump into but that old time SU1EC who is in the same outfit. Between the two of them they should have a great time. We'll be anxious to learn that G call.

Now back to USA for a minute. W1HSX, who is mostly on 80 meters, says that during the contest he called FM8AD every time he tossed out a CQ for about an hour and then gave it up as a hopeless job. Said everyone else in W called him at the same time and that was probably the trouble. FM8AD undoubtedly thought it was static. Hi.

Here's a sort of an endurance QSO or 'sumpin'. W7BSJ had a QSO with W9AGO on 28 Mc. which started at 11:06 a.m. p.s.t. and finished at 5:09 p.m. Both transmitters were on the entire time although they stood by for chow for about an hour and twenty minutes.

This seems to be about as good a spot for this next splash as anywhere else, so pull up a chair and gather 'round. G6QX, who needs no introduction, writes a few pages on how the whole contest looked to him. We think it is very good and without going into a lengthy build-up, here 'tis—by Bob Jardine, G6QX:

"Impressions of the Tenth DX Contest"

"Well, another dx contest has come and gone, and many amateurs are sitting back nursing tin ears and sprained wrists, having caught up on lost sleep and regained a little brightness of the eye and a little color in the cheek.

Looking back, it was a hectic nine days, and we can now reckon up where we failed to achieve our heart's desire, i. e. to be top for our country.

Prior to the starting gun, we made a list of all the little jobs we thought should be done, such as

1. Calibrate Bi-Push for 9 xtals, 4 bands and type an 8" x 5" record card.
2. Rebuild four 150-watt final amplifiers for 28, 14, 7 and 3.5 Mc.
3. Install three switch boards for quick QSY of the four finals, one for filaments, which were 6v., 6v., 7.5v. and 8 volt, one for the "B" minus, one for "B" plus, isolating each final and making it a separate unit.
4. Install four tuned antenna tanks, one to each final, with a quick release chuck for attaching the antenna wire, each tank sliding in runners out of the plate tank field.
5. Check the two antennas, one 137 feet and fed 46 feet high, one 33 foot Windom 46 feet high.
6. Check the lightning switches and earth system to the power plant for continuity.
7. Check the monitor, and have the "A" and "B" batteries all renewed.
8. Prepare a 15 QSO per page foolscap log book, with the code numbers 733 all ready, enough for 600 QSO's.
9. Check the Comet Pro and Peak preselector.
10. Adjust the straight key.
11. Fix the dial setting chart for finals and antennas right on the eye line.
12. Hang the high voltage gloves on a nice hook on eye level just in case we get sleepy and have another jolt like the last one.

Having done these chores, we are all set. We could change from 3.5 to 28 in less than 2 minutes, we could change from 7022 to 7268 in one and a half, boy! did we fancy our chance!

What staff work—look out G6NF and G6WY, we are on our way.

Zero hour draws near. Yes! we'll go to bed, not much use starting before 0600 Gmt, remember last time, we wasted time at zero hour trying to raise W on 7 Mc.

We set two alarm clocks, one for 0530, one for 0535, and sure enough we are in the shack with a flask of coffee at 0545. We are set for 3.5 Mc., so off we go.

Gee whiz, but 3.5 is slow, NF and WY block the receiver, reduce-volume, ah, here's no. 1. Yes! we click, but oh boy! 3.5 is slow.

Check frequency on receiver. Yes! we thought so, 3634 is QRM—a quick change to 3522. Can't see ourselves averaging 6 an hour, and that's what we have to do, QX old

The station at ZB1H. A complete description is to be found on the opposite page.

man, to be up with the G aces. Work four W1's one zone, boy what a score so far. NF must be 80 by now and Ham Whyte is sure 80 also. Let's get on 7 Mc. Yes! that's better, we are doing six an hour now and 7268 is clear for a solid two hours. Getting slower and F fone boys splashing the band and eliminating dx every second. Don't these guys know it's a c.w. contest? My hat! one guy in Paris talks to another in Paris for half-an hour on end at full speaker strength.

We think of 20 years ago, and wonder why we did not pinch an SE5 fighter with two nice Vickers guns plus a Lewis on the top plane with a full drum of 96 in it. Handy thing to have right now and do a bit of straffing. Yes! old man, but these boys are hams like yourself, and have their own ideas of radio, and who wants to use c.w. anyway but those dx cranks.

No, it's no good, let's breakfast now. So off go the switches, but we are disappointed so far. Not much good going on again until 28 is live. So at 1310, we go on 28, Oh boy! oh boy! what a difference, one after the other, one every two or three minutes, nice solid R8 sigs, tuned nice and sharp on the old Pro, no need to tune over more than 100 kc. on the Pro. We are on 28088 and they are queuing up. Here's three at one time. Sorry OM's but only one at a time.

Well, I guess we are holding our own with NF and WY on this band anyhow. Hullo, here's G6RB coming up, but where's Pete Pennell, 2PL and Johnny Hunter, 2ZQ?

Perhaps it won't be so tough after all, with these two aces resting, because Pete certainly put up a grand show last year, averaging 8.65 QSO's per hour, and so we go on.

The days pass, the rig is sure fb and standing up ok, but 3.5 is still dead slow. Work W6QD on 28 and 14, and we fix a sked for 0700 on 7 Mc. h.f. Sure enough, dead on the dot we hear an unmistakable W6, putting the key down with single dots at 5-second intervals, and in comes Herb dead to sked and 599X. Oh boy! what a sweet signal.

More days pass, we have 13 zones on 28, 13 on 14, want VE3 only, 9 on 7 Mc., no VE's yet, 3 on 3.5, W1,2,3, only, total 38 and our hopes begin to dwindle. Why, NF had 47 zones last year. No, we knock 'em up, 400, 450 QSO's, 475, let's make it 500 QSO's and call it a day. 493 now, and about 45 minutes to go. Ah! here's VE3GT, call him on 14 and by heck, got him, good old GT, could give you a real double strength handshake right now. 39 zones now, about ten minutes to go. Click another W then by the living Harry VE3KC at 2348. What do you know about that, wait nine days for a VE3 on 14 Mc., and click two on the post.

2359 Sunday, March 13th, send a slow "G6QX qrt GN all" and at 2400 or 0000 GMT electrical time, a great stillness comes over the air, and we very reluctantly take off the cans, although our ears are blistered. There has been a peculiar hum in our ears all the week, never have they been subjected to nearly ten hours a day concentrated listening. Without the cans on, everything sounds different, the car engine seems to have a different note, certain notes from the broadcast receiver start beat peep peeps in our ears, and we feel like we were coming out an anesthetic. We have a deep blister under the hard skin on our keying forefinger despite the fact that we wore two finger shields. We feel very tired, just a little disappointed, why didn't we have ear pads made, the cotton wool we tried gave the signals a different note, and why didn't we give 3.5 a miss early on, build up a nice quota on 7, and leave 3.5 to the last two days. 28 was the berries—this, the band shrouded in mystery by the old hands for years was in every way the most rapid means of communication between two continents 3000 miles apart. Louder and sharper signals, snappier operators, rarely a signal which wasn't 100% readable even with another smack on top of it. There must be a solution to the 56-Mc. dx somewhere, and it will not be on antennas either.

A plain honest-to-goodness 33-ft. level Windom, 46-ft. high cut dead to formula for 28088 smacked the numbers across, and had enough leeway for QSY to 28044 and 28712 without any falling off in S, whilst the Comet Pro roped them in every 2 or 3 minutes switched in to the 137 feet end on.

Boy! did we hear some dx on 28; we heard PY, CM, HH, YV, K5, K6, K7, PK, VK, ZL, ZS, ZU, FB, LU and all but VE5, and we guess VE5 was there just the same.

Since the tests we clicked ZL4AO, R6 both ways for 28-Mc. WAC, WBE, which makes us WAC, WBE on 28, 14 and 7.

14 was not so hot, too many fones butting in, and some of the offenders were G's talking across town at that.

7 was good, nearly as good as 28 if you had a clear frequency, fones a little troublesome, but tuning with the xtal in got over that most of the time.

3.5 was poor, the blanketing of large patches of the band by strong transmitters up to 700 miles distance made dx a bit tough, but we believe we heard Henry Sasaki, W6CXW, once at R5.

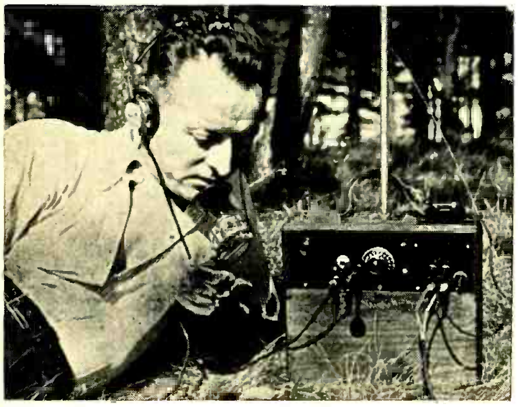
We didn't try 1.7 as we had no 10-watt final available and driving a 10-watt final with a 40-watt Bi-push exciter was not conforming to the licensing rules for G anyhow.

Well, on Monday following, 6NF calls us on the landline and "breaks the news to Mother". 92,000 odd points, 700 odd QSO's on 44 zones, with Ham Whyte, 6WY, 75,000 odd points, 44 zones. Boy oh Boy! are these two red hot. NF whispered that he and WY were settling a little private affair. Ham had been chipping Gay that anybody could knock up a high score and Gay took him on, and it speaks well for these two boys that they both clicked 44 zones. Well, maybe we are third for G although 6RB is a good boy and may be in place number 3.

QX finished with 57,000 odd points and a lot of resolutions for next time, one of which has taken shape in the advent of a McElroy bug into the shack. Maybe our code number in the next test will be 555, we haven't quite decided, but there's some darned funny attempts at Morse emanating from the shack on a buzzer these days, dx gang please note.

To all the boys who gave QX points we say "thanks old man", to G6NF and G6WY we say "Well done old timers, you sure set the pace", to G2PL and G2ZQ we say "What about it next year, speed aces!" and to G6RB or any others with more than 57,000 points we say "Congratulations old man, we had hoped we were third for G".

Roll on Dx Contest Number 11, we hope we can get a week off for that too, and in closing, a tribute to all those XYL's



Al Weirauch, OK1AW, and his 56 Mc. portable transceiver. OK1AW is a watchmaker and jeweler by trade.

who bit their lips, and were very patient with haggard looking husbands whose fingers made Morse passes at the eating tools, who crept surreptitiously from bed at unearthly hours, and whose principal topic of conversation had to do with numbers, and points, and zones and call signs, all of which bored them intensely. To them we say 'God bless 'em, every one.' "

A few months ago something was said about W9EUZ working HS1EL on 7 Mc. At the time it sounded a little funny. And now W9EUZ writes that he has heard from HS1BJ saying that there never was a station with that call, and that it would be impossible for one to operate there without them finding it out. So I guess that just about squelches that bird. Might be tough for two or three other W's who worked him to learn the news but it's better to find it out than to keep wondering why you never get a card. W8CRA has his plate transformer rewound and is now back on the air—that is once in awhile. His yl keeps him on the jump, must be love or maybe it's just astronomy.

W8JK informs us that a friend of his, John DeMyer, SWL, is in receipt of a letter from Fanning Island explaining about VQ1AB. Fred Harry who operates the cable station on Fanning Island says that a number of years ago there was someone there signing that call but at the present time there is definitely no one on the island operating a station. They have been receiving many letters to the supposedly legitimate VQ1AB and have had to return them all. Someone, a yl, was evidently having a lot of fun at the expense of the hams. Instead of being on Fanning I imagine the station better located in Texas . . . and I'll bet I'm not far off at that.

W8EUY dug up a couple of new zones and countries and now has 37 and 95 although he only spent seven hours calling VR6AY. W1HTP has changed his location and since moving he can't seem to work anything but VK and ZL. He's been wondering if Australia is in the Atlantic??? Incidentally, W1HTP is the brother of W6KIP 'way out here in L. A. W3TR grabbed off VP7NT and G8MF (Channel Islands) and now has 34 and 90.

Zone List

No changes whatever are made in the Honor Roll this month, so don't be disappointed if your standings are not quite up to date. They were revised last month and will be again in the June issue. Remember, we do not require that you send in cards as proof of the zones but we do ask that you send a list of the zones worked and a station or two you have contacted in these zones. The countries should be counted as per the list in January, 1938, RADIO.

Frequency List

Thinking that the dx men had seen enough dx frequencies in both the dx contests, none were printed last month or this. Next month, however, there should be some new stuff popping through and I will endeavor to corral a list just in case some of you have renewed your interest. I must ask a little help from you. When you send in a few stations worked and they seem like extra good dx, please don't forget to list the frequency of said station also. It isn't necessary to do this on every type of station, but just use your own judgment on what would be worth while to the next guy.

I notice my friend W6CQI, Dick Segerstrom did a fine job in the phone contest. He finally wound up second high out here with 57,000 points multiplier of 82. Dick lives in Sonora, California, which is in the heart of the old gold mining country. You might say his station is located "on a gold mine". W6CQI uses three rhombics and two separate transmitters. By the way, W6CQI and VK2GU are running phone tests every Sunday on 5 meters at 4 p.m. p.st. VK2GU with 500 watts and W6CQI with 1000 watts xtal controlled.

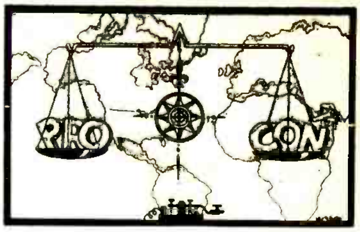
W2HAE used to be on 160 but has got the "bug" and you couldn't hire him to go back. He has a couple of ideas. One is for diathermy machines to go crystal controlled so their QRM will stay in one spot, and the other is a pet peeve on the guy who CQ's so long that he is ashamed to sign his call. Eric Trebilcock, BERS 195, has logged 150 countries and has QSL's from 119 of them. He has still to hear zones 2 and 40 before he is "HAZ". Eric is known to have a stage of r.f. in his ears, as he surely hears 'em. He is wondering why CO2JJ was on c.w.; thought CO was for fone in Cuba. W7AYO thinks he will increase power and chase after a couple of new zones. Stan now has 35 and 81. George Vandekamp, W6GCX, put his 150T on 28 Mc. for the phone contest and ran up 14,500 points, using only that band . . . 127 stations and 38 countries. Karl Duerk, W8ZY, is not a phone any more. He was trying tricks with his phone job and in some way got across his 3000 volts which knocked him cold for five minutes. He's ok now but has converted his phone rig into a 28-Mc. c.w. job.

Don't know what's the matter with W2BJ . . . he runs up 40,000 in the c.w. brawl and now gives his intentions of taking up phone. Ray says that LU7AZ, and CX1CG were tops for SA but he couldn't raise CN8AV. Oh my??? W1ME used four bands and got 65,670 points out of it—199 contacts in 49 countries. He's still using 852's with 500 watts. W4ELQ one of the BirmingHAMS got a big kick out of the dx melle. He started out with 30 zones and ended up with 34 zones and 74 countries, to say nothing of 44,226 points. Norman worked a flock of new ones and he takes it all back about 40 meters being no good. He made 165 contacts with a multiplier of 91. W4ELQ is the first one in town to hook an XU. Other BirmingHAMS who are doing something are W4APU who scored around 30,000

[Continued on Page 92]

The . . .

OPEN FORUM



Endurance Test

New Westminster, B. C.

Sirs:

Reading the letter in the March issue regarding the 24 hour duplex QSO gives one the impression that we Canadians make a practice of holding endurance contests on the air. Nothing could be further from the truth, as most of us have more respect for the other fellow's rights than to go needlessly jamming up our already over-crowded bands, working duplex for any length of time, and especially when the stations are less than a mile apart.

And as far as this being an endurance test—Humph! Anybody could leave their transmitter running for 24 hours while they go about their regular home chores as they did.

I can't quite see that these chaps have anything to brag about; rather I should think they would be ashamed to let anyone know they carried out such an unsportsmanlike act in creating so much interference.

FRED TAYLOR, VE5HA
President Royal City Amateur Radio Assn.

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Present Examination OK

West Lafayette, Ind.

Sirs:

After seeing many letters similar to that of Mr. Poland's in the January *Forum,* advocating all kinds of special licenses, exemptions, and what not, I think a few things should be said in support of the other side of the question.

If Mr. Poland does not have the necessary time to master the "thirteen per", referred to in his letter as "schoolboy mummery", when is he going to operate that kilowatt phone he contemplates? If he isn't interested enough in amateur radio to bother with learning to handle the code at the slow speed required, he shouldn't have a ticket. And surely Mr. Poland has not thought of the time required to review all of the equations relating to vacuum tube operation, so he will be able to pass the rigorous technical examination he intends to require.

Although I failed the license exam because of the code test, I still think it should be required. If a fellow has to put himself to some extra effort to get into the game, he will have a much greater appreciation for its opportunities, and, of course, those who do not have a real interest in it will be eliminated.

Why tax the hams with a license fee to pay for "proper authoritative supervision"? The hams already have enough supervision.

Of course Mr. Poland will be glad to give us the details of a beam to be erected in an apartment window if he is going to require all phone stations on the high frequency bands to use beams. Or does he consider a horizontal half-wave a beam?

Why not keep things as they are? If the examinations were made any easier, the bands would be crowded worse than they are now. If changed to all-code or to all-technical questions, a particular class would be favored. As it is, we have a balanced examination that gives everyone an equal chance, not too much code nor too much technical knowledge being required.

ALBERT D. M. LEWIS.

•

W4-BT6

Sirs:

Quite a few of the fellows in the east often wonder why the "California Kilowatts" never are able to snag high score in the dx contests. Even those in the east that understand the reason do not fully appreciate the handicap the west coast fellows have chalked up against them.

Having "looked in" on dx contests from both coasts in addition to doing considerable regular operating from both coasts, and knowing the ops very well at many of the high scoring stations on both coasts, I feel competent to shed a little light on the subject of geographical disadvantage as pertains to the annual dx contest.

Before getting along too far and to put things on a more equal basis, it might be a good idea to blast the "California Kilowatt" myth. I am convinced after visiting many of the higher-powered stations both in the east and on the west coast that the large majority of super-powered stations will be

[*Continued on Page 86*]

POSTSCRIPTS...

and Announcements

Conventions—Hamfests

Wichita, Kans.

Kansas members of the American Radio Relay League will hold their state convention on May 7 and 8 in Hotel Lassen, Wichita, Kans., with the Wichita Amateur Radio club as host. C. R. Werner, W9MFH, heads the committee in charge of the affair.

Burlington, Iowa

About 400 amateur radiomen are expected to attend the annual hamfest of the Iowa-Illinois Amateur Radio club, when the meeting takes place on June 12 in Hotel Burlington, Burlington, Iowa. L. B. Vennard, W9PJR, secretary, can furnish details.

Milwaukee, Wis.

Sixteenth annual QSO party of the Milwaukee Radio Amateurs' club will be given on May 14 in the Milwaukee Athletic club. The event always attracts amateurs from about eight different states in the middlewest. The attendance of last year—330 persons—is expected to be equaled and perhaps bettered at the coming affair. Write to W9EFX for details.

Jenny Lake Hamfest

Sixth annual W1MU hamfest will be held August 6, 7 and 8 at Jenny Lake near Moose, Wyo., approximately 50 miles south of West Thumb, Yellowstone National park. Jenny Lake is situated at the foot of the Teton mountains in the Teton National park where there is plenty motor boating, swimming, horseback riding and fishing.

Even though there are cabin facilities, nearly all who attend the meeting come prepared to camp, and a section of the park is set aside each year for the W1MU hamfest.

Any amateur may attend and should feel free to bring his or her family; entertainment is provided for the women and children. Further details may be obtained from Henry D. McCuistion, W7AYG, or Leslie E. Crouter, W7CT.

Fargo, N. D., Hamfest

Fargo, N. D., radio amateurs will be hosts to fellow hams from the neighboring territory at a two-day funfest May 28 to May 30.

The committee in charge is composed of W9EIG, W9LHS, W9RPJ, W9SHI and W9ZVE.

•

"The Why of Harmonics"

Through an error on the part of C. B. Stafford, and an error on our part in not noticing it, the resolution of the harmonics under the heading "Practical Application" in the article "The Why of Harmonics" beginning on page 32 of the April issue of Radio was incorrectly done. We are indebted to R. A. Kirkman, W2DSY, and W. L. Stahl, W2KGC, for calling this error to our attention.

The resolution of the harmonics by the network shown in figure 5 of this article should be expressed as follows:

$$E_{out} = E_{in} \frac{-j X_c}{R - j X_c} \quad \text{or}$$

$$E_{out} = E_{in} \frac{X_c}{\sqrt{R^2 + X_c^2}}$$

Thus, in figure 5, with 39 volts impressed across the input and with R equal to X_c, the output voltage would be 0.707 times the input voltage or 27.6 volts. The voltage across the resistor would also be 27.6 volts but there would be a difference in phase existing between them; the voltage appearing across the condenser would be lagging approximately 90° *behind* that appearing across the resistor, the exact value being dependent upon the power factor of the condenser.

Then, substituting the decreasing values of the reactance of condenser C in the equations given above to determine the attenuation at the harmonics of the fundamental of 60 cycles, we find that the second harmonic output would be 0.447 times the input and that the third harmonic would be 0.316 times the input. Thus we find that the harmonic attenuation is slightly less than would be supposed from the original article although the ratios are approximately the same. The same calculations could be applied to the 10-μfd. condenser to determine the harmonic output voltages with the larger condenser.

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type TJ-U capacitors

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Prices have been substantially reduced on all Cornell-Dubilier DYKANOL universal mounting transmitting capacitors.

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C-D type TJ-U transmitting capacitors are impregnated and filled with DYKANOL—the non-inflammable, non-explosive high dielectric impregnant used in the construction of capacitors for the U. S. Signal Corps. DYKANOL has proven its exceptionally stable characteristics through years of dependable operation in tens of thousands of broadcasting and amateur stations throughout the world.

For complete listing of new type TJ-U prices see your local C-D jobber or write for Catalog No. 161. Cable Address "Cordu"

Cat. No.	Cap. Mfd.	Your Cost
600 V. D.C.		
TJ-U 6010	1	$1.62
TJ-U 6020	2	2.06
TJ-U 6040	4	2.65
1000 V. D.C.		
TJ-U 10010	1	1.76
TJ-U 10020	2	2.35
TJ-U 10040	4	2.94
1500 V. D.C.		
TJ-U 15010	1	2.06
TJ-U 15020	2	2.94
TJ-U 15040	4	4.12
2000 V. D.C.		
TJ-U 20010	1	2.65
TJ-U 20020	2	3.23
TJ-U 20040	4	5.29
3000 V. D.C.		
TJ-U 30010	1	7.06
TJ-U 30020	2	8.82
TJ-U 30040	4	12.94
5000 V. D.C.		
TJ-U 50010	1	14.70
TJ-U 50020	2	18.82

Compare the prices! Compare the quality! You will find no better buy anywhere! Demand the original oil transmitting capacitors—Cornell-Dubilier Type TJ-U's.

CORNELL-DUBILIER CONDENSERS C-D

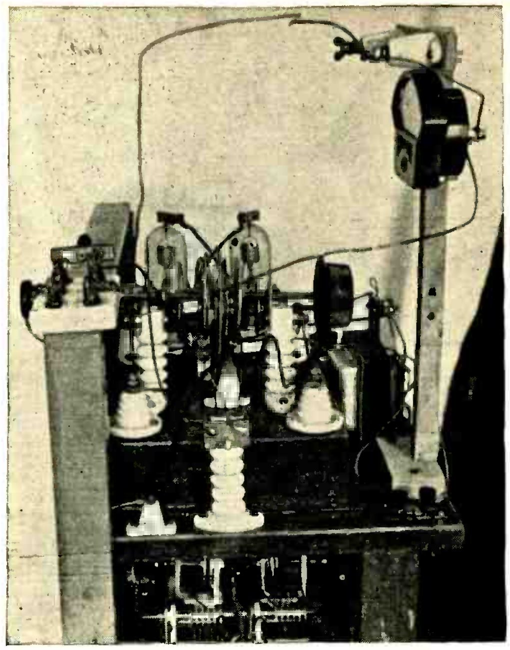
CORNELL-DUBILIER ELECTRIC CORPORATION

1017 Hamilton Boulevard, South Plainfield, New Jersey

56 MC....

Summer DX is Due

By E. H. CONKLIN*



A view of the final stage of the VK2NO five-meter transmitter responsible for world records. The condensers tuning the output "tank" are made in the form of disks on screw threads.

Now that May is here, sporadic E-layer reflections should bring about quite a lot of five-meter dx at 500 to 1200 miles, just as during the last four summers. Let's get all set with good receivers and antennas to snare a lot of points for the 1938 R.S.G.B. 56-Mc. contest, the rules for which appeared in this column in January.

The International tests that we proposed did not result in any two-way work, as far as we know. Conditions for F_2-layer transmission were not as good after January first as they were during the last few months of 1937 when numerous transatlantic signals were reported. Still, there have been some good cases of transatlantic reception on 56 Mc.

GM6RG Transmission Confirmed

On February 22, GM6RG in Scotland was heard on 28 Mc., telling W2JCY about being heard in the U.S., while using his 500- to 900-watt crystal-controlled rig on 57,016 kilocycles. He writes us as follows:

"The position regarding 56 Mc. with me so far is that I have been able to confirm reports from W2JCY, W2KHR and W1KTF. The first two on fone and W1KTF on c.w. The latter was able to tell me word perfect the call I was making, and which I have cut on a tape, and repeated for ten minutes at a time. I would add that the wording on the tape is changed every week, so I have the means to check every report exactly."

GM6RG also wrote this to G2HG:

"Where W2JCY did come into the picture again recently was to tell me that W1KTF had heard me on 56 Mc., and would like a contact on 28 Mc. I listened for him and made contact OK. W1KTF was able to tell me word perfect what is cut on the tape of the automatic machine I am using for the calling on 56 Mc., and of course also the exact time of the transmission. There is thus no possible doubt that he heard me, as also have W2JCY and W2KHR. I have no information to give of other stations who claim to have heard me, for the reason that they have not offered time and date. I am thus doubtful. Of the three I give, though, there is complete confirmation."

The dates of the above reports were not given.

VK2HL Heard in Wales

Don Knock, VK2NO, received a letter from Cecil Mellanby of North Wales, British Isles, in further regard to five-meter reception. He mentioned having heard VK2HL on phone, this apparently having been in December. Don was interested in our comment about the best location being on top of a hill above sea water or salt marsh. He says that his location is right on the coast on a hill about 380 feet above sea-level, overlooking the wide Pacific from the north to the east and southeast. This kind of a

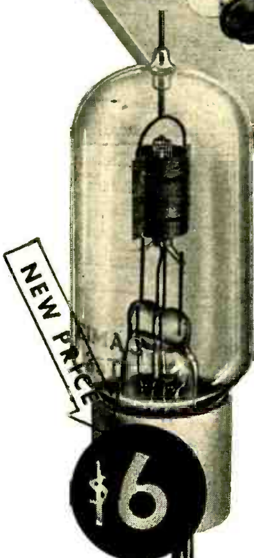
*Assistant Editor, RADIO.

4 EIMAC 35T's
give a "normal" output of
475 WATTS
with this transmitter

NOTE! *Eimac's newest development . . . watch for early announcement*

Your dealer has the complete plans for this unit . . . blue prints, parts and Eimac 35T's.

ASK ABOUT IT!



When the first Eimac tubes were placed on the market, thousands of radio operators experienced a new conception of tube performance. This was due to Eimac's radical departure from conventional design, far superior construction, revolutionary technical advances. Eimac changed the old standards; set new marks which have since never been equaled. Conventional tube appearances were changed; prices cut; ratings boosted; but Eimac has continued to maintain top place. One outstanding example of this is exemplified in the 35T tube.

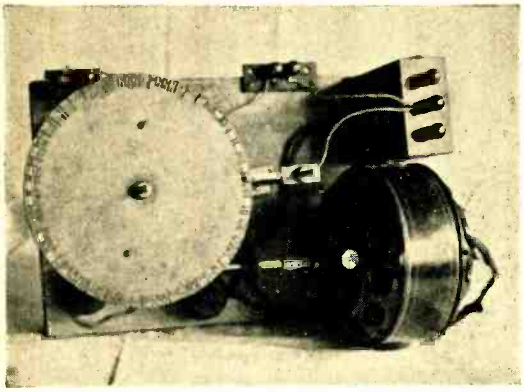
The transmitter illustrated on this page has been written about, talked about and lectured about, by radio men from coast to coast for the past two years. It was constructed by the Eimac research department in order to test the 35T tube under extraordinary operating conditions. One 35T is used as a crystal oscillator, one as a frequency multiplier and two connected in push-pull in the final. Special attention is called to the new type vacuum, tank condenser.

This little "rig" gives a "normal" output of 475 watts on 160, 80, 40, 20 and 10 meters. A 160 meter crystal being used on 160, 80 and 40 meters, while a 40 meter crystal permits operation on 40, 20 and 10 meters. It operates at 600 watts input to the final, being excited by the fourth harmonic of the crystal by means of the frequency multiplier. As an example of the stamina of Eimac 35T's, this transmitter was operated, through the entire phone contest, with 1000 watts input (4000 volts; 250 milliamperes) to the final; carrier power 850 watts, 100% modulated. No other tube of like power ratings has equaled this performance.

Ask your dealer today for complete details of this assembly. Actual construction plans are available for your use, or your dealer may be equipped to construct the entire transmitter for you.

Eimac TUBES

EITEL-McCULLOUGH, INC.
San Bruno, California



The automatic telegraphy device in use at VK2NO, for 56-Mc. long-distance test transmissions. It is made up from a fan motor and a double-reduction worm drive. The disc is of three-ply with saw cuts and interleaved copper foil to make up the Morse code characters. It sends "CQ FIVE DX DE VK2NO" at 12 words per minute.

location should be a great help when low-angle radiation is necessary, even if the ocean surface is not tilted! Don sent us a picture of his 35T transmitter and automatic CQ machine. The code disk on the latter is made of three-ply with saw cuts inward from the edge to enable a thin copper strip to be woven in and out to make the code characters. Ingenious, what?

VK2AZ and VK2NO heard an unmodulated carrier R3 to R7 on January 23 at 7:45 a.m., Sydney time, about right for a signal from the U.S. It sounded like a dx signal but it was still unidentified when it passed out.

E. H. Swain, G2HG, has had no luck at all during recent months except on February 13th at 1945 G.m.t., when he heard, "CQ REF de ??EV," on a weak and fading signal, possibly a harmonic of a French station such as F8EV.

42 Mc. Passing Out

Clyde Criswell in Phoenix, Arizona, heard mobile W1XOU on 39.700 kc., driving near Bloomfield, Conn., on March 8. He believed the 2200-mile reception to be a record for mobile operation at seven meters. However, police cars across the country have been heard in the past, and ZS2A in South Africa heard one of the eastern cars. Criswell says that March 11 and 12 were good above 40 Mc., when W2XHG and Alexandra Palace, London, were heard. He reports no reception above 40 Mc., on March 3, 4, 5, 9, 14, 15, 16 and 17. Of course, summer conditions may put a stop to 40-Mc. reception beyond 1200 miles or so.

More Activity in Australia

A move is on foot in Australia to start a live-wire 56-Mc. dx group, to include VK2MQ, VK2EM, VK2NO, and all others who will cooperate by "taking the pledge" for consistent five-meter work, dx or otherwise. During the coming Australian winter, long F_2-layer dx in the east-west direction across their continent and to Africa and South America should be favored. VK2NO thought that our idea of watching for 300-400 mile 28-Mc. signals, to indicate when 800-1200 mile summer sporadic E-layer five-meter work is possible, isn't much help to him. The southern coastline is about 500 miles away and the only other direction would be somewhere in North Queensland or in the heart of Australia where there are very few amateur radio stations. You might try New Zealand again next summer, Don, but a 28-Mc. signal half way between, as a dx indicator, would be difficult to obtain there too!

W4DRZ Looking For DX

In March we called on the "one man Chamber of Commerce," Bud Haskins, W4DRZ, in Fort Lauderdale, Florida. He is going ahead with the construction of a concentric-line tuned converter using acorn tubes, and promises to look for 56-Mc. dx this spring and summer. He is ideally situated for hearing the sporadic E-layer type of dx from the well-populated areas of New England over to Chicago, and on down to Dallas. He plans at first to double in his T-155 28-Mc. final.

We also saw W4EDD in Coral Gables, who is still looking for the perfect 56-Mc. receiver. He has decided definitely on a horizontal Yagi array, using a reflector and several directors, all spaced one-quarter wavelength and properly tuned. Robbie plans to organize a bunch of the boys to take turns listening for five-meter dx.

In Lakeland, W4TZ, who was one of the 28-Mc. pioneers, told us that there are a number of active 56-Mc. stations on the Florida west coast including W4AKA, W4BRY, W4AJX, Marion Gulick of the Tampa Police, and Julian Betts of WDAE in Tampa. W5EHM reported working W4AKA on "five" last summer, so we look for some real activity in Florida

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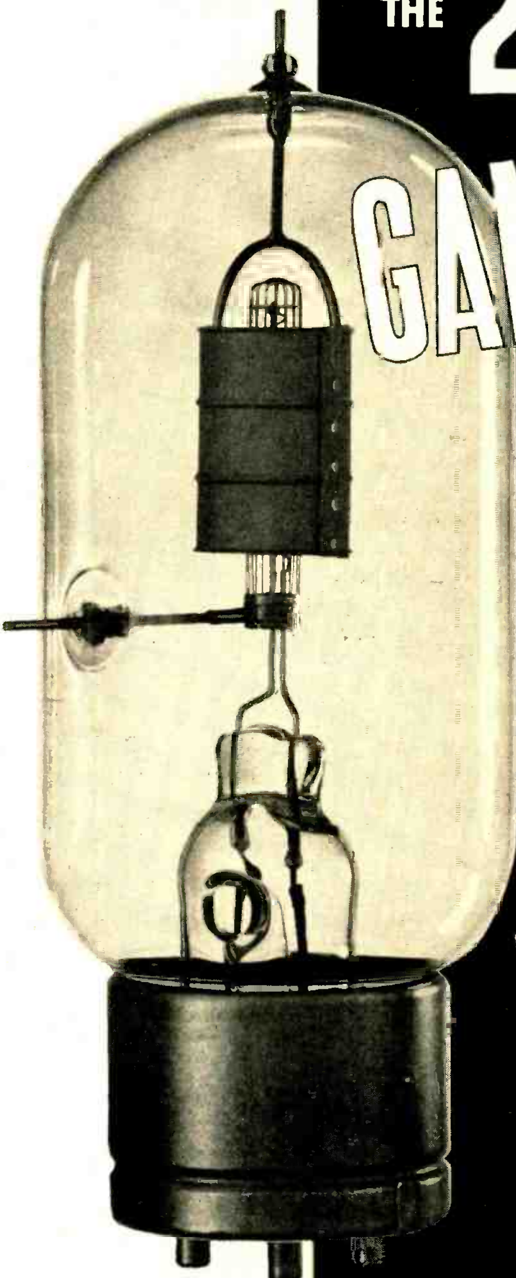

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GAMMATRON

- 100 Watt Plate
- MU = 25
- Tantalum Grid and plate
- NONEX envelope
- No "Getter"
- MAX. plate ma = 200
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A NEW TUBE VALUE

$12.50

AT YOUR DEALER

HEINTZ AND KAUFMAN LTD

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YARN *of the* MONTH

"YEARN OF THE WEAK"

June 1, 1937.

Dear Bill:

I started out on a new job this morning. The chief engineer and a lot of important-looking men came into the station and said that they wanted to talk to me for a few minutes. I turned the station over to one of the relief operators, who was about to come on duty anyhow, and went out into the office with them. After a round of introductions and small talk, they said they were planning on moving the station. Yes, sir, they're going to put the little signal pusher out into the country. They threw around a lot of terms like Sommerfeld's Integral, ground conductivity, etc., and everybody looked wise, including yours truly, but I don't think any of them knew what they were talking about.

After more baloney, they finally got down to business and said they wanted me to build a little five-watt transmitter to use for testing out the new location. Apparently nobody knows what I'll have to use, so they said to write to the Commission. Among other things, they want me to fix up a trailer upon which to use the field strength set. That f.s. meter gets the jitters every time a fly lights on it, so you can imagine the fun we are going to have when we start bouncing it around on a one-wheeled trailer.

Well, Bill, I must stop to keep a schedule. I'll write more later.

73, Cy.

June 5, 1937.

Dear Bill:

Oh, me! What fun. The F.C.C. wanted blueprints on the proposed test transmitter and nobody even knew what we were going to use in it. After much argument, I finally just copied a circuit out of the handbook, estimated power capabilities and other things, and gave it to the boss. He then wanted to know what it would cost to build. I gingerly estimated it at $150 and held my breath. His eyebrows raised up to where his hair used to be before he worried it away on radio problems, and I knew I had overdrawn. You can guess the rest of the story. By rebuilding an old antenna test oscillator we have here, using parts out of the station, swiping a few from my transmitter, and putting a fan on the entire works to keep it from melting down, I'll be able to build the test rig for about twenty rocks. I have yet to figure out how to put up a 100-foot vertical radiator for ten bucks, but I guess I can do it. Maybe I'll tie a wire onto a carrier pigeon, or hang it from a sky hook. I'll probably end up by using some nearby farmer's barbed-wire fence.

That problem is simple compared to the trailer business. I can get everything from garbage carts to house trailers, but they all have one thing wrong—the price. One man manufactures trailers and I spent two hours learning the intricacies of operation of his spring-contained, built-in shock absorber. Another dealer says that unless I use a trailer with his style of hitch (the gadget they tie the things onto your car with) that my car's rear end will waddle like an overgrown duck! Also, if you don't use super left-handed, double-twisted, ingrown fiber tires, you're liable to have your tires go bad every 356 miles. I asked him for the limits of accuracy on the 356, but he didn't seem to know what I was talking about. After hearing all of the warnings that each dealer made to boost his product, I'm beginning to think that no trailer is a safe investment.

We finally settled on a little steel job with a canvas cover. It looks like a covered wagon made out of a sardine tin. I have three inches of head-room when I sit on the floor. (Did I tell you! The boss is going to let me ride in

By Cy Stafford, W9KWP

MORE WATTS PER DOLLAR

in

Audio- FREQUENCY TUBES

as well as in R.F.

New 805 Zero Bias

up to

450 WATTS

Class B Audio Output

$13.50

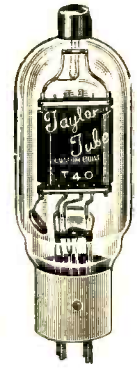
CLASS B AUDIO OPERATION

(value for 2 tubes)

MAX. RATINGS

D.C. Plate Volts	1750
Bias	-22½
Peak AF Grid to Grid Voltage	250
Zero Sig. D.C. Plate Cur. MA	60
Max. Sig. D.C. Plate Cur. MA	390
Plate to Plate, Ohms	10,000
Driving Power, Watts	8.0
Power Output, Watts	450

The 805 operates at zero bias at lower plate voltages. The 805 is also a fine RF Tube. Insist on Taylor 805's. EXCLUSIVE FEATURES—Processed Carbon Anodes—Floating Anode. Complete technical bulletin free for the asking.



TZ-40 Zero Bias

up to

175 WATTS

Class B Audio Output

$3.50

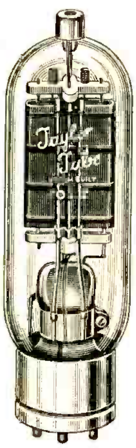
CLASS B AUDIO OPERATION

(value for 2 tubes)

MAX. RATINGS

D.C. Plate Voltage	1000
Bias	0
Peak AF Grid to Grid Volts	200
Zero Sig. D.C. Plate Cur. MA	44
Max. Sig. Plate Cur. MA	280
Plate to Plate Load, Ohms	6900
Av. Driving Power, Watts	3
Power Output, Watts	175

The leading transformer manufacturers recognized the unusual value of this WONDER TUBE and are announcing special Class B Output units to match. Thordarson T-14-M-49 and Stancor A 3829 transformers are already in your distributors stock. General, Utah, Kenyon, UTC, Inca and others will announce their units soon. Listen on the Ham Bands for real testimonials.



203Z Zero Bias

up to

300 WATTS

Class B Audio Output

$8.00

CLASS B AUDIO OPERATION

(value for 2 tubes)

MAX. RATINGS

D.C. Plate Voltage	1250
Bias	0
Peak AF Grid to Grid Voltage	220
Zero Sig. D.C. Plate Cur. MA	90
Max. Sig. Plate Cur. MA	350
Plate to Plate Load, Ohms	7900
Average Driving Power, Watts	8
Power Output, Watts	300

822

up to

700 WATTS

Class B Audio Output

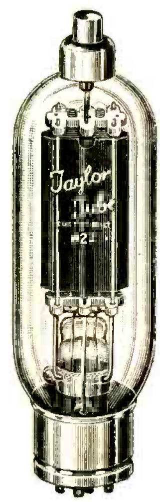
$18.50

CLASS B AUDIO OPERATION

(value for 2 tubes)

MAX. RATINGS

Plate Volts	2000
Bias	-67
Peak AF Grid to Grid Volts	345
Zero Sig. Plate Cur. MA	60
Max. Sig. Plate Cur. MA	545
Plate to Plate, Ohms	8000
Driving Power, Watts	12
Power Output, Watts	700



"More Watts Per Dollar"

TAYLOR TUBES, INC., 2341 WABANSIA AVE., CHICAGO, ILLINOIS

the trailer continuously and take readings, while he drives over country roads at 80 miles per!) The dealer says that it rides remarkably well, the wheel rarely bouncing more than a *foot or two* off of the pavement.

I'm not going to tempt you with any more of the details, as you might give up your grocery business and get into field strength measurements.

As ever, CY.

•

June 6, 1937.

Bill OM:

Today is Sunday, day of rest. I should say it is the day when I do the rest of the things I couldn't do during the past week. I had just finished making drawings on all of the special fittings I would need for the trailer's spring suspension of the f.s. set when the boss came in. I didn't like the look in his eye, but I didn't shoot. He looked positively wild. Without going into all of the details involved in the production of a blue haze of profanity around the room, I'll just mention the result. Someone over the boss' head has decided to junk the test transmitter idea and to run the trailer suggestion into the nearest river. Instead of this, we are first going to run a series of tests on the existing station to determine the present coverage area more accurately.

The boss says we are going to start out tomorrow morning, so I had better knock off and hit the hay. After we take a pile of readings, I have to locate them on a map and jot down the field strength at these points in millivolts per meter. This should be fairly simple with the road maps they give out at service stations.

73,

CY.

P.S.—Just heard the wx forecast for tomorrow—RAIN!

•

June 7, 1937.

Bill:

I know I wrote to you yesterday, but I'm so mad I must blow off to someone. As usual, the weather man was wrong. He said it was going to rain, but he didn't mention anything about being practically flooded. No kidding, it was one cloudburst after another for the better part of the day. And what a wind! The boss opened the car door to get out, and enough rain blew into the car in those few seconds to form an inch deep puddle on the floor. These new cars have a water-proof bottom to keep water from splashing into them from below, but the darned things ought to have drain holes in them too. We carried a sloshing puddle of cold water around, off and on for most of the afternoon.

The field-strength set seems to be ok. We took about ten readings today, and nothing went wrong with the equipment. Of course, we tried to keep the loop contacts dry with little success, but it didn't seem to impair the set's operation any. The loop is detachable from the set and sits on sliding contacts.

But the hardest job was trying to navigate, and I mean that word in its full watery significance. The boss says that reënforcing in concrete, wire fences, power lines, and telephone lines makes any reading taken in their vicinity somewhat questionable. So we had to find places where there were none of these.

I thought I was lost in the wilds of Illinois, but I realize now that there isn't a spot in the state without some of the aforementioned obstacles. We drove off the state road at one point to get rid of the reënforcing, two fences, a high-tension line, and a telephone cable. After about a mile of gravel road, the rural telephone line stopped, leaving us with just two fences to contend with. A mile further, one of the fences dropped out, but we began to get into a heavily wooded section. We turned to the right onto a dirt road and got away from the woods, but picked up another fence. A quarter of a mile farther, we made a series of turns onto various dirt roads and we were able to eliminate all of the fences and telephone lines, but we were in a hollow. So we drove to the top of the next hill in high spirits. Just over the brow of the hill was a high-tension line, two fences, a railroad, a steel-frame building, and a bunch of telegraph lines.

Well, it was that way all day, plus rain. We had water-logged sandwiches for lunch, got mired down four times, and every time we moved water oozed out of our clothes and our shoes just went "squish, squish."

A few minutes before sundown we stopped taking readings to avoid night effect. Just as we took the last reading, the rain stopped, the wind died, and the sun came out in a last blaze of glory. It was almost impossible after we got home to locate some of the readings on the map. I don't know much about the station's field strength, but I know that mine is miserably low just now.

With a "code in my nodes,"

73,

Cy.

•

June 10, 1938.

Dear Bill:

Do I have fun? No doubt you haven't yet recovered from my last display of field strength. You hams don't know how lucky you are. When you want to move the station, you fill in a couple of pages for the F.C.C. and that is that. If you want to change power, you don't even have to fill in anything but the hole in your pocket-book. But b.c. radio is surely different.

I sat down this morning to plot the readings which we took on Saturday. By the time I got them all plotted, the map looked like an ink-footed hen had run across it. After this, I calculated the field strengths at these points and found that all of the readings had been taken too close to the station. We were looking for the 1 millivolt and the ½ millivolt contours, and we found only the 5! Apparently we shall have to calculate the f.s. after each reading so that we may know where to take the next one. I can see myself reading a slide-rule at 80 miles per hour.

I've been plotting and calculating all day, and I think it about time to get a little sleep. It looks like a long hard grind ahead.

73,

Cy.

•

June 28, 1937

Bill Ol' Top:

I haven't been home long enough to write to you for what seems like years. I'm therefore full of all sorts of things. We've been making f.s. measurements all over the state for the past two weeks. Woe is me. I'll just name the happy little incidents in the order in which they occurred.

We went twenty miles out the first morning and were sitting in a field waiting for the station to come on the air when we realized that we had forgotten the earphones. You can get along without them until you get some distance from the station, and then its field strength isn't sufficiently strong to allow you to keep it accurately tuned in with the output meter. This occurred at Hoopleburg, and we tried to find earphones there. One service man said that he had never seen a pair! Another said that he sent his to his ham nephew in Chicago and seemed surprised when he heard that I wasn't a personal friend of this young man. The third serviceman we visited, who runs an undertaking establishment, yielded the very vital information that there was a ham in town. This ham works in a canning factory, which was closed. The factory manager gave us the ham's address, and we went out to his house. He wasn't home, so we adjourned for lunch. We found him after lunch and he loaned us his featherweights. We left the boss' $100 camera for security. When we brought the cans back that night, the ham had a list of questions which would reach from here to there, so we spent most of the evening explaining why antennas didn't radiate, etc.

After the second trip, it was apparent that the sliding contacts on the loop would have to be rebuilt. The instrument cost $945.07. The 7 cents must be the cost of the loop contacts, although I doubt if they are worth that much. I replaced them with solid brass slugs, held in place with massive steel springs. We shall have no more trouble from contact resistance variation.

The next day, we took the set out for more readings. It went dead on the second one, so I took it out of its case and started trouble-shooting. All of the screws were loose as they weren't equipped with lock-washers. Replacing a few cable leads and tightening things up fixed the set. About an hour later, the battery cable broke. More corn-field repairs followed. Then the set got as noisy as your receiver would if you tied the antenna to an arc light. Everything inside the set is double-shielded, and the shields rub together with intermittent contact. Some adhesive tape insulated the two chief offenders and we went on our way. An hour later, she died again. A tube had jarred out of its socket. After that we gave up and came back home.

I spent most of the night servicing the darned f.s. meter, and we started out again the following morning. We headed for a wild, isolated section over on the state line. Just as we got there, the car radiator boiled dry. The air temperature was about 106, and we had to walk about two miles to get water. After we got moving again, the loop broke. It is made in two pieces, joined together by a spring arrangement. We borrowed some bailing twine from a farmer and asked him where we were. He wouldn't commit himself as his farm was half in one state and half in the other. He had been having trouble with taxes, and wasn't sure from what state we hailed. After nearly backing off a cliff into the river, we again went to work.

The next day found us in the northern part of the state. When we plotted the readings, we found that the signal strength increased past a certain point as we drove away from the station!

The northwest portion was really the most fun. As usual, we got lost. Then we mired down in sand. The battery later tipped over, spilling all of the electrolyte. When we finished the day's readings, we went into a nearby town for supper. Somebody let the air out of one of our tires while we were eating.

We finished the northwest portion the next day. Everything went well until the last reading was taken. We were tearing down a steep hill at about 70 (a Model A will do that when it is on a downhill stretch and headed for the barn). Just as we got to the bottom, the right rear tire blew. The boss stepped on the brake, and the pedal went right down to the floor with no resistance, as the pin had fallen out! We came to a stop at the top of the hill and got out of the car. When the boss stepped out, he stepped near a stake with a nail sticking out of the side. Said nail caught his new pants and ripped them up to the knee. Then I put the jack under the rear axle. Just as I got the wheel off the ground, the jack collapsed. It was just as well, though, as we remembered that we didn't have the spare tire with us, having taken it off to facilitate moving the f.s. set in and out of the back end of the car. I went to a nearby house and discovered the nearest phone to be three miles down the road. We got home about midnight.

Taking the readings was easy compared to finding where they had been taken and plotting them on the map. After a week's work, I completed this on a service-station road map. Then I started to transfer them to a big state map which didn't show the roads. Imagine my surprise to find that the road map was not a scale map!

I suppose by now you have a clear idea of the fun involved in a field strength survey. So I shall trundle off to bed. I start back to work at the station tomorrow, and I hope I never see anything more of field strength surveys.

73,

Cy.

•

July 4, 1937

Dear Bill:

Fireworks aren't half the noise around this house. I've been raving for hours. The boss got back from the hearings this morning and called me up as soon as he got in town. He said that the F.C.C. wanted a survey showing our interference area with a station on an adjacent channel and wanted us to check most of our previous readings. The boss said that in view of my previous experience, he was going to let me do the job alone!

Oh, oh—the doorbell. Sounds like the boss. I'll write more later.

73,

Cy.

•

Telegram received by Bill the following day:

HAVE PURCHASED MY OLD FARM STOP ARRIVE SUNDAY STOP
SIG CY

After the "SK"

[*Continued from Page 20*]

cards have been received in a single delivery. The largest percentage of cards is still sent by parcel post from A.R.R.L. headquarters but many countries, especially Germany, England, Russia, and Austria send cards direct in large quantities.

At one time s.w.l. cards constituted about one-half the receipts but they have fallen off sharply and now represent only about 10% of the total. Phone stations garner one out of every four cards.

How the Bureau managers contrive to sort this avalanche of cards, earn a living, and pound brass in a respectable fashion is a mystery, but without exception they are well up in the ranks of dx men. Frank Pratt of the seventh district has a long-suffering x.y.l. who acts as "Bureau-Secretary" and he admits that without her the job would be a nightmare. W2SN spent 1586 hours in the shack during 1937 sorting and mailing cards.

There are postage dues—often as high as twenty cents on a single envelope. Sealed envelopes arrive with no return address and a one-cent stamp as a starter. Ten-cent duty stamps are common on mail from one particular country although postal officials cannot explain the reason. The incoming envelopes must be dated and mailed in rotation. It's a full time job and one that pays in a rather indefineable satisfaction.

With only one minor exception, not a card has been destroyed because of non-delivery, no matter how old. It smacks of sacrilege to destroy them (and why not!). They're all there waiting for a stamped envelope and the chances are better than good that if you've been on the air during the last five years there's a foreign QSL—or more—waiting for you at your district Bureau.

A Diversity Receiver

[*Continued from Page 28*]

action, both r.f. circuits lined up to signal frequency, we will note a marked increase in output.

As we have indicated before, use of the three dial controls will not involve difficulties in tuning, particularly if the r.f. bandspread is limited and service coverage is confined to the 14- or 28-Mc. bands or the phone portions of those bands. At least that is our experience. Nor will it be difficult to bring both channels into precise alignment on a desired signal.

56 Megacycles

[*Continued from Page 70*]

this year, and hope that the boys will knock off the dx like W5EHM did in 1937.

W8CVQ in Kalamazoo, Michigan, received a telegram from W9CLH in Elgin, Illinois, in February asking for a signal on which to test some receivers. The signal strength was low on that day so that the whole story of the tests was not mentioned to us but we think that George Lang was testing out a new converter against his old receiver. With WGN about to move to a new location where a tall vertical radiator is being installed, George may not find time to put W9CLH's signals all over the east coast as he did last summer.

W8CVQ has been reported frequently by W8NKJ in Detroit, and is looking forward to numerous contacts over that distance when the band isn't open for "real dx."

Modulation-Transformer Design

[*Continued from Page 41*]

permit the use of the recommended wire sizes as well as sufficient insulation for 4000 volts, one may very well base calculations on 500 CM per ampere in determining wire sizes. In the proposed 100-watt transformer, computations disclose that there will be just sufficient window space for the use of nos. 25 and 26 wire with enamel insulation. Equation (5) above may be used to calculate the airgap needed for $\mu_a = 400$ assuming $\mu_{ac} = 5500$. It is found that $l_2 = 0.0023 \times 30 = 0.069$ cm. or 0.027 inches. Thus each gap in figure 8 should be 0.0135 inches.

Problem number two for the 250-watt transformer should prove of interest since each of the three variables (A, L and N) is to be computed, rather than assuming one of them to be known. From figure 9 we allow E to be 1750 and I to be 0.25. The audio current in the secondary will then be $250/1750 = 0.143$ amperes. Therefore, the total current handled by the secondary wire will be $0.25 + 0.143 = 0.393$ amperes necessitating the choice (at 1000 CM per ampere) of number 24 wire for the secondary and one size larger, number 23, for the primary. Figuring on plain enamel for insulation, the diameters of these two wire sizes will be, secondary $d_1 = 0.054$ cm., primary $d_2 = 0.060$ cm. Substituting these values

$$E = 1750$$
$$I = 0.25$$
$$d_1 = 0.054$$
$$d_2 = 0.060$$

in equation (16) we obtain:

$$A^3 + 63.7A^2 + 1014.6A - 146550 = 0.$$

$A = 33.9$ sq. cm. (5.25 sq. inches) is a solution of this equation. Then, from equations (12) and (15) we find $L = 45.17$ cm. (17.8 inches) and $N = 2530$ turns. The total number of turns of wire on the primary will be $N/1.2 = 2108$ turns.

A slight advantage in window area can be gained by stacking the core laminae somewhat thicker than their width. By having the core laminae two inches wide and stacking them two and five-eighths inches deep we acquire the necessary 5.25 sq. inches of cross-section. To meet the requirement of $L = 17.8$ inches the core may have the dimensions shown in figure 10. If two air-gaps are to be used as shown, each will be one-half the amount calculated from equation (5), above. Thus the proper air-gap length would be $l_2 = 0.0023 \times 17.8 = 0.041$ in. Each gap is therefore 0.0205 inches and may be filled with paper, mica, etc.

In any transformer the most flexible design

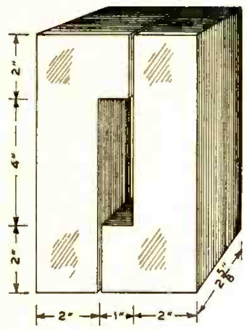


FIGURE 10

sistance and r.f. load impedance. Suppose, for example, one had a modulator using tubes operated so as to require a plate-to-plate load impedance of 6700 ohms and the plates were connected to terminals 8 and 11, B+ being connected to 9 and 10. (See portion of left-hand column in figure 12 labeled 8-9-10-11.) If r.f. load terminals 9 and 10 were connected together with the class-C plate current flowing from terminals 7 to 11, the proper r.f. load would be 0.9 × 6700 ohms or approximately 6000 ohms. The second column in

dictates a unit having split primaries and secondaries, each half being tapped off center so as to provide the largest possible number of impedance matches. The windings must be balanced electrically with respect to each other and to the core so that two "pies" are required, each containing half the total primary and half the total secondary. These "pies" are placed side by side if on a shell-type core or on opposite legs of a core-type core. Figure 11 illustrates a design worked out after many hours of "cut and try" to determine the best possible ratio of turns. The turns ratio between total primary and total secondary is step-up 1 to 1.2, while the half-primary and half-secondary taps are taken out .38 and .29 of the half-primary and half-secondary turns, respectively. This will be clear by referring to figure 11. Care must be taken in the direction of winding so that terminals 3 and 4 may be connected together as the center-tap for the total primary and terminals 9 and 10 connected together as the center-tap for the total secondary.

The chart in figure 12 will hold for all transformers whose winding ratios are made according to figure 11 and shows under the various r.f. load connections the impedance ratios between modulator tube plate to plate load re-

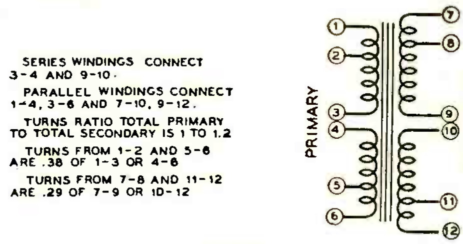


FIGURE 11

figure 12 shows the maximum recommended plate to plate resistance that should be used for the various input connections. Obviously one may use just so much audio voltage on a given number of turns for a certain low-frequency response although over a range of perhaps two to one the loss in speech intelligibility is slight. It is better, in case of doubt, to use impedances lower than those recommended for any particular connection for best results. While the table in figure 12 shows 48 fundamental impedance terminations, there are almost an infinite number of terminations available by permitting various input impedances to exist. Figure 13 gives tabulations correct to one per cent or better on a few of the more

Connect Mod. to P-B-B-P	Max. P-P Load (Ohms)	Connect	7-11 8-12	8-11	8-10 9-11	7-10 9-12	9-11	9-10	9-10	9-10
		Load to	7-8	7-12	8-9	7-9	7-12	8-11	7-11	7-12
1-2-5-6	1500		.21	.84	1.25	2.5	4.15	5.0	7.3	10.0
2-3-4-5	3000		.079	.315	.47	.94	1.56	1.89	2.74	3.75
1-3-4-6	12500		.03	.12	.18	.36	.59	.726	1.05	1.44
		Connect	1-5 2-6	2-4 3-5	2-5	1-4 3-6	3-4	3-5	3-4	3-4
P-B-B-P		Load to	1-2	2-3	1-6	1-3	2-5	1-6	1-5	1-6
7-8-11-12	1250		.3	.8	1.2	2.06	3.2	3.93	5.42	8.26
8-9-10-11	7500		.05	.132	.2	.344	.53	.656	.90	1.38
7-9-10-12	20000		.025	.067	.1	.174	.267	.33	.456	.694

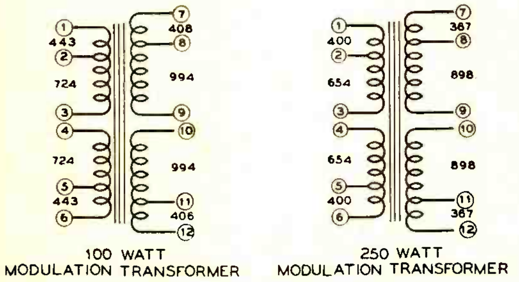
Figure 12. Load Impedance Matching Chart: Impedance Ratio.

Connect Mod. to P-B-B-P	P-P Mod. Ohms	Connect 7-11 8-12	8-11	8-10 9-11	7-10 9-12	9-11	9-10	9-10	9-10
		Load to 7-8	7-12	8-9	7-9	7-12	8-11	7-11	7-12
1-2-5-6	2000	420	1680	2500	5000	8300	10000	14600	20000
"	3000	630	2520	3750	7500	12450	15000	21900	30000
"	3800	800	3190	4750	9500	15750	19000	27700	38000
2-3-4-5	3000	237	945	1410	2820	4680	5670	8220	11250
"	3800	300	1200	1785	3570	5925	7200	10400	14250
"	5000	395	1575	2350	4700	7800	9450	13700	18750
1-3-4-6	5000	150	600	900	1800	2950	3630	5250	7200
"	6000	180	720	1080	2160	3540	4360	6300	8640
"	6700	200	800	1200	2400	3950	4870	7030	9650
"	8000	240	960	1440	2880	4720	5800	8400	11520
"	10000	300	1200	1800	3600	5900	7260	10500	14400
"	12500	375	1500	2250	4500	7375	9075	13100	18000
		Connect 1-5 2-6	2-4 3-5	2-5	1-4 3-6	3-4	3-5	3-4	3-4
		Load to 1-2	2-3	1-6	1-3	2-5	1-6	1-5	1-6
7-8-11-12	1000	300	800	1200	2060	3200	3930	5420	8260
"	1500	450	1200	1800	3090	4800	5900	8120	12400
"	2000	600	1600	2400	4120	6400	7860	10840	16520
8-9-10-11	3800	190	500	760	1310	2020	2500	3420	5250
"	5000	250	660	1000	1720	2650	3280	4500	6900
"	6700	385	885	1340	2310	3550	4400	6030	9250
"	8000	400	1050	1600	2750	4240	5250	7200	11040
"	10000	500	1320	2000	3440	5300	6560	9000	13800
7-9-10-12	6700	168	450	670	1165	1790	2210	3050	4650
"	8000	200	535	800	1392	2135	2640	3650	5550
"	10000	250	670	1000	1740	2670	3300	4560	6940
"	12500	362	825	1250	2175	3340	4125	5700	8675
"	15000	375	1000	1500	2610	4000	4950	6850	10400
"	17500	438	1170	1750	3040	4670	5770	7970	12150
"	20000	500	1340	2000	3480	5340	6600	9120	13880

Figure 13. R.F. Load Terminations: Actual Impedance Values.

common impedances terminated to various r.f. loads, all of which (and more) are possible with a transformer tapped according to figure 11.

For our 100-watt transformer having 2800 turns on the secondary and 2334 turns on the primary, each half of the primary will be 1167 turns tapped at $0.38 \times 1167 = 443$ turns from the outside or $1167 - 443 = 724$ turns from the center and each half of the secondary will have 1400 turns tapped at $0.29 \times 1400 = 406$ turns from the outside or $1400 - 406 = 994$ turns from the center. This is shown in figure 14. The winding taps for the 250-watt unit are taken out similarly and are shown in figure 15.



FIGURES 14 and 15

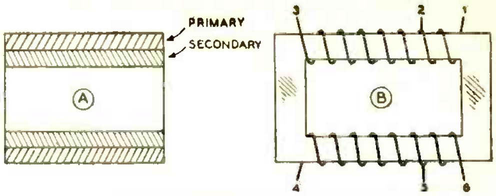
There are advantages to having both primary and secondary windings of the same resistance, and this can be accomplished by winding the secondary next to the core with the primary over it, as shown at A in figure 16. With a shell-type core it is necessary to wind the coils on a form into which are slipped the core laminae, while with the core-type it is usually possible to wind the coils directly upon the core which has been tightly taped. The latter method tends to minimize "back talk" although by careful clamping and wedging the shell-type may be made fairly quiet. In severe cases mounting in oil becomes necessary. Figure 16B also shows clearly the method of winding so as to insure proper coil continuity in the finished transformer.

A representative group of modulation transformers have been designed based on two separate low-frequency responses, one group based on 70 cycles, the other on 100 cycles and the design data presented in figures 17 and 18, respectively. In most cases, the amateur experimenter will find figure 18 good enough for the transmission of speech, and the better fidelity gained through the use of figure 17 seems hardly worth the extra expense. The data based on 70 cycles were included, though, for those who might care for it.

To clarify the question that usually arises as to the amount of class-C plate current that can be allowed in the secondary under various conditions, simply remember that it is the number of "ampere-turns" that is effective in causing core saturation and, therefore, if the secondaries are used in parallel the amount of plate current will be twice that used with them in series. Similarly, for any number of turns of wire used on the secondary, the product of the number of turns and the proposed class-C plate current should not exceed the total secondary turns times the value of current used in computing the transformer design (N I).

Insulation

Many excellent treatises are available on the actual process of transformer winding, so that



TERMINALS 3 & 4 ARE BEGINNINGS OF "PIES"
TERMINALS 1 & 6 ARE ENDS OF "PIES"
ONLY PRIMARY WINDINGS ARE SHOWN. SECONDARY IS WOUND SIMILARLY PREFERABLY NEXT TO CORE AS AT Ⓐ

FIGURE 16.

it is unnecessary to dwell upon that phase of the subject here. Insulation of a class-B transformer should be regarded above everything else, for of what use is a nicely constructed unit that has blown through to the core or to the other winding? Empire cloth is excellent for insulation and has a break-down test of about 600 volts per mil. An allowance of 100 volts per mil is a reasonable factor in design. Actual tapping of the winding should be done with heavily insulated wire such as "brush cable" or its equivalent and ample room should be left on the ends of each layer of wire to prevent leakage of current to the core ends. Of course, the windings will be put on in layers with thin bond paper between.

Audio Watts	Core Area (Sq. in.)	Core Length (Inches)	Primary Total Turns	Secondary Total Turns	Primary Wire Size	Secondary Wire Size	Approx. Core Wt. (Lbs.)	Insulate for (Volts)	Total Air-Gap (In.)
100	2.3	14.0	2750	3300	25	26	8	5000	.032
175	4.0	16.2	2392	2870	24	25	16	7500	.037
250	5.25	17.8	2108	2530	23	24	24	8750	.041
350	7.6	19.6	1658	1990	22	23	38	10000	.045
500	11.9	22.4	1327	1592	21	22	67	12500	.052

Figure 17. Tabulations Based on Core Permeability of 400 and Audio Response from 70 Cycles. (See also figure 18.)

For air insulation between ends of windings and core or case, allow 20,000 volts per inch and wherever possible use micanite "flash strips" between the ends of the finished coils and the assembled core.

As to wire, enameled insulation will usually prove sufficient but if the window space permits, use single cotton enamel. Baking and dipping in insulating varnish is fine but not an absolute necessity if care is used otherwise. Some builders may wish to suspend the completed unit in transformer oil; this procedure is to be recommended highly.

To-Specification Transformer Design

The two transformers that have been designed in the earlier part of this article were necessarily universal-impedance units. For this reason it has been assumed (from practical experience in this respect) that the secondary-to-primary turns ratio would be 1.2/1. Of course when a special transformer is being designed for a particular application, it will be necessary to calculate the turns ratio from the familiar equation:

$$\frac{Z_p}{Z_s} = \left(\frac{N_p}{N_s}\right)^2,$$

where Z_p and Z_s are the primary and secondary impedances and N_p and N_s are the number of turns for primary and secondary respectively.

Then, knowing the primary turns (from the equations that have been given) the number to be placed upon the secondary can be determined.

Summary of Computation

1. Determine the maximum r.m.s. audio voltage appearing across the transformer windings. This can be determined from the tube characteristics if the transformer is to be used with specific tubes, or it can be approximated from figure 9 if the transformer is to be a multi-usage unit.

2. Determine the maximum unmodulated class-C plate current that the secondary will be called upon to handle.

3. Determine the wire sizes necessary to handle both audio and class-C currents (d_1 and d_2 in cm.).

4. Apply equation (16) (if 70-cycle response is desired) and solve for the cross-sectional area of the core.

5. Compute L and N from equations (12) and (15). Or, if an available core is to be used, apply equations (12) and (13) to find A and N directly.

6. If the transformer is to be a universal unit, compute the winding-tap locations from figure 11.

7. Proportion dimensions of the core to fit the calculated dimensions and compute the air gap needed from equation (5).

8. Finally, check window space to insure ample room for all the required wire and insulation. Always insulate for four times peak E.

W8OMM is named *Bonadio*. He thinks we forgot him when we regretted that no English word rhymed with radio. We said English, o.m.!

Audio Watts	Core Area (Sq. in.)	Core Length (Inches)	Primary Total Turns	Secondary Total Turns	Primary Wire Size	Secondary Wire Size	Approx. Core Wt. (Lbs.)	Total Air-Gap (Inches)
100	1.75	12.8	2524	3028	25 E.	26 E.	6	.030
175	3.0	14.8	2182	2618	24 E.	25 E.	12	.034
250	4.0	16.3	1912	2294	23 E.	24 E.	18	.038
350	5.9	17.8	1500	1800	22 E.	23 E.	28	.041
500	9.0	20.3	1200	1440	21 E.	22 E.	49	.047

Figure 18. Tabulations Based on a Core Permeability of 400 and Audio Response from 100 Cycles.

5-Meter Super-Gainer Receiver

[*Continued from Page 46*]

tuning condenser with short heavy leads. The detector coil is similar except that it has 8 turns. The antenna is coupled to the detector through a mica trimmer condenser having a range of 3 to 30 μμfd. It is set at a fairly low capacity—the two plates well separated.

The total minimum capacity (with an average antenna) in the detector circuit is about 14 μμfd. The revised tuning condenser has a range of about 5 μμfd. so the detector circuit capacity ranges from approximately 14 up to 19 μμfd., enough to more than cover the amateur five-meter band. The oscillator minimum circuit capacity, trimmer, tube and other stray capacities should total 45 μμfd. to track with the detector with the two coils shown. The oscillator tuning condenser, having 5 plates, has a capacity variation of about 14 μμfd., which gives a maximum circuit capacity of 59 μμfd. and a minimum of 45.

Alignment

An all-wave test oscillator is a great aid in lining up even a simple superheterodyne receiver. The i.f. can be aligned to 1600 kc., and harmonics of the signal generator can supply 5-meter signals to check for detector-oscillator tracking. However, it is possible to line up the whole receiver on stray noise or signals in the 5-meter band.

3-Mc. I.F. Channel Operation

The 1600-kc. i.f. provides about the proper degree of selectivity for reception of crystal-controlled or stabilized modulated-oscillator phone signals. Badly overmodulated or frequency-modulated signals are nearly unintelligible on this receiver. If reception of that type of signal is desired, the single stage of 1600-kc. i.f. should be replaced with two stages of 3 or 5-Mc. i.f. which would have less selectivity. The oscillator tracking would have to be changed to make the oscillator tune 3 or 5 Mc. higher in frequency than the detector. The oscillator coil could be stretched out to be a little longer, and the trimmer condenser should be set at a little less capacity for a 3-Mc. or 3000-kc. i.f. system.

Vacuum Condensers

[*Continued from Page 50*]

cover only a rather limited range in frequency by this method.

On 160 meters, and on 80 meters if it is desired to cover the whole band, a single shorted tuning loop will not suffice. For full coverage of these two bands, one or more turns may be rotated within the coil in a variometer arrangement; in other words, the coil conductor is opened at the center of the coil and one or two rotatable turns connected in series by means of heavy pigtail leads.

Another method of tuning a 10-, 20-, or 40-meter tank utilizing a fixed vacuum condenser is to connect either a commercially-built high voltage neutralizing condenser or homemade affair across the tank, tuning it by means of an extended insulated shaft to minimize body capacity. The shorted turn arrangement is somewhat simpler, however, and just as satisfactory.

Open Forum

[*Continued from Page 65*]

found *east* of the Rockies. The number of super-powered stations is roughly proportional to the population in both cases. This is not just my opinion, but also that of several other fellows who have had an opportunity to view the situation first hand on both sides of the continent.

Anyhow, the number of active "5 kw." stations in the whole country could probably be counted on one hand. Most of the offenders run between 1600 and 2000 watts, and while they are undeniably breaking, the law it makes one laugh to hear, "No *wonder* he got nearly twice as many points; he was running *1700 watts*". The difference in signal strength between that power and an even kilowatt is just *barely* perceptible.

The W6's on the whole *do* pack more of a wallop than the eastern stations (making allowances for the difference in population) but it is not due to any great difference in power; it is because the W6's put up antennas with a vengeance.

And why do the W6's come out on the little end of the horn when they poke such a hole in the ether? It might be because they are poorer operators, but it isn't. The W6's are just as good operators as their eastern brethren, and possible just a little bit better. They have to be, because of their geographical handicap.

The reason the W6's don't roll up more points is because of the difficulty in working Europe. The path is nearly all over land, while from the east it not only is much shorter but is nearly all over water. Easterners can get an idea of what the W6 boys have to buck by sitting down and trying to work a few Asians. Supposing just China were divided into a bunch of little countries averaging less area than California, and supposing there were lots of active amateurs in these hypothetical countries on all bands from 10 to 160 meters? The W6 boys could be able to work them like locals on 10, 20, and 40, and with little trouble could hook them on 80 and 160. I have a hunch there would be about twice the usual number of points rolled up by the west coast participants.

It is a rare occasion indeed to work a European on 80 meters from W6 land. The Easterners will say, "How about Asia and Australia from here?" Well, Asia is hard, but Australia is much easier to work from the east than Europe is from the west. The *big* item is the fact that Europe represents *so many countries*. I know the W6 boys would be only too willing to throw out their Australasian contacts if the east coast boys would throw out their Europeans. Boy, what a difference there would be when scores were figured on this basis!

I thought the static was bad at home on the lower frequency bands, but after listening from California I decided that I was pretty well off. And Georgia is no peach when compared to the eastern seaboard.

Of course the rules stipulate that a station actually is competing only with stations in his own section or area, but most dx-ers are after the high score for the U.S.A. I will not say that it is impossible to make the high score from the sixth district, but it is highly improbable.

What I would like to see in preference to By Goodman's expedition would be a "Sand Bowl" dx

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"Unit-Construction" Final Amplifier

[*Continued from Page 58*]

support the plug-in plate coil and the two neutralizing condensers. The lower condenser, for tuning the grid circuit, is fastened to the large condenser with an angular-shaped back plate. At the top of this plate is bolted the horizontal bracket which serves as the mounting for the two tubes. At the lower edge of the back plate is mounted the plug-in grid coil. This plate is also drilled for mounting the plate r.f. choke and the two filament by-pass condensers. All brackets come completely drilled, machined and finished if the kit is purchased. The overall dimensions of the completed unit are 13" high, 8½" wide and 8" deep.

With the plate tank condenser shown, the full rating of the tubes, 1500 volts at about 300 ma., may be run to them on c.w. For phone, the plate voltage will have to be cut down to about 1000 to eliminate the danger of condenser flash-over.

The "Flextal" Exciter

[*Continued from Page 54*]

A few simple precautions will provide stable operation of the oscillator. All low frequency r.f. leads and leads connected to the tuned circuit as well as any leads that fall in the field of the oscillator coil should be of heavy bus and firmly anchored at both ends. The mica trimmers on the b.c. condensers should have their set screws removed and the movable plates bent out at right angles to their normal positions to eliminate the possibility of drift from this cause. The b.c. condensers used should be of good quality, with heavy, wiping rotor contacts.

It should not ordinarily be necessary to use any type of voltage stabilization on the l.f. oscillator but if it is desired to do so because of excessive line voltage variation the circuit of figure 2 may be employed. Each neon bulb maintains a constant voltage drop of approximately 70 volts across its terminals, two providing 140 volts and three 210 volts for the plate of the oscillator. It will be necessary to remove the resistors in the base of the bulbs before they can be used for this purpose.

The series resistor R will have a value of between 5000 and 15,000 ohms, depending upon the power supply voltage and the number of neon lamps used. The resistor should be rated at 15 watts and have a slider so that it may be adjusted for best operation.

With the frequency range of the low frequency oscillator fixed at 300 to 450 kc. and the output range fixed at 3500 to 3650 kc. the choice of frequency for the crystal oscillator is limited. Either the sum or the difference of the two oscillator frequencies may be used to give the desired range in resultant frequency. Use of the sum of the frequencies places the high frequency (crystal) oscillator at 3250 kc., while the use of the difference frequency calls for a 3950-kc. crystal. The 3950-kc. frequency has two distinct advantages. It allows an easily obtainable crystal to be used, without resorting to "rolling your own" or having one ground to special order as would be the case with the 3250-kc. frequency. Also, as was mentioned earlier, by utilizing the difference in frequencies a certain amount of compensating action is obtained. This is due to the fact that an increase of frequency of the low frequency oscillator causes a *decrease* in output frequency from the unit, while an increase in frequency of the high frequency, or crystal, oscillator causes an *increase* in output frequency and vice-versa. Thus, if the crystal oscillator is made approximately ten times more stable than the low frequency oscillator as regards changes in voltage (proportionately to the frequencies involved), then the compensating action is nearly perfect. In practice, the ten to one ratio of stability between the crystal and l.f. oscillators may or may not actually be the case, as no tests have been conducted along this line. But whatever the actual ratio may be, the theoretical advantage due to the use of the difference frequency is there, and is thrown in without extra charge.

It is not necessary, of course, that the crystal used for conversion be exactly on 3950 kc. Any frequency from 3925 to 3975 kc. will be satisfactory.

The pictures and diagram are nearly self-explanatory as far as the actual construction of the unit is concerned. The whole unit is built on a 2"x 7"x 13" steel chassis and housed in a 7"x 8"x 14" ventilated steel cabinet. It is inadvisable to try and squeeze the parts into a smaller cabinet. The "two story" low-frequency oscillator tuning condenser is made by mounting the two b.c. condensers one above the other on long angle brackets. The top condenser is used as the fixed padder and, when its proper setting has been found, is locked in position with a rotor lock. The only other part mounted above the chassis is the 802 shielded plate tank circuit. This tank circuit contains a small coil form and two 25-μμfd. midget condensers, which are used in parallel across the coil. The condensers are set for the middle of the 3500- to 3650-kc. range and the circuit is sufficiently broad to cover the 150-kc. range without retuning.

The tube sockets are evenly spaced along the rear of the chassis, with the 76 at the left, the 42 in the center, directly behind its tuning condenser, and the 802 at the right, behind its tank circuit. Four, five-prong crystal sockets are provided in front of the 76 socket. It should be emphasized that four crystals are extremely desirable, if not absolutely necessary, in the "Flextal" unit. One is needed near 3950 kc. for conversion use; one on or slightly higher than 3500 kc. to provide an accurate "spot frequency" on the low frequency end of all bands; a crystal on or slightly lower in frequency than 3600 kc. to use on the high frequency edge of the 14 Mc. band; and another similar crystal near 3650 kc. for the high frequency edge of 7 Mc. For the exclusively phone man these crystals could be replaced with crystals near 3537.5 and 3562.5 to provide both edges of the 14-Mc. phone band and a marker for the low frequency end of the 28-Mc. phone band.

Under the sub panel, parts are mounted where convenience dictates. The crystal switch, an Isolantite tap switch, is on the left, directly under the crystal sockets. This switch is a two-gang, four-pole, six-position affair and switches both sides of the crystals along with the jeweled pilot lights on the panel. Three green jewels indicate each of the three spot frequencies available with straight crystal control. The fourth jewel is red and comes on when the 3950-kc. crystal is in the circuit, indicating that the unit is "ready to go" with variable frequency output.

The filament switch is on the opposite side of the panel from the crystal switch, with the filament transformer behind it and mounted to the side of the chassis. The transformer is mechanically insulated from the rest of the unit by four rubber grommets placed between it and the chassis. The grommets are held in place by a spot of Duco cement on each. This prevents 60-cycle mechanical vibration of the low frequency oscillator, which would result in frequency modulation.

The b.c. coil is easily obtainable at radio parts houses. It is of the variety commonly known as an "inter-stage" coil and has a sliding primary, which is used as a conveniently adjustable tickler.

Filter Condenser

The only other parts deserving of individual mention are the low frequency oscillator filter condenser C_{13}, the line by-pass condensers C_{12}, and the voltage divider. The filter condenser on the low frequency oscillator voltage tap may or may not be necessary, depending upon the particular power supply used; it is good insurance to include it, however. *Under no circumstance should the voltage divider be mounted under the chassis or inside the cabinet,* as the intermittent heating and cooling of the divider as the transmitter is turned off and on will have a very detrimental effect on the frequency stability. It is not absolutely necessary that the voltage divider be mounted on the unit at all; it may be located at the power supply and the various voltages brought to the unit through a five wire cable and plug. Likewise, the filament transformer may be external to the unit, or the filament voltage may be taken from the receiver or transmitter filament supply.

The line by-pass condensers will probably not be necessary in most cases. In one case they were found to be absolutely indispensable, however. In this particular case, operation of the "Flextal" unit was perfectly normal until the key was pressed. When this was done the frequency began to crawl steadily. When the key was released the unit slowly returned to its original frequency. The trouble was finally traced to a large amount of r.f. finding its way into the filaments through the 110 v. line and causing a gradual increase and decrease of cathode temperature. The line by-pass condensers quickly cured the trouble. They can probably be omitted in the majority of cases.

To make sure that the operation of the original "Flextal" unit was not just a lucky "freak" condition, similar units were built by W6QD and W6ADP, a couple of the local low power dx boys. The operation of these units was identical with that of the original model, and Herb and Glenn can now be heard, like the man on the flying trapeze, "swinging through the band with the greatest of ease."

Initial Tuning

The initial tuning of the unit is best done in the following manner: After the filaments have been lighted, the plate voltage of from 350 to 500 volts should be applied to the unit and the voltage divider taps set to the proper points. Approximate voltages taken from the divider are: 802 suppressor, 50 volts; 42 plate, 175 volts; 76 plate, 250 volts. The total voltage across the divider may be anything from 350 to 500 volts, or even higher if it is desired to exceed the ratings on the 802 slightly. None of the voltage adjustments is extremely critical and wide variations from the above figures will not seriously affect the output. Do not, however, exceed 300 volts on the crystal stage.

After the voltages have been adjusted, the 42 should be removed from its socket and a crystal somewhere between 3500 and 3650 kc. (preferably near 3575) switched into the crystal oscillator circuit. The unit should then have plate voltage applied again and the 802 plate circuit tuned to resonance as indicated by a neon bulb touched to the 802 plate or a flashlight bulb connected across the link terminals. Next, link leads from the transmitter itself should be connected to the "Flextal" unit and the grid circuit of the first stage in the transmitter tuned to resonance and the 802 plate tank condenser retuned slightly if necessary.

With these adjustments completed, the plate voltage should again be removed from the unit and the 802 and 76 removed from their sockets. From this point an ordinary amateur band super will be very helpful. Replace the 42 in its socket and set the low frequency oscillator tuning condenser at minimum capacity. Slide the tickler coil along the grid winding until its positive end is above the ground end of the grid winding and again apply the voltage. Rotate the l.f. oscillator padding condenser until a strong, pure, signal is heard, one which cannot be tuned out on the receiver. This should occur at about 2/3 maximum capacity of the padding condenser. The oscillator is now tuned to the receiver i.f. frequency, which will be somewhere between 456 and 470 kc. depending on the make of the receiver. Replace the 802 and 76 in their sockets, turn the crystal switch to the 3950 kc. crystal and check the output frequency in the receiver. It should be near 3485 kc. If the receiver used will not tune far enough out of the band to pick up the signal from the unit, tune the receiver to 3500 kc. and increase the capacity of the I.f. oscillator tuning condenser until the signal is heard crossing the receiver frequency.

Check the band spread for the 3500 to 3650 kc. range and center it on the dial by readjusting the I.f. padder, remembering that, due to the use of the difference frequency beat, the unit tunes "backward"; that is, an *increase* in capacity causes an *increase* in output *frequency* and vice-versa. With the band properly set, lock the rotor of the padding condenser in position and tune the output to the center of the 3500-3650 range and retrim the 802 plate circuit for maximum output. The quality of the signal from the unit should now be checked in the receiver. It should be impossible to notice any difference in the tone of the signal when switching from straight crystal control to control by conversion. Adjust the oscillator feedback by sliding the tickler along the grid winding until the quality of the output is uniformly good over the range of the unit. A small amount of adjustment of the taps on the voltage divider for best output, and the tuning is completed. The tuning adjustments are actually much less complicated than they sound; the whole job can be done in 15 minutes.

Ready to Drive

The unit is now ready to drive the transmitter either with straight crystal control or on any frequency between crystals merely by setting S_1 to the proper position. The link to the transmitter may be any reasonable length without sacrificing a great deal of output. Twisted lines of widely differing characteristics will affect the tuning range of the 802 plate tank circuit, so the number of turns on L_1 may have to be changed to suit individual cases.

The output to be expected from the "Flextal" unit is on the order of five to ten watts, depending upon the supply voltage, and it will replace the present crystal stage in a majority of cases. Where a 40-meter crystal is being used at present, a simple conversion of the crystal oscillator into a doubler by the addition of an 80-meter grid tank will solve the problem. If a tri-tet oscillator is being used with an 80-meter crystal and the plate circuit on 40, it likewise can be converted into a doubler by using the cathode tank circuit as an 80-meter grid circuit. The only case where an additional stage should be required is where a 40-meter crystal is used in a tri-tet oscillator with 20 meter output or where 20- or 10-meter crystals are used.

Two last precautions: *always make all major tuning adjustments of the 802 plate circuit with the 42 removed and the unit operating on a crystal between 3500 and 3650 kc.* This will eliminate all possibility of tuning the transmitter to the wrong output peak. Final minor adjustments of this tank circuit may be made with the 3950 kc. crystal and the 42 both in the circuit, and the output set near 3575 kc. If you care to flirt dangerously with the edges of the bands, *use crystals which are known to be safely in for edge of band operation* and then *keep inside of them* when using the variable frequency control.

The "Flextal" type unit, having again made operating a pleasure for one ham and having received favorable comment from others who have used it or seen it in operation, is offered to those who care to try it for what it may be worth.

DX

[*Continued from Page 64*]

and W4ECI started out well but got sick during the middle of the stretch. W4EHH was in there for new countries mostly and W4BOE didn't quite get his new kw. rig finished in time.

"Ma" Mayer, K4KD, in scoring his 131,895 points really tore 'em apart. He had 977 QSO's and used four bands. Mayer says everything went off slick until the last few days when he had trouble responding to the alarm clock although the xyl came through with hot coffee and midnight lunches which were very welcome. K4KD wants to tell the gang that if they don't get their cards right away not to give up as he is having a new batch printed and everyone will get one. Gil Williams now has his 30th zone. He has been hunting for Asians for years then works four of them in a month. W6MVQ got himself 8 new countries during the contest and now his total is 71. He was on 57 hours and made about 20,000 points. Says he isn't using a "California Kw". Incidentally, MVQ, who is 16 years old, has had his license only two years and has made WAC over 60 times.

W3EVT ran up 150,000 points and earned a few new countries some of which are XU6MK, ZC6AQ, U8ID, VP2LB, W1OXAB, VQ4KTF, YV2CU. Clem now has 37 and 110. W1ZB worked PJ4F in Saba (wherever that is) and FG8AH in Guadelupe for his 129th country. PJ4F, 7000 kc., and FG8AH, 7120 kc., T5. W8DWV says the QRA for ZU9K on the island of Tristan de Cunha is Kenneth Stevens, Anspike British Postal Dock, Tristan de Cunha.

ES7D has worked a few of the boys on 40, W1BYI, W2BHD, W2UK, W3CHH. ES7D says dx on 7 Mc. is quite rare. His rig uses a 310 final with 50 watts input. ON4AU now has 151 countries, and contacted the following on 7 Mc. during the contest: W6CD, W6CIS, W6GNS, W6QD, W6GRL, W6KUT, W6HX, W6ITY, W6CII, W6BIP, W7AJN, VE5OJ. W6BAM snags FU8AA in New Hebrides and VP2LB for new ones.

GI6TK did a noble job in rounding up 81,000 points. He worked 53 districts and hooked W6GRL on 3.5 Mc. Frank has 31 zones and 76 countries to his credit so far. He is much in need of contacts with hams in Arizona, Utah, Nevada, New Mexico, Mississippi, So. Carolina and So. Dakota. Frank will seek anybody in any of these states at any time. His usual operating time is as follows: Week days, 14 Mc. 0700 to 1000 G.m.t. Sundays and week days, 28 Mc. 1500 to 2000 G.m.t. There you are boys, go get him. More on GI6TK later.

VP9L C.W. Station Doubtful

During the phone contest while W6GRL was QSO VP9L in Bermuda Dave mentioned he was glad to hook him on phone after working him on c.w. VP9L said that he had been getting all kinds of cards all over the world for c.w. contacts but he had never been on c.w. Apparently the true VP9L is the phone station and if this information is correct there will be plenty of fellows losing points from that VP9 contact in the c.w. contest and not only that but a country from their list as well to say nothing of coining a flock of words that won't fit into any dictionary. This is one of the lowest of the low in tricks.

Bill Breuer, K6TE, is back on Wake Island fur awhile 14350 kc. K6BAZ has a new load of gas and is at it again on Howland, 14390 and 7190; K6DSF on Baker Island, 7080 kc., using 3 watts (dig for him boys), K6GNW on Enderbury Island in the Phoenix Group, 7185 kc., K6HCO on Canton Island, Phoenix Group, 8429 kc. (no, I didn't slip); K6NVJ on Jarvis, 7190 kc.—all of these boys are T9.

Charlie Perrine didn't wait for the dx cycle to roll around, he just went out and worked the above mentioned countries, plus a couple of VP7's. Charlie now has 136 with 39 zones. Come you zone no. 23. CUH has a new final with a pair of 250TH's, but using no tank condensers . . . tunes the coils "accordion fashion". I guess that's low C. The rig was in the March issue.

I must mention something about the gadget called the "Flextal" Conversion Exciter described by Leigh Norton, W6CEM, in the front part of this issue. This seems to be quite a good unit and the one I have built up for use at W6QD has been like a new toy. As far as I can tell it has the clear tone and stability of crystal-control, and the flexibility of an electron coupled oscillator. It has been great sport "skooting" around the band with it setting on any spot desired. Hope I don't forget and skoot the wrong way.

W8RL is a new one to the phone section of the zone list with 21 zones and 49 countries. G2QT has 34 zones and 88 countries. OK1AW now has 33 and 90 and ON4AU finally writes in with the total of his countries worked placed at 148. Here's an item of interest, from OK2BR. He says that our old friend OK2AK who used to put out such a potent signal is now with the Telefunken Laboratories in Berlin. Therefore his OK2AK license was revoked and being a foreigner he cannot, as yet, hold a license in Germany. OK2BR also adds that OK2PN, who is a good dx man, needs cards very badly from stations worked by him up to 1937. He is trying to get enough to get into the Zone list and WAS. He has worked Arizona, New Mexico and Colorado but no cards as yet . . . so, come on and kick through.

W1DKD worked a nice one on 7 Mc. It was ZD1Z in Gambia, and he said he was operating portable and to QSL to G8DF. The funny part of it was that W1DK didn't give it much thought but when he came to look up G8DF in the call book, he wasn't listed. However, a few days later he was put at ease when QSO G5FA. He asked G5FA if he had ever heard of G8DF and 5FA told him they were good friends, and then went on further to say that ZD1Z was operating about 200 miles inland in Gambia and running 25 watts to a single ten. That's a good one to get and I wouldn't be a bit surprised if he was the first W to land one of 'em.

XE1BT who paid us a visit a short time ago is back home now. In fact when he reached San Francisco on his trip he was suddenly called back, so as it happened he got on in the phone contest and made 780 contacts. He didn't say what the multiplier was so I have no way of knowing the score. On his way home from San Francisco, XE1BT met a number of hams in New Mexico and Arizona.

While I think of it, KA1ZL scored 17,200 points in the phone contest, and it was entirely handled by the xyl . . . . . as you will recall KA1ZL is ex-W6BAY, Ted Curnett. 320 contacts were made during the session.

Speaking of traveling hams . . . . . . some of you dx men scattered throughout the world, keep an eye open for W6JWQ, Larry Sorensen. He has just left on a trip around the world and will not return until September first, which should give him a fair amount of time in each country visited. His itinerary briefly is this: Tokyo, Yokohama, Shanghai, Hongkong, Manila, Java, Bali, India, Suez, Athens, Turkey, Italy, Germany, France, Denmark, Moscow, Leningrad, Belgium, Norway, Sweden, England and home. He's a lucky guy, this W6JWQ, and if he locates any of you, don't lead him astray.

We're just full of it this month . . . . . maybe I should have a "visitors and travelers" section. Anyway, G5SA, Price Jones, is now located in Hollywood. He expects to be here for a few months. I hate to think what a few months in Hollywood *might* do to him . . . . . of course, he has his charming xyl with him, so everything will be all right. G5SA is doing a little work in one of the "movie" studios, in the sound end of it, I think. Price says for the past year or so he has been on phone, although he is still a c.w. man, too. Hi. He has gotten the itch to get on the air while here so is assembling a Bi-Push in his spare time. You might hear G5SA/W6 any day now.

Here's something from New Guinea: VK9DM on 14,410 kc. with a T6 note. Claims that he has difficulties hearing W stations at the present time because he is shielded by 10,000 foot mountains. That apparently doesn't affect his signal in getting out for he has the whole band calling him. VK9DM expects to have a new receiver in a short time and so the W's will be given a better break.

Just a few closing thoughts from here and there. A couple of laughs were had during the contest when out of a clear sky a W2 was heard sending a mile a minute on his bug "CQ SS CQ SS de W2—" and then about ten minutes after the contest closed a W9 was heard exchanging numbers with an FY8 . . .

and a loud snicker was had late that night when a certain station in South America was still passing out numbers . . . habit I guess. I had a good laugh on myself when one night on 7 Mc. the gang of 689 hams were calling CN8AV and I was one of them. This was about 9 p.m. and I was pretty groggy that p.m., but every time this CN8 would sign off I would automatically call him anyway . . . thinking I would have one chance in 689. When I finally awoke it was 1:15 a.m. . . . still had the cans on with two cramps in my neck. Anyway the payoff came when W6GRL breezed into town after the contest and asked why I didn't go back to CN8AV after I had raised him. Aw shucks, I'd rather sleep anyway.

Activity around Manhattan Beach hasn't gotten into the summer dx season yet but I am looking forward to it. Any day now the yl's will begin flocking to the beaches to drape themselves over the sand in order to show off their nice new shiny satin, or rubber bathing suits—bathing suits that will never see the water. Anyway, they like to be looked at, so you see, gang, dx in the summer takes somewhat of a slump, that is, if you get what I mean. Our "shack" is only three steps and a stumble from the ocean, so we haven't far to go to demonstrate our ability to "sink or swim".

If any of you fellows are still reading, you deserve a medal, but in the absence of a medal suppose you dig in there and find out where some of those "foney" stations are coming from. Keep up the swell work, gang, fire in all of that dx news and we'll put it in print if we have to run a special edition. I'll do my part . . . in fact I've started already getting back to normal . . . just the other night I worked three W9's in a row. For me, that's something. Next month watch out. That's it.

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.

T-40 TEN-METER PHONE RIG

C_3, C_4—Solar "Domino's"
C_8—Bud no. 898 condenser
C_9—Cardwell MT50GD
C_{10}—Bud no. 92 condenser
RFC_1—Hammarlund CH-X
RFC_2—Hammarlund CH-500
Sockets—Hammarlund
Insulators—Johnson

HK-254 AMPLIFIER

Johnson parts as follows:
C_1—100FD20
C_2—100DD70
C_3—6G70
Two 204 dials
Two 211 sockets
One 225 socket
One 252 coupling
One 258 coupling
Two 602 insulators
Two 67 insulators
Two 76-A jacks
Six 77-A plugs
Two 40 insulators
Five 40 insulators

JONES 56-Mc. SUPERHET

C_1—Hammarlund MEX trimmer
C_2, C_3—Hammarlund HF-15
C_4—Hammarlund APC 50 µµfd.
Tubulars and mica by-passes—Cornell-Dubilier
Flexible shaft couplings—Bud
R_5—Centralab 72-103
R_7—Centralab 72-107

"UNIT-CONSTRUCTION" AMPLIFIER

Complete kit of hardware, brackets and screws—Hammarlund
C_1—Hammarlund MTCD-100-B
C_2—Hammarlund MTCD-100-C
C_N—Hammarlund N-10 condensers
RFC—Hammarlund CH-500
Tube sockets—Hammarlund S-4
Coil socket—Hammarlund S-5
Grid coil form—Hammarlund XP-53

DAWLEY SPEECH MODULATOR

T_1—Thordarson 81D42
T_2—Thordarson 15D79
T_3—Thordarson 11M77
T_4—Thordarson 70R62
T_5—Thordarson 16F13
CH_1—Thordarson 74C29
CH_2—Thordarson 13C28
All tubular condensers—Cornell-Dubilier
All filter and coupling condensers—Cornell-Dubilier

ADAMS DIVERSITY RECEIVER

Tubular condensers—Aerovox 284 and 484
Mica condensers—Aerovox 1468
C_{48}—Aerovox PR5 8 µfd.
C_{51}, C_{52}, C_{53}—Aerovox PBS 58-8 µfd. in series
C_1, C_8, C_{15}, C_{24}—Hammarlund APC 25 and 100 µµfd.
C_{25}—Hammarlund HF15
C_2, C_9, C_{17}—Hammarlund MEX
C_3, C_{10}, C_{18}—Ganged Hammarlund MC20MX
$RFC_{1,\ 2,\ 3}$—Hammarlund CH-X
Coil forms—Hammarlund CF-M
TR_1—Meissner 6643
TR_2—Meissner 6123
TR_3—Meissner 6869
I.F. chokes—Meissner 5590
R.F. coil cans—Meissner 8281
R_7—Yaxley H control
R_{15}—Yaxley H control
R_{18}—Yaxley E control
R_{24}—Yaxley M control
R_{28}, R_{29}—Yaxley N controls
Diversity switch—Meissner 18254
Plugs, connectors, sockets—Amphenol

Open Forum

[Continued from Page 87]

contest here in Calif. Let each section select two operators who are its pride and joy and pay their expenses to California to enter the melee. The juice ordinarily burned during the contest would pay for it. Instead of cluttering up the air, the rest of the operators could stay home and be spectators, rooting for their own entry.

Oh—oh. I think the same man is looking for me—you know, the one with the blue coat and brass buttons.

DAVE EVANS,* W4DHZ

*Winner for U.S.A., 1936 dx contest.

A New Receiver

[Continued from Page 57]

termediate frequency eliminates the possibility of low frequency QRM sneaking into the second detector when one is located near low-frequency commercial stations or shipping lanes.

The controls on the front panel include r.f. gain, band switch, audio gain, a.v.c. switch, main tuning, b.f.o. switch, tone control and power switch, pitch control, and communications (standby) switch. A headphone jack is also located on the front panel.

Both main dial and auxiliary band-spread dial are actuated by the same tuning knob, the tuning mechanism incorporating a weighted wheel which permits one to "spin" the main dial across the scale quickly when going from one frequency to a widely different one.

The loudspeaker, which is self-contained, is well made and provides surprisingly good quality for a 5-inch speaker. While it leaves something to be desired in the way of bass response for broadcast reception of music, the quality is better than the majority of midget b.c.l. sets and insofar as voice intelligibility is concerned, which is the important consideration in communications work, the small speaker seems to be actually superior to a big "boomy" speaker in a large cabinet.

The receiver has provision for balanced (doublet) antenna input, and while best results were obtained with a resonant antenna and balanced two-wire transmission line, good results were also obtained with a 40-foot wire used as a regular untuned Marconi. Good performance on both phone and c.w. on all bands was experienced on the model under test—especially good when the very moderate price of the receiver is considered.

The Marketplace

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

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

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

(d) No display permitted except capitals.

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

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

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

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

(i) We reserve the right to reject part or all of any ad without assigning reasons therefor. Rates and conditions are subject to change without notice.

VERNIER drive for metal disc dials; one-hole panel mounting. INTRODUCTORY, 35c coin, postpaid. New England RADIOCRAFTERS, 1156 Commonwealth Ave., Brookline, Mass.

WANTED: Best transmitter that $100 to $150 cash will buy. Craig, W7ALO, First National Bank Building, Salem, Oregon.

DOUGLAS Universal Class B transformers of quality. Designed by W8UD. Sold exclusively by W9IXR. 50 watts audio $4.95 pair, 100 watts audio $7.75 pair. Postpaid in U. S. A. Guaranteed. To promote faster service we have moved. Write W9IXR, 17 West Knapp Street, RICE LAKE, WISCONSIN.

WANTED: 100-watt, factory-built transmitter for 10, 20, 40 and 80 meter c.w. and phone. Will consider Temco, Harvey, etc. Also want Harvey UHX-10 for mobile use. Give full particulars. C. J. Clark, 925 Montrose Ave., Chicago.

PANELS, chassis, racks, portable cases, specials. R. H. Lynch, 970 Camulos, Los Angeles, Calif.

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

RECEIVERS: Sell or trade for test equipment: S. W. 3, like new—power—with 59 output, 20-10 meter coils. S.W.5—Velvet B, 40 meter coils. Motor generator, 110 a.c. input, 400 V. D.C. 250 mils. output, $6.00, W6BTL.

FOR SALE: New 600-watt, c.w., 150-watt phone in relay rack with 250TH final amplifier from 10 to 80 meters. Tube keying and built-in power supplies in silver and grey panels. Price complete with tubes and coils $215, f.o.b. Berkeley. New six-band, plate-modulated phone with four HK54 tubes. Input approx. ¼ kw. Relay rack and panel of silver and grey finish. Complete with all tubes and coils for $260 f.o.b. Berkeley. F. C. Jones, 2037 Durant Avenue, Berkeley, Calif.

WANTED: Power supply or odd parts. 3/4000 volt, 500/1000 mil; modulator or parts 700/1000 watts audio. Cash. W6OCH.

CASH for modern super with xtal. Must be perfect. W6HEZ, Laguna Beach, Calif.

W6KX QSL's, like the YL's in RADIO's office, are fb. Estimates on special cards furnished. Suggestions for card layout appreciated. How abt ur QSL for a change . . . Hi! Keith LaBar, W6KX, 1123 North Bronson Ave., Hollywood, Calif.

HK-254 AMPLIFIER described in this issue, laboratory model, less tubes and coils, $26.00 f.o.b. RADIO, Ltd., 7460 Beverly Blvd., Los Angeles.

TZ-40 MODULATOR described in this issue, laboratory model, $60 complete with tubes, f.o.b. RADIO, Ltd., 7460 Beverly Blvd., Los Angeles.

METER Repair—Accurate and dependable service. Standard types of meters repaired in 24 hours. Repairs priced so that anyone can afford them. Write for price quotations. Braden Engineering Company, 305 Park Drive, Dayton, Ohio.

HAVE you seen Fritz's newest QSL's—SWL's? They're different! 455 Mason Ave., Joliet, Illinois.

FABERADIO, after years of successful manufacturing, still sells "Y" 160 and 80 meter crystals for 75c each. More than 5000 users are satisfied. "X" cut $2.25. "A" cut $2.75. Molded holders $1.00. Variable frequency holders $4.95. Commercial crystals a specialty. FABERADIO, Sandwich, Illinois.

METERS repaired, Ham's prices, W9GIN, 2829 Cypress, Kansas City, Mo.

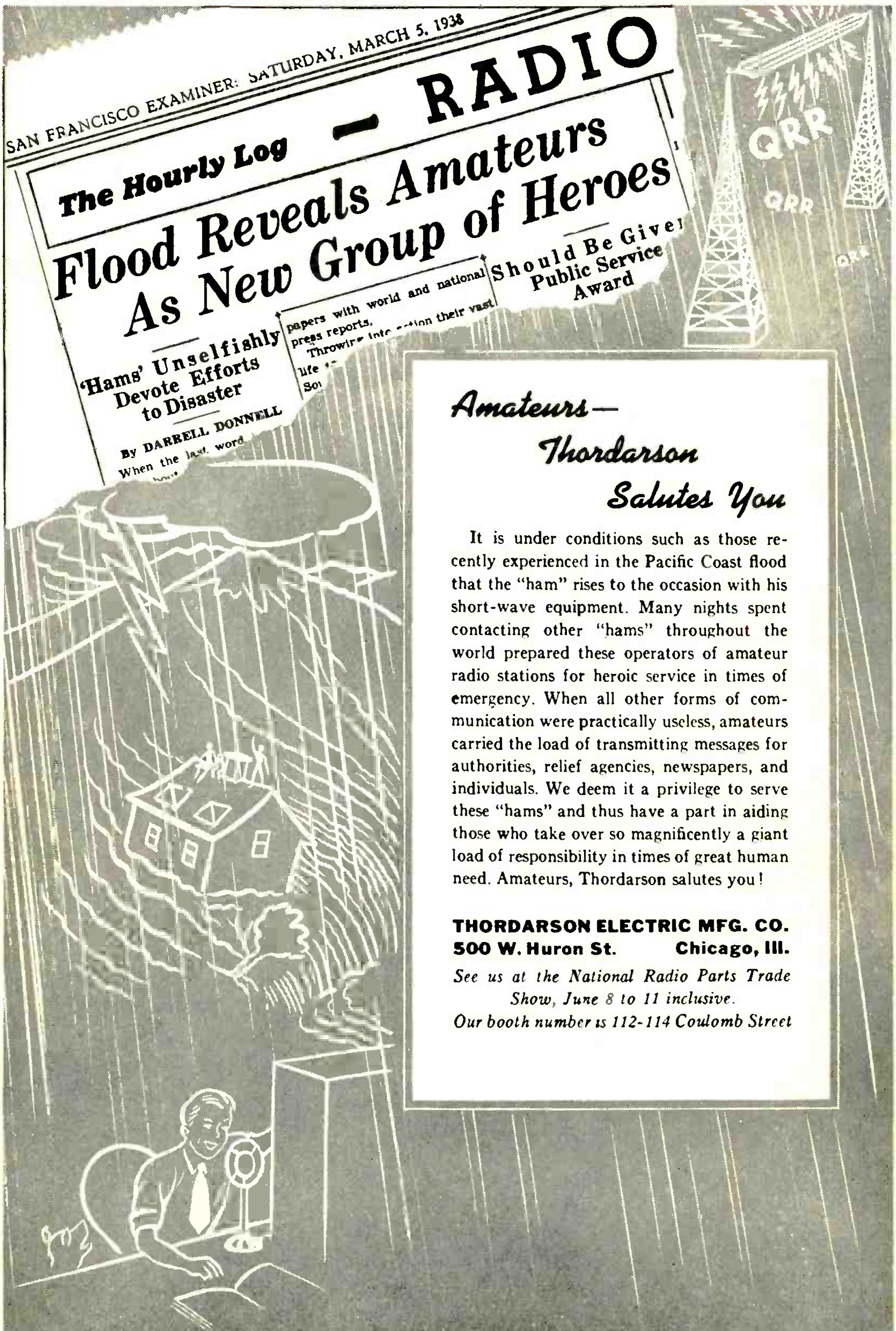
METER Repair—D.C. Milliammeters, springs repaired $1.75. Change range, new scale $1.75. Thermocouples 1 to 5 amperes, $2.50. Change thermocouple range add 25c. All repairs reasonable. Braden Engineering Co., 305 Park Dr., Dayton, Ohio.

BLUE Print (dime) and Photostat (quarter) International "Q" Signals—convenient size. W9OC, Spencer, Iowa.

TRANSMITTER: built by Frank C. Jones, pictured and described in February, 1938, RADIO. 600 watts c.w., grid-modulated phone. Complete with all tubes and coils for ten and twenty meter bands. Broadcast quality, R9 reports from nearly everywhere. Reason for selling: installing more powerful transmitter. $155 f.o.b. Hopkinsville, Kentucky, which is less than cost of parts. W9WOI, A. W. Wood, Jr., Hopkinsville, Ky.

GUARANTEED "PRECISION TRANSFORMER" PIE WOUND, 1790-760-0-760-1790. 450 milliamperes. $16.50. All types power equipment, request prices. Michigan Electrical Laboratory, Muskegon, Michigan.

QSL'S—The Best. W8NOS, 27 Houston, Buffalo.



Amateurs—
Thordarson
Salutes You

It is under conditions such as those recently experienced in the Pacific Coast flood that the "ham" rises to the occasion with his short-wave equipment. Many nights spent contacting other "hams" throughout the world prepared these operators of amateur radio stations for heroic service in times of emergency. When all other forms of communication were practically useless, amateurs carried the load of transmitting messages for authorities, relief agencies, newspapers, and individuals. We deem it a privilege to serve these "hams" and thus have a part in aiding those who take over so magnificently a giant load of responsibility in times of great human need. Amateurs, Thordarson salutes you!

THORDARSON ELECTRIC MFG. CO.
500 W. Huron St. Chicago, Ill.

See us at the National Radio Parts Trade Show, June 8 to 11 inclusive.
Our booth number is 112-114 Coulomb Street

A Few Facts About Ratings

RCA Amateur Contest Reveals Your Approval of Policy which Maintains Tube Ratings on Consistent, Conservative Basis

RCA tubes are given ratings which will insure satisfactory service and long life. These ratings establish a foundation for reliable tube operation. These ratings determine your true tube cost—which is Watt Hours per Dollar.

We know, from our life tests, breakdown overloads, and other tests, that RCA tubes will perform well above ratings but it is not recommended that tubes be operated in excess of ratings since the difference between the actual capabilities of the tube and the rating is provided as your factor of safety.

While it is probably true that a satisfactory life, less than normal, could be obtained by operating tubes somewhat in excess of ratings, the varying operating conditions imposed by each different application would necessitate a new rating study for each application. Many amateurs were frank in telling us that they were running RCA tubes in excess of our ratings and obtaining good life. Our ratings were used simply as a guide in deciding how much overload was to be applied. We are familiar with this school of thought and recognize that the tube user following it is probably aware that he is compromising life expectancy for greater tube output. The fact remains, however, that our ratings are set up to insure for you satisfactory performance on the basis of both life and output, and we cannot recommend operation in excess of these ratings.

In RCA Transmitting Tubes we endeavor to give you a well designed, skillfully manufactured product, rated so as to assure you a minimum cost of tube operation.

For a more comprehensive discussion on tube ratings, refer to pages 141, 142 and 143 of your "Air-Cooled Transmitting Tube Manual", TT3. If you haven't a copy, send 25¢ to the Commercial Engineering Section at Harrison, New Jersey, and one will be mailed to you.

RCA presents "Magic Key" Sundays, 2 to 3 p.m., E.D.S.T. on NBC Blue Network.

Ask your distributor, or send 10¢ to Camden, New Jersey, for a commemorative advertisement on RCA's television tube announcement.

RCA Radio Tubes

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