RADIO

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

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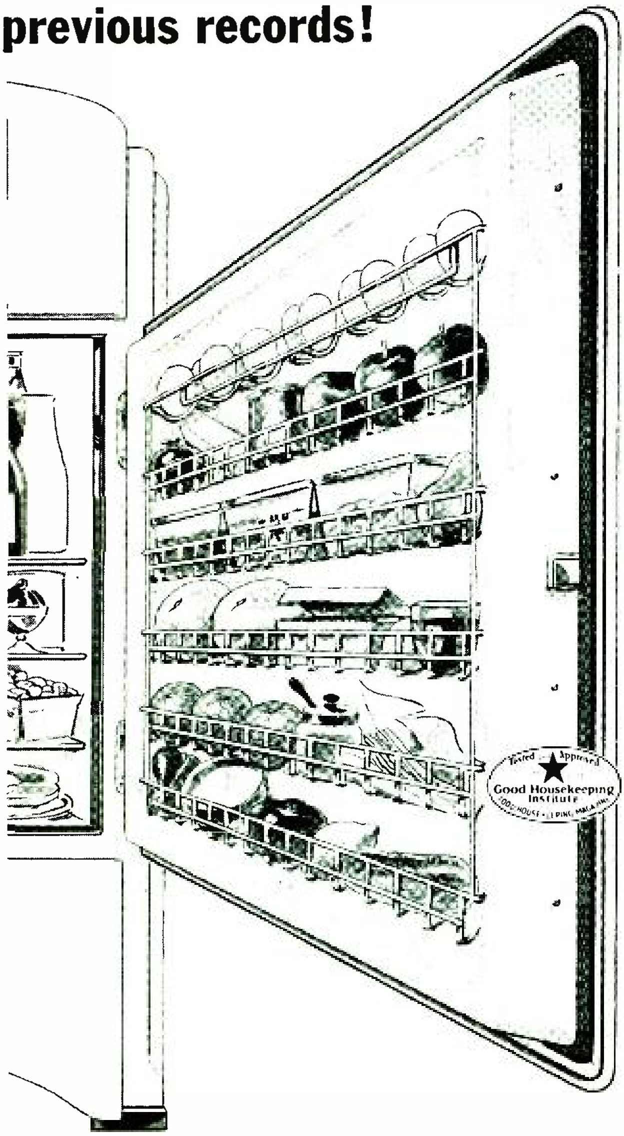

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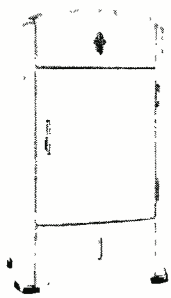

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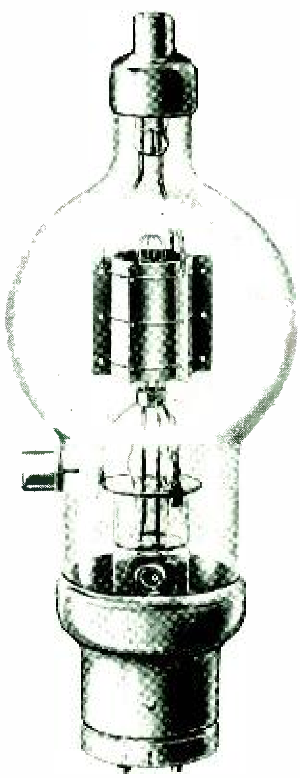

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RADIO

The publishers assume no responsibility for statements made herein by contributors and correspondents, nor does publication indicate approval thereof.

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Contributions to our editorial pages are always welcome; though they will be handled with due care we assume no responsibility for those which are unsolicited; none will be returned unless accompanied by a stamped, addressed envelope. We do not suggest subjects on which to write; cover those you know best; upon request, we will comment on detailed outlines of proposed articles, but without committing ourselves to accept the finished manuscript.

Since we regard current "chiseling" policies as decidedly unfair, a small payment will be made, usually upon publication, for accepted material of a technical or constructional nature. Freehand, pencilled sketches will suffice. Good photographs add greatly to any article; they can easily be taken by the layman under proper instructions. For further details regarding the taking of photographs and the submission of contributions see "Radio" for January, 1936, or send stamp for a reprint.

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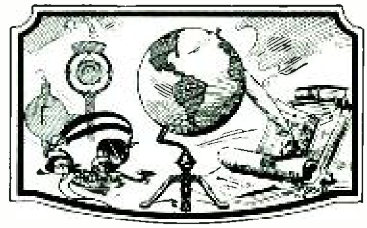
RADIO with the EDITORS



Deferred Dog Fight

The editors of RADIO are all "dyed-in-the-wool" amateurs, and being also human, are like other hams inclined to lean either towards phone or c.w., having a particularly "soft spot" for one or the other, even though both may be used in their stations. It is a strong temptation at times to join in the current "phone vs. c.w." argument, (each according to his own viewpoint) either in these columns, or by allowing particularly well-written letters to see the light of day in the "Open Forum".

Nevertheless, with the Cairo Convention not so far away, we firmly "sit upon" such inclinations, in the belief that both phone men and c.w. men should cooperate and concentrate on securing as much additional territory for amateur radio as a whole as possible. Let's worry about dividing the spoils—if any—after the convention is over.

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In a Nutshell

One of the most apt, appropriate, and succint statements that we have ever read relative to the true status of A.R.R.L. affairs has recently been made by Central's Roberts in his recent annual report. Says Mr. Roberts:

The publication business has been a success, but the League has not.

There is certainly nothing reprehensible in being in the publication business, nor in being successful at it. But certain persons at Hartford, and many outside of Hartford, seem to have forgotten that the League's prime purpose is to defend amateur radio, to retain its rights and frequencies, and to augment them if necessary. In this purpose it has lamentably failed, for amateur radio retains but a mere pittance of that which it formerly held.

The considerations involved in successful publishing, especially in the radio field, and those involved in the League's prime functions are bound to be antagonistic at times, particularly if those interests which are trying to deprive the amateurs still further of frequency assignments are those which contribute heavily to the advertising revenue of the publication business.

Perhaps the situation is unavoidable, in as much as the League must have a source of income with which to finance its activities in amateur radio's behalf, *but* it certainly is not necessary at least to have the *same man* in charge of these antagonistic functions. Hence, we second heartily Mr. Roberts' suggestion that Mr. Warner be made Business Manager, and deprived of his editorship as well as his control over the political activities of the League.

Anchoring in Hartford

According to reports emanating from the east, Mr. Warner now proposes that the League purchase the building in West Hartford, whose second story it has occupied for a number of years as headquarters offices. The reported purchase price is to be $25,000 or $30,000, and the annual rental which has been paid is in the neighborhood of $4000.

Offhand, this might seem like a good bargain. The saving in rent certainly represents a good return on such an investment. But the rental which has been paid is an exhorbitant figure—considering that it is a semi-isolated building far from the downtown area. Furthermore the ground floor which, say reports, Mr. Warner has considered as rentable, has been vacant for a considerable amount of time; its rentability is not likely to change suddenly upon a change in title to the building.

But, to our minds, a far greater objection than the financial one, is that such a purchase would tend to anchor the League headquarters to Hartford* forever, which is doubtless the real motive behind this suggestion by the present management and some of its yes-men.

We reiterate the suggestion made by *R/9* some years ago, which has found increasing popularity: that A.R.R.L. Headquarters be removed to some "middle-western" point. It would make possible more frequent meetings of the Board of Directors, something vitally necessary if dictatorship is not to continue to flourish; it would make HQ more readily accessible to the great majority of members; and it would provide a more central mailing point. Many other advantages will readily suggest themselves.

[*Continued on Page 84*]

*To the gentleman, bursting with civic pride, who took exceptions to our remarks in a recent issue regarding Hartford, let us say that we have nothing against the city itself, which the writer has always found to be a pleasant place in which to sojourn. Our remarks would be the same were A.R.R.L. HQ located in any other city in the same part of the country.

The "Conversion Exciter"

By K. V. Keeley* and Ed. Hayes*

A crystal oscillator with continuously-adjustable frequency control! Yes, you can spot your frequency anywhere in the band, and with but negligible sacrifice in frequency stability. In fact, for all practical purposes, the stability may be considered "just as good as straight crystal". Although construction details must be followed implicitly, there is nothing tricky or complicated about the circuit or operation.

The mention of crystal control brings to mind pleasing thoughts of pure d.c. notes and excellent stability, but lurking just behind is the discouraging thought of inflexibility. As a result we find that even though crystal control has during the last five years stolen the show almost completely, we have not forgotten the fine flexibility of the self-excited circuits. More than five years are required to forget that, and it is felt that amateurs will welcome the "Conversion Exciter", which combines such flexibility with a good share of the crystal's stability.

This circuit is not a step backward, but rather a compromise between the good features of the crystal and the self-oscillator, and in fact uses both to gain some of the merits of both.

Stability Plus Flexibility

To get down to facts and give a brief general description of the hookup:

The conversion exciter is a heterodyne circuit, using a quartz-crystal-controlled oscillator for the basic frequency, and adding to (or subtracting from) it 50 to 400 kilocycles, generated by a tunable self-excited *low* frequency oscillator. The important point is that the tunable oscillator works at a low frequency, so that even a fairly large *percentage* change in its frequency is still only a fraction of a kilocycle. This oscillator is built for stability and can easily be held within 500 cycles. By changing its tuning the output of the conversion oscillator is varied over a large portion of any amateur band—with good stability wherever it goes.

For instance, we might use a 3900 kc. crystal and heterodyne it with a low-frequency oscillator tuning from 300 kc. to 400 kc., giving an output-frequency range of 3500 to 3600 kc. The tuning dial of the low-frequency oscillator may accordingly be calibrated in output-frequency directly and any frequency from 3500 to 3600 kc. can be chosen accurately by setting this dial.

A doubler stage will give a range of 7000 to 7200 kc. with the same crystal, while a second doubler stage will give an output of 14,000 to 14,400 kc., which is the entire 20 meter band.

The Stony Road

The developing of this "paper idea" into a heterodyne circuit usable for amateur transmitters was not an easy task. Myriads of tubes and circuit combinations were available. After trying many combinations it was decided that simplicity was the feature to strive for. It is true that higher output can sometimes be obtained by the use of series mixer coils, multiple-tuned input coils and other schemes, but the sacrifice in simplicity is too great. A simple tuned circuit and a buffer tube give better satisfaction than the same material used in a complicated mixer circuit. The conversion exciter shown here is simple; little trouble should be experienced by anyone who constructs a similar unit.

The Circuit

The 6C5 crystal-controlled oscillator tube generates an r.f. voltage at the crystal frequency. This voltage is capacitivly coupled to the control grids of the pair of 6L7 mixer tubes. These grids are connected in parallel. The low frequency is generated by the self-oscillating 6F6 tube, and the low frequency is fed to the "injection" grids of the same 6L7 mixer tubes, but these grids are not connected in parallel. Instead they are in push-pull. The two frequencies are mixed by the 6L7 tubes and the sum or difference appears in the output, depending on which one the 6L7 push-pull output (plate) circuit is tuned to.

The crystal-frequency is fed to the control grids of the 6L7 tubes in parallel because this eliminates the crystal frequency in the output circuit, L_3C_8, which is push-pull connected. At the same time the low frequency of the 6F6 oscillator does not appear because such a very low frequency is wiped out by the selectivity of L_3 C_8.

It will be noted that there are only two tuning controls in the entire unit. One tunes the 6F6 low-frequency oscillator; the other tunes the plate output tank of the 6L7 tubes to the

*W6BC, El Monte, California.

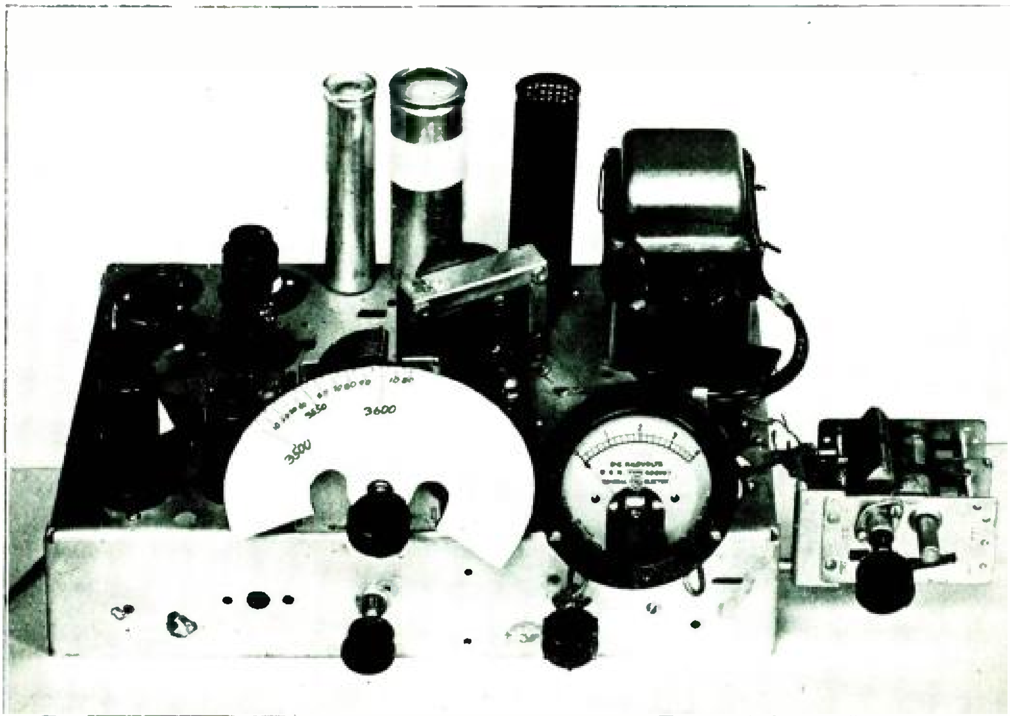


Figure 1

The Conversion Exciter, when working with a 3900 kc. crystal and 280-400 kc. l.f. oscillator, giving a 3500-3620 kc. output range as shown by the dial calibration. The two oscillators, crystal, and l.f. tuned circuit are grouped at the left. The l.f. tuning gang and control are at center front with filament switch below and h.v. switch to right. The 6L7 plate milliammeter is at the right and between it and the dial is the 6L7 pair. The 6L7 tank circuit consists of the coil behind the meter, and the outboard tuning gang. The power supply is at the rear. The chassis measures about 11 by 9 inches.

desired sum-frequency or difference-frequency.

The Special Crystal Oscillator

Looking at the diagram of figure 2 it is seen that the crystal oscillator is a special and unusually simple one. It has *no* tunable circuit at all. Any crystal may be plugged in and the circuit will oscillate without adjustment of any sort. Its operation is explained by figure 3. Figure 3A shows a familiar oscillator circuit which may be called a modified Colpitts circuit or a shunt-fed Ultraudion. Figure 3B is the same circuit with a crystal replacing the tuned circuit and a resistor replacing the r.f. choke. Since the crystal and its holder are a condenser, the condenser C_2 has been dropped. In figure 3C the resistor R_2 and the bypass C_p have been transposed to permit putting the plate at zero r.f. voltage by connecting it to chassis through C_p. Since there is very little r.f. voltage across C_p it is just as well to connect the crystal to the other side of C_p as shown in figure 3D. Now the crystal holder is "cold", the plate has no r.f. voltage to escape into the B supply, and the tube is self-shielded by grounding its metal shell.

The L.F. Oscillator

The low-frequency 6F6 oscillator uses the plate-tickler feed-back system. The coils L_1 and L_2 are the primary and secondary of a 465 kc. i.f. transformer. The coil used for the grid must be center-tapped; many such transformers are available commercially. Condenser C_6C_6 is a 2-gang broadcast receiver condenser with a maximum capacity of about 450 µµfd. per section. The capacity across the grid coil L_1 should not be less than 100 µµfd. (2 sections of 200 each in series) as lower capacity will tend to cause frequency drift. In preference to using the low-capacity end of the tuning range of C_6C_6, one should use fewer turns on L_1 and use a second tuning range secured by switching in additional capacity, as for instance a 200 µµfd. fixed mica condenser indicated as C_4. As the voltage and frequency are moderate a small mica condenser is satisfactory.

The 6F6 is used triode-connected, as this

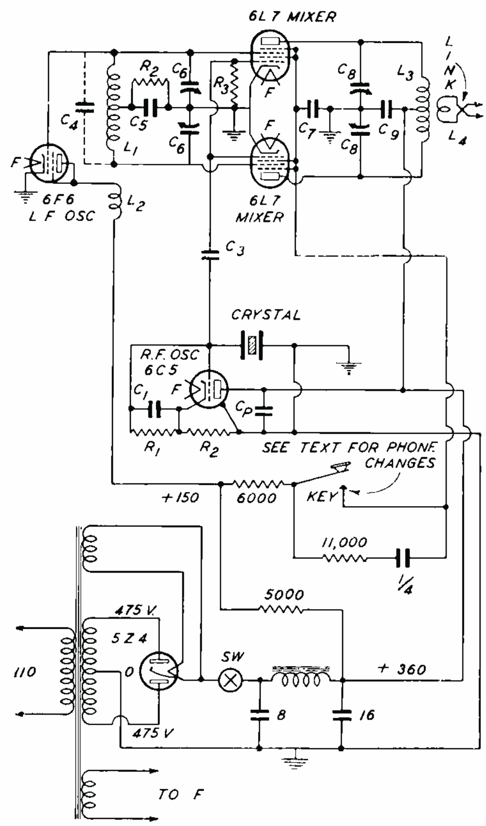


Figure 2
The Complete Circuit Diagram

C_P—Plate bypass. .001 µfd. or larger, mica
C_1—25-50 µµfd. mica
C_2—Omitted, see text and fig. 3
C_3—10-20 µµfd., mica
C_4—Pad, see text
C_5—Grid condenser, .005 µfd. or more
C_6—Receiving gang, see text
C_7—Screen bypass, .001 µfd. mica
C_8—Receiving gang, see text
C_9—Tank bypass, .001 µfd. mica
L_1 and L_2—Center-tapped secondary and primary (untapped) of 465 kc. i.f. transformer
L_3—Close wound on 1½" form, 60, 28 and 14 turns respectively for 160, 80 and 40 meter bands
R_1 and R_2—Each 50,000 to 100,000 ohms
R_3—100,000 ohms
R_4—50,000 ohms

gives a low-µ tube, which is desirable since a relatively high a.c. grid voltage is wanted, as this is the voltage used to drive the 6L7 tubes.

If used with a 40 meter crystal the lower frequency limit of this oscillator should be 200 kc. so as to space the sum and difference frequencies (in the 6L7 tubes) 400 kc. apart so that the 6L7 plate circuit tuning will suffice to select between them. With an 80 meter crystal the oscillator may be run to a lower limit of 100 kc., and with a 160 meter crystal a lower limit of 50 kc. should be maintained. It is important that only the "wanted" frequency appears beyond the 6L7 tubes as the "unwanted" frequency will in many cases fall outside an amateur band and in any case might cause interference if not eliminated. The frequency limits stated are good assurance that both frequencies will not be present in the final output at the same time.

The *upper* limit of the low-frequency oscillator is chosen for several reasons as 400 kc. Many superheterodyne receivers have an intermediate frequency in the vicinity of 450 kc. and would be troubled by a local oscillator at that frequency. Above that the broadcast band is approached. Last, but decidedly not least, stability is sacrificed as the frequency is raised. Thus a proper choice of the low frequency oscillator range coöperates with the 6L7 circuit previously described to avoid interference.

As a further step in this direction the 6L7 tubes are made non-regenerative by the method of feeding the low-frequency into their "injection" grids. These grids are connected directly to the coil L_1, and as both halves of this coil are shunted by the relatively large tuning capacity C_6, they are effectively grounded for any r.f. which may be fed back to them from the 6L7 plate circuit.

While the explanation of these various precautions is somewhat lengthy the circuit is simple in both construction and operation. The complete absence of all tricky or delicate adjustments more than compensates for the rather limited power of the 6L7 tubes. Many mixing circuits were tried but the 6L7 tubes lent themselves in the most straightforward manner to the problem. These tubes are designed to isolate the two input circuits, which results in greater reliability.

The Output Circuit

The output coil L_3 is a common plug-in coil tuned by another 2-gang receiving condenser, which should have a per-section capacity of 200 µµfd. or more. The turns of L_3 should be close-wound (not spaced) to insure good coupling throughout the coil. Particular care should be used to construct L_3 as precisely equal on the two sides of the center-tap as is possible, and very "low C" operation is not recommended because the gang condenser is likely to be unbalanced when adjusted for less than ¼ capacity. The coil dimensions are given with figure 2.

Power Supply and Keying

The conversion exciter shown in the photograph is built on a broadcast-receiver chassis, using power-supply and other parts made for receivers. In figure 2 the power supply has ac-

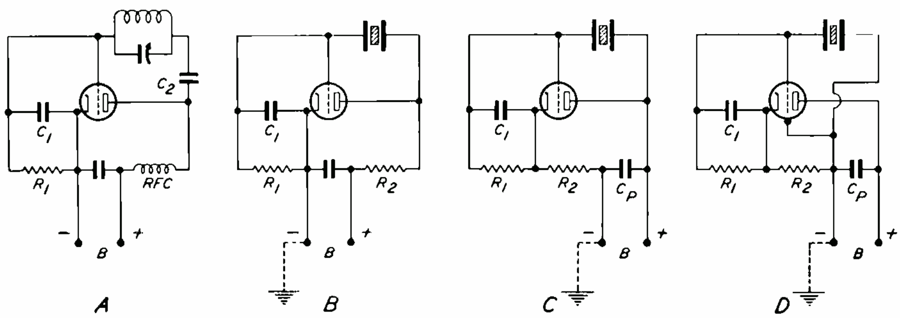


Figure 3
Development of the special crystal oscillator circuit.

cordingly been shown as a portion of the diagram, but this is not essential and the reader may use his own judgment. There is nothing critical about the voltages, or the circuit constants of the power supply or the exciter.

If there is no intention of keying the exciter, a switch may be used in place of the key as a "standby" switch, or the lead "A" may be connected directly to the "+150" point and the switch "Sw" used for this purpose. Break-in operation is possible as the crystal is off the transmitting frequency by 50 to 400 kc. and therefore usually at the opposite end of the band.

Placing the Unit in Operation

The first step is to make sure that both oscillators are oscillating. The most useful test is to place a milliammeter in series with the plate supply of the 6L7 tubes. When the oscillators are removed one at a time, each should cause a change in the 6L7 plate current. With both oscillators working this current will be about 5-7 ma. The polarity of the l.f. oscillator coils must, as always in such circuits, be right. Reversing the connections of either coil will make it right.

The adjustment of the l.f. oscillator to the proper frequency range may seem puzzling, as most amateurs cannot measure frequencies in the range of 50-400 kc. However, it is simpler than it seems. Knowing that L_1 was meant to tune to about 465 kc. with the trimmer originally supplied with it, and estimating the capacity of the trimmer, one can almost offhand set C_6C_6 to put the frequency in the neighborhood of 400 kc. If the device is then placed near a broadcast receiver its harmonics should be heard as beats with broadcast stations on 800 and 1200 kc. The first trial will find them elsewhere, but a little hunting and readjusting of the l.f. oscillator will soon locate one frequency spot, after which the oscillator may be reset to a lower frequency. When about 3 points have been found one has an idea whether turns must be removed from L_1 or capacity added across it to secure the desired range. Once the range is right the same procedure is followed to make a more permanent calibration, for it is convenient to have a low-frequency calibration as well as an output-frequency calibration if it is ever necessary to change crystals. In making these calibrations it is only necessary to remember that the harmonics of an oscillator are spaced apart by the oscillator frequency. Examples:

Osc.	*Harmonics*
410	410, 820, 1230, 1640
350	350, 700, 1050, 1400, 1750
200	200, 400, 600, 800, 1000, 1200

When both oscillators are functioning the only move left is to tune the 6L7 plate tank to either the sum or the difference frequency using a simple r.f. indicator, such as a neon lamp. The calibration of this tank is simple, as amateur frequency meters operate in this range.

More Power

The r.f. voltage appearing at the 6L7 plate tank is not high. At the RADIO laboratory it was measured with a cathode-ray voltmeter and was found to vary from 20 to 40 volts, depending upon the load across this coil. The most power was put into a 7,500 ohm load. As the 6L7 tubes draw only 5 to 7 ma. it is not surprising that this output was but a fraction of a watt. However, during the experimental work with the conversion exciter it has been found that a buffer stage consisting of two parallel 6F6 receiving pentodes gives an output of more than 10 watts when working with a 7 mc. crystal.

Another way of raising the power level is to use the conversion exciter to drive the (existing) crystal tube of a transmitter as an r.f.

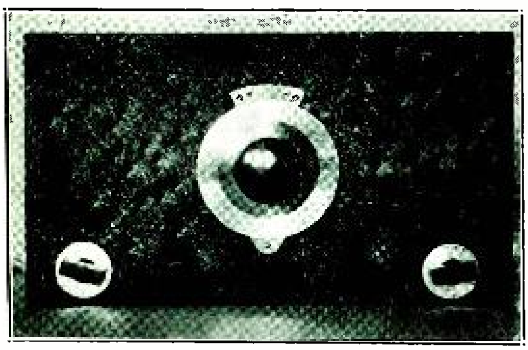
[*Continued on Page 77*]

A Super Dx Super

By David H. Evans,* W4DHZ

During the recent dx contest, W4DHZ-CBY was able to copy 100%, stations that most amateurs in that part of the country could not even hear. The success of this station in winning the contest was largely due to this advantage. Now visiting in California, Evans was prevailed upon to build up in the "Radio" laboratory a duplicate of the receiver on which he heard much of the rare dx he worked during the contest.

The original model of the receiver brought to you in this article began to materialize in the fall of 1935. What with all the new stations coming on the air, it looked as though Old Man QRM was getting ready for a banner year. So instead of spending a lot of time and energy "griping" about the crowded conditions, we applied it to developing a receiver that would do something towards bettering receiving conditions.



Front Panel Layout

The first step was to try the much-ballyhooed metal tubes, to see if they really were an improvement over the glass type. Two of these were purchased: a 6K7 and 6L7 to replace the 6D6 and 6C6 preselector and first detector respectively in the old receiver. The first improvement noticed was smoother regeneration control on the 6K7 r.f. stage. This is quite a help because the highest degree of sensitivity is reached when the tube is just under the oscillation point, and a smooth control assists greatly in achieving this condition, especially on the higher frequencies. Right away improved reception of extreme dx signals was noted, KA1HR being heard much louder than ever before. A "CQ DX" brought an answer from J2LL and several other Asians who had called us before but which we had never before been able to hear.

It was then that the decision was made to build an all-metal-tube receiver, and also to incorporate iron core i.f. transformers in our quest for the ultimate in performance. The old set was left intact for comparative test purposes.

The increase in gain and selectivity from the iron core i.f. transformers was a revelation, and the signal-to-noise ratio was noticeably improved over that of the old receiver. The latter was probably due to the fact that the iron-core transformers allowed the omission of one i.f. stage without sacrificing overall gain.

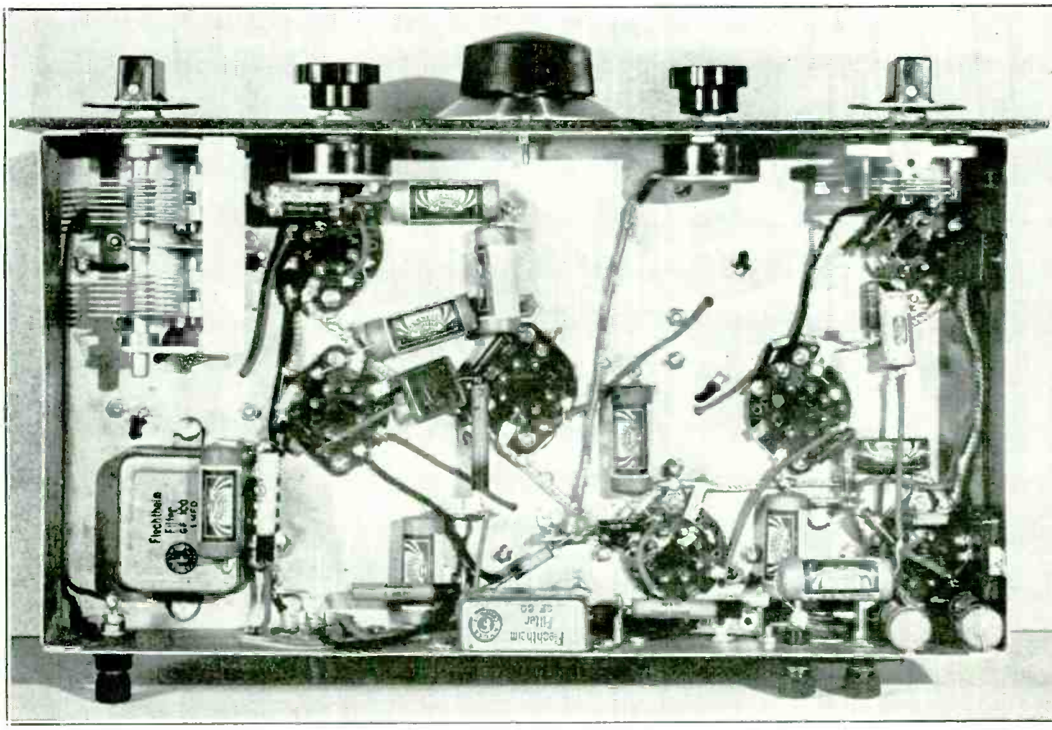
A crystal filter would have further improved the receiver, but after all, it was being built largely for work in the coming dx contest, and under most conditions better work can be done without a crystal filter in a dx test. For example: Suppose we were QSO G2PL on 14,300 kc. and he had just given an "ok" to our number, when 100 cycles or so different in frequency, F8EO is just finishing a "CQ DX". We give F8EO a call and raise him, but had a crystal filter been used we would not have even known he was on the air. Of course a crystal filter can be switched on and off, but when one is incorporated in the receiver it is a terrific temptation to use it more than when absolutely necessary.

However, a crystal filter is a very handy adjunct to any superheterodyne for general work, and space was left on the chassis for one to be put on at a later date. The addition of this unit will be covered in a future article, along with some new ideas on the operation of crystal filters.

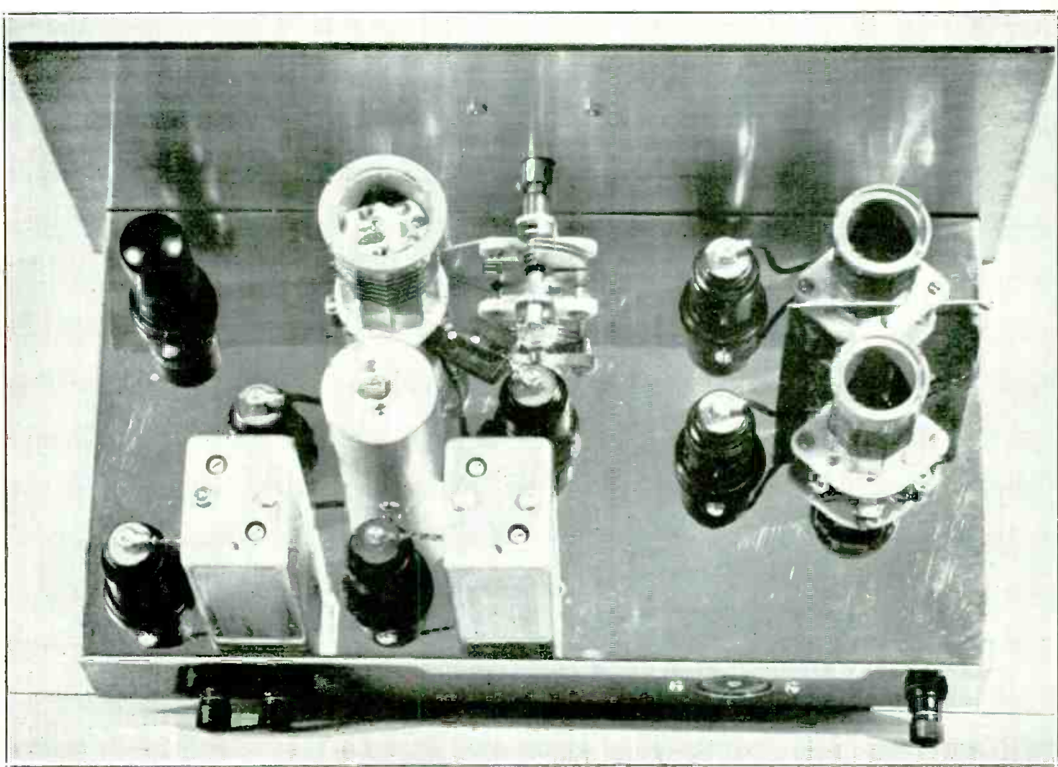
Although a.v.c. was left off the receiver for the sake of simplicity, it is not strictly a c.w. job by any means. It works well on phone, and except for the fading drawback will outperform most factory-built receivers when it comes to pulling phone signals out of the noise level.

The tube line-up finally decided upon is as follows: 6K7 r.f. stage; 6L7 first detector; 6J7 high frequency oscillator; 6K7 i.f. stage; 6J7 beat oscillator; 6J7 second detector; and 6F6 audio stage.

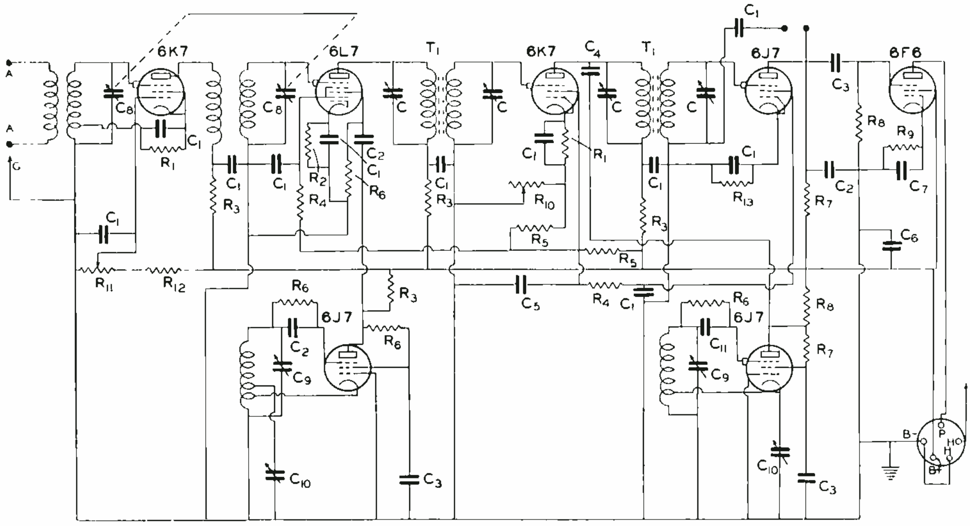
*Temporarily BT-6, address care W6QD.



Bottom View of the Receiver. Note the Shielded Wire Used for the "Hot" Filament Lead. The Carbon Resistors Are the New Insulated Type.

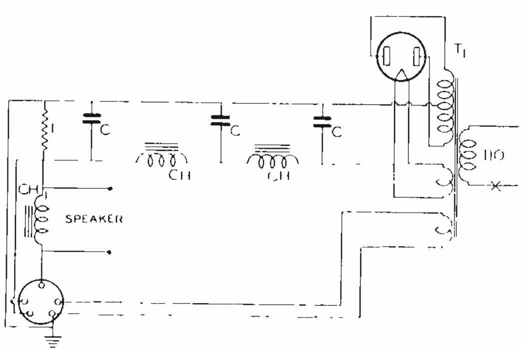


Top View of the "Works". The Blank Space Was Left for a Crystal Filter, To Be Added at a Later Date When the Best Filter Circuit Has Been Determined.



The General Wiring Diagram

C_1—0.1 µfd. tubular
C_2—.0001 µfd. mica
C_3—.01 µfd. mica
C_4—B.f.o. coupling condenser, approx. 1 turn push-back around plate lead on 6K7
C_5—0.5 µfd.
C_6—1 µfd. paper
C_7—10 µfd. electrolytic
C_8—100 µµfd. double section "Midline" midget
C_9—100 µµfd. sub-midget air-tuned
C_{10}—35 µµfd. "Midline"
C_{11}—.00025 µfd. mica midget
T_1—Iron core, air-tuned i.f. transformers, 6K7 to 6J7
R_1—500 ohm ½ watt
R_2—35 ohm ½ watt
R_3—2000 ohm 1 watt
R_4—5000 ohm ½ watt
R_5—20,000 ohm 1 watt
R_6—50,000 ohm ½ watt
R_7—100,000 ohm ½ watt
R_8—250,000 ohm ½ watt
R_9—400 ohm 1 watt
R_{10}—15,000 ohm midget pot. tapered to bias 1 tube
R_{11}—50,000 ohm midget
R_{12}—50,000 ohm 1 watt
R_{13}—25,000 ohm ½ watt



Wiring Diagram of the Power Supply

T_1—B.c.l. transformer, 60 ma., with 6.3 and 5 volt windings
C—8 µfd. electrolytics
CH—60 ma. 30 hy. chokes
CH_1—30 ma. 30 hy. choke
R—100,000 ohms, 2 watts

The r.f. and detector stages are tuned separately from the oscillator by a dual-section 100 µµfd. midget condenser which is located under the chassis directly under the respective coils. Besides having other advantages, this arrangement allows use of the receiver as a monitor, as the transmitter will not block the receiver when this condenser is detuned, and a perfect reproduction of the transmitted signal will result. This condenser is tuned by the first knob on the left, looking at the front panel.

The control on the b.f.o. is a midget 35 µµfd. condenser directly across the cathode turns. One of the rotor plates is bent slightly so as to short out the cathode turns at 100 on the dial.

Except for one change the high frequency oscillator is conventional. The plate is coupled to the second control grid of the 6L7 instead of coupling from the cathode. This results in smoother performance of the oscillator on the higher frequencies.

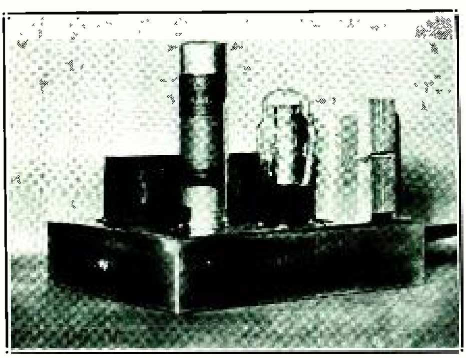
When the cathode method of coupling is used, the plate on the oscillator is bypassed to ground with a small mica condenser of about .01 µfd. This type coupling is supposed to reduce oscillator hiss, but when used in a set having separately-tuned r.f. and detector stages (regenerative r.f. stage) there is a slight pulling effect on weak signals when the stages are resonated, unless the coupling capacity is carefully adjusted in each instance, which is somewhat impracticable.

The oscillator coils are cut to their respective bands and inside each coil is put a small, sub-midget air trimmer to "put the band on the dial".

Not being able to find a b.f.o. unit of suitable size, and having quite a few spare parts lying around, a compact unit was built up to fill the requirements.

The whole unit, except for the rod for panel control, is self-contained in a shield can 1.5 x 3.5 inches. An "APC" midget condenser is about the only type that will fit, though no trouble will be encountered in mounting one of these condensers as they have insulated mounting bushings. The coil may be purchased at any well-stocked parts store. If you can't get one that is tapped about a third of the way from the ground end, you can tap one yourself. The coil, fixed mica condenser, and resistor are all mounted to the small air condenser.

Great care should be taken to do a good mechanical job, especially in mounting the parts associated with the high frequency oscillator. This adds in a big way to the stability.



The Power Supply and Speaker Coupling Unit

Care in wiring will be well-repaid in performance as well as appearance. The filament circuit should be completed before the r.f. wiring is started, and should be kept well against the chassis. It is a good idea to use shielded wire for the ungrounded filament leg, grounding the outer braid to the chassis every inch or so.

The headphone connection is taken from the second detector and has plenty of gain for a pair of phones; it does away with the tube noise of a stage of audio. The 6F6 "speaker stage" has sufficient gain that any signal above the noise level can be heard at good room volume.

The power supply is conventional, and for that reason constructional details will not be given. Just be sure to use high grade components of known quality.

A little time and care in the construction of the receiver will pay big dividends, because you will have a receiver that is hard to beat. A good receiver gives you a tremendous "edge" on the other fellow. Remember, "You can't work 'em if you can't hear 'em".

◆

Free Handbooks!

Each month we will pick at random from the latest callbook several amateur calls and list them somewhere on the "Marketplace" page among the classified ads. If the holders of the calls listed will drop a postcard to RADIO to the effect that they have noticed their call, they will be mailed free a copy of the 1936 *"Radio" Handbook*. The card must be postmarked before the 15th of the month on the cover of the issue in which the call appears.

Station WEE, world's tiniest broadcasting station, Tom Thumb brother of WLW, world's most powerful broadcasting station, was featured in Hecht Brothers' Electrical Exposition in Baltimore from April 24 to May 2.

This tiny broadcasting station is only 54 inches long, 22 inches deep and 20 inches high. It uses four hundredths of a watt power, less than the twelve-millioneth part of the 500,000 watts power used by WLW. It weighs 175 pounds, and is equipped with studios and moving orchestra. Its broadcast range is about 200 feet.

The towers which are complete in every detail including airplane warning lights, are 24 inches high. There are 1024 soldered joints in their construction, 112 steps in the little ladders that ascend them. Station WEE was built by John R. Boyle of Philadelphia. A year's time was required in its construction.

◆

A glass-drilling method said to surpass the file scheme in speed and effectiveness has been used by ZL2PN.

A short length of copper tubing is filled with fine carborundum and fastened in a hand-drill. The drill is used in the usual manner, and the size hole is governed by the diameter of the copper tubing used. A little kerosene will speed up the cutting.

◆

W2HNX uses his sister's red nail polish for marking clips, binding posts, etc. to indicate "positive" polarity. The "polish" he uses is the thick, creamy, non-transparent kind. It dries almost instantly.

Minute Men of Radio*

By Earl Jerome

The following article, taken from the Readers Digest, though not wholly accurate in detail and terminology, is a pleasant relief from the usual amateur radio story written for the layman. Such stories, which unfortunately have been notoriously few, have been largely "balled-up" masterpieces of inaccuracy, containing such flagrant factual errors as to be humorous reading for radio amateurs. This story is one of the best examples of beneficial publicity which we have seen and at the same time is of interest to the "non-amateur" reader.

If your parlor radio set is one of the all-wave kind, you may have dipped into the short-wave quadrant and fished up some such fragment of conversation as this: "Calling CQ . . . CQ . . . WRPM calling CQ and standing by . . ." No doubt you attributed them, rightly, to amateur radio operators, their handmade broadcasting kits, and their love of inconsequential gossip. You'd never guess that these rag-chewing amateurs—"hams", they call themselves—constitute a trained communication corps of incalculable value in time of disaster; they are the minute men of radio.

On March 10, 1933, Long Beach, Calif., felt the first tremor of an earthquake that crumpled walls, toppled buildings, and injured 5000 people. Fires lit the sky for 200 miles along the coast and 30 miles inshore. There were 130 dead. Relief forces were helpless without accurate information from the devastated area. But telephone, telegraph, and commercial radio were reduced to tangles of useless wire.

A Long Beach schoolboy with a brand-new amateur radio license finally broke the silence. His station was close to the shore, and rumors of tidal waves had sent most of the populace toward the hills, but he stuck to his post and kept his homemade wave on the air, giving the world its first authentic news from within the earthquake zone. Other amateurs worked through the dusk to salvage tubes, parts, and power facilities sufficient to get their stations operating. At 8:00 p.m. the first official messages went through from Mayor Harris of Long Beach to the adjutant general of the state, over Francis Sarver's amateur station W6AOR.

"Ham" emergency work then began in earnest. A five-station amateur net was set up, keeping the earthquake zone in constant communication with outside centers of rescue work. Vernon Keyes stayed on the air from 8:05 p.m. until 10:00 a.m. by hanging on to receiver and transmitter with both hands as each new upheaval rocked his home. Other hams swung into the air to keep Major Albert Jones in touch with headquarters after he had assumed control of the earthquake zone; to coöperate with the police; to broadcast messages from the injured for distant relatives and friends; to handle vital traffic with the Red Cross, the Los Angeles General Hospital, the Salvation Army, the Highway Patrol, and county relief agencies. For a solid week, radio amateurs carried the most imperative messages from the earthquake zone, winning the unstinted praise of every authority participating in the relief work.

This amazing communication system, springing into operation at the first ominous rumblings of disaster, was not created on the spur of the moment. Many of the more proficient amateurs are members of organized relay nets. There's the relay net of the American Radio Relay League, the official ham organization, an Army net and a Navy net—all amateurs. There is now a special emergency net, whose members must be equipped with their own power supply, sufficient to operate their stations when the local power system in their community fails. Each central station of such a net works with four adjacent stations—north, south, east, and west— with which communication can be established at specified times, under all weather conditions, and without serious interference. The operators are held to a high standard of efficiency; the net is kept in working trim by weekly drills over the air; each operator is pledged to preserve the secrecy of all private messages he receives or transmits, and is forbidden to accept any compensation for his services. Hams are usually glad to transmit personal messages when there are no commercial services available.

The Long Beach area is not the only community that has had occasion to be grateful for the existence of hams. Only last March, when unprecedented floods devastated the Ohio Valley and New England, the amateurs spent days and nights on end without sleep, transmitting

*Reprinted, with permission, from *Readers Digest*, issue of May, 1936.

news, family messages, and relief information into and out of the inundated regions. They were only carrying on their tradition of service that had been exemplified in the Vermont floods of 1927, when 128 persons were killed and Montpelier was completely cut off from all contact by wire, phone, rail, or truck. It was an amateur then who sent the message that brought food and supplies by plane. The New England ham net went into action, keeping the beleaguered city in touch with the outside world.

Again, when the hurricane of September, 1928, cut its deadly swath across the West Indian seas, killing 3000 persons along its path, an amateur in the Virgin Islands broadcast warnings to the United States. As a result, amateurs in Florida established emergency communication routes before the storm struck. Two amateurs in Palm Beach—Ralph Hollis, a driver for the local fire department, and Forrest Dana, a civil engineer—commandeered every dry-cell battery in town to assemble the 500 volts necessary to get their station on the air after city power had failed. Though they lost their homes and possessions in the disaster, they kept their wave on the air, and for three days furnished the only means of communication with northern points. Seven years later, after the first warning of Florida's 1935 Labor Day hurricane, an amateur carried his portable set down to the Keys. In Miami, state officials clustered about the set of another amateur. Messengers scurried in and out. With all roads and wires wrecked, the two amateurs furnished the Keys' only communication with the mainland.

In January, 1935, hams brought order out of the chaos resulting from two feet of snowfall in British Columbia in 20 hours, followed by a week of rain and sleet storms. All railroad lines into Vancouver were completely blocked, and remained so for nine days. Power and communication lines were down. Amateurs located lost trains and relief planes, provided newspapers with news, brokers with market quotations, and the general public with communication.

Back in 1917, when the United States entered the war, our fighting forces had immediate need for thousands of radio operators. To make them from plumbers, farm hands, and clerks in the time available was an insurmountable task. The organized radio amateurs were appealed to. In 60 days 4000 of the most enthusiastic and skillful radio operators the world possessed enlisted in the Army and Navy. Their record is one of the classics of the war.

Amateurs exist in their present strength largely because the powers who originally divided up the ether guessed wrong. In 1912, wave lengths below 200 meters were thought to be useless. The preferred wave lengths were divided among commercial interests, and the short waves were given the amateurs to play with. But the amateurs, inspired by the late Hiram Percy Maxim, founder of the American Radio Relay League, developed short-wave radio, and made it a useful channel for communication over the longest distances on earth. Ham pioneering blazed the trail down through the 80-, 40-, 20-, and 10-meter bands. When an amateur refers to a given "band", he means the region adjacent to the designating number—thus the "160-meter band" means 155-165-meter wave lengths. Within these bands, certain wave lengths are allotted to code, the rest to phone communications. A licensed amateur may use either code or phone within his bands; both are widely used.

Beginning in 1931, amateurs established the practical utility of 5-meter operation, which is now one of the most widely used bands in amateur radio. Contributions now are being made to the development of still shorter waves, down to 2½ meters. Amateurs taught the police the advantages of short-wave communication 14 years ago, and later convinced the Navy of its practicability.

The tremendous jump in "ham" traffic—from 17,000 licenses in 1929 to 60,000 today (of which 40,000 are in the United States)—has crowded the shorter wave lengths uncomfortably. Hence highly selective receivers have been developed which will bring in clearly the minutest variations of frequency and segregate different messages that would come in as an unintelligible babel on an ordinary broadcast receiver.

Most hams are self-taught, and amateur radio is one of the most truly democratic of American institutions. Banker and office boy, millionaire and mechanic, clergyman and clerk meet on equal terms in the ether. A movie technician on Long Island calls a barrister in New Zealand by his first name. The amateur radio clubs of Schenectady, N.Y., and Sydney, Australia, hold joint meetings over the air. Among celebrities who have succumbed to "ham fever" are Wilmer Allison, the U.S. tennis champion; Herbert Hoover, Jr.; Freeman Gos-

[*Continued on Page 78*]

A New Linear Amplifier of High Efficiency

By W. H. Doherty*

High efficiency linear r.f. amplifiers seem to be receiving a great deal of attention. Besides the Doherty amplifier described herewith and the Hawkins amplifier described last month, we know of two other well-known engineers who are working on the same general problem: namely, to reduce the plate loss in a linear r.f. amplifier when unmodulated. We hope to be able to present data on the other two systems in the near future.

The general idea behind the Doherty high efficiency amplifier is in the use of at least two separate r.f. amplifier tubes effectively in parallel. One tube runs wide open all the time and supplies the unmodulated carrier output. The second amplifier tube draws no plate current until the r.f. grid exciting voltage swings above the unmodulated value, at which time the second tube is brought into action and starts to deliver output power to the antenna. In addition, when the second tube comes into action it changes the load on the first tube, which increases the output of the first tube. The method of coupling the excitation and output of the two tubes is rather complicated and at first glance it looks as though the Hawkins amplifier will be easier to get going for the average amateur. The overall power efficiency of both the Doherty and Hawkins amplifiers is approximately the same.
—Editor.

Those who are accustomed to operating vacuum tubes at the low power levels employed in wire transmission or in radio receiving systems are frequently startled to learn of the extremes to which one must resort in the operation of power amplifier tubes in radio transmitters. The transmitting tube, far from being operated over a small linear part of its characteristic, is subjected to large alternating grid voltages which cause the plate current to be zero over approximately one half of the radio-frequency cycle, and frequently to reach the saturation value determined by filament emission on the other half-cycle, with accompanying large grid currents. This extreme mode of operation makes possible much larger power outputs than could be obtained if operation were confined to the linear part of the tube characteristic.

Figure 1 shows the circuit of a simple form of the conventional radio-frequency power amplifier, in which two tubes are connected in parallel and coupled to the transmitting antenna. The coupling circuit is so tuned as to be equivalent to a pure resistance load of the desired value over the relatively narrow transmission band occupied by the carrier and the side-frequencies due to modulation, while for frequencies much lower or much higher than the carrier, the impedance of the circuit is very low. Hence, although the radio-frequency plate current wave contains large harmonic components due to the extremely non-linear operation of the tubes, only the fundamental component encounters any appreciable impedance, so that the plate voltage wave is very nearly sinusoidal. The power delivered by the tubes to the circuit is therefore almost entirely at the fundamental frequency. High-quality amplification of a modulated wave then requires merely that the fundamental component of the plate current be proportional to the radio-frequency grid voltage. It turns out that if the tubes are biased nearly to the cut-off point, so that plate current flows only during the positive half-cycle of the alternating grid voltage, a close approximation to this requirement of proportionality is readily obtained.

Under these conditions, which are represented in figure 2, most of the plate current flows while the plate potential is near its minimum value, and if this minimum value is sufficiently low, i.e., if the amplitude of the plate voltage wave is sufficiently great, the power lost in the tubes—which is proportional to the product of instantaneous plate voltage and current—will be small, and the efficiency correspondingly high. The efficiency is, in fact, very closely proportional to the amplitude of the plate voltage swing. By permitting the plate voltage to swing down to a value as low as 10 or 15 per cent

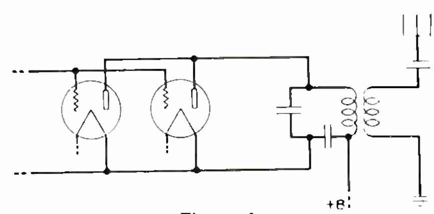


Figure 1
Radio-frequency power amplifiers are coupled to the load by tuned circuits which present a very low impedance to the tubes at harmonics of the carrier frequency.

*Bell Telephone Laboratories.

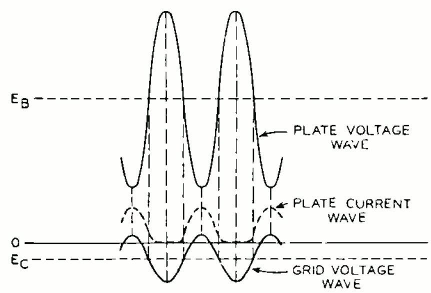


Figure 2
Most of the plate current of a power amplifier flows while the plate potential is in the vicinity of its minimum value, so that the tube loss can be made small by using a plate voltage swing of large amplitude.

of the applied d.c. plate potential, large power outputs may be obtained at an efficiency of 60 to 70 per cent; but unfortunately such large amplitudes correspond only to the peaks of modulation, and since these peaks at 100 per cent modulation have amplitudes of twice the carrier amplitude, the plate voltage swing for unmodulated carrier must not be more than half of its peak value.

The efficiency of the conventional power amplifier, then, is but 30 to 35 per cent when the carrier is unmodulated, and only slightly more for the average percentage modulation of the usual broadcast program. An efficiency of 33% means that the d.c. power supplied to the plate circuit of the amplifier must be about three times the carrier output, and two-thirds of this input power has to be dissipated at the anodes.

With power levels of 50 kilowatts and higher becoming almost commonplace in radio broadcasting, it has become very important to find means for increasing efficiency to reduce the cost of power. Since early in 1934 a succession of tests has been conducted at the Whippany Laboratory on a new power amplifier circuit in which the usual practice of dividing the load equally between the tubes at all times was discarded. The idea was conceived that by obtaining the power from a reduced number of tubes up to a certain point—in particular, the carrier output—these tubes could be operated at this point at their maximum plate voltage swing, and consequently at high efficiency; then if the remaining tubes were brought into action in a certain manner they would not only contribute to the output, but would so change the operating conditions for the original tubes as to permit the latter also to increase their output power without having to increase their output voltage.

Figure 3 shows schematically the method of connecting the tubes to the load in the new high-efficiency circuit. V1 and V2 are two tubes that in the conventional amplifier might have been connected in parallel with a circuit whose impedance, for the fundamental frequency, may be represented by the resistance R. In the new circuit a network N is interposed between R and V1, the tube which is to deliver the carrier power. This network is the equivalent of a quarter-wave transmission line, and like such a line has the interesting property that its impedance as measured at one end is inversely proportional to the impedance which is connected at the other end.

For all values of grid excitation from zero up to the carrier level, V2 is prevented by a high grid bias from having any plate current, and the power is obtained entirely from V1. The network N is so designed as to present to V1 an impedance so high as to require this tube to operate at nearly its maximum possible radio-frequency plate voltage swing in order to deliver the carrier power. The efficiency at the carrier output is accordingly high, and may be from 60 to 70 per cent.

If we were to plot the current in the load impedance R against the radio-frequency voltage applied to the grids of the tubes, as in Figure 4, the curve would be quite linear up to the carrier point A and then, if V2 were not allowed to come into action, would flatten off along a path AB because the plate voltage swing on V1 has attained its maximum value.

By permitting V2 to begin coming into play at point A we obtain a twofold action: V2 not only contributes power to the load, but in coming into play in parallel with R it effectively increases the impedance in which the network N is terminated. This increase in terminating

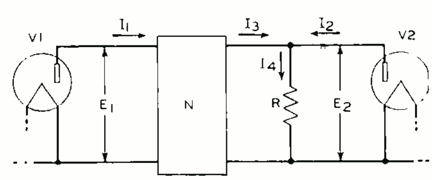


Figure 3
In the high-efficiency circuit, an impedance-inverting network, N, is inserted between one of the tubes and the load.

impedance, by virtue of the inverse characteristic of this type of network, results in a decrease in the impedance presented to V1, so that the radio-frequency plate current, and hence the power output, of V1 may increase without any increase in its alternating plate voltage, which was already a maximum at point A.

As the grid excitation on the tubes increases beyond its carrier value e_0, V2 contributes more and more power to the circuit and thereby permits V1 also to supply more power, until at point C, which corresponds to the instantaneous

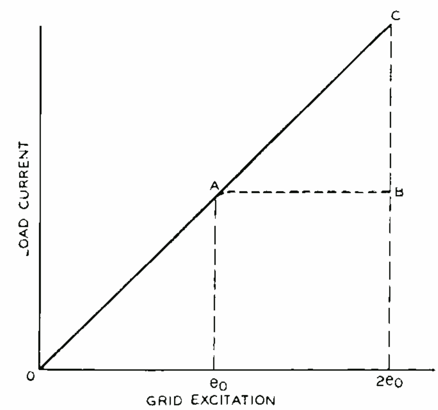


Figure 4

If the second tube were not permitted to come into action at the carrier excitation e_0, the load current could not increase and would follow the path OAB.

peak of a completely modulated wave, half of the power in R is being contributed by V2. The network N is at that instant effectively terminated in 2R ohms instead of the original R ohms, and the impedance presented to V1 is half of its original value, permitting V1 to deliver twice its original output power with no increase in its output voltage. The total power in the load, then, at the peak of modulation is the required value of four times the carrier power, corresponding to an increase in load current to twice its carrier value.

It is a characteristic of networks having the impedance-inverting property of network N that a definite current at either pair of terminals is associated with a definite voltage at the other pair of terminals, entirely without regard to the terminating impedances. From this rather remarkable property we may deduce that if the output voltage E_1 of tube V1 is linear with respect to the grid excitation up to the carrier excitation e_0 of figure 4, and then remains constant up to the peak excitation $2e_0$, then the current I_3 fed into the load from network N behaves similarly, as shown in figure 5(a); whence, in order to have the total load current I_4 linear with respect to grid excitation, the current I_2 fed into the load from tube V2, which is zero at the carrier point, must rise linearly beyond this point and be equal to I_3 at the peak of modulation.

From this same property of network N we also deduce that if the voltage E_2, across the load and the second tube, is linear with respect to grid excitation, then the current I_1 fed into network N by tube V1 must also be linear. Figures 5(a) and 5(b) therefore give the complete picture of the conditions existing at the plates of the two tubes for all values of radio-frequency grid input voltage to the amplifier, and the behavior of each tube during the modulation cycle may be studied by considering the grid excitation to vary at audio frequency about its average value e_0, to the extent corresponding to the percentage modulation.

When samples of the radio-frequency plate potentials on the two tubes during modulation are viewed on the screen of a cathode ray oscilloscope the patterns are of the shape shown in figure 6. Patterns (a) represent the envelope of the plate potential of V2, which, being directly associated with the load, is required to be sinusoidal when the modulating signal is a pure tone. Patterns (b) show the envelope of the plate potential of V1, which, though sinusoidal over the negative half of the modulat-

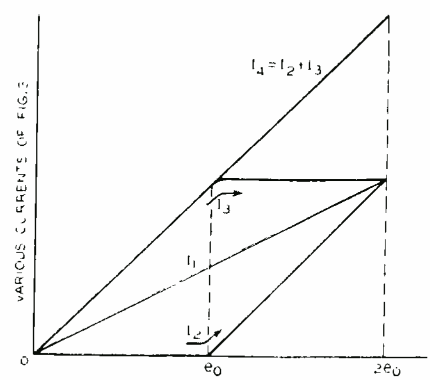


Figure 5-A

The current I_2, furnished to the load by tube V2, supplements I_3 to make the total load current linear with respect to the grid input voltage.

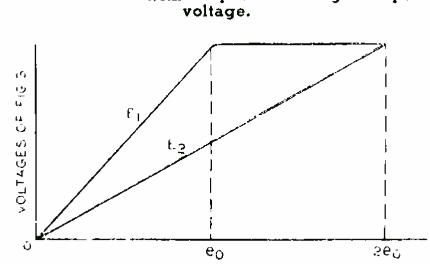


Figure 5-B

As the grid excitation is modulated about its carrier value e_0, the plate potential of tube V-1 does not respond to the positive half-cycles of modulation, since it has reached its maximum value at the carrier output.

ing cycle, is twice as high as that of V2 over this range, and being unable to increase appreciably beyond its carrier value, remains flat during the upper half of the cycle of modulation.

The network N employed to obtain the impedance inversion may be one of a number of networks of which an example is given in figure 7. They always have a 90-degree phase shift, which means that the plate potentials on the two tubes are always in quadrature. This requires the insertion, in the grid circuit of one or the other of the tubes, of another 90-degree network in order that both tubes may be excited from the same source. The complete amplifier then assumes one of the forms indicated in figure 8.

The numerous tests conducted on the high-efficiency amplifier at various power levels have been uniformly successful, and the new circuit is being incorporated in the new high-power broadcasting equipment of the Western Electric Company. The overall efficiency obtained in the tubes and output circuits is 60 per cent for unmodulated carrier and a few per cent higher with complete modulation. This represents a reduction in the plate power consumption of the final stage of a radio transmitter by nearly a factor of two, as compared with the power required by an amplifier of the conventional type. A 50-kilowatt amplifier, for example, with 33 per cent efficiency, would require a d.c. plate input of 150 kilowatts, of which 100 kilowatts would be dissipated at the anodes of the water-cooled tubes. With the new circuit the power input for unmodulated carrier is 83 kilowatts, and the dissipation accordingly only 33 kilowatts, permitting a considerable saving in the water cooling system as well as in power requirements. These items are of great importance in modern high-power broadcasting where the cost of apparatus and power constitutes a large part of the operating expense.

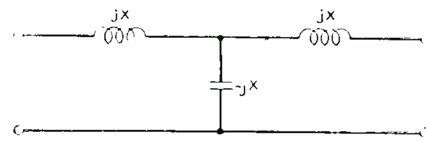


Figure 7
A section of simple low-pass filter at 0.7 times the cut-off frequency consists of three equal resistances, and has a 90° phase shift and the desired impedance-inverting characteristic.

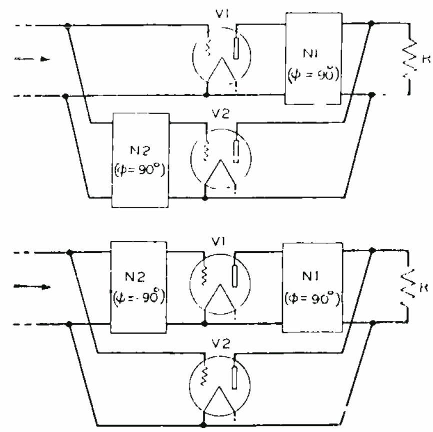


Figure 8
With a 90° phase shift in the plate circuit of one tube, a compensating phase shift must be inserted in the grid circuit of one of the tubes so that both tubes may be excited from the same source.

By the application to radio transmission of another Laboratories development, the feedback principle* of H. S. Black, to reduce the effects of non-linearity in the amplifier characteristics, the new high-efficiency equipment has been made to perform with a quality of transmission which satisfies the most rigorous requirements of high-fidelity broadcasting.

Finally, the new circuit, being purely an amplifying scheme, can be applied to special types of transmission, such as the single-sideband transmission employed in the transoceanic service of the Bell System. Other schemes that have been proposed for improving the efficiency of broadcasting radio transmitters do not appear to be of such broad applicability.

◆

The Chinese Calling Radio Club of China, consisting entirely of native Chinese amateurs, conduct a QSL bureau and are glad to forward cards and messages. Address cards to XU8CC.

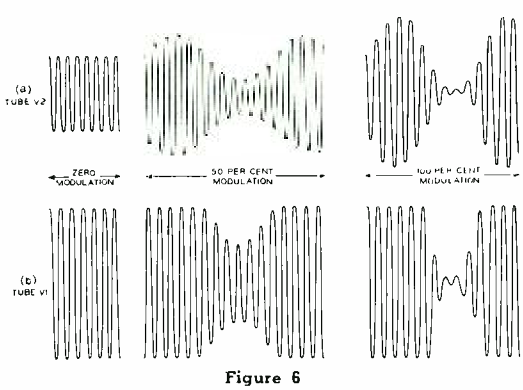


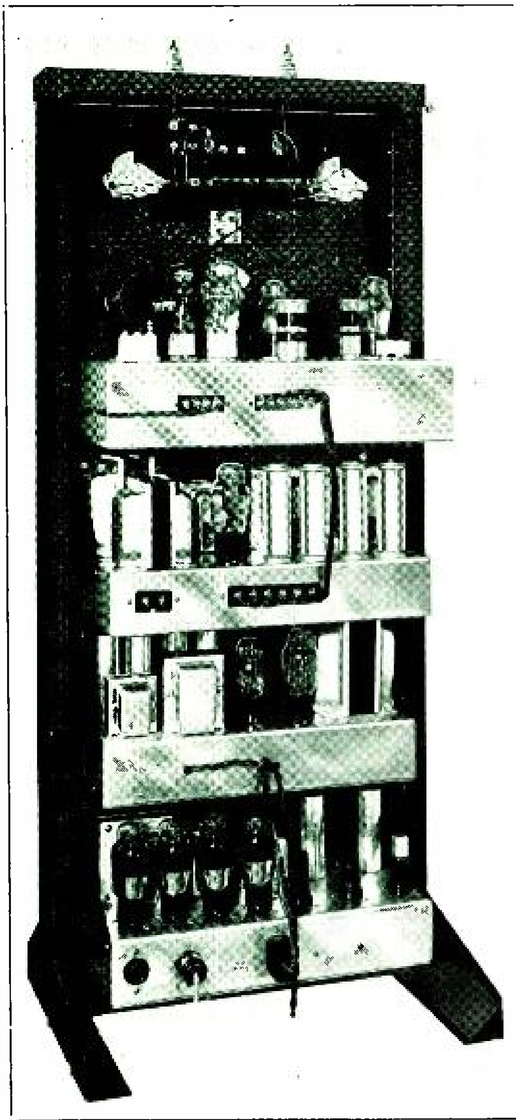
Figure 6
Cathode ray oscillograms of the plate potentials of the tubes.

*Record, June, 1934, p. 290.

New 50 Watt Transmitter Kit

The following story is a "prevue" of the new Inca RF-50 phone-c.w. transmitter kit soon to be released. The laboratory model gave a very good account of itself when tested at "Radio". The results of the tests are given herewith, along with a general description of the transmitter.

Much time and labor may be saved in the construction of an amateur transmitter by purchasing one of the several transmitter kits now offered by various manufacturers. Much of the time that ordinarily would be spent in laying out parts and drilling holes is thus saved, and one does not have to worry about design or "bugs" because that part of the work has already been done by competent engineers.



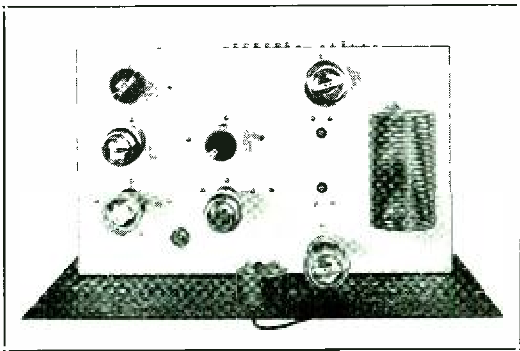
One of the newest kits that has come to the attention of RADIO is the Inca 50-watt phone-c.w. transmitter kit. On phone an output of 50 watts on 20, 75, and 160 meters is obtained, 100% modulated, and on 10 meters an output of 35 watts is available for those interested in that band. The foundation unit consists of a drilled and punched relay-rack, with chassis and panels; and all transformers and chokes used in the power supplies and speech system. Other components are standard items of well-known makes and may be purchased individually at any large amateur supply house. If parts of the same manufacture as specified in the instruction sheet are used, they will match the holes in the rack and panels exactly, and mounting will be an easy job. A screwdriver, sidecutters, and soldering iron will be the only tools needed to assemble the transmitter.

The approximate cost of a complete radiophone transmitter assembled from this foundation kit will run $175 or so, including all coils, tubes, crystals, microphone, etc. This is but little more than one would pay for the necessary components for a haywire "breadboard" rig of equivalent output and performance.

A transmitter constructed from the Inca foundation unit was tested in the RADIO laboratory and the quality was excellent and output all that could be desired from a 210 transmitter. The transmitter was "air tested" on the 20, 75, and 160 meter phone bands with very gratifying results.

Examination of the circuit will show the circuit to be straightforward and devoid of any "trick" arrangements that might cause the builder trouble. The receiving-type tubes are inexpensive and perform their functions at a minimum of cost per watt of carrier. Tuning is not critical; the buffer-doubler is self-neutralized and the final stage, with its split-stator condenser, need be neutralized but once, the adjustment holding for all bands.

Although the circuit shown in figure 1 will reach 10 meters (with a 20 meter crystal), the



Top view of the r.f. unit, showing layout of parts.

arrangement of figure 2 is recommended if operation on this band is contemplated. If one is not interested in 10 meters, the circuit of figure 1 allows a simpler and more inexpensive layout. Using a 20 meter crystal in the circuit of figure 1 to reach 10 meters is permissible, but a 40 meter AT-cut crystal in the circuit of figure 2 will be found much more satisfactory for 10 meter operation.

The power supply delivers 525 volts at 200 ma., and is provided with separate plate and filament transformers. The full power supply voltage is applied to the ceramic-base type '10's, which normally are loaded to draw about 130 to 140 ma. Bakelite base '10's could be used, but the ceramic base type cost but a few cents more and are not prone to blister in the base as regular '10's sometimes will on 10 and 20 meters. Two terminals are provided in one leg of the plate transformer primary to allow "on-off" control from an external switch, which may be placed beside the receiver at the operating position.

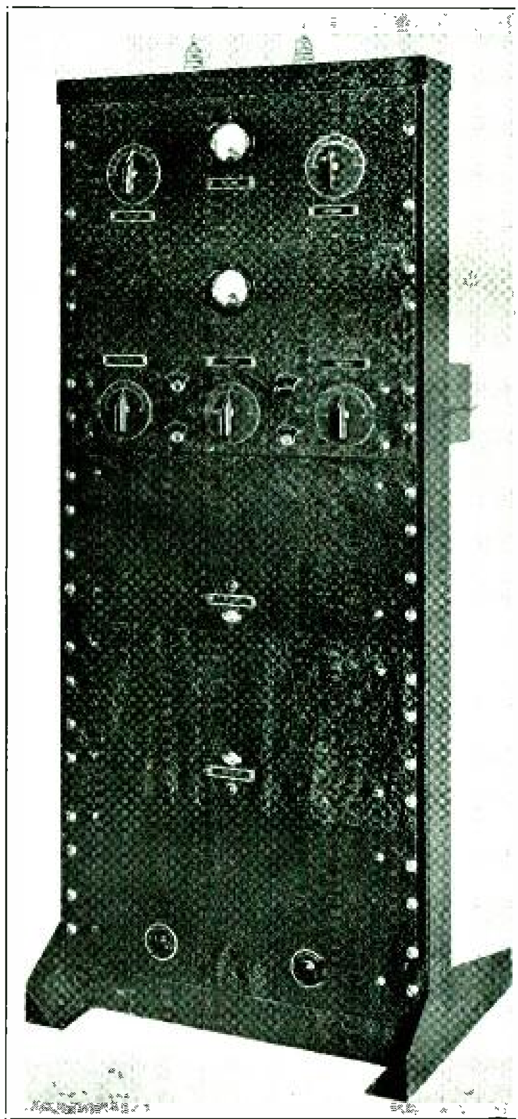
The final amplifier grid circuit is operated self-tuned except on the 160 meter band, where a small trimmer condenser is mounted inside the coil form to allow fewer turns on the coil. The coils for the final tank are self-supporting and may be obtained ready-made as a complete set.

A novel scheme is used for converting the 6A6 buffer from a push-push doubler to a straight neutralized amplifier. Condenser C_6 blocks off the d.c. from the one plate when the switch is open, yet leaves the effective circuit capacities practically unchanged. Opening the switch permits operation of the 6A6 as a straight neutralized amplifier, the "dead" section acting as a neutralizing condenser for the other triode section.

Construction

The r.f. unit is mounted on a cadmium-plated chassis which bolts to a standard 19" panel. All component parts excepting the tank coils, tubes, and crystal are mounted inside the chassis. The condenser shafts, excepting that of the final stage, which is at ground potential, are extended through the panel by means of couplings and quarter inch bakelite rod.

The power supply terminals are brought out to a strip in the rear of the chassis, as are two additional pair of terminals: one pair in the final center-tap, for keying, and a pair in the final amplifier plate lead to receive the output



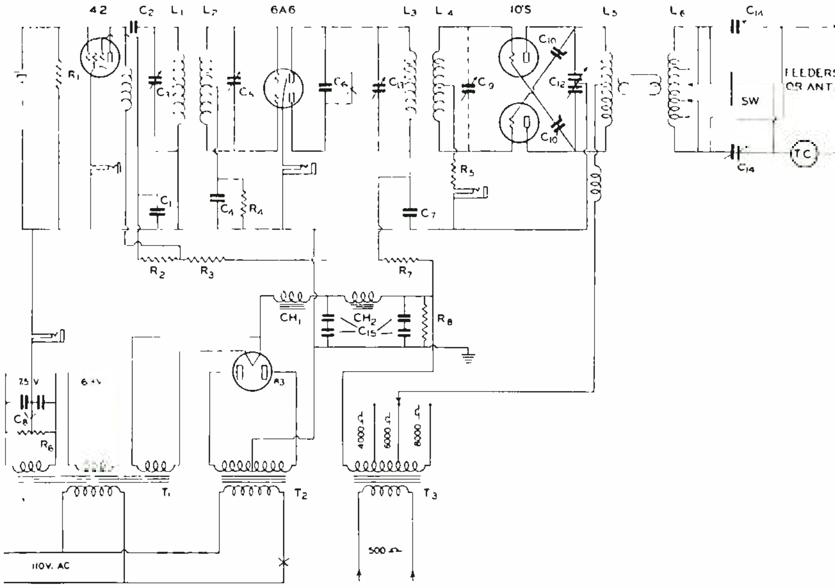


Figure 1

Wiring Diagram of the R.F. Portion and Associated Power Supply

R_1—50,000 ohms, carbon, 2 watts
R_2—50,000 ohms, 2 watts
R_3—5000 ohms, 10 watts
R_4—1500 ohms, 2 watts
R_5—10,000 ohms, 10 watts
R_6—40 ohms, c.t.
R_7—1000 ohms, 10 watts
R_8—50,000 ohms, 10 watts
C_1—.002 µfd. mica
C_2—.002 µfd. mica
C_3—100 µµfd. midget
C_4—.002 µfd. mica
C_5—100 µµfd. midget
C_6—.01 µfd. mica
C_7—.002 µfd. mica
C_8—.002 µfd. mica
C_9—Trimmer condenser inside 160 m. coil form
C_{10}—18 µµfd. neutralizing condensers, double spaced
C_{12}—100 µµfd. (200 per section), 3000 volt spacing
C_{13}—100 µµfd. midget
C_{14}—250 µµfd.
C_{15}—8 µfd. electrolytics
CH_1—8-40 hy. swinging choke, 350 ma.
CH_2—20 hy. smoothing choke, 350 ma.
T_1—Filament transformer with 5 v., 6.3 v., and 7.5 v. windings
T_2—700 v. each side c.t., 120 watts
T_3—Modulation transformer (500 ohms to class C stage)

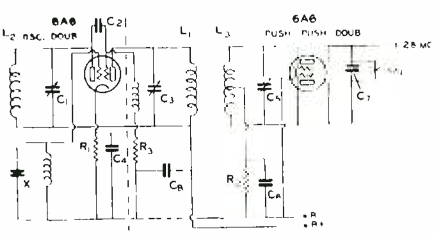


Figure 2

Optional Exciter Circuit (Allows 10 Meter Operation from a 40 Meter Crystal)

C_1—100 µµfd. midget
C_2—100 µµfd. mica
C_3—100 µµfd. midget
C_4—.01 µfd. mica
C_5—100 µµfd. midget
C_6—.002 µfd. mica
C_7—.01 µfd. mica
C_B—.01 µfd. mica

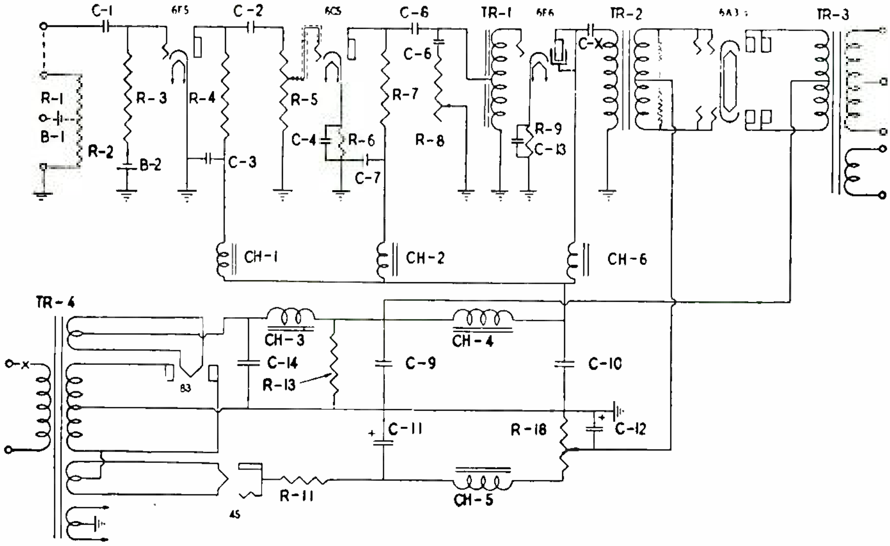
of the modulator. Amphenol Steatite sockets are used throughout, as they are particularly easy to mount directly on a metal chassis. The several "floating" variable condensers are mounted with small angle brackets on midget stand-off insulators.

The layout is such as to facilitate short direct leads where they are important. Number 12 bus wire is used for wiring in order to provide rigidity and low-resistance connections. A heavy copper ground bus runs from one side of the crystal socket to the final tank condenser, and all ground connections are made to this bus. Short grid leads are important, but so are short *return* leads.

The A. F. System

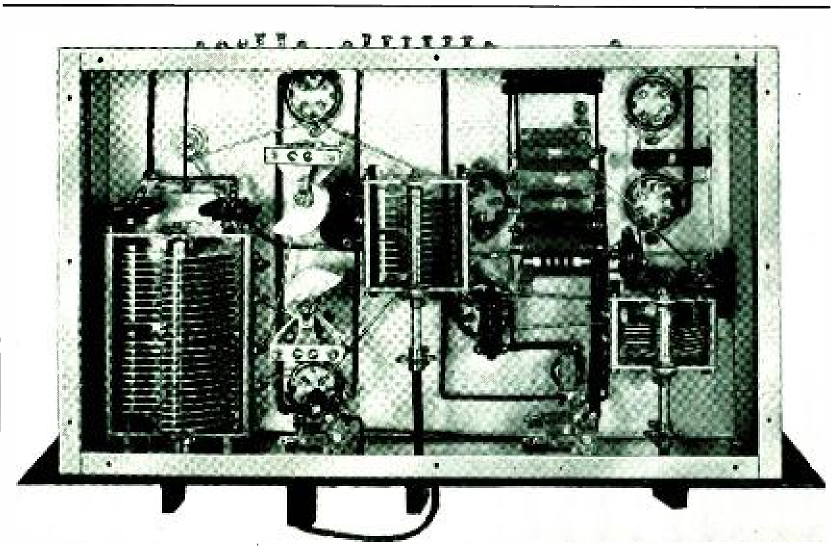
The audio system utilizes a standard Inca 30 watt amplifier kit with 500 ohm output. This is matched to the r.f. load by the modulation transformer, which has a 500 ohm primary and 4,000; 6,000; and 8,000 ohm taps on the secondary, making it possible to match almost any possible combination of r.f. amplifier loading. The gain is sufficient for working out of the common types of diaphragm crystal microphones, and the input is designed for either this type microphone or a two button carbon microphone, though with minor modifications most any type microphone may be used.

For those who have on hand and wish to use 2.5 volt tubes in the r.f. portion, the 6.3 filament winding has been tapped at 2.5 volts,



Audio Channel

R_1, R_2—200 ohm ½ watt
R_3—2 megohm ½ watt
R_4—250,000 ohm, 1 watt
R_5—500,000 ohm, volume control
R_6—3,000 ohm, 1 watt
R_7—100,000 ohm, 1 watt
R_8—250,000 ohm, tone control
R_9—750 ohm, 1 watt
R_{11}—25,000 ohm, 3 watt
R_{13}—50,000 ohm, 3 watt
R_{18}—20,000 ohm, 10 watt semi-variable
C_1, C_2, C_8—0.1 µfd. paper (400 v.)
C_3, C_7—16 µfd. (or dual 8 µfd.) electrolytic in cans (450 v.)
C_4, C_{13}—10 µfd. 35 v. electrolytic
C_6—.01 µfd. 400 v. paper
C_9, C_{10}, C_{14}—8 µfd. wet electrolytic in cans (450 v.)
C_{11}, C_{12}—Dual 8 µfd. electrolytic in can (450 v.) (must have separate negative leads)
Cx—0.25 µfd. 400 v. paper



Left

Under side of r.f. unit chassis. Note that most of the r.f. components are "downstairs". This arrangement allows short and symmetrical r.f. leads. If the "optional" exciter unit is used the layout will differ from that shown, though the general arrangement will be the same.

and is of sufficiently heavy wire to carry the extra current drawn by 2.5 volt tubes. Thus a 2A5 and 53 may be used in place of a 42 and 6A6.

A 0-200 milliammeter is patched into the grid circuit of the '10's or any of the plate circuits by plugging it into any of four insulated jacks. The jacks were first connected in the cathode circuits to allow grounding of the jacks (simplifying mounting) but this system was not altogether satisfactory, and the jacks were therefore insulated and connected directly in the various plate circuits.

The commercial output rating of the audio system is 30 watts, but actually the amplifier will modulate as high as 80 watts input to a class C stage with negligible distortion.

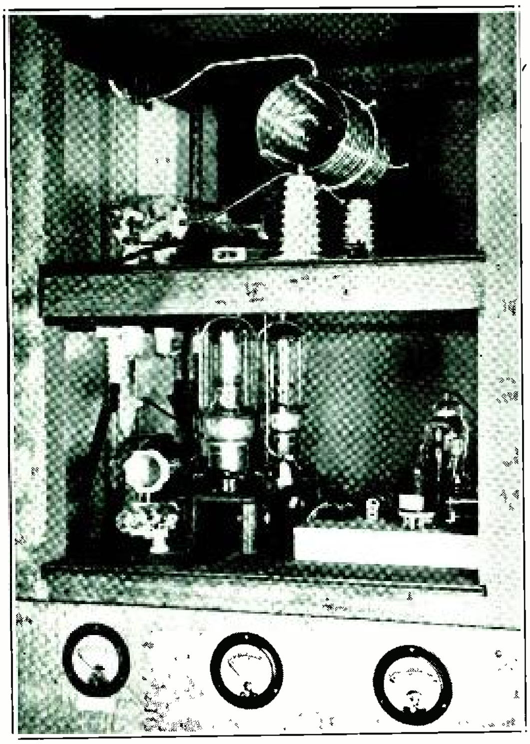
If one wishes to increase power a pair of large tubes can be added in a linear amplifier stage. Then, when one can afford a high power class B modulator, still more carrier power can be realized. The low impedance of the push-pull parallel 6A3's makes them ideal drivers for the high power class B modulator stage when and if it is added. Thus nothing in the transmitter is discarded when going to higher power.

A High Power, Controlled Carrier Transmitter

By Carl H. Jones,* W6SE

Upon noticing that the quality of W6SE's controlled carrier signals was consistently excellent, that he had an outstanding signal by contrast with most controlled carrier signals, we asked Jones for his "prescription". He explained that the main idea is to use not too much "control", and to use a system that "takes hold fast". He further obliged us with the following description of his rig.

Controlled carrier is a means of varying the mean plate voltage of a modulated amplifier so as to maintain heavy modulation at all times. The mean plate voltage is varied so that it is always equal to (or slightly greater than) the peak audio voltage supplied by the modulator. Under this condition, high percentage modulation will occur regardless of the speech level.



Front View of the Linear Amplifier with the Panels Removed

This arrangement is desirable for several reasons. Since the average modulation percentage of a phone transmitter is around 15 to 20% it is obvious that most of the time the station is on the air a large percentage of the carrier is wasted, causing heterodyne interference. This is avoided in the carrier controlled transmitter by reducing the carrier to just that needed for the audio power used. In addition to the saving in power and reduction in QRM, the tubes run cooler during periods of no audio input and low speech level, giving longer tube life.

While controlled carrier may be used with good results on any modulated amplifier, the maximum result is obtained by using a linear amplifier after the modulated stage so that high power may be used without costly modulating equipment. With this arrangement, relatively low power tubes may be used in the modulator, modulated amplifier and control circuits.

A circuit of the controlled carrier transmitter at W6SE appears in the diagram. Radio frequency excitation is supplied for the class C amplifier tube, V_1, which is modulated by the modulator tubes, V_5. The modulator is conventional and is capable of supplying audio power equal to half the peak plate input to the modulated amplifier. Following the modulated amplifier is a class B linear amplifier, shown as two tubes in push-pull. Operating as a controlled carrier linear stage, its plate input varies according to the audio frequency input level to the modulated stage. Across a portion of the linear amplifier grid coil is the usual "swamping" resistor used to absorb most of the output from the modulated amplifier and to stabilize the linear stage.

A control unit is used to keep the modulated amplifier mean plate voltage equal to the modulator audio peaks. The output tubes of this unit are in series with the plate supply of the modulated amplifier.

Operation of the control unit is as follows: Audio voltage from the speech amplifier is rectified by the full-wave rectifier tube, V_3, and filtered by the condenser, C_1, and resistor, R_1. The voltage across R_1 opposes the C bias voltage so that when there is an audio signal in the system the total bias is reduced in proportion to the volume level of the signal. Variations in bias on V_2 change its plate resistance, caus-

*2463 McCready Ave., Los Angeles, Calif.

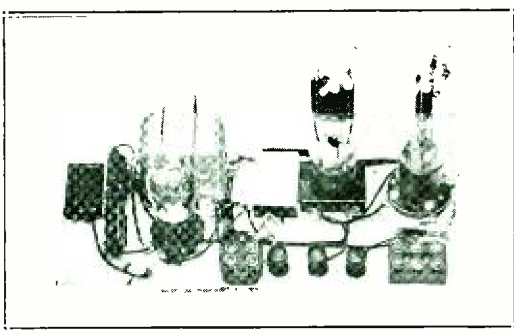
ing the plate voltage of V_1 to vary accordingly. Since V_1 is being modulated at the same time, its plate voltage will vary according to the audio output of the modulator. C_2 is a bypass condenser used to keep audio from the modulator out of the control circuit.

Across the plate circuit of the modulated amplifier is an over-modulation indicator, consisting of a half-wave rectifier and a low-range milliammeter.

The first consideration in building a carrier controlled transmitter is the maximum power output and the type tubes to be used in the linear stage. For the purpose of this article a transmitter will be considered which has a maximum power input of one kilowatt to the linear amplifier.

Tests showed that a pair of HK354 tubes in the linear stage would take peaks of 1 kw. at 3000 volts. Since the power output of a 100% modulated transmitter consists of approximately 1/3 sideband and 2/3 carrier (depending on the wave form of the modulating signal) there will be about 330 watts of carrier and 165 watts of sideband power during periods of complete modulation.

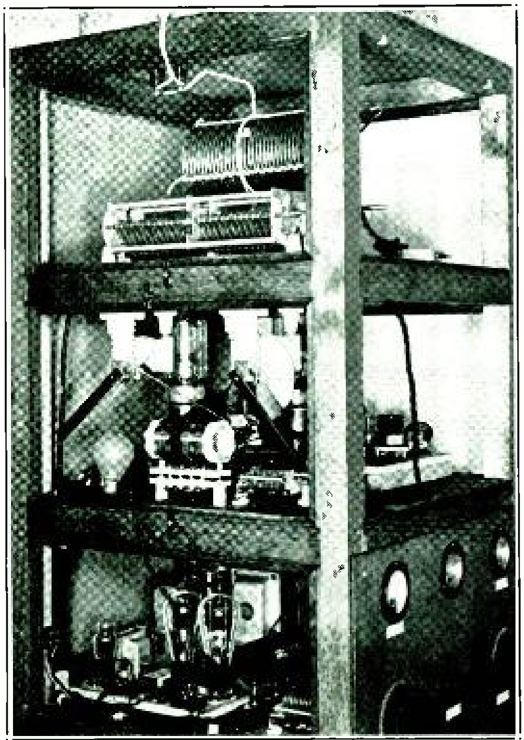
With no audio input the linear amplifier efficiency is very low, but the plate input is reduced by the control tubes to a point where the plate dissipation is below the tube rating. The control tubes could be biased so that no carrier would be radiated. However it is neither



Control Unit

Farthest left is C_1. Next are the two condensers, C_3. The 84 is seen in front of the input transformer, and to the right is R_1. Between the transformer and the 50's may be seen C_2.

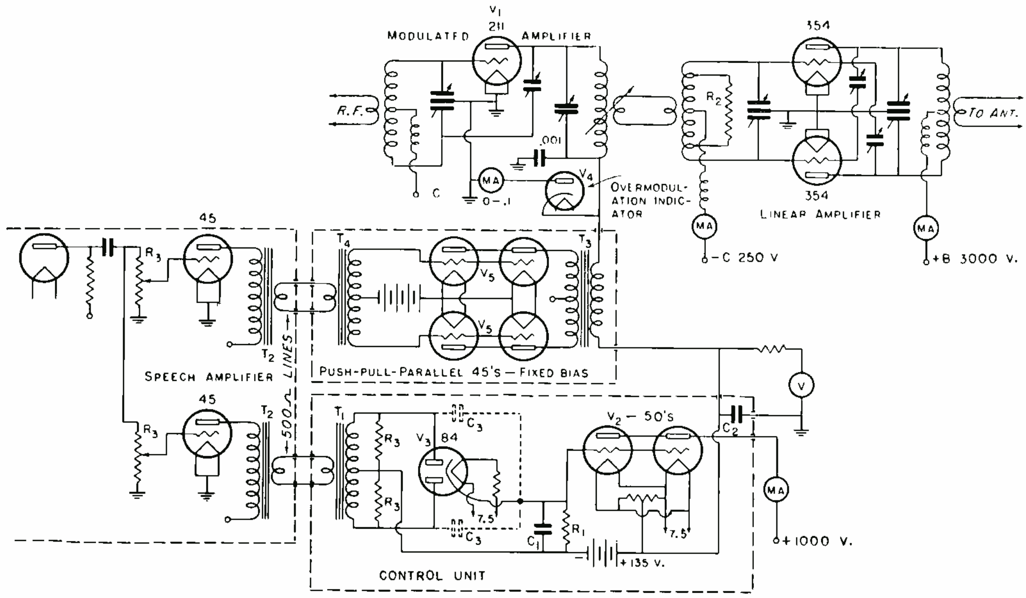
desirable nor necessary to carry the control to this point. There are several reasons why there is a definite limit to the amount the carrier should be reduced. First, the final power supply would have to have extremely good regulation from zero to one kw. input in order to



Side View of the Transmitter

prevent non-linear distortion. This is also true of the power supply for the modulated amplifier. Second, there would be an undesirable action at the receiving station. The a.v.c. would allow the background noise to come up between words and sentences, and the beginnings of words would be accented due to the receiver being made more sensitive by the a.v.c. when the carrier was reduced. Third, there are certain limitations of the control circuit which would cause over-modulation at the beginning of each word. This is due to the lag in the rectifier-filter circuit of the control unit, which causes the modulator plate voltage to rise slower than the audio frequency modulator voltage. If, however, there is already some plate voltage on the modulated amplifier, it will take an appreciable length of time for the audio frequency voltage to rise to this value. During this interval the control circuit increases the plate voltage with the result that the lag is compensated for by the "margin" of plate voltage.

For these reasons the carrier should not be reduced more than is necessary to limit the plate dissipation of the linear amplifier. The



The Carrier Control System

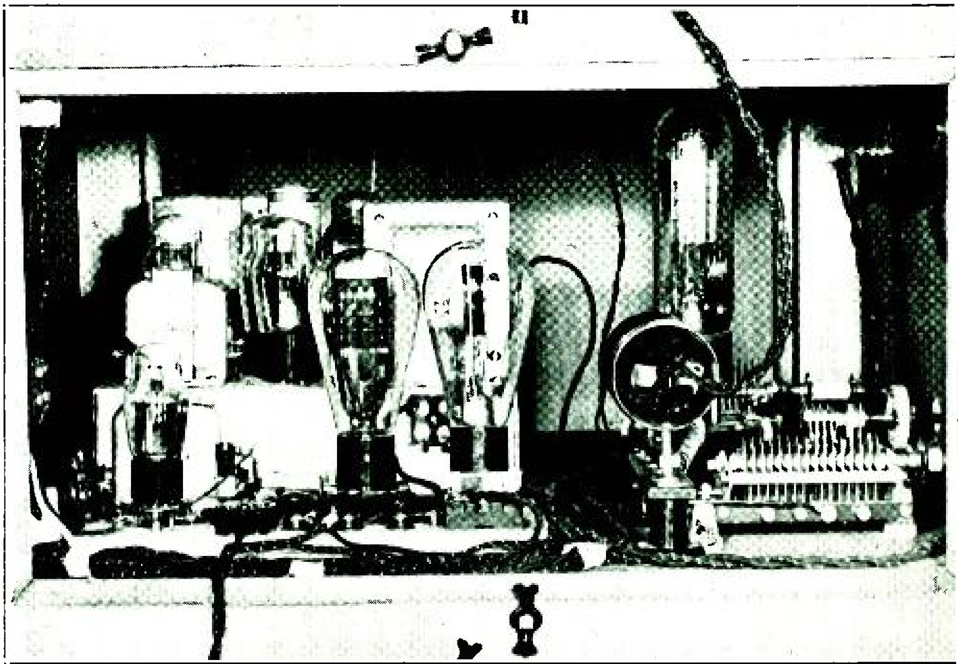
C_1—0.5 µfd.
C_2—1 µfd.
C_3—.002 µfd. (necessary only if trouble from r.f.)
R_1—30,000 ohms
R_2—50 watt Mazda lamp
R_3—5000 ohms
T_1—Push-pull output, 500 to 8000 ohms
T_2—4000 to 8000 ohms
T_3—1750 to 10,000 ohms
T_4—Class B input transformer
V_1—Half wave rectifier to stand 1600 peak inverse volts (such as 879)

"resting" input need only be lowered to a point where the plate dissipation remains at less than 300 watts.

The next consideration is the driver stage. The input to this stage should run around 5 to 10% of the linear amplifier plate input, depending on circuit conditions, type tubes used in the linear stage, etc. About 7% or 70 watts should be sufficient. Next the plate current and voltage may be found which will present the proper load to the modulator, at 70 watts input. For this discussion 10,000 ohms is taken as a typical modulator load. The voltage required to match 10,000 ohms may be found by the formula: $E = \sqrt{RW}$, where, E=the plate voltage, R=the resistance of 10,000 ohms, and W= plate input of 70 watts. Having found the voltage, the current may be found by dividing the wattage by the voltage. The calculated peak syllabic voltage and current are 836 volts and 83.6 ma.

The control unit is the heart of the controlled carrier transmitter. The purpose of the control circuit is to vary the plate voltage of the modulated amplifier so that it is always equal to or slightly more than the peak audio voltage supplied by the modulator. This is accomplished by rectifying a portion of the audio voltage from the speech amplifier, and using it to oppose the fixed grid bias on the control tubes. This reduction in bias increases the plate current and reduces the plate voltage, i.e., reduces their d.c. resistance. Since these tubes are in series with the modulated amplifier, its plate voltage will increase in proportion to the input to the control unit.

As mentioned above, the plate voltage of the modulator must be kept equal to or above the *peak* audio voltage. In order to do this the rectifier portion of the control unit must be a peak rectifier. By "peak rectifier" is meant one in which the d.c. output voltage is equal to the peak a.c. input voltage. The rectifier of the control unit has an input condenser which charges up to the peak of the audio wave. This condenser must be large enough to maintain the d.c. output of the rectifier equal to the audio peaks. The load on the rectifier must be small so that it will not discharge the condenser between peaks and reduce the average d.c. voltage. At the same time it should be large enough to reduce gradually the opposing voltage as the audio peaks are reduced. The size of the condenser, however, depends on another



Modulated Stage Set-up

In back of the control unit is the modulator. To the right is the modulated amplifier.

characteristic of the circuit, the time taken to charge it up to the audio peak. In order for the plate voltage on the modulated amplifier to rise as nearly as possible at the same time as the modulation voltage, the rectifier-filter circuit must be designed to cut the delay to a minimum. This is done by keeping the size of the condenser as small as possible and proportioning the ratio of condenser to resistance so as to maintain the peak rectifier characteristic. In reducing the lag, the input portion of the circuit, including the input transformer and the rectifier, should have good regulation. The input transformer should have a low resistance secondary, such as a class B input, or push-pull plates to line transformer, reversed. The rectifier tube should have a low internal voltage drop. This insures against having the peaks cut off or the condenser charging up slowly. Tests show that a 0.5 μfd. condenser is large enough for the peak rectifier if a resistance of 30,000 or 40,000 ohms is used for the load, R_1.

The amount of audio voltage necessary for correct operation of the control unit depends on the control tube bias necessary to obtain minimum plate voltage on the modulated amplifier. This bias is around 100 to 150 volts for type '50 tubes. A 45 or 42 triode connected in the speech amplifier will provide this voltage when a transformer ratio of 1:2 is used between the plate of the speech amplifier output tube and the total secondary of the input transformer of the control unit.

One other item in the control unit requires comment. This is the condenser across the plate circuit of the control tubes. It should be large enough to bypass audio from the modulator around the control tubes. It must, however, allow the variations of control tube voltage to pass without delay. A one μfd. condenser is large enough for this purpose. It will bypass frequencies down to 150 cycles or less with little loss and still allow the control voltage variations to pass without delay. If a lower load resistance for the modulator is used the size of the condenser might be increased to two μfd.

The control tubes may be selected after examining the conditions under which they operate. They must pass the maximum plate current drawn by the modulated amplifier. The maximum voltage across them will be their own plate voltage plus the drop used in reducing the plate voltage of the modulated amplifier. They should have as low a minimum plate resistance as possible in order to keep the total applied plate voltage down. For this reason it is desirable to use two tubes in parallel in this circuit. Low μ tubes of the '50 type make the best control tubes.

The lowest control tube plate voltage which will pass the 83.6 mills required by the modulated amplifier for peak conditions may be determined by looking at the plate-voltage plate-current curves of the tubes selected. Follow the zero bias curve up to the 83.6 ma. line on the graph, then across to the voltage side where the plate voltage necessary to draw 83.6 ma. may be read. If two tubes in parallel are to be used the plate voltage drop will be half that for one tube. The tube data for the type '50 shows the plate voltage to be 200 volts for a single tube, which becomes 100 volts for two tubes in parallel.

The total voltage for the system (power supply voltage) then, is the maximum modulated amplifier plate voltage of 836 volts plus the control tube plate voltage of 100 volts, or 936 volts. However, there is an advantage in having more voltage than is actually necessary. Any additional voltage is taken care of by allowing a larger voltage drop through the control tubes. This means that instead of having zero bias on the control tubes during peak conditions, there will be some bias, depending on the amount of additional voltage. This is an advantage in case the audio level runs above normal for peak output. Up to the point of zero bias the control tubes increase the modulated amplifier plate voltage linearly in respect to the modulator output. When zero bias is reached the control tubes start to draw grid current. At this point the linearity stops. The audio output from the modulator continues to rise but the modulated plate voltage rises slower due to the load on the control tube grid circuit, causing over-modulation at peak output. However, if there is still some bias on the control tubes when peak conditions are reached, the plate voltage on the modulated amplifier will continue to rise and no over-modulation will result. The only effect will be to increase the distortion of the linear amplifier.

The amount of bias to be used with any control tube plate voltage which does not require zero bias to draw sufficient plate current for peak conditions may also be obtained from the tube curves. In this case find the intersection of the 83.6 ma. line and the plate voltage line equal to twice the plate voltage to be used. (The parallel tubes cut the plate voltage to half that for one tube. In order to obtain the bias for both tubes, twice the plate voltage for one tube must be used in calculating.) This intersection will be close to one of the grid bias curves and the proper amount of bias may be estimated. As an example: if the power supply to be used delivers 1000 volts, the control tube plate voltage will be 1000 less 836 or 164 volts. To find the bias for this voltage, follow the 83.6 ma. plate current line out until it intersects the plate voltage line for twice the plate voltage or 328 volts. The intersection of these lines will be close to one of the grid bias curves and the proper amount of bias may be estimated. Type '50 tube curves show this bias to be about 30 volts.

Grid bias for the resting condition may be found in the same manner. The control tube plate voltage will now be equal to the control voltage swing plus the control tube plate voltage for peak output. Tube curves may not give voltages high enough to use with the plate voltage doubled. However, the bias may be estimated by finding the bias for one tube. The actual bias will then be somewhat more than twice that for the single tube.

The speech amplifier used with the transmitter is conventional with the exception of the output stage. This stage consists of two tubes with the grids operating in parallel. A volume control is incorporated in each grid circuit so that the volume on each tube may be varied independently of the other. The output of one tube goes to the modulator and the other to the control unit.

The over-modulation indicator shown is a necessary part of any carrier controlled transmitter. With it the circuits may be properly balanced to prevent over-modulation. It consists of a half-wave rectifier tube in series with a low range milliammeter. The peak inverse voltage of the rectifier tube must be high enough to stand twice the peak mean plate voltage of the modulated amplifier. It is connected across the modulated amplifier plate circuit so that it does not read unless the peak modulator a.c. voltage becomes higher than the plate voltage. When this occurs, current flows through the rectifier tube and can be read on the meter, indicating over-modulation.

In adjusting a carrier controlled transmitter it is recommended that the transmitter first be tuned up as a regular modulated amplifier followed by a linear. The adjustments necessary to make a linear work properly are somewhat critical and it is well to become familiar with the conventional layout before testing with controlled carrier.

The transmitter circuits need not be changed while the outfit is in use as a standard transmitter. It is only necessary to reduce the plate input to the modulated amplifier and linear amplifier to a point where adjustments may be made without danger to the tubes. A good starting point would be 450 watts input to the linear stage. Bias on the linear should be adjusted to cut-off at the reduced plate voltage, and may be determined by dividing the plate voltage by the μ of the tubes. The input to the control unit should be cut off. The control tubes however, may be left in the circuit if desired.

After neutralizing the modulated amplifier the plate voltage may be applied and the linear stage neutralized. While this is being done the swamping resistor should be disconnected so there will be some grid current on the linear stage. After the linear amplifier has been neutralized, the swamping resistor should be clipped across enough turns to reduce the grid current to a few ma. The coupling will probably have to be varied in making these adjustments. The use of rather high C circuits is recommended for the linear grid and modulated amplifier plate circuits.

With all adjustments made, the final amplifier plate voltage may be applied, the final plate circuit tuned to resonance and coupled to the antenna or dummy antenna. Coupling may be increased until the plate dissipation equals 70% of the plate input. When the plate voltage is applied to the linear stage the grid current should *decrease* slightly. An increase shows an unstable condition such as regeneration or parasitic oscillations. It should not show a tendency to oscillate with no r.f. (excitation). Split stator neutralizing is strongly recommended whether the linear is single ended or push-pull. This method is more stable even though a little harder to excite.

When the r.f. portion of the transmitter is working, open the speech amplifier gain control and speak into the microphone. The gain may be turned up till the over-modulation indicator meter begins to kick occasionally, this indicating 100% modulation. The plate meter of the linear amplifier should not vary during modulation, when operating as a straight constant carrier linear.

After becoming familiar with the straight linear amplifier, controlled carrier may be tried. Increase the linear amplifier grid bias for the higher plate voltage and check the adjustment of the swamping resistor and coupling at the peak output condition. To do this reduce the control tube bias to the point where peak modulated amplifier input of 70 watts is drawn. After any necessary adjustments have been made, increase the bias to its former value, turn up the gain control for the control unit, and speak into the microphone. The modulated amplifier plate current meter should read up to 83.6 mills on peaks, showing the full power input.

The linear amplifier plate voltage may now be applied. If the resting input is not approximately 350 watts, the control tube bias may be changed. When the microphone is spoken into the input should run to a kilowatt on peaks.

One word of caution should be given. Do not test the control circuit with the 354 plate voltage on without the driver being modulated. The efficiency of the linear stage will be lower for this condition and serious overloading on the tubes may result during peaks of plate current.

If care is used in building a carrier controlled outfit, excellent results may be expected from it. The power output fully justifies the extra equipment necessary. The important consideration is a control circuit that "takes hold fast", adjusted to give just enough control to allow the tubes in the linear stage to run at about 2/3 maximum rated dissipation when "resting". Greater degree of control is not necessary, and makes adjustment and proper operation much more difficult, in addition to making a.v.c. somewhat impracticable at the receiving end.

◆

They used to tell a stock joke on the small communities with police radio and but two patrol cars; the operator was supposed to get excited when radioing information relative to a holdup, with the following result:

"Calling all cars; calling all cars; calling both cars!"

But we notice by the F.C.C. reports that there now are towns with but *one* radio patrol car. The nice thing about such a "fleet" of prowl cars is that the station can "call all cars" every time, regardless of whether the cruiser is being directed to a murder or sent to rescue a pet cat from an overly-playful pup.

A Dual-Purpose Exciter Unit

By George P. Huntley, Jr., W6LIP

This complete unit including the RK20-804 carries its power supply in the same rack. The unit can be used as a 15-20 watt portable phone or is ideal for driving the Dawley 500 watt amplifier shown in the January issue. The universal antenna coupler makes it a most versatile piece of equipment.

Like the weather, everyone talks about a pentode portable c.w. and phone transmitter but no one does anything about it. The writer, being in the picture business, often wished he had a good portable for use when on location, often several hundred miles from home. The portable shown herewith was started Saturday noon and was put on the air Sunday night.

In order to economize on gear it was required that the portable also serve as an exciter for a larger transmitter when portable operation was not required. Therefore the RK20 tritet oscillator shown herewith was built up and results have been quite satisfactory in every respect. When used as the r.f. exciter for the big rig, 50 watts of fundamental output and about 25 to 35 watts of second harmonic output are easily obtained at 1000 volts plate voltage.

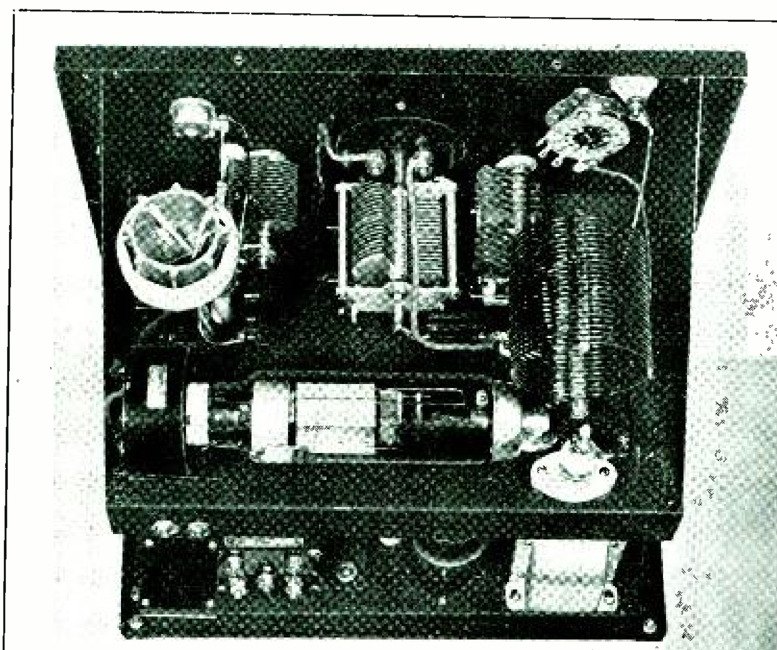
The circuit is standard except for the use of the Jones load-matching network, which is just as useful for controlling the coupling to a power amplifier as it is to an antenna.

The switch in the suppressor circuit is used to change from positive to negative suppressor bias when going from c.w. to phone.

The oscillator tube is mounted horizontally with the plane of the filament vertical to minimize filament sag. This allows the tank circuits to be mounted symmetrically and simplifies the panel layout. The cathode, or feedback tank circuit is on the right hand side, while the plate tank is on the left hand side, facing the front panel. The crystal plugs into the rear of the upper, or r.f. chassis and the antenna coupling condenser C_6 is mounted in the center. The cathode coil is tapped for operation with 160, 80, and 40 meter crystals. The taps were found to be not critical.

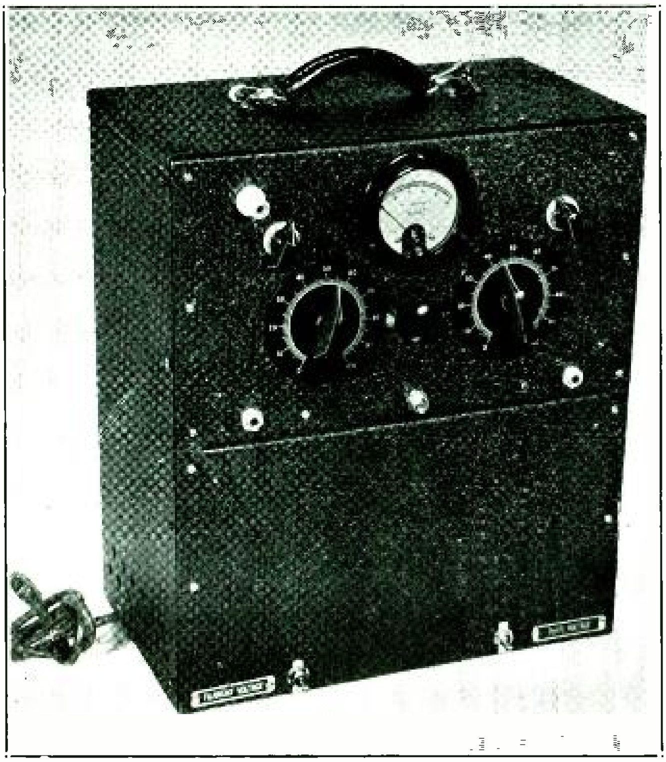
The power supply gives about 1350 volts with condenser input. Transformer, chokes and filter condensers are all oversize, even though this feature does run up the weight somewhat. However, there is nothing more irritating than to get a hundred miles away from a telephone and have the rig blow up with important traffic to handle. Thus it was felt that an abnormally large safety factor was desirable.

A power switch is mounted in the upper right hand corner of the front panel and the suppressor bias switch is in the upper left hand corner of the panel. When voice modulation is used a separate audio amplifier is used to supply the small amount of audio required



Left

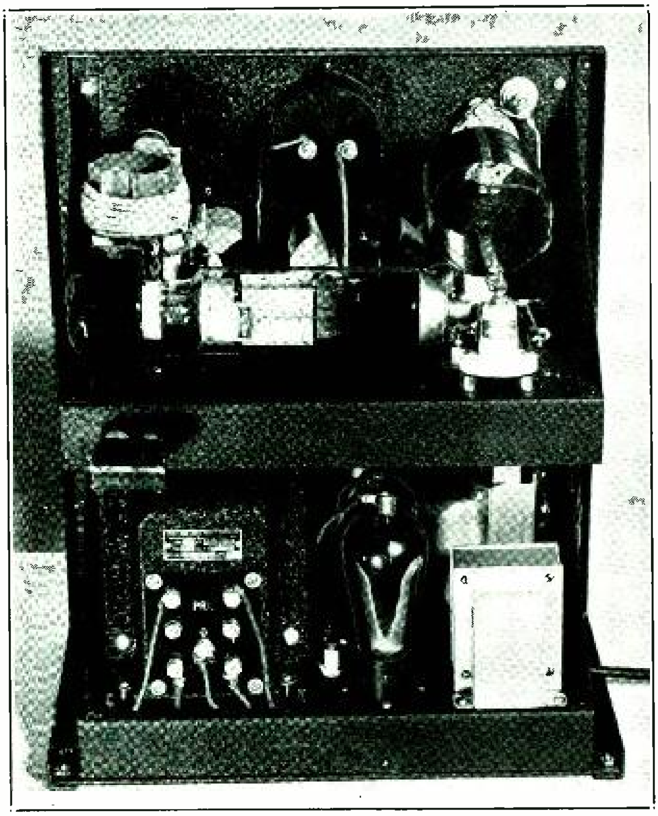
Top view of the combined exciter, portable transmitter. The crystal was mounted outside the cabinet to keep it at a more constant temperature.



taken to measure and adjust the suppressor grid voltage with reference to the filament center tap and not to ground. A bothersome bug which is common to many pentode oscillators and amplifiers is that the constructor taps the d.c. suppressor grid return on the screen voltage divider to a point perhaps 45 volts positive *with respect to ground*, but the presence of as much as 90 volts of negative cathode bias really makes the suppressor 45 volts *negative with respect to cathode, or filament center tap.* Then the operator spends time and energy swearing at the tube manufacturer because he can't get much power output from the tube.

The whole oscillator and power supply is mounted in a 14 inch rack of commercial manufacture. The weight is quite low and it makes a very handy gadget to throw into the car on 30 seconds notice when off on a trip.

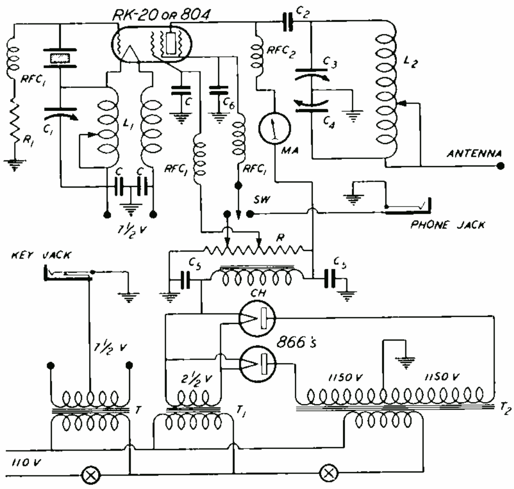
Two Views of the Talking, Walking Exciter Unit



to effect substantially complete modulation of the 15-20 watt carrier output of the RK 20 adjusted for phone use. Incidentally, no one should frown on the utility of a 15 watt phone carrier when high quality modulation is used. On 4 megacycles, the reports received on this rig averaged only about an R less in received field strength than a 150 watt carrier phone transmitter operated at the same location.

The extreme simplicity of the whole rig is such that no particular constructional hints are necessary to avoid those bugs that multiply as the complexity of a transmitter increases. The illustrations show the complete layout and if a mechanical layout is chosen that avoids excessive r.f. lead length and plate to grid coupling, no troubles will be encountered.

One thought occurs for those who may desire to supplement grid leak bias with additional cathode bias, for protection against possible tube failure while tuning up, etc. If cathode bias is used, care must be



Wiring Diagram of the Portable Tritet

C—.01 µfd. mica
C_1—.00035 midget, receiving type
C_2—.002 µfd., 2500 volt mica
C_3—Midget split-stator, 35 µµfd. per section, sections in parallel, 3000 volt spacing
C_4—.00035 µfd., 1000 volt spacing
C_5—2 µfd., 2000 volts d.c. working voltage
R—50,000 ohms, 75 watts, slider type
R_1—15,000 ohms, 2 watts
RFC_1—Receiving type h.f. chokes
RFC_2—125 ma. h.f. choke, 2.5 mh. or more
MA—0-100 ma. d.c.
CH—30 hy., 150 ma.
T—7.5 volts, 3.5 amps.
T_1—2.5 volts, 10 amps.
T_2—2300 volts, c.t., 150 watts
L_1—10 turns no. 14 d.c.c. on 2¼" form, with 10 similar turns wound directly over first winding. Outside winding tapped at 5th turn and shortened by small toggle switch for 40 meter crystal
L_2—24 turns no. 14 enamelled, space wound diameter of wire and supported on celluloid strips. (80 m.) Tapped at 12 t. from ant. end (40 m.) and 20 t. in from cold end (20 m.). Diameter of coil, 2¾".

A compact, high-frequency superhet and a simple audio channel with a common power supply go into a similar portable rack. All the writer needs now is a pair of portable 100 foot self-supporting masts.

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TO THE WIVES OF HAMS

I was a little disappointed in your account of a "Ham's Life" in May RADIO, Mrs. W7APU.

While there is much truth in what you say, there is another side to the story. Therefore, I feel obliged to come to the defense of these creatures, inasmuch as I am one of them—with a "label" all my own, and can therefore speak from the standpoint of a "ham" rather than an "x.y.l.".

We odd creatures isolate ourselves in a corner of our home, or in a damp and dusky cellar, or in the garage, or in a shack, by reason of the fact that our precious knobs and coils and condensers are not appreciated as artistic compliments to the appearance of the household, also because we do not trust them to the—shall we say—*normal* members of said household.

We know that if we place a "*high voltage*" sign thereon, said members will be cautious enough to keep their distance. However, if that fails, we can pull a pencil across the tank coil and scare respect into them with some hot r.f.!

Also, about the many and varied pictures in the form of QSL's: you couldn't possibly know the anxiety—the hope—that springs eternal in our hearts that the other fellow will QSL. These cards are definite and thrilling proof of a "rag-chew" or "dx" contact. The "bottles" and condensers oftentimes represent years of saving and sacrifice. The milliammeters and voltmeters that you so termed *speedometers* often require weeks of diplomacy and tact (to wheedle them from a brother ham).

When we get our hands on the key we forget all about our sacred vows—and can subsist for hours without sleep or food.

As for the "receiving" of the receiver—every little squawk has a meaning all its own. The "soul-tearing sobs" emitted therefrom are oftentimes music to our ears.

When we are riding of a Sunday and discover Zepp. feeders, we know that here is someone who speaks our language and understands and appreciates this fatal fascination.

If you are unfortunate enough to be labeled the *XYL* or *OW*—why don't you do something about it? Why don't you achieve an exclusive and distinctive title of your own? I know without a doubt that your o.m. will prove to be a proud and willing teacher if you ask, "How do I get a ticket?" So instead of having a house divided—why not put up *two "high voltage"* signs?

"And that's the dope on that!"

—DOROTHY HAGERTY, W6JMH
(MRS. W6JMI)

◆

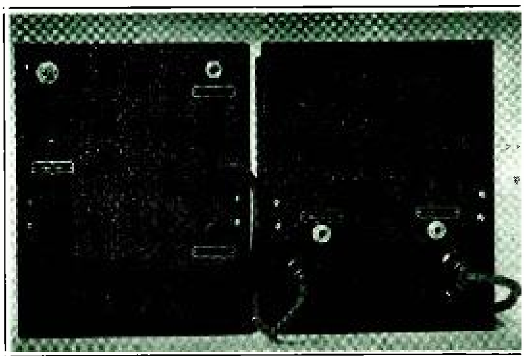
One of the gosh-darnedest pieces of interference is produced by a light bulb on the verge of burning out. On a.c., the noise is a grating hum. On d.c. the grating is minus the hum component. To locate the culprit, start turning out all the bulbs in the house. The offending lamp seldom will light up again, once it is switched off.

Stabilized U.H.F. Mobile Transmitters

By H. B. Calvert,* W6EAN

Now that steps are finally being taken to clean up the fixed-location "modulated wobbbulators" on the 5 meter band, the next step is to clean up our mobile transmitters. This does not entail elaborate or expensive equipment, as study of the transmitter described here will show. Built to stand the rigors of police operation, it makes an ideal 5-10 meter amateur mobile transmitter.

The following article is a description of ultra high frequency equipment designed for use on police frequencies for our Pasadena "prowl cars". It occurred to us that the low complete cost, which is under seventy dollars including power supply, would make this an ideal mobile



Front View of the Speech and R.F. Units

transmitter for work on the five and ten meter amateur bands.

In designing the equipment we attempted to keep the parts to an absolute minimum and still maintain decent efficiency. For the sake of simplicity we decided to build a push-pull, tuned-plate and tuned-grid, master-oscillator, power-amplifier transmitter using 6A6 type tubes, and mount the amplifier directly over the oscillator to make the leads as short as possible.

In constructing the oscillator everything was securely anchored down tight and the condenser bearings were pressed in until it was necessary to use considerable force to tune the plate tanks. The grid coil was adjusted a turn at a time until minimum plate current reading was obtained. This procedure is very important.

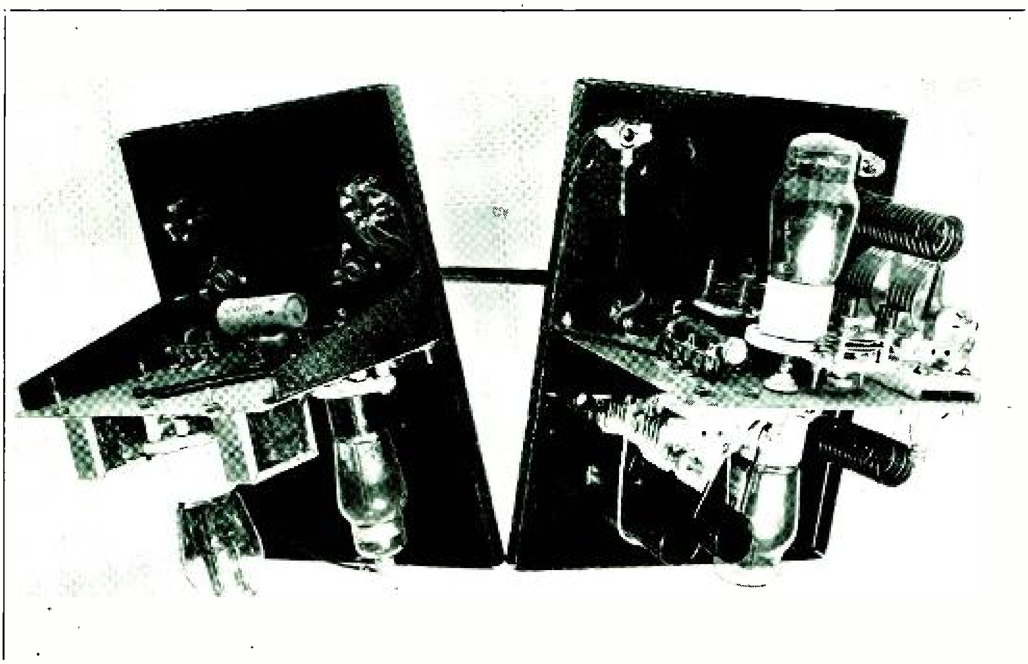
Under actual operating conditions the oscillator draws twenty-five milliamperes or less with three hundred volts on the plate, and delivers thirty grid milliamperes to the amplifier with fairly loose coupling.

*Chief Operator KGJX; Pasadena, Calif. Police Dept.

The small pie-wound radio frequency chokes with about two and one-half millihenries inductance were found to be very fine for this particular work, and worked as well as several larger ones that were tried. To tune the plate tank circuit a thirty-five μμfd. split-stator condenser, double spaced with rotor grounded, was utilized; and as already mentioned the bearings were pressed tight to keep the circuit locked. There is little more that can be said of the oscillator except that it has proven so-far to be very stable, and maintains its frequency over long periods of time to within limits allowed by the F.C.C.

The radio frequency amplifier, so often the source of many headaches to experimenters on the ultra high frequencies, if followed part for part will give no trouble. We might say here that to add any more parts will not improve the amplifier in any way, and may cause grief, especially with neutralization. To keep tuning controls to the least number possible, we duplicated the oscillator circuit in the amplifier, adding only the neutralizing condensers, and inductively coupled the amplifier to the oscillator by placing the amplifier grid coil parallel to and about one-half inch away from the plate tank of the oscillator. The amount of excitation may be varied by moving the amplifier grid coil closer or father away from the oscillator tank coil. This method has proven very satisfactory, and certainly is fool proof as well as simple.

This amplifier is one of the easiest to neutralize of any with which we have ever worked. However, here are a few tips that we found to be great aids in simplifying this operation: First of all, do not try to neutralize any radio frequency amplifier without a grid milliammeter, as it is a long and hopeless task without this instrument. The condensers, which have two rotor and two stator plates, double spaced, are adjusted equally a little at a time (tuning the amplifier plate tank through resonance with the excitation on but with the plate current to the amplifier cut-off). This procedure is repeated until no dip of the grid meter is noticed when



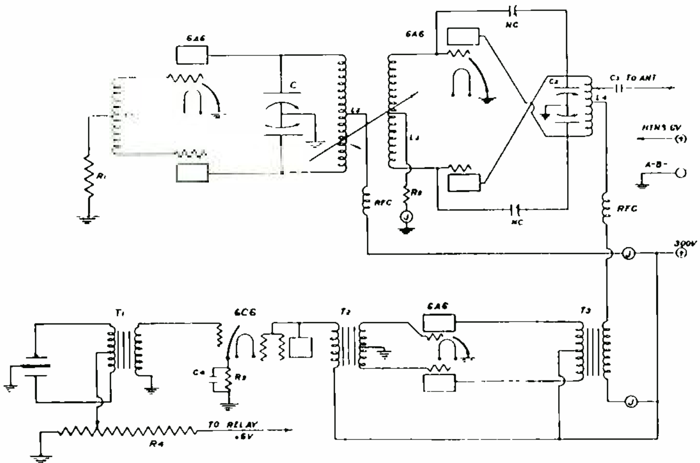
The R.F. and Speech Units with Covers Removed

the amplifier is tuned through resonance. This is the old method of neutralizing so often overlooked by the amateur, but one that is reliable, simple and effective. With this method we had no trouble neutralizing the amplifier at once. We found the circuit as shown will neutralize perfectly, and then tried a few changes, but they did not work nearly as well as the original setup. This is the reason we stated earlier that to add any parts to the circuit would probably invite trouble. We attempted to make the amplifier oscillate after it was neutralized but were unable to do so, and found that changing tubes had little effect on the adjustments. The same type radio frequency chokes and tuning condenser as used in the oscillator were used in the amplifier with excellent results.

The antenna used is the conventional "fish pole", obtained for one dollar and forty-five cents, telescoping in three sections from two and one-half feet to eight feet. We use approximately seven feet, off center fed, with the lower end bolted on the rear bumper of the car, and have found this to work the best of several systems tried. The single-wire feed line is tapped directly to the amplifier tank, in series with a fixed condenser to prevent shorting of the high voltage supply, due to the lower end of the antenna being grounded to the car. Under load fifty milliamperes current are drawn at three hundred volts on the amplifier, with the no-load current being about twelve milliamperes. Believe it or not, one can draw small sparks from the antenna with a lead pencil or light a neon bulb very brightly, which proves that the radio frequency current is actually reaching the antenna where it belongs.

The modulator unit is very simple and inexpensive, also using a minimum of parts. We experimented with many types of tubes for the first stage but finally settled down to the 6C6 hooked up triode as the best tube to drive the 6A6 modulator, which is running class B. There are no tricks to this circuit as it is merely a straight audio amplifier circuit and with the transformers used will supply sufficient power, from a double-button hand mike, to modulate fully the radio frequency amplifier. This modulator unit gives very excellent quality (with a double-button mike) that will compare very favorably with any good amateur phone on the air.

Test jacks are included for oscillator and amplifier plates as well as the amplifier grids, and are very necessary for successful operation. The plate jacks were kept in the modulator unit in order to keep all wire possible away from the radio frequency portion, and since the radio frequency unit derives its power through the modulator unit, the wiring is really a simple



9-10 Meter Mobile Transmitter

L_1,L_2—19 t. no. 10, ¾" dia., 3" long
L_3,L_4—15 t. no. 10, ¾" dia., 3" long
C_1,C_2—35 μμfd. split stator, isolantite
C_3—.002 μfd. mica
C_4—10 μfd., 25 volt electrolytic
NC—"micro-midget", 2 rotor, 2 stator
RFC—2.5 mh. pie wound chokes
R_1,R_2—2000 ohms, 2 watts
R_3—2500 ohms, 1 watt
R_4—100 ohms, c.t.
J—test jacks
T_1—midget mike trans.
T_2—midget class B input
T_3—midget class B output, 6A6 to 5000 ohms

matter and easily done.

The test meter used for these circuits is a two-inch model, bolted to a phone plug to make changing quick and convenient.

These two units are housed in two shield cans eight by ten by six inches, with all parts mounted on a sub-panel so that they may be easily removed for servicing or future changes. We will add here that the set as arranged makes possible the very short and direct leads so essential to successful ultra-high-frequency operation. Some may think that the unit could be more compact, and so it perhaps could. However, in our case we had plenty of room, as the units are mounted with the power supply to a board which is placed on top of two inch felt padding and bolted in the compartment behind the rear cushion of our cars. We did not anticipate any trouble with the audio portion so therefore kept it separate to facilitate servicing the radio frequency section with the least amount of trouble. But we have had no occasion as yet to remove either unit for servicing in over ninety days of very hard service.

The power supply is a three hundred volt, one hundred milliampere Genemotor operated by a relay controlled with the microphone switch. This relay also cuts the current to the microphone buttons at the same time. By using a relay and running number eight Packard cable to the Genemotor from the battery we are able to get a full six volts at the input. It is important that heavy leads be used as any drop in the input voltage will seriously affect the output. Many of us have condemned dynamotors for low output without measuring the input. Attempting to pass five to eight amperes through number 18 wire results in considerable loss in voltage.

We have made many tests and have covered distances (two-way) with our main station, which operates on 1,712 kc., up to twenty-five miles over country which is not entirely level. We also have worked shorter distances from tunnels and behind mountains with good success, and have found the set to be very reliable. At least one amateur has adopted this circuit for his home station on five meters, and from all reports is having real success. We believe that most fellows who wish to try this set will have no difficulty in doing so by following the parts list, diagram, and pictures as given, and when finished will have a transmitter that is very simple and really works.

We do not claim this to be an original idea entirely as far as circuit diagrams go, but the laying out of parts and working out the circuit as we use it is an original one that fits our purpose. We know that for mobile work it will surpass anything in this field that can be built for the low cost of this transmitter, and many in the higher priced class too.

The only change necessary to adapt this to the amateur bands of five and ten meters is to change the coil turns, as the ones given are for the 30.1 mc. police band. We would appreciate hearing from any amateurs as to the success they have obtained with this set-up after trying it out for a time. We also will be glad to answer any questions on this equipment written to us, but please enclose a self-addressed, stamped envelope.

Typical operating conditions, 300 plate volts:

Oscillator plate current 22 ma.
Amplifier grid current 27 ma.
Amplifier plate current 50 ma.

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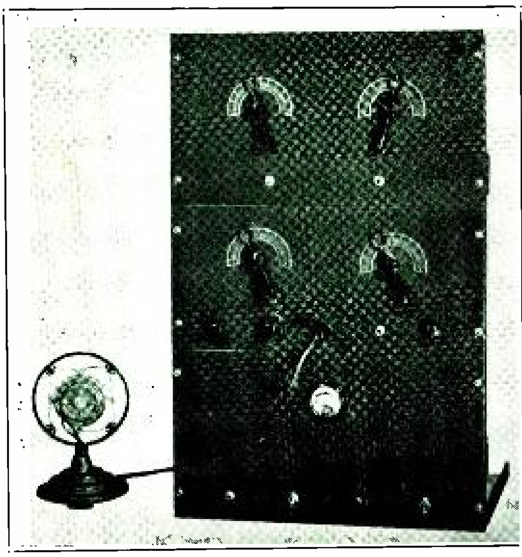
S. W. Siggs is W8LYS.

Controlled-Carrier Suppressor Modulation

By Frank C. Jones

The "sectional" idea in transmitters is catching on. Nothing is discarded when going to higher power. This controlled carrier, phone-c.w. transmitter delivers a husky signal, but if at any time you wish to increase power all you have to do is add a high efficiency linear amplifier, the controlled carrier feature allowing one to obtain large outputs from 100 watt tubes in a linear amplifier stage.

This transmitter is a good low power phone or medium power c.w. set which will not become obsolete if more power is desired at a future date. A high powered linear amplifier may be added to obtain several hundred watts output at relatively high efficiency, since the phone output is controlled carrier. A linear amplifier following a controlled carrier stage operates at good efficiency and will deliver twice as much output as the same stage could when connected to an ordinary constant carrier phone transmitter.



Front view of the suppressor-modulated controlled carrier phone, standard rack mounted.

The maximum phone carrier obtainable is between 25 and 30 watts, since a suppressor or modulation system limits it to that with a pair of RK-20 or RCA 804 tubes. Parallel operation is shown since either one or two tubes may be used without any circuit changes. Generally one tube will deliver enough output to drive a pair of 211-H or similar tubes in a linear amplifier to $1/4$ kw. carrier output. Push-pull operation of the RK-20 or 804 tubes is best for 10 and 20 meter operation; so if these bands are desired the circuit should be changed from parallel operation, providing two tubes are wanted.

The c.w. output for 2 tubes runs about 150 watts, which will take care of plenty of dx without much cost or complication of equipment. The RK-20 or 804 tubes are r.f. screen grid pentodes, therefore require no neutralization and need very little grid excitation. A pair of 53 tubes furnish more excitation than is needed for either phone or c.w. The first 53 is a push-pull crystal oscillator and the second is a push-push doubler supplying either 160 or 80 meter excitation to the final amplifier when a 160 meter crystal is plugged into the crystal socket.

The 53 push-pull crystal oscillator supplies high output without much strain on the crystal, since the tube element capacities are in series. This oscillator drives a push-push 53 doubler which has its grids in push-pull and the plates in parallel. The output of the doubler is a little greater than from the oscillator, a desirable feature since the grid circuit losses are greater at higher frequencies.

For simplicity, an external 90 volts of C battery furnishes control grid and suppressor grid bias to the final amplifier. The transmitter suppressor is connected to a tap on the low voltage supply for c.w. transmission, which increases the output to about 75 watts per tube. The screen current increased a little too much when primary keying was tried; best results were obtained by keying in the crystal oscillator cathode for c.w. This also allows break-in or push-to-talk phone operation.

A high quality, two-button carbon microphone is shown for voice input. A crystal microphone would require an additional 56 resistance coupled audio amplifier between the 57 pentode and 45 modulator tubes. A separate 3 to $4\frac{1}{2}$ volt dry battery supplies microphone current of 8 to 10 ma. per button to the carbon mike. The 57 and 45 tube amplify the microphone output enough for close-talking input. Some carbon microphones are more sensitive (at a sacrifice in quality); therefore a gain control was wired into the circuit.

Modulation takes place by variation of suppressor voltage. The suppressor grid is connected to a higher value of negative C bias than for normal modulation when used with controlled carrier. The higher value of bias reduces the carrier to a low value when there is no voice input. Either -67½ or -90 volts bias will serve the purpose, the 90 volt value giving a more complete control of the carrier output.

Carrier Control

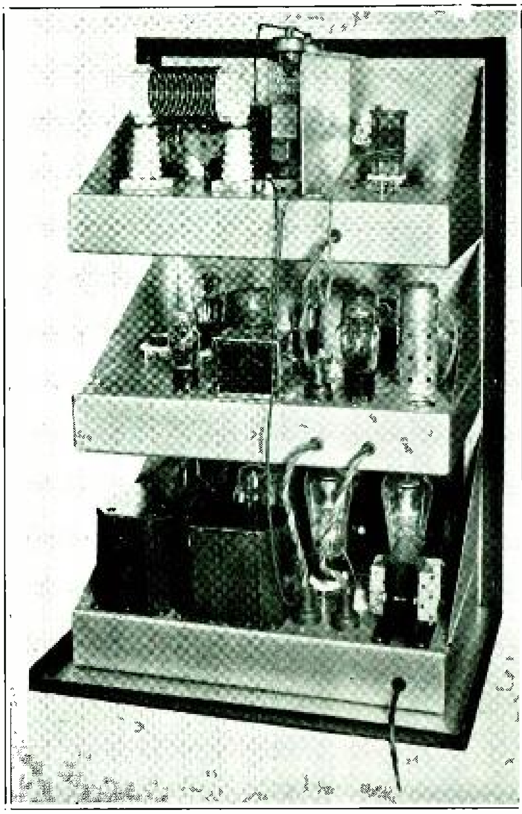
A 1-v rectifier tube functions as a simple diode control element for varying the d.c. suppressor grid bias. For controlled carrier, the suppressor grid bias is varied from -67½ or -90 volts down to about -50 volts, the normal voice operating point. This is accomplished by rectifying some of the modulator voice output voltage, filtering it, and using this current through a resistor to change the suppressor grid bias voltage. This bias varies in accordance with the voice envelope, and since the carrier output varies with the d.c. suppressor voltage, a simple method of controlled carrier is possible.

A small 50 henry audio choke and 1 µfd. 400 volt condenser serves as a filter and audio by-pass to prevent the controlled carrier system from affecting the voice quality. A 10,000 ohm variable resistor controls the degree of carrier control by varying the amount of voice input to the 1-v diode. A 1-to-1 ratio, small class B output transformer couples the 45 modulator into the 1-v tube and into the suppressor grid circuit. The audio voltage modulates the suppressor grid as in any normal system of constant carrier.

The cathode currents of the 53 tubes run from 40 to 70 ma. and supply from 12 to 16 ma. of d.c. grid current to the final amplifier when two tubes are operating. On phone the plate current of the final stage varies from 25 ma. up to about 90 ma. and runs constant at about 160 ma. for c.w. when loaded properly with an antenna. A series link couples either fundamental or second harmonic power into the RK-20 grids, depending upon the tuning of this circuit.

Mechanical Construction

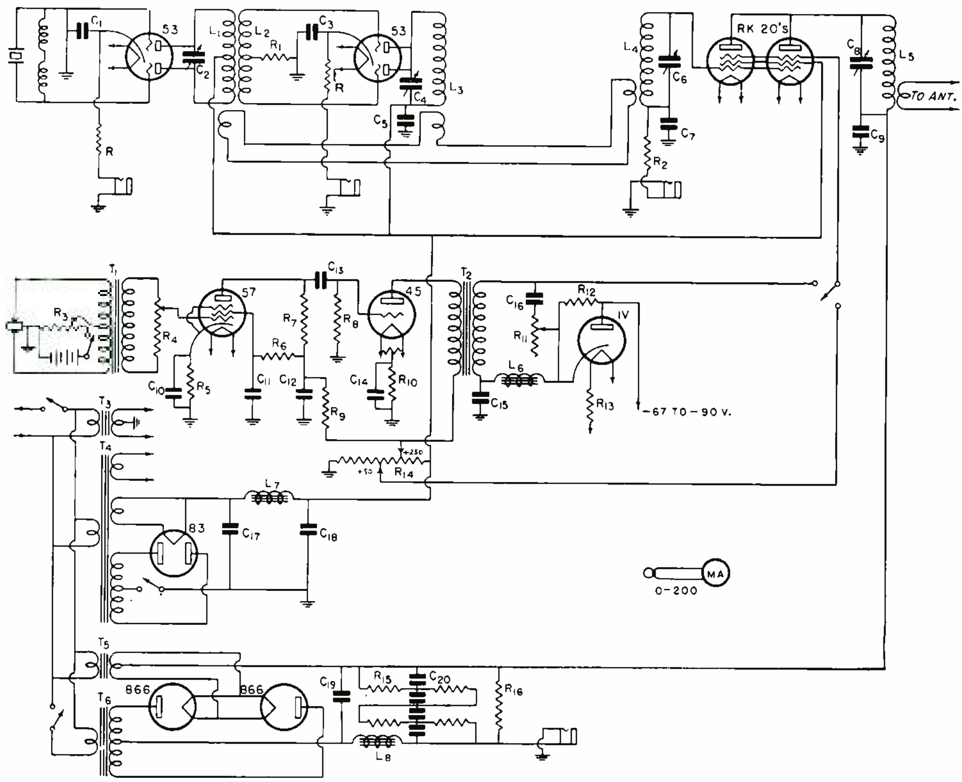
A standard 30" x 19" relay rack supports the three units of this transmitter. The power supply and final amplifier panels are of 14 gauge iron 10½" x 19". The exciter and speech unit is 8¾" x 19". All three chasses are of 18 gauge iron 12" x 17" x 2" and have end supports to the front panels. A heavy aluminum shield separates the final amplifier grid and plate circuits. Insulated shafts extend out to the tuning dials for all four variable condensers, which are mounted on insulated vertical subpanels.



Showing interior construction of the transmitter. It is entirely self-contained.

The speech and modulator apparatus is built into the exciter chassis, and since its leads are all below the chassis and all r.f. leads are above it, no r.f. feed-back takes place. The microphone plug and cable are shielded and the shielding is grounded. One plug-in 0-200 milliammeter measures currents in all stages by means of closed circuit jacks. The only hum trouble observed was due to that picked up by the microphone input transformer, which should be doubly shielded or oriented in position on the chassis for minimum pick-up from the power transformers on the next chassis below.

For 80 meter operation from a 160 meter crystal, the oscillator has 60 turns of no. 24 d.s.c. wire close-wound and center-tapped on a



The Controlled Carrier, Suppressor Modulated Phone

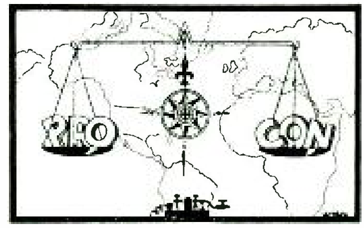
C_1—.01 µfd. tubular
C_2—50 µµfd. midget
C_3—.01 µfd. tubular
C_4—50 µµfd. midget
C_5—.01 µfd. tubular
C_6—50 µµfd., 3000 volt spacing
C_7—.002 µfd. mica
C_8—100 µµfd., 3000 volt spacing
C_9—.006 µfd., 2500 volt mica
C_{10}—10 µfd., 25 volt electrolytic
C_{11}—0.1 µfd. paper
C_{12}—0.1 µfd. paper
C_{13}—.01 µfd. mica
C_{14}—10 µfd., 50 volt electrolytic
C_{15}—1 µfd., 400 volt
C_{16}—0.5 µfd. paper
C_{17}—8 µfd. electrolytic
C_{18}—8 µfd. electrolytic
C_{19}—2 µfd., 1500 volts
C_{20}—8 µfd. electrolytics
R—500 ohms, 10 watts
R_1—10,000 ohms, 2 watts
R_2—5000 ohms, 10 watts
R_3—400 ohm pot.
R_4—250,000 ohms, tapered
R_5—3500 ohms, 1 watt
R_6—2 meg., 1 watt
R_7—250,000 ohms, 1 watt
R_8—1 meg., 1 watt
R_9—50,000 ohms, 1 watt
R_{10}—1500 ohms, 2 watts
R_{11}—10,000 ohms
R_{12}—10,000 ohms, 2 watts
R_{13}—4 ohms filament dropping resistor
R_{14}—20,000 ohms, 50 watt slider type
R_{15}—0.5 meg., 1 watt
R_{16}—50,000 ohms, 100 watts
T_1—Mike to grid
T_2—One-to-one output
L_6—50 hy., low current
L_7—15 hy., 150 ma.
L_8—10 hy., 200 ma.

1½" diameter plug-in coil form. The doubler grid coil has 50 turns of no. 24 d.s.c. wire with center tap, wound over the oscillator coil with a layer of celluloid to separate the windings. A ⅛" space is left at the center of each coil and each winding starts from this mid-point.

The doubler plate and final grid coils are similar in construction on 1½" forms. For 80 meters, each have 35 turns of no. 20 d.s.c. wire wound to cover a space of 1¾". The final tank coil consists of 22 turns of no. 12 wire on a 2½" form wound to cover 3" of space for the 80 meter band.

A phone monitor is necessary to check voice quality of the r.f. output on phone. A 50 watt mazda lamp connected to 6 or 7 turns of wire wrapped around the final plate coil will serve as a dummy antenna for phone testing. Three such lamps in series are needed for checking c.w. output. A pilot or flashlight bulb connected in a turn of wire makes an excellent r.f. indicator for checking outputs from the crystal oscillator and doubler stages. Link coupling can be varied for either one or two tubes in the final amplifier. These tubes should not be driven too hard and are quite easily over-driven. The output can be coupled to a twisted-pair feeder system by a few turns around the final tank coil. Coupling to any other type of antenna feeders can be accomplished by link coupling to another tuned circuit with the feeders tapped on it at the appropriate places.

THE OPEN FORUM



Sydney, Australia.

Sirs:

In your issue for January there is a brief article dealing with Australia as a Radio Utopia, from a broadcasting viewpoint.

Australian comments are invited.

Perhaps the enclosed page [showing a "startling" decrease in the rate of growth of listeners' licenses.—EDITOR] will show that "all that glitters is not gold" with broadcasting here. My own opinion is that our National service has little to elicit criticism, but our private, or "B" stations, are in most cases, plainly rotten.

If you want to hear brilliant examples of mutual admiration societies, you should hear some of our Australian "B" stations. Advertising goes over in most blatant form, with the exception of recorded sponsored programmes, which are often tolerable.

As for announcers, may the Gods protect us! Some of the "B" announcers are passable, but many are "B" awful.

When the license returns show so many cancellations, something is wrong somewhere, and I am certain that the National service is not primarily to blame. In my opinion, private broadcasting in Australia has been responsible for pitchforking a lot of rag-tag and bob-tail in front of microphones. That does *not* apply to the National stations where announcers are carefully selected. They at least, *do* speak English.

Sincerely,
GEORGE EDWARDS.

◆

Hinton, West Virginia.

Sirs:

With the number of stations increasing by leaps and bounds, what is more timely than suggestions of efficient methods to reduce QRM? Too often we lose "that dx station", or miss the "main thing" because some well-meaning o.m. breaks through on our listening frequency and lengthily spells out that which could just as well be said in a fraction of the time.

After considerable observation I have found that such statements as, "What are you using?" or, "What is your power?" occur with almost as much regularity as do the most-used "Q" signals, such as QRK, QRA, and QSL; and certainly with more regularity than do the great majority of "Q" signals. In other words, there is no standard method to facilitate the speedy, efficient description of parts, or the whole of the radio station, itself, which is obviously of primary importance. Here is the proposed solution:

Question

QTW?—What is the tube plate input, in watts, to your antenna coupled transmitting unit?

Answer

QTW—The tube plate input, in watts, to my antenna coupled transmitting unit is ....

Question

QTX?—What is the type and arrangement of your transmitting tubes?

Answer

QTX—The type and arrangement of my transmitting tubes is as follows: ....oscillator; ......doubler or amplifier (state which), etc.

Question

QTY?—What type of receiver are you using?

Answer

QTY The type of my receiver is ....

Question

QTZ?- What is the description of your station?

Answer

QTZ - The description of my station is as follows: QTX ....; QTW ....; QTY ....

What do you think of these "Q" sigs, om's?

—VERNON DAMERON, W8HGA.

The consensus of opinion seems to be that too many "Q" signals would be undesirable, that amateurs don't make enough use of the ones they have. Nevertheless, we must admit that the ones suggested above would be greater timesavers than many of those now listed.

But why "QTZ?"? Are not most amateurs always too ready to give unprovoked descriptions of their rigs, *without* solicitation?—EDITOR.

◆

The following gem was swiped from *Podunk News*:

"The 160 meter phone sissies in St. Louis seem to be having quite a tussle with the big bad police department. The police claim they can't hear KGPC because little Willie with his wireless set is calling CQ and announcing that that's the dope on that. After hearing representatives of the 160 meter gang and of the police department, we c.w. men suggest that the police department use HRO's in the squad cars and that the phone lads buy a key and do some sensible operating."

[EDITOR'S NOTE: If you 160 meter phone men want to voice objection to the above disparaging reference, you will have to take it up with the St. Louis c.w. men. The above is quoted verbatim.]

Band Pass Crystal Filter Possibilities

By Frank C. Jones

In the January issue of Radio, a super-heterodyne receiver was shown which had 12 tuned circuits in the i.f. amplifier and used iron-cored coils. This system gives a high degree of selectivity and the following discussion is along the lines of using quartz crystals to give the same degree of selectivity without too sharp

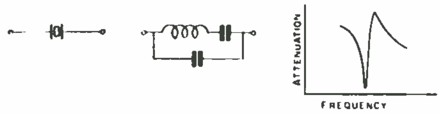


Figure 1

a peak. Properly designed crystal filter circuits using more than one crystal will give a more true band-pass effect, which is desirable.

An ideal characteristic for an i.f. amplifier in a c.w. receiver would be a band width of 500 cycles broad at the top and practically straight sided, with the total attenuation down at least 120 db at 100 or so cycles either side of this band-pass. Similarly, an ideal receiver for phone reception in the amateur phone bands would be one having a width of about 2000 cycles or so—just enough width to allow intelligible reception of voice-modulated signals. The attenuation should extend down to 120 db in order to eliminate slop-over from R9 *plus* signals from local stations. With such a degree of selectivity, the forty meter c.w. band and 75 meter phone bands would not seem particularly crowded. The bands would accomodate many times more signals than can be tolerated with present day receivers.

A multiple quartz crystal filter plus a number of tuned i.f. circuits would approach this

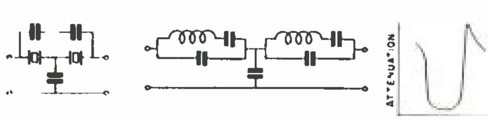


Figure 2

ideal for phone reception but not for c.w. reception. The series-crystal filter circuits used in single-signal superheterodynes give a very narrow width, but the curve is shaped like the "outline of a volcano". It is too sharp for easy tuning on the peak, and altogether too wide at the base to eliminate strong local signals. The peak portion of the curve is too selective for good phone reception so these series single crystal circuits are suitable only on c.w.

The equivalent circuit of a quartz crystal in which both series and parallel resonance occur is shown in figure 1. Series resonance is due to the equivalent inductance and series capacity given by the expression:

$$F_S = \frac{1}{2\pi\sqrt{L\,C_S}}$$

The crystal holder causes a shunt or parallel capacity C_P across the crystal and parallel resonance occurs at:

$$F_P = \frac{1}{2\pi}\sqrt{\frac{C_S + C_P}{L\,C_S\,C_P}}$$

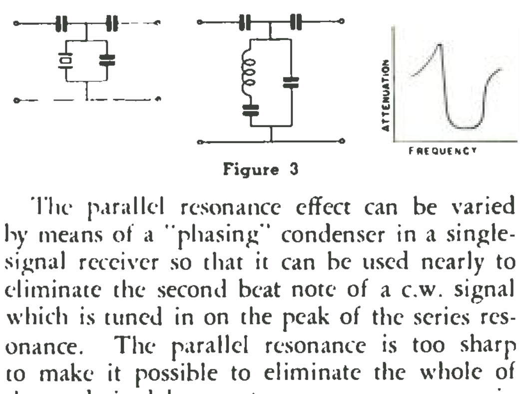


Figure 3

The parallel resonance effect can be varied by means of a "phasing" condenser in a single-signal receiver so that it can be used nearly to eliminate the second beat note of a c.w. signal which is tuned in on the peak of the series resonance. The parallel resonance is too sharp to make it possible to eliminate the whole of the undesired beat note except over a certain range such as from 800 to 900 or 1000 cycles. This leaves a weak undesired signal of higher or lower beat note when tuning across the desired signal if the latter happens to be strong enough.

In figure 2 are shown 2 crystals in a band-pass circuit. The crystals are ground to slightly different frequencies and need to be of the AT cut type in order to prevent frequency drift with room or receiver temperature variation In this circuit the response curve is wider at the base, which is the point of least attenuation (the peak of response in a receiver), than for the single, series crystal of figure 1.

In figure 3 is shown a shunt single-crystal

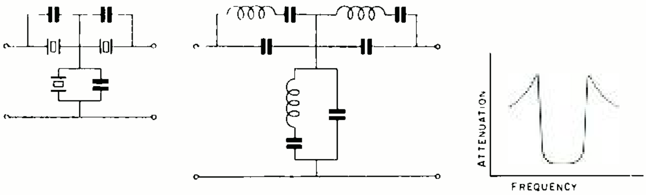


Figure 4

filter circuit with series condensers which is similar to that of figure 2 except the reversal in the point of greatest attenuation. In the ordinary parallel position of a crystal in the usual crystal filter circuit, this point of greatest attenuation is used to eliminate an undesired signal when listening to a phone signal. In this case it is not a band pass circuit, since no series condensers are used and no proper termination is made to the input and output of the filter. In figure 3 the response curve depends upon proper impedance termination as well as the correct values of shunt and series condensers.

Figure 4 shows a system utilizing three crystals to give a better band-pass characteristic. All of these circuits would be suitable for phone reception but hardly good enough for c.w. reception. The band-pass width is less than .4% of the series resonance frequency of the crystals; so for a 465 kc. crystal, the band width would be not over 1750 cycles. By proper adjustment of series and parallel condensers, and correct impedance matching to the input and output, the band-pass might be narrowed enough for c.w. reception.

These band-pass filters have a low impedance that depends upon their band widths. The narrower the band, the lower is the value of impedance to match. This impedance is from a few hundred ohms downward. Impedance matching can be accomplished with tuned i.f. coils having low-inductance, untuned secondary and primary windings.

The attenuation of these band-pass crystal filters is from 30 to 40 db except at the points of greatest attenuation, which may run from 60 to 100 db. This "sliding off" effect on the sides beyond the parallel-resonant cut-off points means that additional attenuation in the i.f. amplifier would be needed, or more than one section of crystal filter used between stages. Two of the shunt type of figure 3 with a total of at least six tuned i.f. circuits in a two-stage i.f. amplifier would approach the conception of a really satisfactory receiver—one that would "widen the bands" for us.

RAISE YOU 570

In the May issue there is mention of a 100% QSO at 30 miles with the antenna down. Nothing at all—really nothing. Why, back in the spark days Bob Trump of 9BT (no W in the call then) at Topeka, Kansas, called, raised, and worked both 8NH at St. Mary's, Ohio, and 8AEZ at Lima, Ohio, with the antenna down and covered by 5 inches of sleet. All three senders were rock-crushers with about 600 watts input, all three receivers were 1-tube regenerative "audiotrons." The dx is about 630 miles.

Nor is that all. During the same winter an Ohio station blew a high-voltage transformer, replaced it with a "one inch spark coil," stopped the rotary spark gap with the teeth close together and proceeded as usual. The signals were copied solid for several evenings at Lawrence, Kansas, by Harry C. Zieseness, Henry Alback Jr., and another amateur—the one who had that 60 foot iron mast on Indiana Street. I believe the Ohio station was 8NH. While not sure of that I do remember that 9DM (owned and operated by Zieseness) worked the station easily one evening and swapped a few messages as confirmation of the QSO. The receiver at 9DM was a 1-tube regenerative DeForest "tennis-ball" audion with a magnet to distort the field inside the thing, and a layer of soot on the outside where it had been softened by flaming it with Ohio blue-tip matches (Ohio seems to keep coming in). This 600-mile affair was with all antennas up, and high at that.

Once there was such a thing as 1-way reception of a "one inch coil" at larger distances, but I believe that was less well confirmed. However, Missouri Valley stations with Model T Ford spark coils regularly worked up to 30 miles to tubes, and up to 10 miles to crystal receivers. Arno Taylor's flivver-coil rig at Six Corners was reliable as a church at 5 miles with any old crystal we happened to use. Used to talk to him at noon when the static was too tough for a soft audion or a sensitive crystal and only molybdenum would stand up.

—*R.S.K.*

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A small sheet of cellophane folded loosely several times makes a shock-proof envelope for quartz crystals.

The New 6L6 Beam Power Amplifier

The new 6L6 is a man-sized tetrode (screen-grid, four-element tube to you) designed for use as an audio frequency power amplifier. It is a metal tube and has the conventional 6.3 volt 0.9 ampere indirectly heated cathode. In audio circuits and also in r.f. applications it acts much like a pentode. The design of the tube is rather new and it avoids some of the disadvantages of usual types of pentodes. Due to the special design of the screen or accelerating grid no suppressor grid is necessary to minimize secondary emission from the plate to the screen. There is wide separation physically between the screen and the plate. The wires in the screen grid are lined up directly behind the wires in the control grid so that the presence of the screen grid causes no "electronic shading" of the plate with a consequent undesirable increase in plate resistance. The importance of minimizing the undesirable electronic shading effect of screen and suppressor grids has been brought out several times in RADIO during the last eighteen months. The elimination of the suppressor grid is highly desirable when it can be done without affecting the suppression of secondary emission.

The 6L6 has an astonishingly high transconductance and gives a really surprising output with low plate and driving voltages.

As a crystal oscillator the tube has a little more power output than a 42 and a little less power output than a push-pull 6A6, all running at the same plate voltage. All three oscillators were about the same as far as r.f. crystal current was concerned.

As a doubler driving a 35T grid the following comparative results are interesting: The 35T amplifier was operated at 660 volts and

Tube	*Plate volts*	*Plate current*	*Screen volts*	*35T grid current*
6L6	400 v.	45 ma.	100 v.	39 ma.
802	500	34	180	37
42	400	32	100	24

78 milliamperes on 3946 kc. A 6L6, an 802 and a 42 were used as a doubler from a 1973 kc. crystal oscillator stage. The grid leak on the 35T was 2000 ohms and was left constant during the test. The d.c. grid current was used as an indicator of relative r.f. output of the three doubler stages.

While the above results cannot be compared exactly due to slight differences in plate input and plate loading, they are indicative of results that can be expected. The grid drive on the above doublers was increased until the output stopped increasing. The bias was chosen to give approximately the same angle of plate current flow in each case.

The 6L6 is really outstanding in the audio field and it is highly suitable for use as a modulator. Due to its design it ordinarily will not be used in single-ended amplifiers, but rather as either a triode or tetrode class AB amplifier. A pair of 6L6's can be relied on to give from 50 to 60 watts of low-distortion output at 425 plate volts plus cathode or semi-fixed bias. At higher plate voltages and high-percentage distortion tolerances the tubes can be pressed to give materially more than rated audio output, although their life will be shortened somewhat by overloading. With voice waveforms, fixed bias, and about 500 volts of plate voltage, no trouble will be experienced in modulating 175 watts of class C plate input with a pair of 6L6's.

One strange habit of the 6L6, which may have been due to the fact that we used some handmade experimental tubes rather than final production tubes, was that the tubes were quite persistent oscillators at various parasitic frequencies from 50 kc. on up. The extremely high transconductance makes it rather difficult to introduce enough loss at the parasitic frequencies to stop oscillation. This was bothersome only when using the 6L6's as audio amplifiers, and the use of large screen bypass condensers together with 200 ohms in each grid lead and 50 ohms in each plate lead eliminated the trouble. However, we are inclined to think that this trouble was peculiar to the experimental pair we obtained as we have found other 6L6's free from this trouble.

BEAM POWER AMPLIFIER
(Tentative Data)

Heater voltage (a.c. or d.c.)	6.3 volts
Heater current	0.9 ampere
Maximum overall length	4-5/16"
Maximum diameter	1-5/8"
Base	Small octal 7-pin

STATIC AND DYNAMIC CHARACTERISTICS

Heater voltage	6.3 volts
Plate voltage	250 volts
Screen voltage	250 volts

Grid voltage	—14	volts
Amplification factor	135	
Plate resistance	22,500	ohms
Mutual conductance	6,000	micromhos
Plate current	72	ma.
Screen current	5	ma.

PUSH-PULL CLASS A_1 AMPLIFIER

Plate voltage	375	max. volts
Screen voltage	250	max. volts
Plate and screen dissipation (total)[1]	24	max. watts

Typical operation—2 tubes:

VALUES ARE FOR 2 TUBES.

	Fixed Bias	Self Bias	
Heater voltage[2]	6.3	6.3	volts
Plate voltage	250	250	volts
Screen voltage	250	250	volts
D.c. grid voltage[3]	—16	—16*	volts
Peak a.f. grid-to-grid voltage	32	35.6	volts
Zero-signal d.c. plate current	120	120	ma.
Max.-signal d.c. plate current	140	130	ma.
Zero-signal d.c. screen current	10	10	ma.
Max.-signal d.c. screen current	16	15	ma.
Load resistance (plate to plate)	5,000	5,000	ohms
Distortion:			
Total harmonic	2	2	pct.
3d harmonic	2	2	pct.
Max.-signal power output	14.5	13.8	watts

PUSH-PULL CLASS AB_1 AMPLIFIER

Plate voltage	400	max. volts
Screen voltage	300	max. volts
Plate and screen dissipation (total)[1]	24	max. watts

Typical operation—2 tubes:

VALUES ARE FOR 2 TUBES.

Heater voltage[2]	6.3	6.3	6.3	6.3	volts
Plate voltage	400	400	400	400	volts
Screen voltage	250	250	300	300	volts

	Fixed Bias	Fixed Bias	Self Bias*	Fixed Bias	Self Bias*	Fixed Bias	
D.c. grid volt.[3]	-20	—20	—19	—25	—23.5	—25	volts
Peak a.f. grid-to-grid volt.	40	40	43.8	50	57	50	volts
Zero-sig. d.c. plate cur.	88	88	96	100	112	102	ma.
Max.-sig. d.c. plate cur.	126	124	110	152	128	156	ma.
Zero-sig. d.c. screen cur.	4	4	4.6	5	6	5	ma.
Max.-sig. d.c. screen cur.	9	12	10.8	17	16	12	ma.
Load res. (plate to plate)	6,000	8,500		6,600		3,800	ohms
Distortion:							
Total har.	1	2		2		0.6	pct.
3d har.	1	2		2		0.6	pct.
Max.-sig. power output	20	26.5	24	34	30	23	watts

PUSH-PULL CLASS AB_2 AMPLIFIER

Subscript 2 indicates that grid current flows during some part of input cycle.

Plate voltage	400	max. volts
Screen voltage	300	max. volts
Plate and screen dissipation (total)[1]	24	max. watts

Typical operation—2 tubes:

VALUES ARE FOR 2 TUBES.

	Self Bias	Fixed Bias	
Heater voltage[2]	6.3	6.3	volts
Plate voltage	400	400	volts
Screen voltage	250	300	volts
D.c. grid voltage[3]	-20	—25	volts
Peak a.f. grid-to-grid voltage	57	80	volts
Zero-signal d.c. plate current	88	102	ma.
Max.-signal d.c. plate current	168	230	ma.
Zero-signal d.c. screen current	4	6	ma.
Max.-signal d.c. screen current	13	20	ma.
Load resistance (plate to plate)	6,000	3,800	ohms
Peak grid-input power[4]	180	350	mill.
Distortion:			
Total harmonic	**	**	pct.
3d harmonic	**	**	pct.
Max.-signal power output	40	60	watts

*With no signal.

**With zero-impedance driver, plate-circuit distortion does not exceed 2%.

[1]Precautions should be taken to insure that dissipation rating is not exceeded with expected line-voltage variations, especially in the case of fixed-bias operation. Fixed-bias values up to 10% of each typical screen voltage can be used without increasing distortion.

[2]The heater should be operated at 6.3 volts. Under no condition should the heater voltage ever fluctuate so that it exceeds 7.0 volts. The potential difference between heater and cathode should be kept as low as possible.

[3]The type of input coupling used should not introduce too much resistance in the grid-circuit. Transformer- or impedance-coupling devices are recommended. When the grid circuit has a resistance not higher than 0.05 megohm, fixed bias may be used; for higher values, self-bias is required. With self-bias, the grid circuit may have a resistance as high as, but not greater than 0.5 megohm provided the heater voltage is not allowed to rise more than 10% above rated value under any condition of operation.

[4]Driver stage should be capable of supplying the grids of the Class AB stage with the specified peak values at low distortion.

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56 Mc. S.F. Transmissions

For the benefit of amateurs in the Boston area, W1AY will transmit standard frequency signals in the 5-meter band, starting at 8 p.m. local time each Monday evening from May 4th to October 5th.

The first transmission, at 8 o'clock, will be made on 56 mc. Each carrier frequency will be announced by voice as the tests progress from 56 to 60 mc., and after each announcement a prolonged tone-signal will be transmitted on the stated frequency.

The weekly broadcasts will be useful in the calibration of 5-meter receivers, monitors, and frequency meters; and, it is hoped, will encourage the construction and use of frequency-measuring equipment for direct indications in the 5-meter band.

With the 5-meter population in the Boston area now reaching almost fabulous proportions, it is important that attention be directed toward frequency measurements and high-stability transmitters.

The u.h.f. transmitter at W1AY is crystal-controlled. The crystal stage operates in the 40-meter band and is followed by 20-meter, 10-meter, and 5-meter doublers, a 5-meter buffer, and a 5-meter final amplifier.

The standard frequency program, planned some time ago, has been made possible by the Bliley Electric Co., which has furnished for the purpose a number of their low-drift 40-meter crystal units.

◆

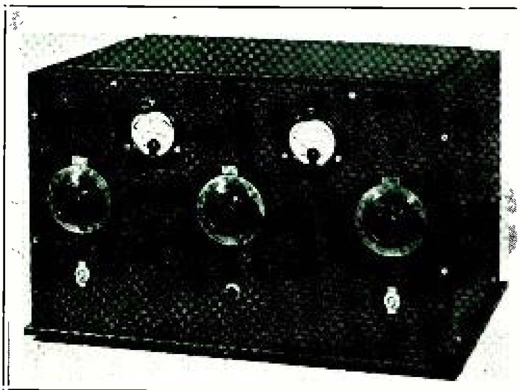
Section 29-d, *Rules & Regulations of the F. C. C.*, provides that call signals may be deleted where the licensee has been adjudged insane. Lucky dogs, some of these 5-meter hams!

160 Meter Phone Made Easy

By W. W. Smith, W6BCX

Many Breting 12 owners have requested us to describe a simple, inexpensive r.f. unit that can be modulated by the receiver for phone operation. Most of these requests specified 160 meter operation; therefore we are showing an r.f. unit for that band that delivers a 35-40 watt carrier and can be modulated 100% by a Breting 12 or by any speech system delivering 25 or 30 watts of audio to either a 200 or 500 ohm line.

A novel feature of the Breting 12 receiver, popular superheterodyne released several months ago, is the provision for bringing the audio output to a pair of tip jacks on the back of the receiver. Throwing the communication switch connects these jacks to a 200 ohm winding on the output transformer and disconnects the voice coil of the speaker. As the commercial rating of the output stage is 18 sine-wave watts at 5% distortion, this means that for amateur work, where 15% distortion can be tolerated on the occasional voice-peaks of 100% modulation, approximately 75 watts input to an r.f. stage can be fully modulated on voice with very acceptable quality.



Not a receiver, but the r.f. end of a 40 watt, 160 meter phone transmitter.

Two more tip jacks connect through the communication switch to the input of the audio system, which has sufficient gain to work from a high-output, diaphragm-type crystal microphone for close talking or from most any good two-button carbon microphone. The crystal microphone may be connected directly to the input terminals; the carbon type will require an external microphone transformer and battery. Full instructions and connections for using the receiver as a modulator or speech amplifier come with the receiver, so will not be gone into in detail here. Only three or four connections from the receiver are required, and are easily made.

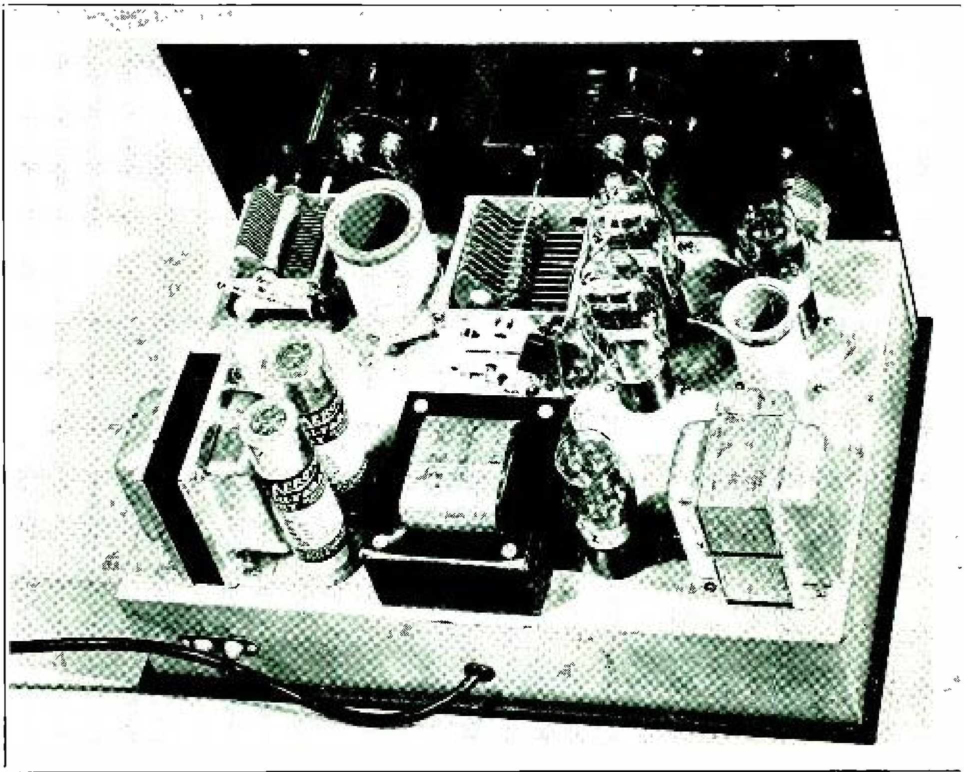
The transmitter shown in the photographs, using a pair of 802's in parallel, makes an ideal combination for a 160 meter transmitter for the newcomer who wants to get on phone as economically and with as little trouble as possible. When modulated by a Breting receiver it will put out a husky 40 watt phone carrier that will really go places on a good antenna (meaning high and in the clear). No neutralization is required, tuning is not critical, and the tubes are protected against overload from excitation failure by cathode bias, making practically a fool-proof transmitter that is safe in the hands of the most inexperienced amateur, and at the same time performing as well as much more elaborate and more "fussy" rigs.

The whole r.f. portion and its power supply were built into a "blank" Breting cabinet, making a unit that matches the receiver perfectly and resulting in a combination very pleasing to the eye as well as to the ear. The circuit was so designed that all variable condensers have their rotors at ground potential with respect to both d.c. and r.f. This allows mounting of the condensers directly on the metal panel, greatly simplifying construction.

The Power Supply

The power supply delivers slightly over 600 volts under load, which applies just 600 volts to the plates of the 802's after allowing for the d.c. drop through the cathode resistor and the d.c. resistance of the modulation transformer winding. The filter condensers consist of two, double-unit 8 μfd. electrolytics, the 8 μfd. sections in each can series connected to give greater breakdown voltage rating. Make sure when connecting the condensers to get the polarity right, or you will be buying new electrolytics. The resistors R_9 maintain equal voltages across each of the sections in spite of slight variations in internal resistance of the different condenser sections.

The switch in the high voltage center tap acts as the "off-on" (communication) switch. The switch in the primary of the power trans-



Top View of the 802 R.F. Unit with Cabinet Removed

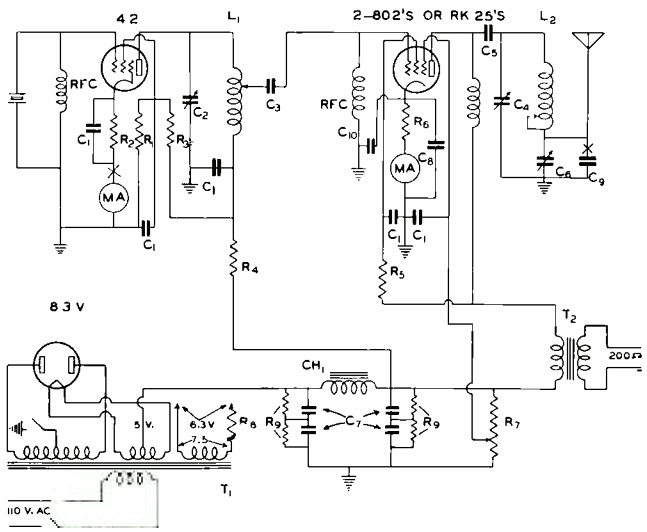
former is turned on and left on until one is through working the transmitter. A green pilot jewel on the panel (under the center dial) shows when the filaments are on, and is good insurance against inadvertently leaving the filaments on all night.

An 83-v is used as rectifier, though a 5Z3 may be substituted at a sacrifice in plate voltage. However, a full 600 volts from cathodes to plates is desirable for the 802's, and the 83-v is therefore preferable. For a given input, 802's do their best work at high plate voltage and low plate current, rather than lower plate voltage at higher current. A positive voltage on the suppressors also does wonders insofar as output and efficiency are concerned. The voltage divider, R_7, was incorporated in the power pack to provide an adjustable suppressor voltage source. The screen voltage could also be obtained from the divider were the rig to be used only on c.w., but for phone it is necessary to modulate the screens as well as the plates in order to obtain good linearity. This is simplest to do when the screen voltage is obtained directly from the modulated plate supply through a series dropping resistor.

It just so happened that a suitable transformer with a 6.3 volt winding was not available, although a transformer was found that just filled the bill except for the fact that it sported only 7.5 volt and a 5 volt filament windings. By inserting a $\frac{1}{2}$ ohm dropping resistor the 7.5 volts was reduced to the proper value for the 42 and 802's.

The Oscillator

The 42 oscillator runs at slightly over 500 volts (plate to cathode), yet the crystal current is quite low. By keeping the screen voltage down, the tube shows no signs of strain at this plate voltage, and the output is considerably greater than at 400 volts or so. The cathode bias protects the tube from "creeping" and from high plate current when in a non-oscillating condition. A "Y" cut crystal will be found to give more output than an "X" cut crystal, but the frequency stability will not be as good. At 40 and 80 meters an "X" cut crystal may be ground to have as much output as "Y" cut, but at 160 meters an "X" cut will not oscillate as freely as a "Y" cut. Probably the best crystal will be a a 160 meter "A-T"



The Wiring Diagram

L_1, L_2—See text
MA—2 inch, bakelite case milliammeters: 0-50 for osc. and 0-200 for amp.
C_1—.006 µfd. mica
C_2—100 µµfd. midget
C_3—100 µµfd. mica
C_4—150 µµfd. double spaced
C_5—.002 µfd., 2500 volt mica
C_6—365 µµfd. receiving type
C_7—Dual 8 µfd. can-type electrolytics (must have individual negative leads)
C_8—.003 µfd. mica
C_9—350 µµfd. fixed mica, 1000 volt
C_{10}—10 µfd., 50 volt electrolytic
R_1—50,000 ohms, 2 watts
R_2—300 ohms, 2 watts
R_3—50,000 ohms, 2 watts
R_4—1000 ohms, 10 watts
R_5—10,000 ohms, 10 watts
R_6—300 ohms, 10 watts
R_7—50,000 ohms, 30 watts, slider type
R_8—0.5 ohm, 10 watt dropping resistor
R_9—100,000 ohms, 1 watt
T_1—600-0-600 volts at 150 ma., 5 volts at 3 amps., and 7.5 volts at 2.5 amps.
T_2—500 ohms to 4,000; 6,000; or 8,000 ohms. Must be designed to carry current to r.f. stage.
CH_1—20 hy., 200 ma.
RFC—All r.f. chokes should be 8 mh. or more, preferably pie wound

cut, as these have very low drift yet oscillate quite freely. However, any will be satisfactory so long as it oscillates readily when loaded as in the diagram, even vigorously-drifting "Y's". "Cycles per million drift per degree" does not become a serious item until we get to the higher frequencies. 800 cycles drift at 20 meters represents but 100 cycles drift at 160 meters.

The oscillator coil is wound with 63 turns of no. 22 d.c.c. wire on a standard 1½" form, tapped at the 37th turn from the "cold" end (26 turns from the "hot" end). To tune the oscillator, merely adjust the tank condenser to the maximum capacity at which the stage will oscillate stably, as indicated by the milliammeter. This point will coincide very closely with the point of minimum oscillator plate current. If the oscillator does not come on each time the switch is thrown, decrease the tank capacity very slightly.

The 802 Stage

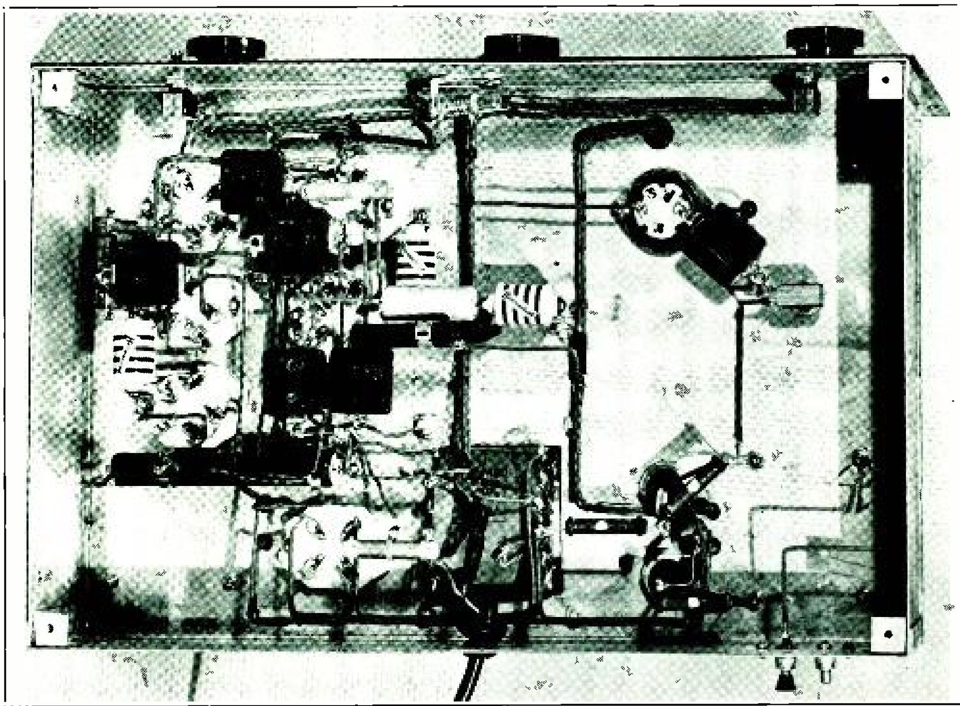
The tank coil for the 802 stage is wound with 55 turns of no. 18 d.c.c. on a "Giant" 2¼" form, tapped at the 4th and 8th turn from the antenna end. This is necessary because of the comparatively great width of the 160 meter band in meters, and also because the output circuit acts very much like a conventional Collins antenna coupler in that it is sometimes necessary to short out a few turns with certain antennas to make it tune up properly. If provision for shorting out turns were not made, trouble might be experienced in covering the whole band, or in trying to tune up with certain antenna lengths or types.

The slider on R_7 should be adjusted with the transmitter loaded (pulling normal plate current) to give about 60 volts plus on the suppressors when measured from suppressors to cathode, *not from suppressor to ground.*

The large audio bypass C_{10} prevents modulation from generating an audio voltage across the cathode resistor, which would modulate the suppressor voltage and control grid bias voltage.

Any type single-wire-fed or single-wire antenna may be used with the transmitter. The only requirement is that if the transmitter is directly connected to an antenna that is very close to a quarter wave long, a very short lead to a *good* ground connection, not over 15 or 20 feet, be made. Otherwise the chassis of the transmitter will be "hot" and will have "hand-capacity." If you cannot avoid a longer ground lead, try to make the antenna close to a half wave long (between 230 and 260 feet long overall) and "end feed" it. The current as measured in the ground lead will then be much lower, and a good, close ground connection is not as important.

The condenser C_6 is used for adjustment of antenna loading; the greater the capacity, the less (lighter) the loading and the lower the plate current to the 802's and the lower the output. For each adjustment of C_6, the condenser C_4 should be "re-dipped" to minimum plate current, as the adjustments of the two condensers interlock and are interdependent.



Underneath View of Chassis, Showing Position of Components

C_6 should be so adjusted that C_4 dips to about 135 ma. as read on the meter in the cathode circuit of the 802's. The tubes should not be loaded any heavier than this or their life will be shortened. Do not expect the meter to dip way down when the antenna is removed and C_4 varied, because the meter reads not only plate current but also control grid current, suppressor current, and screen current; and the latter three do not drop way down as does the plate current when the load is taken off the output tank.

Under certain conditions, especially when the receiver is tuned close to the transmitting frequency, it may be necessary to turn the band-change switch to another band to prevent feedback and sometimes detuning of the transmitting antenna circuit, which will be manifest by a change in plate current to the 802's. The same result can be achieved by detuning the receiver, but this procedure demands that a station be logged and tuned in again each time. Ordinarily trouble will not be encountered unless the receiving and transmitting antennas are in close proximity. Another way to dodge the trouble if it appears is to put a switch in the receiving antenna lead and open it when transmitting. If you do this, be sure the switch is open when originally tuning up the transmitter, as it affects the transmitter tuning.

By substituting 75 meter coils and crystal the transmitter will work well on 75 meter phone, but constants are not given because we cannot indorse phone operation on that band without at least one buffer stage except for portable operation. The rig was designed exclusively for 160 meter phone and for such work is hard to beat on a results-per-dollar basis.

With connections to T_2 made to the 4000 ohm taps, approximately 100% voice-peak modulation will be indicated by *occasional* swings of the right hand meter on the Breting receiver to full scale. This meter may be used as a level indicator, and is very handy in keeping a watch on percentage modulation.

If a neon lamp is coupled to the antenna or feeder lead, approximate 100% modulation will be indicated by an *occasional*, barely-perceptable flicker during speech transmission. You may get a few reports of "not hitting the carrier very hard," but checking on an oscilloscope will reveal that the loud voice peaks are hitting 100%.

When running properly the approximate cathode currents for the two stages will run about 35-45 ma. for the crystal stage and 125-135 ma. for the 802 stage. Use the fewest turns on the amplifier tank coil with which it is still possible to load and resonate the 802's (short out as many turns as you can and still hit resonance at proper load). This gives a higher "Q" tank, and is conducive to good linearity.

With certain length antennas (notably a quarter wave Marconi) it sometimes will be found impossible to get the amplifier to tune and load properly because of insufficient capacity at C_6 even with the plates all the way in. Rather than using a bulkier and more expensive condenser of greater maximum capacity, C_9 was incorporated. When more capacity is needed for certain set-ups, close the switch that connects this fixed shunt condenser in the circuit, and tune C_4 as has already been described. Do not close the switch, however, ("on" position) unless it is impossible to tune up the rig properly without doing so.

Incidentally, many of the small, 2½ mh. pie-wound r.f. chokes are none too effective at 160 meters. Chokes of at least 7 or 8 mh. will be found much more effective at this frequency. 160 meters is not exactly a "short wave" band, and many of the "high frequency" r.f. chokes were not designed to work at that frequency.

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QRR MOOSE RIVER

Moose River, a little mining village about 70 miles east of Halifax, has a 30 party rural telephone line as normal contact with the outside world. At the time of the recent mine disaster this line proved hopelessly inadequate to handle even the calls of the inhabitants, much less the emergency news flashes and bulletins of the dozens of newspapermen and cameramen who descended upon the scene from all points west.

After an unsuccessful attempt by a commercial radio communications company had failed to establish contact with Halifax and the outside world, local amateurs were allowed to try their hand. A party of three: A. M. Crowell, VE1DQ, S.C.M. of the Maritimes; Bill Horne, R.M., VE1GL; and Trevor Burton, VE1CP (part of whose transmitter was commandeered) started for Moose River early Sunday morning, April 19th. Contact was made with Halifax early that afternoon just a half hour after arrival. Permission of the Canadian Dept. of Marine was obtained to use the portable call VE1DQ. A Canadian Press commercial call VYA also was made available in case it be found necessary to use it. It was not used however. Power input to the little transmitter (6F6 crystal osc. and 42 amplifier) usually ran about 30 watts, the heavy duty "B's" furnishing close to 600 volts the greater part of the 96 hours of almost continuous operation. Frequencies of 3545 and 3730 kc. were used, the former almost all the time, because of slightly better output and less QRM trouble at that spot.

The receiver (VE1GL's) was the old stand-by for this kind of work, an SW-3.

The rig was set up in the old boiler house on the same bench vacated a day before by our commercial friends. Noise, noise, all around; fifty odd miners, newspaper men, cameramen; all crowded into that shack to snatch a bit of warmth at the boiler, get relief from the cold rain, or take their turn at the telephone in attempts to contact their different papers. Yells of command were continually being heard above the loud drone of excited conversation and press typewriters. Through the phones came noises almost as bad in intensity; a tiny light plant to aid the miners just 20 feet away was making plenty of hash; a large gas driven compressor gave it's spasmodic ignition barrage, and the almost hourly arrival of supply planes swooping low over the shack with their relief equipment from Halifax added to the din. A listen on VE1AW showed him there lining up another ham as a relay point. VE1AG was on the job! A call "QST QRR HALIFAX" brought VE1ET (Walt Wooding) to the key at 1AW's and the fun commenced. The 3.5 mc. band behaved rather badly on all nights but Wednesday, and during fadeouts or periods of skip, VE1AG, with Bill Bligh (BC) at the key, came into the picture for rapid relay. No time was lost and as soon as conditions opened up for direct contact with Halifax, the DQ-AW skeds were resumed. Thousands of words were handled from that boiler shack. From the private greetings of the men from Ontario and distant points to the last Canadian Press flash of rescue and bulletin of safety when the men were finally brought to the surface by the draegermen, all went on the "cleared" hook in record time.

The ops., "Art" and "Bill" snatched odd naps coiled up on a box or leaning over the bench during brief lulls of "QRX 5 mins," periods while waiting for news from the pit while the hook was cleared. A mug of black coffee from the passing tin bucket, a sandwich jammed in the mouth while waiting for a "check" and "ok", was the regular bill of fare during the 96-hour vigil in the boiler house with its carbide fumes and dirt floor (and we mean dirt: dust inside and mud outside).

At VE1AW, "Walt" and "Cliff" kept their phone (land line) open as it was in use continuously. C.N. messengers snatched odd naps on the couch between runs to the Can. Press Office, while Walt cussed the skip and fade, and all asked, "when do we eat or sleep". VE1FN dropped in and gave much needed relief with a trick at the set. VE1HJ took a "long one" and shot it through in good time. VE1AG stood watch on "DQ" while "Bill" snatched a few winks on the floor between fades at AW's. Transmissions of the Moose River rig were copied in Moncton and several reports were later received from Penn., U.S.A. as having copied most stuff direct.

All concerned at this end desire to thank those of the 3.5 mc. gang who so nobly stood by or helped in any way to "clear the channel" and thus do their bit in showing the world just what amateur radio can do in the way of real service to the public.

—VE1DQ.

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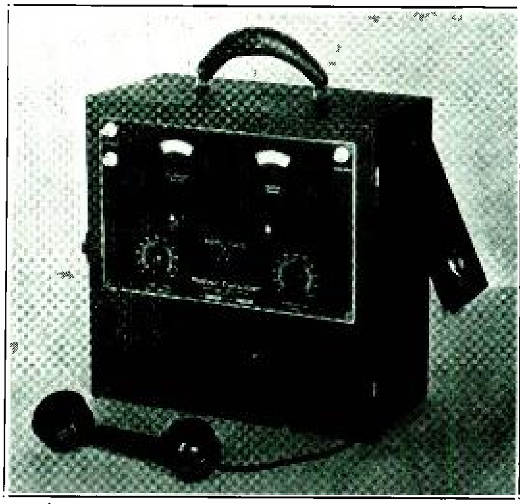
Latest candidate for the longest name honor: Carl *Ahrenhoersterbaeumer*, W9BTB.

The "Transceptor"

By Frank Lester*



The "Transceptor" with the hinged front cover removed from the case.

The "Transceptor" is believed to be a logical improvement on the "transceiver", and in fact was evolved from experience gained in the building of hundreds of transceivers. The transceiver, which has been extremely popular in the 5 meter field, suffers from one serious shortcoming, which becomes more and more objectionable as the user becomes more proficient in 5 meter technique. Inasmuch as the same antenna is used for both sending and receiving, and practically all of the other parts of the instrument likewise serve a dual purpose, some compromise in adjustments becomes unavoidable. This is especially true of the extremely important adjustment of antenna coupling. The best coupling for transmitting unavoidably proves too tight for receiving, and prevents the receiving portion of the transceiver from superregenerating properly. Therefore some intermediate value of antenna coupling must be chosen which will permit the transceiver to function passably in both the sending and the receiving combinations. This means that it does not give the best performance of which it is capable.

The Transceptor Idea

If a standard antenna were to be used one might, to be sure, provide the send-receive switch with additional contacts capable of changing the antenna coupling when switching from "Transmit" to "Receive". But such a device would be rather puzzled by the variety of antennas used in practice. It was accordingly decided to divorce the sending and receiving antennas altogether, and to use two independent antennas. As 5 meter antennas are small this produces no difficulties, while on the other hand it does permit proper coupling adjustments to be made independently for both sending and receiving, using the simplest and most familiar methods: clips and a midget variable condenser.

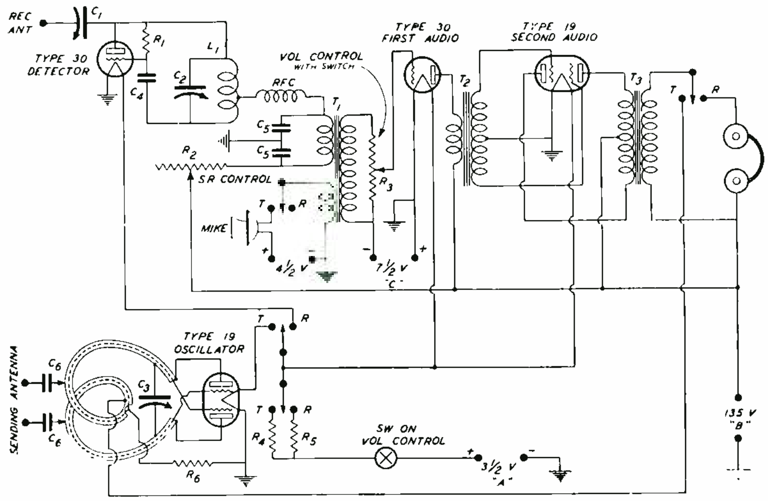
To put this conclusion into practice and at the same time to preserve the highly desirable compactness and portability of the transceiver, the writer has designed a 5 meter portable rig which is known as the "Transceptor".

Circuits and Physical Form

This "Transceptor", which is shown in the accompanying illustrations, measures 15 x 15 x 7½ inches, and is therefore a trifle larger than a portable typewriter. The black crackle-finished steel case is fitted with a hinged cover which protects the controls when the unit is not in use. This cover also makes a container for the necessary antenna wire, paper, pencils, and even a cheap watch, and incidentally becomes a writing surface. A compartment at the right side of the case houses the handset. There is no need of an additional handbag as is so often the case for (apparently) compact equipments.

Electrically the "Transceptor" comprises 4 tubes in a thoroughly reliable circuit. A type 30 tube functions as a self-quenching super-regenerative detector, operating with a *separate* 1-wire receiving antenna which is connected to the terminal at the upper right corner of the panel. The send-receive switch is on its central or "off" position when the set is not in use. If it is thrown to the "Receive" position, a transformer, T_1, operates as a straight audio amplifying transformer, feeding the detector output to a second type 30 tube as a first audio amplifier stage. This stage in turn feeds a type 19 tube through another transformer, T_2. The type 19 tube operates as a class B audio stage and its output is fed through a third transform-

*Engineer, Wholesale Radio Service Co., Inc., also W2AMJ.

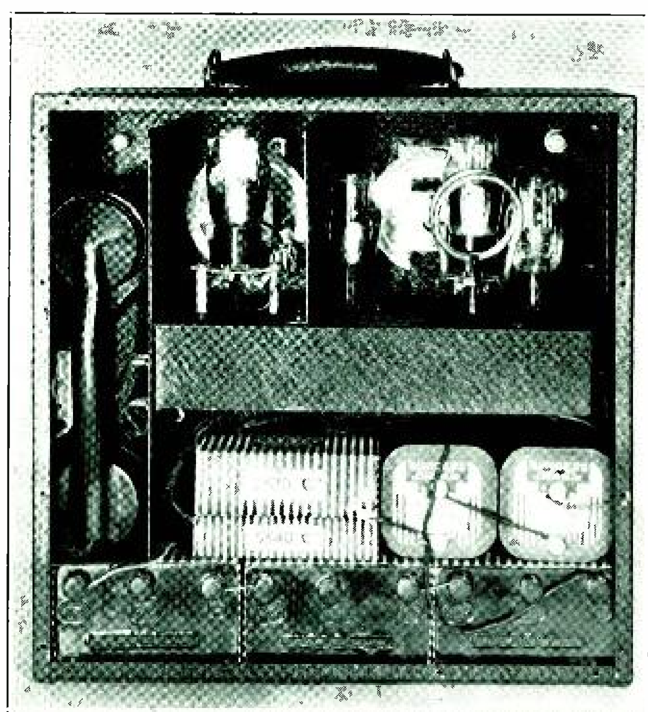


The "Transceptor" Wiring Diagram

C_1—3-25 μμfd. trimmer
C_2—10 μμfd. midget
C_3—15 μμfd. midget
C_4—.00025 μfd.
C_5—.004 μfd.
C_6—.0002 μfd.
R_1—20 meg., 1 watt
R_2—100,000 ohms
R_3—500,000 ohms, tapered (with switch)
R_4—1 ohm, 5 watts
R_5—2 ohms, 5 watts
R_6—5000 ohms, 1 watt
T_1—Midget interstage with 200 ohm winding for mike
T_2—Midget driver transformer
T_3—Midget modulation transformer, 19 tube to 5000 ohms

er, T_3 to the receiver portion of the headset.

When the send-receive switch is thrown to the "transmit" position, another type 19 tube operates as a unity-coupled push-pull r.f. oscillator in conjunction with the *other* antenna, which is reserved for sending. The oscillator is coupled to this antenna by a feeder or feeders brought to one or both of the terminals at the upper left of the panel. These terminals go through stopping condensers to clips on the plate coil of the r.f. oscillator. Meantime the microphone portion of the handset is connected in series with a special primary winding of the transformer T_1, already referred to, so that the two audio tubes now function as voice amplifiers. The transformer T_3, which will be remembered as the output transformer of the class B type 19 audio tube, is disconnected from the headset and instead is switched in series with the B+ lead of the oscillator tube and accordingly modulates the plate supply of the oscillator, which accordingly generates a modulated r.f. output.



Interior View of the Transceptor

Back view of the unit with the cover removed. This is the 2 volt battery model. In the 110 volt model, a power pack takes up the space occupied by batteries in the one illustrated. Note the shield between the receiving and transmitting r.f. circuits.

It is of course necessary to remove the detector from the circuit in some way to prevent feedback via the two-antenna system, and also to prevent additional modulation of the transmitted signals by strong incoming signals. This is accomplished by another switch contact which opens the filament of the detector tube. Resistors are provided in the filament circuit to compensate for the slight voltage differences that occur between the receiving and the sending circuit combinations. The warm-up of the detector filament is very brief and causes no delay when returning to "Receive" position. When receiving the oscillator filament is cut off, so that there are never more than 3 tubes "on" at any time.

Beyond this the controls are found to benefit from the divorcing of functions. The tuning controls for sending and receiving are independent. That this is a huge improvement over a transceiver will be evident to any person who has had experience with transceivers. These are not mere expectations; the Transceptor, in field tests, has proved to be exceptionally successful in all respects. The improved mechanical construction makes for freedom from trouble, but also makes it humanly possible to effect repairs if they become necessary through mischance or rough usage. These features must appeal to the experienced 5 meter operator who has wrestled with ordinary transceivers.

The particular "Lafayette" Transceptor illustrated is the 2-volt self-contained battery model, which incidentally shows how a slightly enlarged case has permitted the placement of all batteries without crowding. There is also a model in which the 2 volt tubes are replaced by those of the 6.3 volt series. This model may be used in an automobile with either battery or dynamotor plate supply, or it may be used on a 110 volt supply with the aid of a powerpack which fits into the space occupied by the batteries in the 2 volt model. The 6.3 volt model accordingly makes a compact 5 meter station for fixed use, or for semi-portable use outside.

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Did you know you can buy very serviceable taps and dies and handles for 10c each at most 5 and 10c stores? While you are there look over their stock; you may find other little gadgets of value around your shack for a very nominal price.

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Sissies is the longest all-dot English word—*motto*, the longest all-dash.

The Past History of "RADIO"

In view of the recent change in the management of *Radio*, and the merging of *R/9* and the old *Radio* to form the new *Radio*, the following statement regarding the several different periodicals published in the past which are now represented in *Radio*, is given as a record for the benefit of librarians and others interested in such history.

R/9 commenced publication under that title with the issue of September, 1932 designated no. 37, and it was published regularly through December, 1935, designated no. 73. Nos. 47, 48, and 51 were double numbers for July-August, September-October, 1933, and January-February, 1934. Following no. 48 (September-October, 1933) a small special extra number, no. 49, was published primarily for advertisers, which was dated November, 1933; the December, 1933 issue was designated no. 50. Otherwise the numbering of the issues was regular each month. K. V. R. Lansingh was Editor and Publisher of *R/9* throughout this period. R. S. Kruse became Technical Editor with no. 60 (November, 1934), and the size of page was enlarged from 6" x 9" to 7" x 10" at the same time. *R/9* began with no. 37 because it succeeded and continued the numbering of the *Oscillator* previously published.

The *Oscillator* was a local monthly magazine published prior to January, 1932 in Los Angeles and Gardena, California by the Amateur Radio Research Club of Los Angeles; Melvin S. Wood, W6AVJ was editor. This began with vol. 1, no. 1, dated December, 1928, and continued each month regularly through December, 1931, vol. 3, no. 12, with a page of size 6" x 9". Therefore in starting with no. 37, *R/9* continued the numbering of the *Oscillator*. Vol. 1 of the *Oscillator* closed with the December, 1929 issue and contained thirteen numbers. Vol. 1, no. 7 was dated May, 1929 instead of June. Vol. 2 of the *Oscillator* began with January, 1930, and vol. 3 began with January, 1931, and each contained twelve numbers. Otherwise the numbering of the *Oscillator* was regular.

The publication of *Radio* commenced under the title *Pacific Radio News* with the January, 1917 issue (vol. 1, no. 1), and continued monthly through May, 1917 (vol. 1, no. 5). With the entry of the United States into the war and the discontinuance of amateur radio activities, publication was then suspended through December, 1919. Publication was resumed with the issue of January, 1920 (vol. 1, no. 6) and continued regularly each month through January, 1933. Vol. 1 concluded with the July, 1920 issue (vol. 1, no. 12) and all issues of vol. 1 had a small page size 6" x 9". With the August, 1920 issue (vol. 2, no. 1), the larger page of 9" x 12" was adopted and continued through December, 1935. H. W. Dickow and Paul R. Fenner were the editor and manager at the beginning, and it was then published by the San Francisco Radio Club. Vol. 2 covered from August, 1920 to July, 1921.

There was a change of management and Arthur H. Halloran became Editor with the October, 1921 issue (vol. 3, no. 3). With the November, 1921 issue (vol. 3, no. 4) the title was changed from *Pacific Radio News* to *Radio*, and vol. 3 closed with no. 5 (December, 1921). Vol. 4 began January 1922, and the numbering was then regular until

[*Continued on Page 87*]

28 and 56 Megacycle Activity

[Reports and other material referring to the 28 and 56 mc. bands, should be sent to E. H. Conklin, W9FM, Assistant Editor of RADIO, 512 No. Main St., Wheaton, Illinois, who will correlate and assemble the data for publication. Reports should *reach him* by the 22d of each month.]

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56 Mc. Open Again!

J. C. Patterson, W5EHM, writes from down Dallas way as follows:

"Unusual conditions prevailed on 56 mc. on the night of April 30 from 8 to 10 p.m. Central time. Several W9's and one W8 were heard, fading rapidly. Due to the fast signing of calls, we were not able to be sure of many of the calls. They talked of how they liked 56 mc.; so we are sure that they were on 56 mc. This list gives peak reports, and calls as nearly as we could catch them: W9CFE-7; W9CSB-6; W9EWO-7; W9EII-6; W8EGE-8; W9UHU-5; W9AEQ-8; W9RGT-6. The best was W9AEQ to whom we listened for 45 minutes. No contacts were made, but we hoped that these conditions would repeat the next night; so we put up a high gain antenna the next day. Up to May 4, no additional signals have been heard. We guess that this was one of the good 56 mc. days like those of a year ago. 28 mc. has been very dead lately."

On March 28, W6CNE was overheard on ten meter phone saying that his five meter phone (50 watts input) had been reported R9 on Long Island, N.Y. The receiver was a Philco all-wave. The time was 8:15 p.m. Eastern time. W6CNE also was heard R8-9 in Cincinnati on a two tube super-regen at 8:30 p.m., and in the daytime in Oklahoma.

By the publication date of this issue, we expect to hear of many Chicago-New York contacts on 56 mc., which may become fairly common again this year from mid-May to mid-July. During the same period, stations in southeastern U.S.A. should have a fine chance for long-distance five meter work on the short skip to the populous northern sections, particularly on week-end afternoons. When 28 mc. is open to a distance of 400-500 miles, 56 mc. should be open to some point—though the absence of a second station at the proper distance may make the band sound dead. Plenty of calling, particularly on code with c.w. or a modulated signal, should prove helpful.

Jerry Gorman, W6JJU, is setting up a 56 mc. V beam for Japan to try for J2HJ, stacking several V's vertically to hold the radiation down to useful low angles.

Charlie Myers, W3SI, has planned a five-meter beam aimed west, which should land some reports from W6 and western W9. Charlie complains of bootlegger QRM and pleads for stabilized transmitters on 56 mc.

FLASH

On Saturday, May 9, between 9 and 11 p.m. Eastern time, W9LWI heard 33 eastern stations on 56 mc. Three or four were worked, but most of the time was spent logging them.

Carl Lightcap, W8NSS, on May 9th, heard the best bunch of 56 mc. dx stations that has ever been reported to us. In an hour and fifteen minutes in the evening, eighteen W1's, one W2 and one W3 were heard, the reception taking place in Dayton, Ohio. All were on phone, ranging from R5 to R9, except W3HG who was using i.c.w. Here is the log as reported to us:

8:50 pm. E.s.t.	W1AAL	R6
8:55 p.m. E.s.t.	W1JPW	R5
8:56	W1IFT	R5
9:00	W1AQV	R7
9:01	W1JCT	R7
9:01	W3HG	R8 (i.c.w.)
9:05	W1ILT	R8-9
9:07	W1HXP	R9
9:16	W1JAR	R8-9
9:21	W1WG	R9
9:21	W1ADR	R8-9
9:22	W1DPP	R8
9:26	W1BJ	R8
9:26	W1BKE	
9:35	W2JCY	R8
9:36	W1EER	R6
9:45	W1AGO	
9:52	W1EYM	R6
9:57	W1ASB	R7
10:12	W1ZE	R8

28 Megacycles

The major break in ten meter conditions over the north Atlantic took place on schedule March 17. There were only a few isolated days, in the six months prior to that date, when some Europeans were not heard. Up to mid-April, Europeans came in occasionally, while southern hemisphere continents were still coming through. Then the dx dropped out except for HI5X and NY2AE. Beginning April 19 there were some practically dead days for signals at any distance. In contrast to this, W6KLU on April 18 said that in the two previous days he had worked all continents except Africa, so west coast conditions might have been better. At the same time, southern hemisphere stations have been able to work each other with increasing success, something that was seldom done during the northern winter.

We expect that South American signals will continue during the summer, being the most nearly north-south path. South Africans should occasionally get through to North America, and a few Aussies particularly in July or later.

We do not expect a return of the fine W6-W9 conditions which we have had consistently for the past six months, until next October. Some contacts are probable, though, on days of relatively long skip, or for short periods at the beginning and end of the 28 mc. working day. But from late May to August we should have excellent daytime and evening conditions for distances of 400 to 1500 miles.

Station Reports

ZS1H: Via W9JGS. Reported being on 28 mc. during the whole dx contest in March, working over 250 W/VE stations. On March 25, conditions were very good, being QSO many stations in Europe, north Africa, both Americas.

ZE1JJ: In a 28 mc. contact on April 10 with W9TJ, reported that the first QSO on *any* band between Southern Rhodesia and New Zealand (ZL1AR) took place April 1 on "ten". Still needs Asia for w.a.c.

PK4AO: Heard loud on 28.4 mc. on February 22 by W9LF.

G2YL: During the first two weeks of March conditions were excellent and stations in all continents were consistent. The band was open to 2300 G.m.t. on several occasions. But on the 17th a change took place; though South African and South American signals continued to come in well there was an almost complete absence of North Americans. These conditions continued for ten days; the only W's that did get through were weak and soon faded out. From the numerous reports received by the R.S.G.B. 28 mc. section, it is obvious that an ever-increasing interest is being taken in 28 mc., and in the future if the band goes dead we shall at any rate know that conditions, and not the apathy of transmitters, are to blame.

G6DH: Worked VU2AU on phone March 1 for the first European phone w.a.c. on 28 mc. During March, made first G contacts with HJ, K4, K5, CM and J.

G6NF: Worked all U.S. and Canadian districts in March, the contact with VE5EO on the 5th being, it is believed, the first QSO between Europe and VE5.

G6LK: Scored 960 points on 28 mc. in the dx contest, and made the first G contact with VS6AH for this band on March 1.

(G)2AXX: Heard PK1MC on March 8.

BRS1847: Logged some unusual dx for England in March, including K6 and VP1.

W6EWC: On April 1 reported conditions very good in March for dx but poor for U.S.A., just a few mid-western stations in all day, with W1 in and out.

W9JGS: ZS1H was consistent the last week in March and was worked four consecutive days. No Europeans heard in the month following March 22, all dx being southern hemisphere stations, central Americans, K4DD and HI5X. Band completely dead even for W6 April 19 and following several days.

W9TJ: In a month ended in mid-April, worked 18 countries, all continents.

W1LZ: Ten meters has been rather quiet since the contest, so have been on "20".

W2DTB: Both 28 and 14 mc. have been poor in the week ended April 19. The first two weeks of April were marked by good signals from VK, ZL, LU, and South Africa. On April 4, four ZL's and 5 VK's were heard. VK3YP on phone heard on several occasions. K6KSI, CP1AC and PY2MO also heard. Europeans have been below par except for short periods when German signals come through strong. Now have a three-band contact with a station in every continent except for 20 and 40 meter QSO's with J2HJ.

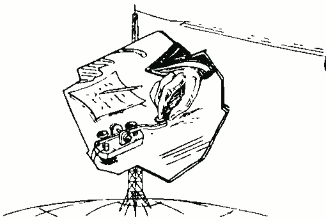
W3AIR: 36 countries now on 28 mc. Still getting through to Europe at times in April on the beam. South America seems the best bet so far this month. Signals are good from the South on the great skip only.

W3FAR: Europeans fair in March up to 17th, returning on the 22nd, April 2, 3, 7 (good), 8 and 11. As for other dx up to April 17, VK or ZL was heard on the 1st, 2d, 4th and 10th; South Africa on the 5th, 12th and 16th. K6MVV came in on phone on the 6th, XE1AY and LU8AB on the 16th. U.S.A. signals erratic. In March I used only 5 watts input to my 210's, working PA0AZ, G2TM, G5BP, G6RH, G6DH, G6CL, G2NH, G2IO, OK2OP, D4PBV, FA8BG, CP1AC and ZS1H.

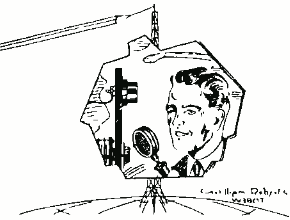
Antennas

We are glad to be able to report greater use of "improved" antennas on 28 mc. W6JN has a stack of four, phased vertical doublets and reflectors, giving a broad-nosed, uni-directional pattern with low angle radiation. W3AIR and W9JGS use horizontal double-zepps, stacked vertically, giving some sharpening of the pattern in the horizontal plane but getting more gain from concentration of power in the lower angles. W2DTB uses two verticals, one above the other and coupled with a quarter wavelength stub, giving non-directional radiation at a low angle—but he has an innovation in driving schemes, a single wire feeder attached to the stub.

[*Continued on Page 92*]



CALLS HEARD AND DX DEPARTMENTS



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

Arthur Stevens, ZL2HR, Menawapon Road, Hawera, New Zealand To March 12, 1936

(3.5 mc. c.w.)

W 1BVP-4; 6DYL-5; 6RH-6; 7AMH-4; 7AMS 5; 7EAA-5; 7EUA-3; 8AIW-6; 8DOD-6; 8VP-4; 9UHQ-3. VE7JT-4.

(14 mc. phone)

W 1BY-6; 2AAM-6; 2AI-5; 3LMF-5; 4BQG-6; 4CLE-6; 5FMN-5; 6CB-4; 6CLS-5; 6CQG-8; 6FXR-5; 6FZR-6; 6LLQ-5; 6MD-4; 7BS-5; 8FA-6; 9LDI-7. G6FF-4; G6RK-5; K6BAZ-5; K6JLB-7; KA1AN-7; KA1ME-6; NY2AE-8; PK1MX-6; TI2AE-6; TI2RC-8; TI2AO-5; TI3AV-6; VK6MO-6; VK6MW-7; VP2CD-6; XE1CT-6.

(14 mc. c.w.)

W 1AVF-6; 1BN-5; 1CJP-5; 1CO-3; 1DLD-7; 1DMK-5; 1GCX-6; 1GH-4; 1HM-5; 1HOA-5; 1HWP-4; 1IAS-3; 1IBD-6; 1IQZ-7; 1IYB-5; 1KN-6; 1SZ-6; 1TS-4; 2AIO-5; 2AFU-7; 2AMA-6; 2BHW-3; 2CQV-5; 2EWH-4; 2FF-7; 2GIZ-4; 2GMM-6; 2GOM-6; 2GVZ-7; 2HMJ-5; 2HQY-4; 2KL-5; 2KUD-3; 2MO-6; 2OR-5; 3AAT-7; 3CVK-3; 3DAZ-5; 3EJM-5; 3ELD-3; 3ERD-3; 4AJX-4; 4BZA-3; 4BQR-5; 4CFD-7; 4CHB-3; 4CQG-5; 4DCK-4; 4DLD-3; 4OC-6; 4TR-7; 5ASG-6; 5FBQ-4; 5OJ-5; 6ASV-4; 6AWT-7; 6AZS-7; 6BAG-8; 6BGC-3; 6CEM-5; 6CVV-7; 6CXW-9; 6EEP-7; 6EJC-6; 6EPM-3; 6FG-7; 6FKZ-5; 6FMY-3; 6HFB-5; 6HFU-7; 6HGE-4; 6IDW-7; 6IFW-5; 6IJX-5; 6INC-6; 6ITH-6; 6IXJ-5; 6JBQ-6; 6JJU-7; 6JNL-4; 6KDV-6; 6KHV-7; 6KQL-5; 6KRI-3; 6LCF-7; 6LCJ-5; 6LDF-5; 6LHN-5; 6MSM-6; 6QD-7; 7CD-6; 7DSZ-7; 7ERU-3; 7WL-6; 8ARX-5; 8BCT-5; 8BFG-5; 8BK-7; 8BO-3; 8BOF-6; 8BOS-4; 8CRA-5; 8CTE-5; 8GNN-7; 8HRD-7; 8IBM-6; 8JAN-7; 8KDO-6; 8KER-4; 8KL-5; 8LNI-4; 8MAH-7; 8OJI-5; 9AHX-6; 9BPU-6; 9CDM-5; 9DJE-3; 9EQP-6; 9HTP-7; 9IWE-4; 9JNU-6; 9LVG-7; 9PHQ-6; 9RBI-6; 9RF-3; 9RRM-6; 9RRS-5; 9RXL-5; 9SRE-4; 9STP-6; 9TOQ-5; 9UOX-6. K 4BRM-5; 5AC-6; 5AG-6; 5AL-4; 5AM-5; 6AUQ-7; 6BAZ-5; 6CJG-6; 6CMC-6; 6DU-5; 6ESU-4; 6HZI-6; 6JFV-5; 6JPD-7; 6LBH-6; 6LHK-7; 6MEG-5; 6MTE-4; 6NEK-6; 6UA-5; 7EXU-7. - KA1AK-6; KA1AN-7; KA1CM-3; KA1DD-7; KA1HR-4 KA4AA-7. VE 1IR-4; 3ACL-5; 3ER-4; 4BQ-6; 4HG-3; 4IO-5; 4MO-3; 4NM-4; 5BI-5; 5EC-5; 5G5-6; 5KP-3; 5LW-4.

Kunio Shiba, J2HJ, 12 Akebonocho Hongo, Tokyo, Japan March 1 to April 1

(28 mc. c.w.)

W 1CMX-5; 1EWF-5; 1SZ-6; 1TS-6; 2TP-6; 3AIR-7; 3PC-5; 5AUJ-5; 5EHM-7; 5QL-6; 6ANN-6; 6ATR-6; 6AWT-7; 6BAM-6; 6BPD-7; 6BXN-5; 6BYB-7; 6CIS-6; 6CJJ 7; 6CSI-6; 6CXW-6; 6DGW-7; 6DIO-7; 6DJJ-7; 6DVT-6; 6EWC 6; 6EXQ-7; 6EYC-5; 6FMY-7; 6FQY-6; 6FZY-6; 6GRL-7; 6GRX-7; 6ITH-7; 6JN-7; 6JNR-7; 6KBD-7; 6KIP-6; 6KNF-6; 6LBX-6; 6LDJ-5; 6TT-6; 7AMK-6; 7AVV-6; 7BYW-6; 7CHT-5; 7DAA-6; 7EVV-6; 7FLU-7; 9CJJ-8; 9FLH-6; 9FUR-6; 9HAQ-7; 9KFA-7; 9LF-6; 9PED-5; 9PGS-6; 9PRI-6. -- D4ARR-6; EA4AO-6; LU9AX-7; U3AG-6; VE5BE-6; VE5BI-7; VE5KC-5. VK 2AE-6; 2AS-5; 2HZ-7; 2LZ 8; 3BD-9; 3CP-7; 3JJ-5; 3KR-6; 4GK-8; 5IH-5; 5LD-6; 5WK-6; 5WJ-6; 5ZC-8; 6SA-5; 7JB-7; 7KV-5. VU2BL-5; XU8KY-5; X1AY-6; ZS1H-4.

James Alexander, 2AXX, 63 Tennyson Road, Birmingham, England January 1 to March 14

(7 mc. c.w.)

W 1AIW; 1BLI; 1CAE; 1EFF; 1FBD; 1FRZ; 1GPJ; 1GPU; 1HRJ; 1HWY; 1IFK; 1INE; 1IZZ; 1JCE; 1JNB; 2ABX; 2AUF; 2BJR; 2CFX; 2DTR; 2EQQ; 2FCX; 2GVX; 2HRB; 2IGL; 2WW; 3BNF; 3COZ; 3ETB; 3EUJ; 3EXB; 3FEI; 3FXC; 3FKQ; 3FSD; 3FXF; 4BKS; 5AQV; 8GFF; 8ITG; 8MIE; 9KGU. — K4AM; K5AM; OS1BR; VE1HS; VE1HT; VE2CW; XU6LN; ZB1H.

(14 mc. phone)

W 1CHG-7; 1CPD-9; 2ELO-8; 2OA-6; 2UK-7; 2ZF-7; 3PC-8; 4AH-8; 4BLH-9; 4BZA-8; 4CPG-7. — CO7CX-8; PK4AU-7; VE1DC-8; VE1ET-8; VP2CD-9.

(14 mc. c.w.)

W 1AF; 1AIQ; 1AQ; 1BHQ; 1BLA; 1BLU; 1BUX; 1BXC; 1CJP; 1DEO; 1DZE; 1ELR; 1GPE; 1GPU; 1HJ; 1IKT; 1ILY; 1JA; 1LZ; 2AHC; 2AZB; 2BEF; 2BPD; 2CYF; 2CZV; 2DVV; 2DVW; 2DYT; 2EPJ; 2FXZ; 2GAM; 2GLD; 2GMM; 2GNQ; 2GZS; 2HAN; 2HVM; 2INH; 2KL; 2KU; 3AHS; 3ANT; 3BMA; 3BQP; 3BWI; 3EJM; 3EMF; 3ENZ; 3EQA; 3FIB; 3FQP; 3QV; 4CDE; 4DRD; 4TR; NCNX; 6DVI; 8AKC; 8AYQ; 8BYS; 8FIP; 8JAN; 8JRW; 8KJW; 8KMQ; 8LDA; 8MMT; 8YA; 9AR; 9JLR; 9POW. CM2AZ; FMBD; J2CL; K5AC; K5AP; LU5BL; LU6JB; PJ4CO. — VE 1AA; 1AR; 1DZ; 1GE; 1GK; 2DC; 2EE; 3HF; 3UG; 4BQ. - VO1C; VO4Y; VP2BX; VP2RT; VQ8AA; ZD8AC.

(28 mc. c.w.)

W 1ER-6; 1EVJ-7; 1FNW-7; 1HER-7; 1IVU-7; 1IYO-8; 1JCE-6; 1JOO-6; 1QH-7; 1QR-8; 2AGV-6; 2AYS-8; 2GSQ-6; 2IYO-6; 2JBO-6; 3EE-6; 6QD-5; 6SN-5; 8ADX-6; 8BEN-8; 8BTI-5; 8CBC-6; 8EQQ-7; 8ERZ-7; 8GQB-7; 8IBQ-6; 9CP-5; 9OR-8; 9PDY-6. CT1BV-8; HAF9D-6; I1IY-4; OH6NS-5; OK3CF-7; PK1MC-5; SP1GX-7; SU1TM-6; TF3C-8; VE4BN-5; YR5NP-7.

H. T. Petersen, OZ7Z, Fribo, Ostergade, Noerresundby, Denmark February 23 to April 1

(28 mc. c.w.)

W 1AAK-5; 1DBE-6; 1DUK-4; 1DZE-5; 1EWF-3; 1WV-4; 1ZD-5; 3AIR-4; 3C-3; 4DGJ-4; 5AFX-5; 5EHM-5; 5LNX-5; 5QL-5; 6BAM-5; 6GRL-3; 6GRZ-3; 7BYW-4; 8ANN-5; 8DSU-5; 9BHT-7; 9BPM-4; 9BYE-3; 9DXX-5; 9EPI-5; 9FLH-6; 9GIC-4; 9HUV-5; 9IH-4; 9ISU-4; 9JFB-5; 9KPD-4; 9LF-3. — EA3EG-8; FA3JY-4; FA8BG-7; FT4AF-6; HJ3AJH-6; LU9AX-3; OK1BC-3; SU1JT-6; U3VC-6; U9AV-5; VE2DC-5; VE3ER-5; VE3KF-3; VK3BD-5; VK5IH-3; VK6SA-4; VU2AV-5; ZE1JU-4; ZS1H-5; ZS2A-4; ZT6K-6.

(14 mc. c.w.)

W 1EWD-6; 1FGX-5; 2CJM-5; 2DLF-6; 2GTZ-5; 4EG-7; 5EHM-5; 8OE-6; 9BFX-5. — CR7AD-5; FA8FR-7; FB8AB-5; FB8AG-5; KA1DS-3; LU8DI-5; PY9AH-7; U9AL-6; VE1ET-6; VE3AC 6; VE4BQ-5; VE4FT-4; VE4TJ-4; VK2BQ-5; VK2LZ-4; VK3CZ-5; VK5KL-5; VK6FL-3; VK7JB-6; VP2CD-5; VS6AF-5. — ZL 2BU-3; 2BZ-5; 2CI-4; 2FY-5; 3DJ-3; 3GR-3; 3JA-5; 3JR-3; 4AO-4. - ZS1B-4; ZS1Z-4; ZS6A-5; ZT6M-6.

E. L. Walker, W8DFH, 2717 Connecticut Avenue, Pittsburgh, Penna. January 1 to March 1

(14 mc. c.w.)

CE3AO. CM 2AZ; 2DO; 6AA; 6AG; 6AW; 6DW; 7AA; 7AI; 7JP; 8AH; 8MQ. — CO 2HY; 2JV; 2RA; 2WZ; 6OM; 7CX; 7HF; 8RQ; 8YB. - CP1AC; CT1BY; CT1JU; CT4DU; CX1BG; CX1CG; CX2AK. D 3BAN; 3BEN; 4ARR; 4BIU; 4BQO; 4CEF; 4CSA; 4DLC; 4GAD; 4GDN; 4GUC; 4GOF; 4IJH; 4JVB; 4KMG; 4KRJ; 4QET; 4SMO; 4SXR; 4TKP; 4XCG; 4XCM. — EA 1AZ; 2AD; 2BT; 3AN; 3CZ; 3ER; 4AB; 4AO; 4AP; 4AV; 4BM; 5BE; 5BS; 7AV; 8AF; 8AO. — EI2G; EI6F; EI8B; EI9F; EI9G; ES7C. - F 3AD; 3AU; 3DN; 3IM; 3LE; 8DC; 8DT; 8EB; 8EO; 8FE; 8KJ; 8NR; 8NV; 8OK; 8OZ; 8PY; 8PZ; 8QM; 8TQ; 8WK; 8XH; 8YP; 8ZF. — FA8SR; FB8AB; FM8AD; FM8D. — G 2AP; 2BY; 2BK; 2CL; 2DH; 2DL; 2GK; 2HQ; 2IM; 2IN; 2KB; 2KZ; 2ML; 2MV; 2MR; 2NM; 2NO; 2RL; 2TM; 2UM; 2WW; 2YB; 2ZQ; 5BD; 5BJ; 5BP; 5CU; 5CV; 5FN; 5IS; 5JO; 5JX; 5KG; 5LA; 5LL; 5ML; 5NI; 5RI; 5SO; 5SP; 5TZ; 5UU; 5VB; 5WP; 5WT; 5YX; 5YH; 5ZG; 6AH; 6CJ; 6CL; 6CW; 6DL; 6DX; 6GF; 6GH; 6GN; 6JQ; 6JW; 6NF; 6NJ; 6NX; 6OS; 6PY; 6PK; 6QP; 6QS; 6QX; 6QZ; 6RB; 6RJ; 6RL; 6RV; 6UF; 6VP; 6WQ; 6WY; 6XI; 6XL; 6YV; 6ZU. — GI5QX; HAF8D; HB9AK;

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

HB9AQ; HB9B; HB9J; HC2MO; HH1P; HH2B; HH3L; HH5PA; HI1W; HI2K; HI2T; HI5A; HI5X; HI6O; HI7G; HJ3AJH; HK1ABM; HK1Z; HP1A; J2LL. — **K** 4AAN; 4BRN; 4BU; 4DDH; 4DRN; 4DTH; 4UG; 5AA; 5AB; 5AC; 5AF; 5AH; 5AL; 5AQ; 5AV; 6AKP; 6AUQ; 6BAZ; 6BHL; 6BUX; 6CGK; 6CMC; 6DV; 6EO; 6FJF; 6FKN; 6GCL; 6JLV; 6JPD; 6KVX; 6LJB; 6MBT; 6NEK; 7CEE; 7ELM; 7ENA; 7PQ. — KA1ME; LA4P; LA5P. - **LU** 1AD; 1EX; 2AM; 2AX; 5AN; 5CZ; 5FC; 6AP; 6AX; 6JB; 7DI; 7EF; 8DI; 9BV; 9EA. — N8KCO; NX2Z; NY1AA; NY2AB; NY2AD; NY2AE; OA4AK; OA4J; OA4M; OA4N; OA4R; OE1ER; OE3FL; OE7JH; OH3NT; OK1AW; OK1BC; OK1FK; OK1JC; OK2HX; OK2MA. - **ON** 4AU; 4CC; 4CN; 4CSL; 4DS; 4DX; 4GB; 4GW; 4HC; 4HM; 4HW; 4MT; 4PA; 4UU; 4VK; 4VW. — OX7ZL; OZ2B; OZ2M; OZ3FL; OZ7G; OZ8JB. -- **PA** 0AZ; 0CE; 0FX; 0HT; 0HZ; 0JJ; 0JMW; 0MS; 0PN; 0QZ; 0TSK; 0UN; 0WR; 0XD; 0XF; 0XM; 0ZK. — PK1BO; PK1MX; PK2KO; PK4RY; PK6AJ; PY1DR; PY1CX; PY2BX; PY7BB; PZ1AA. - **SM** 5SX; 5UU; 5WJ; 5WZ; 6SO; 6SS; 6WL; 7WS; 7YN. — SP1DE; SU1SG; SU1SS; TI2AV; TI2EA; TI2FG; TI2FR; TI2RC; TI3AV; TI3WD; U1AD; U1CR; UE3EL. — **VK** 2MH; 3KX; 4ER; 5WK; 6FO; 7CL; 7JB; 7KV; 7XL. -- **VO** 1C; 1I; 1N; 1P; 3HM; 3R; 4K; 4Y. — **VP** 1JR; 1WB; 2AT; 2BX; 2CD; 2ER; 2TG; 3BG; 4TH; 4TJ; 5AC; 5AF; 5CC; 5GM; 5JB; 6MY; 6YB; 7ND; 9R. - VQ4CRO; VR1HR; VS6AF; VS6AK; VS6BD; VU2AN; VU2BG; VU2CQ. — **XE** 1AA; 1AG; 1AI; 1AK; 1AM; 1B; 1DA; 1DD; 1G; 1FL; 1HH; 1U; 2CV; 2CK; 2FM; 2L; 2N; 2V; 3O; 3V; 3W. — YM4AA; YN1AA; YN1HS; YN1OP; YN1IP; YU7QA; YV4AC; ZD8A; ZL1HY; ZL2BZ; ZL3AZ; ZL4AO; ZT6Q; ZU5X; ZU6P; ZZ2A.

(7 mc. c.w.)

CM 2DO; 2DT; 5CX; 6AB; 6SM; 7JP; 8AN; 8GF; 8JC. — CN8MI; CO2JV; CO2XF; CO5RY; CO8YB; CT1BG; CT1FI; CT1GG; CT2BJ; CT3AN. — **D** 4AAA; 4AII; 4IHH; 4IZI; 4NXR; 4OYT; 4TKT; 4XCG; 4YJI. **EA** 1AZ; 3AN; 3BP; 3EG; 4AO; 4AT; 6AJ; 7AV; 8AO; 8AF. — EI4J. **F** 3AU; 3HG; 3HR; 3IW; 8EO; 8GV; 8IL; 8JI; 8KJ. — FA8BG; FM8D; FT4AF. — **G** 2JH; 2PL; 5IL; 5LX; 5RK; 6JZ; 6LK; 6NJ; 6VX. — HAF8G; HB9AS; HC1FG; HC2RL; HH2A; HI2P; HI6F; HJ4ABG. — **K** 4AAN; 4DTH; 5AG; 5AM; 5AY; 6CFQ; 6CJG; 6IDK; 6JUY; 6KUX; 6MEG; 6MTE. — LA2B; LU1AZ; NY2AB; OE3AH; OK2PL; ON4FE; ON4GU; ON4HC; ON4MD; OZ7A; PA0PN; PA0RT; SP1DT; TI2AD; TI2FG; TI2RC; VK2FM; VK3MR; VK5US; VK6CP; VK7PA; VO2N; VP1JR; VP6MO; VR2FF. - **XE** 1AA; 1BC; 1D; 2BB; 2CK; 2L. — **ZL** 1AR; 1DI; 1HY; 1JW; 2BV; 2LB; 4GG; 4GM. — ZZ3A.

Warren Mallory, W9PGS, 915 15 Street,
Boulder, Colorado
March 14 to 22

(28 mc. c.w.)

CM2AI-4; CM2OP-9; CP1AC-7; D4AJJ-7; D4AKK-7; D4GWF-7; EA3EG-8; EA4AO-5; EA4BM-7; EI8D-4; EI8B-7; F8EO-5; F8KJ-8; FA8BG-8; G5LA-7; G5YG-6; G6NF-8; HJ3AJH-7; J2HJ-7; K4DDH-8; K4KD-7; K5AY-7; LU1EP-8; LU9AZ-9; OK1AW-6; OK1BC-7; OK2AK-7; OZ2M-7; ON4NC-5; PA0AZ-6; PA0FX-7; XE1AY-8; XE1CM-4; YM4AA-7; ZL2KK-5.

Ernie West, W6JNR, 2016 West 70 Street,
Los Angeles, Calif.
March 1 to April 1

(28 mc. c.w.)

CP1AC; D4CSA; F8CT; F8EO; FA8BG; G2TM; G5KF; G5NF; G6QB; HJ3AJH; J2CE; J2HJ; J2LO; J3DC; J3FJ; J3FK; K4DDH; K4KD; K6SKI; K6MVV; K6NJV; K6MBT; LU1EP; LU7PD; LU9BV; LU9AX; OA4J; ON4JB; OZ2M; VP5PZ. — **VK** 2LZ; 2PN; 3BD; 3BW; 3CP; 3JK; 3KR; 3KX; 3MR; 3WX; 3YP; 4AP; 4GK; 4YA; 5HG. — **ZL** 1CD; 1DV; 1GX; 1HY; 2KK; 3JA; 3DJ; 4AO.

Al Parham, W4MR, 1711 W. Lee Street,
Greensboro, N.C.
March 14 to March 22

(28 mc. c.w.)

W 6AWT; 6BAG; 6BIP; 6CUH; 6CXW; 6DOB; 6DTB; 6DTY; 6EPZ; 6GRL; 6GRX; 6GUQ; 6GZU; 6IOJ; 6KBD; 6KIP; 6PN; 6QD; 6ZH; 7AMX; 7BLT; 7BYW; 7CHT; 7DL; 7DOC; 7ESN; 7KO. — CX1CG; CX2AK; F8EB; F8EO; F8JI. — **G** 2DV; 2FI; 2IO; 2NH; 5KG; 5QY; 5YG; 6CL; 6DH; 6GS; 6NF; 6NJ; 6WN. - HJ3AJH; HI5X; K4DDH; K4KD; K5AY; LU1EP; LU9AX; LU9BV; OA4J; PA0LF; PA0PN; PA0UN; PA0ZK; VK2LZ; VK2YP; VK4AP; VO1N; VO2N; VP5CC; VP5PZ; XE1AA; XE1AG; XE1AM; XE1AY; XE1CM; XE2N; YR5AA.

Frank C. South, W3AIR, Princeton, N. J.
Heard during March, 1936

(28 mc.)

CM2FA; CN8MJ; CP1AC; CT3AB; CX1CB; CX2AK; D3CFH; D4TKP; D4ARR; D4PBV; D4DIC; D4XCG; D4GAD; D4QET; EA3EG; EA4AO; EA4AV; EA4BM; EI8B; F3AV; F3KH; F8WK; FBPK; F8KJ; F8RR; F8EO; F8EX; F8EB; FA8BG; G2NH; G5BQ; G6NF; G6RH; G6GS; G6QB; G6ZU; G6WY; G5BY; G2GO; G6LK; G5QY; G6WT; G5BP; G6DH; G5KJ; G2PL; G6IR; HB9J; HI5X; HJ3AJH; I1IT; J2HJ; J3FK; K4KD; K4BRN; K4DDH; K5AY; K6MVV; K6NJV; LU1EP; LU3DD; LU9AX; LU9BV; OA4J; OE1ER; OE1FH; OH2PX; OH7ND; OK1AW; OK2AK; OK2HX; ON4JB; ON4PA; ON4NC; ON4FE; ON4LX; OZ7T; OZ3V; PA0ZK; PA0AZ; PA0UN; SM6WL; VE4PW; VE4PH; VE4LZ; VE4MP; VE4JV; VE4UY; VE4OC; VE5KC; VK2LZ; VK3BD; VK3BQ; VK3YP; VK3CP; VK3MR; VK4GK; VK5HG; VP1JR; VP5PZ; XE2N; XE1AA; XE2CG; XE1AM; XE2CM; YM4AA; ZL1CD; ZL4AO; ZL4BQ; ZL3DJ; ZL2KK; ZL2BG; ZL4FW; ZL3AB; ZS1H; ZS2A.

Donald W. Morgan, 15 Grange Road,
Kenton, Middlesex, England
March 15 to April 5

(14 mc. phone)

W 1ADE-7; 1ADM-8; 1ADW-8; 1BIC-8; 1BR-8; 1CJC-7; 1CUC-7; 1DNL-8; 1IHF-7; 1KJ-7; 1MX-8; 1VA-7; 1ZD-8; 2AJF-7; 2BSD-8; 2CFU-7; 2EDW-7; 2EOY-7; 2HG-8; 2HSF-7; 3ABN-7; 3APO-7; 3CQ-7; 3CBT-7; 3DLL-7; 3DNC-7; 3EGU-7; 3FI-7; 3MD-7; 3MK-7; 3OM-8; 4AH-7; 4AKY-6; 4BCQ-7; 4BVM-7; 4CAY-6; 4CFO-7; 4CPG-7; 4CRE-8; 4CYD-6; 4DJU-7; 4FK-7; 4ST-7; 6IBS-6; 8CNA-7; 8CPC-7; 8HPX-7; 8JK-7; 8ZA-7; 9AYH-6; 9HCR-7. - CE1AR-6; CO2HY-7; CO2WZ-7; CO7CX-7; CT1BY-7; CT1CB-8; EA2BC-7; EA3CZ-7; EA5BC-7; EA5BE-6; EA7BB-7; EA8AF-7; EA8AO-8; HI2AW-6; HI2HC-6; HI5X-7; HI6O-7; HI7G-7; I1IY-7; I1KN-7; I1NK-7; I1RK-6; I1TKM-7; K4DDH-7; LU1DA-7; LU1EX-7; NY2AE-7; OA4R-7; OH2NE-7; OK3VA-8; OZ1NW-8; PY1CK-7; PY1EK-6; PY2AB-7; SM5TC-8; SM5WZ-6; SM7YA-6; SP1AR-6; SU1RO-6; TI2AV-6; TI2RC-6. — **VE** 1CN-7; 1DC-7; 1DQ-7; 1EA-7; 1FW-7; 1JK-6; 2BO-7; 2CW-7; 2DX-7; 2HY-7; 3EO-6; 3HC-7; 3JV-6. — **VK** 2BC-6; 2BY-5; 2YW-6; 3AH-5; 3AZ-5; VO1I-8; VP2CD-7; VP6YB-7; VP9R-7.

J. Vincent McMinn, NZ 16W, 12 Edge Hill,
Wellington, C.3., New Zealand
January 1 to March 1

(7 mc. c.w.)

CM2AF; CN8MN; CT1AA; CT1FG; CT1LZ. **D** 4BRJ; 4JFG; 4LOM; 4NAP; 4NXR; 4OFT; 4SXR; 4UYD; 4XBG; 4XCG; 4YCF; 4YJI. **EA** 1AW; 1AZ; 1BB; 1BR; 1BZ; 3BM; 3DL; 3EV; 4AT; 5AD; 5BK; 5BM; 5CD; 5CG; 5CK; 7BE; 7CL. — **F** 3AD; 3AU; 3EY; 3KR; 3LE; 3LS; 8GR; 8JD; 8JI; 8KY; 8LO; 8LX; 8NO; 8NV; 8NY; 8PK; 8RS; 8SX; 8TQ; 8VI; 8WM; 8XH; 8ZF. — FB8AD; G2NA; G6CJ; G6CW; G6DL; G6JW; HB9AC; HB9BB; HB9M; HB9T; HB9Y; HAF2L; OA4CL; OE6MP; OE7EJ; OK1CX; OK1ZD; OK2MV; OK2PL; ON4GU; ON4HM; PA0HC; PA0ZP; PK1PK; PK4BQ. — **SP** 1BQ; 1EY; 1FU; 1GX; 1HZ; 1IB; 1IH; 1JB; 1LN. TI2FG; UK1AA. - **U** 2AV; 2BE; 3AA; 3CY; 3DM; 3QT; 5AC; 8UX; 9AB; 9AF; 9AY; 9MF; 9MJ. — VQ4CRO; VS7RP; VU2EM; VU2KJ; VU7FY; XE1FM; XE2N; XE3AC; XU3CK; XU5U; YR5NP.

(7 mc. phone)

CT1EP; CT1JW; TI2AV; X2CK.

(14 mc. phone)

W 1IFD; 2EDW; 2FWK; 2OJ; 2SP; 3APO; 3BFH; 4PW. - F8II; HB9AT; HK1Z; HP1A; K4UR; KA1ME; NY2AE; TI3AV; VO1I.

(14 mc. c.w.)

CE3AC; CT1LC; CT1OI; CX1BG; CX1CB; CX2AK. **D** 4ARR; 4CEF; 4FND; 4GJC; 4MNL; 4SXR; 4TKP; 4XCG. EA1AW; EA1AZ; EA3CZ; EA4AB; F3CX; F3KR; F3LE; F8BF; F8FC; F8FE; F8FG; F8GB; F8LX; F8NV; F8PZ; F8WB; F8WK; F8XR. **G** 2AX; 2DC; 2DK; 2HX; 2ID; 2IO; 2MQ; 2PL; 2SD; 2WQ; 5BP; 5EK; 5IW; 5JU; 5KG; 5OI; 5OV; 5QA; 5SP; 5VB; 5WP; 5XG; 5YY; 5ZU; 6AG; 6BS; 6CL; 6DL; 6IF; 6NJ; 6QX; 6RV; 6UF; 6WY; 6XN. HAF2L; HAF3D; HB9AK; HB9AQ; HB9AT; HB9AY; HB9J; I1IT; J8CA; LA2B; LU1AD;

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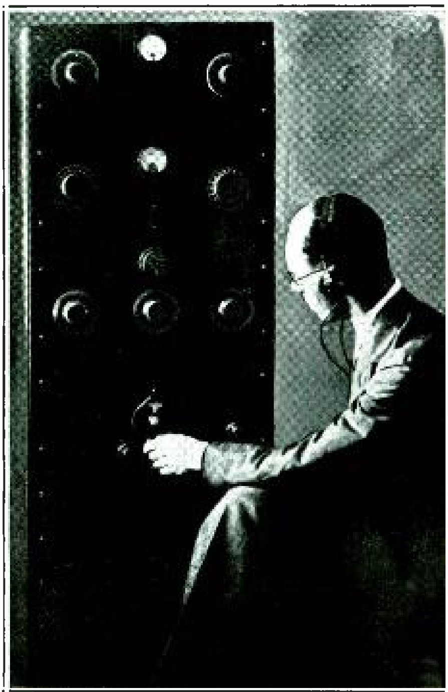


SM6UJ at Askersund, Sweden

SM6UJ

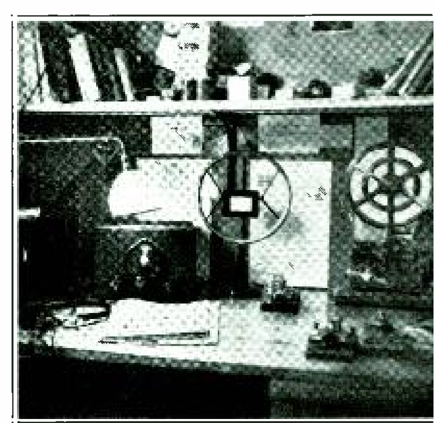
This story of SM6UJ runs along a somewhat different vein than the average ham station. It is about a man who, after being a commercial radio operator for a number of years, turned to the amateur side of the game.

In the fall of 1920, Mr. G. Ahner (now SM6UJ) obtained his first operator's license . . . a first class commercial ticket, and immediately went to sea. During the next three years while he was pounding brass, he was traveling all over the world, visiting most of the capitals and principal ports. For a considerable period of this three years they hauled loads of sugar and bunkers between Cuba and U.S.A. In the fall of 1923, Mr. Ahner's contract expired, and, not wishing to renew it on the same ship, he drew his pay and headed for New York City. It was not long before he landed a job with the Pacent Electric Company as an assistant in charge of the Inspection Department. He had a very fine boss, who happened to be Mr. M. C. W. Wright, an old time brasspounder at the New York Herald, Battery Park station.

A little later he located with Mr. Hazeltine, doing laboratory work. It was here that Ahner received his first information on short wave and amateur radio. For three years he continued with Mr. Hazeltine, then decided to go back to Sweden. This was in 1927. There was no possibility of owning a ham station in the U.S.A., but upon getting back home he was granted a ticket and went on the air early in 1928 as SM6UJ.

In those days there were no specified frequencies for the SM hams and they ran their transmitters anywhere between 30 and 40 meters. The 40 meter band then was not what it is today . . . one could work Swedish stations all day long. Today it is never used for what SM6UJ calls "interior work". The 80 meter band is the one where they do all their local rag-chewing.

Mr. Ahner's first rig was a Hartley . . . using a 40 watter running on a.c. At that time he was putting about 15 watts into the antenna . . . never more. The receiver was a Reinartz with one audio stage. In the winter of 1934 he rebuilt his transmitter, this time using crystal control but still with the same 40 watt tubes. However, inasmuch as these tubes seemed to have seen better days, SM6UJ decided to rebuild using more up-to-date equipment. The new job is of the rack-and-panel type and uses an RK-20 as a p.a. The present receiver is a National SW-3, and as Ahner puts it, "surely brings in sigs from all corners of the world." He really gets out and snags plenty of dx, and readily admits that he likes nothing better than



Receiving Position at SM6UJ

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DX

By 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, California.

Last month you fellows really took a beating . . . I mean those that read the dx section clear through, if there are any who did read the whole thing. However, this time you're all going to get off easy. Many of the boys haven't yet caught up on the sleep they lost in the dx contest and have not sent in any news, but any time now I expect they will be back to normal and making plans for next year's brawl.

Over Honolulu way our friend K6CGK says that K6AKP is going after dx in a big way . . . has worked EI, ON, F8, SM, D4, G, OZ, PA, UE, EA4. K6JPD, however, establishes the first K6-HB contact. K6CGK worked his 125th J station, but K6AKP still leads with 127 to his credit. K6CGK says that a while back when K6CRU, K6CQV, K6JPD and W6FZY attended a JARL meeting . . . a near-riot almost occurred.

April 27th G6NJ made his quickest w.a.c. by hooking all six of 'em in 2 hours and 18 minutes. Stations worked were FB8AG, W3FPX, VK4HR, G5JF, J4CT, and LU6JB. G6WY made his best w.a.c. on April 19th . . . doing the trick in 1 hour and 15 minutes. G6NJ has been on several occasions QSO all 9 U.S.A. districts in one day. His rig consists of a 47 osc., 46 doubler, T25D buffer/doubler kicking a T61D final. It might be of interest to know that the T25D and T61D tubes are made in England by Mullard. G6NJ's receiver is a Comet-Pro with a Peak pre-selector, and at the present time he is thoroughly disgusted with all the automobile ignition around his QRA so is going to install a noise suppressor. Dx is naturally his strong forte . . . has worked 35 zones and 91 countries. In the contest he scored 35,496 points . . . 348 contacts in 34 districts. The antenna in use is a 66 foot Zepp.-fed, 50 feet high and running North and South. Will try to get a photo of Dyson's station one of these days.

Whoa . . . here's Charlie Myers, W3SI, the man with more transmitters than Solomon had wives. Don't know which would cause the biggest headaches . . . the transmitters or the wives. At least you can turn your transmitter on and off at will. Oh yes . . . W3SI . . . he is using a half-wave "Q" type on ten, and a half wave "Q" on twenty. A little later we'll give a complete description of Charlie's new set-up . . . photo and all. Guess the contest is still on at W3SI as he now has 79,000 points. Hi . . . And say, this same wild man from Harrisburg, made a 10 hour w.a.c. on phone . . . April 14th. Yeah, I said *phone*. See there, fellows, what happens to a good dx man sometimes. Just like spring fever . . . he's gotta have his yearly fling at it. Anyway I know his phone is getting out 'cause both Dave and I heard him one evening (calling a W6 for a couple of hours). That silk-like voice should surely slay the y.l.'s.

Johnny Hart, W8FCB, has been trying for six years to make w.a.c. . . . A couple of weeks ago he put up a "Q"-type antenna and w.a.c.'d three times right off the bat. W3EYS worked ON4CJJ for country no. 60. Bumped into my friend Reg Dunlap, W6UD, the other day. . . . He claims a record for perseverance or something . . . after 12 years he finally snagged ZS1C for his w.a.c.

ON4AU told W7AMX that he ran into F8EX in Paris a week or so ago and 8EX said he was going to be married in two weeks. We hate to see Jean leave the air but that's the way it goes. Please accept our hearty congratulations anyway, Jean. A few dx stations being worked by Art . . . W7AMX . . . I1TKM, 14,375 T9; I1IY, 14,440 T8; I1RRA, 14,000 T8 MG RAC; ZB1H, 14,375 T9; VQ4CRE, 14,355 T9; VQ3FAR, 14,175 T9; YN1AA, 14,260 T9. W7AMX got 19,800 points in the contest, and says that since the test 28 mc. has been dead.

The other night W6CUH was trying to hook up CP1AA (Harry Smith, ex-CT2BK) with OK2AK. The CP was calling OK2AK . . . but when 2AK tunes around looking for him, he hears dozens of other sigs calling him. Not knowing which one of those could be CP1AA, he was almost stopped, when he pulls a wise stunt. He asks CUH to tell CP1AA to call 'himself'. From then on it was simple . . . just listens for a sig calling CP1AA. A perfect QSO resulted.

W4DRZ has been hearing some nice ones . . . ZB1H, 7090; J2KJ, 7070; OZ9U, 7150; OE7JH, 7125; F3AI, 7000; EA5BK, 7120; HJ4ABG, 7115; CN8MI, 7000; SP1IT, 7130; VK6KB, 7110.

W8AAT worked a couple gooduns . . . YU7GL who was using 12 watts with an indoor antenna . . . was R6 T9 . . . freq. 14,442 kc. The other was LX1AS, 14,290 kc., T9. Nice going, Ralph. Two years ago W3UVA visited the coast and at that time wasn't very much interested in dx . . . but now it's a different story. He is using an 860 in the final . . . 600 watts, has worked 57 countries, w.a.c. and w.b.e. A few stations worked by W3UVA: OE3AH, the Archduke of Austria; VS6AH; ZT6Q; VR2FF; YU7GL; YU7DX; HAF1YL (I haf one). Chas has heard PK2GC, PK7AJ. Says he has two lousy 40 meter Zepps. at right angles to each other.

G5YH is still yelling for W6 QSL's . . . says only received one this year. Some fellows would consider that as one too many. Anyway, Harold gives some nice dope on things over in G. . . . W6CNX the loudest W6 and W6FZY the most consistent, FZY being audible almost any time day or night. K6 stations come in well but apparently they are not gunning for dx. XE2N, XE2O and XE2C are being received quite well and G5YH has worked XE2N. VE4 and VE5 come through well, but he claims that the VE5's "CQ DX" and then work the first W6 they hear. A few of the most active London stations are: G2ZQ, G6WY, G6QX, G5YH, G6CL, G2BY, G6NF. G6WY said to have worked 120 countries; 2ZQ, 110; 5YH, 106; 6LK, 104; and G2PL had 101 a while back. The boys over there are surely hoping that K7UA will QSL all the stations he has contacted. G5YH wants it understood that he is using a T61D with 150 watts input. This in answer to the rumor that he had an 852 with a kw. . . . to which Harold says 'tain't so, and then pops up with, "Where are the amateurs of New

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Practical Screen Grid Modulation

By CARL J. MADSEN*, W1ZB

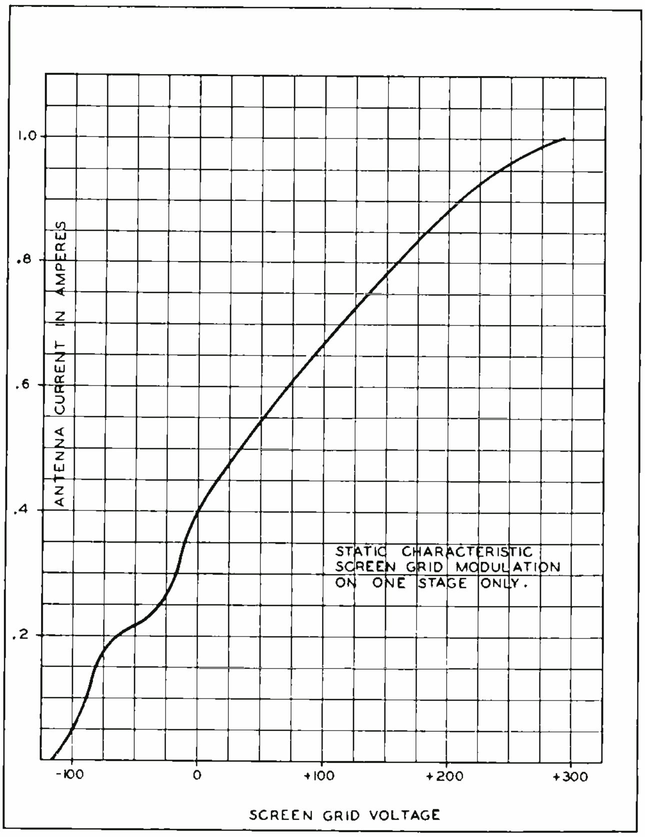


Figure 1

Many harsh things have been said of screen grid modulation. The chief arguments against its use have been low percentage modulation, high distortion, and complicated adjustments. Incidentally, most of these arguments can also hold for control or suppressor grid modulation.

All of the objections to screen grid modulation are easily overcome when two stages are modulated. In order to illustrate this point the curve in figure 1 gives the characteristic of screen grid modulation commonly known, and, in general, responsible for its unpopularity. Screen-grid modulation as shown makes possible only 60 to 75% modulation without serious distortion.

Curve A of figure 2 illustrates what happens when two stages are screen-grid modulated. It will be noted that the characteristic is straight over a much greater portion than shown by the curve in figure 1. In fact it is comparable, if not superior, to the suppressor grid modulation, which has been finding favor during the last year or so. The curves illustrate that there is a very simple way of converting a high power c.w. rig into a medium power phone transmitter without much expense. In fact, most amateurs will have the necessary parts available, since only 1 to 2 watts of audio are required to modulate a 100 watt carrier.

It is of course well known that screen grid modulation operates on the same general principle as control grid or suppressor modulation. Plate efficiency and plate current are changed by the modulating potential. For this reason the tube input is limited to approximately 50% more than the rated plate dissipation. For example, the 860 has a rated plate dissipation of 100 watts. The plate input, therefore, should not exceed 150 watts if tube ratings are to be respected. The carrier power will be approximately 50 watts (less the tank circuit losses).

Adjustment

The following general procedure may be followed in adjusting the equipment: Since the two screen grid stages to be modulated use the same screen potential, the adjustment is quite simple. A static characteristic is run, using a dummy antenna for the load on the power amplifier. The reading of the r.f. ammeter in the load circuit is then plotted against screen grid voltage as shown in figure 2. The screen voltage of both stages is changed simultaneously in steps of approximately 25 to 50 volts, from zero to normal class C rating. By recording the p.a. plate current at the same time, it is comparatively easy to determine the proper operating point.

From the resulting curve the correct value of the screen grid potential for the steady carrier condition is picked. If, however, the op-

*69 Osborn Ter., Springfield, Mass.

timum adjustment is to be reached, several curves should be taken with different values of coupling to the dummy antenna.

If the two stages are different in normal screen potential (865 and 860 for example), the screen voltages should be changed in proportion while obtaining the modulation characteristic.

Figure 2 gives some idea of the family of curves that are obtained with various degrees of coupling. Note that after taking each curve, the approximate center of the linear portion is selected as the optimum screen grid voltage. If this value of screen grid potential does not give a value of plate input near the limit of 1½ times the rated plate dissipation, the coupling should be adjusted. If the input is high, the coupling may be reduced or vice versa. If an attempt to regulate the carrier by means of the screen potential alone is made, particularly with excessive coupling, the result will be unusually low plate efficiency. This is illustrated in figure 2 by curve B, showing that such regulation provides a carrier output of considerably less than obtained with optimum coupling, for the same value of plate current. (Also excessive plate dissipation will result.) Note: For a peak output of 1.1 ampere antenna current, curve B actually has less distortion than A, an advantage nullified by excessive plate input at the optimum screen voltage. At the author's transmitter, W1ZB, the coupling normally used for c.w. operation was found to be satisfactory, which eliminated the need for any adjustments in the r.f. circuits in making the changeover from c.w. to phone.

The Modulator

Though normally an 860 uses 10 watts on the screen grid, this is reduced to approximately one watt when the screen potential is adjusted for phone operation. Since the modulation power required is very low, the output of the modulator can be loaded with a resistor to reduce the distortion caused by the screen grid current on the positive peaks of modulation. The output from a pair of 45's in class A was found adequate to modulate both the 850 buffer and a pair of 860's in the final stage. The circuit used at W1ZB is shown in figure 3. Figures 4 and 5 show a photo of W1ZB's modulator.

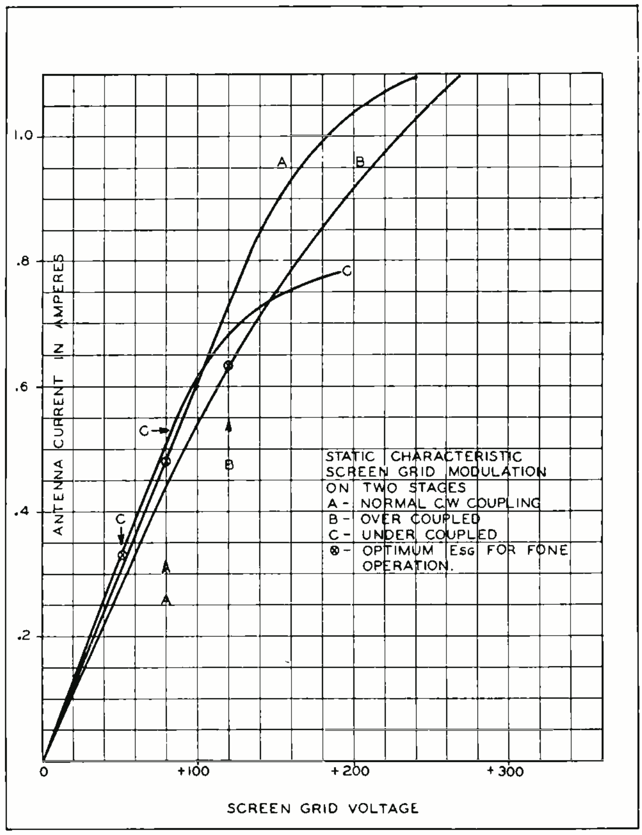


Figure 2

Another feature of this means of changing from c.w. to phone is that the only change necessary to revert to c.w. operation is to return the screen potential to normal. This can be accomplished by means of a simple, double-pole, double-throw switch, with all circuits at comparatively low-potential d.c. It is not necessary to readjust r.f. excitation taps. All tuning, however, should be done with the screen voltages at the normal c.w. value.

In view of the fact that it is not necessary to pass audio frequencies above 4000 c.p.s., and since it is actually desirable to reduce the sidebands to 2500 c.p.s. (for reduction of interference in the crowded ham bands), the usual s.g. bypass condensers of .01 μfd. may be left in the circuit. If one prefers to clutter up the maximum possible number of kilocycles, the s.g. condensers may be reduced to .002 μfd., keeping the r.f. circuit to ground as short as possible, thus preventing r.f. feedback.

If the circuit employed on a c.w. transmitter normally uses series screen grid resistors, the

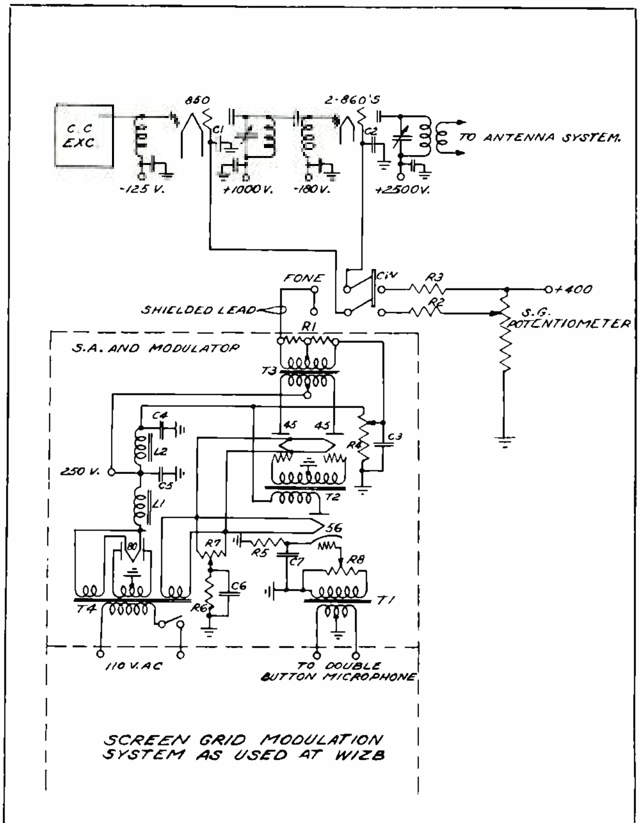


Figure 3
The Wiring Diagram

C_1,C_2,—.01 µfd.
C_3—16 µfd.
C_4,C_5—8 µfd.
C_6—5 µfd. (optional)
C_7—35 µfd.
R_1—15,000 ohms
R_2—3000 ohms
R_3—5000 ohms
R_4—10,000 ohms tapped
R_5—2500 ohms
R_6—1000 ohms
R_7—100 ohm Humdinger
R_8—500,00 ohm potentiometer
T_1—High ratio microphone transformer
T_2—Class B input transformer
T_3—Class B output
T_4—Power transformer (b.c.l. type)

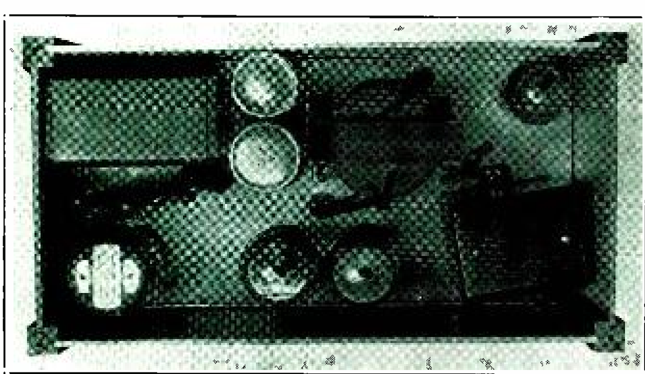


Figure 4
The Modulator Used at W1ZB for Modulating an 850 and Two 860's

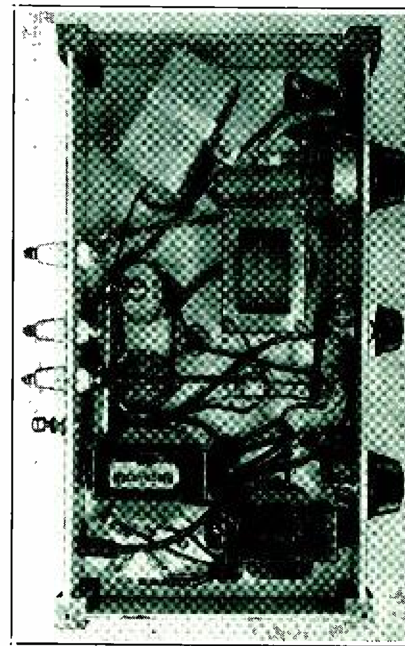


Figure 5
Underside of the Speech Unit with Cover Removed

switching arrangement as used here will fit. However, all resistors in the set between the "high" side of the modulation transformer secondary and the screen grid must be removed for phone operation. A curve taken with the usual series resistors in the circuit proved entirely unsatisfactory.

In case the c.w. transmitter has a triode stage preceding the tetrode final, plate modulation of the triode in combination with the screen modulation of the final stage will be equally satisfactory. The purpose is to reduce the excitation on the final stage during the minimum portion of the audio cycle to eliminate distortion caused by the delayed cutoff of the screen with normal excitation.

Observations with the cathode ray oscillograph, made while various percentages of modulation were tried with both the trapezoid and linear sweep modulation figures, proved that the fidelity is comparable to any approved amateur system and is well under 5% at 90% modulation. Any change in plate current of the modulated stages

[*Continued on Page 83*]

Expanding Linear Amplifier Notes

By J. N. A. Hawkins, W6AAR

We had hoped to present some constructional data on the expanding linear amplifier in this issue, but Mr. Hawkins has been so busy with patent matters associated with the amplifier and also so many new ideas have come out of tests of the theory that this month's article will be concerned with additional notes on various methods of obtaining dynamic expansion of the linear amplifier. We also held up development and construction of a complete medium-powered rig in order to see whether or not the Doherty amplifier developed by the Bell Laboratories (described on page 18 of this issue) would be more suitable for amateur operation. While we have not yet tried the Doherty high efficiency amplifier, we are inclined to think that its construction and adjustment are more complex than the Hawkins amplifier and therefore somewhat less suited to amateur operation.—Editor.

The general theory of operation of the expanding linear amplifier was covered rather completely in last month's Radio but a brief description of its operation may be in order.

Conventional modern linear amplifiers operate unmodulated at a plate efficiency equal to one-half of the peak attainable plate efficiency. The average d.c. plate input is the same modulated or unmodulated, so that the plate loss in the unmodulated condition is usually equal to 1.5 to 3 times the carrier power output.

Thus the power output from a given linear amplifier is limited by the tube plate loss when the amplifier is unmodulated.

In the dynamic expanding linear amplifier the unmodulated peak grid drive operates somewhat above the 50% point on the dynamic grid voltage-plate current characteristic, which increases the unmodulated plate efficiency but also reduces the modulation capability. During audio modulation of the r.f. grid drive applied to the grid circuit of the linear amplifier, the syllabic components in the audio modulating signal are used to shift the grid voltage-plate current characteristic of the amplifier to increase the modulation capability back to 100% by increasing the d.c. plate and grid bias voltages.

Thus when resting, the expanding linear amplifier operates at high efficiency and also its d.c. plate power input is reduced, which allows the resting, or unmodulated plate loss to be quite low. In fact, the resting plate loss no longer limits the power output. The limit on the maximum carrier power output of the expanding linear amplifier is either filament emission or plate loss when operating completely modulated. At low plate voltages the filament emission is the limit and at high plate voltages the modulated plate loss limits the output. In general, however, there is no difficulty in obtaining a carrier power output equal to the maximum permissible tube loss from the tubes used in the linear amplifier, and under certain circumstances the carrier output can be above 1.5 times the permissible tube loss.

As the output limitations are effective at the point of 100% modulation, the analysis or design of an expanding linear amplifier is started at the point of 100% modulation. Then we work backwards to determine the operating conditions for the resting, or unmodulated condition. Thus, dynamic axis shift is defined as a percentage *drop* in d.c. plate voltage from 100% modulation to zero modulation. 20% axis shift indicates that the resting plate volt-

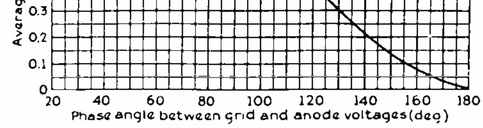


Figure 1
Showing relation of the average anode current to the phase angle between grid and anode voltages (phase shift method of control). Curve courtesy General Electric Co.

age is 20% *less* than the plate voltage when the transmitter is completely modulated.

It was shown last month that 16.6% axis shift is optimum for expanding class B linear operation. For class BC expanding linear operation there are two optimum values of dynamic shift, depending on the construction of the

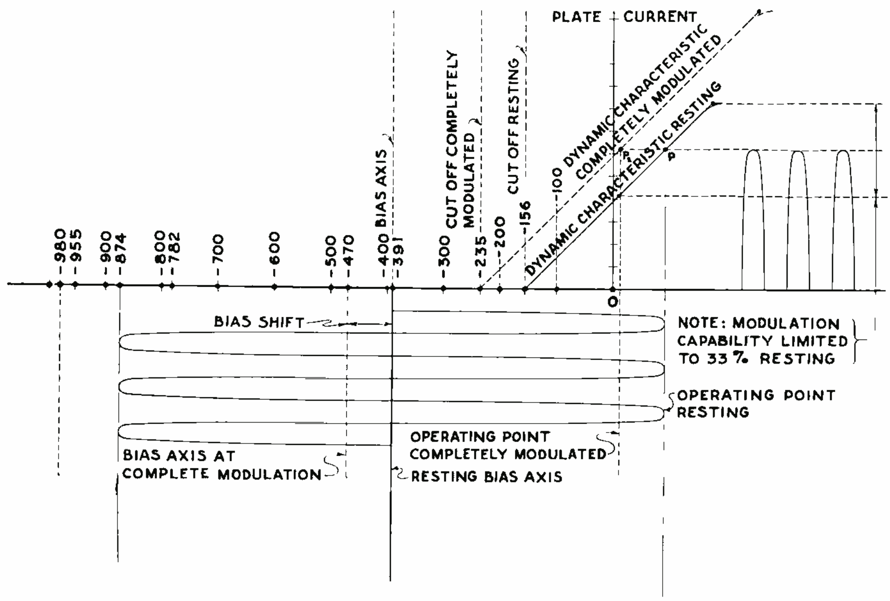


Figure 2
The Class BC Expanding Linear Amplifier, Resting Condition (Axis Shift 33%)

tube or tubes used in the linear amplifier. If the maximum instantaneous plate loss can not be allowed to exceed the maximum continuous plate loss (as is the case for the majority of transmitting tubes), the optimum value of dynamic axis shift is 20%. For those tubes whose momentary instantaneous plate loss can be 150% of the rated maximum continuous plate loss, the optimum amount of dynamic axis shift is 33%. Figure 2 shows a graph of class BC amplifier operation resting with 33% axis shift.

Methods of Shifting the Dynamic Axis

Last month the use of a balanced saturable control reactor (Variactor) was shown in series with the power mains supplying 60 cycle energy to the plate and bias power packs of the linear amplifier. See figure 3. Note that the use of a *balanced* saturable control reactor is not essential, although desirable when the syllabic plate current variation through a class B modulator is used to control the expansion of the linear amplifier.

An ordinary power transformer can be used as a saturable control reactor when a separate control tube is used, as is shown in figure 4. As the saturating characteristics of different transformers vary widely all possible range and resting adjustments are shown in the diagram of figure 4. Not all of the adjustments of R_1, R_2, R_3, R_4, B_1, C_1 and C_2 will be necessary in any one case, but all the possible points of adjustment are shown so that almost any type of power transformer can be used as a saturable control reactor. All of the adjustments shown, which will be discussed in detail, are of the "set and forget" kind and the adjustment procedure is quite simple.

The operation of the circuit of figure 4 is as follows. Some audio voltage from the audio channel is fed across the input potentiometer R_1 and into the push-pull input transformer T_1. T_1 need not be able to handle any particular amount of audio power and can be the usual push-pull input transformer commonly used in low-level audio amplifiers. The center-tapped secondary feeds the full-wave 84 rectifier. An 80 or even a triode used as a half-wave rectifier could replace the 84 or the 84-6A6 combination, although the two-tube combination shown is somewhat more flexible for experimental work.

The 6A6 with elements in parallel draws very little plate current at zero bias, but under certain circumstances it is desirable to bias it beyond cut-off to give some amplitude delay to the system. In other words, sometimes it is desirable to delay the expansion of the linear amplifier until the modulation exceeds a given predetermined percentage instead of starting the expansion as soon as any signal comes along, regardless of its amplitude. This allows the linear amplifier to run cooler and is particularly desirable for broadcast use where the average percentage of modulation runs about 10 to 15% and only a few peaks ever run over 35 to 50% modulation. By providing some amplitude delay the linear amplifier might expand only once or twice an hour to take care of an unusually loud audio peak, providing the modulation capability in the resting condition were high enough to handle average program peaks. As most broadcast stations using expanding linear amplification will probably use about 20% axis shift, the 60% resting modulation capability associated with 20% axis shift will easily take care of 99% of the program peaks. Thus if the expanding control circuit were adjusted with some amplitude delay so that the linear expansion started only when the percentage of modulation exceeded a predetermined point, such as 45% modulation, the amplifier would operate most of the time as a conventional linear amplifier with merely limited modulation capability to allow high average plate efficiency.

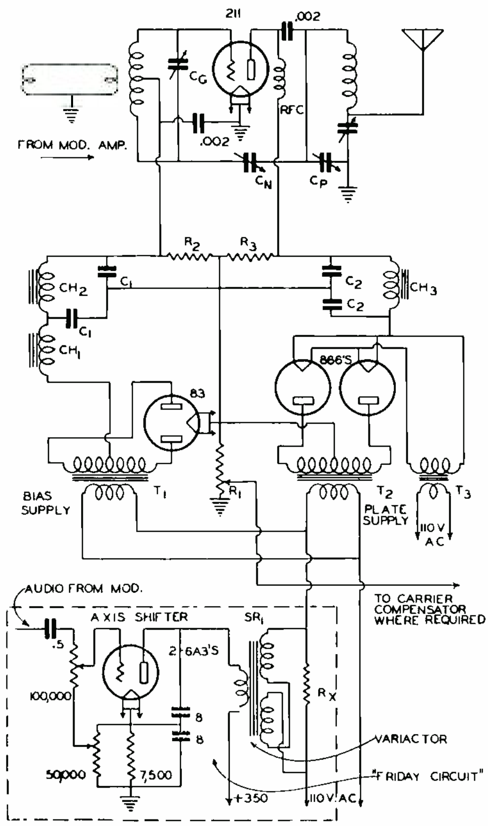


Figure 3

Thus when it is desirable to introduce some amplitude delay into the control circuit, the bias battery voltage can be chosen so that the grid of the 6A6 only swings positive with respect to its cathode when the syllabic output of the 84 audio rectifier exceeds the predetermined value of amplitude delay.

Note that the polarity of the rectifier output, which is d.c. pulsating at a syllabic rate, *opposes* any bias on the 6A6 and thus the d.c. plate current of the 6A6 will be proportional to the syllabic output voltage supplied across load resistor R_2 by the 84 audio rectifier.

Plate voltage for the 6A6 is 60 cycle alternating current induced in the primary of the saturable control reactor, or transformer, by the alternating current flowing in the secondary, or controlled winding of the reactor. Thus the 6A6 is really a grid controlled rectifier. The rectified direct current which flows through the control winding, or primary, of the saturable control reactor, saturates the iron core of that reactor and therefore reduces the a.c. voltage drop (reactance) of the secondary or controlled winding. If the core were completely saturated the resistance of the secondary winding would drop to the d.c. resistance of the wire in that secondary winding.

Capacitances C_1 and C_2 act as low pass filters in order to bypass all but the syllabic components from the rectified output of the 84 audio rectifier. The size of C_1 and C_2 must be a compromise value. If these condensers are too small, high frequency components, such as noise and switching clicks, may affect the expanding circuit. If the condensers are too large there will be an undesirable time lag in the operation of the expander and a steep front audio signal of high amplitude may catch the modulation capability of the linear amplifier napping. It might be mentioned at this point that momentary overmodulation of an expanding linear amplifier, while undesirable, causes materially less interference to signals on adjacent channels than similar or equivalent overmodulation of a controlled carrier transmitter, a high level modulated transmitter, or a conventional linear amplifier of 100% modulation capability. By overmodulation is meant modulating in excess of the expanding amplifier's instantaneous modulation capability, which does not call for clipping of the negative peaks. The overmodulation occurs only on the positive peaks unless the percentage overmodulation is extremely high. The wave form deformation occurring as a result of positive-peak modulation is much less than occurs

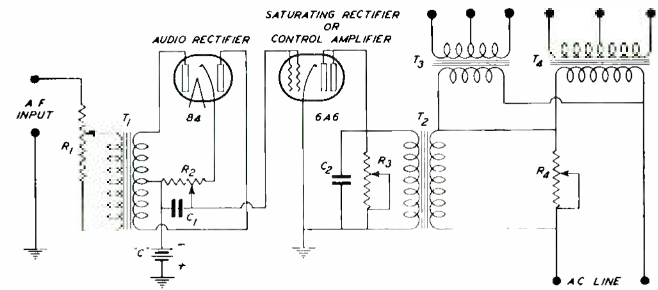


Figure 4

on overmodulation of the negative peaks, and thus fewer spurious frequencies and "splatter" are generated.

However, it should be pointed out that the expanding linear amplifier is much less subject to possible overmodulation than a wide-range controlled carrier system, and thus the time constant of the control system is much less critical than in a controlled carrier system. A time constant of 25 milliseconds is easily attained in practice and is small enough to take care of practically all speech and musical sounds although the transmission of certain dramatic sound effects may require the use of a shorter time constant. An oscillographic study is being made of the steepness of the wave fronts of various sounds, which will aid materially in determining the maximum allowable time delay in the expansion control circuit.

Thus, briefly, the dynamic expansion of a linear amplifier merely consists of placing a voice-controlled variable resistance in series with the plate and bias voltage power supplies, and then varying that resistance in accordance with the syllabic envelope of the audio modulating signal.

There are two useful types of voice-controlled resistances which can be used for dynamic-shift linear amplification. The first type of variable resistance is the primary saturable control reactor discussed last month and shown in figures 3 and 4. The second useful type of voice-controlled resistance is the grid-controlled mercury vapor rectifier. The use of the grid-controlled mercury vapor rectifier has some advantages, particularly for broadcast use, but these grid-controlled rectifiers are not generally available for amateur and experimental use. However, steps have been taken to have the General Electric (Thyratron) and the Westinghouse (Grid glow tube) grid-controlled rectifiers made available to licensed amateurs through their branches or the radio supply houses. All amateurs interested can help to make these tubes available by writing both General Electric and Westinghouse and asking that these tubes be offered generally for amateur and experimental use. We hope to be able to present data on as many of these grid-controlled rectifier tubes as possible in the near future.

A simplified circuit showing one method of controlling the voltage output of a d.c. power supply using grid controlled rectification is shown in figure 5. A half-wave rectifier is shown for simplicity although the same principle is used in full wave and polyphase rectifiers. There are two commonly used methods of control of grid-controlled rectifiers: the amplitude control and the phase shift method of control. The phase shift method of control is generally desirable as it eliminates a source of low resistance bias for the rectifier tubes and also allows a wider range of control. Due to the reversal of d.c. grid current which occurs in practically all mercury vapor grid-controlled rectifiers at close to the operating point, a low-resistance grid return to ground is essential. Before describing in detail the control circuit of figure 5, it is essential to outline briefly the operation of a grid-controlled mercury vapor rectifier. In construction, the rectifier is much like any common hot-cathode mercury-vapor rectifier except for the presence of a control grid which screens the cathode from the plate. It is known that

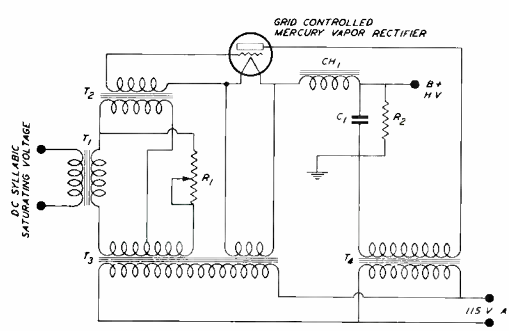


Figure 5

in a common mercury-vapor diode rectifier the plate voltage must exceed a certain minimum value before the tube will start to conduct. This voltage is in the neighborhood of 10.5 volts for most mercury vapor tubes and varies with the temperature and the element spacing in the tube. The addition of a control grid allows

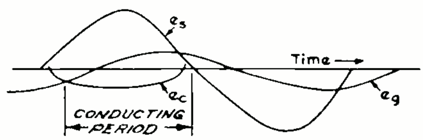


Figure 6
Showing grid-voltage, critical-grid-voltage, and supply-voltage relations for phase shift system of control.

this starting voltage to be controlled over a wide range, perhaps from 15 volts to 15,000 volts and higher. See figure 6. E_c is the critical grid voltage at or below which conduction starts. However, it should be noted that while the control grid voltage controls the plate voltage at which the tube *starts* to conduct, once the conduction has started the grid has no further control over the current flowing though the tube. Also, note that the grid has no control over the amount of current that flows through the tube. Once the conduction starts the space current is purely a function of the applied plate voltage and the resistance in the external load circuit. Thus, once the tube has started to conduct the grid can not regain control until the plate voltage drops to something below about 10 volts (positive) and the tube de-ionizes.

At first glance, it looks as if the grid merely acts as a switch to turn the tube on, and can't even turn the tube off once it is on. This conception is quite correct, although it is difficult to see how such a limited degree of control could be used to vary the voltage output of a power supply using such grid-controlled tubes, especially when the voltage control must act at syllabic frequencies.

The explanation is quite simple. The plate voltage swings negative on the rectifier 60 times a second (assuming a supply frequency of 60 cycles per second), which gives the grid 60 opportunites each second to regain control and to delay or prevent the start of conduction through the tube on the next positive half cycle.

The amount of electricity which flows through the tube on each half cycle when the plate voltage is positive with respect to the cathode of the tube can be reduced by delaying the start of conduction. The later the tube starts to conduct, the less current can flow through it before the plate swings negative on the next succeeding half cycle of operation. As the instantaneous plate voltage on the tube starts from zero, rises to a peak, and again drops to zero, a rise in negative grid bias forces the tube to wait until the plate voltage swings farther up before it starts to conduct. Figure 6 shows a typical characteristic curve of grid voltage and plate voltage for a grid-controlled rectifier tube. Conduction starts whenever the plate voltage exceeds the critical starting voltage set by the grid voltage. Thus it will be seen that the longer the grid delays the start of conduction on each positive half cycle of applied plate voltage, the lower will be the current in the load resistance, which corresponds to lowering the d.c. output voltage.

In the circuit of figure 5, transformer T_3 supplies filament heating power and also an a.c. grid voltage whose phase, with reference to the a.c. plate voltage supplied by transformer T_4, is varied by the phase shifting network composed of the reactance of the saturable control reactor T_1 and the resistance R_1. The transformer T_2 is used to isolate the high voltage on the rectifier cathode from the phase-shifting network and also to provide a low resistance grid return for the rectifier grid circuit. When the reactance of the saturable control reactor (sometimes termed *saturable control transformer*) is varied by the syllabic d.c. flowing through the primary or control winding, the phase (but not the amplitude) of the a.c. grid voltage applied to the grid of the rectifier also varies. If the rectifier grid and plate voltages are 180 degrees out of phase, the grid will be most negative when the plate is most positive and if the peak plate voltage is not great enough in proportion to the peak grid voltage, the tube will not start to conduct at all. See the curve of figure 1 for a typical Thyratron. However, as the phase of the a.c. grid voltage is varied by forcing more and more d.c. through the control winding of T_1, the phase of the grid voltage changes more and more, which reduces the peak a.c. plate voltage at which the rectifier tube starts to conduct. Thus as the d.c. in the control winding is increased, the current conduction through the rectifier tube starts earlier in each cycle of supply voltage and the higher is the output voltage of the rectifier system. This principle can be applied to keying a c.w. transmitter, varying the voltage output of a laboratory power supply, or any other application where a wide range of control over a rectified a.c. power supply is necessary.

When the above control circuit is applied to the plate and grid power supplies of an expanding linear amplifier the resting voltages are set by adjusting the resistance R_1 on figure

[*Continued on Page 83*]

RADIO

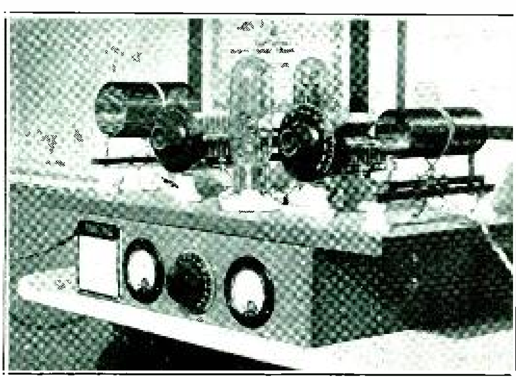
A Well-Designed Half Kilowatt

By LAWRENCE A. LASER,* W3CIC

While it is advisable for a newcomer to start in with low power and work up, there is nothing that says he can't start right off with a bang and a pair of 203-A's. Most articles on medium-high power transmitters have been written for the advanced amateur, and assume a certain amount of previous experience and working knowledge; hence are of no help to the newcomer. This article goes into more detail, and makes construction of a 500 watt stage as simple as one using 210's.

The transmitter herein described is probably not the acme of dx squirters, nor the paragon of traffic crushers; but is an all-around general-purpose transmitter capable of dx galore, a gem for traffic, a glutton for punishment, and just about the ultimate in simplicity and reliability. The main objects, namely rapidity of band changing, minimum of stages, and complete and easy logging were attained without sacrifice of efficiency.

The design was adopted after much weighing of factors, and careful analysis on paper. The time thus spent was fully justified, for when constructed it went into operation without a single major kink. Not a parasitic reared its ugly head. The design was such that none was anticipated, though knowing full well that many "ham" transmitters, much to their detriment, are infested with parasitic oscillations. Design reduced the neutralized stages to one: the final, and horse-sense construction and placement of parts resulted in perfect neutralization with a single adjustment, and no readjusting when changing bands.



The 500 watt stage, using a pair of carbon plate 203A's in push-pull.

Decalogue for a Good Transmitter

(1) The transmitter shall be operated extensively on all three of the old faithful bands, namely: 20, 40, and 80 meters, and must be available for operation on any one of these bands at a moment's notice.

(2) *Reasonably* high efficiency must be obtained. However, the 6CUH all-high of efficiency need not even be contemplated, with all respect to Charlie and the other "efficiency plus" boys. Greatly increasing the output and cost of the exciter to squeeze a last few watts from the final, partly in the form of additional harmonics, is not always best economy.

(3) Modern, high grade 203-A's are very rugged, and in a properly designed and constructed push-pull amplifier, such as the one herein described, they prove very efficient on wavelengths as low as 20 meters. They are not hard to drive, their cut-off bias is low, and reasonable output and efficiency is obtained without resorting to excessively high plate voltage; high-voltage apparatus being hard on the purse.

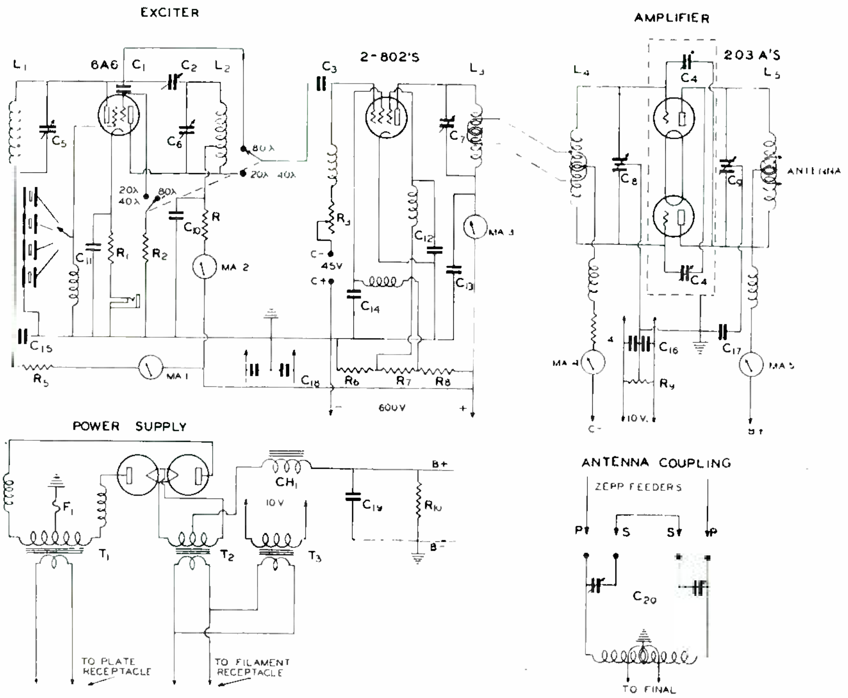
(4) Nothing resembling parasitics, or lack of perfect neutralization shall be tolerated, and harmonics radiation shall be very low. Careful design and layout alone will ward off these evils. A weather-eye must be kept for those "circuits within circuits" that parasitics feed on. A properly laid-out push-pull amplifier is not generally subject to parasitics, and it is the easiest of circuits to neutralize. It also has the virtue of suppressing second harmonic radiation, and the higher ones are not usually very troublesome.

(5) Stages must be reduced to a reasonable minimum, for a multiplicity of stages is conducive to a multiplicity of "bugs." And stages must be isolated, for any feedback to a preceding stage is undesirable. Link coupling allows a reduction of stages, and also provides good isolation and a minimum of tuning reaction.

(6) Band changing must entail as few operations as is consistent with efficiency and flexibility, and every operation must be loggable, including neutralization and antenna coupling. Band changing becomes a bogie if one has to repeat the entire neutralizing procedure with every change of band, or if antenna coupling has to be readjusted and reguessed at each time.

(7) Maximum efficiency through the transmitter must be aimed at for the highest frequency band to be used, in this case 20 meters. If the exciter will fully push the final on 20 meters, it will more than push it on the lower frequencies. Therefore, it is not necessarily poor design to sacrifice some efficiency in the ex-

*Quarles St. and Eastern Ave., Kenilworth, D.C.



Exciter, Amplifier, Amplifier Power Supply, and Antenna Coupling Unit

C_1—100 μμfd. mica
C_2—35 μμfd. midget
C_3—50 μμfd. mica
C_4—34 μμfd., 6000 volt spacing
C_5—150 μμfd. midget
C_6—150 μμfd. midget
C_7—150 μμfd., 1000 volt spacing
C_8—150 μμfd. per section, 1000 volt spacing
C_9—150 μμfd. per section, 3500 volt spacing
C_{10}—.005 μfd. mica
C_{11}—.01 μfd. tubular
C_{12}—.005 μfd. mica
C_{13}—.005 μfd. mica, 1000 v.
C_{14}—.005 μfd. mica
C_{15}—.005 μfd. mica
C_{16}—.002 μfd. mica
C_{17}—.002 μfd., 5000 v. mica
C_{18}—.006 μfd. mica
C_{19}—4 μfd., 2000 v. working voltage
C_{20}—220 μμfd., 3000 v. spacing
R—4000 ohms, 10 watts
R_1—400 ohms, 2 watts
R_2—50,000 ohm 2 watt carbon
R_3—20,000 ohms, adjustable
R_4—1500 ohms, 20 watts
R_5—5000 ohms, 10 watts
R_6—4000 ohms, 10 watts
R_7—15,000 ohms, 10 watts
R_8—5000 ohms, 10 watts
R_9—100 ohms, c.t., 10 watts
R_{10}—50,000 ohms, 100 watts
T_1—1650 v. each side c.t., 700 watts
T_2—2.5 v., 10 amps., h.v. insulation
T_3—10 v. at 7 amps.
MA_1—0-50 ma., d.c.
MA_2—0-100 ma., d.c.
MA_3—0-250 ma., d.c.
MA_4—0-150 ma., d.c.
MA_5—0-750 ma., d.c.
CH_1—500 ma. 12-40 hy. swinging choke

citing stages on 40 and 80 meters in the interest of overall flexibility and economy. If we make a buffer tank coil low-C on 20, and tune the same 20 meter coil with a large condenser to give high-C on 40, we are covering two bands with this buffer by merely twisting a dial from near the bottom of the scale to near the top. The tank efficiency is slightly reduced on 40, but what of it; the overall efficiency on 40 will still be greater than on 20 and there will still be an excess of 40 meter excitation.

(8) Link coupling must be used between the buffer and final to allow high buffer efficiency on 20 meters.

(9) Keying must be done in one of the exciting stages and the following stages must be fixed-biased to cut-off. The rest of the class-C bias can be either fixed or from gridleak, preferably the latter for the sake of economy. Keying a low-power stage usually gives clean-cut keying, free from clicks and thumps. But the stages following the keyed stage must be biased to or near cut-off and perfectly neutralized, or trouble may ensue. 67½ volts of "C" battery will bias 203-A's past cut-off at 1500 volts on the plates. This amount of good battery does not cost a fortune and on a c.w. transmitter will give fair service.

(10) No more than two power supplies should be necessary. But they must be able to do the work demanded of them and give good voltage regulation. A 200 watt power supply should not be asked to do a 600 watt job, even though it is being tried every day.

The Final Amplifier

The transmitter will be described as it was built, final class "C" amplifier first, which is probably the best construction procedure. Above is shown a schematic wiring diagram. The photographs give a rough idea of the placement of parts. The plate and grid tank coils and condensers are placed aboveboard. The *ganged* neutralizing condensers are placed below, and terminate in a Velvet-Vernier dial on the front panel. The grid and plate milliammeters are on this front panel; also a tuning chart.

A copper shield can extends the full width and depth of the compartment, but not the full length. It is open on the bottom side. Its main purpose is to shield the meters and other non-r.f. apparatus from powerful fields. It is not absolutely essential. The neutralizing leads are carried through shielding by 1" isolantite bushings, and the neutralizing condensers are well insulated and separated from shields and each other. The two r.f. chokes are beneath the breadboard, but on the outside of the shield can, and at right angles to their respective tank coils.

TABLE 1

Wire-Wound Inductances

40 m. and 20 m. plate coils are 3/16" copper tubing and described in text.

Plate coils	80 m.	40 m.	20 m.
Wooden form diam.	3⅛"	———	———
Wire	no. 12 enam.	———	———
Turns	30	———	———
Grid coils			
Wooden form diam.	2⅛"	2⅛"	1¾"
Wire	no. 14 enam.	no. 12 enam.	no. 10 enam.
Turns	42	24	14

All spacing same as wire diameter except 20 meter grid coil which is spaced to occupy a length of 5 inches.

The plate tank is tuned by a split-stator condenser, the rotor of which is grounded through a fixed mica condenser. The latter protects the power supply in case the plate tuning condenser arcs over. If this is beyond the realm of probability, the rotor can be directly grounded and the mica condenser eliminated. 100-100 μμfds. is satisfactory for the plate tuning capacity. The neutralizing condensers are 34 μμfd., 6000 volt, with a special extended shaft on one, and the two are ganged together with a *very good* insulated coupling. 25 μμfd. condensers will fill the bill, but be sure they have 6000 volt spacing. Long experience with balanced push-pull amplifiers has shown that the two identical neutralizing condensers will track with identical tubes in a well-balanced layout, and that a *very slight* off-adjustment of one can be compensated for with the other; so it was logically concluded that they could be ganged. This particular amplifier neutralizes perfectly, and a single dial on the front panel logs the adjustment, which is identical on all three bands. These condensers are placed directly beneath the tube sockets and no neutralizing lead is more than two or three inches long.

A push-pull r.f. amplifier is essentially a balanced circuit. For best results keep a balance both electrically and mechanically. A push-pull job that is mechanically jumbled is also electrically jumbled, in that it has its r.f. balance upset. Keep corresponding leads on each side of the circuit the same length. Leads from sockets to tank condensers should be short, and those from tank condensers to tank coils should be as short as possible consistent with proper condenser and coil spacing.

The 1500 ohm grid leak and 90 volt "C" battery at normal 70 ma. rectified grid current as shown by the grid meter gives approximately three times cut-off bias, which is about optimum in this case. There seems to be little advantage in exciting the grid circuit to more than 70 or 80 ma., but keep to at least 60 ma. If excitation is a little shy, reduce the value of the grid bias resistor and operate nearer cut-off.

The plate voltage is run at 1500 and the plate current between 300 and 400 ma., giving up to 600 watts plate input. Don't put over 1500 volts on the plates, nor run the plate current much above 350 ma., if you would have your tubes live to a ripe old age. A little lower voltage would be conducive to greater longevity, especially on 20 meters. At this plate voltage do not remove the antenna load. To do so is almost bound to cause a stem failure. Reduce voltage when tuning and testing.

Caution—1500 volts is 1500 volts in any man's country, and your heart is in the circuit between your fingers and pedal digits; keep your fingers out of the final when the juice is on.

All plate, grid and feeder tank coils are nearly 100% or are 100% air dielectric (in the high power stage). The 20 meter plate coil is entirely self-supporting and consists of 12 turns of 3/16" copper tubing 2¾" outside diameter and spaced to occupy a length of 7⅜".

This coil is close-wound on a length of 2" pipe and spaced after removal from the form. Polish the tubing with steel-wool, secure one end to the pipe with a machine screw, and the other end in a vice. Walk towards the vice as you wind. At finish of winding release the tubing, and its diameter will increase to that specified. Remove from form and run a screwdriver of proper size spirally between turns to give proper spacing. Finish ends to fit the plug-in mounting, solder on the center tap and give a coat of clear lacquer to prevent tarnish. When dry, clean lacquer off the terminals and mount.

The 40 meter plate coil is wound similarly on a 2½" pipe form. It has 20 turns of 3/16" copper tubing 3⅜" outside diameter and spaced to occupy the same length. In addition, this coil has four ½" strips of celluloid running lengthwise and equi-spaced cemented to the turns on the inside with Duco household cement. This keeps the center turns from sagging and vibrating, and contributes next to nothing to the dialectric losses.

The 80 meter plate and 80, 40 and 20 meter grid coils employ solid enamelled wire and are wound on diagonally-split wooden removable forms with four ½" strips of celluloid placed between the form and the winding. Duco cement holds the turns in place when applied to the strips. Table 1 gives wire size, turns, spacing, etc. Where spacing is equal to wire diameter, two wires are wound tightly side by side, one being removed later.

A little care and exercise of ingenuity in construction of coils and mountings will add greatly to the appearance of the finished transmitter and probably some to the efficiency. All coils in the final stage are plug-in and mount on a strong strip of *good insulating* material provided with five banana plugs (2 for the link). In the case of the grid coils, a similar strip carries five jacks for them and is permanently fastened above the breadboard by two small stand-offs. The plate coils plug directly into five stand-offs provided with jacks. The coil strips and their corresponding jack strip are drilled together so that all coil assemblies make a neat fit. Use a good, husky type banana plug as heavy r.f. currents are handled by those connecting to the link circuits and final tank.

Antenna and Feeder Tuning

While on the high-power end of transmission, a few words might be appropriate on the subject of feeders and antennas. The writer uses a 160 meter zepp. for its dx capabilities on 20 and 40 meters. Very few are fortunate enough to have the space for such an unwieldly affair. Such a high-harmonic antenna is especially effective for dx work on 20 meters, though it is also especially hard to keep up during a blizzard.

This particular antenna is 267 feet long with 40 foot feeders. The flat-top is of no. 12 enamelled copper-clad steel wire, chosen for its strength and nonstretching qualities. It is strung between two very large oak trees, and all wire between the main antenna insulators and the trees is broken up every 12 feet by egg insulators to prevent absorption of r.f. energy. At one end it connects to a quarter inch flexible bronze tiller cable that passes through a pulley and ties to several hundred pounds of elevator weights. This keeps a steady pull on the antenna at all times, and all the furies in concerted action are not supposed to bring it down —if an insulator does not divide itself.

Casualty number one was just such a failure of a hefty glass insulator. Casualty number two was the fraying of the original galvanized clothesline type of flexible cable where it worked back and forth through the pulley: hence the present bronze.

Lest you be worried about little children that are wont to play under sturdy oaks or others that may seek shelter beneath their leafy canopies, let it be known that a ⅜" steel cable passes through the weights and about the trunk of said tree, with a foot or two of play, of course. In case of antenna breakage the drop of the weights is suddenly and surely arrested after a few feet.

There are probably more efficient feeder systems than the Zepp. system chosen, but the one outstanding virtue of a Zepp. is that a given feeder readily tunes to all bands, whereas most feed systems are one-band affairs, or at best only work at peak efficiency on the band they are designed for.

Unfortunately, most Zepp. feeder lengths require parallel tuning on some bands and series on others. This usually makes for an awkward or inefficient tuning arrangement. Separate condensers may be used, but this adds to the cost, bulk, and number of controls; and adds nothing to the ease of logging and operating.

After much cogitation the scheme shown in the diagram was adopted. Less condenser tuning capacity is required when parallel tuning, but higher condenser voltage rating. Advantage was taken of this fact by placing the two identical condensers in series with each other and across the coil when parallel tuning; and separating them and putting each in series with its respective feeder wire when series tuning. Thus in series tuning we get the wanted extra capacity and in parallel tuning we get the wanted extra voltage rating; and we get all this without anything that really resembles a switching arrangement.

The two condensers are identical except that one has a special extended shaft, which connects to the shaft of the other condenser by a good insulated coupling. The tank coil connects to the two stators; and four 3" standoff insulators with banana jacks are placed, two near each condenser, on the side opposite the coil. A banana plug on each feeder wire, or flexible extension thereof, and a short jumper of copper or brass provided with two plugs spaced to fit the two inside jacks completes the equipment. The photograph shows this clearly.

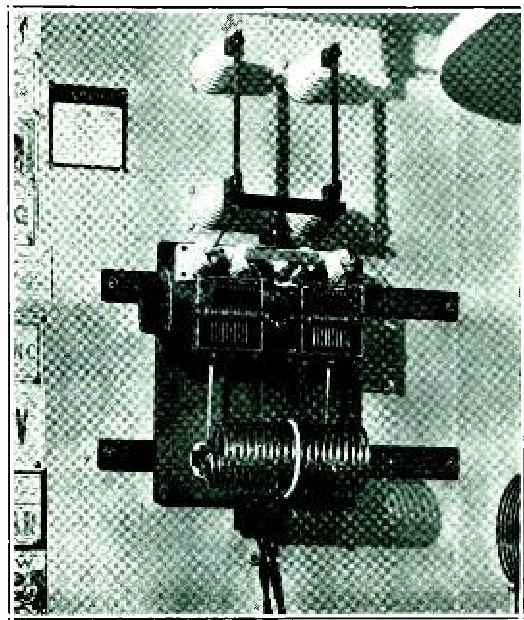
Plug the feeders into the outside jacks and the jumper into the inside jacks and you have parallel tuning. Remove the jumper and plug the feeders into the inside jacks, and presto, you have series tuning in each feeder. And all this with single dial tuning and 100% loggability. Grounding the center tap of the feeder tank coil proved desirable; but it might not be so in all cases.

The link from the plate tank to the feeder tank should not be smaller than no. 12 solid twisted wire, insulated of course, though not much insulation is needed as the power in the circuit is at high current and low voltage. Low resistance contacts are more important than high-voltage insulation.

The loops about the coils should be of the same size solid wire. The one about the plate coil should be well-insulated due to the presence of high d.c. voltage. Both loops are tightly coupled at points of low r.f. voltage, in this case the center of each coil. When parallel tuning, one turn suffices at the plate end and two at the feeder end. When series tuning, three turns are used at the feeder end and two at the plate end. These figures may not hold true in all installations. At any rate, adjust the turns ratio until at normal working voltage and correctly tuned the final amplifier plate current is normal; that is, until the antenna system is drawing full load.

Conductive coupling can be substituted for the loop at the feeder end. In this case merely clip the link an equal number of turns each side of the feeder coil c.t. A few trials will soon reveal the proper location of clips.

Another advantage of link coupling between final amplifier and feeders is the ease of switching the link circuit from one transmitter to another, or from final to buffer when substantially decreasing power. Because of the nature of link circuits, capacity effects are negligible, and miniature d.p.d.t. knife switches fill the bill, provided the contact surfaces are fairly large and good contact is assured.



The versatile antenna coupling unit. Note the neat construction.

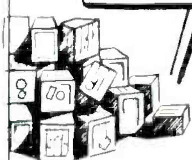
The feeder tank coils are of 3/16" copper tubing, constructed and mounted similar to the final plate inductors. Their dimensions depend upon the feeder dimensions. When parallel tuning, proportion the coil to tune low-C. When series tuning use high-C.

The Exciter Unit

In designing any exciter unit, aim to get enough output on the highest frequency band to be used to excite fully the final stage to peak input. The reason for using the highest frequency band as a gauge is that all circuit losses are greater at higher frequencies. Also, the extra frequency doubling cuts down efficiency. Therefore, if a given exciter will fully kick a given final stage on, say 20 meters, there is no doubt about its ability to fulfill its duty on the lower frequency bands. On the other hand, an exciter that does a good job on 80 meters may be a total flop on 20.

[Continued on Page 88]

THIS LITTLE "HAM" *went to market and this is what he found at* WHOLESALE RADIO SERVICE CO. INC.



1. The most modern display rooms in radio! Equipped with vast stocks of nationally known receivers, X'mitters, parts. Most every manufacturer is represented here. You'll find all the latest type apparatus arranged for your inspection.

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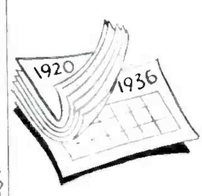
Manufacturers too, realize the "Leadership" position we hold in the radio field. They come to our purchasing agents with the latest innovations—always giving us the benefit of their lowest prices because of our volume "buys."

These savings we pass on to you—our policy demands it—we know you welcome and appreciate our efforts to save you money and to at all times furnish you "The Character Merchandise" you are entitled to expect.

Seldom is an item listed by a competitor at a lower price than ours. However, should such occur just send to us the competitors' name and catalog page number. If the item listed is identical to our quality merchandise we will make shipment to you at the same price. Further should any price reductions take place after this catalog has been printed you will receive a refund in full for the difference in price.



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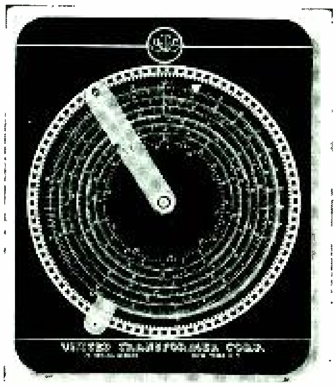
WHAT'S NEW

Handy Calculator

The United Transformer Corp., 72 Spring St., N.Y.C., will soon release to amateurs a very handy slide rule in conjunction with a 48-page technical bulletin which includes data and circuits on amplifiers and transmitters from ½ watt to 1000 watts. The



bulletin contains many useful charts and tables that save much time in calculations, and many data on amplifier design and operation.

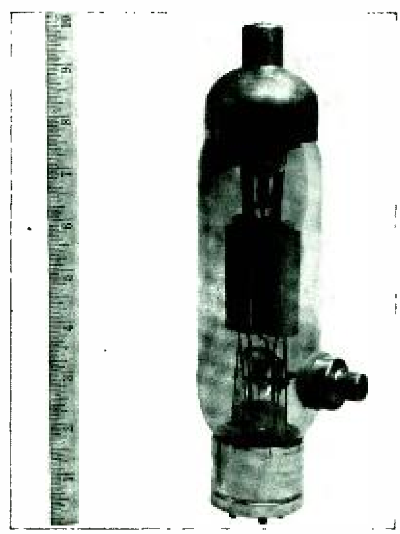
The circular slide rule gives direct answers to the following electrical and mathmatical problems: Multiplication; division; proportion; reciprocals; squares; square roots; voltage drop in a resistor; wattage in a resistor for a given voltage or current; impedance of an inductance at a given frequency; impedance of a condenser at any frequency; resonance calculation; effective capacity of condensers in series; effective resistance of resistors in parallel; calculation of bias resistors; power level conversion to db.; voltage or current ratio conversion to db gain; sound and light calculations; circumference and area of circles; stroboscope for checking 33 1/3 or 78 r.p.m. turn-tables. Due to its 20 inch effective length, the accuracy of this rule is greater than many of the standard rules selling for several dollars. Size, 8 x 10 inches. Inclose 25c for a slide rule and 48 page technical bulletin to defray cost of postage, wrapping, etc.

Condenser Catalog

A catalog listing the more important electrolytic condensers recently developed by their laboratories for the radio servicing field is announced by the Cornell-Dubilier Corporation. Catalog No. 131A furnished on request by the Cornell-Dubilier Corporation, 4377 Bronx Blvd., New York City.

New Low-C Transmitting Tube

A new oscillator tube, capable of delivering 250 watts at wavelengths as low as six meters, is announced by the Westinghouse Lamp Company, Bloomfield, New Jersey. Designed for operation in short



The WL-460 H.F. Triode

wave therapy machines, the new Type WL-460 tube has three electrodes, a thoriated tungsten filament, is air cooled; and may be used at a.c. plate potentials up to 2500 volts. The grid lead coming out the side and the plate lead coming out the top facilitate circuit arrangement and application of the Type WL-460 in six-meter fever machines used in therapeutic work.

Typical high frequency ratings of the WL-460 are as follows:

A FACT THAT CANOT BE DENIED!

THERE ARE MORE

Taylor HEAVY CUSTOM BUILT DUTY Tubes

IN AMATEUR RADIO TRANSMITTERS
THAN ANY OTHER MAKE OF TRANSMITTING TUBES

"MORE WATTS PER DOLLAR"

NOW with these NEW type TAYLOR TUBES than ever before.

TAYLOR T-55

FOR ULTRA SHORT WAVES
55 WATTS PLATE DISSIPATION

$8.00

CHARACTERISTICS

Filament	7.5 Volts
Fil. Current	3.25 Amps.
Max. Plate Volts	1250
Max. Plate Current	125 M.A.
Plate to Grid	2.5 MMF.
Grid to Fila.	1.7 MMF.
Amp. Factor	25
UX250 Envelope	
Nonex Glass	

TUBE FACTS

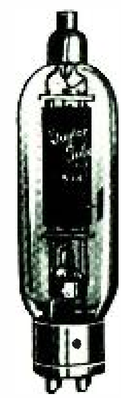
A properly designed tube will operate at a temperature low enough so that good insulation is maintained at all times. The lava insulators (so necessary for uniformity) used in TAYLOR TUBES, have a resistance of many million ohms. Hence, TAYLOR TUBES have no "ceramic losses" at the higher frequencies.

It is a physical law that a rough black surface will radiate heat four times faster than a bright metal surface. THAT'S THE REASON TAYLOR TUBES HAVE CARBON ANODES.

TAYLOR 814

HIGH EFFICIENCY with LOW DRIVING POWER
designed for efficient operation on
ALL BANDS from 10 to 160 meters

$18.50



CHARACTERISTICS

Fil.	10 Volts-4 Amps.
Max. Plate Volts	2000
Max. Plate Current	300 M.A.
Plate Dissipation	200 Watts
Class C Output	500 Watts
Amp. Factor	12
Grid to Plate	13 MMF.

TAYLOR 822

A Super HD203A **$18.50**

A pair will deliver 600 WATTS OF AUDIO in Class B. Excellent R.F. Amplification on ALL BANDS—10 to 160 METERS. Same appearance and general characteristics as the 814 except AMPLIFICATION FACTOR is 27.

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[Continued from Last Page]

Wavelength (Meters)	Frequency (Megacycles)	A.c. (R.M.S.) Plate (Volts)	D.c. Plate (Amperes)	Approximate Plate Output (Watts)
50	6	2500	0.200	250
20	15	2500	0.200	250
10	30	2500	0.200	250
5	60	2500	0.200	250
3	100	1500	0.175	150

A push-pull type of circuit is recommended at the wavelengths or frequencies indicated in the foregoing table. Plate voltage and current figures represent the highest values which should be used at the designated wavelengths. D.c. grid amperes represent the approximate grid current with a grid leak of 5,000 ohms. Since grid resistor and grid current values are not particularly critical, satisfactory operation can be obtained over a wide range of values. But the best value should be determined beforehand and then used in service.

Output watts represent the power output from one tube and are typical values rather than minimum or maximum figures. In some cases, it may be possible to obtain greater than the tabulated values. This is permissible so long as the plate voltage and current as well as the plate input and dissipation maximum ratings are not exceeded. A slightly reddish color of the plate indicates when dissipation reaches its maximum rated value of 150 watts.

Noise Bucker

A new "noise discourager" of the fast a.v.c. type, effective in eliminating or reducing several types of man-made static, has been released in unit form by

the Amplivox Radio and Sound Labs., and is known as the "Amplivox Noise Bucker". It is attached to most any standard superheterodyne with two or more stages of i.f. by making a few simple connections.

Speaker Catalog

Just off the press is the first "Magic Magnet" speaker catalog with a de luxe array of 8, 10, 12, and 18 inch speakers for use in receiver, car and public address fields. The catalogs, conveniently punched, are of standard size for insertion and quick reference in technical files.

Transmitting Tube Data Sheets

The Audio Products Co., 4189 West 2nd St., Los Angeles, have compiled a series of data sheets on common transmitting tubes in which a certain amount of "judicious" overloading is assumed. For obvious reasons manufacturers cannot indorse such operation of their tubes, and therefore are usually quite conservative in their ratings. However, as some manufacturers are inclined to be more conservative than others, it is not feasable to take the ratings on any bunch of miscellaneous tubes and multiply the ratings by a common factor to determine by what amount the tubes may be safely overloaded.

The figures given in these data sheets are based on actual laboratory tests under typical overload conditions, and therefore are quite valuable to an amateur who is concerned with getting the last ounce of performance per dollar out of his tubes without shortening their life to an extent where he would save money over a period of time by using larger tubes.

These data sheets are available upon request to licensed amateurs by writing the Audio Products Co.

Microphone Shock Absorber

To eliminate "floor noise", and at the same time to eliminate noises caused by the raising, lowering, and moving of a microphone stand, the American Phenolic Corporation has introduced a small, inexpensive shock absorber which is said to effectively do the job. This unit is but 1⅛ inches long and ¾ of an inch wide, has standard ⅝ inch-27 threading (male and female at the respective ends) for ready installation between mike and stand in all existing assemblies, has a 1/16 inch opening throughout its entire length for the mike-to-stand cable, and uses a cushioning element of live para gum rubber for the absorption of vibrations set up in or by the stand and ordinarily transmitted on to the microphone.

Installed in any mike-stand set-up, the item should materially aid in the attenuation of background noise caused by vibrating floors and microphone supports.

Conversion Exciter

[Continued from Page 11]

amplifier, neutralized if necessary. As the changes are easily restored to their original form this does not interfere with the ordinary type of operation if one ever wishes to return to it.

Stability

The low-frequency oscillator described has been tested under practical operating conditions during long and short runs and during variations of room temperature. These tests can be summarized in the simple statement that it has never been found to be more than 300 cycles (3/10 kc.) off chosen frequency 4 minutes (or more) after the filaments are turned on.

◆

W6QD, editor of our DX department, has considerable difficulty in computing the distance to a given place when he wants to find how many miles away a certain dx station is located from him. You see, he has to take the direction of his transmitting antenna into consideration when figuring the actual distance. His transmitting antenna is well over 1000 feet long!

Minute Men

[Continued from Page 17]

den (Amos, of "Amos 'n Andy"); Frank Hawks, the speed flyer; and Carter Glass III.

Physical disability does not exclude one from hamdom. Many hams are permanent shut-ins; some are blind. One copy of the *Radio Amateur's Handbook* has been made in Braille, and though it is not yet available in quantity, this single copy has made it possible for several blind operators to get their amateur licenses.

Hams speak a language among themselves that is entirely meaningless to the uninitiated. On the air, a YL (young lady) is a female radio operator or a ham's girl friend, and XYL is a ham's wife. OM means "old man", OB is "old boy", and FB (fine business) means "very good". When you hear an amateur monotonously repeating "Calling CQ . . . CQ . . . calling CQ", he is asking any other operator who hears him to answer and strike up a conversation.

Hams are bitterly attacked sometimes by neighbors with out-of-date sets who complain of interference with broadcast reception. If the offended parties would go directly to the ham with their complaints, they would find quick relief. Installing a wave-trap is only a ten-minute job, and the ham is glad to do it gratis.

The spirit of experiment is as much alive in hamdom today as ever. At a meeting of a New York amateur radio club recently, a member spent fifteen minutes explaining the hookup of his transmitter, fifteen more minutes proving that according to all known laws of electricity the hookup was *wrong*, and a third quarter of an hour introducing strong evidence that he was getting *better results* with the new circuit than with standard radio formulae.

"What I want to know," he concluded, "is why the damn thing works."

Thirty hams knit their brows and settled down to figuring out why the damn thing worked. And they *will* figure it out.

That's how these amateurs developed the science of short-wave radio in the first place.

◆

W9AKH seems quite pleased with the new Jones-RADIO single-wire-fed antenna, as is evident from the following excerpt from a letter from him:

"Used a 67' antenna tapped 9'4" off center on 14 mc. all last year and didn't work any dx to speak of. Since tapping the feeder 11' off center, as described in April RADIO, my dx on 14 mc. has increased 100%. Worked 20 new countries within a week."

◆

A few months ago, an inductotherm machine at Harvard university, used to bake injured athletes, was belching out radio interference described as *ghost signals, messages from another planet*, etc. With everybody wondering what to do with the dingus, the Radio Authorities put it in its class. It has been assigned a channel and is now radio station NDLA.

◆

Hams Across the Sea

[Continued from Page 58]

to hook up with some dx station for a good old rag-chew.

In Sweden there is a society of SM hams (the S.S.A.) which is steadily growing and at the present time has 225 members. Each year they have three or four National Test Competitions and from all reports the gang over there really goes for them.

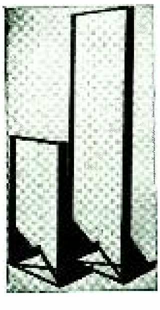
Approximately 80% of the SM stations are crystal controlled, with some Hartleys still batting away. Most of the hams run their input between 25 and 100 watts, although there are a few with 150 watts, and possibly one or

[Continued on Next Text Page]

REMARKABLE PRICE REDUCTIONS

On LEEDS Constructional Accessories due to greatly increased demand

RELAY RACKS



Our Relay Racks are built to stand up under the heavy loads of modern transmitter construction. Uprights are made of 3/16" stock, 1¾" wide. Welded angle supports, cross braces and sturdy cross bars insure extreme rigidity. LEEDS Racks unlike some units on the market, are drilled for panel mounting according to Bureau of Standards specifications.

Table Rack type RAD 33¼" panel space high, 20½" wide, 12" deep, with a complete set of drilled and tapped panel mounting holes **$5.75**

Shipping weight 30 lbs.

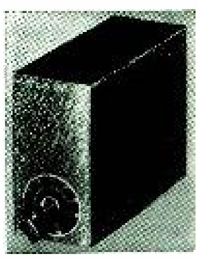
Type RBD rack 66½" panel space high, 20½" wide, 12" deep, with a complete set of panel mounting holes **$7.45**

Shipping weight 50 lbs.

Brackets—4" high, 5⅜" deep, ½" bend for mounting; pair **25c**; 7½" high, 9½" deep, ½" bend for mounting, pair **35c**

NOISE SILENCER ADAPTERS are a great help on reducing natural static too. Leeds "QUIET CAN" and "SILENT CAN" also provide freedom from ignition noises and afford an ideal arrangement for push to talk phone and break-in CW.

Leeds **"Quiet Can"** illustrated herewith, for receivers with 2 IF stages; complete with tubes and instruction. **$8.55**



Leeds **"Silent Can"** for receivers with 1 IF stage; complete with tubes and instruction. **$10.95**

OUR VACATION Special

ATWATER KENT Model No. 48 TRF broadcast six tube battery receivers, in sealed cartons. These receivers may be operated from 6 volts with 201A's, or 2 volts with 230's with 90 volt B battery. Ideal for the summer camp "beyond the power line". Quantity limited better order early. Less accessories **$4.95**

National HRO Receiver

with coils from 30 mc. to 1.7 mc. and tubes **$179.70**

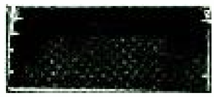
Important Announcement

On our NEW LD-5 Mounted Crystals

These low drift plates, factory sealed in the new LEEDS metal holder are outstanding from the standpoint of stability, accuracy, high output and low cost. Low drift—5 cycles per million per degree. Accuracy of calibration better than .05%. Orders filled plus or minus two kc of specified frequency. Last but not least, the price of the mounted crystals, anywhere in the 160-80 and 40 meter bands is only **$3.50**

Money back guarantee if you are not Completely Satisfied.

Rack Panels



By LEEDS are furnished with black shrivel finish in the standard 19" length, ⅛" thick. Mounting slots are spaced according to Bureau of Standards specifications, insuring freedom from all trouble in mounting or interchanging panels.

Steel	*Price*	*Width*	*Aluminum*	*Price*
PS-1	$.52	1¾"	PA-1	$.74
PS-2	.57	3½"	PA-2	1.03
PS-3	.68	5¼"	PA-3	1.30
PS-4	.71	7 "	PA-4	1.55
PS-5	.95	8¾"	PA-5	1.90
PS-6	1.15	10½"	PA-6	2.45
PS-7	1.30	12¼"	PA-7	2.90
PS-8	1.50	14 "	PA-8	3.35
PS-9	1.70	15¾"	PA-9	3.70
PS-10	1.90	17½"	PA-10	3.95
PS-11	2.05	19¼"	PA-11	4.45
PS-12	2.30	21 "	PA-12	5.20

Brass panel mounting screws ½" long 10/24 thread, 15c per dozen.

LEEDS Low Cost Power Supply Equipment

LEEDS Plate Transformers, Primary 115 Volts A.C. 50/60 Cycles

LB-10 900 v. center tapped at 150 MA; 5V-3A; 2½V-10A; LB mtg. **$3.25**
LA-2 1000 v. center tapped at 200 MA; 2½ V.C.T. 14A; 5 V.C.T. 3A. **$4.00**
LA-3 1200 v. center tapped at 200 MA; 2½ V-10A; 7½ V-3A; 5V-3A. **$5.00**
LA-4 1600 V.C.T. at 150 HA **$3.75**
LA-5 1600 V.C.T. at 250 Ma **$5.50**

LEEDS Smoothing Chokes

LB-1 12 H., 200 MA; D.C. res. 140 ohms, LB mtg. **$2.50**
LA-30 12 H., 300 MA; D.C. res. 105 ohms, LA mtg. **$3.75**
LA-50 12 H., 500 MA; D.C. res. 70 ohms, LA mtg. **$6.50**

LEEDS Input Swinging Chokes

LB-2 5/25 H., 200 MA; D.C. res. 110 ohms, LB mtg. **$2.50**
LA-40 5/25 H., 200 MA; D.C. res. 105 ohms, LA mtg. **$3.75**
LA-60 5/25 H., 500 MA; D.C. res. 70 ohms, LA mtg. **$6.50**

LEEDS Filament Transformers, Primary 115 Volts A. C. 50/60 Cycles

LA-15 2½ V.C.T. 12A; 5000 V. insulation; 10 V.C.T. 6½A; LA mtg. **$4.00**
LA-16 5 V.C.T. 20A; 7,000 V. insulation; LA mtg. **$3.75**
LA-17 5 V.C.T. 20A; 10,000 V. insulation; LB mtg. **$5.00**
LB-12 2½ V.C.T. 12A; 7,000 V. insulation; LB mtg. **$2.25**
LB-13 7½ V.C.T. 6½A; 5,000 V. insulation; LB mtg. **$2.25**
LB-14 10 V.C.T. 6½A; 5,000 V. insulation; LB mtg. **$2.50**
LB-15 5 V.C.T. 3A; 5 V.C.T. 6A; 5,000 V. insulation; LB mtg. **$2.50**

LEEDS
The House of RADIO

LEADS THE FIELD

World Wide Service to Aamateurs

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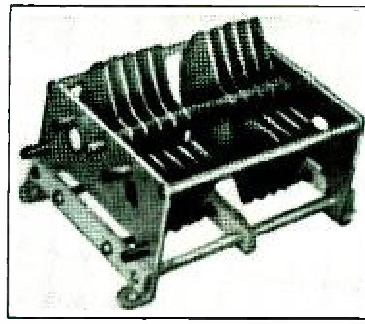
NEW YORK CITY

Telephone Cortlandt 7-2612
Cable Address: "RADLEEDS"

BASES and DEMI-BASES

By LEEDS for use with rack panels are now available in a greatly increased variety at lower prices. Crystaline finished units of 20 gauge steel; each base is finished with a bottom cover plate, so that apparatus underneath the chassis may be kept free from dust and at the same time electro statically and electro magnetically shielded.

8½ x 8 x 2	**.65**	10 x 17 x 2	**1.10**
8½ x 10 x 2	**.70**	10 x 17 x 3	**1.30**
8 x 17 x 2	**.95**	12 x 17 x 2	**1.30**
8 x 17 x 3	**1.15**	12 x 17 x 3	**1.40**
4 x 17 x 2	**.70**		



LEEDS Offers Outstanding Condenser Values

Isolantite insulation, polished plates, sturdy construction; for 1 KW phone transmitters.

Split stator, 40 mmf. per section, .375 spacing 12000 volt, per section **$7.20**

We recommend two in parallel for 75 meters, for 1 KW CW or 500 watt fone transmitter.

Split stator 60 mmf. per section, .250 spacing, 9000 volt, each section **$10.20**

Split stator 100 mmf. per section. For 500 watt CW transmitter. .185 spacing 600 volt, each section. **$9.60**

Exceptional values in single section units TOO.

50 mmf.	6000 volt	**$3.60**
100 mmf.	6000 volt	**5.40**
230 mmf.	6000 volt	**8.70**
50 mmf.	12000 volt	**4.35**
100 mmf.	12000 volt	**6.60**

LEEDS Type 1-B Freqmonitor

is now in use in hundreds of amateur stations. A complete description of this two purpose instrument may be found in the April 1934 issue of "QST". "Ask the man who owns one." Complete with tubes and calibration chart **$19.75**

Our type **1-E Power Supply** is ideal for use with the 1-B priced at **$6.50**

[Continued from Last Text Page]

two with 400 to 500 watts. Some of the different makes of tubes in use by the boys over there include RCA; Raytheon RK-20, RK28; Phillips; and Tungsram. For receivers, there are a number of FBXA's and Comet Pro's, together with many home-built s.s. supers.

SM6UJ says the hardest spot to work from Sweden is South America, the easiest U.S.A. In the recent dx contest SM6WL probably ran up the best score in their country, with 5685 points.

Mr. Ahner says that dx conditions on the 14 mc. band are best now around 0400 to 0600 G.m.t. (this being for W stations). The frequency mostly used by SM6UJ is 14,304 kc., and he is endeavoring to get on the air daily around 0500 G.m.t. for a few dx rag-chews.

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Calls Heard

[Continued from Page 57]

LU1JH; LU5CZ; LU7BH; LU9AX; LU9BV; OE1FP; OE7EJ; OK1BC; OK1FZ; OK1LM; OK1SU; OK2AK; OK2KP; OK2LK; OK2MA; ON4AS; ON4CH; ON4HC; ON4UU; PA0FF; PA0KH; PA0PN; SU5NK; U2NE; VE1BV; VE1ET; VE2BG; VE2DC; VP5AB; VQ8AC; VS6AK; VS6AO; VS6BD; VU2EP; VU2EQ; VU2JP; VU2LS; XG2SD; ZB1H.

Lloyd M. Jones, W6DOB, 547 West 106 Street, Los Angeles, Calif.
March 1 to April 1

(28 mc. c.w.)

CP1AC-8; CT1BY-8; EA3EG-7; EA4AO-9; EA4BM-7; EI8C-7; F8EO-9; F8HS-7; F8KJ-8; F8WK-9; FA8BG-9. G 2HX-7; 2GS-4; 2NF-5; 2NH-4; 5LA-9; 5WP-9; 5YG-9; 6CJ-5; 6DH-6; 6QB-6; 6QL-5; 6RV-5; 6WN-8; 6ZU-7. — HJ3AJH-8; J2LO-4. K 4DDH-7; 4KD-6; 5AY-7; 6CGK-7; 6CRU-8; 6DV-7; 6FJF-8; 6JKI-5; 6MVV-9; 7PQ-4. - LU1EP-9; LU9AX-8; LU9BV-6; OA4J-6; ON4JB-6; ON4NC-3; PY2BX-6; SP1DE-9; TI3WD-7. — VK 2LZ-8; 3BD-7; 3BW-5; 3CP-8; 3GP-6; 3MR-8; 3YP-9; 4AP-7; 4BB-8; 4GK-7; 5HG-8. - VP5PZ-8; VO1N 7; ZL2CI-7; ZL2KK-6; ZL3DJ-6.

N. Shumacher, W9IWX, 6139 Cornelia Ave., Chicago, Ill.
March 14 to 22

(14 mc. c.w.)

CM2AO; CM7AC; CT1BY; CX1CG; CX2AK. - D 4ARR; 4BIU; 4GAO; 4GJC; 4GWF; 4IJH; 4QET. — EA 1AM; 3EG; 4AB; 4AO; 4AP; 4BM; 8AF; 8AO. — EI8B; EI8D; F3LE; F8EB; F8EO; F8NR; FB8AB; FM8O. — G 2AX; 2PL; 5KG; 5LA; 5QA; 6IF; 6NJ; 6WQ. — HAF3D; HB9J; HB9AQ; HJ3AJH; I1TKM; J2LL; J2LK. — K 5AC; 6AUQ; 6IDK; 7ELM; 7ENA; 7PQ. — KA1LB; OA4J; ON4CC; ON4DX; OZ2M; OZ3FL; PA0CE; PA0UN; PA0XD; PY2BU; SU1SG. - VK 2LZ; 2QE; 2VA; 3FJ; 3KR; 3MR; 3OC; 3WW; 3XP; 4LW; 5MD. VP2BX; VP2TG; VP5JB; VU2CQ; XE1AM; XE2N; YM4AA. - ZL 1BV; 1DV. 1HY; 2II; 2KO; 2MM; 3DJ; 3FZ; 3GR; 4BQ; 4CK. ZU6P.

(28 mc. c.w.)

CM2FA; D4ARR; F8EB; F8RR; F8WK; G2NH; G2PL; G5KG; G6DH; G6GS; G6LK; G6NF; HJ3AJH; LU9AX; OA4J; OK1BC; OK2HX; ON4FE; ON4NC; OZ2M; PA0AZ; PA0FX; PA0UN; VK2LZ; VK2PN; VK3CP; VK3MR; VK3YP; VK4AP; XE1AA; XE1AM; ZS1H; ZS2A.

Alston Ramsay, VE5PW, Penticton, B.C., Canada
March 1 to April 1

(7 mc. c.w.)

J2MH-6; J3FI-5; K6AUQ-5; K6HZI-8; K7UA-8; KA1EL-4; KA1ER-5; KA1MD-6; KA1RW-8; KA9SK-7; KA9WX-5. - VK 2DG-4; 2EQ-4; 2LZ-5; 2PX-6; 3FB-6; 3FM-5; 3MR-5; 3WX-7; 4UW-4; 5BH-5; 7RC-5. — VS6AH-5; XE2DQ-6; XU8AG-5; ZL1GX-7.

(14 mc. c.w.)

CO2HY-6; CO2KY-5; CO2OO-4; CX1GG-4; CX2AK-3; HJ3AJH-6; J2CC-6; J2CL-4; J2KO-4; J2LK-6; J2LO-4; J2ME-4; J5GX-4. — K 5AC-7; 6AKP-7; 6BUX-5; 6BHL-8; 6IDK-8; 6MEG-8; 7BHR-7; 7ELM-9; 7ENA-6; 7EXU-6; 7PQ-6. — LU1EP-5; OA4J-5; TI2FG-6; U3QT-5. — VK 2BW-5; 2EO-4; 2GK-4; 2HZ-5; 2JA-3; 2LZ-3; 2PX-4; 2QE-5; 2QU-4; 2XN-4; 3CG-3.— XE1DA-6; XE2C-6; XE2N-8. — ZL 1CV-6; 1HC-4; 1HY-6; 2FA-8; 2FG-8; 2KO-5; 2PC-7; 3CU-2; 3GM-7; 3GR-5; 3JD-6; 3OJ-3.

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Dx Notes

[Continued from Page 59]

Mexico?" That's easy . . . New Mexico. But seriously, that is the only State not heard in England. However, there is always W5ZA, Louie and Louise Falconi, in Roswell, N.M. who is on 20 meter phone, and caries plenty of sock, too.

Ah, here's Arizona . . . will wonders never cease. OM Rawls, W6DRE, kicks in with a little dope. Dx is better than last year. 14 mc. is staying open much longer and some of the better stations coming through are SU1SG, OZ2M, SU1RO, HAF2G, UE3EL, HB9J, OK2AK.

•

On April 12th, W8BKP made w.a.c. in 1 hour and 35 minutes, which is supposed to be good time for that neck of the woods. Geo. uses an 800 with 135 watts input. Receiver is a Super-Gainer. Here are some stations and frequencies which should be of interest to the boys who are after Asia. These are from Bob Haas, W8HWE, the guy who has his call printed on his safety matches: J2LL 14,270, J2LB 14,270, J2HQ 14,245, J2CL 14,350, J2LK 14,360, J2ME 14,260, J3CR 14,310, J3DP 14,400, J3CX 14,260, J3FI 14,290, J5CE 14,325, J8CD 14,275, VU7FY 14,385, KA1WP 14,300. From W9KG, new stuff includes LA1M, U4LD, ZS5A, SP1GZ, OZ7KB, YR5CP, YR5OR, LY1J, J3CR, U9MI, U9MF, U9ML, U9AV, OH2OV, OH5NR and LDHQ, a Norwegian ship between Midway and Guam. YR5CP was worked in consecutive order by W9ARL, W9LBB and W9KG .. . all in Kansas City, Hi. W9ARL and W9KG worked Y95OR. In one Sunday 9ARL had 23 foreign contacts. W9CCT tossed up a new 3 half-wave antenna and it really perks. W8BTK has worked these nice ones lately: SU1SG, SU1RO, J2CL, J2LK, J2LL, J3DP, VS6AQ, YN1AA, OX7ZL, VQ8AG, VQ8AF, FB8AB, FB8AG, YL2BB, U9MF. 8BTK uses an Eimac 150T with about 500 watts, RME 69 receiver . . . W8DHC now using p.p. 276A's in final and has worked 93 countries . . . W9TJ, the B battery king, has worked 37 zones and 103 countries. From May 1st to May 9th, W9TJ worked 17 J's, 2 XU's, 2 VS's, 3 U9's, 1 U6. On May 7th Bill was calling J2ME on c.w. and when he listened there was ZT6S coming back to him on phone . . . same frequency, Hi. Bill's idea of perseverance . . . W6CXW spending 3 hours trying to raise PZ1PA.

Resonant Filters and Dx

Notice some cracks about resonant filter recently . . . all from the fellows who have never tried it. Did you ever notice how "distinctive" clicking p.d.c. can be? And it will cover lots more space in and out of the band. But that doesn't mean *all* resonant filters are ok! Some are more like i.c.w. . . . (known as the "Grand Island Special"). When the resonant filter originated at the old QD-CUH combine in 1933, it came as a real money-saving filter for the high power man, and as such has been used ever since by most of the dx gang *without* trouble. That was because their filters were correctly adjusted. By now a lot more dope on correct operation of the resonant filter has come to light, and if you fellows show enough interest we will put it in RADIO. It is the answer to the high power filter problem, and what is more . . . it *works* (when properly adjusted).

•

Look what we have here . . . BERS 195, who is none other than Eric Trebilcock of the land of VK's. He furnishes the following: 14 mc. r.a.c. same as QRA of VK2BP, but reason for using that call is unknown. F7JDY 14 mc. 9 watts input . . . QRA J. Duplat, Noumea, New Caledonia. Doesn't know why he uses old prefix when FK8 is it now. Heard VQ3FAR on 14 mc. with a swell sig . . . he is ex-G5FA and is in Sekenke, Tanganyika. SXAD is being copied on 20 in VK8. Wonders if he is a Greek ship. Although Trebilcock has been logging s.w. sigs for 10 years, during which time 126 countries have been heard, it was not until February 29th

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that he logged a VE1. VE1IW was the guy, but since then he has logged four of 'em. BERS 195 as he is known throughout the world, is probably the premier dx observer, and out of the 126 countries logged since 1926 he has QSL's from 96. He thinks that if W phone stations would repeat their calls more slowly they would be understood by more VK's. On February 18th he copied all continents in 15 minutes . . . which is pretty good. Wants QRA of OS1BR. (So do I.)

•

W9IWE has worked 30 zones, and some of his best dx includes FB8AB, FB8AG, U1CR, U3AG, U9AL, U9MF, PK4, PK3BM, FR8VX, SP1AU, YL2BM, OH2NE, FA8SR, ON4CJJ, VK6CA, J2CL, OX7ZL and VU2CQ; and this VU feller was worked 3 times, which mebbe disproves the rumor that he has no receiver. W6IOJ hung up a new sky-wire and worked 23 new Europeans and 20 African stations in the past month . . . darn good for 75 watts. W9OLC now is in St. Louis and will be on soon with a pair of Gammatrons. G2ZQ spending his time between 28 mc. and a certain femme . . . OK1BC using a pair of Eimac 150T's . . . although says he can only be allowed 50 watts input. . . . Ho-hum, wotta shame . . . U3AG must have an endless supply of QSL cards as he still sends one for each QSO and wants you to do the same, Hi. . . . Speaking of cards, YL2BB has 2000 new cards just off the press and says he is going to catch up on his QSLing; so don't give up, fellows. . . W8CRA is going to write a story called, "Why My Telescope Is N.G. on Foggy Days." Frank 'Hugo' Lucas worked his 119th country . . . YR5CP. A couple of months ago CRA was laying for VS7JW and wouldn't give his frequency. Well, it wasn't necessary as W6GAL worked him, being the fellow's first W contact. VS7JW 14,300 kc. T9. W6GAL uses 210's you know, and a V beam antenna. . . . But alas, the worst is yet to come; after working 95 countries from this choice QRA he is going to have to move to a fairly populated location . . . and as he says, "I'll be lucky to be able to put up a vertical, Hi." His 95th country was FK8AA. Other new countries during the past month are YU7GL, ES5C, YM4AA, and VP2KM on St. Kitts Island. George has made his w.a.c. on phone, working such stations as G5NI, ON4VK, VP2KM, G6HL, PA0FB, HI2K, PK4AU, CE1AR, OA4AA, K7FCR, J8CA, NY2AE, TI2FG, HH5PA . . . all of these being two way 20 meter phone QSO's. . . . W9NTW says 40 is lousy, but finally got his African and G6UT, VK2CX, and ZL2BV; also worked a K6, getting R8 from a sig that came out of a single 24 with 18 watts input, Hi. W5DXG worked the 6 continents in 11 hours 55 minutes a couple of weeks ago, and wonders if that's tops for a W5. . . . And now W7ADU seems a little burnt up because the o.w. decided they had to move right in the middle of the dx season, but he says UE3EL was R9 for 24 hours each day . . . though few ever raised him . . . (er, yes, I know). Anyway 7ADU has been hearing some stuff up there and wants to know what the gag is on ZZ2A. . . . Alright you tell me on that one.

•

G2PL has a gal by the name of Cleopatra, but I've forgotten the name of G6HB's big moment . . . think it was Nell. F8EO is pounding through on 14 mc. almost nightly, and has been doing quite well on 10 also. F8EX on 10 seems to be doing very well. F8EO still has his sked with FM8D, FB8AB, etc., doing a little traffic work for the Colonial Emergency Research. From the little publication "Amachewer" which is published in Vancouver, B.C. I see they are to have a Convention on August 29 and August 30 along with Vancouver's Golden Jubilee. From all indications this will be *some* affair as I have heard they really don't fool around up there. Johnny

Kraus, W8JK, got R7 on his phone from J2LB . . . which makes him w.a.c. on phone. Also, he has contacted KA1ME several times for good two-way phone QSO's. Rumor has it that W3SI, W8CRA and W8BKP are going to combine, but I hardly think so as geographically they are too far apart. Just a rumor, I guess . . . and thasall. Speaking of the word 'almost', this is a good chance to use it. The other night W6CUH spent most of the night with Dave (W4DHZ) and me at the shack. Dave was at the key and we noticed him "crawl" into the receiver. Result was: worked 5 continents in 18 minutes. And of all the ones not coming through, was *Oceania*. . . . Imagine that; not a VK, ZL, or K6 for quite a few minutes. Anyway he *almost* made w.a.c. in 20 minutes, Hi. For those not being able to figure out how Charlie, CUH, got away . . . well, his o.w. was 'outa town' for the week-end. Charlie seems to have things pretty well under control at his QRA now; I mean of course, with his rig. And as for Dave, this is a laugh. . . . Last Sunday we were down on the beach with some of the fellows getting some much-needed exercise running around, when Dave stumbled and fell into the surf. And that, you dx'ers, was Dave's first trip into the Pacific Ocean. The weather at the beach has been perfect for the past month, so if our quota of W9's runs a bit low . . . just blame it on the typical Southern California climate (and I don't get a cent from the Chamber of Commerce for saying that, either). Dave is losing that Georgia complexion . . . as a matter of fact he will look more like a ZU if this weather keeps up.

Well, gang, please don't forget I'm still trying to get the number of the zones you fellows have worked, and when the list has enough on it we will print it for your information; so before it slips your mind just write it down on a card and shoot it to me . . . and of course, if you include some news from your particular locality, so much better.

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Screen Grid Modulation

[Continued from Page 62]

will indicate over-modulattion with its attendant distortion.

From the foregoing the ease with which the transmitter may be changed from phone to high-efficiency c.w. seems to make screen grid modulation, from the amateur's point of view, superior in some respects to control grid modulation. While the system at W1ZB has been in operation only a short time, the results obtained have been well worth the little amount of equipment and effort necessary to convert the c.w. set into a 100 watt phone.

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Expanding Linear Amplifier

[Continued from Page 67]

5 and the amount of expansion is set by adjusting the amount of increase in d.c. control current that flows through the saturating winding of T_1. The flow of syllabic d.c. through T_1 is obtained by the same control circuit as is used with the primary control shown in figures 3 and 4.

There are other methods of control, such as varying the field excitation, at a syllabic rate, on the plate and bias generators where such d.c. generators are used to supply plate and

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bias voltages.

In general, probably the primary saturable reactor in series with the a.c. line is most desirable for low-powered transmitters, while the grid-controlled rectifier system will show economic advantages for high-powered transmitters.

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With the Editor

[Continued from Page 7]

Two disadvantages present themselves. HQ would be farther from Washington, with which it now makes frequent contact. The answer to this lies in Director Roberts' suggestion of a permanent political representative in Washington—one who knows his way around in the kind of politics which we must indulge if we are to save our skins. In fact, if the League is to retain the present management we regard it as a distinct advantage that HQ be moved farther from Washington. The second disadvantage lies in the expense of moving the personnel to the new location. This is not as serious as may at first appear; some could be left behind to the benefit of all concerned; others (and these form the great majority, no doubt) are satisfactory enough but could be easily replaced at the new location with help which would become equally satisfactory in a short time. And the League's heavily-laden treasury can easily stand the proper proportion, whatever it may be, of the moving expense of those few who are really indispensible.

The exact point to which HQ should be moved is not as important as the fact that it should be moved to the central portion of the country. Our own suggestion is that a smaller city should be chosen somewhere in the neighborhood of Kansas City, this being roughly, as we have pointed out before, half way between the center of population and the geographical center of the country. A small city would probably be more agreeable to the personnel and involve lower living costs. It is not, of course, essential that the city contain a printing plant capable of printing *QST*; *QST* is not printed in Hartford at present nor has it been for a number of years; it is printed in Concord, New Hampshire.

Let's consider the welfare of the League for a change, instead of the welfare of its management.

A Favor, Please!

RADIO is not widely distributed on newsstands because of its limited appeal to the general public. We would appreciate it, however, if our readers will drop us a card as to any dealer or jobber with a "ham parts" department who does not sell RADIO over his counters; most good dealers have already found out that their customers demand it, and that it's good business.

In cities with a considerable ham population but without a ham parts store, please let us have the names of the leading newsstand or bookstore specializing in material of this type.

The "Lone Wolf"

It seems regrettable that there aren't more A.R.R.L. directors on the Board like Central's Roberts—for the welfare of amateur radio. That there are some (unfortunately, as yet, a minority) on the Board whose opinions coincide quite closely with Roberts' published ones is a well-known fact; it is amateur radio's misfortune that these gentlemen are not as articulate as Mr. Roberts, though it must be said in their behalf that this is probably due not to a lack of desire but to lack of time and resources which they can afford to devote to the purpose.

We suggest that those directors who wish to dethrone the dictator (whether he be shorn of his power entirely or just in major part) form themselves into a sort of informal committee, with a central publicity office which will circulate the opinions of each to the others, and when appropriate to clubs, magazines, and elsewhere. Though those of us "in the know" are aware of its incorrectness, there seems to be a growing impression that Director Roberts is a lone wolf in the fight, and that it must therefore be due to personal animosity of a sort instead of genuine conviction. These other gentlemen must in some manner or other make themselves more articulate if the ham body in general is to understand that "there's really some fire beneath the smoke".

* * * *

Director Roberts had some remarks to make in the May issue of RADIO well worth any ham's reading. Since then we have received a copy of

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his annual report to the A.R.R.L. Board meeting, from which we extract some excellent remarks and suggestions:

He first "takes the investigating committee apart" for the biased and whitewashing manner in which the so-called investigation of the majority members was conducted and in which its "report" was rendered. He points out that, unlike his own minority report, the majority was so afraid of the storm of criticism bound to follow any release of its report that the chairman refused to release it where the amateurs in general might see what their alleged representatives were doing.

K. B. Warner holds too many offices, among them those of Editor, Business Manager, Secretary, and many minor ones. No man could fill these three jobs well, even a man with abilities far exceeding those of the incumbent. It is suggested that he be made Business Manager, and nothing more, and that his salary be adjusted proportionately.

All salaries should be reviewed annually by the Board; at present salaries amount to 27½% of the League's gross income, a far too high percentage.

The work of the Cairo committee should be supplemented by the appointment of a Washington representative, a man who "knows his way around" that town, who can do effectively that which the League has so far refused to do —lobbying. The ethics of lobbying do not enter into the situation; our opponents do it, and so must we if we are to retain our rights and frequencies.

Permanent Board committees should be appointed to supervise the various, more important League activities between meetings of the Board.

The president and vice president should be elected by the general membership, and neither should hold office for more than two terms. We should look to these officials for more active service than has been the case in the recent past.

At least two meetings of the Board should be held each year. Obviously an organization of the League's size cannot be run effectively by the Directors when they meet but once a year; hence, to a certain extent, a dictatorship—good, bad, or indifferent—is inevitable under the present system.

Headquarters should be moved to some point in the central states; this would make HQ more readily accessible to the majority of members, more convenient for Directors' meetings, would give it a broader outlook and a better insight into members' wishes, would result in a better mailing point, and in many other lesser benefits.

A full-time field contact man should be appointed to attend as many hamfests and meetings as possible, and should bring with him a "laboratory car" containing measuring equipment, samples of new developments of the A.R.R.L. Technical Department, League printed matter, etc.

Director Roberts also calls for a halt in the present practice of the Executive Committee of making expenditures from the League's surplus funds, the right to make such expenditures being limited to the Board by the Constitution.

Because of the fact that so many new "lid" operators on 160-meter phone are giving amateur radio a "black eye", it is suggested that all new operators be compelled to operate for a year on c.w. before being allowed to operate phone.

The privilege of taking the Class C license examination by mail is being widely abused, and should be revoked except for permanent invalids, C.C.C. camps, and regular naval or military stations.

Changes are suggested in the procedure of handling and counting the ballots in Directorship elections to avoid any suspicions of irregularity. Some or all of the tellers should be outsiders not interested in the results. The present tellers consist of League Employees and their wives.

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History of "Radio"

[*Continued from Page 53*]

1932. October, 1932 was vol. 14, no. 10 and November, 1932 was no. 12, no issue vol. 14, no. 11 being published. Vol. 15 began with December, 1932 (vol. 15, no. 1) and January, 1933 (vol. 15, no. 2), and continued with a combined February and March, 1933 issue (no. 2-3). There was no issue for April and May, 1933, publication being suspended. Publication was resumed under new auspices with the June, 1933 issue (vol. 15, no. 6) and then continued regularly.

In 1929 *Radio* ceased to be primarily devoted to amateur radio, and became primarily devoted to radio retail trade interests, and carried the title "*Radio*, the

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National Trade Magazine". In 1930 the name of Arthur H. Halloran disappeared from the title page, and P. S. Lucas and K. N. Ford appeared as editors. With the June, 1933 issue, *Radio* again became primarily an amateur radio magazine with A. Binneweg, Jr. as editor.

With the January, 1926 issue, *Radio* absorbed *Radio Journal* which was published in Los Angeles from June, 1922 through October, 1925.

In 1933, *Radio* absorbed the monthly periodical *Modern Radio* which had been published at Hartford, Connecticut from July, 1931 to April, 1933, with R. S. Kruse as Editor.

With the January, 1936 issue, *R/9* and *Radio* were merged to form the new *Radio*, with K. V. R. Lansingh as Editor and Publisher, and Frank Jones, R. S. Kruse, and J. N. A. Hawkins as Engineering Editors. The January, 1936 issue had the title *Radio* and was designated no. 205, thus continuing the numbering of the old *Radio* in slightly different form. The page size of *R/9* (7" x 10") was adopted. The same comprehensive interest in amateur radio which had been maintained by *R/9* and *Radio* is continued in the new *Radio*. With the March, 1936 issue W. W. Smith became Editor.

Effective December 1, 1935, a new policy of ten issues annually was adopted, this including the special enlarged annual issue. The August and September issues (which would normally appear in July and August, the least active radio months) are omitted. This policy is experimental.

No annual title page or index was published for any of the several periodicals mentioned above. An annual index is planned by the new publishers, though it has not yet been definitely decided whether this will appear at the end of the calendar year, or with the last issue preceding the summer "suspension" mentioned above.

Radio therefore has a long history of devotion to amateur radio, dating back before the world war when no amateur and very few commercial companies seriously contemplated radiotelephony or even c.w., and most transmission was a brass key and a high decrement spark. With the combined experiences and energies now coöperating, it is believed that *Radio* is not only continuing the performance records of its predecessors, but is certain to give to amateur radio a periodical best suited to meet amateur needs.

Without any pretense of being able to see into the future, the new publishers plan, so far as is humanly possible, to avoid the frequent changes that have characterized the past.

We are indebted to Mr. R. S. Ould of Washington, D. C. for much of the foregoing information.

Well Designed Half Kw.

[Continued from Page 72]

Preliminary experiments were conducted with a small exciter unit, already on hand, which ended in a pair of 46's with 500 volts on their plates. It furnished enough excitation on 80 meters, barely enough on 40; but was somewhat lacking on 20. It was concluded that a pair of 10's or tubes of similar rating would do the work. But 10's require neutralization and also quite a bit of excitation themselves. 802's were chosen because they do not require neutralization and because they could be excited themselves with next to nothing. To assure the necessary output on 20 meters they work as a straight buffer and all the doubling is done in the stages ahead.

In this case, it was decided to use a 6A6 twin-triode in a "Jones" circuit as a combination crystal oscillator and doubler. A Tritet osc.-doubler would probably have done the trick, or a straight pentode crystal oscillator followed by a doubler stage; but the 6A6 appeared to be what the doctor ordered in the way of simplicity and flexibility. 40 meter crystals are used on 20 meters, 80 meter crystals on 40; and on 80 meters the doubler section is switched out, and the pair of 802's in parallel are excited directly by the 80 meter xtal oscillator. A keying jack is provided in the 6A6 cathode circuit, but other keying arrangements could be used.

Push-pull connection of the 802's and link coupling from the 6A6 would probably give a little more efficiency and output; but as the present layout fulfills its obligation, even on 20 meters, there was no reason to increase the expense and complication.

Figure 5 gives the complete circuit of the exciter. The radio publications have been full of similar exciters for many months; so there is no need to go into minute details of construction. The crystal oscillator plate tank L_1 consists of a coil and condenser so proportioned as to give low-C tuning on 40 and high-C tuning on 80 meters, using 40 and 80 meter crystals respectively. Thus, a plug-in coil is eliminated. The doubler plate tank coil L_2 and condenser are also dimensioned so that they tune low-C to 20 and high-C to 40 meters. Another plug-in coil is eliminated. In both of these tank circuits the low-C efficiency comes on the higher frequency band where it is most needed.

There is a milliammeter in every plate circuit. Better a half-dozen fifty-nine cent meters than one five dollar one, though of course a half dozen five dollar ones would be just so much better if one can afford them. Looking at a high-power, multi-stage transmitter through a single meter dangling at the end of a cord and plug is like viewing a three-ring circus through a 1/2" mailing tube.

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Variable capacity coupling is used to the buffer. The buffer grid circuit contains a 20,000 ohm wire-wound rheostat and 45 volts of "C" battery. The rheostat proves useful in controlling excitation to the final amplifier, but a fixed resistor of the proper value could be substituted. The "C" battery gives fixed bias beyond cut-off. Due to the low d.c. grid current an ordinary 45 volt midget "B" battery will last an incredibly long time. It could be eliminated; but a single blasted 802 would buy several batteries. The 802 suppressor grids are run at 45 or 50 volts positive. This jacks their output up considerably.

The buffer tank coil L_3 is plug-in, but one coil tunes low-C on 20 and high-C on 40, and it is only necessary to change coils when using 80 meters.

A low-reading milliammeter can be temporarily connected into the grid circuit of the 802's to ascertain if proper excitation is being furnished by the 6A6. A permanent installation would be advisable if one has a suitable meter collecting dust. Six ma. should be sufficient rectified grid current, and about 10 ma. is the limit. Excitation to this stage can be varied by varying the coupling condenser, or the input to the osc.-doubler stage.

The exciter unit is built into a neat cabinet. A shield box is provided for the buffer stage and one for the osc.-doubler stage. They are mounted near together, but not touching, and are grounded together and to ground at one point only. This makes for real shielding, and not just unspecified coupling condensers. All bypass and other r.f. grounds in each stage terminate at, or near, one common ground point on their shield. Observance of this may obviate peculiar behavior of the stage.

Where r.f. leads pass through shielding, make the holes large enough to keep the leads a respectable distance from the metal. Locate the components in the cans so that the coupling lead between stages is as short and direct as possible. Make tank coils of small diameter and small wire to keep r.f. fields down, and space them from shielding and other large metal objects. Provide some ventilation for the tubes, especially the 802's.

Breadboard construction could be used; but the shielding would not be as complete and dust would reign supreme. Also, while a final breadboard, especially a push-pull job, can be made attractive and easy to clean, this type of construction is not so nifty for exciter units, containing a multitude of small parts.

Any other exciter unit with sufficient output could be employed, and many may wish to use their present low-power transmitter to excite a high-power final such as this article describes.

Power Supplies

Figure 6 shows the wiring scheme of the low-voltage power supply. The rectifiers are 81's; they were in stock. Other types could just as well (or better) be used. The first filter condenser is made 4 μfd., not so much for its extra filtering action as for its help in improving the voltage regulation. Mercury vapor tubes don't always hold up so well with such a filter. The charging current drawn by the 4 μfd. input condenser each time the supply is switched on has a deleterious effect on them. If mercury rectifiers are used it might be advisable to change to choke input. In this case the transformer voltage should be raised in order to get the necessary 600 volts output under load.

The two twin receptacles are a good grade of the type employed in standard house wiring. One is for the final amplifier filament transformers, and also the "C" pack if used. The other is for the final amplifier transformer. A small electric fan for cooling the 203-A's can also be plugged into this receptacle and the fan will start when the plate voltage is turned on and stop when it is cut. The real purpose of these receptacles is to concentrate all controls. The three control switches on the operating table wire to four binding screws on the low voltage supply and control the complete transmitter. One controls all filaments, one the low plate voltage supply, and the other controls the final plate supply.

The control switches are miniature indicating tumblers, and the three switches and three corresponding pilot lights fit into a two-gang "gem" box. A brown bakelite cover makes a neat job. The pilot lights are optional, but nice. The filament pilot is white, low plate amber, and high plate red.

The filament switch is actuated by a removable key, and can be locked "on" or "off". Also, the plate switches are wired in series with the filament switch. Thus, when the filaments are locked out, the plate voltages cannot be turned on. When the operator inserts the key to turn on the filaments, he is bound to notice if plate switches have been molested, being adjacent to them. Not much danger of slapping filament and plate voltages on together this way. Filaments are left on during an entire transmission period. Without pilots a four-wire cable runs from low-voltage supply to switches; with pilots a seven-wire cable is necessary. Two of the wires, the common and the high plate supply, should be heavy no. 10. The wiring from house mains should be heavy also.

Figure 7 shows the wiring of the final supply. The transformer should be about 1650 or 1700 volts each side of center, and rated for 750 watts. If the transformer has two 110 volt primaries, all the better. A d.p.d.t. switch can be made to throw the two windings in series across 110 volts for testing, and in parallel for normal operation. The swinging input choke is rated at 500 ma. The rectifiers are a pair of 866's.

For c.w. work the filter shown is sufficient. Timid souls can replace the 4 mike condenser with a pair of 2 mikes and a 500 ma. 20 henry smoothing choke for greater peace of mind.

The 500 ma. r.f. chokes in the rectifier plate leads are optional, but advisable. Ditto for the h.v. fuse in the transformer c.t. The 50,000 ohm bleeder does its bit in keeping down no-load voltage surges.

Both supplies are built into heavy sheet iron boxes, the tops of which are removable. All apparatus is underslung from these tops and the only things external are the tubes, receptacles, fuses and terminal strips. The latter are bakelite with protective covers. Two heavy screen door handles on each top facilitate removal. This construction makes for neatness and safety, and is dustproof, rustproof, and ratproof. A neat screen cage should be constructed over the 866's to protect against high-voltage contact. The screening and the r.f. chokes in the plate leads will diminish the field of the mercury vapor tubes, reducing receiver "hash".

28 and 56 Megacycles

[*Continued from Page 55*]

W3FAR recently put two horizontal doublets at right angles in his attic, and finds them noticeably directional. W3SI says that so far in his experience, the best method of feeding a single antenna on high frequencies appears to be with a quarter wave matching transformer of the "Johnson Q" type. This type, incidentally, is widely used in complicated commercial arrays.

The present tendency in ten meter transmitting antennas seems to favor radiators concentrating the signal in the low angles, but without giving very much horizontal directivity. Such antennas provide gain without having to be re-aimed at each station worked.

Tubes and Gain

According to RCA Victor[1], some measured advantages of the 6L7 over pentagrid converters (as first detectors) in typical mixer circuits were found to be the following:

1. An increase in gain of between 5 and 8 to 1 at twenty megacycles.
2. Appreciably less oscillator power required, resulting in greater stability of the oscillator circuit.
3. Improved selectivity and increased intermediate frequency circuit gain because of the high plate resistance.
4. Easier alignment of tuned circuits due to less reaction between r.f. and oscillator components.
5. A greater range of operating frequencies. Good results have been obtained at 60 mc., whereas 'A7 type tubes will not operate well at frequencies above forty megacycles even when a separate oscillator is used. At 40 mc. the improvement in sensitivity was measured as 20-to-1 over that of the pentagrid converter circuit.

W. R. Ferris of R.C.A. has pointed out[2] that at high frequencies the time an electron is in transit between tube elements is a large factor in gain. He states that in spite of the good values of circuit impedance obtainable, the maximum possible gain of the '57 tube is only about fifteen at 30 mc. and is reduced to unity somewhere near 100 mc. With tubes of the dimensions of the RCA 954, the input resistance at a given frequency is some twenty times better than for standard tubes. This permits signals of a frequency four or five times higher to be amplified with the same gain. Gain of unity or better has been obtained at about 430 mc. with the 954. The construction of amplifiers operating at 30 mc. with a gain of 50 or 60 per stage should be possible with these tubes, although neutralization of the grid-plate capacity might be necessary with the high load impedance which this would necessitate.

One operator who has an HRO recently replaced the r.f. and first detector tubes with 954's, and claims that on ten meters the im-

[1] "A New Tube for Use in Superheterodyne Frequency Conversion Systems", by Nesslage, Herold and Harris, *Proc. I.R.E.*, February 1936.

[2] "Input Resistance of Vacuum Tubes", by W. R. Ferris, *Proc. I.R.E.*, January, 1936.

provement was like taking off your ear muffs, though no difference was noticeable on the lower frequency bands.

Sun Spots or Magnetism?

We have tried to correlate 28 mc. conditions with sun spot data provided by Science Service. We have compared sharp changes in conditions with large variations in solar activity. So far, the results are discouraging except over an eleven year cycle without regard to shorter periods. Perhaps it will be necessary to consider only the spots that have arrived at a point close to the center of the sun's "disk" or to confine comparisons to another solar-affected phenomenon on the Earth, such as the prevailing state of terrestrial magnetism.

An interesting paper on the latter subject by H. E. Hallborg has been published in the I.R.E. proceedings for March, 1936. Mr. Hallborg shows why communication between New York and the Far East is erratic and unsatisfactory for commercial circuits. A similar condition exists for communication between San Francisco and Northern Europe. On magnetically quiet days, such communication can take place, but not with great regularity. He also explains the use of higher power transmitters in America than have been found necessary in Europe for transatlantic work.

If you are interested in a self-excited oscillator as stable as crystal control, read "Frequency Control by Low Power Factor Line Circuits", by C. W. Hansell and P. S. Carter in the Proceedings of the I.R.E., April, 1936.

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When using 866's and other tubes drawing heavy filament current, it is essential to use socket with good filament contacts in order to maintain proper filament voltage under load. Some of the newer wafer sockets heat badly when handling more than two or three amperes of filament current. Fifty watt sockets are also bad offenders in this respect and it pays to clean the contact springs with sandpaper every now and then.

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Erratum

In the diagram of the RK20 suppressor modulated phone on page 20, the junction of the two r.f. chokes across the crystal should be connected to ground.

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During the funeral of King George V, New Zealand hams preceded their silent hour with a transmission period of short duration, during which they all threw on unmodulated carriers in all bands.

J2HJ

It is with deep regret that we learn that Kunio Shiba, J2HJ, passed away April 12th after a short period of illness. Shiba has been a pioneer on 28 and 56 mc. in Japan, and has been the means to many a 28 mc. "w.a.c."

Set-analyzer type selector switches of the style in which one circuit is broken while another is being made allow switching a grid-plate milliameter in and out of the usual number of transmitter stages. Such a switching arrangement does away with the jack and plug arrangement.

Osockme, Japan,
Aprils 23, 1936.

Information Free Dept. of
Hon. RADIO, Dear Sir Ed:

I have just come into receipted possession of letter writings from my friend commercial radio ship operator who make recent visit on Scratchi you remember such? He say he arrive safely home in port and make bees-line to first nearest cafeteria and eat off one arm of chair. He say he have comfortable trip and have make many acquaintances with passengers who travel sewrage class on ship. Scratchi are become infected with sea going fever and will soon make prepare for commercial license for sea going purposes.

Scratchi wander down by waterfront and go aboard ships to make acquaintance with commercial operators on such. Many other visitors also go aboard ship. Chief attraction on such are radio room. Visitors poke noses into such rooms and ask many foolish question. Every time some person ask radio operator some question, operator get sick and tired of answering all such and he merely make inform with resnort such as "Aw, go ask the cook". He say such over and again many times to many information seekers. One old squaw come up longside radio cabin door and ask question from operator. As usuals, he make same resnort, "Aw, go ask the cook". Old hag snap back at him, "Pawdon me, Sir, I thought *you* were the cook." To which radio operator give howling scorn and make long reach for more generator to throw at insulating spinster. Scratchi quickly find out that radio ship operator job are no bunk of roses or bed of wild flowers.

Scratchi are smarter persons than information seekers. I make dumb natural look into radio room door and ignore big chested operator who sit like statoo in arm chair from which arms have long since been worn off because of wear. Finally, operator take squint look up at Scratchi and bark, "What for you look so dumb anyhow?" And Scratchi come back with, "I are preparing myself for commercial radio operator and I are first acquiring dumb look like you have." To which he make toothsome smile at me and invite me into radio cabin for big drink from freshly opened can of condenser oil.

He pass out few second-hand cigars and invite me to help myself to take lots, take two, he say. I take long puff on such. I say then, "I smell something like burning rubber." He say, "Don't flatter yourself, Scratchi, you smell much worse than that." He have a sign which hang on wall of radio cabin, and it say on it, "Please do not smoke in this office unless you have to. I mean two cigars." So Scratchi give him back his cigar, and he put same back in safe again. He are big hearted, gentlemanly person, you see, Hon. Editor? I ask him what use he make of all spare times he have on ship with business so slack and static so heavy. He tell me he whittle away much time because he are official ship's referee of cockroach races which are held in ship galley every night after chow.

I ask from him many questions which would mayhap give Scratchi free information assistance in passing commercial examination. His answers are same to all and every question. He just say, "It all make depend upon local conditions," and he tell me to try such on Hon. Radio Inspector when I go up for examinatioos taking. When I try make plead with him for free advice he snap back and say such are in violation of his oats of secrecy. He are tight lip person, those fellow.

I make studies of magazeenes to find advertisings from commercial radio operator correspondence schools and it make dawn upon me that the more advertisings I see the higher up go salaries which ship radio operators get paid for doing no work at all. From such advertisings which offer gigantic salaries Scratchi make no wonderment that so few ships carry radio operators, except such on which liquor are sold to passengers. Such advertisings cannot make lie, Scratchi reason, because else such could not continue to make lies bigger every month otherwise some persons would sometime get spicious and ask owner of correspondence school why he himself do not go to sea as commercial radio operator. Scratchi make decide to take commercial radio coarse so he also can make trip on ship and see worlds through spacings in tank coil windings.

If I are make succeed in passing such examinations, Hon. Editor, I will first make apply for positions on ship which come headed in direction of you so I can thank you personally for illuminous help I have receive from your colyums. Hoping you also read such before you print your Hon. magazine, I are,

Respectively,
HASHAFISTI SCRATCHI.

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Gordon 50 Watt Transmitter

Several observing amateurs have called us on a discrepancy that slipped into the Gordon transmitter article in the January issue of RADIO. The diagram shows the rotors of the final tank condenser connected to the center of the tank coil, making the rotors "hot" with d.c. This is perfectly all right, except that the photograph shows the rotor of the condenser to be grounded. Grounding the rotor is perfectly all right too, provided connection to the tank coil terminal is broken. But one must use one system *or* the other. Either method works well. Our mistake was in shooting the photo with the circuit one way, and drawing the diagram the other way. In other words, follow the drawing or the photograph, but don't try to do both, or there will be a direct short across the power supply. Grounding the rotor has the advantage of reducing the number of "hot" components in the transmitter, making just one less thing from which to keep one's hand clear.

HAMFESTS AND CONVENTIONS

Michigan

Michigan chapter of the Central Division Radiophone association has scheduled its hamfest for June 14 in Hotel Fuller, Detroit. The affair opens informally on Saturday evening, June 13, with a stag party for out-of-town guests and local phone association members. Sunday's program includes registration in the morning, speeches and demonstrations in the afternoon, and a dinner-dance and entertainment in the evening. A large number of prizes are to be awarded. Among the speakers will be John Krause, W8JK, of Ann Arbor, who will discuss directive antennas. An interesting u.h.f. demonstration will be re-broadcast over W8XWJ, the u.h.f. station of the Detroit News.

Florida

Another one of those annual hamfests that is talked of over the air for months afterwards will be held down in Florida on June 20 and 21, W4KB on Chotawhatchee Bay, Valpariso, Fla., writes. The committee in charge of the meeting is expecting a crowd of about 100 persons.

Ohio

Well-known radio celebrities and amateurs are appearing on the program for the Ohio state A.R.R.L. convention in the Deshler-Wallick Hotel, Columbus, Ohio, on Aug. 1 and 2. The Columbus Amateur Radio association is sponsoring the confab. The banquet Sunday evening includes a floor-show, with Bill Bennett's dance band. J. M. Bayes, chairman, says to be sure and bring the yl's. and the ex-yls., since the committee has prepared a fine program, as well as prizes, for the ladies. Registration starts on Saturday noon, Aug. 1. Registration tickets, which include the banquet, are $2.00 apiece. Interested parties may obtain further information from W8BZY, 371 Olentangy Street, Columbus, Ohio.

Illinois

Five hundred hams will turn out for the Illinois State A.R.R.L. convention on June 20 and 21 in Bloomington, Ill., Norman Baird, secretary, predicts. The conference is given under the auspices of the Central Illinois Radio club. E. A. Roberts, Central division director, is planning to attend.

British Columbia

The Golden Jubilee of Vancouver, B.C., Canada, will provide a magnificent background for the 1936 Vanalta Division convention, sponsored by the British Columbia Amateur Radio association, on Aug. 29 and 30 in Vancouver. Entertainment for the whole family is assured the ham who brings the y.l., or ex-y.l. and in-laws. Prominent speakers are to be heard, prizes awarded and a boat excursion to Bowen island, one of Vancouver's summer resorts, enjoyed.

Registration starts at 10 a.m., Aug. 29, at the Hotel Georgia. The fee is $2.50. Registration applications postmarked prior to midnight, Aug. 15, will be eligible for a special prize. Further information may be secured from the Secretary, Convention Committee, 1349 East First Avenue, Vancouver, B.C., Canada.

Iowa

The Tri-City Amateur Radio club and the High Frequency Communications association are "doing things up brown" this year by holding a joint hamfest for members of the two organizations on June 7 in Iowa. The Radio club's attendance at its 1934 hamfest in Rock Island totaled more than 400 active amateurs, while the 1935 conclave of the High Frequency Communications association drew a crowd of almost the same amount. Those interested should communicate with G. B. Corey, hamfest chairman, 1710 - 32d Street, Rock Island, Ill.

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Contest Winner

The manuscript of Mr. H. Frank Jordan, W5EDX, was chosen by the contest committee as winner of the recent RADIO article competition. The winning article will appear in an early issue.

BUYER'S GUIDE

Where to Buy It

CALIFORNIA—Fresno

Ports Manufacturing Co.
3265 E. Belmont Ave. Radio W6AVV
National FB7-SW3 and Parts; Hammarlund, Cardwell, Bliley Crystals; Johnson Insulators Distributors RCA-DeForest Transmitting Tubes
Established 1914 *Send for Wholesale Catalog*

CALIFORNIA—Los Angeles

Radio Supply Company
912 So. Broadway

THE AMATEURS' HEADQUARTERS OF THE WEST

All Nationally Advertised Parts for Receiving and Transmitting Carried in Stock at All Times. 9 Licensed Amateurs on Our Staff.

CALIFORNIA—Oakland

Radio Supply Company
2085 BROADWAY
Hammarlund, Yaxley, Carter, National, Johnson, IRC, Cardwell, Miller, Morrill, Flechtheim, Triplett, Haigis Transceivers.
W6GFY

CALIFORNIA—San Francisco

OFFENBACH ELECTRIC COMPANY

1452 Market Street
"The House of a Million Radio Parts"
Hammarlund and National sets and parts
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Arcturus Receiving Tubes.
Trimm Phones, all types.
Johnson Antenna Feeders, Insulators, Transposition Blocks.

ILLINOIS—Chicago

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ALL SUPPLIES FOR THE SHORT WAVE FAN AND RADIO AMATEUR
QUOTATIONS FREELY GIVEN ON ANY KIT OR LAYOUT
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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 may usually be substituted without materially affecting the performance of the unit.

40 Watt 160 Meter Phone

L_1—Wound on Hammarlund XP-53 form
L_2—Wound on Bud Giant form
C_2—Hammarlund Star SM-100
C_1—Cardwell MR-365-BS
C_6—National TMC-150
C_7—Aerovox type GGL-5 (can type)
RFC—Hammarlund CH-8
MA—Hoyt type 17
CH_1—Inca type D-5
T_1—Inca type B-7
T_2—Inca type N-18
Cabinet—Breting Radio Mfg. Co.
Dials—Crowe, 2¾ inch

CHICAGO—Illinois

Mid-West Radio Mart
520 South State Street
Rex L. Munger, W9LIP, Manager
America's Amateur Headquarters

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Complete Stock of Amateur Radio Supplies at Wholesale Discounts

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CAMERADIO COMPANY
603 GRANT STREET

(Also at 30—12th St., Wheeling, W. Va.)
Tri-State "Ham" headquarters
Standard apparatus—standard discounts

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611 First Avenue

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LAST CHANCE . . . complete volume "RADIO", entire year 1934 and also entire year 1935. 24 copies, $5.00, postpaid anywhere. Either volume separately, $3.00. All in perfect condition. Also available few copies 1917 *Pacific Radio News*, forerunner of "RADIO". These 19-year-old issues, $100.00 each. Send for list. Pacific Radio Publishing Co., P. O. Box 3278, San Francisco, U.S.A.

W9RAB may write for free Handbook.

SHIELD Cans for individual receiver stages. Any size. R. H. Lynch, 970 Camulos, Los Angeles.

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

A free Handbook to W5BBW.

PHILATELIC HAMS! Will exchange collection (about 10,000 stamps in four volumes plus duplicates) worth about $1000 (including many now unobtainable) for amateur transmitting equipment. S.R.C. Allen, Casa Remington, 141 Main Street, Gibraltar.

GENERAL ELECTRIC dynamotor 24/750-1500 volts, 350 watts, extended shaft, $27.00. RCA 852, $10. W6DPJ, Provo, Utah.

One Handbook free to W1BKS.

CRYSTALS: AT cut, your frequency 80 or 160 meters, $1.75. BT cut, 40 meters, $3.25. All full size. Holders $1.00. W8CHJ, 9255 Herkimer, Detroit, Mich.

One Handbook free to W6CYZ.

CRYSTALS and blanks. X or Y cut; 1750 to 2000; 3500 to 4000; close to your specified frequency $1.35. Blanks, unfinished 60c. Bill Thiem, W8FN, 4021 Davis Ave., Cheviot, O.

TRANSFORMERS REWOUND and built to specifications. Very best quality materials and workmanship. Ecoff Transformer Co., 1929 Forest Ave., St. Louis.

W7AFX may write for free Handbook.

$1.50 will buy an Eidson "T-9" 40 meter crystal, accurately calibrated and fully guaranteed—see May ad. Something new:—attractive and efficient Insulex (low-loss ceramic) 40 meter plug-in holder only $1.10 postpaid, very FB. "Eidson's", Temple, Texas.

SPECIAL 866B's—$3.75. 866's—$1.65. Guaranteed six months. F. B. Condenser mike heads $10.00. 100 watt Universal Class "B" transformers $8.00 pair. Langrick Radio Engineering Service. W6PT. 626 Maltman Ave., Los Angeles, Calif.

TRANSFORMER—2½ kw., 110 V.—New, Hilet, 3000-2400-1850 each side. Cost $78.00. Will sell or trade for gun, binoculars, machinery, or what have you. Leitch, Park Drive, West Orange, N. J.

RACKS, cabinets, shield cans. Send for circulars. R. H. Lynch. 970 Camulos, Los Angeles, Calif.

A free Handbook to W9DQJ.

RAW QUARTZ—finest quality, for the manufacture of piezo crystals. Largest, most complete and varied stock in America. Brazilian Importing Co., Inc., 6 Murray St., New York City.

TRANSCEIVER, cabinets. Send sketch for price on size you want. R. H. Lynch, 970 Camulos, Los Angeles.

METERS repaired—reasonable prices. Braden & Apple Co., 305 Park Drive, Dayton, Ohio.

CRYSTALS, 80 and 160 meter bands 95c, 40 meter band $2.00. New type shielded holders 60c. White Radio Laboratory. Sandpoint, Idaho.

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QSL SWL Cards, neat, attractive, reasonable. Samples free. Miller, Printer, Ambler, Pa.

SUPER-SIGNAL, the new crystal supreme, $5.00. Information on request. Also V, AT, and X at popular prices. W1BD.

To W3CR a free Handbook.

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

SKYRIDER BARGAINS, all models, sell or trade. PHILCO 16-X 5 band chassis, new $50.00 Leica Cameras. Wells Smith Radio Corp., 26 N. Wells St., Chicago, Ill.

FOR SALE: Complete 250 watt fone transmitter. Microphone to antenna. Push-pull class A. modulated. A real quality job of commercial appearance. $235.00 complete. For complete details, write W6DA, 829 Boston Place, Pomona, Calif.

WRITE us for trade in price on your old receiver. We buy meters Walter Ashe Radio Co., St. Louis, Mo.

QSL's! Snappy! Bright! Different! 200 Two Colors $1.00. W5AUB, Tupelo, Miss.

GENERAL ELECTRIC dynamotors 24/750 volts, 200 mils., $25.00. Two for 1500 volts $40.00. Westinghouse 27/350 $10.00. 500 Watt, 500 cycles, $10.00. List. Harry Kienzle, 215 Hart Blvd., Staten Island, New York.

TRANSFORMERS, chokes, all types. Reasonable. Guaranteed. Special universal class B inputs and outputs 100 watts audio—pair $8.00. California Radio Labs., W6CYQ, 2523 South Hill Street, Los Angeles.

To W8DOI a free Handbook.

FINE QSL's! SWL's! Samples. W9UH Press, 2009 Fremont Street, Chicago.

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

60 WATTS of audio from pair 6L6's; 120 watts from four. Special 6L6 modulation transformers; write for information. Langrick Radio Engineering Service, 626 Maltman Ave., Los Angeles, Calif.

NEON TUBES, four inches, for RF testing. Oscilloscopes, special lengths made to order. Postpaid (U. S., Canada) $3.00. W8AXB, GLOMU SPECIALTIES. 3411 Harrison Avenue, Cheviot, Ohio, Dept. B.

CRYSTALS—40 meter band x cut $1.85. Guaranteed satisfaction or money back. 80-160 bands $1.50. Omaha Xtal Labs., 501 World Herald Bldg., Omaha, Nebr.

New ... UTC VARIMATCH

Patent Applied for

Modulation Transformer

● *The Answer to Your Modulation Problem. A New Transformer providing a very wide range of load impedances for any modulator.*

Due to the wide range in operating conditions, of RF tubes in class C, a corresponding wide range of load impedances, reflected to the modulator stage, is effected.

Standard transformers for matching modulator tubes to an RF load, as available today, afford the use of 2 or 3 specific impedances on the secondary. The result is that frequently a transformer is purchased for this service with the thought that it is the "nearest thing" to the impedance desired.

This can only result in comparatively high distortion levels.

As a solution to this problem, UTC has developed its new line of Varimatch transformers, which, through proper design, permit a very wide range of impedance matching. (The chart on next page illustrates the impedances available on all Varimatch units. In addition to the values shown, units VM-4 and VM-5 also have higher impedance combinations to take care of the new high impedance tubes.)

The value of a VARIMATCH transformer for amateur work cannot be over-emphasized from the angle of universal application. New tubes have been and are being brought out constantly (witness the 6L6 and 35T.)

The Varimatch Transformer Never Becomes Obsolete

TYPE	VARIMATCH Modulation Transformer	LIST PRICE	NET PRICE
VM-1	Will handle any power tubes to modulate a 20 to 60 watt Class C stage	$8.00	$4.80
VM-2	Will handle any power tubes to modulate a 40 to 120 watt Class C stage	12.50	7.50
VM-3	Will handle any power tubes to modulate a 100 to 250 watt Class C stage	20.00	12.00
VM-4	Will handle any power tubes to modulate a 200 to 600 watt Class C stage	32.50	19.50
VM-5	Will handle any power tubes to modulate a 450 watt to 1 KW plus, Class C stage	70.00	42.00

The secondaries of all Varimatch transformers are designed to carry the class C plate current.

CONTEST CLOSES JULY 1st . . . See previous issues for details.
MAIL YOUR SUGGESTED NAME FOR THE UTC TRANSMITTER KITS—IMMEDIATELY

Pri. Ohms P to P	SECONDARY RF LOAD IMPEDANCES AVAILABLE										‡AUDIO LOAD IMPEDANCE	
2000	1070	1950	2150	3620	3920	4300	6350	6550	7900	8600	11400	200	350
3000	1620	2950	3240	5500	5900	6500	9400	10000	11800	13000	17000	300	520
4000	1380	1850	2160	2850	3450	4300	5500	7300	8650	12500	17400	250	400
5000	1730	2300	2700	3500	4300	5400	7000	9150	10800	15700	21600	300	500
6000	1070	2140	2180	2750	3620	4250	4300	5150	6350	8300	8600	200	370
7000	1250	2400	2500	3200	4280	5000	5050	6000	7300	9700	10000	230	430
8000	1440	2760	2900	3700	4900	5650	5800	6900	8400	10000	12000	270	500
9000	1620	2050	3100	3240	3900	4150	6200	6500	7750	9400	12500	300	550
10000	1800	2300	3500	4300	4600	6100	6900	7100	8600	10500	14000	330	600
12000	2070	2150	2750	4250	4320	5150	7250	8300	8700	12500	17400	370	400
14000	2440	3200	4900	6000	9700							430	
16000	2780	3700	5600	6900	11000							500	
18000	3140	4150	6300	7750	12500							550	
500*	1070	1950	2150	3620	3920	4300	6350	6550	7900	8600	11400		

* In some cases it is desired to match an RF load to the 500 Ohm output of a PA amplifier. The terminal arrangement noted will take care of this application.

‡ These impedances are suitable for PA applications. If a monitor speaker is desired, proper distribution of power is obtained by operating this low impedance into the high impedance primary of the speaker transformer.

TYPICAL APPLICATION EXAMPLES

VM-1, Class B46's—25 watts AF. P to P Z=6000 ohms modulating a single 35 T at 650 V and 77 MA.-RF load impedance is 8450 ohms. Corresponding to 6000 ohms in the left hand column we find the nearest available impedance in the other columns to be 8300 ohms giving an impedance match within 1.8%.

VM-3, Class B 35 T's—1000 V—P to P Z=10,000 ohms 115 watts AF—To modulate 2-203A's at 1000 volts and 230 MA.-RF load impedance is 4350 ohms. Corresponding to 10,000 ohms in the left hand column we find the nearest available impedance in the other cols. to be 4300 ohms giving an impedance match within 1.2%.

VM-4, Class B 203 A's—1250 V—P to P Z=9000 ohms 260 watts AF—modulating a 150 T at 2500 V and 208 MA.-RF load impedance is 12,000 ohms. Corresponding to 9000 ohms in left hand column we find the nearest available impedance in the other columns to be 12,500 ohms giving an impedance match within 4%.

VM-1

VM-4

VM-5

Exclusive U.T.C. Distributors carrying a complete stock of U.T.C. Products

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Goldhamer's, Inc. ..... 610 Huron Road, Cleveland, Ohio
Wholesale Radio Service Co. 100 Sixth Ave., New York, N.Y.
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W. H. Edwards & Co. ..... 32 Broadway, Providence, R.I.
Seattle Radio Supply, Inc. ..... 2319 Second Ave., Seattle, Wash.
Warren Radio ..... 1119 State Street, Erie, Pa.
Radio Laboratories ..... 1515 Grand Avenue, Kansas City, Mo.
Comet Radio ..... 65 Cortlandt Street, New York, N.Y.

Thor Radio ..... 167 Greenwich Street, New York, N.Y.
San Francisco Radio Exchange 1284 Market St., S. Fran., Cal.
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Northeastern Radio ..... 281 Columbus Ave., Boston, Mass.
Springfield Radio ..... 397 Dwight St., Springfield, Mass.
Kraus & Co. ..... 89 Broadway, Providence, R.I.
Braid Electric Co. ..... 107 Ninth Ave., Nashville, Tenn.
Wisconsin Radio Supply ..... 434 W. State St., Milwaukee, Wis.
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Radio Supply Co. ..... 912 S. Broadway, Los Angeles
Radio Television Supply Co. ..... 1701 S. Grand Ave., Los Angeles
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Zack Radio Co. ..... 1000 S. Broadway, Los Angeles

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