An International Magazine of
Shortwave, Citizen, and

EXPERIMENTAL RADIO

THIS MONTH:

Parasitic Oscillations—Cause and Cure

A "Common Sense" Exciter Unit

New 28 Megacycle Records

Curing Sideband Splatter

A 4 Watt, High Quality Amplifier

Two Wire Transmission Line Data

A General Utility U.H.F. Receiver

December, 1935 | No. 73 | 20c in U. S. A.

FOR BETTER RADIO

Use

Hammarlund

XP-53 FORMS

1. NEW XP-53 DIELECTRIC— NATURAL COLOR— LOW LOSS
2. GROOVE RIBS— AIR SPACED WINDINGS— CORRECT FORM FACTOR
3. GREATER SIGNAL STRENGTH — MORE SELECTIVITY
4. FLANGE GRIPS — METER INDEXES—EASY DRILLING
5. 4, 5 AND 6 PRONGS
6. *LOW COST!*

WRITE DEPT. R/9-12 FOR GENERAL CATALOG

HAMMARLUND MANUFACTURING CO. • 424-438 West 33rd Street, New York

CANADIAN OFFICE: 41 WEST AVENUE NORTH, HAMILTON, ONTARIO

The New 5D Superhet!

...We Believe It's the Finest Amateur Set Built Today!

THESE FEATURES TELL THE 5D STORY:

- No plug in coils — efficient band switching and send-receive switch.
- Two tuned r.f. stages on all 4 bands.
- Low C tuned circuits—all circuits air trimmed and tuned.
- Bliley crystal filter for single signal C.W. and super-selective phone reception without loss of volume.
- Accurately relogging band spread anywhere in its tuning range—hundreds of degrees for each amateur band.
- Covers all five amateur 10, 20, 40, 80 and 160 meter and all S W broadcast bands—9 to 175 meters.
- Almost no inherent noise—the quietest yet most sensitive set you've ever operated.
- Sensitivity better than 1 microvolt at all points of all bands
- Selectivity, just what you want, variable iron-core and air-tuned i f transformers
- Tone what you want — from single signal "peaked audio" to fine broadcast quality.
- Ten new Raytheon 6 3 volt tubes—with 12 tube functions!
- "R" or sensitivity meter.
- All AC operated in one unit with no hum
- 8" matched Jensen dynamic speaker.
- Polished chromium finish on heavy welded steel chassis fully shielded and temperature isolated for 100% frequency stability.

NO SINGLE important new engineering feature has been overlooked in designing the 5D. We know it has more valuable features than any other professional communication receiver offered at anywhere near its price. It's the ideal receiver for amateurs.

• Available from your jobber, the fully laboratory-assembled and tested 5D, complete with ten Raytheon tubes, Bliley crystal and Jensen loud speaker, RCA and Hazeltine licensed, is priced at $109.80. net to amateurs.

NEW PARTS

17E — 500 Ma. 1 Kw. R.F. Choke

An extremely efficient plate choke capable of carrying 500 ma. continuously at 2000 volts or more for 10 to 160 amateur bands. Has D.C. resistance of 15 ohm, inductance 2.5 m h., distributed capacity approximately 2 mmf. Provided with two terminal lugs and one mounting screw, net to amateurs 96c.

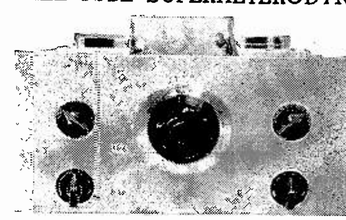
17G Crystal Auto Transformer and Shield

Designed to materially increase gain and improve performance in single-signal superhets by providing proper crystal impedance match. Requires no circuit tuning adjustment. Supplied with aluminum shield, screws, grid lead and grid clip. Net price to amateurs 60c.

6F Steatite Socket for RK-28 — RCA 803

Meets the need for a low loss but inexpensive socket for the new large five-pin transmitting tubes. Steatite base with large spring steel reinforced contacts with soldering lugs and two mounting holes on a 2" diameter. May be mounted above or below chassis. Net price to amateurs 90c.

JONES-SILVER "SUPER GAINER" THREE TUBE SUPERHETERODYNE



Designed by Frank Jones technical editor, "RADIO" and McMurdo Silver

The three tube Super Gainer with double R F and I F. regeneration gives results almost equalling those of expensive factory built superhets.

Its sensitivity is unlimited, exceeding even that of the highest priced receivers. Its selectivity is controllable—anything up to practically single signal.

The circuit uses a 6C6 regenerative first detector, 76 H.F. oscillator and 79 as regenerative second detector and audio stage with Aladdin iron core I.F. transformer.

The mechanical assembly is of the most advanced communication type, with all parts arranged for the shortest direct leads for wiring. It will immediately give results no other set at its price can touch.

Price, fully assembled, wired and tested, with one pair of coils for 80 meter amateur and 49 meter broadcast, $23.40 net.

Add for four additional pairs of coils to cover 10, 20 40 and 160 meter amateur and all short wave broadcast bands, $4.50 net.

Add for resistor-cord and plug, two electrolytic condensers and choke for complete A C or D C operation, $4.50 net.

SCOOP! . . . R9+ ANTENNA

The new R9+ Antenna not only eliminates noise, but increases volume of all s.w. stations from 4 to 5 **times.** Easy to put up, and costing only $8.85 net, it is the first tuned short wave antenna available. It's like adding a stage or two of r.f. to any standard all-wave receiver! Check and mail the coupon for complete details.

McMURDO SILVER CORPORATION

Division of G. P. H., Inc.

3358 N. PAULINA ST., CHICAGO, U.S.A.

McMurdo Silver Corporation,
3358 N. Paulina St., Chicago, Ill.

☐ Enclosed 10c for 32-page Manual of Design, Construction and Operation of 5D Superhet.

☐ Send free circulars on the new 5D and Jones-Silver "Super Gainer", also R9+ Antenna.

Name. . . . .

Address . . . .

City . . . . State. . . . .

12-R9

R/9, December, 1935. No. 73. Published monthly by Radio, Ltd., 7460 Beverly Boulevard, Los Angeles, Calif. By subscription $2.00 yearly in U.S.A. Entered as second-class matter March 7, 1934, at the post office at Los Angeles, Calif., under Act of March 3, 1897.

R/9

7460 BEVERLY BOULEVARD
LOS ANGELES

RATES AND NOTICES

Effective December 1, 1935

Single Copy Rates

On newsstands:
30c in U.S.A.
35c in Canada
1/5 in the United Kingdom
1/9 in Australia and New Zealand

By mail, postpaid from home office:
30c in U.S.A.
35c in Canada, current duty included
35c elsewhere, duty, if any, not included

(These rates do not apply to annual or other special issues)

Subscription Rates

	1 Year	2 Years
U.S.A.* (and possessions), Andorra, Argentina, Bolivia, Brazil, Chile, Columbia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Salvador, Spain (and possessions), Uruguay, and Venzuela	$2.50*	$4.00*
Canada, including current duty	3.25	5.50
Newfoundland; also Canadian libraries	2.75	4.50
Elsewhere, duties, if any, not included	3.25	5.50

**In California, add 3% sales tax.*

FREQUENCY

Published monthly except July and August; ten issues yearly including special annual number. Short-term subscriptions are accepted pro-rata, but no special numbers will be included.

Terms and Remittances

Terms, strictly cash or equivalent with order. All foreign and territorial remittances must be payable *at par* in U.S.A. or Canadian funds or at current exchange in British funds. Cash, stamps, "bearer instruments", etc., are at sender's risk. Gummed, unused U. S. postage stamps accepted in small amounts; 3c denomination preferred.

Back Copies

Subscriptions cannot be started with back issues. Back copies, if available, will be supplied from the home office at single copy rates above.

Changes of Address

Notice of change of address must *reach* us by the first of month preceding nominal date of issue with which it is to become effective. We will not supply back issues nor pay forwarding postage because of failure to receive such advance notice.

Payment for Articles

A small payment is made on publication for acceptable material of a technical or constructional nature except shorts or notes. Send stamp for details. Other material is welcome, but payment cannot be made therefor.

Advertising

Advertising is accepted only at terms stated on our current Advertising Rate Card which will be sent on request to the Los Angeles or New York offices. For classified advertising, see classified section of any issue.

PRINCIPAL FOREIGN AGENTS

Canada: T. J. Corley, 2163 W. 2nd Ave., Vancouver.
Europe: N. E. Read, 37, Willow Street, Oswestry, Shropshire, England.
Australasia: "The Bulletin," Box 2521BB, Sydney.

R/9

7460 BEVERLY BOULEVARD
LOS ANGELES

Phone: WHitney 9615 **Published by Radio, Ltd.**
New York Office: 500 Fifth Ave. **CHickering 4-6218**

Eastern Laboratory and Editorial Office:
Great Hill Road, Guilford, Connecticut

Direct all correspondence to the home office at Los Angeles except as otherwise requested.

◆

Editorial Department

Editor
K. V. R. LANSINGH, W6QX
Associate Editor
W. W. SMITH, W6BCX
Technical Staff
J. N. A. HAWKINS, W6AAR
ROBERT S. KRUSE, W1FG[1]
W. W. SMITH, W6BCX
RALPH O. GORDON, W6CLH
CHARLES D. PERRINE, JR., W6CUH
Assistant Editors
GEORGE WALKER, W4CTO[2]
RUFUS P. TURNER, W1AY[3]
WALLIE GEE, W6EGH
CHARLES A. HILL, W6BRO
E. H. CONKLIN, W9FM[4]
Laboratorians
JACK HARWOOD, W6DJZ
RAYMOND DAWLEY, W6DHG
MARTIN A. BROWN, W6ABF
FAUST GONSETT, W6VR
LOUIS E. TOTH, W1BNR[1]
Draftsman
WILLIAM ROBERTS, W3BOI

◆

Business Department

Publisher
K. V. R. LANSINGH
Managing Editor
W. W. SMITH
Circulation
B. L. HOVER
Eastern Manager
V. R. LANSINGH

◆

Correspondence and Manuscripts

Address all correspondence and manuscripts to the home office at Los Angeles except as follows:

1. Technical and constructional manuscripts and relevant correspondence from east of the Mississippi which may be sent to R. S. Kruse[1].
2. *Radiodities, Strays*, and the like may be sent to Rufus P. Turner[3].
3. Calls Heard may be sent to George Walker[2]; also dx news and station descriptions from eastern America and from transatlantic countries.

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

◆

Printed in U.S.A. by
GLENDALE PRINTERS, GLENDALE, CALIFORNIA

[1]Care *R/9*, Great Hill Road, Guilford, Connecticut.
[2]Box 355, Winston-Salem, North Carolina.
[3]159 W. Springfield Street, Boston, Massachusetts.
[4]512 N. Main St., Wheaton, Illinois.

Devoted to Experimental Transmitting

Radio and to the Radio Amateur

No. 73 December, 1935

CONTENTS

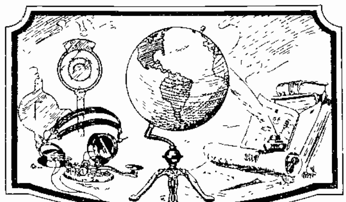
CORRESPONDENCE AND MANUSCRIPTS

Send all correspondence and manuscripts only to the General Office at Los Angeles except as follows:

1. Technical articles and relevant correspondence from east of the Mississippi should be sent to R. S. Kruse; from elsewhere, send to home office.
2. Advertising inquiries which may be sent to any Branch Advertising Office or to Los Angeles.
3. Subscriptions which may be sent to any subscription representative or to Los Angeles.

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

With the EDITOR



Too Late

"Join the League and take control of it in an orderly way" sounds well, and no doubt should be done, but it is a slow process. The damage will already have been done at Cairo before one gets far on that road. The more direct and effective method is to disavow at Washington that defeatist Hartford attitude which permits the government to consider the U.S. amateur as being well pleased with the leavings from the tables of Europe and our own U.S. commercial companies. This attitude has never been disavowed in any organized manner, and Washington will assuredly continue to think of us as satisfied until a decisive disavowal is made. The repeated statement of Summer B. Young, "you won't get anywhere until you fire Warner" may well be augmented to end, " . . . and by that time it will be too late".

The Cairo Committee of the A.R.R.L. Board recently voted to remove Warner from all connection with the preparation for the defense of amateur radio at Cairo and the preparatory conference therefor. Assuredly this is at least a step in the right direction, though we fear that such measures will have but little benefitting effect until he is deprived of all direct connection with the League's policies and their administration, and of the power to write editorials such as recent ones in *QST* effectively telling the world in general and our enemies in particular why the amateurs need no more frequencies and why they won't get them.

Forging Ahead

We feel no little pride in being able to announce elsewhere in these pages that, just as *R/9* once was graduated from the ranks of the little magazines to those of the medium sized ones, it now is to be graduated to the ranks of the largest.

The first enlarged, improved issue will be dated January, 1936, but should be in the hands of most U.S.A. readers before Christmas. One hundred pages is our new minimum size. The same enamel-coated paper and high-grade typography which has made *R/9* so superior to other magazines physically will be maintained. It will, we hope and believe, be as superior editorially as it is physically.

Our technical staff has been increased by several well-known engineers (yes, they're amateurs, too) including Mr. J. N. A. (Jayenay) Hawkins, W6AAR, formerly Associate Editor of *Radio*.

Those Merger Rumors

Apparently our impression that our readers weren't interested in *R/9*'s business affairs was "all wet". We're referring particularly, of course, to the many "rumors" that *R/9* and *Radio* were to merge. Those who are particularly interested will find a short statement in these columns or elsewhere in the editorial section of *R/9* in the next issue. Suffice it to say for the present that no merger is now contemplated.

Diplomacy

Not long ago a member of our staff had as a visitor a prominent attorney who knows his way around Washington pretty well. This gentleman having had considerable experience with those international dog-fights euphemistically called "conferences" or "conventions", the subject of Madrid came up. And it seems that at Madrid there was another little incident of the sort that never gets into the long-winded "reports" we read in *QST*.

The start occurred when an Italian delegate "shot off his mouth" about the *un*importance of amateur radio—which relieved his feelings and hurt no one. Then what does our "representative" do but burst forth into a long speech explaining statistically just how important amateur radio is as a message-handling system! Every European delegate present then and there decided that such a formidable competitor must be held down by any means, fair or foul.

It was a blunder for which any first year State Department career man would have been laughed out of the service, and yet this is the type of man to whom we time after time entrust the destinies of citizen radio. It is high time more able men were selected.

PARASITIC OSCILLATIONS

Their Cause, Effects, and Cure

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

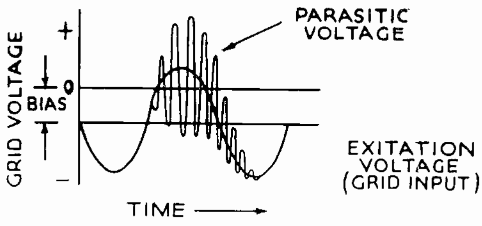


FIG 1

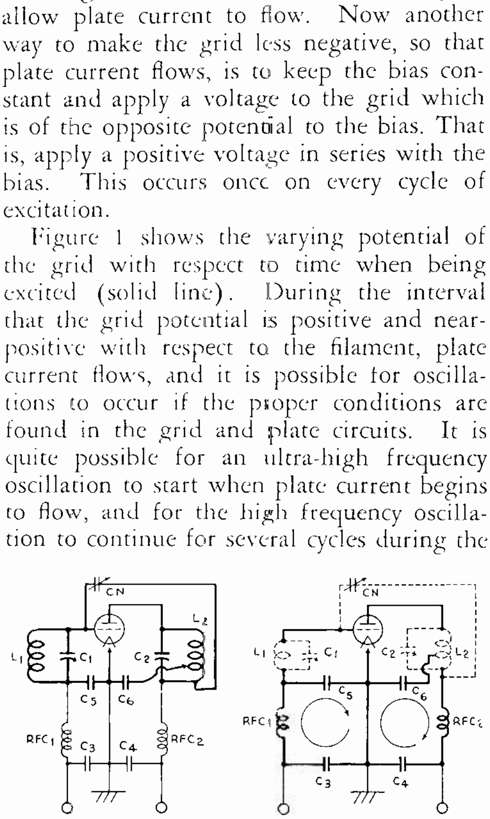
The usual r.f. amplifier has a tuned plate circuit and some kind of a tuned input circuit, both of which are tuned to the desired operating frequency. Spurious oscillations every now and then call our attention to the fact that it is very easy to make a circuit oscillate, and mighty hard to stop it. The purpose of this article is to briefly discuss a few of the more common undesired oscillations and give a hint toward their eradication. It must be pointed out that every amplifier is a case of its own, and that there is no one cure-all which can be applied to all cases of parasitic oscillations.

It has been the writers' experience that fully 50% of the usual run of amateur transmitters have parasitic oscillations of one type or another present. The most common indication of these oscillations is lower efficiencies than the excitation, bias, and plate voltage would indicate should be the case.

Because the usual class "C" amplifier has high bias and excitation, it is often impossible to note any other evidence of parasitic oscillation than lowered plate efficiency. But if there is any doubt that the amplifier will oscillate at other frequencies, simply reduce the bias to lower than cut-off and apply no excitation, being careful to keep an eye on the tube. In a large percentage of the cases, oscillations can then be noted.

At this point some of you are probably saying, "Aha! But I don't operate my amplifier with low bias, so why should I worry about parasitic oscillations that don't occur unless the bias is reduced?" It must be remembered that the oscillations began as soon as the grid bias was reduced sufficiently to allow plate current to flow. Now another way to make the grid less negative, so that plate current flows, is to keep the bias constant and apply a voltage to the grid which is of the opposite potential to the bias. That is, apply a positive voltage in series with the bias. This occurs once on every cycle of excitation.

Figure 1 shows the varying potential of the grid with respect to time when being excited (solid line). During the interval that the grid potential is positive and near-positive with respect to the filament, plate current flows, and it is possible for oscillations to occur if the proper conditions are found in the grid and plate circuits. It is quite possible for an ultra-high frequency oscillation to start when plate current begins to flow, and for the high frequency oscillation to continue for several cycles during the



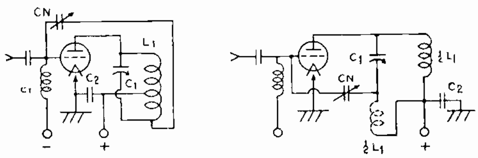
2A (H.F) 2B (U.H.F.)

period that the exciting voltage is positive, and then when the grid goes negative, for the oscillation to cease It will then start up on the next positive cycle, etc. If the ultra-high frequency oscillation is very strong, it would be conceivable for the amplifier to oscillate all the time, instead of only on the positive halves of the excitation voltage.

Parasitic oscillations are usually thought of as occuring only at high frequencies, but they may also occur at frequencies much lower than the desired amplifier frequency. Spurious oscillations may also occur in audio

*W6BC, Monrovia Road, El Monte, California.

amplifiers, because of the dynatron characteristics of certain tubes. This discussion will be limited to oscillations occuring in r.f. amplifiers.



3A

3B ULTRAUDION

Low Frequency Oscillations

Parasitic oscillations may be divided into two groups, low frequency and high frequency; and the above groups may be divided into single-ended oscillations and push-pull oscillations.

Figure 2a is an innocent-looking neutralized amplifier that was encountered recently. The layout neutralized properly, but as soon as the plate voltage was applied it was impossible to get a plate current dip as the plate tank was tuned. Using a neon bulb, it was found that the whole plate tank was hot with no nodal ground point. (A wooden, or other insulating rod fastened to the neon bulb is a decided asset with high power). The same was noted in the grid circuit. The excitation was removed and oscillations continued merrily on.

Figure 2b shows the unintended "sneak" circuits which were causing the amplifier to be a fine Armstrong oscillator. RFC1 and RFC2 were identical, as were C5 and C6. C3 and C4 are the filter condenser in bias and plate voltage supplies. RFC1 and RFC2 have become the plate and grid coils, with C3 and C5, and C6 and C4 the tank capacitors. At the low frequencies, L1 and L2 are but long leads and do not have any appreciable effect on the frequency. It will be noted that the neutralizing capacitor, Cn, is actually increasing the capacitance between grid and plate and causing the feedback to be even greater than if Cn were not present. In this type of oscillation, high r.f. current flows through the filter capacitor, often ruining the capacitor. To cure this type of oscillation it is simply necessary to detune either the plate or grid "sneak" circuit. This can be done by changing the value of RFC1, RFC2, C5, and C6. However, there is really no need of either RFC1 or RFC2 being used if C1 and C2 are large enough to by pass r.f. at the frequency at which the amplifier is to be operated. As a general thing, do not use an r.f. choke in series-fed circuits, or if you feel that you must, use chokes of different sizes in the plate and grid circuits.

High Frequency Oscillations

Using a high powered tube as a single-ended amplifier often results in high frequency parasitic oscillations. This can usually be traced to the long leads, physically large coils, and variable capacitors.

Figure 3a is a capacitive-fed neutralized amplifier, which turned out to be as shown in figure 3b, nothing more than our old friend the ultra-audion. The plate tank coil is acting as an r.f. choke at the frequencies at which oscillations are occurring. To see if this is the case, feed the plate power through an r.f. choke and completely remove the tank inductance.

The ultra audion type oscillation is a rather mean type to kill at times if the circuit illustrated is used. If a split-stator capacitor, with the rotor grounded, is used to tune the output circuit, the oscillations will usually be completely stopped, as the impedance between plate and ground will then be inversely proportional to frequency, and at high frequencies the plate will effectively

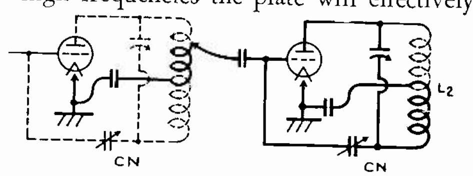


FIG 4

be grounded. The same thing can be accomplished by using a tuned input circuit as then the grid becomes effectively grounded at the high frequencies.

Right now it should be pointed out that the old type absorption wave meter is extremely helpful in running down unwanted oscillations. Once the frequency of the oscillation is known, together with the type (push-pull or single-ended) one is well started on the cure of the spurious oscillations.

A trick which sometimes works is to put a resistor in the grid or plate circuit—preferably the grid. The losses occurring in the resistor will be proportional to the square of the current flowing through it. The r.f. grid current is proportional to frequency; hence the losses will be much greater at high frequencies, and often the losses will be sufficient to stop the spurious oscillation. The use of a non-inductive carbon resistor

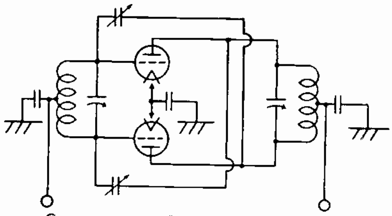


FIG. 5

of 100 ohms or so has been incorporated in a number of linear amplifiers using high powered tubes, and has resulted in all signs of parasitic oscillations completely disappearing. The linearity of the amplifier, as checked by a cathode ray oscilloscope, was not affected by the use of the resistor and the power lost in them was insufficient to cause any noticeable heating. A warning: do not be too hopeful of the carbon rods as cures. More often than not a complete cure will not be affected, but they are worthy of trial on a stubborn case.

Another high frequency, single-ended oscillation is shown in figure 4. Here the 2nd tube is acting as a t.p.t.g. oscillator as shown by the heavy lines. It is to be noted that the neutralizing capacitor Cn is actually furnishing feedback. If capacitive coupling must be used, the only remedy is to move the tap on L1 up to the plate end of the coil and decrease the size of C1. Yes, it's a poor scheme, but so is capacitive coupling. The best bet is to have a tuned input circuit and use link coupling.

Using 852's in parallel occasionally results in a push-pull oscillation of extremely high frequency, in which the tank inductances are the leads connecting the grids and plates together. This oscillation may be detected by noting the point of low r.f. potential at the mid-point of the connecting leads. The remedy is quite simple: turn or move the tubes so that the leads are shorter. Another scheme which is just as effective is to make the wiring slightly unsymmetrical to the two tubes. It may even be necessary to put a small ½ inch-diameter 2-4 turn choke in one of the plate or grid leads to one tube and not to the other.

Figure 5 is a push-pull amplifier in which parasitics are especially apt to occur, the frequency being extremely high as determined by the length of grid and plate leads to the tank capacitor. The leads to the neutralizing capacitor are usually long enough for a phase shift to occur. The out-of-phase neutralizing voltage which is being coupled back to the grid isn't really out of phase with the plate voltage when it gets to the grid. The simplest remedy in the above case is to use in either the grid or plate circuit, a split-stator capacitor, with the rotor at ground r.f. potential, keeping the lead from the filaments to the rotor as short as possible. The capacitive reactance decreases as the frequency increases and the result is that at the frequency at which oscillations try to occur the grid or plate is grounded.

Figure 6 is the diagram of a class "B" linear amplifier which was recently worked upon, whose frequency range was from 3 mc. to 15 mc. The mechanical arrangement was such that the leads from the grid tank to the grids were 9 inches, and the plate leads approximately twice that length.

When power was first applied to the amplifier, the plate current was 500 ma. or greater, *with no excitation!!* With the d.c.

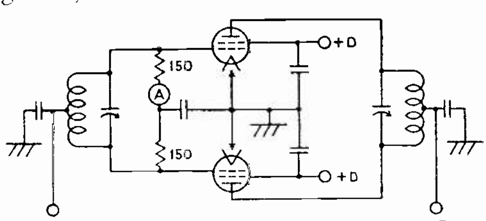


FIG. 6

voltages which were applied to the grid, screen grid, and plate, the plate current should have been 200 ma., indicating that something was very much amiss. Touching the grids with a neon bulb indicated that oscillations were taking place. An absorption-type wavemeter was brought near the grids and it was found that the wave-length was around 7 meters. Shorting the plate and grid tank coils resulted in no change, indicating that the high frequency tank circuit consisted simply of the leads to the variable capacitors, the variable capacitors

[*Continued on Page 50*]

THE "COMMON SENSE" EXCITER

Sure Fire, 10 to 160 Meters, High Output, Economical

By FAY W. HARWOOD, W6BHO*

The last three years have seen the birth of sundry "exciter units" designed to supply as many watts as possible on all of the common amateur bands with the least number of parts. In the last analysis nearly all of these exciters are nothing but good old tried-and-true circuit combinations in fancy dress, the main idea being to see how many different jobs a single tube can be made to handle. We even try to fool ourselves by incorporating dual-purpose tubes so that technically we may have fewer tubes, though common ordinary horse sense tells us that merely putting two tubes in one envelope does not cut down the total number of tube elements utilized in the transmitter.

If glass cost $5 an ounce, there might be some logic in using a single dual-purpose or dual element tube rather than two separate ones, but with tubes selling at $.49, there is no legitimate excuse for this practice that seems to be fast becoming a fad. True, there is a saving of sockets, but who is worrying about sockets when good wafer sockets can be purchased for four bits a dozen? The insulation is at least as good as that of the tube base, unless the tube has a ceramic base (and receiving tubes don't).

The design of the exciter to be described is based on the indisputable fact that the pentode reigns supreme as a crystal oscillator, is very hard to beat as a doubler, and excels as a straight amplifier where power gain rather than extremely high efficiency is desired. There are actually no more tube elements and tank circuits in the exciter than if a combination of trick dual-purpose tubes were used. And it is logical to believe that the best tube for a purpose is one which has been designed to do one thing well rather than two or a half dozen different things "after a fashion".

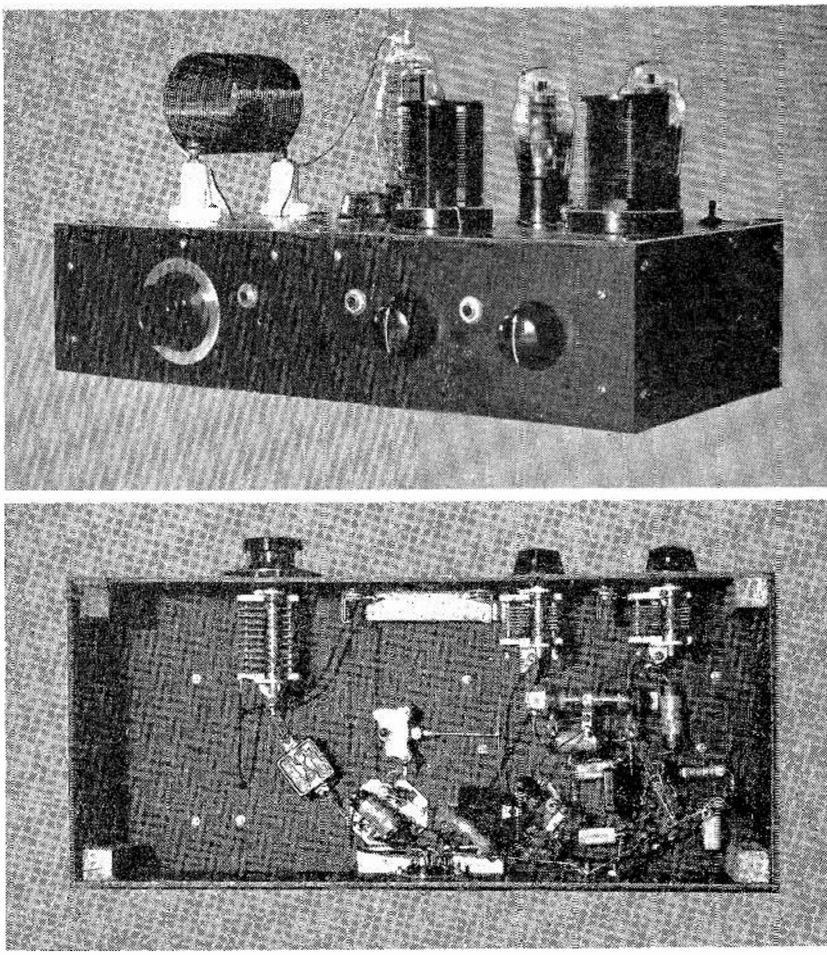
Referring to the diagram, the first 42 always works as a pentode crystal oscillator, or it is cut out of the circuit and is not used at all. The second 42 works either as a pentode oscillator or as a pentode doubler, depending upon the positions of SW_1 and SW_2. The 802 usually works as a straight pentode amplifier except on 10 meters, when it always works as a doubler.

With two crystals, one 160 meter and one 40 meter, it is possible to work 5 bands from 10 to 160 meters with over 15 watts output on all bands down to 10 meters, where the output is approximately 10 watts.

With but one crystal it is possible to work 3 bands, with over 15 watts output on two bands and 10 watts output on the third band. By showing how three bands may be worked with one crystal, the many combinations possible with two or three crystals will readily be apparent. But first it might be well to explain that the coil form plugs for L_1 and L_2 are exactly similar, as are the coils (connection being made to the same two prongs). This allows a coil to be used either in the first or second stage (which becomes the first stage by throwing the two switches aforementioned). The crystal holders should all be standard as should the mounting receptacles, so that a crystal may be plugged into either the grid circuit of the first 42 or the grid circuit of the second 42.

Suppose we have a 160 meter crystal; let's see what all we can do with it. By plugging it into the grid of the second 42 (X_2), plugging a 160 meter coil into L_2 and L_3, we have over 15 watts of output on 160 meters. Now let's take the crystal out and plug it into the grid of the first 42 (X_1), and take the 160 meter coil from L_2 and plug it into L_1. The first 42 is now made the oscillator instead of the second by flipping SW_1 and SW_2 to the proper (obvious from study of the circuit) positions. 80 meter tank coils are plugged into L_2 and L_3, and we have 15 watts output on 80 meters, the second 42 acting as a doubler. All this can be done in less than 10 seconds, including tuning of the tanks to resonance, after one has done it a few times and is familiar with the procedure. By replacing the 802 tank coil, L_3,

*R. F. D. 1, Santa Paula, Calif.



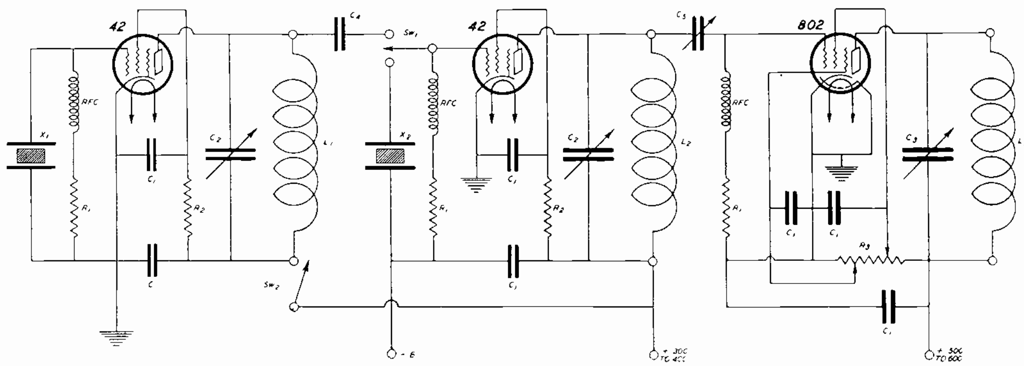
Two views of the W5BHO exciter. It is a good example of careful design; note the simple and straightforward construction. The model shown above was tested in R/9's laboratory and gave an excellent account of itself.

with a 40 meter coil, the 802 will furnish 10 watts of 40 meter output as a doubler. In the same manner, three bands may be worked with either an 80 or a 40 meter crystal.

At the plate voltages shown, the 42's make no attempt to "run away" even when detuned or out of oscillation, and the crystal current is lower than with any of the popular exciters in common use. Yet the output is more than sufficient fully to excite the 802; in fact, the plate voltage on the 42's may be reduced to around 200 volts and satisfactory excitation still be obtained for the 802. However, it is well to have a little "push" in reserve, and the excitation is made more than ample by increasing the plate voltage slightly on the 42's. The crystal current is still very low. The loading on the second 42 is adjustable by varying C_5. This adjustment is advantageous when the tube is working as a doubler, as slightly different loading is required from the optimum adjustment used when the tube is run as an oscillator.

Screen and Suppressor Voltage

The taps on the voltage divider on the 802 stage should be adjusted to supply approximately 150 volts to the screen of the 802 and 50 volts positive on the suppressor grid. The positive voltage on the suppressor increases the plate efficiency considerably, allowing greater output for a given plate dissipation or plate current.



The Wiring Diagram

A minute of study of the diagram will make it clear how the second 42 may be used either as a crystal oscillator or as a doubler. A simpler and more economical exciter may be had by leaving off the 802 stage, though it is necessary to forgo 10 meter operation. Such an exciter will be described next month. The 802 stage should preferably be link coupled to the following stage, especially on the higher frequencies. The output is high, the crystal current low, and operation is not the least bit tricky. The positive suppressor voltage on the 802 permits high efficiency and results in output of over 15 watts at 500 volts and over 20 watts at 600 volts. The plate current to the 802 must not exceed about 55 ma. or the tube will be damaged.

RFC—Small r.f. chokes, at least 6 mh. if 160 meter operation is desired.
R_1—15,000 ohm 2 watt carbon resistor grid leaks.
R_2—50,000 ohm 3 watt carbon resistors, screen dropping.
R_3—25,000 ohm 50 watt slider-adjustable resistor.
C_1—0.006 μfd. or larger mica blocking condensers.
C_2—50 μμfd. midget variable condensers.
C_3—50 μμfd. midget double-spaced condenser (single spaced if less than 500 volts on the 802).
C_4—Two 40 μμfd. mica condensers in series (20 μμfd.).
C_5—100 μμfd. midget variable coupling condenser.
L_1—L_2—L_3—See text.
SW_1—Single pole, double throw toggle switch.
SW_2—Single pole, single throw toggle switch.

The optimum value for the grid resistor of a 42 pentode is somewhat different when the tube is used as an oscillator from the optimum value when doubling. However, the 15,000 ohm compromise is close enough that little difference is noticed between operation with the optimum value and with 15,000 ohms. By using a "compromise" value, it is not necessary to switch grid leaks when changing from doubler to oscillator operation. 15,000 ohms is high enough to allow good doubler efficiency, and does nothing to the oscillator operation except raise the crystal current a very few percent over that obtained with a lower value grid resistor.

If a single meter is to be used to read plate current to all three stages (0-100 ma. d.c. is about the right scale), circuit closing jacks should be provided in each plate lead. These three jacks may be seen in the photograph. If one wishes to spend a bit more money, three separate meters may be permanently incorporated in the circuit, facilitating rapid tuning and frequency change.

Coil specifications are not given, because the coil forms used in the model described were not standard, being the old type "Silver Marshall" forms popular some years ago. These were used mainly because several were purchased for about a dime apiece at one of the "junk parts" stores. Any good coil forms may be used; just make sure to make all coils the same (connections to same pair of pins). The coils should be wound of such size that they hit resonance with a very low value of tank capacity, low L/C being especially important in the doubler circuit. The 802 tank coils are manufactured, "air wound", celluloid-supported coils of standard low-C type for each band. If desired, the 802 tank coil may be wound on the same type form as is used for the 42 stages, making coils for all three stages interchangeable.

The output of the 802 tank should be link coupled to the next stage for best results, especially on the higher frequency bands. Capacity coupling may be used, however, if one is willing to sacrifice some efficiency.

The chassis for the exciter was constructed from "Masonite" wallboard, and sprayed with black lacquer to give it the appearance of bakelite. The sheets of Masonite are first sawed to size and then assembled by fastening with wood screws to four corner posts as seen in the photograph.

Those who wish to elaborate upon the exciter may use band switching instead of plug-in coils, and replace SW_1 and SW_2 with a single gang-switch. However, by

[*Continued on Page 56*]

TWO-WIRE TRANSMISSION LINES

Construction and Operation

In amateur radio we have, as should be well known, two distinct sorts of 2-wire r.f. lines.

Kind number 1 is the tuned "feeder" such as is found in "zeppelin" and similar antenna systems. For such "feeders" we find that the currents and voltages on the feeder are much like the currents and voltages on the radiating portion of the antenna system. This is to say we have high current at some places and high voltages at others. Further it is to say that we should (but seldom do) insulate the line fully as well as the radiating part of the system. On the other hand the tuned feeder can well be made of the same kind of wire as the antenna, and may be of the same piece of wire.

Kind number 2 is the true transmission line. On this true transmission line we have nearly the same voltage and nearly the same current through the entire length of the line, very much as would be the case for an ordinary 50 or 60 cycle power line. Not having the high-voltage points found on a tuned "feeder" we do not need insulation as good as that of the antenna. Not having the high current "spots" of a feeder we apparently can get along with a smaller wire—but only apparently, as will shortly appear.

"Discontinuity"

It is usually assumed that a 2-wire (true) transmission line is non-radiating if its impedance is matched to its load—that is to say a 600 ohm line is assumed to be non-radiating if it works "into" a 600 ohm resistive load. Unfortunately that is not all there is to it. A purely non-radiating line is possible only if we do actually have smooth current-distribution all along the line, but that is not possible in any line we can actually build. A real 2-wire line cannot be hung on air; it requires insulators. Each insulator is a small condenser and therefore produces a small irregularity and some radiation instantly results. Furthermore, the line is hung on the insulator and therefore kinks a little at that place, which is another sort of irregularity—also producing a little radiation. If we take the line around a sharp corner we have a better chance of causing the same thing.

It is possible to make these things small by using low-capacity insulators, and not too many of them, and by keeping the wires reasonably tight and avoiding sharp corners. To do so is not by any means old-maidish; look over a recent broadcast or commercial station and observe the care taken in the transmission line which is a part of nearly every recent installation.

As another illustration of the effect of small things, consider a 50 or 60 cycle line which has become noisy enough to bother nearby broadcast receivers. Drive along under this line with an automobile receiver and observe that at every pole there is a "bump" in the noise, showing that there is radiation at the pole, due to the irregularity produced when the wire passes over the insulator and cross-arm. This is a true r.f. effect and is observable for miles and miles from the point at which the noise originated in a bad transformer or the like. If the line has a larger irregularity such as a branch line, or a transformer or a surge-arrester of any kind, so much noise will radiate at that point that the trouble-shooter is not uncommonly mislead into thinking it is the *source* of the noise. Many an innocent device has been yanked off a line for radiating r.f. that had wandered to it from a source 5 or 10 miles away and "squirted off" when it ran into the device.

Spacing and Wire Size

Any unevenness in the spacing between the two wires is another sort of irregularity productive of radiation. Since we can get the same line impedance with larger wire, spaced farther, this is one way of cutting down the importance of such irregularities. For instance we can make a 600 ohm line out of a pair of no. 24 wires spaced about 1½ inches (on centers) and such lines are useful and convenient in the laboratory. But out in the wind where the wires vibrate perhaps ½ inch we'd have the separation flopping from 1″ to 2″ with a resultant impedance-change of 550 to 650 ohms or thereabouts, and the radiation that results is enough so that it modulates the carrier at the vibration-rate of the wires, and the modulation can be heard at the receiving end very nicely.

A more normal line would be one using a pair of no. 12 wires. Since these wires are about 4 times as thick, we use about 4 times as much spacing and the vibration is only ¼ as important at the worst (actually less than that for some other reasons which we shall skip).

To do a real job we'd use a conductor about ¼″ thick, either a number 2 wire or a ¼″ tube, and space it about 17 inches—assuming of course that we were a rich corporation.

What Impedance?

Another way of making the variations in spacing unimportant is to use wider line-spacing without going to a larger wire. In that case the line impedance goes up, of course, and the impedance-matching transformers at transmitter and antenna must be re-adjusted or re-made to suit. The accompanying chart shows approximately what different combinations will produce. Curves are shown for the more common amateur wire sizes (8 to 18 inclusive) and also for the tubing used occasionally for certain purposes. This does not apply in any way to tubing used as tuned feeders or standing-wave lines, or impedance-matching sections. The curves for the no. 24 and no. 30 are added because sometimes it is actually better to use such wires. Where the frequency is quite high, and the power moderate a lighter and more practical structure may result from small wires.

Very close spacings are not to be recommended because (as already hinted) the unavoidable movements of the wires then cause bad changes. Furthermore it is necessary to use more insulators, thus increasing the insulator-loss. For impedances between about 450 ohms and 800 ohms neither excessive insulator-loss nor absurdly large wires are encountered.

This sounds like a sweeping condemnation of twisted-pair lines, and also of the tube-sections used in the Johnson "Q" antenna. This is not the case because these devices are "saved" by other effects.

The quarter-wavelength impedance-matching section of the Johnson antenna does, it is true, use tubing spaced very closely, but the losses are very moderate for the double reason (1) that these insulators are of good design and limited number and (2) that insulator losses go down *faster* than the voltage. Thus if we make a *very* low-impedance line and can contrive to make it short and rigid enough to avoid spacing-troubles we can get the insulation losses down to decent amounts. In a quarter-wave aluminum-tube section this can be—and has been—done.

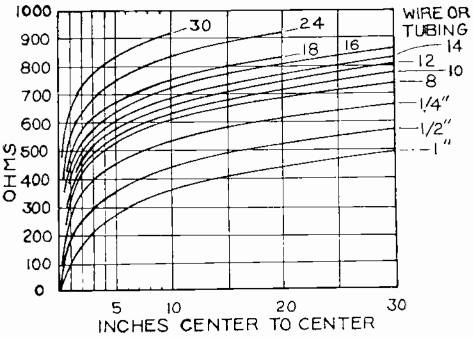
In the case of the twisted-pair lines we once more rely on the effect of having insulation-losses go down faster than the voltage. Rubber, of course, isn't as good as air. Rubber is bound to have losses. However, these losses do go down a great deal faster than the voltage and since the voltage (for the same power) goes down with the line impedance it is perfectly apparent that we can get the rubber-losses down by making the wire reasonably large, the rubber not too thick but of good quality. On this last point you are in the hands of the manufacturer. Some rubber-compounds are excellent for a while but go to pot in sun and rain. Some measure excellently at lower frequencies and not so well at higher frequencies. Any cotton which is present must be weatherproofed magnificently or it will soon spoil the picture, especially during rain. Some engineers are "agin" any covering braid whatever, while others like it for sun-protection of the rubber. It is unfortunate that some of our best anti-oxidizing "dopes" when mixed with rubber spoil it for r.f. insulation.

However, none of us is likely to do our own rubber-insulating so it really does not matter at all whether we understand what has been done in the rubber-compounding, as long as we are able to adjust the line after we have unspooled it. If the manufacturer has done a good job we shall soon know it.

Twisted or Parallel?

Assuming proper impedance matching at the ends and the avoidance of sharp bends, bad bushings, and low-grade insulators there is little to choose in efficiency; either the twisted-pair or the parallel-pair with separate suspensions will do the job. The choice should be made on first cost, on the weight your poles and other supports will carry (consider sleet and wind also) and the useful life you expect of the line.

Either sort may be used with any variety of radiating system; it is always possible to match impedances in some way, whether the line be a 70 ohm twisted pair or an 800



Handy quick-reference chart for determining surge impedance from spacing and wire size of line.

ohm open pair. Many sorts of impedance-transformers are possible but all of them boil down to a few fundamental ideas—and don't let anyone sell you the notion that one system has all the delegates. They all cook down to one of the following approaches:

1) A coil acting as an auto-transformer. Usually the coil is tuned.
2) A series-tuned circuit consisting of a coil and two condensers of unequal size, all in series. The low-impedance (usually) line goes across the larger condenser—lower reactance; therefore it matches low impedance. The antenna or the tube goes across the smaller condenser or across the coil.
3) One tuned circuit with high inductance and small capacity coupled magnetically to another one with low inductance and large capacity. This is the same thing as no. 2 thinly disguised by the interposition of the magnetic coupling.

The bewildering number of ways these three arrangements can be re-drawn has given birth to a lot of "new" circuits for tying a tube to a line, or a line to an antenna.

For instance in no. 1 the "coil" may be straightened out into an antenna, the line's ends being tapped on it a short distance either side of center—the so-called "delta match" or "triangle match".

In no. 2 and no. 3 the antenna's own capacity may be one of the condensers, or we may use the antenna capacity in series with another condenser.

The schemes classed as no. 1 are somewhat unpopular just now because they transfer harmonics to the line and thence to the antenna in a much-too-good way. Either scheme no. 3 or scheme no. 2 is better in that regard. Scheme no. 2, by the way, is inherently lop-sided because originally devised a good many years ago to couple a tube (single) to an antenna (grounded) without any line at all. To tie a push-pull stage to a 2-wire line or to a Hertz (ungrounded) antenna it must be shuffled a little. The coil is broken in two and one half placed between the condensers. One of the condensers then goes across the line, the other across tubes or antenna-input. This does not change the low-pass filter action in the least and it remains the same thing that has for many years been used in broadcasting stations as a harmonic-suppressing antenna coupler. However, we have for no reason chosen in the last few years to call this an "impedance-matching network."

Looks as if we are being respectful to a bogey-man we whittled right out of our own heads. If we "grab holt" of r.f. lines and line terminations as confidently as we do ordinary audio devices they are just as meek. No—they are a great deal tamer. No r.f. transmission line ever motor-boated until it yanked the center out of the loudspeaker diaphragm.

◆

W9DNG's middle name is *Sunshine*. *Robert Burns* operates W4BYD. *B. Going* is W4CBF. Raymond *B. Forehand* is W4CRJ, and W6HST is named *Kay K. Kidd*. W8QP's last name—N O X O N—spells itself out forward, backward, or upside-down. *R. F. Post* operates W6HXN.

◆

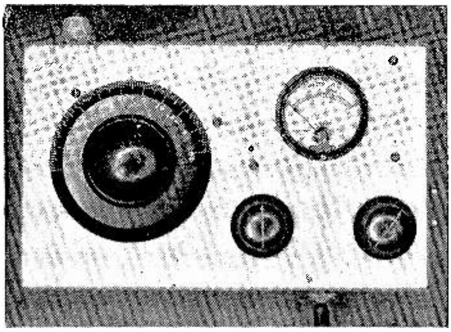
A piece of copper the size of a penny offers virtually no resistance to the passage of an electric current. The same piece drawn into a wire of no. 40 size would have a resistance close to one-thousand ohms.

◆

The flashing of a gas mantle when a spark-coil was discharged nearby led to De Forest's discovery of grid control in tubes.

QUARTER-WAVE 56 MC. RADIATORS

By Robert S. Kruse



The Franks transceiver was used for transmitting both the fixed-point tests and those from the car.

One of the commonest 5 meter antennas is the ¼ wave Marconi antenna—that is to say, a more or less straight rod or wire at whose lower end there is a connection to the actual earth, to the set, or to some mass of metal such as an automobile, which is big enough to serve as a pretty good earth-connection at 5 meters. The extreme convenience of this sort of an antenna is probably its main reason for popularity at a time when everything else seems to be using Hertz antennas, antennas which are not grounded at all, but have both ends out in the air, the simplest form being a straight ½ wave rod or wire (one which is roughly twice as long as the Marconi one). A meter is about 39.3 inches; hence for the 5 meter amateur band this works out in inches:

	½ wave (*Hertz*)	¼ wave (*Marconi*)
Longwave end of band......	105.½″	52.¾″
Shortwave end of band......	98.¾″	49.⅜″

However, one finds that the antenna is loaded with more or less stray capacity due to nearby objects (including the operator) so that the antennas are made a little shorter, frequently 95% of the lengths stated, which is to say the Marconi antenna winds up at 48″ to 50″ at the very best—and anything on down to 40 inches when an antenna coupling-coil is used and actual resonance obtained.

Antenna-Current Meters

Let us at this point stress the fact that many 5 meter rigs never do get the antenna into tune at all. It is the exceptional "transceiver" which has any sign of an antenna-current meter, or even an antenna-current lamp. If such a rig is given an antenna in the 48-50″ region there is nothing whatever to indicate that the antenna is out of tune. To find out whether it is actually of any consequence to have the antenna in tune some tests were run along the general lines shown in figure 1, the field-strength meter being nothing but a vacuum-tube voltmeter equipped with a pickup rod which was *not* resonant anywhere near the 5 meter band, as the proportions in the sketch show. The distance X was made large enough to give a reasonable assurance of freedom from trick local effects, and the whole business was done away from wires, both outfits being entirely battery-driven to permit this. The dimension Y was varied to see if any standing-wave effects between the field-meter and earth took place. None was found near the elevation which was used.

Resonance

While it seemed rather obvious in advance, the importance of antenna resonance was first established. The transmitter was a tolerably normal transceiver in which the only alteration was the addition of a 55 micro-microfarad variable condenser, located as shown in figure 2. The transceiver case was set on a large metal sheet laid on the earth. The antenna coupling coil, and the leads connecting it to the condenser, and the condenser to the antenna *milli*ammeter, totaled 0.04 wavelength. The condenser had one corner of one rotor plate kinked over so as to short onto the adjacent stator plate when turned to maximum capacity.

The utility of this condenser was immediately demonstrated when it was found that antenna resonance could be found immediately with it, whereas the ordinary procedure of tinkering with the rod-length sometimes took as much as 10 minutes to give an equally good adjustment.

It was found that the field strength at the point of measurement was always larger with a resonant antenna than with a non-resonant one. This held true no matter whether the antenna was tuned by length-change (tuning condenser shorted) or by use of the tuning condenser. Even a 25 inch antenna which had to be loaded with an additional coil gave better field strength than a 48 or 50 inch antenna put on in the too-usual way, i.e., without a series condenser and accordingly resonant nearer 6 meters than 5.

"Capacity Shortening"

Having satisfied ourselves that the antenna should be resonant there remained the question of the desirability of the series condenser. Aside from its convenience in tuning this condenser has the effect of "electrically shortening" the antenna, which permits (or compels) the use of a longer rod or wire. The question then is whether we had better use a rod whose electrical length is 1/4 wavelength, or whether we had better use a longer rod and "condenser shorten" its electrical length to 1/4 wavelength.

To be sure, this is a somewhat well settled question for stations of somewhat longer wavelength. Since the original suggestion by Stuart Ballantine that a Marconi antenna should be run at or below its fundamental wavelength, it has gradually become unfashionable to run medium-wave Marconi antennas without some "capacity shortening". If you prefer, one may say that the antennas are made taller than 1/4 wavelength (we still speak of electrical tallness) instead of being made squatty and then loaded up with a coil—as for instance the antenna-coupling coil of the normal transceiver.

However, it seemed worth while to run a few tests, just to find out if the nearly universal absence of series antenna condensers in 5 meter equipment might not be

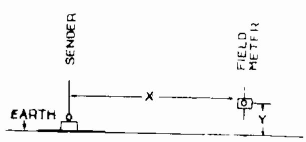


Figure 1

sound after all. It might even seem that the usual coil-loaded 5 meter antenna was a step in the *right* direction since our 25 inch (but resonated) antenna had done fairly well, and was certainly convenient. At this point we attempted to theorize as to 5 meter results, on the basis of old 200 meter and 100 meter data. For these longer wavelengths the high (capacity-shortened) antenna had the advantage over a lower (coil-lengthened) antenna in that it "got its head above the trees", that its smaller currents caused lower earth-losses at the ground connection, and finally there resulted some advantageous alternations in the angle of radiation, which effects are today being used by the broad-

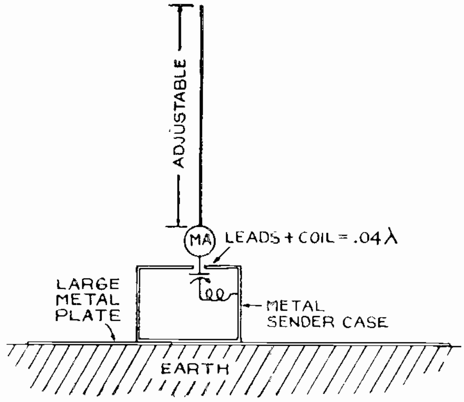


Figure 2

casters. But none of these 3 reasons seemed adequate for making a 5 meter recommendation. Since experimental confirmation was needed anyway, we might as well start there.

The curves of figure 3 show what came of one such test, run at a fixed wavelength in the 5 meter band. Curve A shows how the readings of the field-meter changed as the sending antenna's rod-portion was changed in length, but the lengths stated on the curve are *total* length, counting both the rod and the 0.04 wavelength portion below the meter in figure 2 The lengths here are ruler-measurements, because the electrical length was each time adjusted for resonance by varying the series condenser, until the antenna meter gave the largest reading.

We have here something that seems to suggest about a 40% improvement by using an antenna-system about 0.34 wavelength long (with series shortening-condenser) instead of the usual 0.25 wavelength system without a condenser. The last point to the left on curve A is actually the 1/4 wave system with the condenser shorted.

To find whether this could be carried further another curve was run with the antenna coil-loaded at its base—that is, with another coil inserted in addition to the antenna coil. This coil consisted of two turns, 1" in diameter. The reduced field is apparent, especially toward the left side of the figure, where the coil is a relatively larger portion of the antenna than at the right.

The conclusion from these two curves would appear to be that it pays to make the antenna electrically longer than ¼ wavelength and then to use a shortening condenser, also to put most of this length out into rod portion, the part which is able to

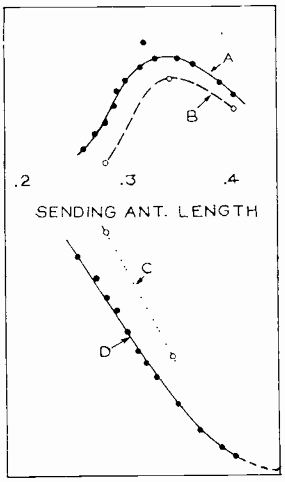


Figure 3

radiate. Thus the conclusions of former years and longer wavelengths were checked as far as local effects were concerned.

Transmission Tests

In field communication one would not expect the effect to be so decided because of the weird habit of the usual super-regenerative receiver of giving about the same output for a strong signal and a medium one—that is, its automatic-volume-control effect. But the same receiver has a pronounced "threshold effect", meaning that below a certain field strength it rather abruptly quits altogether. Therefore another test was run with a mobile transmitter, the Franks transceiver described on page 13 of the October issue, while the distance was gradually increased until the super-regenerator as usual went out. At the same time the signal was also being received with the super-heterodyne described on page 10 of the same issue.

The findings agreed very well with curve A. Working near the "limit range" of the super-regenerative receiver at the fixed station the signal of the mobile Franks transceiver could be made to appear or disappear by using:

0.35 wave antenna with series C..signal good.
0.25 wave antenna without C..........no signal.

Both antennas were carefully resonated, and the transmitting power and frequency kept constant.

Meanwhile the superheterodyne receiver showed about a 30% output change. Since this receiver has some unintentional a.v.c. effect of its own this amounts to a check on the curve.

Ancient experience was once more confirmed in another way; though the super-regenerative device at the receiving point was better than average, the superior sensitivity of the super-heterodyne was strikingly apparent.

By-products

It is easy to carry conclusions too far and no sweeping recommendations can be made on such simple tests, unless one leans on their agreement with the experience at longer waves.

Curves D and C show how one could easily walk into some errors by trying to stretch the conclusions.

Looking first at curve D we see the antenna current getting ever smaller as the rod-part is lengthened. Knowing that the power is constant we might start in to calculate the antenna-resistance as varying in a corresponding manner. This, however, would not be safe, for the antenna meter is not in the same place for any two measurements. As the rod is made longer and the series-condenser smaller, we are in effect sliding the antenna meter further and further from the maximum-current point which necessarily always remains nearly ¼ wavelength from the free end of the antenna. Thus we have a curve that shows the composite result of two changes, and is not very informative. Note also that the lower end curves instead of continuing straight onward, nor does it exactly strike the zero-zero corner. The reason is that if we lengthened the antenna to ½ wavelength we would *not* have zero current, for even end-fed antennas draw current; voltage alone does not represent power and the antenna is receiving power. Similarly if we have a wire which is several half-waves long we can't find actual zero-current points; we merely find small-current points. Only at a free end of the antenna does one find zero current, because there the electricity reaches a place where it can't pass power along and must back-track. Of course a very precise person will object that even there we have an insulator-loss and there will be a few micro-amperes of current into the insulator!

Curve C is of no great importance. It was run on a coil-loaded antenna, but unfortunately the coil was not the same as the one used in curve B; hence these two curves are not to be compared or related. C accordingly shows nothing but the obvious fact that if we curl up a part of an antenna, thus reducing its radiation, the current in it will be larger for the same power. This naturally runs up the heating loss a trifle and leaves less power to be radiated.

From this viewpoint also our conclusion is to use a longer-than-usual antenna with a series condenser, but the whole thing is rather meaningless unless the antenna is resonated. An antenna meter or lamp is therefore once more heartily recommended.

This somewhat casual series of tests was triggered off by a discussion with Mr. C. J. Franks, whose transceiver was used as above mentioned. He accordingly shares the credit—or blame. However, he is not guilty of actual participation.

◆

IMPOSTER

In June of this year a person giving his name as Jerry Stowell was reported to be visiting various radio stations on the Pacific Coast stating that he was a representative of the F.C.C. and illegally presenting what purported to be an identification card issued by the Commission. He conducted inspections; and in some cases, claiming to have found irregularities, he obtained money on the basis of a promise that he would not take any further action with regard to the alleged discrepancy.

On or about June 15 at National City, Calif., the sheriff of San Diego County arrested Jerry Stowell. It was found that he had on a number of occasions represented himself to be a special radio inspector of the Federal Communications Commission and that he had obtained $15.00 from Charles Bartell on the promise that he would not destroy a short wave set which he found in Bartell's possession. He had in his possession a card bearing the following information on the front thereof:

Number 98
FEDERAL COMMUNICATIONS COMMISSION
Washington, D. C.
Date—May 28, 1935
Zone 5—B.C.
Zone 6—S.W.
Name—Jerry N. Stowell
Address—234 Cataline, Burbank, Calif.
Capacity, Radio Inspector (Special)
Signature—J. Smith, Secretary.

Stowell was indicted by the Federal Grand Jury on July 13, 1935, entered a plea of guilty and was sentenced to serve ten months in the San Diego County jail. The sentence was suspended for five years on the condition that the $15.00 be refunded to Bartell.

Other cases of impersonation have been reported from various parts of the country. The public should beware of these imposters. The Federal Communications Commission's inspectors carry a gold badge bearing the seal of the Commission which will be exhibited upon request. They are not authorized to destroy radio apparatus or to take any disciplinary action on their own motion. All disciplinary action is handled from the Commission's office in Washington. The public is reminded that radio receivers are not subject to regulation or inspection by the Federal Communications Commission.

Any person believing that he has been visited by an imposter is requested to report all the facts to the Commission in order that suitable action may be taken.

◆

WWV S.F. Transmissions

The Standard Frequency transmissions of the Bureau of Standards from WWV now occur three times a week and on three different frequencies. Dates and character: Tuesday, unmodulated; Wednesday, a.f. modulation of approximately 1000 cycles; Friday, unmodulated. Time and frequency: noon to 1 p.m., e.s.t., 15,000 kc.; 1:15 to 2:15 p.m., 10,000 kc.; 2:30 to 3:30 p.m., 5000 kc. Power: Tuesday and Friday, 20 kw.; Wednesday, 1 kw.

◆

Another novel application which is being made of radio carrier currents along wires is the turning on of street lights.

THE CLASS C AMPLIFIER

Part I

By J. N. A. Hawkins, W6AAR

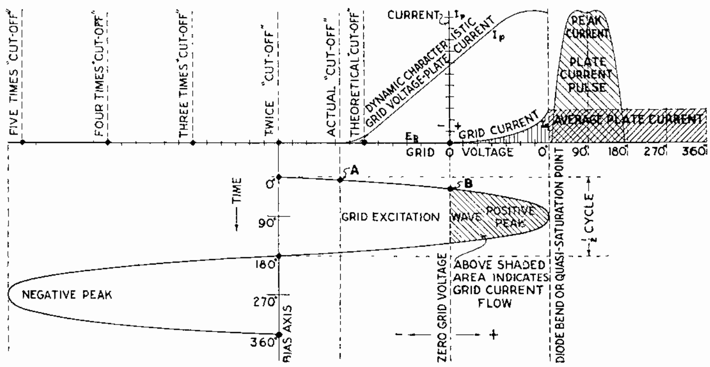


Figure 1

Vacuum tube amplifiers are classified by the conditions under which they operate and the purposes for which they are used. The three most common types of amplifiers are the class A, class B and class C amplifiers. The class A amplifier is a low efficiency amplifier noted particularly for its linearity of amplification. It is capable of relatively low power output and is rarely used in the r.f. amplier stages of a transmitter. The class B amplifier is capable of somewhat higher efficiency and power output than the class A amplifier but still gives much less efficiency and output than the class C power amplifier. The class C power amplifier is not linear and its output is a very distorted replica of the excitation voltage applied to its grid circuit, but distortion in a radio frequency amplifier is not particularly bothersome as the harmonics can be readily eliminated.

The class C amplifier might be defined as one biased somewhere beyond "cut-off" so that plate current flows for something less than one half of each cycle of grid excitation. It is usually excited quite hard so that the control grid goes quite positive with respect to the filament on each positive half of the excitation cycle. As the resistance of the plate to filament circuit in a vacuum tube goes down as the instantaneous control grid voltage is made more positive it will be seen that the plate resistance of a class C amplifier swings all the way from infinity, when the instantaneous grid voltage is negative with respect to cut-off bias, down to a value which can be as low as 100 ohms in certain tubes when the grid is driven highly positive. It is this variation in plate resistance that causes the d.c. plate current to vary widely, which variation in d.c. plate current induces an alternating voltage in the secondary winding of the output tank circuit. Thus the class C power amplifier is really a grid-controlled power converter which changes the direct current supplied by the plate power supply into radio frequency alternating current whose frequency is determined by the excitation voltage applied to the grid circuit.

Graphic Illustration

In figure 1 is shown a graphical representation of what goes on in a class C amplifier. Note that grid voltage is indicated along the horizontal axis and plate current is indicated along the vertical axis that intersects the horizontal axis at the point of zero grid voltage. The sloping line marked "dynamic characteristic" is a characteristic of the tube used in the amplifier and expresses the relation between grid voltage and plate current for that particular tube. Note that the dynamic characteristic curve is practically a straight line over most of its length. The point on the grid voltage axis marked "theoretical cut-off" represents the point where the projected extension of the straight portion of the dynamic characteristic intersects the grid voltage axis. A theoretically perfect vacuum tube would have a grid structure which would actually allow the plate current to drop to zero when the grid voltage equals this theoretical cut-off value. This theoretical value of cut-off voltage is that obtained by dividing the plate voltage by the amplification factor of the tube.

However, due to the slight "variable-μ" characteristic of all practical tubes, somewhat more than theoretical cut-off bias is necessary actually to stop the flow of plate current. As a class B amplifier must be biased to the point of "theoretical cut-off" there is always some slight flow of plate current when the amplifier is resting without grid excitation. Thus it follows that those tubes that draw the least resting plate current when biased class B have the best electrical characteristics. The type 211 is particularly outstanding in this respect.

In figure 1 the bias axis is seen to be opposite the line marked "twice cut-off". Thus the amplifier is biased to twice cut-off. With-

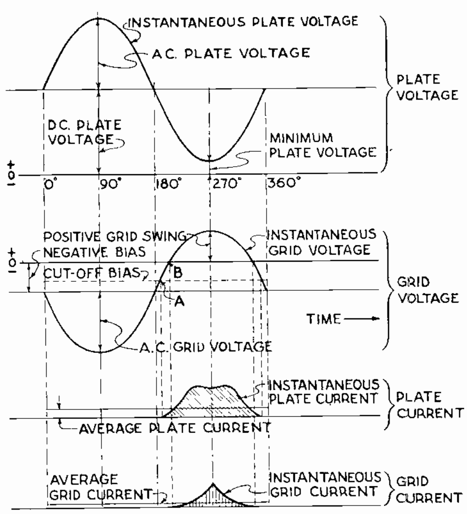


Figure 2

out excitation the plate current is zero. When an a.c. voltage is applied to the grid from some preceding amplifier or oscillator the *instantaneous* grid voltage varies back and forth about the bias axis. Note that the time arrow points downward on the bias axis. The point on the bias axis marked 0° indicates the start of the a.c. grid excitation cycle. As a complete electrical cycle consists of 360 electrical (vectorial) degrees, the point marked 90° indicates the end of the first quarter cycle. Note that during the

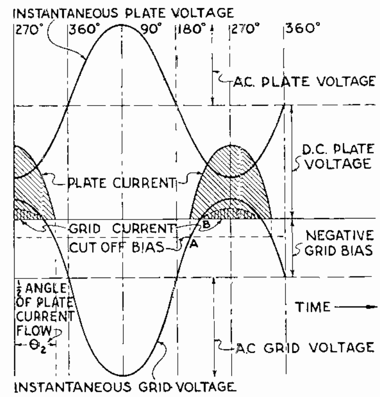


Figure 3

first quarter cycle the grid voltage swings from what might be termed "zero" (using the bias axis as the reference point) to the maximum positive point, which happens to be on the line marked "diode bend" or "quasi-saturation". This indicates that the amplifier is being excited about as hard as is desirable, as driving the grid voltage to the right of the diode bend line adds but little to the efficiency or power output and has the disadvantage that it materially increases the grid driving power required (cutting down the power gain through the stage) as well as increasing the generation of undesirable harmonics in the amplifier.

Note that during the first quarter cycle (from 0° to 90°) the grid voltage swings more and more positive, (in other words, swings less and less negative, with respect to ground, or the cathode potential). Note that nothing happens in the plate circuit until the instantaneous grid voltage crosses to the right of the point "A", or the "actual cut-off" point at which point plate current starts to flow. Plate current continues to flow until the grid voltage swings back to the left of the "actual cut-off" line which occurs something less than 180 degrees after it passes "A". Note that grid current does not flow until the grid becomes positive with respect to the filament. The start of the grid current flow occurs at point marked "B". The shaded area to the right of point "B" indicates the amount of grid current that flows.

Note that after the grid voltage swings to the left of the point marked "actual cut-off" the plate circuit rests until the first half of the next cycle. While the grid voltage is swinging way out to five times cut-off the plate is not drawing current.

In the upper right corner of the graph (figure 1) will be seen the plate current pulse resulting from the grid excursion described above. Note that the plate current pulse has a "double hump" and is not exactly similar in shape to the grid voltage pulse that released this plate current pulse. This is due to the fact that the tube is being driven out of the purely linear portion of its dynamic characteristic. This flattening of the peak indicates the presence of harmonic distortion, which will be largely eliminated by the waveform restoring effect of the circulating current that flows around the resonant plate tank circuit. In other words the circulating tank current acts like a flywheel. The resistance of the tank circuit acts like mechanical friction acting on this flywheel. Thus in order to keep the flywheel rotating it is necessary to add enough energy to the flywheel to overcome the mechanical friction effect of the loss resistance, inherently present in all tank circuits, plus the load resistance introduced in the tank circuit by coupling an antenna or other load to it. Energy is supplied to the tank circuit in the form of the short plate current pulses described above. The circulating current smoothes these pulses out and changes the waveform from short pulses into a fairly good replica of a sine wave. The heavier a flywheel the better it smoothes out any irregularities in the mechanical energy fed to it. By the same token, the more circulating current that flows in a tank circuit, the better the tank circuit performs its flywheel function and the more closely the output wave resembles a true sine wave. Circulating current is closely related to the *electrical inertia* of the circuit.

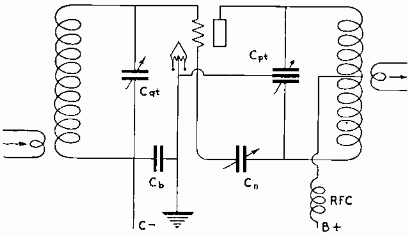


Figure 4

Plate neutralized radio frequency amplifier. This amplifier operates class C whenever the negative bias exceeds cut-off. Note that the coupling links are located close to points of low r.f. potential on the grid and plate tank coils.

The graphs shown in figure 2 and figure 3 indicate exactly the same relationships that are shown in figure 1. These other two graphs will be dealt with in more detail later in this series on class C amplifier operation. These graphs differ from figure 1 only in the method of presenting the curves. In figure 2 there are really four separate graphs, each with its own zero line, and located so that a straight vertical line intersects all four curves at the same instant in time. As the time arrow points to the right in this set of curves, grid voltage, plate voltage, grid current, and plate current can be determined at any instant during the a.c. cycle by following up a vertical reference line.

In figure 3 the same thing is shown but all four curves use the same zero axis. Figure 3 also differs slightly in that it shows one and a quarter cycles instead of just one cycle of operation.

It should be noted that the three graphs of figures 1, 2 and 3 do not all relate to the same amplifier. They are all quite similar but there will be noted small differences in the shape of the grid and plate current pulses resulting from slightly different tube characteristics. These curves were obtained from oscilloscopic analyses of three different class C amplifiers.

A study of all three of these graphs is necessary to get the whole picture of what is going on in a class C amplifier. They all show about the same thing but each shows these important relationships from a slightly different standpoint.

The operation of a class C amplifier is subject to wide variation depending on the conditions under which the tube is operated. Before examining the class C amplifier in detail it is desirable to outline the objectives to be reached.

The fundamental objective of every operator is to obtain a maximum of power output radiated from the antenna for the least cost. The largest single item in any transmitter is tube cost so it is essential that high power output be obtained from the tubes used in the transmitter, particularly from the tube or tubes used in the final r.f. amplifier as they are usually the most expensive ones in the transmitter. The cost of a vacuum tube is not particularly closely related to its power output capabilities but to its heat dissipating ability. Vacuum tubes used as power amplifiers always generate and are required to safely dissipate some heat due to the fact that the process of conversion of d.c. into radio frequency a.c. which occurs in the plate circuit is never 100% efficient. The difference between the d.c. power input drawn by the plate circuit and the r.f. power output delivered to the load circuit must be dissipated in the form of radiant heat from the plate of the tube. Thus in order to get high power output from a small, low-cost tube it is essential that high plate efficiency be realized. In other words, the power output must be a large proportion of the d.c. plate input in order to keep the plate loss within the dissipative capabilities of the tube.

The power conversion efficiency of average class C amplifiers runs between 50% and about 85% under ordinary circumstances. It is possible under laboratory conditions to obtain plate conversion efficiencies of above 90% from a heavily excited class C amplifier operating at high plate voltage. As the plate loss is the difference between the plate input and the power output it is seen that 90% efficiency means that only 10% of the input must be dissipated in the form of radiant heat from the plate of the tube. This means that the tube can be operated with high input and power output due to the high plate efficiency.

While economy requires that high plate efficiency must be obtained in order to get high power output from small tubes it is undesirable to try for too high plate efficiency because it must be remembered that the *power gain* through any class C amplifier *goes down* as the efficiency is raised. In other words, a given tube might have a grid to plate power gain of 20 at 66% plate efficiency and have a power gain of 5 at 90% plate efficiency. Suppose that the tube had a rated plate dissipation capability of 100 watts. At 66% plate efficiency the maximum allowable plate input would be 300 watts which input would be divided 66% output (200 watts) and 33% plate loss (100 watts). As the power gain under these conditions (66% efficiency) is 20 the grid driving power is 1/20 of the power output or 10 watts. 10 watts of grid driving power can be obtained quite economically. Now see what happens when the plate efficiency is increased to the 90% point, where the power gain is only 5.

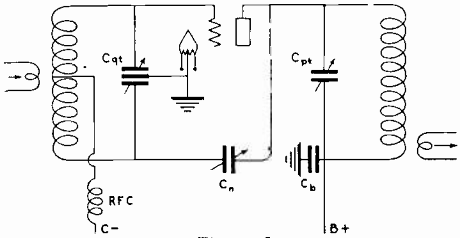


Figure 5

This amplifier is very similar to that shown in figure 3 except that grid, or Rice, neutralization is used. There is little to choose between the two systems of neutralization although grid neutralization allows cheaper tank condensers to be used. If high C tubes are used on high frequencies the use of a split grid coil is preferable to the split stator condenser shown. If either of these amplifiers are biased to twice cut-off and driven to "quasi-saturation," the classic class C definition is fulfilled in that the power output varies as the square of the plate voltage. However, this definition of class C should be considered a special case and useful only for high level plate modulation.

At 90% plate efficiency the maximum allowable plate input (without regard to any tube limitations except plate loss) will be 1000 watts of which 90% or 900 watts will be power output and 10% or 100 watts will be plate loss. However as the power gain is only 5 the required grid driving power will be 900/5 or 180 watts. 180 watts of grid excitation would probably cost more than was saved by using a small tube at ultra high plate efficiency, *especially* since only under very exceptional circumstances can a power gain as high as 5 be realized at 90% efficiency. As a matter of fact, a power gain of 3 at 90% plate efficiency is doing well. Such an amplifier would require *300 watts* of grid drive to get 900 watts of power output!

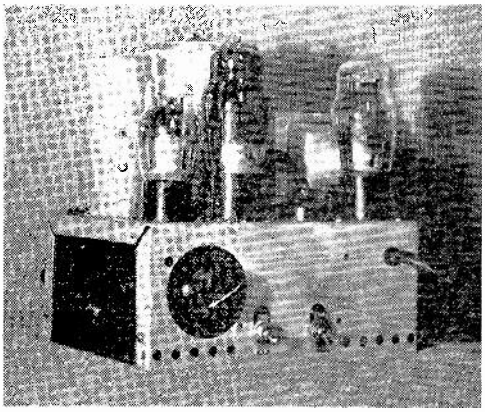
Thus a compromise value of plate efficiency must be chosen, and the cost of grid driving power must be balanced against the saving gained by using a small tube in the final

[*Continued on Page 56*]

A 4 WATT, HIGH QUALITY AMPLIFIER

For Control or Suppressor Grid Modulation

By Jack Harwood*



The 6B5 "Grid Modulator"

A grid modulated phone transmitter requires but a small audio system compared to a plate-modulated rig capable of the same r.f. output. Because the parts needed for the speech channel of a grid modulated transmitter are so few, and of low power, one might just as well exercise a little care in design, choice of parts, and construction. In other words, because the speech system is small (though just as important as in a plate-modulated transmitter) and because the difference in cost between a good amplifier and a mediocre one is so little for an amplifier of this size, we might as well "have ourselves a good one." Probably the ultimate would be an amplifier ending up in push pull 2A3's (or 6A3's) but because of the low gain of the tubes and the high current, a fairly husky power supply would be needed as well as an extra stage of speech to make up for the low gain of the 2A3's.

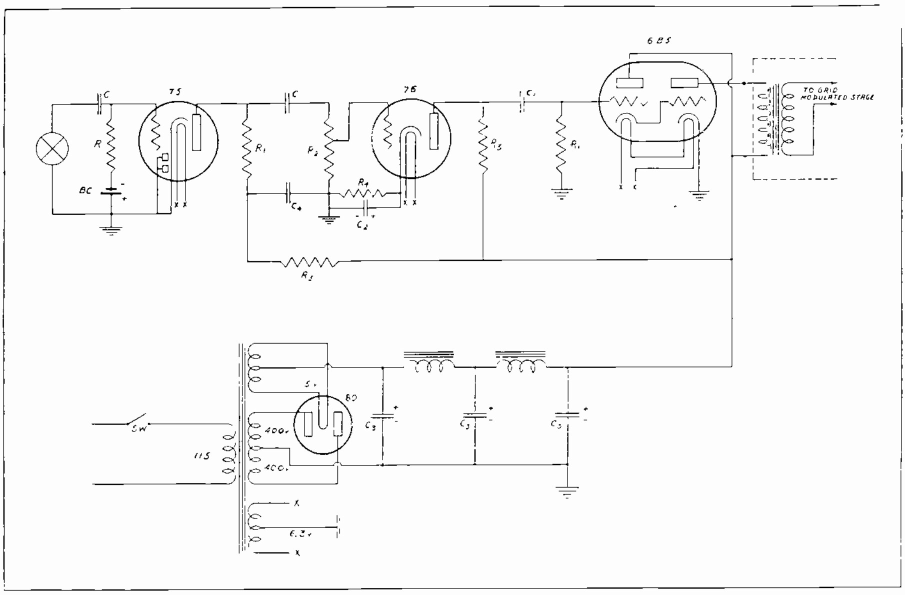
When feeding the grid of a grid-modulated stage, the audio driver must not only be capable of supplying the power, but must be able to do it with *good regulation.* The impedance the audio driver works into varies with modulation much the same as though the stage were driving the grids of a class B modulator stage, and if the audio driver is very critical as to load impedance there will be distortion. That is why pentodes or class B tubes are seldom used to drive class B modulators, even though they are certainly capable of supplying the necessary audio *power.* For the same reason, pentodes and class B stages are not particularly well-adapted to driving a grid-modulated transmitter. When they are used, the modulation transformer must be loaded with a "swamping resistor" to stabilize the plate load on the tube or tubes. This resistor, if low enough to do any good, wastes a good bit of audio power, and we would be just about as well off with a low μ triode of the same size, even though the audio output power is less, because no stabilizing resistor would then be required.

The 6B5, though having a power sensitivity nearly as great as a pentode, requires less stabilizing resistance because of its design features which cut down the effect of changes in load impedance. It is a happy medium between the pentode and the push pull 2A3's, being good enough that the 2A3's could probably be considered an unnecessary refinement for amateur work. We decided that because the speech system does not have to be large we should be sure to make it good enough. However, there is no object in making it better than necessary for the job. Our reasoning resolved itself into the amplifier shown in the diagram, which might be termed a sort of "happy compromise".

The diagram tells its own story. Resistance coupling is used throughout, obviating the necessity for care in placing transformers. The only precautions necessary are the usual ones of making the grid leads short (shielding the one to the first stage) and keeping filament wires isolated from them. The 75 should be provided with a shield, though the other tubes may be left exposed.

The model shown in the photograph was built up on one of the small chassis available for two bits in every large radio store.

*W6DJZ, W6JOO.



The Wiring Diagram

C—.01 µfd. mica.
C_1—.02 µfd. mica.
C_2—25 µfd. 25 volt electrolytic.
C_3—600 peak volt electrolytics, 8 µfd.
C_4—0.5 400 volt paper.
R—10 megohm "S. S. White" resistor.
R_1—250,000 ohm 1 watt.
R_2—500,000 ohm tapered gain control.
R_3—75,000 ohm 1 watt carbon.
R_4—2500 ohm 1 watt carbon.
BC—Mallory bias cell.

By some nosing around we were able to find one with punchings well adapted to the layout contemplated. There were holes for most everything we wished to mount, saving considerable hole-drilling labor. In fact there were a few holes we couldn't find use for, but they do not hurt anything and do not particularly detract from the appearance of the finished amplifier. If you do not like the idea of these extra holes being thrown in free, you can pay a bit *more* for an undrilled one (the punched ones usually are bankrupt stock) and poke your own holes.

One of the switches seen in the photo cuts the 110 volts, while the other breaks the B minus. This latter switch is handy when testing, as it is possible to kill the microphone without waiting for the tubes to warm up to make it operative again; the switch allows instantaneous on-off-on operation. This switch is, of course, optional, and therefore is not shown in the diagram.

The filter chokes are one of the dual-mounting units, saving space. However, any 30 henry 60 ma. chokes may be used as suit your fancy.

The output coupling transformer is not mounted on the amplifier chassis, but rather right at the grid of the modulated r.f. stage. It has been found preferable to have a long plate lead to the 6B5 rather than a long grid lead on the modulated stage. If the amplifier is to be used within a few feet of the transmitter the coupling transformer may be mounted on the amplifier chassis; otherwise it is best to mount it as stated above.

No hard and fast rules can be set forth regarding the ratio of the output transformer; it will depend upon the type tube used, amount of bias, etc. Generally speaking a slight step-down ratio will be proper for either one or two 203-A's (or their equivalent high frequency brothers that have recently made their debut) and either a 1:1 or slight step up for one or two 211's. If much more than twice cut-off bias (most common value for grid-modulation) is used, greater step up (or less step down) will be necessary. A class B input transformer designed to work from push pull drivers makes a very versatile coupling unit for grid modulation as it permits four different impedance ratios by using either all or half of each winding, depending upon the ratio desired. If you are in doubt as to the impedance ratio of the transformer, connect 110 volts a.c.

(better measure it; it may be 118) to one winding and measure the voltage across the other winding. Squaring these voltages (turns ratio) will give the approximate impedance ratio of the transformer.

A swamping resistor should be connected across the secondary of the transformer. It should be of such a value that it reflects about 30,000 ohms plate load on the 6B5. This is high enough that very little audio is wasted in the resistor, yet it improves the quality noticeably. The exact value of the resistor will be determined by the impedance ratio of the transformer. For instance: If a 2:1 step down *impedance* ratio (about 1.4 step down turns ratio) is used, the resistor should have a value of 15,000 ohms. If the amplifier is to be used to suppressor grid modulate a pentode, about a 1 to 1 ratio transformer will be right for most tubes, the value of the stabilizing resistor being calculated in the same way.

The overall gain of the amplifier is sufficient for most all of the newer diaphragm type crystal microphones (minus 55 to 60 db) and leaves a little to spare when talking close to the microphone as is usually desirable for amateur work. The output of the amplifier is sufficient for either control grid or suppressor grid modulation of any of the "100 watt" triodes or pentodes.

◆

KINKS

By Jayenay

Phone Fidelity

In designing or purchasing an output transformer or modulation choke it is desirable to find out the inductance of the coupling device in order to estimate the effect of the coupling device on the low frequency audio response.

The following rule of thumb comes in handy. If the audio response at 60 cycles per second is not to be less than 95% of the 400 c.p.s. response, then the inductance of the modulation choke or output transformer must not be less than .008 times the plate to filament resistance of the class C stage. (The d.c. plate voltage divided by the d.c. plate current). For example: Suppose that our final class C amplifier draws 200 ma. at 1000 volts. That represents a load for the modulator of 5000 ohms. Thus 5000 times .008 equals 40 henrys, which is the lowest choke inductance or primary inductance allowable. If the class C load resistance reflected back into the modulator were 10,000 ohms, 80 henrys of inductance would be necessary. Few amateur stations need an audio response only 5% down at 60 cycles. In fact, as intelligibility is the main objective, little audio response below 150 cycles is necessary. Thus less than 40% of the inductance indicated above will allow a high degree of intelligibility to be maintained.

The high frequency response is often affected by the by pass condensers used to keep r.f. out of the d.c. plate voltage leads to the class C stage. If the 5000 cycle audio response is to be kept up to 95% of the 400 cycle response, the by pass capacity (in μμfds.) must be kept below one-tenth of the modulator load resistance, in ohms.

For example: If the modulator load resistance consists of a class C stage operating at 1000 volts and 200 ma. (5000 ohms), then the blocking condenser capacity must be kept below 5000 divided by 10 or 500 μμfds. Thus a .002 μfd. condenser would cause a serious loss of the higher frequencies. Thus, a split stator tank condenser with the rotor grounded and with the d.c. plate voltage fed into the tank via a good r.f. choke connected to the center, or voltage node of the tank coil, would give materially better high frequency audio response than the use of a single section tank condenser and a large mica blocking condenser from the tank center tap to ground.

◆

During the political meeting of the Ninth Annual A.R.R.L. Convention in the Rocky Mountain Division it was voted that manufacturers, dealers, and jobbers should no longer be asked to donate prizes except for the A.R.R.L. division conventions. Thus perhaps will a plan which started out as at least semi-legitimate advertising (but fast became a major racket) once again return to its original status, in one division at least, if the constituent clubs will abide by the orders of the convention.

◆

Phonokinetograph is the proper name for a talking-picture machine.

THE TRANSMITTING TYPE R.F. PENTODE

In Theory and Practice

There have been few articles written concerning the theory and practice of transmitting pentode tubes. There is a very good reason for this lack of pertinent data on this new and interesting development, namely the highly complex nature of all the phenomena relating to this type of vacuum tube. The highly variable nature of the pentode prevents us from saying that the plate voltage should be so and so and the screen voltage should be such and such and the bias should be so many times cut-off, because cut-off bias is, in itself, such a flexible point. The whole philosophy of the pentode is one of compromise and there is a great deal of question concerning just what elements in the general compromise are to be emphasized and which are to be minimized. We hope herewith to present some of the important and fundamental relationships that affect the various phases of this general compromise.

First, let us define the type of tube under discussion. It consists of a filamentary cathode which is the source of the stream of electrons that comprise the space current in the tube. There is an anode, or plate, which usually has a high d.c. positive potential placed on it, and which thus, by reason of its positive charge, attracts the negative electrons that are thrown off from the filament. There is also a control grid which, by reason of its electrostatic charge, either decelerates or accelerates the flow of electrons from the filament to the plate. When this grid is negative, with respect to the filament, the negative charge repels the negatively charged electrons back toward the filament and thus reduces the number of electrons which can travel over to the plate. Conversely, when this grid is positive, with respect to the filament, it speeds up the flow of electrons over to the plate and increases the plate current.

The control grid is always the one closest to the filament, and in the pentode there are two other grids between the control grid and the plate. The next grid, counting out from the control grid, is usually termed the accelerating grid, or, in some cases, the screen grid. It is preferable to call it the accelerating grid rather than the screen grid for reasons to be described later. This accelerator grid usually is maintained at a fairly high positive potential, with respect to the filament, and thus helps to speed the wayward electron on its way toward the plate. This accelerating action tends to reduce the resistance presented to the flow of current by the path between plate and filament. In other words, the accelerating action of this grid tends to reduce the plate resistance of the tube, which is a highly desirable tendency, as the lower the plate resistance of the tube, the less plate voltage is necessary to obtain a given power output. However, the accelerator grid has two bad features which must be minimized if our hypothetical pentode is to end up with any real advantages over conventional triode tubes. The disadvantage is that the accelerator grid must not be allowed to become more positive than the plate, unless special precautions are taken to prevent secondary emission from the plate to the accelerator. This may sound strange that an accelerator grid must be prevented from becoming more positive than the plate, due to the fact that the d.c. plate voltage is usually from two to five times the accelerator grid voltage.

It must be screened from the plate by the suppressor grid, as otherwise secondary emission from the plate to the accelerator grid will take place during that portion of the a.c. cycle when the a.c. voltage superimposed on the d.c. plate voltage is most negative, thus neutralizing the d.c. plate voltage, or at least reducing the instantaneous plate voltage to a very low value. This lowest value is almost always lower than the constant positive potential on the accelerator grid, so it is easy to see that, during that time, the accelerator grid will exercise a greater attraction for the electrons traveling in the vicinity, than will the plate. The secondary electrons driven out of the plate by reason of the impact of electrons arriving from the filament will be attracted over to the accelerator grid, rather than following their normal course of falling back into the plate. This undesired secondary emission current is prevented by placing a suppressor grid between the accelerator grid and the plate, which is usually at, or close to, the same potential as the filament, and which is also usually grounded.

This suppressor grid is often modulated with an audio frequency voltage which provides a convenient means of varying the plate efficiency of the amplifier and thus modulates the radio frequency output.

Let us consider some of the properties of grids located in an electron stream. The general purpose of any grid structure is to establish an electrostatic charge between any two of the other elements in the tube. The purpose of this charge is either to affect the flow of the electrons or to act as a grounded electrostatic shield so that the electrostatic charge on one element will not affect the electrostatic field of another element. Thus a grid might be described as an element which can either change the flow of electrons or it can have no effect on the flow but can act as a shield between any two elements which have different potentials with respect to each other.

In either case the presence of the grid reduces the total possible flow of electrons from the filament to the plate. This is due to the fact that all grids cast an "electronic shadow" on the plate. If any of these grids is positive with respect to the filament, it intercepts some of the electrons and therefore draws some grid current, which further reduces the number of electrons available for useful work in the plate circuit. An ideal grid would be one of the spirit world, which could establish its electrostatic charge without taking up any physical space and thereby casting an electronic shadow on the plate. We want it around, but its room is preferable to its company. However, such a grid is impossible of attainment at the present time, so we will have to put up with its presence. However, we can do a fair job of building a grid that exercises control over the flow of electrons without too seriously raising the plate resistance of the tube due to an excessive electronic shadow. But, when we start to make our grid act as electrostatic screen we run into difficulty. The mesh of our grid must be smaller or else we run into real trouble. The grid mesh must either be smaller or else the wires must be larger, which amounts to the same thing, as far as the electronic shadow is concerned. If users of pentode transmitting tubes would accept a tube whose grids were designed for the maximum of effective mutual conductance and then forget about perfect screening, something could really be done. They would have a tube that would probably never need to be neutralized at frequencies below 10 megacycles, and the power gain of such a tube would be enormous. Above 10 mc. neutralizing would often be necessary but after all, neutralizing is not a particularly expensive or critical process.

Such a tube would not be perfectly suited to suppressor grid modulation but if it is necessary to use efficiency modulation, there is a means of control grid modulation that is not only as easy to effect, but enables the operator to obtain definitely higher plate efficiencies, and thus power outputs. Needless to say, control grid modulation is now perfected in that complete, linear and symmetrical modulation can be obtained with simple equipment.

Let us take up the variation in the so called "tube constants" which occurs with every change in grid and plate voltages applied to a pentode.

What Goes On

A transmitting pentode consists of a filament, a plate and three grids located between the filament and plate. The first grid, counting out from the filament, is the control grid and serves exactly the same function as the control grid in an ordinary three element vacuum tube. It can, by reason of its electrostatic charge, either reduce or increase the flow of electrons from the filament to the positive plate. As electrons are negatively charged particles of electricity they are attracted by positive charges and repelled by negative charges. Thus when the control grid is negative it repels some of the electrons back to the filament and if it is made negative enough, (cut-off) it will repel *all* the electrons back toward the filament and will prevent any of them from reaching the plate. When the control grid is positive with respect to the filament, it accelerates the flow of electrons and also picks up some of the electrons itself, thus causing grid current to flow through the external grid circuit back to the filament.

The Screen Grid

The second grid, counting out from the filament, is the *screen grid*, or as it is sometimes called, the *accelerator grid*. The grid serves a twofold purpose. It accelerates the electron flow by reason of its positive charge and also acts as an electrostatic screen between the plate and the control grid. The screen grid is almost always bypassed to the filament, (except in the *tritet* circuit) and is kept at a fairly high positive potential by means of a power supply. The screen intercepts some space current, *especially if the plate voltage is off*, and in many cases the ability of the screen to dissipate heat limits the power amplification and power output of the tube. Also the amplification factor of the tube goes down as the screen voltage is raised; however, the plate resistance goes down faster than the amplification factor, so that the mutual conductance goes up with an increase in screen voltage.

The Suppressor Grid

The suppressor grid is number three, counting out from the filament, and is next to the plate. It adds to the shielding between the control grid and the plate, due to the fact that it is usually at the same potential (d.c. and r.f.) as the filament of the tube. Thus it is grounded, in effect, as the filament is considered the reference point in most circuit connections.

The suppressor grid serves mainly to reduce secondary emission from the plate. When a high velocity electron coming from the filament strikes the plate, it often drives another electron out of the plate due to the impact. This secondary electron ordinarily falls back into the plate due to the high positive voltage that is usually on the plate. However, if the instantaneous plate voltage is plotted on a graph against time, it will be seen that, at certain portions of the alternating current cycle, the plate voltage swings down to quite a low value. The instantaneous plate voltage represents the algebraic sum of the d.c. plate voltage plus the a.c. plate voltage which is the amplified voltage that the tube is supplying to its load. When the a.c. voltage is most negative it tends to neutralize the d.c. plate voltage so that the *sum* or *resultant* of the two voltages may be quite low. When this minimum plate voltage swings down below the value of constant d.c. voltage that is applied to the screen grid, the screen is the most positive element in the tube. Thus any secondary electrons floating about in the tube would be attracted by the screen rather than falling back into the plate, where they belong. The suppressor grid, being at ground (or filament) potential, prevents these secondary electrons from going over to the screen grid and forces them to fall back into the plate. Thus the presence of the suppressor grid materially increases the power output that can be obtained from any type of screen grid tube.

This suppressor grid also can be used to control the power output of the pentode. It is quite useful for keying purposes as it draws no grid current when negative, and very little grid current when positive. If an audio frequency voltage is applied to this grid, the output of the tube may be modulated by what is called "efficiency modulation" and practically no audio power is required to effect 100% modulation with little distortion. The carrier output when used as a modulated amplifier will run between one third and one half of the plate dissipation of the pentode tube, as the unmodulated plate efficiency must be one half of the plate efficiency at 100% modulation. Unmodulated plate efficiencies of from 25% to 33%, depending on plate voltage and the efficiency of the external circuit, can be expected with suppressor grid modulation.

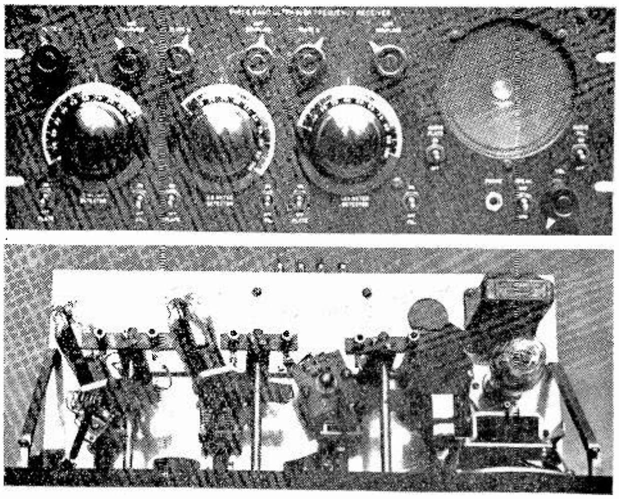
The advantages of the pentode are most evident when used as a frequency stabilized oscillator, as with a quartz crystal or with electron coupling to the load circuit; as a buffer-amplifier, to isolate the oscillator from keying or modulation surges; as a frequency multiplier, to excite a final amplifier at some integral multiple of the crystal frequency; and as an efficiency modulated amplifier where economy of audio power is desired. The pentode also is used as a final

[*Continued on Page 48*]

A GENERAL UTILITY U.H.F. RECEIVER

Designed for Multi-band Operation

By H. SELVIDGE*



Front and top views of the 3 band u.h.f. receiver

The following is a description of a novel three-band, ultra-high frequency receiver recently built at the Cruft Laboratory at Harvard University for work on 5, 2.5, and 1.25 meters. A receiver was needed which would be capable of a rapid change to any of these wave-lengths, and as it was to be used in a portable set-up, it had to be quite compact.

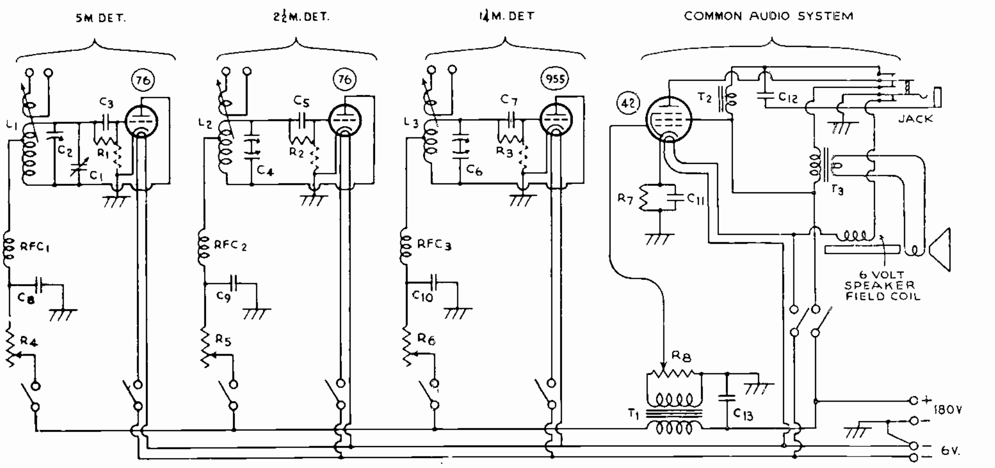
The receiver which was built consists of three separate self-quenched superregenerative detectors (one for each band) which can be easily switched to feed a common audio circuit. Type 76 tubes are used as the 5 and 2.5 meter detectors, while a 955 is used on 1.25 meters. The audio tube is a 42, which gives plenty of output to drive a 5-inch dynamic speaker. Plug-in coils could have been used to change from 5 to 2.5 on a single detector, but the saving of a tube and several condensers was more than balanced by the greater efficiency and mechanical ruggedness of the fixed coil construction with its short r.f. leads. The two 57 tubes are mounted in a horizontal position in order to get the prongs as near as possible to the detector tuning condensers and tank coils. Individual plate voltage controls are provided for each detector. The three pairs of antenna leads plug into General Radio binding posts mounted on victron strips above each detector.

The parts are mounted on a sub-panel behind a ¼-inch aluminum front panel. An aluminum cover (not shown in the photograph) serves as electrical shielding and mechanical protection. The antenna coupling to each tank coil is controlled by knobs on the front panel. If a rapid frequency change is desired, all filaments can be left on and any detector selected by means of its plate switch.

A jack outlet is provided in the audio stage for telephones or output meter. When the plug is inserted in the jack, the speaker and its field are cut off, and the output of the 42 is shifted from the speaker transformer to choke coupling for the telephones.

The set was carefully calibrated for field strength measurement purposes, and the calibration characteristics may be of interest.

*W1XDJ, W9BOE, Assistant in Physics and Communication Engineering, Cruft Laboratory, Harvard University, Cambridge, Massachusetts.



The Circuit Diagram

C_1—35 μμfd. mica leaf trimmer.
C_2—"Trim-Air" cut down to one rotor and two stator plates.
C_3, C_5, C_7—50 μμfd. mica.
C_4, C_6—"Trim-Air" with one rotor plate; two stator plates each cut in half to give split-stator effect.
C_8, C_9, C_{10}—.004 μfd. mica.
C_{11}—10 μfd. electrolytic.
C_{12}—.01 μfd. mica.
C_{13}—1 μfd. electrolytic.
R_1—2 meg., ¼ watt.
R_2—1.5 meg., ¼ watt.
R_3—1 meg., ¼ watt.
R_4, R_5, R_6—250,000 ohm tapered volume controls.
R_7—400 ohms.
R_8—500,000 ohm tapered volume control.
L_1—7 turns no. 18 wire, ⅝ inch diameter.
L_2—5 turns no. 18, ⅜ inch diameter.
L_3—4 turns no. 18, ¼ inch diameter.
RFC_1 RFC_2—40 turns no. 30 d.s.c. close wound on ¼ in. victron rod.
RFC_3—20 turns no. 30 d.s.c. wound on ⅛ inch rod, and form then withdrawn.
T_1—Audio interstage.
T_2—Iron core filter choke.
T_3—Speaker transformer.
Note: The position of the plate tap on the detector tank coil is not critical; any turn between the center and the grid end will be found satisfactory. The gridleaks R_1, R_2, and R_3, shown in two positions in the diagram, work well either way, in spite of the fact that with one connection there is a d.c. path from the grid to the positive plate supply.

The curves show voltage reading on an output meter plotted against signal strength in microvolts per meter. The modulated curve shows the output when the carrier was modulated by a steady 400 cycle tone. It will be seen that the smallest signal than can be read on the output meter is about 3 microvolts per meter in this particular receiver. However, it was noticed that the tone could be audibly distinguished from the characteristic noise for somewhat smaller signals (probably down to about 1 or 2 microvolts per meter).

The modulated signal was generally unsatisfactory for our measurement purposes, however, on account of the effect of changes in percentage of transmitter modulation on the receiver output. In view of this fact, use was made of the "Uda phenomenon", which is the suppression of the characteristic noise in a superregenerative receiver upon the reception of a carrier. On the graph, the carrier curve shows how the output voltage (noise level) decreases with the reception of an unmodulated carrier. It will be noticed that for small signals there may be no trace of unmodulated carrier in the output, while a modulated signal of the same strength is still very evident. This is easily noticed audibly on most ultra-short wave superregenerative receivers.

Changes in plate voltage and aging circuit elements will cause the noise level to change and the calibration curve to shift. It was found that the greatest change is in the region of strong signal reception, and that the general shape of the curve, as well as the lower limit of sensitivity, remains nearly the same, although the strong signal saturation point changes. The saturation effect at high signal inputs is well illustrated, these curves showing the deceptive automatic volume control effect on strong signals. For example, for the calibration shown, a signal might vary from 200 to 10,000 or more microvolts per meter with very little change in receiver output.

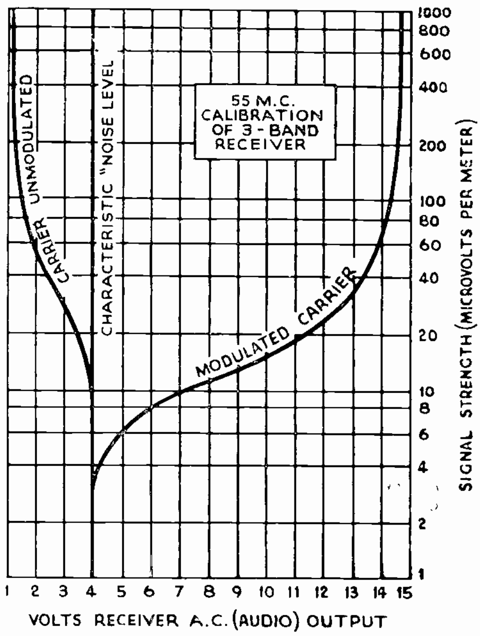
Curves of the same shape but for different voltage ranges were obtained on 2.5 and 1.25 meters. For the 2.5 meter set, the lower limit of sensitivity was about 15 microvolts per meter, and for 1.25 meters, in the vicinity of 50 microvolts per meter. Calibration curves were obtained by the use of a special standard field generator which was built in the laboratory, and was used with a General Radio 604-B standard signal generator. All measurements were made by setting up a standard variable field near the antenna, so the above data show the over-all efficiency of the set plus the antenna system for a given field strength, and should not be confused with calibrations showing microvolts input to the receiver.

This receiving unit has been in almost constant use for six months. During six weeks of this time it was installed in a boat and used for making field strength measurements over sea water. The remainder of the time it has been installed in a mobile laboratory unit. The set has had a rather eventful career, having traveled more than 4000 miles over all sorts of roads. On one occasion it was snatched from a sinking boat on the Maine coast, and it has been doused with salt spray plenty of times. It has worn out three sets of heavy duty "B" batteries, and is still going strong with the original four tubes.

Construction

The arrangement of parts is readily understood if the photographs are considered together. At the right is the audio system consisting of the loudspeaker, the 42 amplifier tube, the input (interstage) transformer and the two output devices—that is, the transformer T_3 mounted on the speaker, and the T_2 output choke. The controls for this stage are grouped below the speaker. Starting from the right we see the audio filament switch, the volume control R_8, a switch for transferring the speaker to another receiver (not shown in the diagram), a headset jack and (upward to the left) the plate-supply switch of the 42.

To this audio system may be fed the output of any one of the 3 super-regenerative detectors whose arrangement along the panel is in the same sequence as shown in the diagram. Referring to the front view, each dial is seen to have 4 controls grouped around it. For example, consider the 5 meter detector at the extreme left. At upper left is the plate-voltage rheostat (regeneration con-



trol) R_4 and beside it a knob for varying the antenna coupling. Below the dial are two off-on switches, plate at the left, filament at the right. The controls of the other two detectors are arranged in the same way.

The top view shows the method of varying antenna coupling. From each "Ant. Coupling" knob (to the upper right of a dial) a shaft is extended to the rear as seen in the photo. The rear bearing of this shaft is mounted between a pair of General Radio "plug-cap" binding posts to which antennas are connected. From the binding posts flexible leads come forward to a three turn antenna coil mounted on an insulating strip carried by the shaft. These strips may be seen near the tube bases. As the shafts are turned the antenna coils move to or from the coils L_1, L_2, L_3, as the case may be. The extreme utility of this slight structural complication is well known to any transmitting amateur or broadcast listener who has used regenerative detectors under various antenna conditions. The ability to vary antenna coupling may easily mark the difference between good reception and no reception at all.

◆

In 1925, Germany enlisted letter carriers and chimney sweeps to hunt unlicensed broadcast receivers.

"Q" SIGNALS, CONTESTS, AND QRM

By E. H. Conklin, W9FM

Without for a moment denying that our bands are excessively crowded and are likely to become more so in future years, we wish to make some suggestions which, if they would reduce interference 25%, would be distinctly worth while.

Our pet illustration of the present state of affairs is an experience during the 1935 A.R.R.L. International contest. When a receiver (with crystal) was tuned from 13,950 to 14,000 kc., we heard nothing; but from 14,000 into the band at least 100 kc., there was just a "wall of sound" in which W calls could simply not be copied. The volume indicator which was at minimum up to 14,000 kc. just went up and stayed there, wiggling somewhat when we tuned into the band. Dx signals could be heard only because conditions permitted them to come through with better volume.

But what were all these W's doing—working each other? No! just calling, most fruitlessly. Many would send 20 calls or so before raising anyone. In fact, some were calling a dx station that had been closed for an hour while the operator was at luncheon. In 1934 we tried to raise ZS2A, did so on the 32nd attempt of the fourth night.

In the 1935 test we heard Dick Bartholomew, K4SA, attempt to "break-in" on stations calling him, mentioning the long calls. But think of the several *hundred* W stations who had spent hours calling—why shouldn't they call, always in the hope that "this time" will raise him? The mistake is not so much that of the long-calling W as that of the dx station that doesn't indicate how he is going to tune his receiver at the end of a QSO.

It would seem that a dx station would follow one of two logical methods: tuning from the frequency of the last station worked, or tuning from an edge or from the middle. What other choice is there? Is there much excuse for tuning just from any old point, unsystematically, to some other point on the dial? But now a station on 7150 kc. will call CQ and be called from *both ends* of the band; another on the 14 mc. band will be called by many stations at various parts of the same end, and even by a few at the other end! What a waste of time and power, interfering with others! What *needless* QRM!

Our suggestion involves using this international abbreviation: QSX—"I will listen for .... on .... kc."

On finishing a QSO, K4SA could have sent, "QRZ? QSX 14,300 de K4SA," or cut it down just to "QSX 14,300," indicating approximately where his receiver is tuned, and only stations close to that frequency need bother to call—the rest having no chance. Or, when there is not a long waiting list of fellows ready to call, use one of these:

QLM—"I will tune from the *low* frequency end across the *middle*."

QML—"I will tune across the *middle* toward the *low* frequency end."

QHM—"I will tune from the *high* frequency end across the *middle*."

QMH—"I will tune across the *middle* toward the *high* frequency end."

These are easy enough to remember; just keep in mind "low, middle and high," using the proper initials to indicate. The use of "middle" seems to some to be a complication, but permits tuning from the middle, giving the fellows in the middle a chance, also making *four* "edges" in each band for the W stations to pile up into. It will help to scatter the stations rather than force them to concentrate at the edges and fight it out.

During the 1935 A.R.R.L. contest, ZE1JB used these, saved plenty of time and QRM. Once, from around 14,300 kc., he used QLM at which Rodimon, W1SZ raised him at 14,004 kc., followed directly by W9FM. Both had been at the other end, made a quick change and a successful, short call. In the recent VK-ZL test, ZL2KK used QHM frequently, could be raised on *three calls and one sign!*

Dx stations could reduce W QRM for each other by the use of these five signals, in and out of contests. Even W stations should make a habit of using them to reduce needless calls, permit short calls on the part of those who then *know* that a short call will be effective.

Let's all use these Q signals *regularly*.

SIDEBAND SPLATTER

And What to Do About It

By J. N. A. Hawkins, W6AAR

The Federal Communications Commission now requires that all amateur phones operating in the bands below 30 mc. not be modulated in excess of their modulation capability. The modulation capability of a phone transmitter rarely exceeds 90% modulation and the maximum *capability* of many amateur phones is below 70%.

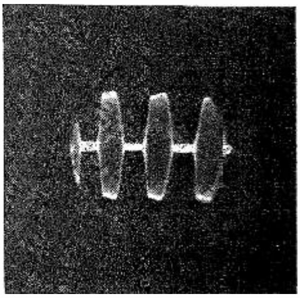


Figure 1
This indicates an overmodulated carrier without carrier shift. The positive peaks cut off at the same point as the negative peaks (100%).

By modulation capability is usually meant that percentage of modulation above which the transmitter begins to generate spurious sidebands which may extend out 50 kc. or more on one or both sides of the carrier frequency. These spurious or extraneous sidebands are generally termed "sideband splatter". They cause a tremendous amount of unnecessary QRM to stations working on adjacent channels and can sometimes be heard thousands of miles. These same extraneous sidebands also can cause bad local QRM to broadcast listeners.

The main source of sideband splatter is *carrier shift*. Carrier shift has nothing to do with frequency modulation or a shifting of the *frequency* of the carrier. Carrier shift describes a shift in the *average* amplitude of the carrier, which is supposed to remain constant during modulation. Carrier shift almost always can be identified by a change in the d.c. plate current drawn by the final amplifier, whether a plate modulated class C stage, a grid modulated stage or a class B or BC "linear" r.f. amplifier. Carrier shift can occur at *any* percentage of modulation and is not necessarily associated with overmodulation. In fact, a transmitter can be considerably overmodulated without any noticeable carrier shift being present. The best indicator of carrier shift is a diode linear rectifier consisting of a 30 tube or equivalent used as a diode (grid and plate tied together) and a 0 to 1 milliammeter. The diode rectifier is placed in series with the meter which indicates the average rectified amplitude of the carrier. If carrier shift is present the meter reading will change slightly during modulation. If the meter reading increases there is *positive* carrier shift. If the meter reading decreases there is *negative* carrier shift present. Note that the meter reading will usually, *but not always*, vary when the carrier is overmodulated. The same holds true for the d.c. plate current to the final amplifier. If there is only

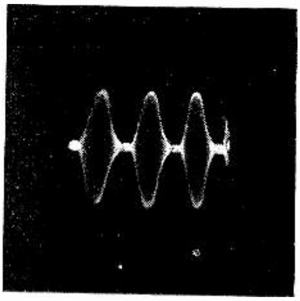


Figure 2
This carrier is also overmodulated but as the positive peaks can swing materially beyond 100% before cutting off carrier shift is produced.

enough r.f. grid excitation to the class C stage to enable the positive modulation peaks to go to 100% modulation, and not beyond, then both the positive and negative peaks will be cut off and little or no carrier shift will result. This explains how some stations can consistently overmodulate yet the operator can truthfully maintain that the plate current to the final amplifier remains absolutely constant. Figure 1 shows an oscillograph of an overmodulated carrier that shows very little carrier shift. This signal was exceptionally broad although neither the d.c. plate milliamperes nor a linear rectifier used as modulation monitor gave any indication of trouble.

By increasing the r.f. grid excitation to the class C amplifier so that the modulation

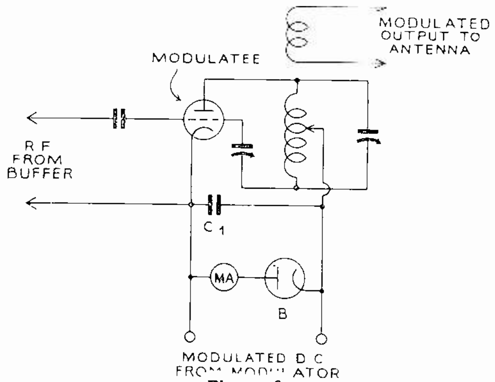


Figure 3
Negative peak clipping indicator. This 0-10 milliammeter in series with the half wave rectifier B (consisting of an 879 in high voltage class C amplifiers) indicates whenever the negative modulation peaks exceed 100%. The rectifier conducts only when the plate of the class C stage goes negative with respect to the filament.

envelope was filled up even with 150% modulation on the positive peaks, as shown in figure 2, the trouble with the linear rectifier described above was avoided. Now whenever the transmitter is overmodulated, the negative peaks cut off but the positive peaks keep going up, causing marked carrier shift. This carrier shift is promptly reflected as a change in both the d.c. plate current and the rectified current indicated by the 0 to 1 milliammeter in series with the linear rectifier. As the negative peaks hit "cut-off" before the positive peaks, there was positive carrier shift and the d.c. plate current and rectified carrier current went up.

The only simple means of locating overmodulation when the positive and negative peaks cut off at the same point, as in figure 1, is the negative peak clipping indicator, shown in figure 3. This half wave rectifier passes current through the circuit to the indicating meter whenever the plate voltage on the class C stage swings *below* zero (in other words, when the plate becomes *negative* with respect to the filament). This type of overmodulation indicator *always* works and it might be noted that it is quite easy to have a cathode ray oscilloscope show only about 85% modulation when the carrier is actually overmodulated. This occurs when some r.f. from a buffer stage is allowed to leak into the oscilloscope. Therefore remember to pick up the r.f. for the oscilloscope from the antenna feeders and keep the 'scope as far away from the buffers as possible.

A sure fire indicator of "100% plus" modulation is not enough to allow the operator to be certain that his signal is as sharp as it should be. As stated above, it is possible to have quite bad carrier shift at even 50% modulation, under certain conditions. In figure 4 is shown an oscillograph of a transmitter modulated about 80% with a tone. Note the jagged edges on the positive peaks. There was not enough r.f. grid excitation to allow the positive peaks to swing up as much as the negative peaks had swung down, so that bad negative carrier shift occurred. This signal was quite broad even though it was modulated only 80%. Practically this same picture was obtained from a class B linear amplifier operating with *too much* unmodulated r.f. grid excitation. Also this same thing happens in a grid modulated transmitter operating with too much

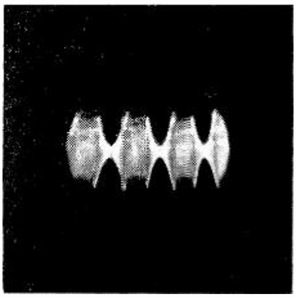


Figure 4
Oscillograph showing bad carrier shift at 80% modulation. High frequency parasitics are also present. This carrier shift was caused by insufficient excitation.

r.f. grid drive. This same picture also can be obtained from a class C plate modulated stage that has plenty of grid excitation when the tubes start to go flat. In other words, the tubes did not have enough reserve filament emission to allow the peak input and output to quadruple during complete modulation. The point involved here is that this

[*Continued on Page 48*]

RECORDS TOPPLE ON 28 MEGACYCLES

Many Stations Hear All Continents; Several WAC

[Reports and other material referring to the 28 and 56 mc. bands should be sent to E. H. Conklin, W9FM, Assistant Editor *R/9*, 512 No. Main St., Wheaton, Illinois, who will correlate and assemble the data for publication. Reports should *reach him* by the 22nd of each month.]

◆

Last month we reported that Jerry Gorman, W6JJU, heard all continents in a single day, October 6. Here they are: 8:30 a.m., p.s.t., ON4AU; 9:35 ZS1H; 3:00 p. m., J3FJ; 4:00, LU1EP and several VK's. He also heard all U.S.A. districts the same day. Jerry says that twenty meters in its palmiest days never did better. He has been "knocking over" South Africans regularly in the early daylight hours.

On October 13 Wayne Cooper of Santa Barbara, Calif., also heard all continents on 28 mc.

On October 20 we heard ZS1H tell W3DLB of hearing all continents that day: "G6WN, ON4AU, OK1AA, PA0QQ, D4ARR, J2HJ, VK4BB, VK4AP, VK6SA, FA8CR, ZU1C, LU1EP and number of U. S.A. stations, who are close enough to cause QRM."

The First Ten Meter WAC

LU1EP on October 6 said that someone else had beat him to the first 28 mc. WAC; W9NY suggests that it might have been X1AY, but we lack confirmation. However, J. J. Michaels, W3FAR, who moved down to the ten meter band October 3rd with only 22 watts into a pair of 210's, completed his ten meter WAC at 5:40 p. m., e.s.t., Saturday, October 12 by working J2CL. The A.R.R.L. ten meter bulletin considers this the first WAC and mentions that ZS1H hooked his sixth continent nine hours later, working J2HJ. Lots of the gang have five continents to their credit, usually lack one continent directly east or west. J3FJ answered W9NY's CQ on October 6th, but Herb tuned from the other end and worked a W6 so still lacks Asia.

October Conditions

Conditions in October seldom permitted 800 mile work, but 2000 mile QSO's were usually possible for six to ten hours a day. The month will be remembered for the ease with which contacts between any northern hemisphere station could work any southern station, and also for the much more consistent east-west intercontinental work. ZS1H is very consistently one of the loudest signals on the air until noon c.s.t., with VK2LZ most consistent from Oceania. W7AVV says that he hears ZS1H best between eight and ten in the morning, Pacific time, and mentions that the VK's often reach R9 in volume.

The first week in October brought scattered reports of European signals in the U.S.A. with October 11 to 15 outstanding. W9GHN said things opened with a bang at 7:15 a.m., c.s.t., on Friday the 11th, and W9NY contacted D4ARR, F8VS, FA8IH, ON4AU, F8OZ and another D4 before going to work. Nearly all of these stations were R6 to R9.

The same day between 8:00 a.m. and 3:00 p.m. eastern time, W3FAR worked F8OZ, ON4AU, F8VS, FA8CR (fone), FA8IH, D4ARR, ZT6K and X1AY; in the next two days he added D4AUU, PA0QQ, J2CL, LU1EP, D4KPJ, VK2LZ and LU9BV to his list. Just a few days before, on October 7, W3FAR held a two-way phone QSO with VK2LZ and was called on the same frequency by LU1EP, making it three-way.

On the 13th between 8:30 and 11:30 a.m. Al Parham, W4MR, raised G5FV, G2HG, G6DH, D4KPJ, F8OZ, G5BY, F8EF, PA0QQ and F8VS. He says he heard D4ARR; we wonder if he worked nine out of ten heard!

With only *twelve watts* into the antenna, G. H. McClurg, W3DLB in Washington, D.C., submits this list of low power 28 mc. dx:

October 12: Worked ZL3AJ; heard VK2LZ.
October 13: Worked F8OZ, D4ARR, F8EF, FA8CR.
October 14: Worked F8VS, ZS1H.
October 15: Worked ON4AU, PA0AL, G6GS.
October 16: Worked ON4JB; heard G6LK.
October 20: Worked G2HG, ZS1H, X2C.

Worked X2C who promised to get the 7 mc. J gang down on 28 mc.

October 21: Worked FA8IH and ZU6P (28,060 kc.)

October 22: Worked FA8IH, FA8CR, ZS1H. Heard F8WK, D4ARR, F8KJ, X1AY, VE4QY, VK2LZ.

October 23: Worked D4WF, D4ORT, D4KPJ (who reports SU1SG on 28,800 kc.) Heard D4ARR and FA8IH (both calling W6GRX) and FA8IH calling W6CAL. Heard D4AUU, YM4AA, and EA4AV.

McClurg says that Europeans come through all morning, 7 a.m. to noon eastern time; ZS1H best about 11:00 a.m., which seems to hold true for the whole U.S.A. Very few South Americans were heard in mid-October, LU1EP being much weaker than usual. ON4AU advised that on October 15, 14 mc. harmonics of W2GOX and W8CRA were R8, and dozens of other W harmonics were getting to Europe.

W9NY worked five continents on the 20th. The day before, he hooked CX1CG for the first ten meter QSO between Uruguay and the U.S.A. That recalls the day just ten years ago when the late Colonel Clair Foster, W6HM, was the first and W9VO (one of the partners being the present W9FM) was the second to raise Uruguay from the U.S.A. on *any* band.

W4AGP was heard having a rag-chew with EI8B at noon eastern time on the 20th.

X1AY has been working VK4BB nearly daily. W9FM has hooked at least one VK each Saturday for a month, finding too much QRM on 28009 kc. and progressively moving farther into the band. ZU1C, W9NY, VK4BB, VK2HZ and VK4BB are parked around 28,250 to 28,300.

Japan leads the Asian stations, J3FJ being reported on about 28,590 kc. J2CL and J2HJ are also coming through. W6JJU, who raised J3FJ on October 2, hears VK's working J2GR. The J's seem to come in from 5:00 p.m. eastern time until local sunset, anywhere in the U.S.A. During the winter this time may advance, but is probably limited by sunrise in Japan, possibly preventing Asian signals in the Eastern U.S.A. between about November 1 and February 15. Mid-summer work with Asia may turn out to be as difficult as with Europe; we are, however, giving considerable weight to the data on propagation reported in *R/9* for October, which may possibly prove unjustified due to effects of the "eleven year cycle."

West Coast Conditions

Gorman, W6JJU, outlines conditions in Southern California as follows: "W4's will be heard most times throughout the day. W9 reception is quite erratic but the average QRK reaches an unbelievable volume, no other signals on any band being quite like them, and from no other district. We do not hear San Francisco, Seattle, etc., signals when eastern signals come through, and not many at any time. I have tried vertical and horizontal antennas, high and low power, but fail to note any change in reports. It seems that any half-decent rig will be R9 even on the east coast. One peculiar thing, though, after putting in two and a half years of active operation on twenty meters using a kilowatt input, I had to get down on ten meters with the same rig using greatly reduced power to get my first R99 plus report from the east coast. Tie that one!" We wish to add that in Illinois we heard W7AVV, an R9 signal using only an 825 doubler as a final amplifier, call W6VQ, so it appears that north-bound signals in the west must be possible along with east-west signals. In Illinois, however, it is seldom that signals from the south and east both come in. Also, W6VQ puts in a louder signal than W6JJU, whether the reason is power, antenna or location.

Equipment Used

When the band is wide open, some surprising records are hung up. W3FAR with only 22 watts input to a pair of 210's worked five of his six continents on phone within a week. The crystal is on 80 meters, with conventional doubling using 46's. The modulator is Class B 46's.

W9NY uses two 59's in the universal exciter circuit going to 10 meters from a 40 meter crystal. The second 59 drives a pair of 801's to 200 watts input. The antenna is a 16 foot vertical, the bottom of which is 22 feet above the ground. While this rig sounds simple enough, it probably puts nearly as much power into the antenna as larger

[*Continued on Page 52*]

MICROPHONE TRANSFORMERS

Primary Inductance vs. Characteristics

While it is fairly obvious that a mike transformer with ample primary inductance must give better low-frequency response, it may not be clear to transmitting amateurs just how important the effect actually is.

From 200 cycles on upward the effect isn't very important for a carbon mike, since at that and higher frequencies even a somewhat skimpy primary affords a good enough impedance match—or would you prefer to say it offers a high enough load impedance? At frequencies above perhaps 3000 the distributed capacity of the secondary coil begins to bypass the output and is a major consideration from there up, which is another subject, requiring careful work by the manufacturer if good response up there is wanted. On that point there is some argument on which *R/9* hopes to offer a few useful comments shortly.

Getting back to the low-frequency response:

The low notes, in speech communication, do not greatly help the *intelligibility*. If nothing more than understandable speech is wanted, they can be attenuated considerably without loss of understandibility. On the other hand if the desire is to "have it sound like you" it is necessary to transmit these "personality frequencies", the only argument against this being that heavier low tones may overload the audio system or over-modulate, before all of the higher tones have gotten above the noise level. How true this is depends upon the voice which is fed into the mike. There simply cannot be a general rule to cover both rumbling basses and piping tenors—not from the overload viewpoint. A little personal judgment and watching of the meters will help settle the point.

However it's useful to have some idea of what to expect. In one test on which figures are available the response was as follows for different transformers. This is *relative* response as compared with the response which could be had from a perfect transformer with an enormous primary impedance and no distributed capacity at all—nor any magnetic leakage.

Primary Inductance in Henries	*30 cycles*	*60 cycles*	*120 cycles*	*240 cycles*
1	76%	93%	97%	98%
½	16%	69% (?)	90%	95%
¼	24%	44%	75%	91%

These figures are not perfect from a theoretical standpoint, since each value should be the same as the value one place to the left and one place upward—that is, the ½ hy. transformer at 240 cycles ought to give the same performance as the 1 hy. transformer at 120 cycles, and so on. The discrepancies are due to experimental error and to differences in the transformers aside from the different primary impedance.

Let no one get too hopeful about the figures! They do not represent *overall* response, but only transformer performance when working out of a *perfect* 150 ohm mike. Naturally the mike also falls off at lower frequencies. Thus if the mike is down 50% at 120 cycles the responses obtained from mike and transformer together will look a trifle sick, thus:

1 Hy	(50%)	(97%)	= 48.5%
½ Hy	(50%)	(90%)	= 45%
¼ Hy	(50%)	(75%)	= 37.5%

This will not bother the mere intelligibility to speak of, so again it simmers down to the question of what the station owner wishes to do—whether he wishes to transmit information only, or whether he'd just a little rather toss in some bits of personality. It cannot be settled *justly* by one person for another; it is each operator's own business, and argument is as much useless wind as is the perennial wrangling between pure-voice and pure-key men. It isn't taken very seriously by most amateurs, who use both key and voice as they find one or the other handier at the moment.

If for any strange reason anyone wishes to use the "personality frequencies" below 500 cycles more sometimes and less at other times it can be done easily by several schemes. One of them is the old familiar stunt of plugging in different transformers. General Radio has 4-plug bases intended for just that. Another stunt is to put a condenser in series with the mike transformer primary, changing the size of this condenser to whittle the lows more or less. If the mike is of a type requiring a d.c. circuit of some sort this may be provided by either a high resistance or a choke with large inductance and a resistance appropriate to the job. Thus a carbon mike would need to have a feed-choke with a resistance not particularly over 50 ohms at the highest, but other mikes could stand a great deal more—anything within reason being o.k. for a condenser mike. However, the condenser mike might as well be worked with a choke, stopping condenser, and gridleak, tinkering the audio response curve to suit by shunting the feed choke with various condensers until the noises that emerge suit the operator. Letting sister talk into the thing while listening to it with the family all-wave receiver is often a good education; it may show what a kindly and forgiving lot the fellows are who have been reporting your "excellent quality".

◆

D. A. S. D. AWARD

In the title *D.S.M.* (*Deutscher Sende-Meister,* or, German Transmitting Master) which is evidenced by a certificate, the D.A.S.D. as the German section of the I.A.R.U. wishes to establish an award for those transmitting amateurs the world over who have done outstanding work on short waves, especially in the field of long distance communication.

The title D.S.M. may be obtained by every short wave amateur who is a member of the acknowledged short wave association of his country. Titleholder is the applicant personally, not the station.

Applications for the title are to be made at the D.A.S.D., D.S.M. Department, Berlin-Dahlem, Schweinfurthstr. 78, Germany. It may be applied for after the conditions of the following paragraph have been fulfilled.

The following code communications have to be proved to the D.A.S.D.

1. Two way communication with all six continents (continental regulations of the I.A.R.U.) on two amateur frequency bands.
2. Ten two way contacts with foreign countries on a third amateur band.
3. There have to be worked three countries in every continent.

Special regulations:

a. *Europe*: At least one communication with one of the west coast districts W6, W7, VE4, VE5, or K7. Only one Asiatic QSO may be with the Near East (YI, ZC, AR, TA) and not more than one African QSO with Northern Africa (SU, FM, EA8-9, CT3, CN). For European stations outside of Germany, at least 20 QSO's with different D4 stations.
b. *Africa*: Only one Asiatic QSO may be with the Near East (YI, ZC, AR, TA); at least one North American QSO must be with the west coast (W6, 7, VE4, 5, K7), and QSO's with 8 different D4-stations.
c. *Asia*: At least 4 QSO's with different D4-stations; for applicants residing in the Near East (YI, ZC, AR, TA), only one African QSO may be with Northern Africa (SU, FM, EA8, 9, CT3, CN).
d. *South America*: At least one QSO with VE or K7 for North America and three QSO's with different D4 stations.
e. *North America*: 5 QSO's with different D4 stations except W6, W7, VE4, VE5 which must work two D4 stations, and K7, one D4 station.
f. *Oceania*: One QSO with D4, except VK, ZL, or PK which must work three different D4 stations.

Any one country may be replaced by one contact of more than three thousand miles (5000 km.) on another amateur frequency band than used for number 1. The required D4 contacts, however, may only be replaced by applicants residing in Oceania and K7.

A paper regarding a technical or scientific problem in the field of short or ultra-short waves, which shall be published in the D.A.S.D. monthly magazine *CQ-MB,* is required. This paper must be written for this purpose only. The D.A.S.D. retains the copyright for that publication alone. The paper must be in a language using Latin letters and shall be typewritten. It is requested that two copies of the paper be sent. The D.A.S.D.-D.S.M. Department has the right to return papers below a certain standard.

The winner of the title D.S.M. is awarded with a certificate from the D.A.S.D. and is entitled to mark the letters D.S.M. on his correspondence and cards.

The certificate bears the year of award. In the following years the D.S.M. may be applied for again, and the applicant then receives an additional certificate for the respective year. The technical paper is not required when D.S.M. is additionally claimed.

CALLS HEARD

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

28 mc. calls heard by W6EWC
August 8 to September 23

K 6dv; 6lej. — **LU** 3dd; 3dh; 9bv; 1ep. — **VK** 4ajy; 4agp; 4azb; 4bbr; 4cen; 4hc; 5bja; 5dgm; 5ell; 6cxw; 6dgp; 6ewt; 6fzh; 6grl; 6jju; 6vq; 7amx; 7avv; 7bd; 7li; 7re; 8cra; 8jax; 9dhn; 9ny. — **X** 1ay. LU's heard between noon and 4 p. m. pacific time; VK's between 1:30 and 6:00 p. m. pacific time, occasionally later.

Byron Goodman, W6CAL, 141 Alton Avenue, San Francisco, California
October 5 to 20
(28 mc.)

ve3du; ve3wa; x1ay; x2c; vk3bd; vk3yp; vk4ap; zs1h; zt6k. — **W** 1av; 1avv; 1csr; 1df; 1dze; 1zi; 2bpk; 2cfw 2dpa; 2tp; 3dlb; 3evt; 4agp; 4ajy; 4auu; 4ef; 4mr; 5afv; 5afx; 5bdt; 5ql; 5wg; 8cra; 8cte; 8cza; 8dvs; 8dyk; 8hgw; 8itk; 8ixm; 8ixs; 8jjw; 8kqf; 8mwl; 9abe; 9abp; 9bpm; 9asv; 9ces; 9dhn; 9drn; 9dwu; 9evx; 9ffq; 9fm; 9gbj; 9gfz; 9ghn; 9haq; 9hja; 9ij; 9isu; 9jgs; 9kpd; 9ny; 9rkp; 9si; 9sno; 9spb; 9tjf.

H. F. Wareing, W9NY, 4547 N. 21st, Street, Milwaukee, Wisconsin
October 1 to 20
(28 mc.)

cm2do; cm2dq; co6om; cp1ac; cx1cg; d4arr; f8oz; fgvs; f8wk; fa8cr; fa8ih; g2hg; g2mv; g2yl; g5by; g5la; k5ac; lu1ep; lu3dh; lu3dx; ok1aw; on4au; pa0qq; py2qd; ve5hr; ve5pt; vk2hz; vk2lz; vk3bb; vk3bd; vk3bq; vk3kk; vk3yp; vk4ap; vk4bb; vk4ei; x1am; x1ay; x1cz; x2l; x2n; zl-gx; zl2gq;zs1h; zu6p. — **W** 1avv; 1cmx; 1gsh; 2bcr; 2tp; 4agp; 4ais; 4ajy; 4bbr; 4bdv; 4cby; 4cqr; 4cuj; 4cyu; 4mr; 5afv; 5afx; 5pl; 5wg; 6aaa 6aef; 6agj; 6bnu; 6bxl; 6byu; 6cal; 6cem; 6cis; 6cuh; 6cxw; 6dc; 6dcv; 6dhz; 6dio; 6djj; 6dln 6dqd; 6epz; 6ewc; 6fkq; 6fp; 6grx; 6gtm; 6hdy; 6hgo 6hko; 6ivu. 6ixj; 6jju; 6jkh; 6jn; 6jnr; 6kbb 6kgd; 6kip; 6kpr; 6krb; 6kri; 6ldj; 6lgd; 6ljv; 6ln; 6ltp; 6lxy; 6lyc; 6qd; 6rh; 6sc; 6vq; 7ahk; 7amx; 7avv; 7blk; 7cat; 7cci; 7dl; 7dmn; 7dzl; 7ejk; 7evv; 7ip; 8cra; 9bqm; 9bsc; 9drd; 94rn; 9fm;; 9haq; 9ij; 9lf; 9si; 9tb.

J. J. Michaels, W3FAR, North Wales, Pa.
October 3 to 13
(28 mc. dx only)

d4arr; d4auu; d4kpj; d4lnm; f8oz; f8vs; fa8cr; fa8ih; g2hg; g2ax; j2cl; k4da; k5ac; lu1ep; lu9bv; lu3dh; on4au; pa0qq; pa0sd; pa0zk; vk21z; vk3bd; vk3yp; vk4ap; x1ay; zs1h; zt6k.

*George Walker, Assistant Editor of *R/9*, Box 355, Winston-Salem, N. C., U. S. A.

Vern C. Sabnow. W7AVV, 518 E. Edison Street, Hillsboro, Oregon
August 15 to October 15
(28 mc.)

x1ay; k5ag; k6aja; k6ewq; j3fj; j2hj; lu1ep; lu2am; lu9bv; py2yd; zl1ba; zs1h; vk2lz; vk2hz; vk2hf; vk3bd; vk3yp; vk4bb; vk4ei; vk4xn. — **W** 1av; 1avv; 1csr; 1df; 1dze; 1ias; 1zb; 2dza; 2fdl; 2gjb; 2tp; 3byf; 3cpk; 3dlb; 3evt; 3far; 4agp 4ajy; 4auu; 4csz; 4ef; 4hc; 4mr; 5acf; 5aki; 5afv; 5afx; 5axi; 5bdt; 5bki; 5cqj; 5dwg; 5dnv; 5ctw; 5ehm; 5wg; 5sf; 5eub; 5ql; 6avt; 6awt; 6cxw; 6dio; 6ewc; 6jju; 6idf; 6rh; 6vq; 7amx; 7acm; 7bd; 7bpj; 7bqd; 7cci; 7dhf; 7fh; 8agu; 8bof; 8cra; 8czr; 8cte; 8cxf; 8cxo; 8dhc; 8dpo; 8dwj; 8dyk; 8enf; 8fda; 8fij; 8fhe; 8hgw; 8itk; 8ixm; 8ixs; 8jhp; 8jin; 8mwy; 9aag; 9abe; 9agx; 9aoe; 9bqm; 9bvr; 9ces; 9dhn; 9drn; 9dox; 9fj 9fm; 9gbj; 9gdh; 9ghn; 9haq; 9hja; 9jgs; 9drd; 9mv; 9ndb; 9nro; 9nrd; 9ny; 9dox; 9oyx; 1f; 9si; 9ffq; 9tif; 9pxj; 9spb; 9uww; 9kpd; 9iwe; 9rso.

G. H. McClurg. W3DLB, 3382 Stephenson Place. N. W., Washington, D. C.
October 12 to 23
(28 mc.)

d4arr; d4auu; d4gwf; d4kpj; d4ort; ea4av; f8ef; f8kj; f8oz; f8wk; fa8cr; fa8ih; g2hg; g6gs; g6lk; k4kd; k4sa; lu1ep; on4au; on4jb; pa0az; ve4ob; ve4qy; vk2lz; x1aa; x1ay; x1cz; x2c; ym4aa (28,250 k c.); zl2aj; zs1h; zu6p (28,060 kc.)

P. Malvert, 9, Charmberlain St., Wells, Somerset, England
To April, 1935
(7 mc.)

W 1aom-4; 1aqh-5; 1awx-4; 1bau-6; 1cae-5; 1ebo-8; 1ekn-5; 1elz-4; 1epc-5; 1gpf-6; 1hyz-5; 1iof-5; 2apg-4; 2bbc-5; 2bef-3; 2cvj-7; 2cwc-5; 2dfn-4; 2dtr-7; 2eco-4; 2egg-4; 2lf-5; 2hrm-5; 2hvk-6; 2vy-6; 3air-6; 3apj-6; 3atl-5; 3bsl-4; 3bur-5; 3cm-5; 3cmg-5; 3cpx-4; 3ctk-5; 3ell-5; 3erc-5; 3fcv-5; 3gu-5; 3kf-5; 3si-3; 3zd-7; 4aak-5; 4abv-4; 4azb-7; 4cyu-7; 5bxx-5; 5fy-3; 6bby-3; 8aax-7; 8bct-7; 8bis-4; 8cpj-7; 6cyu-6; 9aeh-7; 9cpq-4; 9dbj-6; 9hct-8; 9isg-5; 9ndc-4. — cm2ge-5; cm2or-4; cm2wd-5; k4brn-4; k5af-3; ka1or-4; lu1da-5; lu2fc-4; lu5bd-4; lu6jb-3; pk1bo-4; py1aw-3; ti2rc-4; ve1ex-4; ve3ll-7; vo1p-6; vo4k-5; zl1hy-4; zl2lb-5; zl2bj-5; zl3gm-6; zl4bq-2; zl4fk-7; zl4fo-5; zs6af-4.

Rudolf Heyne. Leipsig. Germany
To June 1
(14 mc.)

W 1adx-6; 1amc-7; 1ano-6; 1arb-5; 1asm-7; 1bcq-6; 1bsz-5; 1cox-6; 1ebo-6; 1fok-6; 1ily-6; 2bxc-5; 2dtb-7; 2fkc-4; 2gox-6; 3ab-5; 3dau-6;

3ly-6; 4abz-7; 4ah-5; 4amc-6; 4cpy-8; 5bez-5; 5bzo-6; 5cbj-5; 6adu-5; 6abv-5; 6ahm-5; 6aqf-6; 6cii-6; 6rh-5; 7afh-6; 7aod-6; 7bcv-5; 7bpj-6; 7dl-7; 7hbf-6; 7wb-4; 8abg-6; 8adq-6; 8amf-7; 8awv-7; 8dtm-6; 9aom-6. — ff8mq-5; hh1b-6; hi1c-5; hi8x-5; j3fk-5; k5af-6; k5ah-5; k6hlp-5; ny1aa-5; pk3ox-6; pkwk-5; su1kg-5; su1sg-8; tf3g-6; tf5c-6; u1bx-8; u1cr-7. — **VE** 1bv-7; 1ca-6; 1fn-6; 1hc-6; 2bc-5; 2bg-7; 2bf-6; 2ca-7; 2ee-6; 2fc-6; 2fq-6; 2hf-5; 3hf-5; 3wa-6; 4af-5; 4bf-5; 4du-5; 5hi-5; 5lm-6. — vk3ju-6; vk5hq-4; vk5qc-6; vk7jb-6; vo8z-5; vp9b-5; vq2bz-5; vq8a-8; vs8ab-6; vu2bc-5; vu2vv-8; zb1h-7; zd2c-7; zl2a-5.

Dr. Susumu Mori, J3EM, 30 Kubocho-Itchome, Hayashidaku, Kobe, Japan
To May 1
(7 mc.)

W 1cz-6; 1ek-6; 5amk-8; 5iy-6; 6adp-7; 6am-8; 6ank-6; 6aod-6; 6asd-4; 6asg-4; 6auq-6; 6axn-5; 6azc-4; 6bam-7; 6baq-4; 6bay-6; 6bc-7; 6bco-5; 6byb-6; 6caf-3; 6ckg-7; 6cii-5; 6clp-6; 6coc-6; 6cvz-7; 6cxk-7; 6cxw-8; 6dio-7; 6dsz-7; 6egh-8; 6ejf-6; 6epz-8; 6eqv-6; 6exq-8; 6fet-7; 6fhy-6; 6fip-4; 6fmh-9; 6fmz-6; 6foz-8; 6fsf-7; 6fsj-5; 6fvj-6; 6fyt-8; 6fza-7; 6fzt-7; 6ghd-6; 6gpb-7; 6gpq-7; 6grl-6; 6grx-5; 6gtm-5; 6gww-6; 6gxq-4; 6hci-5; 6hdm-4; 6hrf-6; 6hjt-7; 6hka-6; 6hzk-6; 6hrn-5; 6htl-7; 6hto-5; 6ibq-7; 6ita-8; 6jus-5; 6kbd-5; 6kbx-7; 6kip-5; 6qd-9; 6tt-9; 6ua-7; 6vb-5; 6wo-8; 6zs-8; 7ahx-3; 7alv-7; 7amx-5; 7avl-6; 7ayo-4; 7bgw-9; 7bmr-4; 7cjv-5; 7ckz; 7dms-6; 7ean-5. — **AC** 2gw-8; 2rn-7; 2rt-8; 3al-4; 3do-6; 3me-5; 3ty-9; 7tc-5; 8cb-4; 8ip-7; 8jr-7; 8kc-4; 8pb-6; 9dt-7. — d4bkk-4. — **K** 6akp-3; 6cru-4; 6edh-3; 6eqw-8; 6fkb-6; 6hlp-5; 6ibw-3; 6kcr-6; kcktf-5. — **KA** 1cm-7; 1ee-8; 1hr-8; 1me-4; 1or-6; 1rc-6; 3aa-9. — lu1ab-5; lu4bh-4; lu5bj-4; lu6br-4; om1xu-7; om2aa-8; om2ld-4; om2lp-7; py1hd-3; pk3lc-4; pk3ws-4; pk4wb-5; su1sg-4; u1dm-5; u1dr-6; u1kal-6; u1zb-6; u3fc-4; ux3ea-6; ve5eo-4; ve5hc-5. — **VK**—2cp-3; 2da-7; 2ek-4; 2hg-5; 2ml-3; 2np-3; 2of-5; 2zw-4; 3bj-6; 3cp-5; 3ht-4; 3lp-5; 3nm-5; 3xl-4; 3zb-4; 4ei-5; 4el-5; 4gk-4; 4 jb-5; 4uk-4; 5mf-7; 5wp-3. — vp1am-3; vs3ae-5; vs6ag-8; vs6an-6; vs6aq-7; vs8ab-8; vs8ad-5; vu2dx-3; xu1a-6; xu6x-8; zl1ck-5; zl1gx-6; zl2mr-6.

H. Tscherning Peterson, OZ7Z, Norresundby, Denmark
May 20 to June 1
(14 mc.)

W 1arb-6; 1awy-6; 1axa-6; 1bhq-5; 1bpy-4; 1bqu-6; 1cjc-5; 1co-5; 1cun-7; 1dhd-7; 1duj-6; 1dze-6; 1ebo-6; 1ewd-4; 1fid-5; -fne-5; 1foz-6; 1geh-4; 1gox-6; 1gpe-7; 1hqn-6; 1inn-6; 1iqz-7; 1ius-6; 1lz-6; 1nw-4; 1yu-6; 2amp-6; 2bhz-5; 2cdo-6; 2clm-5; 2czu-5; 2dct-6; 2dib-5; 2dtb-6; 2ecu-6; 2ejp-5; 2exd-5; 2fgx-4; 2gef-7; 2guz-5; 2oa-6; 4agc-6; 3air-7; 3dbx-5; 3eww-5; 3ffd-5; 3hn-6 3zd-6; 4ah-4; 8apd-5; 8bhj-6; 8bkd-5; 8cnz-5; 8dhc-6; 8ezb-6; 8fz-6; 8ixs-5; 8lea-5; 8miv-6; 8moc-5; 9ot-4; 9th-6. — ff8mq-6; fm4af-6; fm8bg-7; fm8cr-7; j2lk-5; j3fk-4; j5ce-4; py1aw-6; py2ae-6; py2ca-4; py2co-4; py9ad-5; su1kg-6; su1ro-6; su1sg-6; tf3g-5; ti2tao-5; ve1dc-6; ve1fn-6; ve2cd-6; ve2dc-6; vehf-5; vk4ap-5; vp2bx-5; vp5is-5; xzn2b-5.

Frank Pettitt, SU1SG, Mushtapha Barracks, Catholic Club, Alexandria, Egypt
To April 15
(7 mc.)

W 1bix-5; 1cto-5; 1fed-6; 1gvh-6; 1idl-4; 2bti-5; 2cnn-5; 2dmh-6; 2erl-5; 2fd-6; 2fdk-5; 2fpt-5; 2gxb-6; 2gtz-6; 2gwe-6; 2gxi-5; 2gyx-4; 2heu-5; 2hhi-5; 2hmi-5; 2hrq-4; 2lqx-4; 3avo-6; 3blq-5; 3cqu-6; 3cvj-5; 3dbk-5; 3ejo-4; 3ig-4; 4cpz-5; 4ddy-6; 4dlh-5; 5brq-4; 8dxd-5; 8exf-5; 8gff-4; 8gwv-5; 8hgc-6; 8hvg-5; 8jal-5; 8yx-6; 9anc-4; 9lyk-5.

Eric W. Trebilcock BERS-195, Moonta, South Australia
July 29 to August V
(7 mc.)

W 1gdy-4; 3adm-3; 3ado-4; 3ant-5; 4cfj-3; 4dac-4; 5ra-6; 6azc-8; 6bip-7; 6cuu-6; 6dfo-5; 6dyj-6; 6gsh-5; 6jjv-7; 6lrn-8; 7amx-7; 7dwq-3; 7li-8. — cr7ao-4; ct1dt-5; ct1ed-6; ct1kz-5. — **D** 4baf-6; 4bec-4; 4fhx-3; 4hyg-5; 4 pen-6. — **EA** 1am-5; 3ee-4; 5cg-4; 7ak-6; 7ao-6; 7bc-6. — f8pq-5; f8ri-6. — **G**—8dl-5; 2nn-5; 2oo-4; 5mu-4; 5no-3; 6dl-5; 6hj-5; 6iy-5; 6ko-4; 6qp-5; 6tr-4; 6uj-3. — j2jk-5; j2mc-5; j6cz-4; k4acf-3; k6ewq-4, k6fab-8; k6gqf-7; k6kpj-7; ka1ee-4; ok1lm-6, on4cm-6; on4pa-6; pa0la-5; pk1bo-7; u1an-5; u3dm-5; u4oj-4; u4ol-4; uk5aa-3; ve4qz-7; vp4tz-4; vs2ag-4.

(14 mc.)

W 1gf-4; 6bxl-6; 6fkq-5; 6lfl-4; 7li-7; 8cra-7; 9aeh-5; 9cpq-6; 9min-6. — j2cn-5; pk3lc-6; ve4gq-4; vs6aq-6.

Wayne Cooper, Box 59, R. R. 1, Santa Barbara, Calif.
September 28 to October 14
(28 mc.)

W 1anu; 1csr; 1df; 1sz; 1zb; 2arb; 2bqk; 2bro; 2bza; 2fdf; 2gjb; 2glj; 2tp; 3bph; 3bvn; 3byf; 3bz; 3djf; 3dlb; 3evt; 4agp; 4ajy; 4auu; 4bbr; 4cma; 4dat; 4dek; 4ef; 4hc; 4mr; 4yc; 5acf; 5aeb; 5afx; 5cew; 5dlm; 5dxt; 5ehm; 5ele; 5fda; 5fdw; 5lw; 5ql; 5wg; 5yw; 6cal; 6cxw; 6dhz; 6dio; 6grx; 6jju; 6jnr; 6kip; 6rh; 6sc; 6vq; 7avv; 8apb; 8bki; 8cra; 8cte; 8czr; 8bsv; 8dyk; 8eih; 8itk; 8ixm; 8ixs; 8jax; 8jin; 8jjw; 8kqf; 8kzw; 8lvh; 8mwl; 8mwy; 8tms; 8abp; 9arn; 9bqm; 9buf; 9ces; 9cmg; 9cyt; 9dhn; 9adi; 9dqk; 9drn; 9duz; 9dwu; 9dyk; 9ege; 9eql; 9evx; 9eyp; 9ffq; 9fj; 9fm; 9gbj; 9dgh; 9ghn; 9gjd; 9gqp; 9haq; 9hcc; 9hgw; 9hiq; 9hja; 9iba; 9im; 9iwe; 9jaq; 9jgs; 9jsz; 9ju; 9kpd; 9ld; 9lf; 9ndb; 9ny; 9oyz; 9pnx; 9psn; 9ptc; 9rcq; 9rou; 9si; 9spb; 9tdk; 9tjf; 9twf; 9uhe; 9usz; 9vkf. — f8vs; g5bo; hi7g; j2hj; j3fj; k5ac; k5ag; k6ewq; lu-ep; lu3dd; lu3dh; oa4j; py2qd; ve3du; ve3wa; ve4is; ve4ob; ve4vl;

[*Continued on Page 58*]

A NON-ROTATABLE BEAM ANTENNA

Directable from Inside the Station

By Milton McClaughry*

Since most of the transmission at this station is in the 20 meter band the antenna system shown herewith is built for that band. Each of the three legs is one wavelength long. Since the intention is to use these wires two at a time as "V" antennas the best theoretical angle of separation between wires would have been 108 degrees but the angle is not extremely critical and it was thought better to cover the entire circle more evenly by using 120 degree spacing.

The directivity of the beam seems to be greatly strengthened if the wires slant downward toward their outer ends, and are there only about ½ as high as at the center.

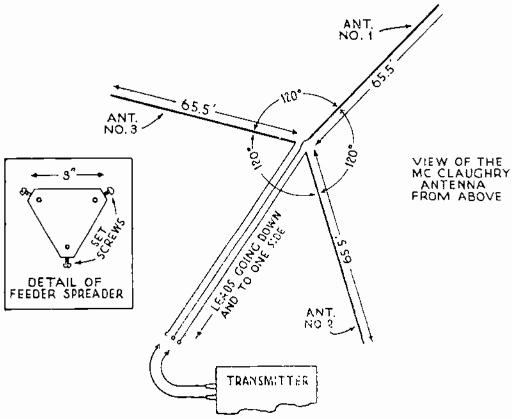
As set up at this station the antenna system has the center of one beam trained upon Africa, but the broadness of the beam is such that it has been found effective for both Europe and parts of South America! (One wonders if the unused wire does not enter the picture.) The second beam is more or less trained on Russia and most of Asia—and the North Pole! The third beam covers whatever is left, lower Asia, Australia, New Zealand, etc.

The feeder system is merely a continuation of the three legs, and is spaced by bakelite triangles about 3" on a side. The corners have been drilled to pass the wires which are clamped by machine-screws entering through tapped holes.

By choosing any two of the three feeders, and connecting them to the transmitter output, one has a "V" antenna aimed into that third of the world. This is a lot easier than tearing out into the yard in a desperate effort to turn a rotatable frame toward a distant station that has just been heard, hoping that he keeps it up until one can rush indoors again. It is the most satisfacory of a great variety of directive antennas tried during about a year.

The transmitter here is only a 60 watter but there was no difficulty in maintaining European and other foreign contacts

*W9LZQ, 2716 Hartzell St., Evanston, Illinois.



throughout the day. On the day the antenna was finished there were worked, in fairly rapid succession, an English station, a Brazilian, a Peruvian, a German, an Irish station, a North African and two more in England. These contacts were all on the (alleged) east beam. The results on the other two beams have been equally pleasing, although by no means as consistent for there are fewer signals here from those directions.

It is a grand feeling to be able to direct signals while all manipulations are being carried out inside the station.

Test Results

It is rather easy to make claims. Accordingly there follows a list of stations-worked for one particular day with 60 watts input: G5QY, PA0XF, PY2BK, VP2BK, OA4J, G2PL, and EI5F.

For the same day there were also worked three other stations from which cards have not yet been received: FM8CR, G2BY, and D4BBN.

Directivity Tests

At the suggestion of *R/9* some additional tests were run as follows: Stations in the United States and Canada were called, beginning with a W1 (New England) and progressing clockwise until stations from all directions had been worked. After hooking up with a station with the beam appropriate to that direction he was informed that a test was to be run and "AAAAAAAAA" was sent on the "correct" beam; then without stopping the next beam to the right was clipped on and "BBBBBB" sent; then the next beam was clipped on and "CCCCCCC" sent. A report on each beam was then asked for. It was necessary to re-run the test several times with 4 of the 10 stations worked because of the fading encountered on the 20 meter band. The findings were as follows:

2 stations (relatively nearby) reported no difference.

8 stations reported an increase of 1 or 2 "R" units in the received signal when the "correct" beam was used.

Receiving Tests

Without going into detail one may sum up the receiving results by saying that there is a definite increase in signal strength when the correct beam is used for receiving.

◆

RADIODDITIES

By Rufus P. Turner, W1AY

The Greeks may have a word for it, but the Chinese go in for phrases. In the land of chop suey and the Great Wall: *radio,* though spelled with four characters, is a four-word expression which when literally translated means, *without wires electric message.* (wu-shien-dien-bao)

Citizen Radio is not a new term; it was the monicker for amateur radio in the good old days.

For each district, there are 676 possible two-letter call-letter combinations, 17,576 three-letter, and 456,976 four-letter—a total of 475,228 for each of the nine districts or 4,227,052 for the entire country. Who said there were not enough to go around? . . . . The Commission has been so heavily besieged with requests for two-letter calls that a special circular letter has been prepared to explain why these requests cannot be filled . . . . The easiest call to sign, EE, is assigned in every U. S. district except the second . . . RI is the Radio Inspector's call in the 1st and 7th districts . . . . 7RI was the first amateur station installed in a radio inspector's office . . . . 1AUG, Cal Hadlock's first ham call, was assigned on the last day of August.

Hertz and *Zepp* are both listed in the Boston telephone directory. So are *Crystal* and *Holder, Key* and *Click,* and *Jack* and *Plug* . . . . *Crystal* is a Boston telephone exchange . . . . Some class to the Boston 'phone book—it has a radio amateur section.

W1BOD and W1BIC live in *Ham*den, Connecticut . . . . Mrs. W6AM's call is W6MA—Mrs. K6AJA's is K6OW.

The term o.w. was originated by a woman op . . . . Hiram Percy Maxim, A.R.R.L. President, learned the code at the age of forty . . . . The QSL card, sworn by and at, was first suggested in a letter published in a radio magazine . . . .

William Penn operates W1CNY . . . . Kenneth A. Warner and Kenneth B. Warner both own stations in the 1st district . . . W1GOS is named *Cocaine* . . . W6ENU and W6IBY live on *Telegraph* Ave . . . . W2ASK is located on comfortable *Fetherbed* Lane . . . . Edgar Harrison, W3AHF, lived nearer to the offices of the old Federal Radio Commission than any other ham in the Country, only one block away . . . . W1GKW's QRA is *China.*

When Peary went to the North Pole in 1908, he was out of touch with the civilized world for a whole year Radio communication, largely over ham routes, has kept modern exploring parties in far corners of the earth in constant daily touch with home and business associates . . . . The name of Franklin D. Roosevelt is not new in amateur radio. When hams were struggling to regain their rights directly after the World War, ham representatives had to confer with F. D., who then was Assistant Secretary of the Navy.

The ill-fated *Shenandoah* was the first airship officially to communicate with amateurs . . . .

The Chair Warmers' Club is composed entirely of amateurs who are shut-ins . . . . Harry M. Leffingwell of Lansing, Michigan, blind from birth, passed the first-class amateur license exam with a grade of ninety-three . . . . Lester Picker, San Ysidro, Calif. ham, broke his back in a fall from an antenna mast at graduation time. However, he was present at his commencement by way of amateur radio. With a 'phone transmitter at his bedside, he delivered the address assigned to him, and his voice came through a speaker in the chair he would have occupied on the platform . . . . Charlie McKeen, W1DEK, well-known 5-meter beacon-light, is deprived of both legs . . . . Max Colvin operated his transmitter while confined to bed, forced to lie on his back, with only one usable arm . . . . James Cotter of Ottawa, Canada, blind, assembled his entire station from diagrams "read" to him by ham friends . . . . Another blind amateur, August McCollom, has relayed many messages, typing them in Braille . . . . Amateur radio took the place of the voice that Bob Trump lost in Naval service during the War.

The Hudson family of Laurel, Delaware, is probably the most ham-conscious in the country. OM Elmer L. Hudson, W3BAK, has seen to the education of his "young 'uns." Son Roland is W3AXP. There is a pretty daughter, Dorothy who holds an op's ticket, and Baby Jean is the world's youngest licensed op. . . . Dr. C. B. Wells of Wichita, Kansas, is credited as the original radio preacher. Before broadcasting came in, he sent out his sermons in code from his ham station, 9BW . . . . Edwin H. Armstrong did his pioneer work on the regenerative circuit while a student at Columbia.

The name *aerial* was given to the skv wire by an American experimenter in 1865 . . . . An American girl, studying art in Paris broke her glasses and the prescription for regrinding the lenses was 3,000 miles away in Montclair, N. J. The mails are slow, so she turned to amateur radio and had her prescription *pronto* . . . . A message filed at a ham booth at a Rochester, N. Y. exposition was delivered at Washington, D. C., forty minutes ahead of a telegram filed at the same time.

The English term *valve* is more significant than the popular *tube* . . . . A Michigan ham, grateful to his dog for saving him from drowning, rigged up a set and speaker in his pet's kennel in order to chat with him while off on lake cruises . . . . in 1930, a girl in Detroit and a gob on board the *U. S. S. Birmingham* one-thousand miles off the coast of California, were married by radio-telegraphy.

Twelve years ago, an official of one of the largest radio companies stated that radio advertising was unthinkable, that nobody would stand for it and it would ruin the radio business . . . Another prognosticator at large, a U. S. Senator, objected to the then newly-proposed legislation to restrict license issuance to citizens only. He said the regulation would never accomplish its purpose. . . . . Another prophet, a war-time radio editor, predicted that hams would be able to radio half-way around the world with power "of the order of half a kilowatt."

Who remembers: When tubes were cheap at seven dollars apiece? . . . . When receiver sockets were reasonable at a dollar each? . . . . And when three-tube regenerative sets listed at $258? . . . . When Moorhead tubes were advertised as having the perfect "hissing point"?

German silver, universally-used resistance material, contains no silver . . . . The whole world was led into the realm of short waves by a handful of Washington, D. C. hams who reduced their wavelength downward from 200 meters to escape interference from NAA, the Naval station across the River . . . . Many of us have built up fixed condensers with waxed paper, but few have known that this familiar predecessor of cellophane was one of Edison's many inventions . . . . Our contemporary, *Radio News* was Radio *Amateur* News in the beginning.

Hawaii's first news of Chamberlain and Levine's successful New York-Paris hop and of Byrd's forced landing on the French Coast came by way of amateur radio signals from the Pacific Coast . . . . A few years ago, one of the large tire concerns erected signs along principal highways calling attention to places of historic importance. One of these billboards outside of Keyport, N. J. proclaimed to the world that in that town two radio amateurs distinguished themselves and established a new record by transmitting phonograph music which was picked up in Aberdeen, Scoland. Another billboard at Yonkers, N. Y. paid honor to Edwin H. Armstrong, inventor of the feedback circuit and vacuum tube oscillator.

Golf, chess, checkers, rifle, and athletic matches have been played successfully between distantly-separated players with amateur radio as the connecting link . . . . Arthur Collins, the fellow who now gives us

[*Continued on Page 48*]

A-B-C OF MODULATION

Radiotelephony for the Newcomer

There can be no doubt but that most beginners in amateur radio today are attracted by the idea of voice communication. Formerly the whole idea of communicating at all was so new to most people that it made little difference whether the method utilized voice or the Continental code. Today, however, the widespread sale of all-wave broadcast receivers has brought an entirely new crop of beginners into the fold who have listened to amateur phone stations through their all-wave receivers. The age of this type of newcomer averages probably 10 to 12 years older than the beginner of only a few years ago who usually consisted of a boy of school age of a mechanical turn of mind. This older type of beginner finds learning the code somewhat more difficult than the younger beginners did, which also partially accounts for the wider interest in phone among beginners today.

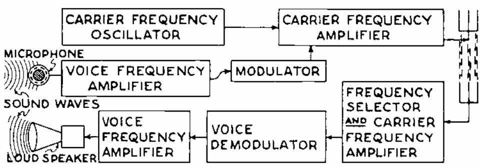


Figure 1

Improved Phone Technique

However, the principal reason for the wider interest in phone among the beginners is undoubtedly due to the vast improvements in phone technique which have occurred in the last few years. It is a fairly simple matter to construct a 25 to 50 watt high quality 160 meter phone today for less than a hundred dollars. Such a phone transmitter can be purchased ready to use for about two hundred and fifty dollars. Good superheterodyne receivers are also available at around fifty dollars or less. Another attraction to the use of phone lies in the fact that it is an activity that can be more or less shared by the y.l.'s of the family.

The fundamentals underlying the operation of a phone transmitter are not particularly complicated when analyzed in their logical order.

Microphones and Voice Frequency Amplifiers

A microphone is a device which transforms the successive compressions and rarefactions in the air caused by the vribrations of the vocal cords in the speaker's throat into a pulsating electrical current. The pulsations, or more strictly, the variations in the electrical output of the microphone, are usually quite small and thus must be amplified before they can be used. This process of amplification takes place in one or more vacuum tubes connected in cascade. A vacuum tube amplifies by reason of the fact that that a small electric current applied to the control electrode (grid) causes the controlled electrode (the plate) to release an exactly similar, though magnified, electric current to the output (load) circuit of the amplifier. If the output of the voice frequency amplifier were suitably connected to a loud speaker or telephone receiver the electrical impulses would be turned back into variations in air pressure which constitute audible sound. Thus far we have described a telephone circuit essentially similar to the one between New York and San Francisco, for example.

It might be thought that merely by amplifying sufficiently the voice currents and then applying them to an antenna might be enough to allow voice communication by radio. This is not the case for several reasons. It is known that the range of voice vibrations runs from about 50 to 10,000 vibrations per second. Thus the electrical equivalent of voice vibrations is composed of an alternating electric current whose frequency of alternation is in the same range (50 to 10,000 cycles per second). Before anyone can hear a radio wave it must be radiated from the transmitting antenna into space. It has been determined that the efficiency of radiation from a transmitting antenna increases as the frequency of the electric current increases, and is far too low to allow any appreciable radiation at the voice frequencies. Also, the size of the transmitting antenna goes down as the frequency goes up and therefore the cost of an efficient antenna becomes less as the frequency of the radiated electricity goes up. Thus it becomes necessary to change somewhat the original voice frequencies which were impressed by the microphone on the voice frequency amplifier into a considerably higher frequency in order that enough electrical power may be radiated from the transmitting antenna to be picked up by the distant receiver. Instead of directly changing the voice frequencies to a higher frequency by some process of frequency multiplication, which would involve many difficulties, a much simpler process is used.

A constant, high frequency alternating current is generated by an oscillating vacuum tube. The frequency of oscillation is usually that which it is desired to radiate from the antenna and might be, for example, 1800 kilocycles, which is in the 160 meter band of amateur frequencies. Then the amplified voice frequencies are mixed, by the process known as modulation, or heterodyning, with the 1800 kc. *carrier* so that the *amplitude* of the 1800 kc. carrier wave is varied up and down about an average value in exact accordance with the variations in sound pressure that the operator's voice impressed on the microphone. Thus the 1800 kc. carrier wave is said to be modulated by the voice frequencies. A voice tone of 400 cycles per second, for example, causes 400 variations in the amplitude of the carrier wave per second. A weak voice tone applied to the mike causes a small variation in the amplitude of the carrier. A loud voice tone likewise causes a large variation in the amplitude of the carrier. These variations in the amplitude of the carrier wave are alternate increases and decreases in the carrier wave. A given increase in the carrier amplitude above the resting value must always be followed by an exactly similar decrease below the resting, or average value. The upper limit of modulation occurs when the voice tone causes the carrier amplitude alternately to double its resting value and then go to zero on the succeeding half cycle. Any increase in modulation beyond this point results in overmodulation of the carrier wave, which is undesirable because it causes unnecessary interference with other radio services.

Thus we come to the conclusion that there is a definite relationship between the resting, or normal amplitude of the carrier wave, and the amplitude of the voice frequency waves which modulate that carrier. Thus any phone transmitter must be designed and built so that the amplitude of the voice waves bears a definite relationship to the carrier amplitude, for best modulation.

Receivers

In the receiver the process generally described above is reversed. The modulated carrier wave is selected from among the many thousands of carrier waves on the air by the process known as tuning.

A selective tuned circuit is simply a filter or gate through which signals of a desired carrier frequency may pass, though signals of any other than the desired frequency are rejected. After the desired signal has been selected and amplified through various vacuum tube amplifiers it is *demodulated* by the process known as detection. This process separates the voice frequency waves from the carrier wave, eliminates the carrier wave and passes the voice frequency waves on to a voice frequency amplifier to be again amplified to a value great enough to actuate a loud speaker. That is all there is to it. In figure 1 is shown a block diagram of a complete radiophone circuit from microphone to loud speaker.

There are certain rules which must be observed in order to get good results from a radiotelephone transmitter which will be briefly outlined here.

The microphone and voice frequency amplifier must not change the voice frequencies in any way. Anything taken away or added to the voice frequency waves constitutes distortion. Frequency distortion occurs when the various complex voice tones are not amplified equally well and tones of certain frequencies become amplified more than others. This destroys the original relationship between the amplitude of the various tones and overtones constituting the original sound impressed on the mike.

The other common type of distortion is amplitude, or harmonic distortion. Harmonic distortion occurs when the output of the

[*Continued on Page 64*]

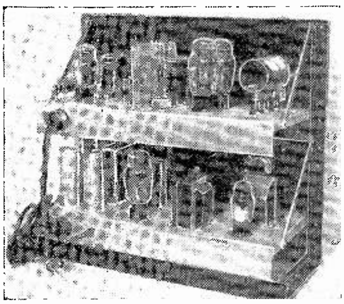
UNCONDITIONAL GUARANTEE TO ALL HAMS

UNCLE DAVE

356 BROADWAY, ALBANY, N.Y.

WE MAKE IT OUR BUSINESS TO SEE THAT ALL AMATEURS GET THE BEST FOR THE MONEY. WE WANT YOU TO BE SATISFIED

PEERLESS "40 DX" TRANSMITTER . . . A crystal controlled transmitter for Phone or C.W. operation. Tube complement: 2A5 oscillator, 2-46's power amplifier, 83 rectifier, 56 speech amplifier. The west coast is worked on 80 meters with this job on C.W. from Albany and often distances up to 1,000 miles are worked on the same band on phone. Here are a few of its features in concise form.



***Standard Rack mounted
***35 to 40 watts output on C.W.
***10 watts output on phone
***Crystal ground to your specified frequency
***Full output on 2 bands with 1 crystal
***2A5 Dow or Tritet oscillator

This transmitter comes complete with "ALL" accessories, including crystal, coils for 2 bands, tubes, microphone, and in fact, everything but key and antenna.

Transmitter for combination Phone CW **$63.50**
Transmitter for CW only **52.00**
PEERLESS "40-DX" R. F. PORTION, complete with coils for 1 band and crystal holder, less tubes, crystal, power supply and rack net, special $17.50

PEERLESS CRYSTALS

160 and 80 meter crystal with holders	$2.50
Above crystal with special ceramic holder	3.25
40 meter crystals, completely mounted	3.95
A cut crystal, complete with special holder	5.00
Crystal Oven, complete with crystal ground to your specified frequency, crystal holder, thermometer, thermostat, net	8.25

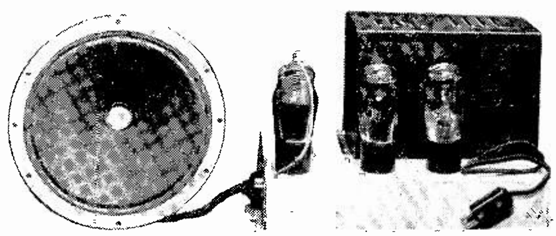
METERS

Weston milliammeters, metal cased, 0-5 to 1 amp ranges, net	$2.95
Weston milliammeters, bakelite cased, 0-5 to 1 amp ranges, net	3.65
Weston model 476 AC voltmeter 0-150 volt	6.00
Weston model 301 0-1 ma-volt-ohm scale	6.00

NEW WESTON & JEWELL METERS IN STOCK

ATTENTION, SERVICEMEN AND AMATEURS

Special Sale of Genuine Sprague Amplifiers. The lowest price in history for a high quality, high gain amplifier. During this sale you can purchase this amplifier at a lower price than you can obtain the components—3½ watts undistorted output—gain sufficient to provide full output when using a double Button Microphone or phono Pickup. Tubes used 24, 2A3, 5Z3 or 80. Heavy Duty Transformer, Genuine Sprague Condensers, I.R.C. metalized resistors, beautiful chassis. **While they last,** less tubes and speaker $2.95



Fabricoid-covered analyzer cases, 12x9x4¼ inches, plush lined, tool partition, compartment for ohmmeter batteries, complete with hardware and leather carrying handle, new, never used, while they last $2.35

SPECIAL CLOSEOUT SALE

The following type tubes, 30c each, 5 for $1.00

UX240	31	46
UX200-A	35/51	56
UX220	32	56

Ward-Leonard & Ohmite 100-watt 20,000 ohm tapped bleeders, each	.25
Transmitting gridleaks and bleedrrs, 25,000 ohms, each	.39
MacKey, professional, versatile speed bug	7.95
Peerless condensers, oil impregnated 5 mfd. 1500 volt	3.25
Oil impregnated 2 mfd. 2000-volt working filter condensers	$2.85

RED HOT SPECIALS

7x18 steel panels, oak finish, FB for transmitter or receiver, 35c each, 3 for	1.00
CG-1162 Navy 5-watters, per dozen	1.00
Peerless 841	2.45
5000 ohm, 200 watt H & H resistors	.79
1-1/2 volt DC relays	.39
3 in pointer knob complete with celluloid scale 0-100 to match, each 15c, 6 for	1.00
Franklin 1/4 K W transmitting & practice key	.95
G. R. 0-7 amp hot wire R. F. meters, Panel type special	1.29
Ceramic crystal holders for crystals to 1 1/4 in.	1.00
Peerless 3 mfd 1500 volt oilfilled condensors	1.95

Cable Address "Uncledave" **Include 20% Deposit with C.O.D. Orders**

LONG DISTANCE PHONE **4-5746**

UNCLE DAVE'S RADIO SHACK

356 BROADWAY ALBANY NEW YORK

Send to Dept. R-6 for our New Ham Catalog—Just off the Press! Foreign Trade Solicited.

Prices F. O. B. Albany

Sideband Splatter

[Continued from Page 35]

transmitter was being modulated in excess of its modulation capability. However, this particular modulation defect was identified by a slight drop in d.c. plate current during modulation.

In general, most modulation defects can be identified when present by a combination

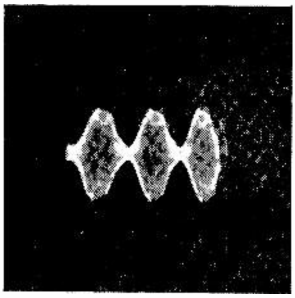


Figure 5
The effect of too little capacitance in the final tank condenser. This causes poor linearity and sideband splatter.

of a lightly damped plate milliammeter in the modulated stage plus the negative peak clipping indicator shown in figure 3.

Tank Troubles

Take a look at figure 5. That oscillograph shows what happens when too low C and too much L is used in the final tank circuit. There is not enough circulating r.f. current to allow the flywheel effect to fill out the positive peaks. Much the same thing happens when the final tank is not tuned to resonance or there are bad standing waves on directly coupled feeders. The use of too low C in the final amplifier or reactive antenna coupling can materially reduce the modulation capability of a phone transmitter.

The best answer is to borrow an oscilloscope in order to determine the maximum modulation capability of your transmitter and then rig up some accurate form of audio volume level indicator so that the operator can constantly monitor his transmissions and prevent the voice peaks from exceeding the modulation capability of the transmitter. The plate current to class B modulators is a *fairly* accurate volume level indicator, but usually there is too much inertia in the meter needle to allow it to swing up far enough on the very sharp voice peaks that so often cause splatter. If possible obtain one of the new "high speed" meter movements that are used in the more modern volume level indicators in broadcast stations and then place that in the audio channel somewhere so that it indicates the audio level.

◆

Transmitting Pentodes

[Continued from Page 29]

amplifier where the complications of feedback neutralization must be avoided, as in a compact transmitter where wide changes in frequency are desired and the use of a split tank circuit adds complication.

It should be noted that the use of a pentode over a triode has few advantages in the final amplifier of a high efficiency, high power output transmitter. In other words, if plate efficiencies above about 80% are desired, the use of a triode with a high mutual conductance will usually give more satisfactory results, due to the fact that a pentode requires more grid excitation at 80% efficiency than an equivalent triode, although the pentode requires far less grid excitation at somewhat lower plate efficiencies and power outputs than does a triode.

◆

Radioddities

[Continued from Page 44]

the very f.b transmitters, was a 15-year old Cedar Rapids, Iowa lad in 1925 when he was the first in this country to pick up signals from the MacMillan Arctic Expedition . . . . Herbert Hoover, Jr., is the only President's son in the realm of ham radio.

Varied are the locations of ham radio outfits. W2LU is in a pantry; W1IGE in a clothes closet; W9GNK in what its owner believes the world's worst location—three-hundred feet from a hydroelectric plant at the bottom of a ten-thousand feet deep canyon; W2BRB is under the kitchen stove.

Remarkable Price Reductions

On LEEDS Constructional Accessories, due to greatly increased demand.

RELAY RACKS

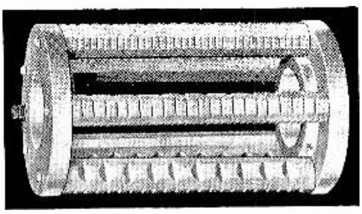
Our **Relay Racks** are built to stand up under the heavy loads of modern transmitter construction. Uprights are made of 3/16" stock, 1¾" wide. Welded angle supports, cross braces and sturdy cross bars insure extreme rigidity. LEEDS Racks unlike some units on the market, are drilled for panel mounting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

Table Rack type RAD 36" 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 5' 8" high, 20½" wide, 12" deep, with a complete set of panel mounting holes. ... **$7.45**

Shipping weight 50 lbs.



VITROLEX Universal Coil Form; diameter 4", length 6¼"; grooved for 10-20 and 33 turns. Just rotate the spacing bars a quarter turn and you have a new form. Ideal for use on all ham bands. Price... .. .. .. **$1.50**

Bars separately **25c** each.

EXCEPTIONAL VALUE

WESTINGHOUSE two wire 110-120 volt, 60 cycle kilowatt hour meters; five or ten ampere capacity. Specially priced at **$3.50**

Shipping weight 15 lbs.

For special buys in transformers and chokes see our adv. in the Nov., 1935, issue.

BUTT INS

in stock at **25c** per dozen. These compact lead through insulators and other Communication Products items now in stock.

Overseas Amateurs Attention

There is a satisfied LEEDS customer near you, regardless of your QRA. LEEDS export service is being used constantly by amateurs and professionals in 70 countries. One shipment will convince you.

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	2.00
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 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**

LEEDS Leads as the only distributor in the country, handling GENERAL RADIO Amateur accessories and laboratory apparatus. Bulletin No. 936 mailed on request.

GENERAL RADIO coil forms type 677-U price **50c**; type 677-Y price **75c**. G. R. amateur accessories always in stock.

GENERAL RADIO dials, with fluted knobs 4" **$1.50**; 3¼" **$1.25**; 2¾" **$1.**

LEEDS
The Home of RADIO

LEADS THE FIELD

World Wide Service to Amateurs

43 Vesey Street
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 lowest 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 electrostatically and electro magnetically shielded.

8½x 8x2 ..	$.65	12x17x2.. ...	$1.30
8½x10x2....	.70	8x17x3......	1.15
4 x17x2 ...	.70	10x17x3......	1.30
8 x17x2....	.95	12x17x3......	1.40
10 x17x2....	1.10		

AT LAST

A band change switch that's RIGHT. Double pole, six point, insulated ¼" shaft; positive contact, ample spacing and they may be ganged. Priced at, each **$1.95**

LEEDS Leads the field with transmitting tubes, embodying the latest improvements in design, at lowest prices.

*203-A.	$8.45	†*830-B	$7.25
†210-HF	1.75	*838	11.75
866	1.50	†*841	2.95
*211	8.45	845	11.50
†800	7.25	*852	11.50
†*801	2.95	866-A......	1.95

*Graphite Anode Tubes
†Isolantite Base
Tubes Shipped by Express Only

Complete line of Weston, Triplett and Hickok meters and instruments in stock

RCA Tubes 866........ ....**$ 2.25**
RCA Tubes 852. .. .. **16.40**

Every purchaser of a **LEEDS** Crystal is protected by our guarantee that he must be satisfied with the "plate" in every respect. Our prices speak for themselves. X cut crystals 1.7 mc. **$2.25**
3.5 mc plus or minus 1 kc..........**$2.25**
7.0 mc plus or minus 2 kc..........**$3.25**
Moulded bakelite holder........ ....**$1.00**
Hill all brass adjustable holder **$1.65**

TOBE KITS IN STOCK

The finest low cost communication receiver on the market. Complete kit **$41.40**
Wright DeCoster 8" speaker in metal cabinet **$4.90**
Receiver cabinet..................................**$4.80**
Complete kit RCA tubes........ ....**$3.32**
Wiring and testing for lazy hams, including single signal reception with regenerative I.F..............................**$6.50**

Parasitic Oscillations

[Continued from Page 9]

being effectively a short at these frequencies. Varying the tuning capacitor had practically no effect on the frequency or output.

A neon bulb touched to the screen grid by-pass capacitors showed that the screens were not at ground potential. These capacitors were attached directly to the socket with a lead of approximately 1 inch from the capacitor to the sub-panel shielding. No sign of r.f. could be found on the ground side of the capacitors. A number of various-sized by-pass capacitors ranging in size from .04 to .00005 μfd. were tried. From .0005 up to .002 μfd. the voltage on the screen grids decreased almost directly with capacitance. From .002 to .04 little difference was noted in the impedance of the capacitors at the parasitic frequency.

A number of different-sized parasitic chokes were tried in both the plate and grid leads. Chokes in the grid leads made the parasitics worse, while chokes in the plate circuit decreased the strength of the spurious oscillations. As the size of the chokes increased, it became harder to load the amplifier sufficiently. The use of 5-turn chokes 1 inch long and ¾ inch in diameter, resulted in oscillations occurring only when the grid tank capacity was set to less than half the maximum value. As the grid tank had been designed so that the over-lap in frequency at each extremity of the band was approximately 5%, it was necessary that oscillations not occur at any setting of the tank capacity.

Carbon rods ¼ inch in diameter and approximately 25 ohms in resistance were tried both in grid and plate leads. When used in the plate leads, the parasitic oscillations were stopped but considerable power—around 15% of normal output—was lost in the heating of the carbon rods.

Combination of Carbon Rods and Chokes

Next the leads to the tank circuit were made of a carbon rod in parallel with small chokes (figure 7), the idea behind this being that the chokes would offer considerable impedance to high frequency spurious oscil-

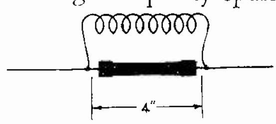


FIG. 7

lations, and most of this current would go through the carbon rod, resulting in sufficient loss in power, or rather sufficient resistance in the high frequency tank, to kill the oscillations. At the lower desired frequency, the impedance of the chokes would be lower than the 25 ohm resistor and most of the low frequency current would go through the choke; accordingly the losses would be low.

This scheme proved to be a considerable improvement over anything previously tried, but the oscillations were so persistent that this failed to be completely satisfactory. If the resistance was high enough to kill the parasitic using a reasonable-sized choke, the power lost in the resistor at the operating frequency was too high to neglect.

By moving things around a bit, it was finally possible to shorten the leads to the grids by approximately 3 inches. This finally eliminated all parasitics.

The foregoing actual case was somewhat more stubborn than the average amateur situation. It gives, however, an idea of the routine to be followed in running down parasitics and preventing them.

Another point of attack is the all-important tank coil. Small diameter coils with the length no more than twice the diameter, wound with number 12 solid wire, have a "Q" *just as high, and some times much higher* than the more bulky, older type copper tubing. In addition to high Q, the field is much more concentrated, resulting in easier shielding and less coupling between adjacent circuits. When used in a neutralizing circuit, the small physical dimensions result in more nearly unity coupling between the two halves of the inductance, resulting in neutralization over a wider band of frequencies.

[Continued on Page 52]

[*Continued from Page 50*]

Some General Conclusions

Use link coupling whenever practical and if push-pull is employed, use split-stator capacitors in either the grid or plate circuit, preferably both. Avoid fancy wiring and the accompanying long leads, as many oscillations are t.p.t.g. and since there is usually a large condenser (physically) used in the plate circuit, it is a good policy to attempt to make the grid leads just as short as possible, thus making the "sneak" grid circuit resonate at a considerably higher frequency than the plate circuit, and eliminating oscillations. *Use small diameter tank coils with a length no more than twice the diameter and wound of no. 12 solid wire.*

If the above precautions have been taken care of in the design, and oscillations are present when the amplifier is given its trial run, it is helpful to go about the elimination of spurious oscillations in a systematic manner. First determine the type and roughly the frequency. With this knowledge, it is simply a case of making the unwanted oscillating circuit a poor one, without impairing the performance of the amplifier at the operating frequency.

See if the leads cannot be made shorter, especially grid leads. Try resistors of the non-inductive type, together with resistors and small inductances in parallel. Keep notes of the steps taken and the effect. It is mighty hard to come back the next evening or the next week and remember just what has been done. Thousands of rigs are in operation free of parasitics and there is no reason why every lay-out can't be without them.

28 Mc. Records Topple

[*Continued from Page 37*]

outfits doubling in the final stage.

We do not have much information on receivers, but several of the stations most successful in dx work use newer models of superheterodynes. The tube-hiss or thermal agitation noise in our own receiver is probably R7, making it difficult to copy the weaker dx signals even when using a regenerative preselector, which gives some improvement. If this noise is due to the "shot effect" of the first tube's filament emission amplified by subsequent stages, we probably need high gain at low plate current in the receiver's first tube, preferably without regeneration. Large antenna pickup is another possibility. One of the broadcast chains has gone over to 6 volt heater type tubes exclusively in pre-amplifier stages, not considering the "acorn" series because of alleged short life. *R/9* will welcome discussion of this problem as it affects both 20 and 10 meter receivers.

W9FM comes in for considerable "razzing" for his six and eight element beams. Although X1AY and W6CAL claim a good 2R improvement over the 16th harmonic horizontal wire, W9NY writes as follows: "Now that your final plate transformer blew up, and you have put up a highly directional beam aimed at Australia, you are putting a signal into Milwaukee for the first time!"

56 Megacycles

W2MO continues to surprise us. In five days in September, operating at an altitude of about 2000 feet from Mt. Wachusetts, some 40 miles west of Boston, he had 336 contacts on five meters. Some of them ranged from 90 to 125 miles. He has now worked 851 *different* stations.

◆

Allen H. Babcock Expires

The staff of *R/9* wishes to extend its sincerest sympathy to the family of Mr. Allen H. Babcock, whose unfortunate death occurred at Eureka, California, on October 25th.

Mr. Babcock was for many years Director of the Pacific Division of the A.R.R.L. Besides radio, his hobbies were astronomy and yachting. He was an engineer and construction expert for the Southern Pacific Company, and a Lieutenant-Commander in the U. S. Naval Reserve. He is survived by his son Thomas, W6ZA, another son, John, and his widow, Mrs. Mary Babcock.

we all have to

run like hell

to stand still in radio!

Radio is the fastest advancing of the sciences.

Look at this partial list of developments of the past year, or developments of the recent past which have been reduced to practice during this year. Some are still too new to be widely used.

Low level doubling.
Controlled carrier modulation.
Class BC low level modulation.
72 ohm transmission lines.
Quantity production of high frequency superheterodynes.
Power pentodes.
High efficiency, low-C transmitting triodes.
Push-pull detection for c.w.
Several *really useful* 56 mc. superheterodyne receivers.
Iron core i.f. transformers
Compact, impregnated filter condensers.
Low loss, high-Q tank coils.
Cheap Isolantite, Mycalex, Steatite, and other low loss insulators.
Really effective link coupling.
High impedance, r.f. chokes good for three or more bands.
AT and V cut piezo crystals.
The negative transconductance oscillator.
Acorn tubes for ultra high frequencies.
The mercury vapor amplifier tube.

Many more new ideas are forcing their way into the limelight and will be reduced to practice in the coming year.

•

"R/9" keeps you ahead of the procession!

"R/9's" recent expansion in laboratory and technical facilities places it at the head of the field technically. It is medium-sized no longer; with the January issue (out before Christmas) we are forced to use 100 or more pages monthly to accommodate the material with which our new technical staff has swamped us. Crammed full of the latest dope on technical and operating advances, it is INTENSELY PRACTICAL. Material is included for the beginner, for the "average ham," and the advanced man.

Unfortunately we can only hint (see page 55) at the startling developments that will first see the light of day in "R/9." We're in a highly competitive field; more than a hint might enable our worthy competitors to "scoop" us. We prefer to make haste slowly, to give these developments in PRACTICAL FORM; "scoops" of but a few hurriedly written technical notes are of little value to anyone.

a bigger, better "R/9"

Improved technically (see pages 53 and 54)—new and enlarged departments—profusely illustrated, better drawings and photographs—100 or more pages per issue—4 color work; enamel, coated paper—dx and calls heard section—56 and 28 mc. dope—everything the others have and much that they haven't—world "DX Zone" map—only usable table for dx contacts, revised monthly.

No axes to grind; no manufacturers to favor; just to help you hear the other fellow and him to hear you as loudly and cheaply as possible, which is the real problem of radio communication.

COMING IN "R/9"

A new Multi-band Exciter

Using the newest tubes; foolproof; high output even at u.h.f.; economical, simple, "easy" on crystals even when keyed; entirely new mechanical mounting.

A two-tube 200 watt C.W. Transmitter for 3.5, 7, and 14 mc.

Simple, efficient; cheap to build; universal antenna coupler built-in; keys crystal for full break-in; "the standard c.w. xmitter of the future."

A Proven and Effective 8-tube Superheterodyne for C.W. Reception

Nothing radical; just a comparatively inexpensive "super" that really works.

A New Band-changing System for Transmitters

Can be remote controlled by one simple relay; foolproof; low loss; no feedback, instantaneous switch-over.

A low cost "50-watt" general purpose transmitter using two 210's.
A similar "150-watt" phone.
A new idea in Quiet Autodyne Receivers.
A de luxe semi-portable transmitter; 200 watts, phone; 400 watts, c.w.
A 15-watt 160-meter phone for the beginner and old-timer.
"The Traffic Tuner."
A 100-watt bias modulated phone.
A high-efficiency, Class BC modulation-gaining linear amplifier.
An entirely new kind of transmitting tube table that tells just what a tube really will do.
Two entirely new tank condensers.
Some radically new ideas about transmitter construction.
Practical Application of rod stabilization to u.h.f. transmitters.

Subscribe Now! ...ALL THIS FOR

1/3 the cost in book form—and more up-to-date than ANY book

1 year (12 issues) for only $2.00*

or 2 years (24 issues) for only $3.00*

THESE RATES POSITIVELY EXPIRE NOVEMBER 30th†

Orders postmarked after that date will be entered pro-rata at

NEW, HIGHER RATES EFFECTIVE DECEMBER 1st AS SHOWN BELOW

REMEMBER! ONE IDEA ALONE MAY SAVE YOU MANY TIMES "R/9's" COST!

*Foreign extra charges: Spain and Independent American countries, none; Canada, $0.50 per year; Newfoundland, $0.25 per year, elsewhere, $0.50 per year.
†Overseas countries, December 31, 1935.

New Subscription Rates

	1 year	2 years
U. S. A.* (and possessions), Andorra, Argentina, Bolivia, Brazil, Chile, Columbia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Salvador, Spain (and possessions), Uruguay, and Venezuela	$2.50	$4.00
Canada†, including current duty	3.25	5.50
Newfoundland†; also Canadian libraries	2.75	4.50
Elsewhere†, duties, if any, not included	3.25	5.50

Single Copy Rates

By mail, postpaid from home office:
30c in U. S. A.
35c in Canada, current duty included.
35c elsewhere, duty, if any, not included.

Frequency—Odd term Subscriptions

Published monthly except July and August; ten issues yearly including special annual number. Odd-term subscriptions are accepted pro-rata (minimum, 4 issues), but special numbers will not be furnished on subscriptions of less than one year.

*In California, add 3% sales tax.
†Remittances must be payable at par in U.S.A. or Canadian funds or at current exchange in British funds.

The Class C Amplifier

[Continued from Page 23]

class C amplifier. In most cases, plate efficiencies between 75% and 85% will usually be found to be close to the optimum from all standpoints. The matter of plate voltage must be considered in this compromise. For a given amount of grid drive the plate efficiency can usually be raised somewhat by raising the plate voltage. However, for every tube there comes a point where additional plate voltage adds so little to the plate efficiency that it is not worth using. This point occurs at about 2500 volts for the 204A and 849; 3000 volts for the 354, 150T, and 50T and about 4000 volts for the 852 and 831. It happens that in practically all other tube types the insulation limitation in the tube limits the plate volage that can be used before this maximum point can be reached.

◆

"Common Sense" Exciter

[Continued from Page 12]

following the construction and diagram shown the cost may be kept down, and it will work every bit as well.

EDITORS NOTE—In a near issue we will describe a modification of the W6BHO exciter, leaving out the 802 stage for those who wish a simpler, less expensive exciter unit. The output is in the neighborhood of 10 watts on all bands down to 20 meters. Where 10 meter excitation is desired, the exciter shown here is best adapted.

◆

At the general session of the Federal Communications Commission held on September 26, 1935, Rule 30 of the Rules and Regulations was modified to relocate the boundary between Radio District 11 and 12 in the State of California. The counties of Monterey, Kings and Tulare were transferred from the 11th to the 12th Radio District with headquarters at 328 Customhouse, San Francisco, California, and the county of Inyo was transferred to the 11th Radio District with headquarters at 1105 Rives-Strong Building, Los Angeles, California.

More Harrison Values

GENERAL ELECTRIC METERS. 2". D'Arsonval Regular moving coil movement with zero adjuster. Supplied with shunt wire and instruction for converting to any desired DC Milliamp range **$1.25**

FILAMENT TRANSFORMERS

2½ Volt 12 Amp For one or two 866s 10,000 Volt insulation Tapped primary **$1.25**

10 Volt 4 Amp Delivers 11 volts at load. Heavy rheostat included with each to adjust to 10 volts. The best way to operate 50 watters for long life. Special Combination Price **$1.10**

UNIVERSAL VOLTAGE FILAMENT TRANSFORMERS

METAL-CASED — 3000 VOLT INSULATION — GOOD REGULATION — FLEXIBLE LEADS

TF-4—Delivers 5 or 2½ volts at 4 Amps	$ .80
TF-5—Delivers 5 or 2½ volts at 6 Amps	.90
TF-6—Delivers 6.3 volts at 4 Amps (Center-tapped)	.95
TF-9—Delivers 7½, 5, or 2½ volts at 4 Amps	1.15
TF-11—Delivers 10, 7½, 5 or 2½ volts at 4 Amps	1.15
TF-14—Delivers 7½, 5, or 2½ volts AND 5 or 2½ volts. Both at 4 Amps	1.45
TF-16—Delivers 10, 7½, 5, or 2½ volts AND 5 or 2½ volts. Both at 4 Amps	1.65

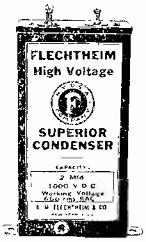
G. E. FILTER CHOKES

4 HENRY 750 MA.

Here's a real high current filter choke at a low price! Connect five in series for a 20 Henry, 760 Milliampere choke. 3000 Volts insulation. In heavy metal case, compound filled, with terminal panel. 21 ohms DC resistance each. 11½ lbs. A REAL Choke at low cost! Slightly used, but guaranteed perfect. Each.... **$1.20**

FIVE for $4.85

FLECHTHEIM FILTER CONDENSERS .... 70% OFF



1000 VOLTS WORKING — TYPE HSM

These well known Flechtheim condensers are their Compact Heavy Duty Filter condenser line. Every condenser in this series is conservatively rated at 1000 volts DC. They have a high insulation resistance of over 1000 megohms per mfd., extremely low power factor, non-inductive windings and are made to a capacity tolerance of 5%. Their flash breakdown rating is 3000 volts DC. These condensers need no further introduction to the discriminating Amateur. They carry the full Flechtheim guarantee and are not surplus or obsolete stock. They are brand new.

2 Mfd.—List Price, $3.50—Special **$1.05**
1 Mfd.—List Price, 2.25—Special .... **.68**

COMBINATION OFFER

Two 2 Mfd. and Two 1 Mfd. Units **$2.80**

NEW! CARDWELL CONDENSERS

MYCALEX INSULATION .200" SPACING

XC-10-UD, Split Stator. 40 mmfd. per section, Rounded plate edges, 5700 volts breakdown		$7.64
XC-18-XS	18 mmfd	3.23
XC-40-XS	40 mmfd	4.41
XC-65-XS	65 mmfd	5.58
XC-100-XS	100 mmfd	6.76

NEW MIDWAY "FEATHERWEIGHT" TYPES!

MT-100-GD	Dual 100 mmfd .07" Air Gap	4.70
MO-180-BD	Dual 180 mmfd .05" Air Gap	4.70

Many other New Types, Lower Prices, Complete stock carried at all times. Immediate Shipment.

SEND FOR NEW CARDWELL CATALOGUE

"YE TRADING POST"

GOOD USED EQUIPMENT—BOUGHT-SOLD-TRADED

Trade in your present receiver, xformer, meter, etc., for a bigger or better one at small cost!!

Here are a few of the bargains which may be found every day on the used equipment shelves of the Harrison Radio Co. We are only trying to give you a small idea of what you may get and what price you can expect to pay. We have dozens of used Weston and Jewell meters in a large assortment of voltage and current ranges. All items are subject to prior sale. When ordering, if you give your permission, if the item you want is already sold, we will substitute the nearest item to the rating and price.

Filament transformer, 2½ volts, 10 Amps, 2500 volt ins	75c
Filament transformer, 7½ volts, 7 Amps	70c
Filament transformer, 10 volts, 7 Amps	70c
Filament transformer, 10½ volts, 100 Amps	$3.60
Filter Choke, Amertran, 13 Henry, 250 Ma	4.20
Filter Choke, T-1998, 27 Henry, 160 Ma 190 ohms	1.05
Filter Condenser, Dubilier, 4 Mfd., 1000	1.65
Filter Condenser, Dubilier, 1 Mfd., 2000	1.90
Filter Condenser, Aerovox, 1 Mfd., 1500	1.30
Filter Condenser, Aerovox, 1 Mfd., 2000	2.20
Filter Condenser, Aerovox, 1 Mfd., 3000	3.20
Filter Condenser, CCA 2 Mfd., 4000	12.50
Voltmeter, Jewell, 0-15 Volts AC metal flange	2.85
Milliammeter, Weston, 0-200, Bakelite case	3.05
Milliammeter, Weston, 0- 50, Metal Case	2.80

Many other sizes. Just state your requirements.

Harrison Radio Co.

142 Liberty Street
Dept. 912, New York City

Calls Heard

[*Continued from Page 41*]

vk2lz; vk2hz; vk3bd; vk3bq; vk3kx; vk3yp; vk4ap; vk4bb; vk7kv; x1am; x1ay; x1c; x1cm; x1g; x2l; x2r; zl1gx; zl3aj; zs1h.

Walfrido Figueira, CX1CG, Box 37; Montevideo, Uruguay

(14 mc.)

W 1cdy-6; 1zzc-6; 1eea-7; 6jmi-6; 8ktl-6. — fm8co-5; g2dv-6; g6qa-5; g6xn-6; oe7jh-5; la1g-5; oh3np-6; on4nil-5; vk2xk-5; vu2fp-5; zd2c-6; zl2bn-6; zl2cb-5; zl2hr-8; zl3gm-7; zl4bt-6; x1cm-6.

(14 mc. phone)

hc1fg-8.

(28 mc.)

w9gfq-5.

W9RXF, 4400 Berkeley Ave., Chicago, Ill.

(7 mc.)

hp1a-5; j2ka-4; j2lc-6; j2lk-4; k4jb-8; k5ac-6; k5ag-8; k6as-6; k6iba-5; k6lb-7; k6meg-5; k6zt-8; k7nc-7; lu4bh-5; lu6ax-6; lu7az-6; on2aa-5; ti2tao-5. — **VK** 2cn-5; 2dg-7; 2dt-5 2hf-6; 2ia-6; 2wn-4; 3fb-7; 3jw-6; 3zw-6; 4er-5. — vp4tc-8; x1bk-8;zl1hy-6; zl2ci-7; zl2db-6.

(14 mc.)

cm2af-8; cm2an-7; cm2do-8; cm2ww-6; cm6rr-4; ct1by-7; ct1ju-5. — **D** 4bgf-5; 4biu-5; 4bnt-5; 4caf-6; 4cpy-6; 4dn-6; 5bar-5; 5hn-6. — ea4aw-5; ea4bm-4; ea7ba-5. — **F** 3ea-5; 3hh-4; 3ib-4; 3le-7; 5dn-6; 8aj-5; 8ex-5; 8fc-7; 8ld-6; 8nr-6; 8tq-4; 8wb-6. — fb8c-7; fm8ch-4; fm8co-6. — **G** 2bk-6; 2bv-6; 2dc-6; 2gs-5; 2im-6; 2ko-5; 2kz-6; 2la-5; 2mr-6; 2pn-7; 2sx-5; 5cy-6; 5fm-5; 5ml-7; 5my-4; 5qy-7; 5wl-6; 5zg-5; 5zn-5; 6bm-7; 6cl-4; 6dl-4; 6gf-5; 6nf-5; 6nj-6; 6oy-7; 6rv-6; 6tt-5; 6uf-4; 6vk-6; 6vp-6; 6yu-5. — gi2kr-4; gi5qx-4; hc2hp-6; hh5bh-5; hp1a-7. — **J** 2cl-7; 2in-4; 2jf-5; 2lb-7; 2lu-6; 3df-4; 5ba-6; 5be-4; 5cn-6; 5jm-5. — **K** 4cvv-6; 4ddh-7; 5aa-8; 5am-6; 5ar-6; 5tc-7; 6bhl-7; 6kef-4; 7bc-5. — ka1cm-6; lu5bc-6; lu6dj-7; oa4j-5; oa4n-7; oa6fe-5; oe2ih-6; oe3fl-5; oe3kh-4; oe7ej-5; oe7ev-5; ok2ak-5; on4au-8; on4cc-6; on4cj-6; on4iu-6; on4rx-7; on4za-5; on4zy-5. — **PA** 0ce-7; 0dc-6; 0jb-5; 0ll-6; 0rn-6; 0sd-6; 0vb-5; 0wd-4; 0xb-5; 0xf-8. — py2bk-5; py2bu-6; py5am-6; sm2vp-5; sm6ua-4; sm7yg-6; su1eg-4; ti2rc-5; u2cr-5; u3ag-5; u3vb-5; u4ed-4. — **VK**—2al-6; 2eo-5; 2rk-7; 2wm-5; 3ej-7; 3st-5; 4zl-6; 5bp-5.— **VP** 1ar-5; 1jr-4; 4tg-6; 5ad-8; 5gm-6; 5pz-8. — vs1aj-4; x1am-8; x1ay-8; x1cm-7; x2c-7; x2nc-6; yt4un-4.

Arthur Stevens, ZL2HR, Manawatou Road, Hawera, New Zealand

(7 mc.)

W 1arb-5; 1ahe-4; 1bd-5; 1da-3; 1foz-5; 1hsu-4; 1hud-6; 1yu-3; 2bpm-4; 2bxw-5; 2cc-3; 2cvz-6; 2cyn-5; 2dei-5; 2eea-5; 2ekm-7; 2fg-3; 2flg-5; 2fpx-5; 2gmz-6; 2kl-4; 2mq-3; 2vl-4; 3anh-6; 3asg-6; 3bbb-6; 3bbx-4; 3bes-7; 3cmg-6; 3cmr-3; 3dqs-4; 3eb-3; 3ect-4; 3ehw-4; 3ekt-6; 3fva-6; 4cde-4; 4cmz-6; 4crg-4; 4dai-7; 4ey-5; 5ahp-6; 4anq-5; 4aqs-7; 5asu-6; 5ate-5; 5avg-5; 5bcw-3; 5beq-7; 5bpn-4; 5brq-6; 5cdx-3; 5cdy-4; 5ch-3; 5cya-5; 5dqd-3; 5dym-6; 5eif-5; 5jy-7; 5ow-4; 5ra-5; 5yh-7; 5zf-4; 6aa-6; 6agc-6;

6ank-6; 6ann-7; 6aod-7; 6aor-7; 6aqb-3; 6aqe-7; 6axc-6; 6azc-6; 6bck-5; 6bxm-4; 6bzp-5; 6cem-5; 6cwy-6; 6cxw-6; 6dqr-7; 6dtj-5; 6dtx-5; 6egh-7; 6fal-8; 6ft-8; 6grh-5; 6grt-6; 6gtm-4; 6gww-3; 6hci-7; 6hjt-5; 6hk-5; 6hsx-4; 6ibq-7; 6icg-5; 6iga-3; 6ikg-6; 6iot-6; 6ira-4; 6itp-7; 6iuf-5; 6iwe-5; 6iwe-6; 6ixo-6; 6jab-4; 6jgo-5; 6jju-6; 6joe-5; 6kgf-6; 6knf-5; 6kyo-7; 6kwb-7; 6qd-8; 6up-7; 6ti-6; 6vc-7; 7abv-6; 7adf-4; 7aew-7; 7apf-6; 7aqj-6; 7awj-5; 7bcf-6; 7bma-6; 7cht-6; 7daw-6; 7dwq-7; 7dxt-3; 7eil-3; 7eir-5; 8ano-6; 8cxw-5; 8ebm-6; 8fcv-5; 8fcy-5; 8fpw-8; 8fwh-5; 8gqu-5; 8hpd-6; 8iey-6; 8mdl-4; 8uv-6; 8zy-5; 9aeh-5; 9afm-4; 9aiw-4; 9bpg-6; 9cpq-6; 9cwh-6; 9dnp-6; 9dxp-5; 9fm-8; 9fst-6; 9hsf-7; 9iki-6; 9ipk-7; 9isr-4; 9jo-4; 9jwi-7; 9ka-6; 9ldj-6; 9lf-5; 9lum-6; 9lrr-5; 9nmo-5; 9nxz-5; 9pc-4; 9rtg-5; 9sck-7; 9tb-5; 9wr-4. — ce3ek-5; cm2rz-3; ct1et-3; d4bar-4; d4blr-5; ea3an-5; ea3eg-4; ea5bs-6; f8lu-5; f8ne-5; f8ny-6; fm4aa-5; fm8ih-6; fm8wh-6; g2vq-3; g5yh-3; g5xh-4; g6wy-6; hb9aq-7; hb9an-5. — **K** 5ag-3; 6atp-6; 6aug-6; 6dv-7; 6ewq-7; 6fws-7; 6lbb-5; 6lej-6; 7dvf-7. — ka1hr-7; ka9wx-8; lu1ad-6; lu5bj-3; lu9dv-6; oa4ai-7; oz7cu-3; pa0az-5; pa0dc-4; pa0xg-3; u2qu-7; u3en-7.—**VE** 2bb-6; 3ea-3; 3er-3; 4nz-3; 5bi-4; 5dr-4; 5fh-4; 5ho-5; 5io-4. — vk6hw-6; vp1al-8; vp1zz-8; vs6ah-4; vs6aq-5; x1cc-6; yt1b-7; zu6p-3.

◆

Our European readers will be glad to know that Mr. David L. Marks, better known as "Uncle Dave", is now in Europe on an extended tour. He may be reached at 3 Kensington Gardens, North Shields, Northumberland, England.

(SEE PAGE 55)

A Tribute

Colonel Foster has gone.

The realization of the full import of those four words cannot but bring to the radio amateurs of the United States a sense of sadness and regret. Sadness at the passing of the very colorful W6HM, regret at losing an outstanding champion of their rights, a vigorous opponent of those influences both national and foreign that have deprived the amateur of rights formerly enjoyed, a bonny fighter who neither asked nor gave any quarter.

To those of us who were associated with him there is an added sadness at the loss of a friend—kindly, lovable, gentle and understanding.

W6HM has signed SK. His legion of friends will "take up the torch". The ideals for which he fought so unselfishly must triumph.

S. G. Culver, W6AN

◆

Broadcasts from WNAC (1230 k.c.) and WAAB (1410 k.c.) go out simultaneously from the same antenna.

Notes on the VK-ZL Contest

As the "Aussie" contest closes, it appears that W1CMX, W2DTB, W3SI, W5QL, W5EHM, W9IJ, W9TB and EA4AO will turn in good scores. The maximum will probably be around 4500 points, representing 150 contacts in the four days, or 133 stations plus the 500 point 28 mc. bonus, while in Australia and New Zealand, a high of 15,000 might be possible.

A month ago one could not have convinced us that it is possible to have more than 40 QSO's with VK and ZL stations in a single day, from the midwest. Yet that is the brand of work necessary to win this year. The contest was as much a test of operating ability as of equipment, and the high scorers had both. When the dx stations tune the edge of the band first, a frequency at the edge is imperative for a high score, yet just having a kilowatt is not enough. An effective antenna is also necessary in order to stand out among the other 1 kw. stations. W9TB used a horizontal antenna with a reflector, the whole system about 70 feet high, supported on four widely spaced poles. Many R9 reports were received; a fellow getting only R7 reports was lost in the "mess" out there on the edge.

This year the VK and ZL stations made considerable use of the 14 mc. band to add countries, which are numerous in Europe. On the middle two days, there were so many on 14 mc. that the 7 mc. band was relatively deserted; one W9 worked every station heard in over two hours, and had only six contacts! It took more than that to win. Particularly important was taking full advantage of 28 and 14 mc. work.

28 mc. was open each afternoon, the number of stations and the signal strength being equal to or better than on 14 mc. during the same "swing-in." The ten meter band was open from 2:30 to 6:30 p.m. central time, the 14 mc. band a slightly *shorter* period. During this time, it was generally possible to raise all stations heard, from any point in the 28 mc. band and from the edge of the 14 mc. band. Later in the evening, however, "20" came back erratically, on the third week still being wide open for dx at 2:45 a.m.! Raising stations then, however, was not always easy. Some did it from the edge or up to 30 kc. in, but our experience was poor in this regard. Slightly better results in our case were obtained on 14,300 kc., competing with Europeans and Africans. With the phones off the air, a phone band crystal might have been better. The 20 meter band was again good from around six to eight in the morning, central time.—W9FM.

◆

The lowest powered broadcaster in the country is KFPM with an operating power of *fifteen watts*.

◆

44 U. S. broadcast stations operate on a power of ten thousand watts or higher and most of these are east of the Mississippi.

◆

Only ten years ago, the Fredonia, Kans., telephone company transmitted programs over their regular lines to operate loudspeakers in subscribers' homes.

ORDER NOW and Avoid Disappointment!

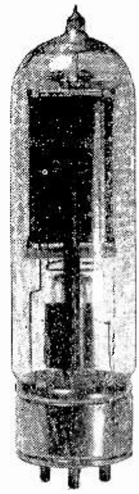
Only through a fortunate purchase have we been able to offer you these tubes for the past few months — at this ridiculously low price. We doubt that the amateur will ever again have the opportunity to purchase a $17.50 tube at anywhere near this price! Remember — we will stand behind every tube we sell! Do not hesitate to purchase . . . **GENUINE**

Western Electric

211-D

FIFTY WATTER
TRANSMITTING TUBES*

$4.90



BRAND NEW
FULLY GUARANTEED!!

Standard Fifty Watter base. Standard characteristics (Interchangeable with type 211 and 211-A). Has new long life filament! Rated RF output as amplifier—**100 WATTS ! !**

Every tube is in its original Western Electric sealed carton! The **WESTERN ELECTRIC** name is your guarantee of highest quality! We guarantee **REAL VALUE** and **COMPLETE SATISFACTION ! !**

Regular selling price—$17.50. Harrison's **SPECIAL PRICE—only $4.90!** Your money cheerfully refunded if you do not agree with us that this is the GREATEST VALUE ever offered to the Amateur! Every tube is **UNCONDITIONALLY GUARANTEED FOR THIRTY DAYS!** (Broken glass or burnt-out filament the ONLY exception!)

W. E. 211-D CHARACTERISTICS

Filament Volts	10
Filament Current	3 Amperes
Normal Plate Voltage	750 to 1000
Average Plate Current	65 Ma.
Plate Impedance	3500 Ohms
Normal R.F. Power Output:	
As an Oscillator	50 watts
As an Amplifier	100 watts

*PLEASE NOTE!

These brand new, fully guaranteed, genuine Western Electric 211-D tubes are not to be confused with the type 211-E which is designed for AF work!

THESE ARE FB TUBES FOR RF

MAIL ORDERS FILLED PROMPTLY!
CAREFULLY PACKED for SAFE Delivery!

→ SEE OTHER ADS ON PAGES 51 AND 57 ←

Harrison Radio Co. 142 Liberty Street
Dept. 912, New York City

WHAT'S NEW

New Catalog

Allied Radio has prepared a new 1936 catalog which they aptly describe as "streamlined." It is very complete, compact, and exceptionally well-indexed. A very wide range of parts is offered the dealer, service man, experimenter, and amateur. The catalog is well-arranged, making it easy to find what you are looking for without thumbing through the whole book. It is apparent that much care was exercised in compiling the catalog, and it makes an excellent buying guide.

Raw Quartz

Because of the small number of potential customers and consequent lack of advertising by companies furnishing raw quartz to the trade, several amateurs have at different times written in inquiring as to where quartz suitable for finishing into oscillating plates may be obtained. Such raw rock crystals (quartz) may be obtained from the Brazilian Importing Co., Inc., 6 Murray St., New York. Some quartz crystals bought from them by *R/9* proved to be of good quality and finished up into excellent oscillating plates.

New Non-directional Microphone

High output level with non-directional 360 degree response is obtained from a new crystal microphone by Shure Brothers. The microphone

New Shure "Billiard Ball" non-directional crystal microphone. It combines high output with good fidelity.

takes the form of a sphere, with a narrow horizontal slit in the top hemisphere. The sound enters through this annular slot. The manufacturers claim a response within 5 db from 40 to 10,000 cycles. It may be connected either for single-ended or push-pull input.

Book Review

THE CATHODE RAY TUBE AT WORK, by John F. Rider, 322 pages, over 400 line drawing and photographs; published by the author at 1440 Broadway, New York, $2.50.

What would you think of a Ford automobile manual which began with a chapter on the Theory of Thermodynamics?

Well, you would know for sure that John Rider had nothing to do with such nonsense. He would know you bought the Ford to use, and wanted the theory of Ford design to stay in Detroit. In just the same way Rider knows that to you the Cathode Ray tube is not a flock of electronic phenomena (with elaborate equations) but just another sort of voltmeter to be used to do things that cannot be done with our other meters, especially in the phone station.

To be sure Rider begins with a chapter called "The Theory of the Tube", but he could just as well have said, "The extremely simple machinery of the tube". This chapter takes up less than one-seventh of the book and thereafter we are given almost 300 pages of simon-pure practice, and never one single bit of mathematics in the whole book to trouble us.

Do not, please, be misled by the comparatively small size of chapter 9 on transmitter adjustment. This chapter merely cleans up those parts of the transmitter not previously touched upon in the discussions of radio and audio amplifiers—which of course covers everything but modulation. However, we admit a belief that chapter 9 will increase in future editions of this book, for most certainly many copies will go into sending stations and be used a great deal, and to excellent advantage.

"Cat Number 1658"

No, this is not the zoo. "Cat. number 1658" is the name of the interesting new tuning unit offered by the Insuline Corporation of America for the tuning ranges of 1½-4 meters (75-200 megacycles) and 3.3-10 meters (30-90 megacycles), with either standard or acorn tubes.

The unit differs from the usual in two ways. One is that either tuning range is covered by 32 (!) turns of the tuning knob, which is just 64 times the usual ½ turn. This gives wide mechanical tuning-spread, needed since "wobbulated" oscillators are at last being frowned upon. The other novelty is that not only the condenser but also the inductor varys with tuning so as to permit the use of a smaller condenser with consequent improvement in gain in the better sorts of receivers, by which is meant those that have some selectivity. The action is possible because the coil is in the form of a helical spring. When the tuning shaft spreads the plates of the non-rotary tuning condenser it also stretches this spring and thus spreads its turns apart to decrease the inductance. There are two coils, one for each of the ranges mentioned above. The unit is of course applicable to both the t.r.f. and superheterodyne types of receivers with equal improvement in tuning-spread. The improvement in gain naturally depends on the extent to which the receiver depends on "legitimate" r.f. amplification. Highly regenerative (and especially super-regenerative) receivers do not appreciate improvements in the tuned circuits, nor does their poor selectivity make tuning-spread so advantageous.

◆

40 METER PHONE?

A few old timers may remember the adventures of a few 40 meter phones that operated when the radio regulations broke down for a few months back about 1927. Those days were recalled by four old timers on November 3, 1935. A W1, a W4 and two W6's, supposedly on 75 meter phone, held a four-way phone QSO for 90 minutes, each listening to the 38 meter second harmonics of the other three. One station was heard on 7,830, two on about 7,900 and one on 7,980 kc. The signals faded considerably but all averaged better than R7. Countless other phone harmonics were heard ranging from R2 to R9 and in distance from 100 to 2500 miles away. Incidentally, one of the few R9 harmonics heard in Southern California that night on the 7800-8000 kc. band came from a W4 on *160 meters*. In the four-way contact mentioned above, only the two W6's could hear each other on 75 meters, and they reported each other from one to two R's louder on the second harmonic. There is some kind of a moral to this story, but whether it indicates that a forty meter phone band is needed or whether harmonics are undesirable we leave to you.

A-B-C of Modulation

[*Continued from Page 46*]

voice frequency amplifier contains voice frequency waves that are generated in the amplifier or microphone itself, and were not present in the original sound impressed on the mike. Harmonic distortion makes the reproduced voice sound "fuzzy" or harsh and makes the voice sound unnatural as well as reducing the intelligibility of the transmission.

There are other faults that can affect a phone transmitter. *Non-linear modulation* is a fault of the coupling circuit between the last voice frequency amplifier and the carrier frequency amplifier to which the modulation is applied. It can also result from improper adjustment of the modulated carrier frequency amplifier. The result of non-linear modulation is harmonic distortion.

Carrier shift is usually a fault of the modulated carrier frequency amplifier. If the *average* amplitude of the carrier output does not stay absolutely constant, the average amplitude shifts either up or down. Carrier shift causes unnecessary interference to other radio services due to what is known as sideband splatter. Carrier shift always accompanies overmodulation of the carrier. Carrier shift is also known as unsymmetrical modulation.

Overmodulation occurs when the amplitude of the voice frequency modulating wave is too great for the carrier. In other words, the carrier amplitude is being varied more than up to twice normal and down to zero.

Frequency modulation occurs when the frequency of the carrier is not held absolutely constant, but is affected by the modulation. This fault causes unnecessary interference and is remedied by improving the isolation between the carrier frequency oscillator and the carrier frequency amplifier to which the voice modulation is applied.

Excessive carrier noise. This fault is usually traced to excessive a.c. hum or ripple in the high voltage direct current power supplies used to feed the various vacuum tube amplifiers used in the transmitter. The result of excessive carrier noise is to mask the weak sounds applied to the microphone. As the upper limit of loudness is set by the point of 100% modulation of the carrier, the lower limit is set by the carrier noise. Thus excessive carrier noise cuts down the *volume range* of the phone transmitter. The remedy is to use additional hum filters in the various high voltage d.c. power supplies.

◆

The human eye is a photoelectric cell.

The Marketplace

(a) Rate: 5c per word, cash with order; minimum, 50c. Capitals: 8c per word. For consecutive advertising, 15% discount for 3rd, 4th and 5th insertions; 25% thereafter. Break in continuity restores full rate. Copy may be changed as often as desired.

(b) QTH Ads: 25c straight. Subscribers allowed one free QTH entry per year on request.

(c) Closing Date: 25th of second month preceding nominal date of issue (e.g., March forms close January 25th.)

(d) Display arrangements not acceptable except capitals; no proofs, free copies, nor reprints sent.

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

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

(g) We reserve right to reject part or all of any ad without assigning reasons therefor.

(h) Remittance should be payable to the order of Radio, Ltd., negotiable at par in U.S.A. funds. Send all Marketplace ads direct to Los Angeles office. No further discounts or commissions allowed.

THE BEST place to buy anything in radio, Palmer's Trading Post, Route One, Duluth, Minnesota. Trade in your old receiver for any make. Finest AT crystals $2.50, 80 and 160 band; "X"-cut, $1.65 for 80 and 160 band. 40 band, $2.00. 5C demonstrator, $62.50.

19" relay racks. 15 panel units. 27½" high, 10" deep. Black crackle finish. Drilled and tapped every 1¾". With screws, less panels. Channel steel construction. Make your own panels of plywood. $4.75. 14 pounds. Postage extra. R. H. Lynch, 970 Camulos St., Los Angeles.

CRYSTAL blanks, y cut, 50c each. Good quartz. Postpaid. W9DGH.

REBUILT Vibroplexes $5 to $7. New large base bugs $9. Set tungsten contacts $2.50. Lydeard, 28 Circuit, Roxbury, Mass.

7000 kc. AT crystals at prices you can really afford—$3.00! Sonneborn's Crystal Laboratory, LaPorte, Indiana.

W5BQU says "The QSL's you printed are just what the doctor ordered." We'll send you samples, OM. What do you say? W9APY, Hinds & Edgarton, 19 Wells St., Chicago, Ill.

RALPH O. GORDON

CONSULTING ENGINEER

High Frequency Radio and Sound Equipment

●

5708 Keniston Ave.
Los Angeles, Calif.
Phone University 7570

"A-T" crystals and blanks, all purposes and frequencies. Fully guaranteed for output and stability. Sonneborn's Crystal Laboratory, LaPorte, Indiana.

OIL CONDENSERS, 2.75 mfd., 4000 volt working. Built to stand lightning surges. 50 lbs. List, $150; sell, $25 or trade. W6CVW.

CRYSTALS: SATISFACTION OR MONEY BACK. 160-80 meters within 10 kilocycles Y-cut $1. X-cut $1.35. Wright Laboratory, 5859 Glenwood, Chicago, Ill.

SELL: Emerson 500 v. m.g. set. Skyrider r.f. a.c. five, other equipment. List for stamp. Hosea Decker, Delaware, Ohio.

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

BACK COPIES of *R/9*: issues no. 37 to 48, 15c each; no. 50 to 59, 20c each, no. 60 and thereafter, 25c each. 25% discount on 12 or more. Foreign, 5c per copy extra.

METERS: New and used Weston, Jewell meters at bargain prices. All types, perfect condition, individually checked. Free bulletin. W2EDW, Far Rockaway, New York.

WHEN you don't know what to build it in, see R. H. Lynch, 970 Camulos, Los Angeles. Steel cabinets and racks, aluminum cans, panels. Special sizes to order. Send for circulars.

BLACK CRACKLE ENAMEL, air drying, half pint $.75. Primer for porus surfaces $.65. Coils for ACSW3, ACSW58, coverage $2.25, bandspread $2.50. LIQUID VICTRON COIL DOPE $.30. Radio Specialties, 433 Monroe, Brooklyn, N. Y.

WANTED: Old spark equipment, step-up transformers, quenched gaps, mica condensers, Weston milliammeters, W5KD.

WANTED: Edison storage "A" batteries, UX852s. Grote Reber, Wheaton, Illinois.

CAPITOL advanced radio course never used ($125). Sell $50 cash. Myron Kluge, 1041 No. Bonnie Brae, Los Angeles.

SW3 NATIONAL receiver, AC operaaed, tubes and 20, 80 and 160 coils. Best offer. Robertson, 608 North Gardner, Los Angeles.

The Most Complete Callbook Ever Published

Your QRA is listed in the latest edition

●

The only radio callbook published that lists all radio amateur stations throughout the entire World.

Also a complete list of high frequency commercial stations, International abbreviations and amateur prefixes, "Q, R, & T," systems for reporting signals, new US inspection districts and high frequency time, press and weather schedules.

Each copy contains a double post card addressed to the CALLBOOK for use in reporting your new QRA. We are extremely anxious to publish a callbook that will be 100% correct and want you to help us by checking your QRA at once in the latest edition and advise us of any errors.

PUBLISHED QUARTERLY MARCH, JUNE, SEPTEMBER AND DECEMBER

Single Copies $1.25 Annual Subscription USA, $4.00

Order your copy today from your local radio jobber or direct from:

RADIO AMATEUR CALL BOOK, Inc.

606 South Dearborn Street, Chicago, Illinois

DIRECTORY OF DEALERS

A List of Dependable Amateur Supply Houses

On request, rates for advertising in this section will be quoted established dealers of known reliability.

CALIFORNIA—LOS ANGELES

RADIO SUPPLY COMPANY

912 South Broadway

Amateurs' Headquarters of the West.

CALIFORNIA—SAN FRANCISCO

OFFENBACH ELECTRIC CO.

1452 Market Street

"The House of a Million Radio Parts"

COLORADO—DENVER

Inter-State Radio & Supply Co.

1639 Tremont Street

Denver's Pioneer Radio Distributors

HAWAII—HONOLULU

Honolulu Furniture Company, Ltd.

Cor. Beretania & Emma Sts.

ILLINOIS—CHICAGO

MID-WEST RADIO MART

520 South State Street

ILLINOIS—CHICAGO

NEWARK ELECTRIC CO.

226 West Madison Street

The Best at Lowest Prices. Write for Complete Catalog.

MASSACHUSETTS—BOSTON

THE RADIO SHACK

46 Brattle Street

The amateur supply house of New England. Distributors for all better radio parts lines.

MASSACHUSETTS—BOSTON

"Ben's"—Tremont Elec. Supply Co.

10 Boylston Street

Up-to-date and complete line of short and long wave receiving and transmitting equipment.

MICHIGAN—DETROIT

RADIO SPECIALTIES CO.

171 East Jefferson Avenue

NEW YORK—NEW YORK

GROSS RADIO INC.

51 Vesey Street

"The Short Wave House"

NEW YORK—SCHENECTADY

M. SCHWARTZ & SON

712 Broadway

Distributors of amateur equipment.

OHIO—CINCINNATI

STEINBERG'S, Inc.

633 Walnut

PENNSYLVANIA—PHILADELPHIA

EUGENE G. WILE

10 South Tenth Street

Complete stock of high-grade radio apparatus

WASHINGTON—SEATTLE

SEATTLE RADIO SUPPLY, Inc.

2319 Second Avenue

Four Hams, W7WE, BRS, CR, AVC, ready to serve you with technical data and highest quality parts.

WASHINGTON—SEATTLE

WEDEL COMPANY, Inc.

520 Second Avenue

Largest assortment of parts and tubes on the Pacific Coast. Wholesale distributors. "The Ham's Paradise".

WISCONSIN—MILWAUKEE

RADIO PARTS COMPANY, Inc.

332 West State Street