25c [30c in Canada]   MAY, 1935   W8HBN $3.00 PER YEAR BY SUBSCRIPTION

RADIO

ESTABLISHED 1917

SHORT-WAVE AND EXPERIMENTAL

OHM'S LAW

$E = I \times R$

$R = \frac{E}{I}$

$I = \frac{E}{R}$

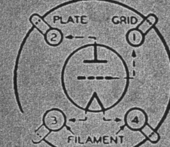
CONDENSERS IN SERIES

$C_{TOTAL} = \frac{C_1 \times C_2}{C_1 + C_2}$

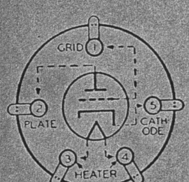
RESISTANCES IN PARALLEL

$R_{TOTAL} = \frac{R_1 \times R_2}{R_1 + R_2}$

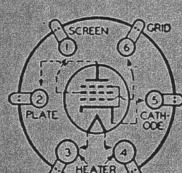
BOTTOM VIEWS OF SOCKETS



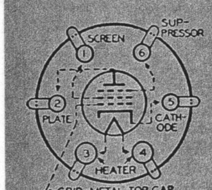
4-PRONG SOCKET
50-201-A, 45, 210, 30, 31, ETC.



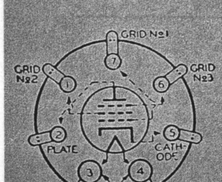
5-PRONG SOCKET
56-46-47-76-27-37



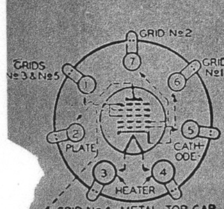
6-PRONG SOCKET
2A5-41-42-43



6-PRONG SOCKET
57-58-6C6-6D6-77-78



7-PRONG SOCKET 59

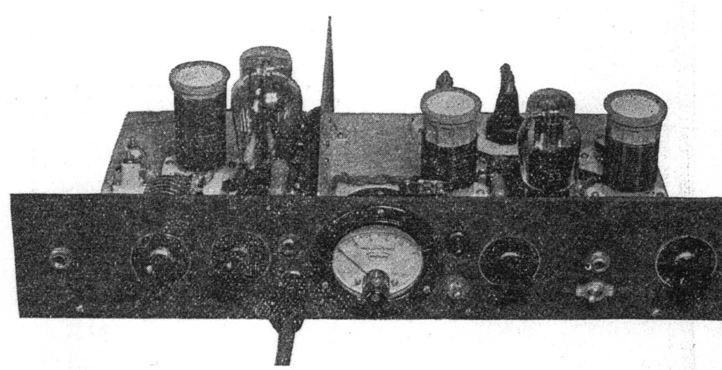


7-PRONG SOCKET
2A7-6A7

—IN THIS ISSUE—

★

The HARMONIC GENERATOR—a new frequency multiplier—gives greater output—has many new features. The answer to more-satisfactory all-band operation. It uses a type 53 tube in the multiplier circuit, a 2A3 or a 45 tube in the buffer stage. The unit here illustrated constitutes a convenient, sensible all-band 20-watt c.w. transmitter with provision for keying either in the oscillator or buffer stage. Almost 2 watts of output is secured when multiplying down from the fundamental frequency to the 8th harmonic . . . 20 watts on the fundamental or second harmonic. A Frank C. Jones development.



FEATURE ARTICLES BY . . .

FRANK C. JONES - I. A. MITCHELL - COL. C. FOSTER
RALPH O. GORDON - J. N. A. HAWKINS - PROF. R. R. RAMSEY

CONTROLLED CARRIER MODULATION

Described by Mr. I. A. Mitchell in the April issue, incorporates the following Hammarlund Parts:

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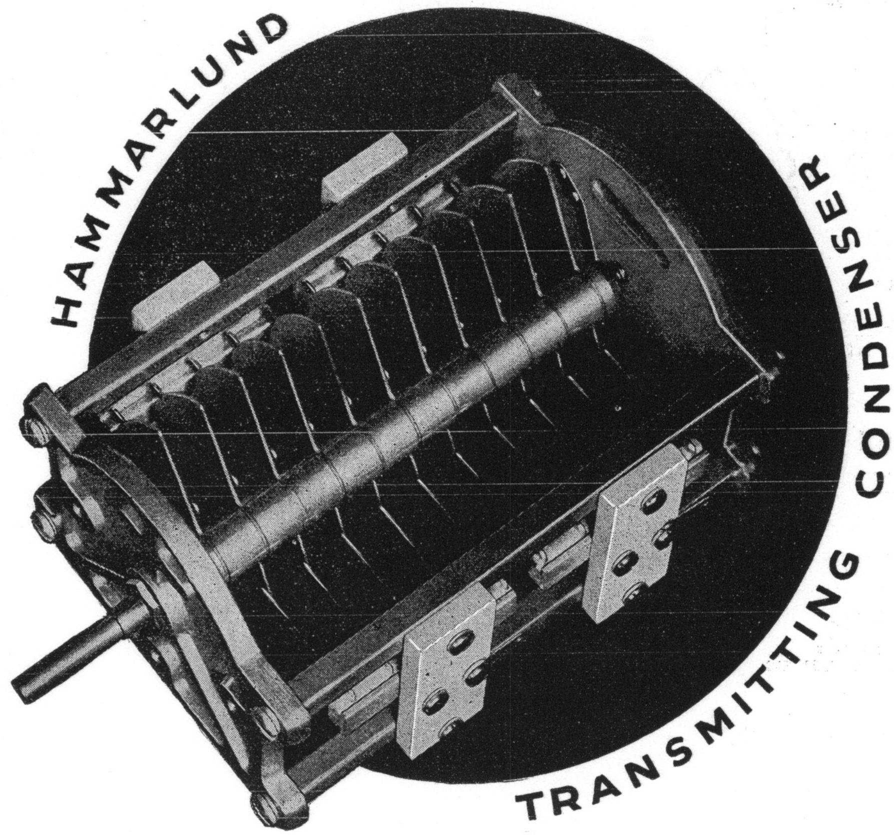
2—TC-350-C
2—MC-100-S
2—MC-20-SX
2—APC-100
1—CH-500
2—CH-X
2—SWF-5
6—S-4
3—S-5
3—S-6

To avoid complications in following the original design, we urge strict adherence to the component parts recommended in Mr. Mitchell's article.



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BOTH frame and plates are "oversize," assuring greater rigidity and absolute steadiness of signal. Features usually associated with only the highest power transmitting condensers.

Heavy aluminum ends, four sturdy duralumin posts and Isolantite insulating cross-bars. Plates are wider spaced than usual and have rounded edges for greatly increased voltages. Smooth bearings; self-cleaning contacts.

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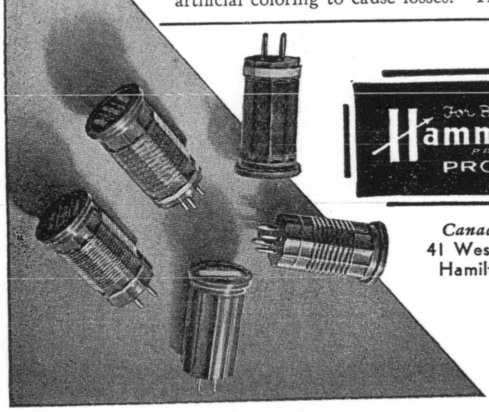
Get more stations, louder signals and sharper tuning with these low-priced Hammarlund Coils *(illustrated below)*. Users say they out-perform any other coils at any price. "XP-53", the new Hammarlund low-loss dielectric, has no artificial coloring to cause losses. The forms are ribbed for air-spacing, have easy-grip flanges and handy "Meter-Index" inserts for coil ranges. Set of four coils for 15-270 meters *(4 prongs, 2 windings)*, $3.00. Set of four coils *(6 prongs, 3 windings)*, $3.75. Extra 4 or 6-prong coil for broadcast band, $1.25 and $1.50 respectively. Coil Forms *(4 or 5 prongs)*, 35c each. 6-prong forms 40c each.



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Radiotorial Comment

THE most critical moment in the life of the American Radio Relay League is at hand. The directors are about to meet for the first time since May, 1934. This year they will either put the League on a sound and enduring basis or they will continue to let it drift downhill. Last year they had the opportunity to reverse its decline and start it on the upward path. They ignored the opportunity, refused to see the writing on the wall, supported all the hypocrisy and ineptitude of its management and voted their confidence in all the acts of the League's officers and employees.

But during the past year the intelligent amateurs of America have learned much about the League that they never knew before. They know now that it is not a national organization purely of licensed amateurs. They know now that their organization—for years proclaimed by its officers to be wholly amateur—is not amateur at all but comprises a vast number of commercial radio people—the very people who have systematically deprived the amateurs of their rights and frequencies. The lambs now know that they have been forced to lie down with the lions.

They know that this situation was brought about solely to make a big pot of money for one man. They now know that the commercial subscribers for "QST" were dragged into the League as **"members"** in order to give K. B. Warner **25 cents out of each subscription**, while his employment contract provided for his receiving a bonus only from the dues of **amateurs** joining the ARRL. They know that the present President and the present Treasurer, who should have been the guardians of the corporation's property and the watchdogs of its treasury, aided and condoned this amazing one-sided scheme and concealed it from the amateurs who then owned the League and all its assets.

The amateurs of America now know—and the directors of the ARRL now know—that the League is **NOT** an amateur organization. They know it must be **MADE** an amateur organization unless it is to fail utterly. They know it can be made an amateur organization by its present Board of Directors. They know that the commercial and other non-amateur element can be removed from the League membership. The commercials can be asked to retain their subscriptions to QST, (which they will do without being asked), but to resign from the League. All of these non-amateur "members" who have the interest of the League at heart will see the necessity of removing themselves from an organization that proclaims itself to be wholly amateur. The few who do not give up their membership will be known and their actions guarded against by a management that has only the interest of the amateurs at heart.

The commercial people know they do not belong in an amateur league. They did not in the first instance become members of the ARRL of their own volition. They were forced into membership by the arbitrary action of re-naming all "QST" subscribers **"members"** in order to make subscription money subject to the levy of the **25 cents commission that Warner's contract provided he should have out of the yearly paid dues of members.** By this action they became fellow-members of the amateurs and the amateurs were forced into a partnership with all commercial people and other non-amateurs who chose to subscribe to "QST".

When this subject of clearing the League of commercials was discussed at the May, 1934, meeting all the directors would concede to those demanding a wholly amateur organization was that any non-amateurs joining after that date could not vote at elections for directors. The reason given to the Board by Warner for not dropping from membership the thousands of commercials whose status would not be affected by the resolution was that these commercial members held "proprietary rights"—that is, that they were part-proprietors of the property and monies of this "amateur" corporation.

Well, who made them proprietors? Certainly it was not the amateurs themselves—the amateurs who were then the sole proprietors. The consent of the proprietors was never given; **it was never even requested by the men who took the action that gave all "QST" subscribers "proprietary rights".** So whatever of proprietorship these non-amateurs hold now they acquired unlawfully, and if they got it unlawfully they are retaining it unlawfully.

The present directors, now that they have no excuse for ignoring the existing conditions, have the opportunity at their coming meeting of making an end of the unwarranted invasion of an amateur body by the ama teurs' demonstrated enemies. The directo can come out in a straightforward manr for a purely amateur League such as amateurs of America **MUST** have if they a to retain any of their rights on the air. They can take the League out of the false position it has occupied for many years with the public, with the government at Washington, with foreign governments and delegations at international conventions and with the amateurs of the world—the general false belief that the ARRL is a wholly amateur body and therefore qualified to act as spokesman for the amateurs. Instead of permitting the League to continue to sail under false colors the directors can instill into the officers and employees a certain measure of honesty.

And with the same stroke the directors can take the League out of the control of the very men who conceived and executed and fostered and then concealed the plan that brought about the present deplorable situation.

If the directors have the independence to take the only logical course of action the League can be made an agency for great usefulness, its popularity among the amateurs restored and the respect of non-amateurs commanded. The League will gain enormously by such forthright action. Of the thousands of United States amateurs who do not belong to it the large majority are the intelligent free-thinkers of mature age who have seen the futility of belonging to it and working for its upbuilding along its present lines. These men will come into the League when, and only when, they have before them the picture of an organization of amateurs ably and honestly managed solely for the benefit of all amateurs. There will be an influx of new members that will be nothing short of a stampede. The publishers of "RADIO" pledge themselves to the amateur fraternity that when such a League exists they will institute at their own expense a sustained drive for new members such as was never seen before.

And now it is up to the directors. The opportunity is staring them in the face. No more will weak palliatives be accepted. They will exhibit the integrity, the independence of thought, the courage and the determination that all directors of all corporations are bound to display. They either will take complete control of the League and lodge its management in men of character and ability, or else watch the intelligent amateurs of America continue independently to organize and act for their own advancement and protection.

Colonel Foster's Comment

The Birth of a Racket

ALMOST every fraternal society that comes into existence is made the medium of a racket for the benefit of insiders if it gives promise of monetary fruitfulness. If you would like to see the birth of a racket I'll lift the corner of the curtain and let you peak in. You are not presumed to know what is going on behind the closed door. You are expected to credit only what the happy father and the midwife tell you later. And here is what the Happy Father said in his report on Page 24 of 'Q'ST" for March, 1920:

"An Announcement

"Heretofore QST has been obtainable by non-members of our League at $1.50 a year, the $2.00 membership dues also including it. Now that the League wholly owns QST that policy has begun to seem inconsistent, and we just recently gave it a test which convinced us—on our expiration notices we printed two forms, one for straight renewal and the other for joining the League. That settled it . . . it has been almost solid for the League.

"And so the separate subscription arrangement is going by the board as outgrown. With the next number the newsstand price of QST goes to 20 cents—meaning we'll have a better QST—and the yearly rate will be two dollars, including membership in the League just as before. To start off the new system and reconcile the differing dates of membership and subscription expirations now on our books, we will issue membership certificates to our present non-member subscribers up to the date of expiration of their subscriptions, without charge, so that thereafter the two will expire simultaneously.

"You're asked to spread this news. We suppose for the next five years we'll be getting those little red coupons (remember the old blue ones in 1917?—they still come in!), and it will be some time before the dollars-and-a-half stop reaching us; so you can help. Meanwhile whatever amounts we receive will be credited for as many months' dues as they will cover.

"The QST reader who is not enthusiastic for ARRL organization and what we can do through teamwork is a rare bird. Of course QST will be available separately on the newsstands, but we'd like to have him as a member and make a believer out of him. Let's build up our membership."

And this was ALL that was ever disclosed of the accouchment to the members of the American Radio Relay League—either before or afterwards.

The Happy Father thus describes his child in terms that are glowing but expressed in involved language that is designed to lead the mind away from the unholy conception and the sinister effect upon the future of the mother organization.

The Happy Father held a contract providing that he might lawfully take from the treasury of the ARRL a salary of $30 a week, plus 25 cents out of each yearly paid dues, plus 25 per cent of the net profits of QST. At the time the racket was born the contract had run a year. Apparently the Happy Father wasn't quite so happy when he found his cut from the dues of members for the year was only $898 and that the net praofits of the magazine held out no prospect for years to come. What to do?

The source of the Happy Father's commissions was limited. There were not then many transmitting amateurs in the country from which to draw members, and the requirement for membership had always been that the applicant must fill out a blank to show that he "has a practical working station and can receive a message." The Happy Father, in his first effort as Secretary-Manager-Editor—the June, 1919, issue of QST—urges the members to loan the money for buying the magazine from Maxim and Tuska, the men who owned it. He says, "The loan will be paid back with interest and the wireless amateurs of the country will have their own organization OF AMATEURS, BY AMATEURS, FOR AMATEURS", emphasized by big capitals. And as far along as January, 1920, he says, "The League and QST are not money-making propositions for anybody. It only is desired that they be self-supporting."

But in the surprisingly short time of three months—by March, 1920—the League became NOT a league "Of amateurs, By amateurs, For amateurs", and DID become a "money-making proposition" for somebody.

While the market for new members was circumscribed by the then dearth of amateurs the field for subscribers for QST, already large, was potentially great because many commercial people were finding in the amateurs a growing market for their wares and making use of QST as an advertising medium. The problem of the Happy Father was how to get 25 cents out of each subscription in addition to the 25 cents he was getting out of each yearly dues of members. The members were paying $2.00 a year, with QST thrown in; the subscribers were paying $1.50. So the scheme devised was, instead, to charge subscribers $2.00 with a MEMBERSHIP IN THE ARRL THROWN IN! In his explanation—which is distinguished by its utter inability to explain—the Happy Father says he tested the device by printing two forms on expiration notices, one for renewal of subscriptions to QST, the other for joining the League, and that the response was almost solid for joining the League.

And why shouldn't it be! If the non-amateurs had to pay the $2.00 for their magazine anyway why not accept the membership certificate at no more expense and have a say in the affairs of these amateurs who promised to be such good customers!

The Happy Father's attempt to rationalize his device produces only the result of this "test" and the spurious reasoning that now that the League owned QST it was inconsistent that members should pay $2.00 for their membership and their magazine while mere subscribers paid only $1.50 for their magazine without the membership. That amateurs had advanced the money to buy for THEMSELVES the magazine that was owned by Maxim and Tuska is a poor reason for bestowing a part ownership of it upon non-amateur subscribers at no cost at all. And there was surely nothing inconsistent about permitting the amateurs to retain sole ownership of a property they had bought with their own money and still permitting outsiders to subscribe to the magazine.

But by the mere arbitrary dictum of accepting as members of ARRL and co-owners of QST anyone and everyone who had the price to subscribe President Maxim got his pay for QST and the Happy Father commenced drawing 25 cents out of each subscription. The sum-total of these commissions that were neither named nor contemplated by the employment contract amounted to many thousands of dollars. And even this does not tell the whole story. The commissions of "25 per cent of the net profits of QST" set up by the contract seem also to have run to huge sums that could be justified only by a cockeyed system of accounting.

To bring into being this racket-child the whole fundamental concept of an association composed only of amateurs working solely in the interest of amateurs and for the private enrichment of none, had to be junked. And the strangest part of the spectacle is that the man who is given credit for originating the idea stood there looking on.

No racket ever obliterates itself; racketeers invariably continue to justify their actions so long as those they have exploited will stand for it. A racket ceases only when others determine it shall cease and ONLY then.

As abstract phenomena the birth and growth of a racket are interesting to witness; as a concrete condition that affects profoundly the fortunes of all amateurs the picture is distressing. The picture has not been erased.

Clair Foster, W6HM.

Christmas in May

IT seems that sometime in May there will be a meeting of the Board of Directors of the ARRL. At these gatherings they are supposed to hash over all the dirt and see what the boys want in their stockings during the forthcoming year. The directors look the various socks over and then scurry around trying to find enough presents to fill 'em. The size of some people's socks is equalled only by their supply of nerve, or "crust". Most crust is an outcropping of a super-abundance of dough, but not invariably.

Anyway, all this is about due to come to pass, so let's look around and see what we'd like . . . Well, for one thing, we'd like to see this "Warner vs. Foster" bout come to an end. The 10th round is not only getting long-drawn out but tiresome. If Br'er Warner is going on the idea that Kunnel Foster'll get exhausted sooner or later and pipe down, he's slightly damp. If he thinks that the proper attitude toward the choice collection of accusations that have been splattered all over the place in print is one of dignified contempt coupled with an "I do not choose to answer" business, he's soaking wet, since they have now reached a point where it is quite impractical to ignore them further. Most of these dainty little quips have contained the makings of a pretty fair libel suit —if they're not true. We wish Kunnel Foster'd make a few of 'em about us. We'd have a kilowatt installed in a dern short time on the proceeds. Perhaps Mr. Warner already has a kilowatt.

However, all these cracks are making many enemies for Mr. Warner. Worse than that, they are making enemies for the League, and that mine frands, is not so good. Therefore, the first thing we'd like in our sock is a list of favorable answers to each and every one of those charges concerning misconduct of ARRL affairs that have been printed in "RADIO" by Senor Foster. Furthermore, soft soap tastes like heck, so we'd like to see the answers backed up by indisputible proof. The League has spent plenty of money on far less necessary processes than this one.

If, by any chance, Col. Foster knows whereof he speaks, it strikes us that the only possible cure for the disease is a major operation on the ARRL, during which it will be deprived of some of its most cherished members. Then, after headquar-

(Continued on page 26)

Common-Sense Link Coupling

How to Get Greater Excitation—How to Link-Couple the Antenna to the Final Amplifier

By FRANK C. JONES

Here Are the Facts!

● Confusion exists in the minds of many experimenters as to the correct methods of applying link coupling to r.f. amplifier stages. Uninformed technical writers have recently attempted to discredit the efforts of more-experienced engineers. Consequently the entire subject of link coupling was thoroughly investigated by Frank C. Jones, discoverer of the idea. His findings are here disclosed. They bring to light many heretofore unknown facts; his investigations should completely remove all doubt from the minds of those who may have been misled by unsound advice. The accompanying treatise by Frank C. Jones gives you the true facts on link coupling.—Editor.

● Link coupling is used in amateur transmitters because of increased output obtained in any stage of the transmitter. One place for its use is in coupling between the final amplifier tank circuit and the antenna. It is highly desirable to use some form of tuned circuit when coupling the antenna to the final tank circuit. For example, the feeders of a Zepp antenna must be tuned, and link coupling can often be used to simplify the mechanical problems involved. Another case is for a single wire feeder to a Hertz antenna; here the feeder circuit should have an additional tuned circuit in order to minimize harmonic radiation.

In the case of coupling a Zepp antenna, the usual arrangement makes use of two coils at either end of the final tank circuit in order to obain a balanced condition. This is an awkward method for varying the coupling and it is sometimes difficult to arrive at the proper number of turns in the coupling coils with respect to the shunt or series tuning condensers. By using link coupling the antenna tuning parts can be located at some convenient point several feet away from the transmitter. More output can usually be obtained if impedance matching is correct. Proper impedance matching is better accomplished when the coupling coils are removed from the plate coil field. The coupling coils are usually wound with heavy copper tubing and thus there is an excess amount of metal with eddy current loss in the field of the plate coil. The use of a two to three inch diameter plate coil of No. 10 or No. 12 wire, space wound, will in such cases give higher efficiency for low C circuits than the use of heavy copper tubing coils, even at inputs as high as a kilowatt. The Zepp tuned coil should be of copper tubing if high power is used because the antenna current runs into high values.

The link coupling circuit should consist of No. 14 or No. 12 rubber covered wire, twisted or paralleled, usually with a one turn loop at the plate coil end and two or more turns in the loop at the antenna coil end. Since only inductive coupling is desired, the link coils should be wound tightly over the RF voltage node points of the coils, providing only sufficient insulation to withstand the plate voltage used. The number of coupling turns used depends upon the closeness of coupling and the ratio of impedances. The antenna current is low and therefore its link coil should have more turns, closer coupled, than the plate coil. This system is shown in Fig. 1. If a single ended final amplifier is used, such as in Fig. 2, the link coil should be at the RF ground potential end and sometimes it is necessary to use two turns to obtain sufficiently close coupling. It is difficult to obtain proper impedance matching with link coupling unless the link coils are very closely coupled to their tuned coils when the impedances of the tuned circuits are widely different.

Fig. 2 shows a method for link coupling to either a single wire fed Hertz antenna or to a Fuchs antenna. The latter is often very effective since no RF feeder is used; the end of the half wave or full wave antenna is brought into the station operating room. The system shown allows the antenna coupling circuit to be located near the lead-in point and link coupling is used to the transmitter final amplifier. The additional tuned circuit allows impedances to be matched and greatly reduces harmonic radiation. This circuit, when properly adjusted, reflects a pure resistive load on the tube circuit, even for moderate variations of antenna characteristics, such as that due to vibration in the wind. For this reason it should be especially useful for use with a self-excited oscillator system, because such circuits are used for certain special reasons.

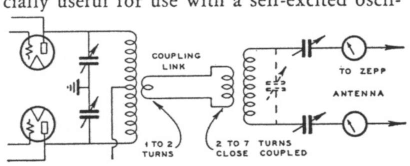


FIG 1.

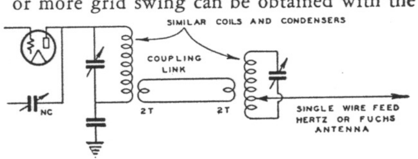


FIG. 2

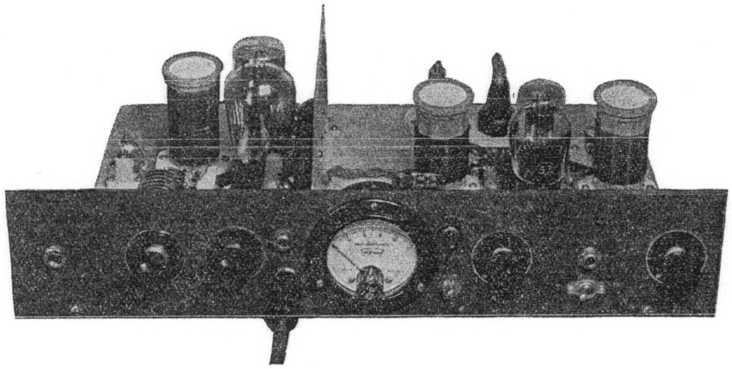
The adjustment of the circuit in Fig. 2 is simple because the impedances can be made nearly equal. One to two turns in the link coils is sufficient. The latter should be located at the RF voltage nodes of the coils. The antenna or antenna feeder should be tapped-up far enough so that normal load is pulled in the final amplifier tube when both tuned circuits are exactly in resonance. A simple field strength meter is very useful in obtaining maximum power into the antenna. This maximum power is obtained when the link coupling, antenna tap and tuned circuit losses are all correct and as low as possible.

Fig. 2 shows the use of grid circuit neutralization which will function satisfactorily with various kinds of tubes, new or old type. Its adjustment is similar to the usual plate circuit neutralization method and, like the latter, is a simple process on 40, 80 and 160 meters . . . but a litle difficult on 20 meters. It will be noted that no split-stator condensers are used. Cost is reduced for a given value of capacity across the tuned circuits. The harmonic output of this circuit is much less than for most other circuits because the plate tuning capacity is connected to ground, thus providing a low impedance path for the harmonics.

Grid neutralization should be used with a grid coil which is center-tapped and by-passed to ground, or filament, in order to obtain an inductive Wheatstone bridge circuit for neutralizing. If a split-stator grid condenser is used, this bridge is capacitive and the varying tube grid to filament capacity unbalances the bridge for neutralizing. No difficulty should be experienced when using grid neutralization, if the grid coils are center-tapped and by-passed to ground, instead of using split-stator condensers with the rotor grounded.

Link coupling can often be used between stages in a transmitter in a form which will give greater grid swing in each succeeding stage. Some tubes which have a high mu, or the screen grid type, have an extremely low grid impedance, especially under plate loaded conditions. In such cases it is difficult to obtain maximum grid swing or reasonable driver plate load with the usual form of one or two turns in the link coupling loop at each end of the link. The answer to this problem is exceedingly simple. Use one or two turns in the link coupling loop on the driver plate coil and use two to six, or even seven turns at the grid coil when the driven tube is a high mu or screen grid tube. The coupling between the grid coil and the link coil should be as close as possible, such as one winding directly over the other, or interwound. The latter is important for proper impedance matching.

Link coupling will give a certain amount of automatic impedance matching, which can be easily proved by noting that about 50% or more grid swing can be obtained with the usual ink coupling over the old form of capacitive coupling between a pair of type 210 tubes. Usually only a small part of this loss in capacitive coupling is due to the grid RF choke, since the latter can be made very effective; consequently the loss is in impedance mismatch when the grid of the following tube is across the entire tuned circuit. Link coupling gives an impedance matching effect because the coupling is usually less than unity or maximum obtainable. The impedance reflected each way is not entirely dependent upon the ratio of tuned coil turns to link coil turns, since the effective coil coupling is relatively loose and resonant circuits are being used. Because the coupling is not unity between the coils, impedance matching takes place . . . providing the ratio of impedances are not too great. When the impedances are greatly different, one being several times that of the other, then link coupling must be used with a little common sense. In short, the low impedance circuit end should have **more turns on the link coil** and these two coils should be **very closely coupled.**



The Harmonic Oscillator

A Better Exciter for All-Band Operation

Greater Output—More Flexibility—More Economical

By FRANK C. JONES

● Here is something the amateur has long waited for—an oscillator-doubler-tripler-quadrupler that gives ***more output than any other system yet tested.*** The development is by Frank C. Jones. It incorporates some of the principles of the "Siamese Exciter" which was described by Mr. W. W. Smith of "R/9" in these pages a year ago. A 53 tube in the frequency-multiplier circuit, driving a 45 or 2A3 in the buffer stage, makes an ideal all-band two-tube amateur c.w. transmitter, using one power supply. Keying can be accomplished in either the oscillator or buffer stage and a simple, effective break-in system is the result. The oscillator-buffer requires but 400 volts for satisfactory operation. The flexibility of this new Harmonic Oscillator will be appreciated by all. Compare its output with any other system you have ever used.

● Quantitative experiments with various types of quartz crystal oscillator circuits proved the fact that a type 53 or 6A6 tube makes an excellent oscillator and harmonic generator which operates with very little crystal heating. The 53 and 6A6 tubes have two high mu triode tubes in one envelope; the type 53 has a 2.5 volt heater and the 6A6 has a 6.3 volt heater. Their characteristics are quite similar and both tubes should be operated with at least their full rated heater voltage, especially if 300 to 400 volts is applied to the plate circuits.

The best results with a type 53 are obtained when one triode is used as an oscillator and the other as a harmonic doubler or generator. The 53 tube has a high mutual conductance and a high amplification constant, thus it is very well suited for use as a crystal oscillator. Considerable output without need of much grid driving power, which in turn means low RF current through the crystal, results when the 53 tube is used. Low RF current through the crystal results in a minimum of temperature change and, therefore, minimum frequency change. For a given allowable amount of RF crystal current, more output is therefore obtainable than with most of the other oscillator circuits. The 53 or 6A6 tube will give high output with low plate voltage. Its harmonic output is higher with 300 to 400 volt plate supply than a Tritet oscillator having a 500 to 600 volt power supply. This results in economy, since an ordinary BCL power supply is suitable.

The oscillator section works fine when heavily loaded, and also with less crystal RF current. Capacity coupling is used to the other triode section and the latter acts as a very efficient harmonic generator. It has a high mutual conductance and with high RF excitation and bias it becomes a fine doubler or quadrupler. About 5 watts of RF is available from the oscillator section to swing the grid of the doubler section and excellent power efficiency is obtained for the overall tube input to output on any desired harmonic frequency.

Fig. 1 shows the simplest oscillator-doubler circuit, while Fig. 2 shows the same circuit with regeneration in the harmonic section in order to secure reasonable outputs up to the 8th harmonic. Using the circuit of Fig. 1, an output of 5 watts is obtained on 80 meters from an 80 meter crystal, 5 watts on 40 meters and 0.7 watts on 20 meters. These outputs are obtained from a 300 volt power supply with a total cathode current of from 50 to 90 milliamperes, which is about equally

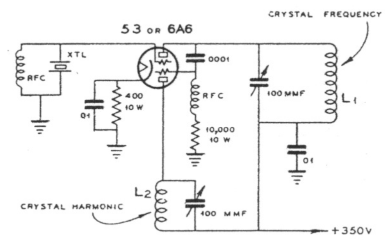


FIG. 1

divided between the two triode plates. The crystal current is about 37 MA.

With a 160 meter crystal, an output of 3.5 watts on 40 meters is obtained with 320 volt

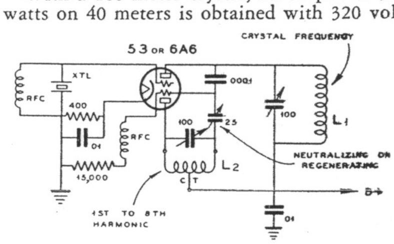


FIG. 2

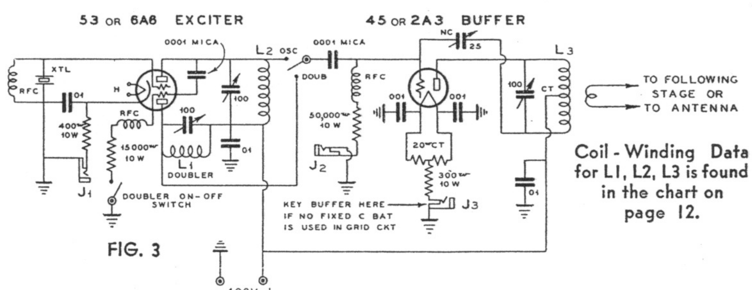


FIG. 3

Coil-Winding Data for L1, L2, L3 is found in the chart on page 12.

ALL BAND TRANSMITTER USING JONES EXCITER
20 WATTS OUTPUT – 15 WATTS ON 14 MCS

The circuit shows the Jones Harmonic Oscillator which uses either a 53 (2½ volt) or a 6A3 (6.3 volt) tube in the oscillator circuit. The output from the buffer stage, which uses either a '45 or a 2A3 tube, is 20 watts on 160, 80 and 40 meters; 15 watts on 20 meters. Keying can be accomplished in the oscillator cathode circuit (Jack J1), for preventing key clicks if battery bias is used in the buffer grid circuit. The buffer can be keyed as shown in the above circuit. A single power transformer is all that is required for both the oscillator and buffer stages, but the transformer should have two separate 2½-volt filament windings, one for the oscillator heater, and one for the buffer tube filament. The +B by-pass condensers are .01 mica, 1000 volt rating. The cathode by-pass condenser is a .01, paper or mica. The RF chokes are the conventional small size 2 MH (approx.) receiving type. The 100 mmf. tuning condensers are Star Midgets, receiving type. The neutralizing condenser is a 15 to 25 mmf. Star Midget, double spaced.

plate supply at 100 MA DC and a crystal current of 18 MA. An output of .15 watts is obtained on the 8th harmonic on 20 meters with the same approximate values of input.

A 40 meter crystal gives 4 watts output on 20 meters with E_B=360 volts, I_B=80 MA. I_X=85 MA of crystal current. The higher frequency crystals always have greater RF current and therefore may be desirable to operate on a higher order harmonic in order to minimize crystal heating. This same condition holds true in practically all crystal oscillator circuits. Ordinary high loss bakelite coil forms and a cheap grade of midget condensers and wafer sockets were used in a laboratory oscillator from which the foregoing data was secured. Undoubtedly, greater output can be obtained if isolantite coil forms, sockets and isolantite insulated condensers are used. The same coils and condensers used with a pentode and Tritet oscillator circuits (so that a fair comparison could be made) brought the following to light: The RF output was measured by means of another tuned circuit, link coupled to the output circuit, across which was placed a non-inductive 500 ohm resistor in series with a thermocouple. This form of load gives a fair simulation of the grid circuit of a buffer stage, or output stage, as shown in Fig. 3.

Next a pentode oscillator was set up with a type 59 tube. This gave an output of 1.6 watts on 80 meters from an 80 meter crystal with E_B=300 volts, I_B=27 MA and I_X=20 MA RF. At E_B=430 volts, I_B=38 and I_X=25 MA, the output was 3.3 watts. The value of I_B included both plate current and screen current, the latter running from 6 to 7½ MA.

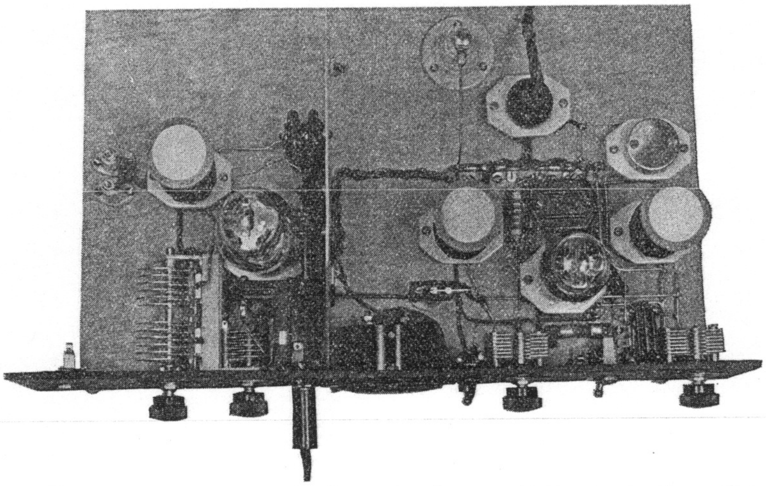
The pentode oscillator with a 40 meter xtal gave an output of 3.3 watts with E_B=380, I_B=50 MA and I_X=45 MA RF. The screen voltage was maintained at from 110 to 125 volts in these tests.

A Tritet oscillator was next set-up, using the same 59 tube. At least 3 tubes of each type were tested in each circuit in order to be certain of the results. The Tritet gave an output of 5 watts on 40 meters from an 80 meter crystal with E_B=400, I_B=45 and I_X=77 MA RF. At the same value of plate voltage as used with the 53 tube oscillator, the output was only 2.6 watts with I_B=30 and I_X=57 MA RF.

With a 40 meter crystal the Tritet gave an output of 0.8 watts on 20 meters at E_B=320 volts, I_B=30 MA and I_X=80 MA and E screen=250. At E_B=400, I_B=43 MA, Ixtal=70 MA and E_{SC}=130 volts the output was 1.2 watts. Raising the screen voltage to 300 increased the 20 meter output to 2.0 watts but the tube and crystal were both overloaded. It was found that the Tritet oscillator gave very poor results with some crystals which worked fine in a pentode or 53 tube oscillator circuit. This seems to be a common complaint about the Tritet oscillator.

The Tritet with 160 meter crystal gave an output of 1.0 watts on 80 meters at E_B=390 volts, I_B=50, E_{SC}=110 volts and I_X=18 MA RF. Its quadrupling output was 0.2 wats on 40 meters at E_B=400 volts, I_B=40 MA, and I_X=22 MA RF. As a quadrupler its output was less than 1/17 of that given by the 53 oscillator-quadrupler, although its input was over half as much. The input was figured as the plate and screen input in the case of either the pentode or Tritet oscillators.

The 53 harmonic oscillator gave much greater output on the higher harmonics when regeneration was introduced into the second triode. With a 380 volt power supply the total plate current ran from 50 to 75 MA with a 160 meter crystal, and outputs were obtained of 5.0 watts on 160 meters; 7¾



Looking down into the Harmonic Oscillator. An aluminum shield separates the oscillator-doubler from the buffer stage. Reading from left to right, the variable condensers are: buffer plate tank condenser, a double spaced 2-section Hammerlund 35 mmf. per section midget variable, with both stator sections connected in parallel to give 70 mmf. Neutralizing condenser, double spaced Star 25 mmf. Doubler plate tuning condenser, 100 mmf. Star midget. Oscillator plate tuning condenser, 100 mmf. Star Midget.

watts on 80 meters; 5.5 watts on 40 meters, and 2.0 watts on 20 meters (8th harmonic). This is sufficient output to drive a type 10 buffer stage at moderate output even on 20 meters from a 160 meter crystal and a single 53 or 6A6.

The overall efficiencies of a 53 oscillator and a Tritet, with the best 80 meter crystal tested, gave 23% for the Tritet on 40 meters and 25% for the 53 with regeneration. In quadrupling there is no comparison at all, because the 53 gives over 10 times as much output as a Tritet for the same input.

Regeneration makes the circuit somewhat complicated and adds another adjustment. If doubling only is desired, regeneration is hardly worth using. On the other hand, regeneration is required for the higher-order harmonics, but care should be taken to see that too much feed-back is not introduced, otherwise the circuit can act as an oscillator at the frequency determined by the harmonic triode tuned circuit.

For general use, the simplest form shown in Fig. 1 is desirable. It can be used to drive one or two 45 tubes as a buffer or low-power transmitter. The 45 tube will deliver as high as 20 watts output on 40 meters, using a type 53 tube and an 80 meter crystal. Over 15 watts output can be obtained on 20 meters from a 40 meter crystal when using a single 53 and 45 tube with a 400 volt power supply, capable of supplying about 150 MA. The circuit shown in Fig. 3 is suitable for this purpose.

The simplest test or adjustment of this circuit is to use a single turn of wire and a 6 volt pilot lamp as an indicator of oscillation. The oscillator is first adjusted for maximum output, then the doubler is similarly adjusted. If the doubler section is not used, its grid-leak circuit should be opened in order to remove the load from the oscillator section. The grid leak increases the bias of the harmonic producing triode to a great many times cut-off bias. The 400 ohm cathode resistor provides a fixed bias to both of the triode sections, and also stabilizes it for use on voltages over 300 as plate supply.

The same loop of wire and lamp can be used to neutralize the 45 stage before plate voltage is applied. Adjust the neutralizing condenser so that the lamp does not light up at all at any setting of the 45 tube plate circuit tuning condenser. Self-bias on a 45 or 2A3 stage is desirable if over 300 volts is used for plate supply, in order to prevent the plate current from climbing.

Calls Heard By W9IJ, Mar. 9 to 17

7 AND 14 MC

CE1AG, CE1AP, CE7AA, CM2AG, CM2FA, CM2JM, CM2XF, CM6DW, CM6RR, CM8AF, CN8MP, CT1AA, CT1AG, CT1BY, CT2BK, CT3AB, CX1CG, CX1CX, CX1FB, CX1FX, CX1VE, D4BAR, D4BDR, D4BFN, D4BHH, D4BIU, D4BKN, D4BQO, D4BUK, D4BMJ, D4CAF, EA1AV, EA3AN, EA3EG, EA4AP, EA4AO, EA4AV, EA5AF, EA8AL, EA8AF, EA8AH, EI5F, EI5AV, EI6F, EI8B, EI8D, F3AD, F3AL, F3AR, F8EX, F8FC, F8GG, F8HR, F8KJ, F8PK, F8PZ, F8RQ, F8SQ, F8TQ, F8UC, F8VJ, F8VT, F8WB, F8ZF, F3MTD, FB8C, FM4AB, FM8BG, G2AK, G2BM, G2DZ, G2HG, G2IO, G2KZ, G2LA, G2MR, G2MG, G2NH, G2OA, G2QO, G2VI, G5BD, G5BJ, G5BY, G5FA, G5JT, G5KT, G5LA, G5QF, G5UF, G5VB, G5VL, G5VQ, G5WY, G5YG, G5YV, G6BS, G6MY, G6NJ, G6QB, G6RV, G6UF, G6XN, G6YU, GI5QX, GI6TK, GI6YP, GI6YW, HAF2D, HAF3B, HAF3D, HAF4H, HAF6G, HB9AQ, HB9J, HC1FG, HC2JC, HC2JM, HC2MO, HP1A, J2GX, K4AOP, K4KD, K4SA, K5AA, K5AC, K5AF, K5AG, K5AO, K5AT, NY1AA, NY2AB, K6AAC, K6AJA, K6AKP, K6AUQ, K6CGK, K6DV, K6ESU, K6HZI, K6HLP, K6IBW, K6IAE, K6JPD, K6KEF, K6KQM, K6LBB, K6LPW, K6LVH, LA1G, LA3R, LU1EP, LU2FC, LU4DQ, LU5CZ, LU6DJ, LU9BV, LY1J, OA4AA, OA4AT, OA4J, OA4M, OE1CM, OE1ER, OE3FL, OE7EJ, OE7JH, OK1AW, OK1AZ, OK1BC, OK2AK, OK2RM, OM1TB, OM2PI, OM2RX, ON4AF, ON4AU, ON4DS, ON4FE, ON4HM, ON4MAD, ON4MX, ON4RX, ON4SD, ON4UF, ON4UU, ON4ZA, OZ1NW, OZ2M, OZ7KG, PA0AZ, PA0CE, PA0DC, PA0FX, PA0PN, PA0RP, PA0SM, PA0VB, PAOXG, PA0ZM, PY1AW, PY1DJ, PY1IF, PY1IW, PY2BU, PY2BX, PY2CD, PY9AD, SM5YS, SP1DE, SP2AS, TI2RC, VK2AE, VK2BQ, VK2BW, VK2BG, VK2CN, VK2DA, VK2EJ, VK2EL, VK2EO, VK2FM, VK2FX, VK2FY, VK2HA, VK2HG, VK2IA, VK2JU, VK2KJ, VK2NS, VK2OJ, VK2OU, VK2PH, VK2PX, VK2QN, VK2SK, VK2VC, VK2WU, VK2XC, VK2XJ, VK2YC, VK2ZH, VK3CO, VK3CP, VK3EG, VK3ES, VK3FB, VK3GQ, VK3HT, VK3HK, VK3KX, VK3ML, VK3MR, VK3MR, VK3MX, VK3OC, VK3RX, VK3SN, VK3UH, VK3VU, VK3VW, VK3WW, VK9XD, VK3XF, VK3YO, VK3YP, VK3ZB, VK3ZC, VK3ZQ, VK4BB, VK4FB, VK4JU, VK4KY, VK5BM, VK5DQ, VK5FM, VK5KG, VK5KV, VK5XU, VK5ZC, VK6MO, VK6SA, VK7BL, VK7JB, VK7KV, VK7RC, VK7XL, ZL1AA, ZL1AR, ZL1DI, ZL1DV, ZL1GX, ZL1HD, ZL2BN, ZL2CC, ZL2DS, ZL2GQ, ZL2GS, ZL2KK, ZL2KI, ZL2LQ, ZL2MM, ZL2OW, ZL3AN, ZL3BJ, ZL3HK, ZL3JA, ZL3JD, ZL4AI, ZL4BQ, ZL4BT, ZL4CK, ZL4DB, ZL4FO, ZL..FS, VO1P, VO1Y, VO4K, VO4R, VO4Y, VO8Y, VP2BX, VP2CD, VP4TA, VP4TB, VP4TF, VP4TG, VP4JR, VP5AB, VP5JB, VP5PA, VP5PZ, VP7NB, VP9R, VQ4CRL, VQ4CRO, VQ4CRP, X1AA, X1AM, X1AX, X1AY, X1CC, X1DA, X1N, X1W, X2A, X2AI, X2C, X2N, X3G, X3Q, X3Z, ZD2C, ZE1JB, ZT1R, ZS2A.

Total—54 countries. 367 stations.

Stations heard on a "home brew" single signal superhet, al during the International Tests.

Antenna: 66-ft. orizonhtal doublet. 60-ft. high.

73s.

Le Roy Moffett, W9IJ.

Surveying the Radio Horizon

An Address Delivered at Des Moines, Iowa, April 26th, 1935, by Sumner B. Young, W9HCC

RECENTLY, some very conservative and apprehensive Radio Amateurs in Southern Minnesota mailed a circular letter to members of the Southern Minnesota Radio Association, warning those who might be planning to attend the convention in Minneapolis on May 3rd, 4th and 5th, not to be swept off their feet by radical Twin City ideas concerning the present management of the American Radio Relay League, Inc., but to be on their guard againsts persuasive speakers. The April issue of "QST" gives similar advice, but mentions no places or names.

Now, a certain amount of what you might call "sales resistance" is a good thing; and a critical analysis of the other man's argument is always desirable.

"High-pressuring" people into ill-considered decisions is short-sighted. The intelligent are not caught at all; and some of the others go home, think matters over, and become resentful. Barnum's famous saying, that "the public likes to be fooled," is not wholly true. Concerning **important** matters, the public does NOT like to be fooled.

Let's see if I personally have ever indulged in any improper methods of persuasion. Then, later, we shall see whether or not Mr. Warner's methods have been as ethical as mine.

Last year, at Des Moines, I made an address suggesting several ways of improving the League. I believe nobody who heard me doubted my sincerity of purpose. Even Director Kerr, who presided at that meeting, told the audience that some of my ideas were sound.

Furthermore, I played fair with the opposition by persuading the meeting to postpone tatking a vote on the question of endorsing the views expressed in the Minneapolis Radio Club's famous pamphlet, "Let's Put Our Own House in Order," until everybody had been given a chance to be heard. Then I left the hall, long before the meeting was over, and took a sleeper up to Minneapolis.

In West Hartford, however, the "insiders" immediately classified me as a "rabble-rouser." They reasoned it out this way: Since they were always right, there could be no legitimate way of convincing an audience that they were wrong; therefore, I **must** have led the Des Moines gang astray by misleading, yet persuasive, means.

I believe there's very little I can add to what I said at Des Moines last year. My address was subsequently printed in the May, 1934, issue of "RADIO"; and if any of you wish to review it, you will find it there. Has any progress been made in the year just past? Yes. QST is a better magazine than it was a year ago. Mr. Warner tells me that following the Board meeting last May, he made great changes in the magazine's make-up. That these changes have been real improvements, is borne out by the fact that League members increased by 3,249 in 1934, and news-stand sales jumped from an average of 16,145 per month to 18,798, an increase of 2,653 per month. **Truly, a little "heat" placed under executive officers by a vigilant membership with constructive ideas, is a good thing.**

A start has been made toward clearing up our membership problems, and confining the voting power where it belongs. In time, I believe this will work out all right—but I think our application blanks should require more details about the prospective members and their stations; and that these blanks should require applicants to state the expiration dates of their licenses.

A "census," too, has been made. The League sent two employees to Washington and checked its membership file against the records of the F. C. C.

By actual count, they found that as of the date selected—which I believe was December 31st, 1934—there were only 12,062 licensed American Amateurs in the League. As of that same date, Mr. Warner's own estimate places the number of U. S. A. " hams" who were licensed and active at 35,000. He made this statement to me at Minneapolis on February 16th, 1935, in the presence of several reliable witnesses. On that very same date, there were, in round numbers, **46,300** station licenses outstanding!

The League has announced that the census shows that 67.76 per cent of its U. S. A. members were licensed amateurs on the date selected.

This census ALSO shows, when we compare it with Warner's own estimate that on December 31st, 1934, there were 35,000 active licensed Amateur OPERATORS in the United States, that about one-third of these 35,000 were IN the league, and about two-thirds of them were OUT of it!

That's not a very good showing, but it is exactly in accord with our Twin City predictions, announced publicly back in February of this year.

I doubt if we can make good on the statement, published every month in the front of "QST," that our membership includes practically every worth-while Radio Amateur in the world.

I think the time is ripe for a vigorous membership campaign to be put into action; and I believe all Affiliated Clubs should be called upon to help. **(That shows, incidentally, how much I want to wreck this League of ours!)**

Some new faces have appeared on the League's Board. Whether or not this represents **progrses**, remains to be seen. The 1935 Board meeting will tell the story.

In the meantime, it seems well to re-emphasize an important truth :There is serious need for high-class, constructive thinking, on the subject of JUST HOW WE ARE TO KEEP, OR TO ADD TO, OUR PLACE IN THE AIR. And to those of you who plan to embark on such a study, I would point out right here and now, that there's no use "writing letters to Santa Claus." **We must PAY for our place by activities which are clearly in the public interest, or serve its convenience or necessity. THE REAL JOB IS TO SAY JUST HOW WE SHALL DO THIS.**

When Mr. Warner visited Minneapolis in February, he called on me at my office, and a group of three other "Hams," namely, Carl L. Jabs, Director of the Dakota Division; Webster Soules, former president of the Minneapolis Radio Club, and Cyrus L. Barker, of Henning, Minnesota, a former director of our Division, were also present, and participated in the conversation.

I asked Mr. Warner a number of questions about membership matters. Then I told him that I believed that the American Radio Relay League had begun its career with a definite purpose, namely; to organize transmitting Amateurs into reliable, workable, relay chains; **and that the League had never been able to achieve that purpose.** That being so, I expressed considerable curiosity to know **exactly what the League now existed to accomplish.**

Warner spent no time denying that the original purpose of the League had failed. He rattled off (from memory) a portion of the speech he was to deliver that evening, but I could find no answer to my question in it.

When he had finished, I told him that the phraseology appearing in the preamble of any written constitution was always flowery, pious, and necessarily general; and that what I was after was a simple, **specific** statement of the prime purpose of the League. As an illustration, I told him that I had in my possession a copy of a letter which a very intelligent English Amateur had recently written to Headquarters, criticizing the poor quality of the technical articles in "QST," and advancing the view that **the only real justification for Amateur Radio was the promotion of research work;** and I then inquired, specifically, whether the League now really existed to spread technical knowledge and to stimulate research work, or whether the main object of the League was to publish a profitable radio magazine, and keep us all amused by contests of various kinds.

Well, after about 2,000 more words of talk on Warner's part, I could piece these ideas together. The League existed to provide an instrument for collecting amateur opinion, ascertaining the majority view, and acting upon it; it also sought to provide the framework within which all of us could practice our own particular brand or branch of "Ham" radio pretty much as we individually pleased, so long as we didn't injure the other fellow; **AND THAT THE REAL PRIMARY OBJECT OF THE LEAGUE WAS TO ENABLE US TO GET MORE PLEASURE OUT OF OUR HOBBY.**

My answer to this effort was . . . that that **was all very nice**—but wasn't it up to the League to provide us with a kind of hard, protecting outer shell of legal protection, within the shelter of which we could all do as we damned well pleased.

Yes, that was part of the job, too.

Well, then, said I, how were we going to **purchase** this hard outer shell? Was it to be done by following our own desires, or was it up to us to do something useful to the public in between wars or public emergencies; and if so, what? If relaying was just so much child's play, should the Traffic Department be abolished, or did it still possess some merit?

Warner put forth absolutely no concrete suggestions. He made a series of interesting observations, however: That without the Traffic Department, we would simply become 'the Junior Institute of Radio Engineers," and something of the fraternal atmosphere would be lost; that it was embarrassing in international conferences to suggest that Amateurs were valuable in time of war; and that since the time when the League had "gone Democratic," back in 1924, and the Board Members had begun to be elected by the membership, instead of being appointed from Hartford, **the Directors hadn't seemed to be very good at producing really helpful ideas on fundamental questions.**

Well, God knows I agreed with that last remark; and I told him so.

I then said, that in my opinion, some simple, understandable, and perfectly definite main objective for the League to achieve should be found, and found at once; and I told him that in my opinion our main objec-

tive right now should be the legal protection of our existence, with everything else subordinated to that end.

I said, further, that I believed that much confusion of thought, and a great waste of energy, had been caused in the past by the policy of just drifting along without any very definite idea of what the League was supposed to accomplish, and without figuring out just how to steer.

I still think this was good advice. I suppose the reason it didn't evoke much enthusiasm on Warner's part, was the fact that he hadn't been so very successful on the political-legal front.

That evening, at the West Hotel, after Mr. Warner got through talking, I went into other matters, which have been reported in the April issue of "R/9," in case you are interested.

By-and-large, the present management of the League, while it has shown some disposition to turn over a new leaf, hasn't **really** reformed. Warner is still the same old Warner, although he is watching his step a lot more closely lately, and can no longer count on choking off all unpleasant publicity, now that there are other magazines than "QST" in the field. For years, he has had spineless Boards to deal with, and his control of the League's magazine has enabled him to keep unpleasant facts from spreading. **Any governing body can entrench itself if it controls the press.** And if you want to see a shining example of the way Headquarters has managed to preserve an appearance of complete candor, while, in fact, it is suppressing or soft-pedaling the facts, just compare the report of the political meeting at Des Moines last year as it appeared in the May, 1934, issue of "RADIO' with the report of the same convention as it appears on page 8 of the July, 1934, issue of "QST." The former account tells in detail exactly what happened. It tells of the endorsement of the views expressed in the pamphlet "Let's Put Our Own House in Order," and the instruction to Mr. Kerr to support those views at the 1934 Board meeting. It records how Mr. Kerr opened the meeting by reading his printed "request-for-advice sheet," followed by a speech by W9AQH of Minneapolis, and other addresses by W9JI of Ames, Iowa, Frank J. Sadilek, Leonard Collett, Guy E. Wilson, W9EL, of Kansas City, Missouri, Louis R. Huber, and Elwin J. O'Brien, W9GND, of Iowa City, Iowa. Then it gives the results obtained when certain questions (such as the extremely interesting one "Do we want Warner?"), were put to a vote. Then all the "fireworks" resulting from a discussion of the "N-prefix" question and the tie-up between RCA and NBC and the A.R.R.L. on the five-meter phone scheme, are recorded.

By contrast, the A.R.R.L. account, above referred to, is quite colorless. It dismisses the events of that Friday night with one sentence, which reads: **"The Friday night open forum was the high light of the convention where League policies were thoroughly discussed."**

Now, I ask you, does that "QST" account **really** give a "Ham" who didn't attend that convention a proper picture of what happened?

OF COURSE IT DOESN'T! AND HEADQUARTERS INTENDED THAT IT SHOULDN'T!

Notice how cleverly they have handled the situation—**Every word they say is true, but they don't tell the whole truth.** And the effect of trying to tell in brief form absolutely everything of importance that happened at the entire convention, is produced by a chronological treatment of the story.

And I am damned good and certain that much of the stuff that is dished out to the "Hams" in "QST" each month, is edited "right up to the handle." **We are told what** they think is good for us, and everything **else is either entirely absent or served up in treated form.**

Recently, Warner made a "contact-trip" through the Middle West, announcing at all stops that he was at last going to ask for some more frequencies at Cairo, and pointing out the difficulties in his path.

His tactics were quite shrewd. In every city on his route, he spent hours with the leaders of the opposition; invited them to dinner, bought them drinks, and kept up a steady flow of talk. In most cases, these people didn't bother him when the evening meeting came around. They sat quietly in their chairs and said not a word one way or the other.

At Chicago and Sioux City, and presumably at other points, extraordinary precautions were taken in advance by those in charge of the meetings TO PREVENT SO-CALLED "RADICALS" FROM GETTING THE FLOOR and spoiling Mr. Warner's evening for him.

In Minneapolis, 250 "Hams" sat silent for what at least **seemed** a long time, and heard Mr. Warner out, without the slightest interruption or discourtesy. After that, I made a speech, followed by several other amateurs, including Boyd Phelps and Rex Munger, who spoke from manuscript. There were also many questions from the floor. Before the meeting was over, I caught myself feeling sorry for Mr. Warner. He went out of town minus several tail-feathers, because in Minneapolis we had information which other places lacked.

When he reached Sioux City, he told some of the gang there that here in Minneapolis, we had played a dirty trick on him—we had talked with him in the afternoon, had gotten a lot of facts and figures out of him, and had then used those facts and figures against him that same evening.

Now, let's pause there a moment. **Warner asked us** to meet with him. **His object was** to pump us dry, if possible. I, for one, had written him an answer to his invitation several days before, saying that I would be glad to talk with him, was interested in learning all the facts, would stick to the truth, and play fair—but that I wanted him to understand that my views were the ones which I had expressed at Des Moines last year, that he could read those views in detail in the May, 1934. issue of "RADIO," and that I did not entertain a friendly feeling either for him personally or for the policies for which he stood. He had replied in writing that he understood my position, and thanked me for the frank statement of my views.

If he gave me incorrect figures and incorrect facts in the afternoon, that was a very unwise thing to do; and if he gave me correct facts and correct figures in the afternoon, how could anybody be fairer than I was, if I took his own figures out of his mouth?

And if we pumped him drier than he pumped us, in an interview sought by him, where he knew in advance that the conference was to be conducted "at arm's length," who's to blame for that situation?

I hate to think what a monkey the "hard-boiled" representatives of the commercial interests must make out of Mr. Warner when he attends one of these international conferences. **Those** birds are sent there on a **"produce-or-else"** basis, and are men capable of traveling in really fast company. Regardless of what you may think of Mr. Warner in other fields, he does **not** make a good public appearance, especially before a critical audience; and he lacks many of the qualities necessary for "rough-and-tumble" dealings with men of that type. These fellows tell him that if he won't make any more demands on behalf of the Amateurs, they'll support him; and he falls for it. Then they slip over a rewording of an important clause in the Madrid Treaty, and Warner reports "no material change."

Well, getting back to the Minneapolis meeting, it would take a long time to recount everything that happened, and I'm not sure I remember every little thing. I made very full notes on Warner's speech, and took a few notes on the questions put to him from the floor. But I do remember, very vividly, one very significant series of statements which Warner made in answer to various "Hams" who asked questions from the floor. First, he explained that if the League should pay even a nominal amount for technical articles, it would cost two or three thousand dollars a year, which in some years might mean the difference between black figures and red. **Then he said that, in his opinion, the League should not pile up a big surplus, but should spend most of its income each year "ON 'HAM' RADIO." At this point, it** must have occurred to somebody in the **audience that Warner might consider that when the League paid WARNER a high salary it was really spending the League's income on Amateur Radio; for he was asked, quite pointedly, what his present salary was. The answer, as we all know, was "TWELVE THOUSAND DOLLARS PER YEAR."**

Think that one over. Although it isn't good judgment to pay the members of the League two or three thousand dollars a year in the aggregate, for value reecived, and then some, still it **is** really good business to pay Warner TWELVE "GRAND"!

Later he wrote me that he was against paying the Amateurs for articles, because of various intangible considerations, and not for financial reasons.

There really is no cure for the situation, other than to elect really good men to the Board of Directors, and then to insist that they **actually direct.** Warner's most common answer when he felt that somebody had him in a hole, was to say that he was only following the directions of the Board. That would be an excellent answer if the Board really exercised its legal power to run things, and if the Headquarters bunch didn't do about as they liked by controlling the Executive Committee. **The Board can't possibly hope to direct on one meeting a year, and live on Warner's letters in between-times.** It's really a rarity to find a Board anywhere that really directs. Ask some of your lawyer friends and business acquaintances who really know how corporate business in the average corporation is transacted.

It is only natural for Warner and the rest of the employees to try to get as much salary "as the traffic will bear." It is up to the Board to see to it that the "sugar" is properly rationed, and to rap the fingers of those who dip into the "sugar-bowl" too deeply or to often. I doubt if the fair market value of Warner's services is twelve thousand dollars a year. Could he **really** command that salary **elsewhere** ?

Then, too, the Board should do away with that part of our Constitution which allows them to select a President and Vice-President who have not been elected by the members at large to the office of Dirctor. The way it is now, they can select **anybody**; and the persons so selected automatically become members of the Board, and have a vote apiece.

For sentimental reasons it has been customary to select Mr. Maxim and Mr. Stewart, year after year; so we have been fortunate in having their choice so wisely exercised. But

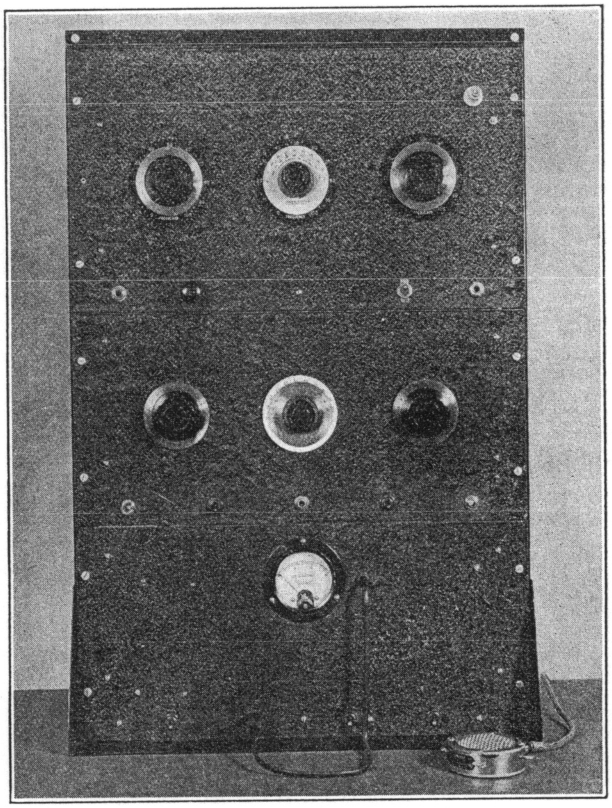
(Continued on page 18)

★ A Simple, Highly Efficient Phone-C.W. Set

Using Class B-C Grid-Bias Modulation, New Harmonic Oscillator and Simplified PI Network Antenna Coupler

By FRANK C. JONES*

● The simplicity and economy of grid-bias modulation becomes apparent only when tubes of the "50 watt" and larger sizes are used, because power supplies and transformers for class B audio amplifiers are inexpensive and thus it is good economy to use high level plate modulation for phone transmitters in which tubes of the size up to the 210 or 830B are used. As the power is increased, the cost of a high level plate modulator rises literally as the square of the power so that the marked simplicity of grid-bias modulation is very desirable. Another advantage of grid-bias modulation is in the fact that approximately 90% of the parts used in a transmitter consist of CW equipment, while the other 10% is used solely for phone operation. Therefore, an operator whose primary interest is CW need but keep only a small portion of his equipment idle when CW is used. On the other hand, in a plate modulated phone probably more than half the total cost of the equipment is tied up in the audio channel and modulator power supply, all of which adds nothing to the CW signal which must remain idle when CW is used.



The complete phone in a 3-section standard relay rack. The bottom section holds the power supply; the center section holds the oscillator-doubler-buffer stages; the upper section holds the final amplifier, modulator and antenna tuning network.

● The Story In a Nutshell

Many phone amateurs have recently contacted W6AAR on the 75 meter band, where tests were conducted to prove the effectiveness of the new grid-modulated phone here described. The results have been most satisfactory. Frank C. Jones has designed this inexpensive phone-c.w. transmitter which uses a 57 and a 2A5 tube to grid-modulate the final amplifier. The tuning-up details are fully told and the many questions relating to grid modulation are answered here. This new transmitter uses the Harmonic Oscillator described elsewhere in this issue.

General Description

● Grid modulated phones are simple to adjust if the proper circuits and constants are used. A grid modulated phone can be put on the air for only a few dollars more than the cost of a CW transmitter. A plate modulated phone of 50 watts or more of power costs at least twice as much as the CW portion of the transmitter and is not easier to properly adjust than a modern grid modulated phone. There are several types of grid modulation systems but the one which seems to give the best quality and efficiency, and which is easiest to adjust, uses the circuit developed by J. N. A. Hawkins for class BC grid modulation.

When this form of modulation is used the grid bias on the final stage is varied at audio frequency by means of a low-power modulator. A 57 tube is used as a speech amplifier from a crystal microphone, driving a 2A5 pentode for modulating a type 211 tube. An audio swing of less than 200 volts is all that is required for complete modulation, while with plate circuit modulation a swing of at least four times as much would be necessary for a carrier of 50 watts. The saving in modulator cost varies about as the square or cube of the audio output required. Thus grid modulation is very economical.

For grid modulation, the RF excitation is much less than for CW or plate modulation, and in most cases the fixed battery C bias is set to 1½ times cutoff. In this form the fixed bias is set for cutoff and self-bias from a cathode resistor is used to give additional bias of 150 to 200 volts. Using only a fixed bias equal to cutoff, and a self-bias to take care of the audio swing in addition, the usual grid modulation distortion is greatly reduced and higher efficiency is obtainable. It is called class "BC" because it operates in a manner similar to an ordinary class B RF amplifier, but is biased fully class C. Using fixed bias greater than cut-off, greatly increases the distortion and makes the system more difficult to properly adjust. This class BC system is simple to adjust because it only requires that the RF excitation be dropped until only a few milliamperes of grid current flow. Furthermore, the antenna load must be slightly greater than is normal for CW operation.

The oscillator and buffer stages are similar to those described under "The Crystal Harmonic Oscillator." Either the fundamental or second harmonic of the 53 tube is used to drive a 2A3 or 45 tube buffer stage. The latter gives from 14 to 18 watts for driving the grid of the final 211 stage. This is needed for CW operation at the plate voltage available. For phone operation this is too much driving power, and part of it can be "swamped-out" by means of a 100-watt lamp shunted across the link circuit and the remainder reduced by slightly detuning either the 211 grid circuit or the crystal oscillator circuit. The second harmonic is needed for operation in the 20-meter band. It also allows operation on 40 meters from an 80-meter crystal. The output from the 2A3 neutralized buffer stage is about the same for either fundamental or second harmonic operation of the crystal oscillator.

The final stage has a very effective method for coupling to either a single wire fed Hertz antenna or an end fer Fuchs antenna. It is similar to the Collins antenna tuning system, but unlike the Collins system there are no losses introduced by an additional tuned circuit. The condenser C1 provides a low impedance path for harmonics and the inductance acts as an RF choke; therefore there are practically no harmonics across the antenna coupling condenser C2, or C2 and C3. The fundamental frequency has its proper impedance drop across the antenna condenser for matching from 2000 down to 50 ohms, or so. The antenna is easily matched with this system and usually more actual power

* W6AJF.

gets into the antenna than when other systems are used. It is possible to use nearly any length of end fed antenna and get results not obtainable with other antenna coupling systems. It acts as a low pass filter and practically eliminates illegal radiation of harmonics.

It is rather difficult to feed into a Zepp antenna with this system. The load on the final amplifier is not heavy enough to properly load it for grid modulation. By tuning the feeders separately to resonance and by the connection of C3 (a 1000 volt mica condenser across C2) Zepp feeders will give satisfactory results. A well spaced receiving condenser, rated at 1000 volts, is sufficient for C2 but C1 should be rated at least 2500 volts in order to keep from breaking down on RF peaks. With the power supply used (1800 volts) the output is about 60 watts carrier for phone and over 200 watts for CW operation. It is conservatively rated as a 50-watt phone and 150-watt CW transmitter. Keying is conveniently accomplished in the cathode of the crystal oscillator because all stages are biased beyond cut-off and the tuned circuits between antenna and crystal stage tend to eliminate key clicks, which are spurious side bands.

Constructional Details

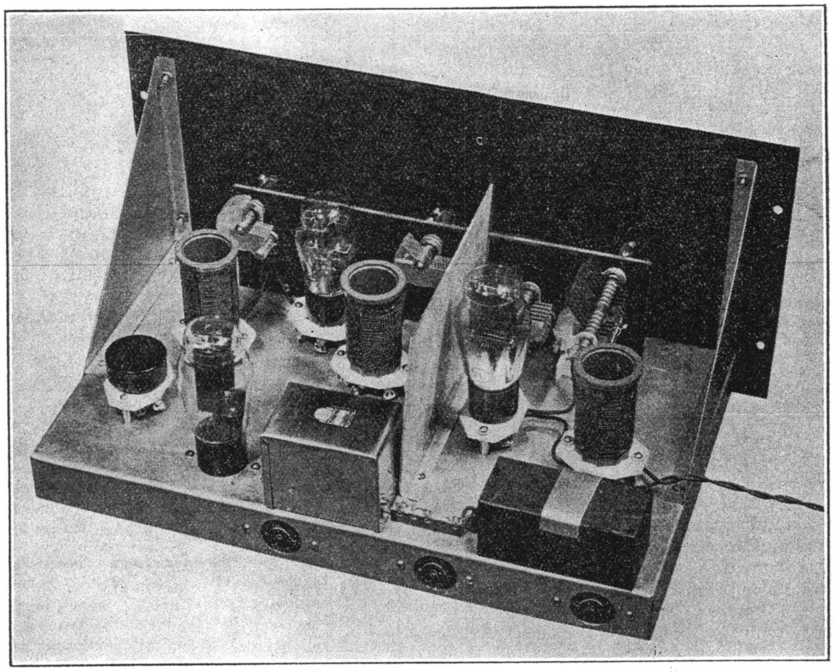
This transmitter can be conveniently built into a table mounting type relay rack as illustrated. The power supply is built into the lower deck on a 10-in. x 17-in. x 1½-in. chassis pan, behind an 8¾-in. x 19-in. front panel. This chassis rests directly on the base and the heavy power equipment does not put a strain on the front panel. Most of the inter-connections between panels are by means of 5 conductor patch cords, using tube sockets at the rear of each chassis for plug-in receptacles. The 10 volt 211 tube filament leads and +B 211 plate lead are run through separate insulators for cross-connection with heavier conductors and higher insulation. This method of cross-connection makes it convenient for testing before the units are assembled into the relay rack.

The power deck holds the high voltage transformer which should be rated at 1500 volts RMS each side of center-tap and capable of supplying at least 200 MA of DC load out of the filter. The filter consists of two 2 mfd. 2000 volt condensers connected across the 15 to 20 henry 250 MA filter choke. This gives sufficient filtering for phone use because the load current is only 100 MA for grid modulation. The heavy antenna load probably helps prevent hum modulation in the form of plate modulation. The 866 rectifiers, filament transformers and low voltage supply transformer, and 0-300 milliammeter are also mounted on this deck and panel.

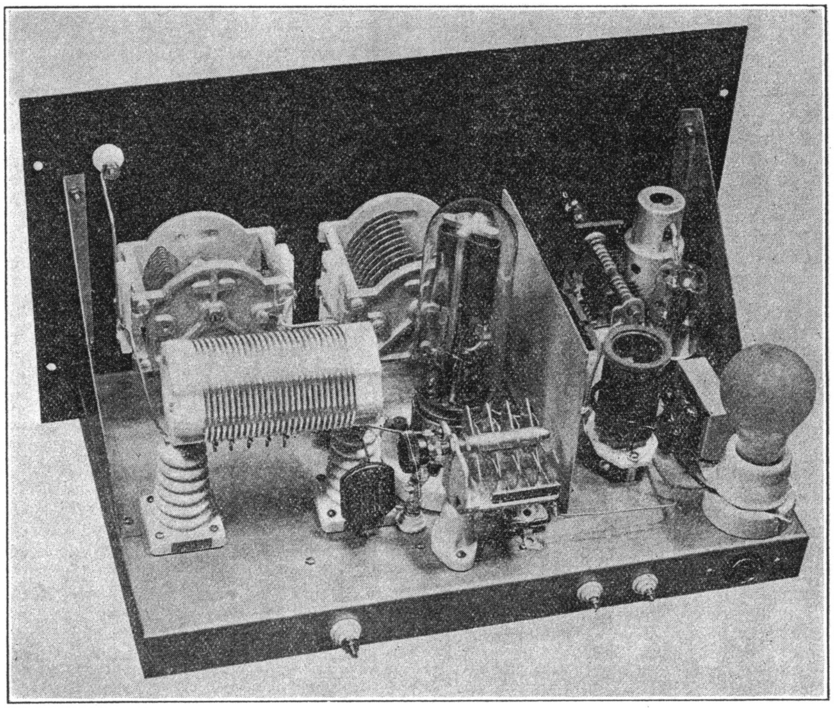
All decks are made the same size, 10-in. x 17-in. x 1½-in., and the second or middle deck also mounts behind an 8¾-in. x 19-in. relay rack panel. This deck contains the low voltage rectifier, 83v, and filter system, and the crystal harmonic oscillator and buffer stage. The tuning controls are brought out through insulated couplings to dials on the front panel. The buffer stage is neutralized by means of a screwdriver adjustment through a hole in the front panel. An aluminum shield is placed between the crystal and buffer stages to minimize RF feedback. The tube, coil, and crystal sockets are arranged for convenience around the midget tuning condensers. Since isolantite sockets are used, ¾-in. diameter holes are made under each socket for the wiring, most of which is under each deck. Ordinary good radio hookup wire is satisfactory for wiring this deck. All high voltage leads are made with small flexible wire, insulated for 10,000 volts breakdown.

The top deck mounts behind a 19½-in. x 19-in. front panel and holds the modulator system and final RF stage. The entire modulator system occupies a space about 2-in. x 6-in. The grid circuit of the 211 tube is link coupled to the 2A3 buffer stage. An aluminum shield is placed between the grid and plate circuits of the 211 stage in order to insure ease of neutralization. Grid neutralization is used and functions perfectly, neutralizing fully as easily and as well as plate neutralization. The plate and antenna condensers are mounted on the front panel; the

(Continued on page 12)



The Harmonic Oscillator and the buffer stage. Note that the tuning condensers are mounted on a long bakelite strip. The condenser shafts are insulated from the front metal panel. At the rear of this unit, to the left, is the 83V rectifier tube and alongside of it is the power supply choke for the low-voltage supply. The filter condenser bank is at the extreme right.



The Final Amplifier and the simplified PI Antenna Network. To the extreme right is seen the 57 tube (shielded) and the 2A5 tube, these two tubes constituting part of the simple modulation system. The small modulation transformer is seen alongside the grid coil. The grid tuning condenser is mounted on a bakelite support and the condenser shaft is insulated from the front metal panel. The 100 (or 200) watt lamp bulb is in shunt with the coupling link, although this lamp may not always be required. The coupling link around the grid coil has two turns, 2 inches in diameter.

Grid-Modulated Phone

(Continued from page 11)

rotors of the condensers are grounded. The grid and neutralizing condensers must be mounted on insulators. The three controls on the top panel are arranged to be symmetrical with those on the middle deck in order to give a pleasing appearance.

The easiest way to build a set of this type is to get all the parts, set them in place on the chassis and then make the layout. Few amateurs use identical parts and therefore no "blue print specifications" are given for exact drilling and mounting of parts.

The current measuring jacks are mounted on the front panels without insulators; however, the two grid current measuring jacks are insulated from the panel because they must be connected-up in an opposite manner to that used for cathode circuit jacks. It is desirable to use a 0-25 MA meter for grid current measurements. Either a 0-200 or 0-300 MA meter is suitable for the other measurements.

The speech amplifier should have the input leads shielded so as to prevent audio and RF feedback. The resistors and condensers can be mounted beneath the upper deck by means of terminal strips. If a small modulation transformer is used, it is desirable to balance-out the DC in the primary winding, as shown. This loading resistor also provides a needed load on the pentode modulator because the grid impedance of the 211 is not constant. This transformer is a small universal type class B transformer, originally designed for either input or output use with several taps. A number of manufacturers have such a transformer on the market. This transformer circuit arrangement greatly improves the audio frequency characteristic of small transformers.

Circuit Adjustments

It is desirable to first test the power supply and, of course, to run the 866s for a half hour without plate voltage in order to remove mercury from the cathodes. If conservative ratings on resistors, filter condensers and transformers have been made, the power supply should stand-up in regular operation on either phone or CW. Under no load, the high voltage supply should deliver nearly 2000 volts, because condenser input is used. The low voltage supply should deliver as high as 400 volts under load of about 160 MA.

The crystal oscillator should light-up a single turn of wire in series with a 6-volt pilot lamp, when it is coupled to either the oscillator or doubler coils. A small neon lamp can be used to test for oscillation and best setting of each condenser dial. The lamp also provides a convenient indicator for neutralizing the buffer and final amplifier circuits. Plate voltage can be removed from these circuits by plugging-in an open-circuit plug in the cathode circuits. It is advisable to shut off the high voltage supply when neutralizing the final, because an open-plug would probably arc across.

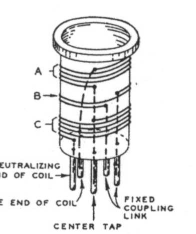
The link coupling and preceding tuning adjustments should be made so as to obtain maximum grid current in the 211 tube. Without plate voltage, this grid current should be between 30 and 40 MA. Under load this current will be less, because the cathode resistor builds up additional bias due to the plate current.

Neutralizing the final amplifier is simple if a tapped coil is used instead of a split-stator condenser in the grid circuit. Neutralizing on 20 meters is somewhat more difficult than on other bands, but even the old 211 tubes seem to neutralize well on 20 meters.

Coil-Winding Table For Grid-Modulated Phone

NOTE—5-Prong 1½-in. Dia. Coil Forms Used Throughout, Except for 211 Amplifier Plate Coil.

Band	OSCILLATOR COIL L1	DOUBLER Plate Coil L2	BUFFER PLATE COIL L3	211 GRID COIL L6	211 PLATE COIL L7
160 Meters	68 turns, No. 22 DSC, close wound on 1½-in. dia. form. Winding space occupies 2$\frac{1}{16}$-in.	NONE	78 turns, No. 22 DSC, close wound on 1½-in. dia. form. Winding space occupies 2¼-in. tap to be taken at center of winding. Also a 2-turn winding is to be wound in center of coil for coupling link. See drawing of coil form for data.	77 turns, No. 22 DSC, close wound on 1½-in. dia. form, center-tapped. Winding space occupies 2¼-in.	51 turns, No. 14 enameled wire, wound on 2½-in. dia ceramic or bakelite form. Winding space occupies 3⅝-in.
80 Meters	27 turns, No. 22 DSC on 1½-inch dia. form. Space wound to cover 1½-inch winding space.	Same coil as 80 meter oscillator coil for doubling to 80 meters from 160 meter oscillator.	45 turns, No. 22 DSC, close wound on 1½-in. dia. form, center-tapped. Winding space occupies 1⅞-in. A 2-turn coupling link is wound in center, same as for 160 meter coil.	44 turns, No. 22 DSC, wound on 1½-in. dia. form, center - tapped. Winding space occupies 2-in.	26 turns, No. 12 bare wire, space wound, on 2½-in. dia. form to cover a winding space of 3½-in.
40 Meters	13 turns, No. 18 DCC on 1½-inch dia. form. Space wound to cover winding space of 1½-inch.	Same coil as 40 meter oscillator coil for doubling to 40 meters from 80 meter oscillator.	22 turns, No. 18 DCC on 1½-in. dia. form, center-tapped. Winding space occupies 1¾-in. A 2-turn coupling link is wound in center, same as for above buffer coil.	22 turns, No. 18 DCC, wound on 1½-in. dia. form, center - tapped. Winding space occupies 1½-in.	12 turns, No. 12 bare wire, space wound on 2½-in. dia. form to cover a winding space of 1½-in.
20 Meters	Use 40 meter oscillator coil.	7 turns, No. 18 DCC on 1½-inch dia. form. Space wound to cover a winding space of 1⅜-inch.	12 turns, No. 18 DCC on 1½-in. dia. form, center-tapped. Winding space occupies 1¾-in. A 2-turn coupling link is wound in center. Same as for above coil.	10 turns, No. 18 DCC on 1½-in. dia. form, center-tapped. Winding space occupies 1⅜-in.	5 turns, No. 12 bare wire, space wound on 2½-in. dia. form, to cover a winding space of ¾-in.



Showing how the buffer plate coil is wound. 5-prong Hammarlund forms are used. The link coupling loop portion of the winding has two turns, in the center of the form. A and C are the two halves of the plate coil winding. B is the two-turn coupling loop, L4 and L5.

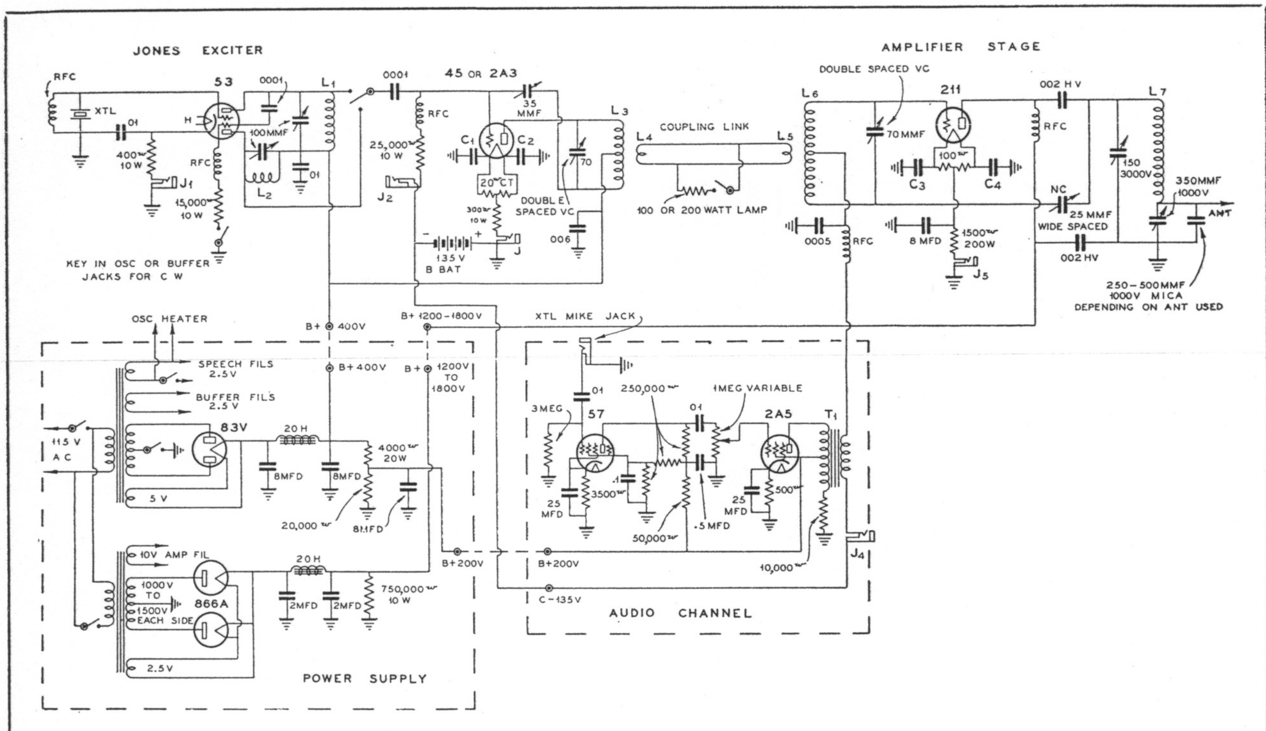
The antenna circuit should be adjusted simultaneously with the plate condenser C1 in order to remain in resonance, as denoted by minimum plate current. Never disconnect the antenna or dummy antenna load unless the plate voltage is reduced to not over 1000 or 1200 volts, because C2 will flash-over on RF peaks. For CW operation, use all of the available grid excitation and adjust the antenna condenser C2 until maximum output with normal plate current is obtained. C1 should always be set for resonance, or lowest plate current. For CW operation the plate current should be in the neighborhood of about 200 milliamperes.

The adjustment for phone is simple—turn on the modulator filament switch—increase the antenna current to maximum, even

(Continued on facing page)

How To Wind the Coupling Link On the Coil Forms

The Buffer Plate Coil for any band is center-tapped. At the center of the buffer plate coil winding, this winding is spread apart so that a 2-turn coupling loop can be wound directly in the center of the coil. This is a fixed coupling loop and the connections are brought to two of the prongs on the coil form base. The link coupling loop of two turns on each of these buffer plate coils does not require a variable adjustment. The same size wire is used for winding the two-turn coupling loop as is used for winding the coils proper. On the 160-meter buffer plate coil this 2-turn loop is close wound with the other winding. On the 80-meter buffer coil this 2-turn loop is separated by $\frac{1}{16}$-in. from both sides of the coil winding proper. On the 40-meter buffer plate coil the loop is separated by ⅛-in.; on the 20-meter buffer plate coil the separation is ¼-in. The illustration of the coil form clearly shows how this fixed 2-turn coupling loop is arranged. Although the coupling loop is fixed on the buffer plate coil, the loop at the other end of the coupling link (around the final amplifier grid coil) is made adjustable. Only one of the coupling loops need be made variable. The coupling loop around the final amplifier grid coil has 2 turns of No. 14 enameled wire, supported around the center of the grid coil, and the loop is two inches in diameter. Thus there is a ¼-in. free space, all around the coil, between the coupling loop and the coil winding proper.



Complete Circuit Diagram of the Grid-Bias Phone CW Transmitter.

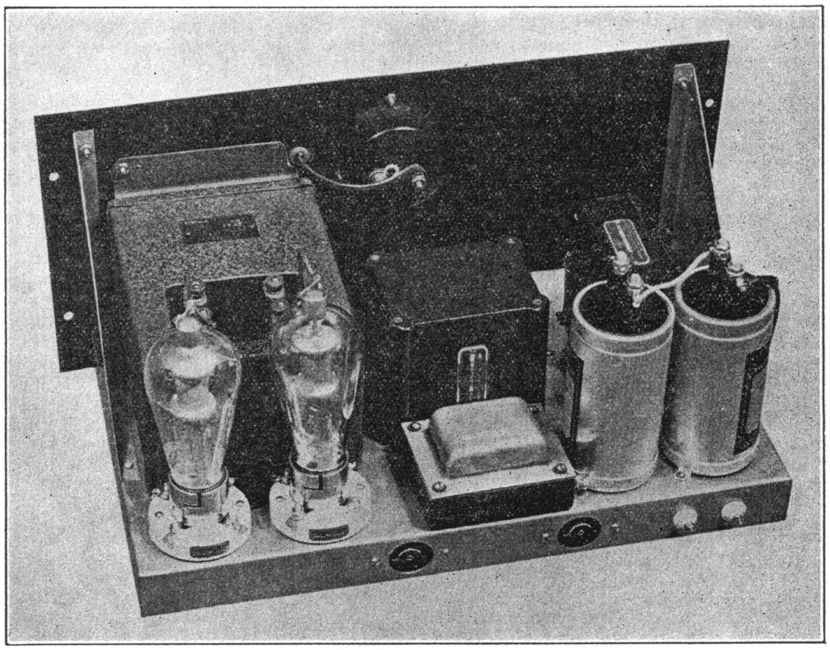
though the plate current is high—then reduce the grid RF excitation until only a few grid mills flow.

If the load is proper, the plate current will run about 100 MA with an 1800 volt supply. Since a cathode bias resistor of 1500 to 1700 ohms is used, the actual plate voltage is only about 1600 volts. This gives 160 watts input. Because as much as 40% efficiency is obtainable, the plate dissipation is within the normal 100 watt rating of the 211 tube.

The flashlight lamp and single turn of wire, or an antenna RF meter, should be used to make sure that upward modulation is being secured when the microphone is whistled into. The antenna current should rise about 22% on a steady tone. When talking, the antenna current should be nearly stationary, as with any plate modulated phone when operated within the 100% modulation rating. If downward or insufficient modulation is obtained, it is usually an indication that too much RF excitation is being used. The grid and plate current meters should stand still on modulation, except for a very slight upward kick on overmodulation peaks.

Reducing the RF excitation by screwing the 100 or 200 watt lamp into the receptacle across the link coupling circuit, and by slight grid current detuning, the carrier is reduced from a 150 or 200 watts on CW to 50 or 60 watts on phone. Normally a good CW antenna load will be sufficient for phone operation and thus only one adjustment is needed—**reduce the grid RF excitation until good upward antenna current swing is obtained when the microphone is whistled into.**

The total speech amplification is only great enough for close-speaking operation with a crystal microphone. One possible source of distortion or "downward" modulation swing is in the modulation transformer. If this transformer saturates, it causes trouble. Usually a 2-to-1 impedance step-down ratio from the 2A5 plate to 211 grid is satisfactory in this transformer. For phone operation the CW key can be used for push-to-talk control, or the low voltage power supply center-tap switch can be used.



The lower section of the relay rack holds most of the power supply equipment, as shown above. The low-voltage power transformer, high-voltage power transformer, two 2 mfd. 2000 volt Aerovox oil-filled transmitting condensers, rectifier filament transformer, two 866A rectifier tubes, heavy duty choke for the high-voltage filter and the milliammeter are clearly shown.

The external C battery of 135 volts is correct for a total applied plate voltage of 1800 volts. The correct value is obtained by dividing the plate-to-cathode voltage under load by the amplification constant of the tube. This is about 12 for a 211 tube. In using a 203A, 50T, 150T, or 354 Gammatron, the same procedure should be used.

(Continued on page 26)

The Controlled Carrier Class B Linear

By J. N. A. HAWKINS*

● Controlled Carrier Modulation is receiving a great deal of attention and numerous systems of controlling the average input and carrier output of a class C plate modulated amplifier have been developed and successfully applied to high-frequency phone transmitters.

One of the earliest systems uses the variation in average plate-to-cathode resistance of a class B audio stage to series-modulate the class C stage. The audio output of the class B audio amplifier is then fed through the conventional class B output transformer into the plate circuit of the controlled and plate-modulated class C amplifier.

This system is quite simple, although it has two disadvantages. The resistance of the plate to cathode path of the class C stage is in series with the B plus high voltage lead to the modulators, which is the equivalent of placing a 5,000 ohm resistance in the B plus lead. This materially affects the voltage regulation of the DC plate voltage supplied to the modulators, with some consequent audio distortion. This variation of the plate voltage applied to the class B modulators also causes the "cut-off" bias point to move around as the audio signal varies. If anything but a zero bias modulator tube were used, this would mean that the modulators would be operating class C part of the time, which is not conducive to high fidelity.

The other disadvantage is that the plate voltage across the modulators, in the resting condition, must be about twice the operating plate voltage, which means that lower than normal operating plate voltages must be used because there are no zero bias modulator tubes available that will stand plate voltages of twice the normal operating voltage. Consequently the maximum power output must be cut down below that which the same tube capacity could deliver in the conventional system of constant carrier modulation.

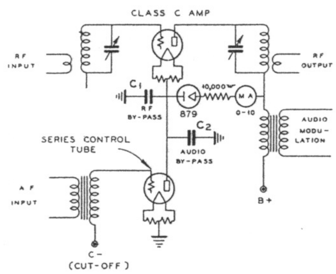
Another system of controlled carrier modulation of a class C amplifier uses grid controlled rectifiers in the plate power supply. These grid controlled mercury vapor rectifiers allow a simple means of controlling the DC plate voltage at syllabic frequencies, but the system has the disadvantage that there is some lag in the power supply filter which prevents the syllabic modulation from following any but rather slow-speed variations in the speech. For this reason, the ratio of maximum to minimum carrier is slightly limited, because enough resting carrier must be provided so that the audio modulation will not catch the carrier napping, and cause overmodulation.

For high power operation this system is extremely useful because, if applied to a three-phase power supply, the lag can be practically eliminated, because a three-phase power supply requires extremely little hum filtering.

Another simple and usable system is the one developed by Mr. I. A. Mitchell. It uses the variation in DC plate current drawn by a class B audio amplifier (the modulators), to control the saturation of a dropping reactor in series with the primary of the class C amplifier plate power supply. As the DC drawn by the modulators increases, the reactor core becomes more saturated, which reduces its AC resistance and allows more current to flow in the primary circuit of the class C plate power supply. This increased current, which corresponds to raising the primary voltage, increases the DC plate voltage and thus causes the input and average carrier output of the class C stage to increase with modulation.

The latest improvement on the original series-control system is shown in Figs. 1, 2 and 3. In these circuits the control is separated from the modulation, and separate tubes are used for each function. This eliminates any compromises in regard to the operation of the modulators and any type of audio modulation can be used, class A, B or class AB, single-ended or push-pull. All three circuits show single-ended class A modulation because it is the most simple and is just about as economical as any other system, for low power use. It is also somewhat simpler to adjust for good fidelity.

Fig. 1 is a simplified circuit which shows



HALF WAVE SERIES CARRIER CONTROL

FIG. 1

that the syllabic control tube's plate-to-cathode path is in series with the negative lead, or center-tap lead, to the class C modulated amplifier. Thus it resembles very closely a conventional keying tube, and that is practically what it is. Instead of merely keying "on" and "off", it keys up and down in accordance with the average power of each syllable in the speech. On the loud syllables the resistance o fthe control tube is reduced, which places most of the plate voltage across the class C tube, raising its carrier output. Of course, the DC plate voltage to the class C amplifier is simultaneously being modulated by the audio output of the modulators, which is shown coming through the output transformer at the right, although choke modulation could have been shown just as easily. Thus it should be remembered that the carrier is really being modulated twice, once by the syllabic control and once by the audio signal. These two modulations do not get mixed, because they differ widely in frequency. The audio modulation components usually are in the frequency range between about 80 and 8,000 cycles, while the control modulation frequencies are in the range between zero cycles and about 20 cycles per second.

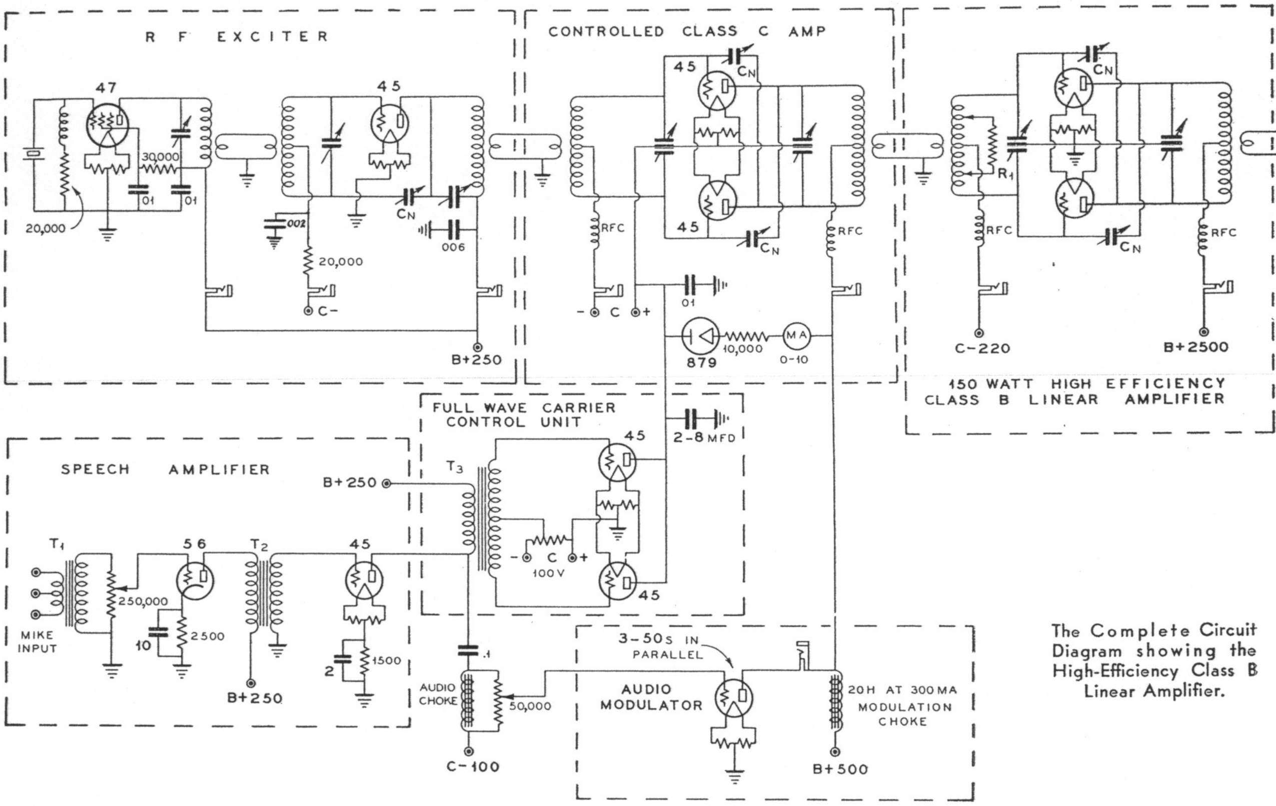
The circuit of Fig. 1 shows only one control tube, and while this is entirely workable, there are some advantages in the use of two tubes.

Fig. 3 shows the use of two tubes as the control elements, in what looks like the conventional push-push doubler circuit. That is just what it is, although a better term for this use of these tubes would be "Full-Wave Rectification". As these tubes are biased close to cut-off, they act as detectors, or rectifiers, because they turn the AC audio voltage into a varying DC voltage which alternately increases or decreases the DC voltage drop across the control tubes. Varying this voltage drop naturally varies the current through every part of the series circuit, and thus varies the power input and output of the class C stage.

The important advantage of the full wave circuit shown in Fig. 3 (and Fig. 2) is that less capacity is required in the audio by-pass between the control plate and ground, which reduces the lag inherent in all carrier control circuits. It corresponds exactly to the hum filtering and primary keying problem in any CW transmitter. It is well known that full-wave, high voltage rectifiers require less hum filtering and thus can follow primary keying with less lag than if half-wave rectification is used. The full-wave control circuit shown applies a DC impulse to the controlled circuit twice each audio cycle, instead of just once per cycle. Of course, there are other ways of obtaining this same type of full-wave control. One usable system would utilize a type 80 full-wave rectifier connected across the secondary of a push-pull input transformer in the conventional power supply rectifier circuit. The DC output of this rectifier could be filtered to remove the audio component and then applied to the grid of a DC amplifier tube whose plate circuit is in series with the ground return to the class C amplifier. The adjustment of such a system would be somewhat more complex than the method shown, and would have no particular advantages.

The 879 rectifier tube shown in each circuit may puzzle the reader, but its use is extremely important if trouble is to be avoided. This tube, with its associated resistor and meter, is an overmodulation indicator. It indicates only overmodulation on the negative peaks, which are the ones in which we are most interested, because the negative peaks cause most of the undesired interference which can be attributed to overmodulation. It works by reason of the fact that when a class C stage is overmodulated on the negative peaks, the plate voltage has been swung BELOW zero. In other words, the negative AC audio voltage exceeds the positive DC plate voltage so that the plate of the class C amplifier becomes negative with respect to its filament, which, of course, has no effect on the power output, as it can only go to zero and no lower. When the plate of the class C stage goes negative, with respect to its filament, it means that the filament of the 879 rectifier tube goes negative with respect to its plate. In other words, the PLATE OF THE 879 HAS BECOME POSITIVE WITH RESPECT TO ITS FILAMENT. This is the condition for passage of current through any rectifier tube, which allows the meter in series with the 10,000 ohm load resistor to indicate overmodulation. It is very easy to overmodulate a carrier controlled class C amplifier and overmodulation is quite difficult to detect unless this indicator or a cathode-ray oscilliscope is used. The 879 is the small, high-voltage thermionic rectifier designed originally for cathode ray tube circuits and can stand peak voltages of 2,000 volts without danger of breakdown. In low voltage carrier controlled circuits it is possible to use an 80 or 81 rectifier, as long as the peak voltages present do not cause the tube to arc over. This overmodulation indicator also acts as overmodulation minimizer because it throws a load across the modulator output as soon as the overmodulation occurs. It has no effect whatever on the circuit as long as the class C stage is not overmodulated.

* W6AAR and "IL" of W6UF.



The Complete Circuit Diagram showing the High-Efficiency Class B Linear Amplifier.

FIG. 2

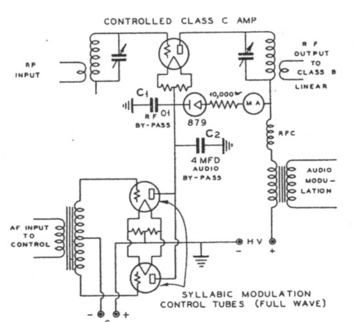
The High Efficiency Class B Linear Amplifier

● It will be evident that carrier control of a class C stage is not particularly economical, when calculated on a basis of watts per dollar of EFFECTIVE carrier. There is some slight saving in the tube capacity required for a given carrier plus sideband output from the class C modulated amplifier because the filaments and plates of the modulated amplifier get a much-needed rest between words and sentences. However, this saving is only a small fraction of the total transmitter cost. The audio modulators and power supplies are not changed, as far as cost per watt is concerned. In some of the best carrier control systems the addition of control reactors or series control tubes more than offsets the savings to be realized from the reduction in class C tube capacity. The advantage of cutting down break-in cross-talk and distant heterodyne interference is worth the extra cost and complication inherent in most carrier control systems if a class B linear amplifier follows the carrier controlled class C stage. The addition of a fairly conventional class B linear RF amplifier to the carrier controlled transmitter allows really surprising economies to take place, when figured on a basis of watts per dollar.

It is well known that the ordinary class B RF linear amplifier is rather undesirable for general amateur use because it is very inefficient when unmodulated (assuming conventional constant carrier modulation). A large amount of plate dissipation capability must be provided in the tubes used in the linear amplifier; at least two watts of dissipation ability for each watt of carrier output.

Thus a 100-watt linear amplifier usually requires about 300 to 400 watts of DC plate input, of which from 200 to 300 watts must be dissipated in the form of heat from the plates of the tubes.

In the controlled carrier system the picture is quite different because the DC INPUT TO THE LINEAR VARIES WITH THE SYLLABIC MODULATION AND IS QUITE LOW WHEN THE TRANSMITTER IS UNMODULATED. This means that the EFFECTIVE CARRIER OUTPUT of a given tube used as a linear amplifier in a controlled carrier system can be from two to four times the carrier output from the same tube when used as a conventional constant carrier class B linear amplifier. Thus the EFFECTIVE EQUIVALENT carrier output that can be obtained from any given tube when operating as a controlled carrier linear rather closely approaches the carrier output that can be obtained from the same tube when used as a high level, or plate modulated class C amplifier.



SIMPLIFIED CIRCUIT OF FULL WAVE SERIES CONTROL

FIG. 3

The maximum EFFECTIVE carrier output that it is possible to obtain from any tube can be estimated by taking two-thirds of the class B audio output of that same tube. This is derived from the fact that at 100 per cent modulation the output from any phone transmitter consists of two-thirds carrier and one-third sideband power. Thus three-thirds equals the maximum safe power output when biased to cut-off, and this amount will about equal the maximum class B AUDIO output from the same tube, because most class B RF amplifiers can be made at least as efficient as a class B audio amplifier.

Thus about 15 watts of effective carrier output can be obtained from a single 210 tube. A 50T has an effective carrier output of about 75 watts and a 150T has a maximum effective carrier output of better than 250 watts. These linear amplifier outputs are better than four times the output from conventional linear amplifiers.

The circuit of such a class B linear amplifier is shown in Fig. 4 and is conventional in every respect. The linear amplifier can consist of either a single-ended stage, or a push-pull stage, because the harmonic distortion inherent in all class B amplifiers is of little importance at radio frequencies. There is no difference in the audio quality which can be obtained from either type of linear amplifier. The linear amplifier should be biased slightly below cut-off, for best linearity. This point is the same as that recommended for the same tube operating as a class B audio amplifier. In fact, in many respects the amplifier acts just like a class B audio amplifier and thus might be said to be modulating itself. The DC plate current in the resting condition (no modulation present) is usually quite low, and is dictated by the minimum value of carrier output from the controlled class C stage.

In one case, a final linear amplifier drew about 150 watts of plate input, unmodulated, and the input rose to slightly better than one

(Continued on page 16)

KW on the voice peaks, at which time the output consisted of close to 750 watts of RF power. This was determined by tone modulation. The class C modulated amplifier was nearly 100 per cent modulated at that point, which indicated that about 500 of the 750 watts of RF output consists of EFFECTIVE CARRIER and the other 250 watts consists of audio sideband power. EFFECTIVE CARRIER means that amount of steady carrier power which would just equal twice the maximum sideband power available. This amplifier consisted of a pair of 150Ts in push-pull, operating at 2500 volts plate voltage. At this output the tubes operated within ratings and remained cool. The modulated class C stage had about 20 to 30 watts of effective carrier output, a portion of which was dissipated in a 5,000 ohm stabilizing resistor tapped across the grid tank of the class B linear amplifier.

Fig. 2 shows a similar outfit which utilizes 50Ts i nthe linear amplifier. A pair of 852s were substituted with practically no changes. The effective carrier output with the 50Ts was approximately 150 watts, and this was increased to about 200 watts with the 852s.

The adjustment of the linear amplifier is simplicity itself. The class C modulated stage is adjusted by means of some kind of audio oscillator whose output is fed through the speech amplifier and whose output is varied either by an output control on the oscillator, or else by the gain control on the speech amplifier.

The grid circuit of the linear amplifier should be coupled to the class C modulated stage (with no plate voltage on the linear) and tuned to resonance. The output of the audio oscillator should then be increased until the plate current of the class C amplifier is about one-half the peak which it would be expected to reach if it were operating as a conventional class C amplifier. In the transmitter shown in Fig. 2 the peak class C plate current is 100 MA, so that the 50 per cent point is 50 MA. The exact amount is not critical because this is just a starting point. The linear amplifier is now neutralized in the conventional manner. With the plate voltage still disconnected from the linear amplifier, the load stabilizing resistance R1 is tapped across part of the grid tank. The resistor is tapped across more and more turns until the plate current to the class C stage is increased by one-half, due to increased loading. The coupling link is then adjusted to reduce coupling until the plate current to the class C stage is back to the 50 MA starting point. The point to remember is that the resistor should dissipate about one-third of the RF output from the class C modulated amplifier. After each adjustment of the loading resistor R1 it will be necessary to retune the grid tank because even the best of the non-inductive loading resistors have quite a detuning effect. With some tubes used in the class B linear amplifier 5,000 ohms will be too large, in which case about 2,000 ohms will usually be satisfactory, particularly when 203As or 852s are used. When the resistor is consuming about one-third of the power output of the modulated amplifier, plate voltage can be applied to the linear amplifier. Tune the plate tank to resonance and couple the antenna. Then increase the tone from the audio oscillator to a point just below where the overmodulation indicator (the 879 and associated milliammeter) starts to kick up, showing negative overmodulation. Then simply adjust the antenna coupling for maximum power output in the antenna circuit.

The only adjustment on which anyone can go wrong is that of the load stabilizing resistor in the grid circuit of the linear. This will vary widely with different transmitters because it depends on several variable factors, including the minimum grid impedance of the linear, the L to C ratio in the grid tank and the amount of excitation available from the modulated amplifier. All the other adjustments are for maximum power output. Be sure, however, that the class C stage is not overmodulated when making adjustments. It is very easy to go wrong unless some form of negative overmodulation indicator is available. Conventional peak vacuum tube voltmeters fall down in measuring percentage of modulation on a controlled carrier transmitter because there is no fixed value of unmodulated carrier to refer to. Thus either an oscilliscope or the overmodulation detector shown in Fig. 1, 2 and 3 should be used.

The proportion of the grid excitation power that will be best dissipated in R1 is not fixed. Thirty-three per cent was chosen because it gave good results in most cases. Certain tubes require more stabilizing than others. In general, the medium-mu tubes of high transconductance, operated at fairly high plate voltages, require somewhat less stabilization that some of the higher mu tubes which draw a lot of grid current in class B.

The linear amplifier should, by all means, draw grid current on voice peaks. This is the only way to get real plate efficiency out of the linear. The grid current drawn by any tube combination used in the linear amplifier should just about equal the DC grid current drawn by a similar class B audio amplifier operated at the same plate voltage.

The power gain through the linear will depend quite widely on the tubes used and on the plate voltage. A gain of about 12 can usually be expected, although it is a good idea to play safe and provide a surplus. The surplus, if any occurs, can be burned-up in the load stabilizing resistor, with a consequent increase in linearity.

The plate current drawn by the linear amplifier varies between the no signal condition and the maximum audio signal condition in exact accordance with the ratio between minimum and maximum class C modulated amplifier power output and thus it will be seen that the high voltage power supply must have rather good voltage regulation in order to avoid voltage variations as the load varies. However, the variations in load current will usually be materially less than in a similar class B audio stage, because the input and output of the linear amplifier do not go down to zero in the resting condition. A variation in plate current of about three or four to one is approximately all that will be encountered in practice. Choke input to the filter of the high voltage supply, with some inductance swing in the choke, will effectively prevent undue voltage variation with modulation.

The really important economies that can be effected through the use of the controlled carrier, plus linear amplifier, should interest everyone. There can be little question but that 35 watts of equivalent carrier power from a pair of 210s operating as linears is real economy.

Table of Effective Equivalent Carrier Power Output

Obtainable with controlled carrier linear amplifier.

Tube Type	Conventional Linear Carrier	Equivalent Carrier from Controlled Linear
210	7½W (max)	15 to 20 Watts
800	15	30 to 40 Watts
830B	15	50
50T	25	75
211	40	75
852	30	90
354	75	200
150T	75	250
212D	100	140
204A	100	200
849	175	333
851	350	666
251A	400	800

Note that the relationship between ordinary class B linear carrier output and the controlled equivalent carrier is not constant for all of the above tubes. The limiting factor is not the same in all cases. In some tubes the filament emission limits the output. In other cases secondary emission or plate dissipation limits the output. The above table is for one tube. For push-pull linear amplifiers multiply the above outputs by two.

The Western Electric 211-D

● This is a standard tube as used by the U. S. Army for many years in portable and mobile transmitters. A pair of 211-D tubes in class B are capable of giving 100 watts maximum audio output, when operating at 1000 volts. At 750 volts, approximately 75 watts of audio output can be secured. As a class C Radio Frequency Amplifier it is possible to secure from 30 to 50 watts of RF output, using a single tube operating at 1000 volts. The plate dissipation should always be kept below 65 watts.

Normal filament voltage	**10**
Normal filament current	**300±.15 amperes**
Normal plate voltage	**750 to 1000**
Maximum safe plate voltage	**1000**
Average plate current for plate voltage 750 and grid voltage—30	**65 milliamperes**
Average plate to filament impedance under above conditions	**3500 ohms**
Voltage amplification constant	**11 to 13**
Maximum intermittent power safely dissipated by plate	**100 watts**
Maximum continuous power safely dissipated by plate	**65 watts**
Power output as an oscillator	**50 watts**

This tube replaces the VT-4-A (211-A) tube and is interchangeable with it except that it operates at a lower filament current. It has a longer life. For maximum useful life the filament voltage should be kept as low as possible to secure the desired output, and should not exceed 10 volts, since an increase of 10% in the voltage may shorten the life as much as 50%.

The discoloration of the bulb is due to a Manufacturing process and has no effect on the operation of the tube.

CALLS HEARD

Calls Heard and Worked In 87 Hours From Mar. 9 to Mar. 17, 1935, by W9TB

7 MC

VK2ZC, VK2PH, VK2PX, VK2FN, VK2EL, VK2XC, VK2FX, VK2NS, VK2HF, VK2OU, VK2ZH, VK2KJ, VK2HY, VK2AE, VK2KS, VK2EO, VK2DA, VK2MT, VK2QP, VK2BQ, VK2CA*, VK2FK*, VK2OJ*, VK2FM*, VK2AP*, VK2EJ*, VK2JO*, VK2WU*, VK2FY*, VK2BR*, VK2SK*, VK2NL*, VK2QN*, VK2IA*, VK3KX, VK3GQ, VK3EG, VK3WY, VK3OC, VK3MR, VK3ML, VK3YO, VK3HT, VK3FB, VK3MX, VK3NG, VK3YP, VK3JO, VK3KC*, VK3MV*, VK3DD*, VK3DP*, VK3UH*, VK3CY*, VK3DQ*, VK3GU*, VK4UU, VK4CV, VK4BB*, VK4BQ*, VK4GK*, VK4JU*, VK5FM, K5MD, VK5LJ, VK5KJ*, VK5BM*, VK5DQ*, VK5GR*, VK6SA*, VK6CP*, VK7JB, VK7RC, VK7XL, VK7JH*, VK7PA*, VK7CP*, ZL1GX, ZL1FT, ZL1HD, ZL1DI, ZL1AA, ZL1AR, ZL2OW, ZL2BN, ZL2GQ, ZL2KI, ZL2BH, ZL2KK, ZL2BZ, ZL2BQ, ZL2MM, ZL2DS, ZL2LQ*, ZL2GS*, ZL3BY, ZL3HK, ZL3AN, ZL3CU, ZL3BJ*, ZL4BT, ZL4AI, ZL4FO, ZL4BQ*, ZL4TDJ*, K6CGK, K6AUQ, K6HZI, K6AKP, K6KEF, K6JPD*, K6AJA*, K6LBB*, K6LTZ*, HC1FG, OM2RX, KA1CS*, HH1P*, X2N, X1AI, X3G, X1AX*, X1CC*, ZS2A*, CT2BK*, EA3EG*, EA8AF, EA8AL, EA8AH*, K4BU, K4CVV*, NY2AB, LU1CH*, LU5CZ.

14 MC

G2LA, G2AK, G2NH, G2KZ, G2MR, G2BM, G2PL*, G2DZ*, G2MV*, G2OA*, G5LA, G5BO. G5VB, G5QF, G5BY, G5VL, G5US, G5HC, G5YB*, G5YG*, G5JT*, G5JF*, G5BD*, G6BS, G6NJ,

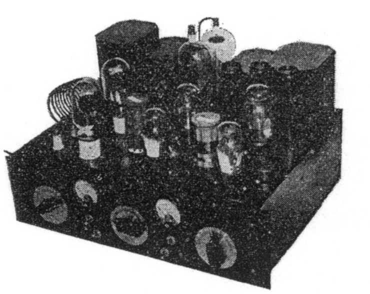
* Indicates stations heard but not worked.

The R.F. End of Controlled Carrier Transmitters

By I. A. MITCHELL*

● Further tests on controlled carrier modulation are substantiating the various advantages which theory would indicate for it. The transmitter described in this and last month's issue of "RADIO" has now been checked extensively. Duplex operation has been used since it was first put on the air and no difficulty has been encountered. However, the major benefit of controlled carrier modulation to the amateur, in addition to the greater DX obtainable, has been found to be the very great reduction in interference. When local calls are made, it is only necessary to speak a little farther away from the microphone to reduce the maximum carrier to the point where it causes practically zero interference. When covering a greater distance, the average value of the carrier is so much lower than that of an equivalent transmitter with standard carrier that a great reduction in the QRM caused by heterodyne between two neighboring carriers is obtained. The result is not only a reduction in the crowding of the ether, but it also permits a signal to get through better.

Added to these advantages of controlled carrier is the possibility of obtaining a considerably greater power than normal from a



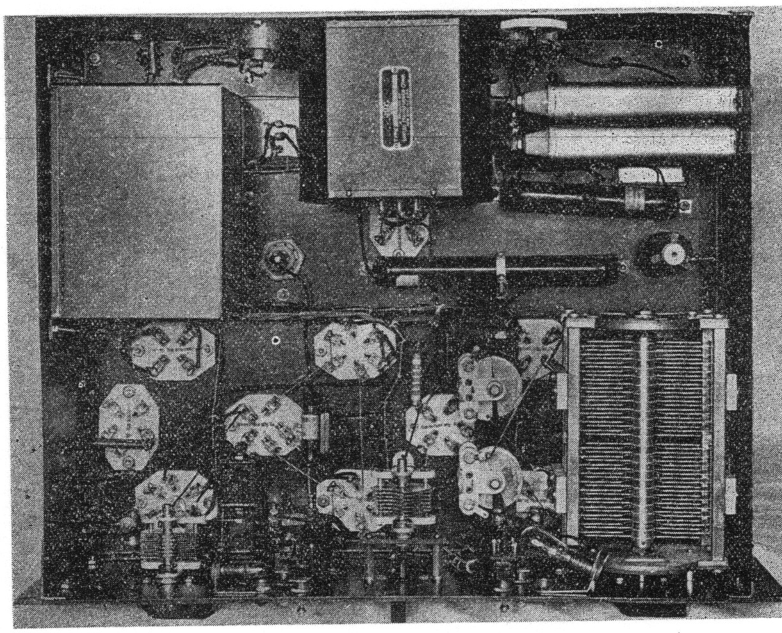
Front view of R.F. Unit

given pair of class C tubes—the increase in power rating of class B linear stages following a controlled class C stage—and a great reduction in the power consumed from the AC line. **And—these advantages entail no sacrifice in quality.**

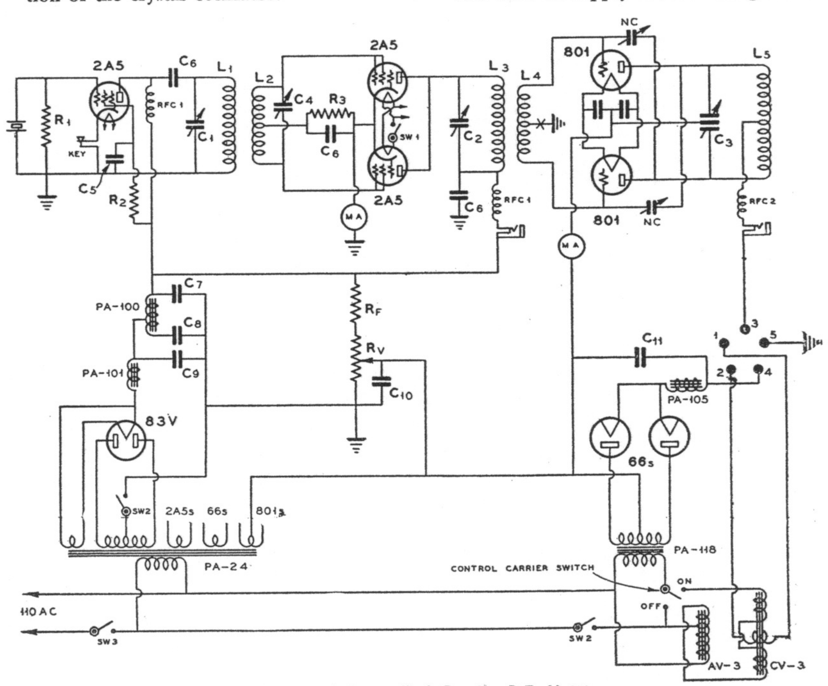
Last month's issue of "RADIO" described the audio end of a complete rack and panel controlled carrier transmitter with 140 watts maximum class C input. The general details of the RF end are described here. Figs| 1 and 2 show the top and bottom views of the compplete unit. The transmitter was built to operate on 20 meters with the view in mind that if it operates on 20 meters first it will be OK for the other bands later. An examination of the circuit in Fig. 3 illustrates the more or less conventional layout of the rig. A 2A5 is used as the oscillator and its tuned plate circuit is properly balance coupled to a pair of 2A5s with the grids in push-pull and the plates paralleled. These tubes are in turn coupled to a pair of 801s or carbon plate 210s in the permanently neutralized final stage. The interesting details of the transmitter may be noted as follows:

1. Once neutralized the transmitter needs no further attention until it is necessary to change tubes.
2. By opening switchc marked SW1, the buffer stage is automatically neutral ized when that stage is being operated as a straight-through buffer. When being used as a plate doubler, the switch is thrown on.
3. For operation on 1.75 MC, 3.5 MC, 7 MC. and 14MC, only two crystals are necessary, one being a 1.75 MC and the other a 7 MC.
4. The 50 mmfd. condenser in the grid circuit is a very small one and is mounted in the coil form which has a mounting pillar inside of it. It is adjusted for maximum output consistent with stable operation of the crystal oscillator.
5. The switches in the plate circuits of the buffer and final are used to read the grid mills and also useful in neutralizing the stage.
6. The milliammeters are placed in the cathode circuits to minimize the danger to the operator and meter. When the plate switch is open the meter of that stage reads the grid mills, and when closed it reads both grid and plate mills combined.
7. The low voltage power supply is also used to supply C bias voltage to the

*Chief engineer, United Transformer Corp.



Bottom view of Controlled Carrier R.F. Unit



Circuit of Controlled Carrier R.F. Unit

final stage. The condenser across the C bias voltage is used to prevent demodulation.

8. The grid coils are wound on the same form as the Plate coils on the "cold" side of the plate winding.

9. The windings L2 and L4 are somewhat critical. Slight variations from the table shown in Fig. 4 may effect improvement in some cases. All coils except L5 are wound on Hammarlund SWF coil forms. Coil L5 is wound on a 2-inch diameter form. The 1.75 MC coils L2 and L4 are also tuned by a 100 mmfd. coil fitting condenser APC 100. For all other bands coil L2 need only be tuned by a 50 mmfd. type APC 50.

10. By interlocking SW2 and SW3 no plate power can be applied until the filaments are lighted first.

The construction of this RF unit is symmetrical in all details and is matched in appearance with the audio unit previously described. While all controls are brought out to the panel, the construction is such that the tubes and crystal are readily accessible. The three main controls are from left to right: Class C tank condenser—buffer tuning condenser—oscillator condenser. The switches include the main filament switch—low plate voltage supply—high voltage plate supply—2A5 filament. One pilot light is provided to indicate that the filament and low voltage is on and another to indicate that the high voltage supply is on. The switch used to change from controlled to standard carrier is also on the front panel, but is not shown in the photograph of Fig. 1. The meter at the left checks class C plate or grid mills. The meter at the right is used to check buffer plate and grid mills. A jack is provided at the rear to plug in a key for code transmission or read the oscillator plate current.

Fig. 5 shows the comparison between the perfect theoretical controlled carrier condition whereby 100 per cent modulation would be obtained at all levels and the actual characteristics with variactor control. The curve shown is that of a variactor for a 250-watt class C input transmitter. The practical curve shown is such that if the reactor is arranged for 100 per cent modulation at maximum level, it is not possible to overmodulate at lower levels, but high percentage modulation is obtained at all levels.

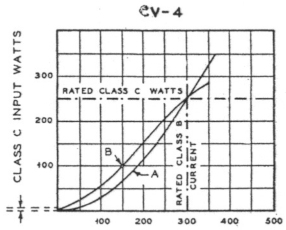
The parts which are not described in detail in the circuit of Fig. 3 are noted below:

Fig. 4—COIL DATA

Coil	1.75 MC	3.5 MC	7 MC	14 MC
L1	55 T #26 en.	30 T #18 en.	18 T #18 en.	6 T #18 en.
Space	1/4"	5/16"	5/16"	3/8"
L2	40 T #26 en.	25 T #18 en.	12 T #18 en.	6 T #18 en.
L3	50 T #26 en.	25 T #18 en.	15 T #18 en.	6 T #18 en.
Space	1/8"	1/4"	1/4"	3/8"
L4	80 T #26 en.	60 T #30 en.	28 T #26 en.	11 T #26 en.
L5	44 T #14	26 T #12	16 T 1/8" tube	8 T 1/8" tube

List of Parts for UTC Controlled Carrier R.F. Unit

C1—Hammarlund type MC 100S.
C2—Hammarlund type MC 100S
C3—Hammarlund type TCD 100X
C4—Hammarlund type APC 50, except in 1.75 MC coil use APC 100.
L1, L2—Wound on Hammarlund SWF5 form.
L3, L4—Wound on Hammarlund SWF5 form.



Class C Power with no audio modulation—3.4 watts
Class B plate current swing
CURVE A—THEORETICAL CURVE FOR 100% MODULATION. CURVE B—ACTUAL CURVE OBTAINED

FIG. 5. Ideal and practical controlled carrier curves.

L5—See winding table.
C5—.006 mfd. 600-v. Cornell Dubilier mica.
C6—.002 mfd. 600-v. Cornell Dubilier mica.
RFC1—Hammarlund type CH-X.
RFC2—Hammarlund type CH 500.
C8—Cornell Dubilier 1 mfd. 600 w.v. paper condenser.
C7, C9—Cornell Dubilier 4 mfd. 600 w.v. paper condenser.
C10—Cornell Dubilier 8 mfd. electrolytic.
C11, C13—Cornell Dubilier 1 mfd. Prranol oil.
C12—Cornell Dubilier 2 mfd. Pryanol oil.
R1—25,000 ohm, 2 watt.
R2—50,000 ohm, 2 watt.
R3— 1,500 ohm, 5 watt.
RF—16,000 ohm, 10 watt.
RV—7,000 ohm, 50 watt, with slide.

RCA Announces 100 Watt "46" Tube

Contrary to early rumors the plate lead of this tube does not come out from the top, but is mechanically similar to the 203A and 211. It is slightly more desirable than a 203A for use as an RF amplifier, and slightly less desirable than the 211 from the standpoint of power gain at any given plate efficiency. As an audio amplifier in class B circuits it eliminates the costly and troublesome bias supply necessary when the 203A or 211 types are used. This new tube should make a good doubler in a CW transmitter.

Class B Modulator, RF Power Amplifier, Oscillator

RCA-838 is a three-electrode type of tube designed primarily for use as a zero-bias class B audio-frequency power amplifier. The grid is designed so that the amplification factor of the tube varies with the amplitude of the input signal. This feature facilitates the design of class B amplifiers to give high output with low distortion. In class B audio service, two tubes of this type are capable of giving an output of 260 watts with less than 5% distortion. The 838 may also be used as a radio-frequency power amplifier and oscillator at maximum ratings for frequencies as high as 30,000 KC. For any class of service, the maximum plate dissipation of RCA-838 is 100 watts.

TENTATIVE CHARACTERISTICS

Filament volt. (AC or DC)	10	Volts
Filament current	3.25	Amperes
Direct interelectrode capacitances (Approx.):		
Grid-Plate	8	uuf
Grid-Filament	6.5	uuf
Plate-Filament	5	uuf
Bulb		T-18
Base (For connections and tube dimensions, see p. 8)		Jumbo 4-Large Pin

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

As A Power Amplifier and Modulator—Class B

DC plate volt.	1250 max. Volts
Max.—Signal DC plate current (per tube)*	175 max. MA
Max.—Signal plate input (per tube)*	220 max. Watts
Plate dissipation*	100 max. Watts

Typical operation (2 tubes):

Filament volt. (AC)	10	10 Watts
DC plate volt.	1000	1250 Volts
DC grid volt.	0	0 Volts
Peak AF grid input volt. (approx.)	90	90 Volts
Zero—Sig. DC plate cur. (per tube)	53	74 MA
Max.—Sig. DC plate cur. (per tube)	160	160 MA
Load resistance (per tube)	1900	2800 Ohms
Effective load resist. (plate-to-plate)	7600	11200 Ohms
Peak driv. power (approx.)	5	5 Watts
Max.—Sig. power output, approx. (2 tubes)	200	260 Watts

* Averaged over any audio-frequency cycle.

As RF Power Amplifier and Oscillator—Class C Telegraphy

DC plate voltage	1250 max. Volts
DC plate current	175 max. MA
DC grid current	70 max. MA
RF grid current	7.5 max. Amps
Plate input	220 max. Watts
Plate dissipation	100 max. Watts

Typical operation:

Filament volt. (AC)	10	10	10 Volts
DC plate volt.	750	1000	1250 Volts
DC grid volt. (approx.)	—80	—85	—90 Volts
Peak RF grid input volt. (approx.)	190	195	200 Volts
DC plate current	150	150	150 MA
DC grid cur. (approx.)	30	30	30 MA
Driv. power (approx.)	6	6	6 Watts
Power output (approx.)	65	100	130 Watts

Surveying the Radio Horizon

(Continued from page 9)

this won't go on forever. Mr. Maxim has again renewed his request to be relieved; and in his current annual report, he states that in his opinion, neither the President nor the Vice-President should have voting power, except where it is necessary for these officers, when presiding at a Board Meeting, to cast a vote in order to break a tie. Mr. Maxim says that the President and Vice-President should not vote, because they do not represent any Division; and he says that only Division Directors and the Canadian General Manager should have votes on the Board, except as indicated.

Some time ago, either Seagall himself, or some Director or Officer of the League, recommended that the League's General Counsel should sit on the Board, and vote. Mr. Jabs tells me that some years ago, Segall in fact did sit in on Board Meetings, and did have a vote, but that it later was taken from him.

This kind of thing, carried far enough, could easily undermine the whole concept of government through a representative Board. As a device for keeping the administration firmly entrenched, it has enormous possibilities.

We are in a rut; and until we all take an active interest in the League, we will never get out of it. In the past, even Directors' elections have failed to bring out many votes. Look back in your filers of "QST" to verify this. No wonder that little attention has heretofore been paid to what the members of the League really wanted. Perhaps we deserve just what we've been getting.

Now, while I believe that the primary object of the League should be to preserve our legal existence as Amateurs, I DON'T RECOMMEND TIMID METHODS OF PRESERVING IT. An offensive may well prove to be the best defense.

Somebody in the Commercial camp has already been capitalizing Warner's (shall we say) "RELUCTANCE' to take positive steps; and he is industriously spreading a feeling of uneasiness among the Directors of the League. Here is part of a letter he wrote to them, not so long ago:

. . . *"Some of our friends in the communications administration at Washington*

(Continued on page 36)

The Level Expander or Reversed AVC

By C. A. HISSERICH* and C. G. McPROUD

● A study of present recording, reproducing and broadcast systems reveals a definite non-linear level range at the output of such systems. This condition is caused primarily by both the mechanical and electrical limitations of the equipment used, and secondarily by the "mixing" method of controlling the input. Let us consider, for example, an orchestral disc recording. The music which you hear has successively actuated a microphone, a cutting head, a pickup arm, and a dynamic speaker—devices with some degree of variable damping which are therefore inherently non-linear with respect to level.

Also, in the recording of the disc, the "mixer" has held down the peaks to prevent overcutting and has brought up the low level passages to insure their overriding background noise, causing further non-linearity of level.

The purpose of this article is to present an expanding device in which the level linearity lacking in any audio system can be regained. This is accomplished by increasing the gain of the amplifier as the audio input increases, giving a gain curve corresponding to the envelope of the audio input.

Referring to Fig. 1, the audio circuit consists of a 58 tube resistance coupled to a 56 in the conventional manner. The input circuit to the 58, however, is split and also supplies signal to the grid of the control 57. The bleeder should be adjusted for a static bias of 50 volts on the 58 and a screen voltage of 100 **with respect to cathode** on the 58. The control circuit consists of a 57 resistance coupled to a 56 which operates as a grid bias rectifier, varying the potential across R3 and thus the bias on the 58.

The operation can be traced out, but a few words of explanation may be helpful. When a signal is applied to the grid of the control 56, which is biased by the 100,000 ohm cathode resistor so that it operates as a biased detector, the tube passes increased plate current. This increased current increases the voltage drop across R3. The variation of this drop was found to be from 18 volts with no signal, to 30 volts on audio peaks. This drop being subtracted from the static bias obtained from the bleeder, it is seen that the 58 actually operates at a bias of (50-18) 32 volts with no audio input, this value being decreased to (50-30) 20 on peaks. In measuring these voltages, remember that you are measuring across 100,000 ohms in a low current circuit, and thus a high resistance meter should be used.

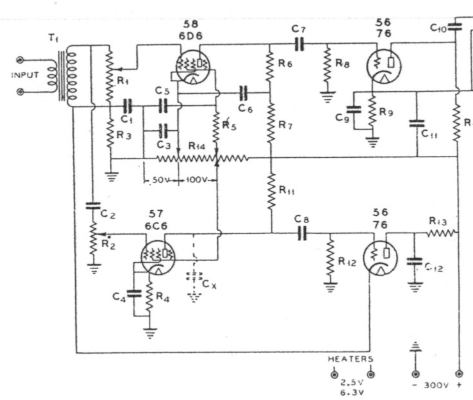
C12, R13, R3 and C1 are the timing elements and a word of caution is necessary; do not use old electrolytic condensers which have high leakage—buy new ones. C8 has a value of .005 MF in order to decrease the bass response in the control circuit and render it linear from a power basis.

It should be remembered that this device is only usable with low level inputs of the order of −40 Db due to the limited range over which a 58 is linear.

While this device was originally intended to increase the realism or depth of audio reproduction, other applications are possible. The amateur fone man is essentially interested in the reception of only that part of the audio spectrum necessary to maintain intelligibility. If the expander is utilized as the low-level audio amplifier stage of the receiver, and introduces frequency discrimination in the control circuit, the operator can counteract, somewhat, for the effects of static, rumble, etc. This is done by decreasing the capacity of C8, and by shunting a small condenser at Cx, say .01 to .05 mfd. to operate, increasing the gain, on the essential frequencies only, thereby holding down the apparent noise level in the receiver, yet not detracting in any way when the speech frequencies are present.

The effect of the expander is little short These changes will cause the control circuit of marvelous. During the tests made in the development of the device, we naturally heard it in use considerably. After becoming somewhat accustomed to hearing the expanded reproduction, we often found it necessary to play the selections a few times without expansion in order to regain a proper perspective regarding the effect achieved.

With the expander set for approximately 10 Db, an orchestral crescendo really becomes natural; the slightest inflection of a speaker's voice is accentuated. The effect is difficult to describe, but "depth" is the result. In conventional systems, the sound seems to come directly from the loudspeaker; with the "expander" the various instruments or voices actually seem to be at different distances behind the speaker screen.



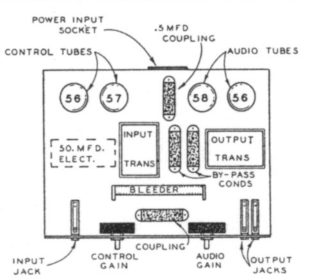
SCHEMATIC OF EXPANDING PRE-AMPLIFIER

LEGEND

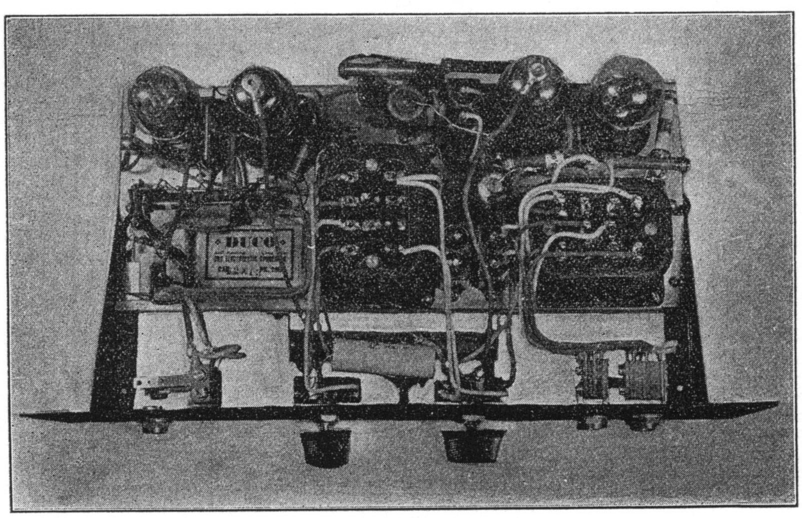
T1—Input Transformer—Sec. imp. 125,000 ohms.
T2—Output Transformer—as required.
R1—.25 ohm Potentiometer.
R2—.25 ohm Potentiometer.
R3—100,000 ohm, 1 watt metallized.
R4—5,000 ohm, 1 watt metallized.
R4—5,000 ohm, 1 watt metallized.
R5—250,000 ohm, 1 watt metallized.
R6—250,000 ohm, S. S. White Resistor.
R7—100,000 ohm, 1 watt metallized.
R8—500,000 ohm, 1 watt metallized.
R9—3,000 ohm, 1 watt metallized.
R10—25,000 ohm, Ohmite Red Devil—10 watts.
R11—250,000 ohm, 1 watt metallized.
R12—500,000 ohm, 1 watt metallized.
R12—500,000 ohm, 1 watt metallized.
R13—100,000 ohm, 1 watt metallized.
R14—50,000 ohm, 50 watt wire wound—2 clips.

C1—50 ufd. 100 V. Electrolytic.
C2—.1 ufd. 200 V. Paper.
C3—10 ufd. 100 V. Electrolytic.
C4—.1 ufd. 200 V. Paper.
C5—.5 ufd. 400 V. Paper.
C6—.5 ufd. 400 V. Paper.
C7—.5 ufd. 1,000 V. Paper.
C8—.005 ufd. 600 V. Mica.
C9—10 ufd. 25 V. Electrolytic.
C10—.5 ufd. 1,000 V. Paper.
C11—.5 ufd. 400 V. Paper.
C12—4 ufd. 400 V. Paper.

All resistors and condensers should be of good quality and conservatively rated.



Correct layout of parts.



The complete unit on a standard relay rack mounting

* W6QJ, 412 N. Oakhurst Dr., Beverly Hills, Cal.

Getting the Most Audio Out of A Class B Amplifier

By RALPH O. GORDON*

● The first consideration in the design of a Class B amplifier is the type of tube used. Generally speaking, the safe plate dissipation of the tube controls the maximum output, but other factors limit the output of certain types of tubes. Tubes with oxide coated filaments are not satisfactory for Class B audio if maximum power output, consistent with safe plate dissipation, is to be attempted. The reason for this is due to emission from the grid. When tubes with oxide filaments or cathodes are used, some of the active material on the cathode leaves the cathode and deposits itself on other parts within the tube after a few hours of operation. Then, when the grid current rises to a high value, which it does in all Class B amplifiers working at high power outputs, the grid heats the active material which has been deposited on it and liberates additional electrons which, in turn, cause more plate current and more grid current. This action becomes of the vicious circle variety and gives rise to serious audio distortion long before the power output has reached the point of safe plate dissipation that would occur if this action were not present. Tubes with thoriated filaments do not, as a rule, suffer from this fault.

In some cases where certain chemicals are introduced in the tube to facilitate the evacuation process (getter), these chemicals cause an action similar to that described, but not as severe. The ideal tube for this work is one that has no secondary emission from the grid, even when the grid runs hot.

Considering plate loss, or plate dissipation, as the limiting factor, it can be seen that in order to get high power output the efficiency must be as high as possible. If a vacuum tube is to have high efficiency, the load impedance must be high in comparison to that of the tube. When the plate current is high, the actual voltage on the plate must be low; when the current is low, the voltage must be high. The voltage drop across the load causes the actual plate voltage to drop. The ratio of the tube impedance to the load impedance controls the efficiency. At high plate current the tube impedance will fall to a low value, and considering the load as a fixed value the efficiency will increase with the plate current, thus the limiting factor is safe plate loss.

With proper grid excitation, the calculated plate loss can be made to equal 21.5 per cent of the DC plate input. This means an efficiency of 78.5 per cent. In actual practice the plate loss and efficiency can be made to approach 70 to 75%. Tube manufacturers rate their tubes for maximum safe continuous plate dissipation so that when the allowable plate loss is considered in a Class B audio amplifier the amount can usually be increased, because only during peak audio plate swings is the loss above rated value.

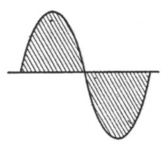
It is common practice to consider the average or effective audio power necessary to modulate 100 per cent, but the peak audio power is the correct factor to consider. When the peak audio voltage and power reaches a value equal to the DC input voltage and power on the modulated amplifier, 100 per cent modulation is obtained. The average audio power at this point is of a value that is not known unless the wave form of the audio is known. The wave forms of voice or music are very complex and the effective power in them is much less than in a sine wave of equal peak voltage, although the peak voltage and peak power are the same. DC current meters read average values and it is difficult to determine when the peak current has reached the correct value for 100 per cent modulation, the average values for voice and music being lower than for a constant sine wave input. The average audio power with a sine wave of constant amplitude necessary to modulate a carrier 100 per cent is 50 per cent of the DC input to the Class C amplifier. But, with voice or music, the average audio power necessary is considerably less.

The shaded areas of Fig. 1 and Fig. 2 show the average power in two different wave forms of equal peak voltage and power. Fig. 1 shows the power in a pure sinewave with no harmonics. Fig. 2 shows the power in a wave of the same fundamental frequency with a strong second harmonic. The aggregate or combined peak power of the wave is equal to that of Fig. 1, but the average power over the entire cycle is much less.

This shows that it is possible to get much more out of the same tubes with normal voice than with a constant tone input. As long as amplifier is to be used for voice or music, and the peak power should not be more than a definite amount, it can be secured from tubes of much lower rated capacity.

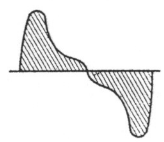
The filament or cathode of a tube will deliver a certain maximum number of electrons per unit of time, which will cause a definite plate current to flow, regardless of how positive the grid voltage may be. This is called "saturation plate current" and is the value of plate current that should flow, on the peak audio swing, to obtain maximum output. Exciting the amplifier to a point beyond the point of saturation will cause distortion due to the flattening-out of the audio peaks because the plate current cannot rise beyond this value. By increasing the plate voltage and the load impedance, the power output can be increased and the limiting factor is the insulation of the tube terminals and the stem seal. Tubes with the plate-lead out the top are ideal because the plate voltage can be increased to a high value and higher power output can thus be obtained.

The grid voltage grid current characteristic of a tube is the most important insofar as the quality or fidelity of the Class B amplifier is concerned. When the grid goes positive, grid current flows, and if this curve is a straight line, little trouble will be caused, but such is not the case. As the grid becomes more positive, the grid current rises more rapidly until finally the grid current curve becomes almost vertical. Some tubes have a negative grid current slope such as shown in Fig. 4. This gives rise to transient oscillation of the dynatron variety and occurs only during a portion of the audio cycle. These parasitic oscillations cause a sort of hash, or fuzz, to appear on the output. They can be analyzed only with the aid of a cathode-ray oscillograph. The string type oscillograph is too slow to respond to the high frequency of the oscillation, but on the cathode-ray type the oscillations show up as a blur on the wave form, as shown in Fig. 3.



SINE WAVE

FIG. 1



STRONG 2ND HARMONIC

FIG. 2

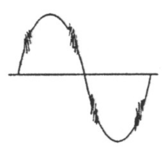


FIG. 3

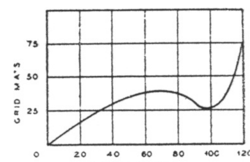


FIG. 4

The 203-A tube usually produces this effect. It can be reduced by a small capacity (.0001 MF) from grid to ground of both tubes, or by neutralization such as is used in any push-pull RF amplifier. Off-hand it would seem that a tube of high amplification factor would be the best tube for Class B work, due to the lower value of excitation voltage necessary, but actually more power is required to excite a pair of 203As to 200 watts output than a pair of 211s. The grid current rises to a higher value and there is a greater grid loss in the 203-A type than in the 211. Of course, the C bias supply for the lower mu type tubes must be given consideration. Owing to the much lower grid current surges, the C bias supply can be taken care of with a small power supply using an 83 rectifier, whereas if a C bias supply were to be used on 203-As it would have to maintain about 30 volts at current changes as high as 75 MA. Practically the same power output can be obtained with any of the 50 watt type tubes, such as 203-A, 211, 845, provided the proper excitation is applied. The high mu types require lower excitation voltage, but better voltage regulation of the driver output is needed. The low mu types require more excitation voltage, but because of lower grid current the source does not need such good regulation. The tubes of medium mu are usually the best, all points considered.

THE TRANSFORMERS

Without transformers of proper design a Class B amplifier can produce many kinds of audio distortion. The input transformer must deliver perfect quality to the Class B grids, even though the grids are drawing current all the way from zero to maximum during any one audio cycle. The grids of the Class B tubes offer a load that fluctuates all the way from infinity down to several hundred ohms. This means that the input transformer must supply to them a perfect reproduction of the signal without distortion, even though the load is varying.

The driver must be capable of delivering sufficient power to maintain the grid voltage swing with the grid current of the Class B tubes flowing through the secondary of the input transformer; furthermore the secondary should have very low DC resistance so that the bias on the Class B tubes does not vary appreciably with the grid current. This fault is common with most input transformers. All of these points must be maintained with a fair degree of constancy over the entire frequency range. This seems like a big order, and it is.

The coils must be designed so that the primary has identical relationship with both halves of the secondary. The capacity, and the leakage reactance, must be the same for the primary and each secondary. If these precautions are not taken, the wave form of the voltage supplied to the Class B grids is not the same for each grid and distortion of the wave form occurs, giving rise to harmonic generation.

The input transformer should have a step-down ratio of such a value that the signal voltage applied to the Class B grids is just

(Continued on page 31)

*W6CLH.

Engineering Problems Encountered in the Design of Dynamic Microphones

By JOSEPH SPEAR*

● The development of the dynamic microphone began when the communication world realized the shortcomings of the carbon and condenser type microphones.

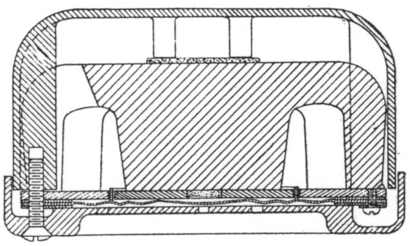
Any one of the foregoing types can be made to have excellent quality, this being a matter of design rather than an inherent characteristic. The dynamic type, however, is inherently more sensitive, due to the fact that the diaphragm is larger than that of the ribbon type of microphone. It is much simpler to obtain a strong magnetic field in a $\frac{1}{32}$-in. gap than in the ¼-in. or more gap usually required for a ribbon microphone.

It is also desirable to eliminate a pre-amplifier and for this reason a device having a suitable internal impedance for transmission of energy over long cables is desired. It is also desirable to operate directly into mixers, with or without the use of mixer transformers. This appeared to be possible with the ribbon type only when high resistance mixers were used which allowed a very small generated current to flow in the ribbon. It was found that a ribbon operating into a low resistance load permitted voice currents to flow through the ribbon which reacted to restrain its motion. This was not serious at the higher frequencies where the inertia due to the mass of the ribbon was comparable to this restraint, but a considerable attenuation of the lower frequencies did result. This same restraint would be experienced with the dynamic type, but is small in magnitude compared to other clamping and is applied to all frequencies without discrimination. The reason for this is apparent from an analysis of the theory of their operation. Both the ribbon and the dynamic types generate voice voltages by virtue of a conductor cutting a magnetic field. In both types this voltage is naturally proportional to the velocity of motion of the conductor. In the dynamic microphone this velocity is made constant with frequency by introducing a restraint such as mechanical friction or the viscosity of the air flowing through passages. Any generated current flowing in the moving coil is likewise such a restraint, and would actually improve the characteristic slightly, although the effect of such a current is small compared to the restraint deliberately incorporated in the device. A ribbon, on the other hand, is mass controlled; that is, if you neglect such factors as resonance in the ribbon and friction of the air in the spacing between it and the pole pieces, the only restraining force is that due to the inertia of the ribbon. This increases directly with the frequency. The response is flat by virtue of the baffling which produces a net difference in pressure between the two sides of the ribbon which is also proportional to frequency. The equilibrium of these forces must not be disturbed, however, by the external circuit, such as would be the case if low impedance mixers or transformers were directly connected to it.

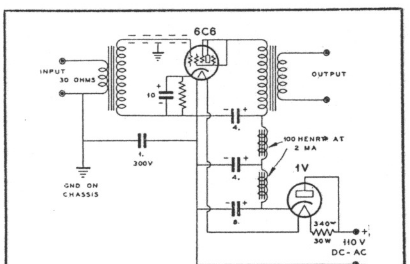
Another consideration is ruggedness. Most microphones are entirely too delicate for dependable service. They are tither damaged by moisture or injured by mechanical shock. The only delicate part in a dynamic microphone is the thin diaphragm and the moving coil. By suitable design the diaphragm may be completely enclosed by the case and thus protect it against mechanical injury. Dynamic microphones have been dropped from a height of 10 feet on concrete without impairing the performance.

A further consideration is directional characteristics. Undoubtedly it is desirable in a few applications to employ directional microphones. It is in general a disadvantage, however, as it seriously limits the position of the speaker or other source of sound and requires more care in microphone placement. It is also desirable to have the structure of the microphone as smooth and regular as possible, with a minimum of irregular projections, and cavities which would disturb the flow of the sound wave as little as possible and thus produce no irregularities in response over the frequency range, regardless of the direction of the source of sound. The dynamic type lends itself readily to this sort of construction.

Certain forms of construction and choices of material are obviously superior or practical. Such was the choice of a magnetic structure having coaxial pole pieces, similar to a dynamic speaker. It is also apparent that the material which has the greatest electrical conductivity per unit mass is aluminum, so that material is used for the wire of the voice coil. The requirement of small mass with light weight ultimately dictates the selection of aluminum alloy as the diaphragm material. It is also obvious that the unit must be completely encased, not only for protection but also to prevent the sound waves from reaching the back of the diaphragm.



Cross-section view of dynamic microphone



Circuit diagram of pre-amplifier for dynamic microphone.

The case and cap are diecast of a nalloy having a strength and other physical properties similar to brass, the thickness being approximately $\frac{1}{16}$-in. Both the inner and outer pole pieces are stamped from electrical sheet steel, giving a uniform product. The diaphragm is, of course, die stamped as is also the bakelite washers between which the diaphragm is clamped. In fact, the only element requiring an appreciable amount of hand work is the moving coil which is wound on an accurate mandrel.

The chief consideration in the design of the unit is a uniform frequency response. It is essential that the velocity of motion of hte coil be proportional to the pressure of the sound wave, but independent of its frequency. It is obvious that the chief restraint imposed upon such motion at the higher frequencies is the inertia of the coil and diaphragm, and at the lower frequencies the stiffness of the diaphragm. Therefore, a means of applying friction to this motion is sought, so that the motion of the coil over the whole range can be restrained at the high and low frequency ends of the frequency range. One obvious method would be the employment of a diaphragm of such material that the friction generated by its flexure would serve the purpose. Celluloid, mica and a variety of other materials were investigated, such as paper impregnated with varnishes and other compounds. Few of these materials introduced this friction to a sufficient degree and those that did introduced additional mass and stiffness to such an extent that even if these new masses and stiffness could have been compensated for, the sensitivity would have been seriously curtailed. The same experience is had with pads of felt, rubber or similar material resting against the diaphragm.

For these reasons, an aluminum alloy diaphragm suitably corrugated is chosen, and air selected as the damping medium. It is found that the air flowing through the magnetic air gap, in which the coil is positioned, as forced by the motion of the diaphgram, is restrained in its flow and offers considerable restraint to the diaphragm. Unfortunately, however, if this path is made sufficiently small and circuitous by partially closing the bottom of the gap, the effect of the mass of the air moved is as great as the viscosity at the higher frequencies. This not only reduces the sensitivity of the unit but in combination with the stiffness of the air cushion between the diaphragm and the pole pieces, introduces undesirable resonant effects at the higher frequencies. This space is, therefore, left comparatively unrestricted so that the mass effect will be negligible. Whatever restraint remains is largely of a friction nature caused by the turbulence of the air flowing over the round wires of the voice coil.

This introduces a considerable amount of frictional damping to the motion of the coil, but quite insufficient to give the characteristic desired. The remainder is secured as follows:

The cap over the front surface of the diaphragm is solid and is perforated with 19 small holes. The space between the diaphragm and the cap is very small so that a very small amount of air flowing into it from the atmosphere will produce a pressure in the space equal to the atmospheric pressure. Therefore, the entrance of any additional air will displace the diaphragm in proportion to the volume of air admitted. If considerable resistance is offered to the flow of air by the size and shape of these 19 perforations, and the volume of air therefore admitted per unit time is proportional to the pressure and independent of the frequency, it follows that the diaphgram and coil will move with a velocity proportional to the pressure and independent of the frequency.

* Engineer, Radio Receptor Co.

Beat Notes, Combination Tones, and Sidebands

By R. R. RAMSEY*
Professor of Physics, Indiana University

THE title of this paper is the same as that of a paper by Herbert Hazel which has appeared in the January, 1935, issue of the (London) PHILOSOPHICAL MAGAZINE. The paper deals with and settles two controversies which were discussed with some heat in Europe.

The first, the Beat Note-Combinational Tone controversy, started sixty-five years ago, in 1870, between Baron Von Helmholtz, professor of physics, Berlin University, and Rudolph Koenig, an authority on sound and musical instruments. (The Koenig tuning forks and manometric flame apparatus are found in all physical laboratories). This controversy flared up from time to time for the next twenty-five or thirty years. Noted men such as Lord Rayleigh, of Cambridge University, England, and many others, took issue one with the other with no convincing argument or proof advanced by either side.

What is the controversy? When one strikes two tuning forks, one making 100 vibrations per second and the other 101 or 99 vibrations per second, a periodic swelling of sound is heard, or one beat per second is heard.

As the difference of frequency is increased the pitch of the low note increases from one to a large number per second, and a distinct tone is heard with our ears. The frequency of this tone is equal to the difference between the frequencies of the two forks. Some people seem to be able to hear a tone whose frequency is the sum of two frequencies. The author has never been able to recognize this high frequency. However, there seems to be no reason why a person with a "musical ear" should not hear this high tone whose frequency is the sum of the frequencies of the two forks. Piano strings or any other musical instruments might be used in place of the two forks. When one listens to the two tones he will always hear the beat note whose pitch is the difference between the pitch of the two strings or instruments. This is the beat note.

The controversy was: Is this beat note which one hears a true tone? Does this tone exist in the medium, air, which conveys the sound from the instruments to the ear? If this tone exists in the air, it is a combinational tone. The combinational tone can be a differential tone or a summation tone. If one—the differential—exists, the summational must also exist, or vice versa. The experimenters, Helmholtz, Koenig, and all the rest, agreed that if the tones existed in the medium a piano string, Helmholtz resonator, or other tuned instrument, tuned to the frequency of the combinational tone, should be set into sympathetic vibrations by this combinational tone or wave in the air. Also, they all agreed that these tones were heard with the ears. Helmholtz, who used a siren, maintained that the tones affected Helmholtz resonators when they were tuned to the difference of the frequencies. Koenig, who used tuning forks as the source and a third tuning fork as detector, said the third tuning fork was quiet and was not set into motion sympathetically. Koenig said Helmholtz was wrong and Helmholtz said Koenig was wrong. At times each side said things not very complimentary to the other.

The controversy was: Are there such things as combinational tones, or are they simply beat notes or noises produced in our ears?

Helmholtz maintained that combinational tones existed in the air and the beat notes or sounds we hear are produced by the combinational tones. Koenig and his followers said there were no combinational tones and that the beats were produced in our ears in some manner, presumably in an unknown manner.

Sideband Controversy

In America there seems to have been no dispute as to sidebands. All seem to have accepted the sideband theory. In elementary books on radio we usually explain the radio telephone modulation by means of a wavy line or sine curve in which the amplitude varies in unison with the voice frequency. Thus if we have a carrier wave modulated at 1000 vibrations per second the amplitude varies at the rate of 1000 times per second. If we set up our equations right we can show mathematically that this varying amplitude frequency is composed of three frequencies, the carrier wave and a wave whose frequency is the difference between carrier and voice frequency and a second whose frequency is the sum of the two parent frequencies. The summation and difference frequencies are known as sidebands. (See Ramsey, "Fundamentals of Radio", page 282, or Morecroft, "Principles of Radio Communication", page 773).

From 1928 to 1931 in England there waged a controversy no less heated than the early beat note controversy. (See WIRELESS ENGINEER, 1929-1931.) The controversy became so heated and so personal that it suddenly ceased. The presumption is that the remarks were so bitter that the editor refused to print them. Noted radio engineers participated in this controversy. Sir Ambrose Fleming, inventor of the two-electrode tube, made the statement that sidebands were nothing more than mathematical fiction. Sir Fleming said the varying amplitude wave was nothing but a varying amplitude and that the varying amplitude was not equivalent to the three waves.

These two controversies were in reality one and the same, the combinational tone controversy being the same as the sideband controversy, inasmuch as combinational tones in sound are exactly the same as sidebands in radio. The strange thing is that no one during the sideband controversy seems to have recognized the fact that both controversies were about the same thing.

One of the very convincing arguments against sidebands was: "If sidebands exist, why do we need the first detector in the superheterodyne receiver?" If two frequencies combine to make two more, why not do away with the first detector? All we want is the intermediate frequency. This frequency may be the difference or the sum of the two original frequencies.

Mr. Hazel began work on the sound proposition, using radio frequency instead of audio frequencies, before the sideband controversy started. The sideband controversy simply added more confusion. For a time he was firmly convinced that there were no combinational tones or sidebands. It was not until he had struck on the fundamental theory and the underlying principles that a conclusive experiment was devised.

In the theory of sidebands we start with the following equation:

$A \sin w_1 t \ (\sin w_2 t)$, or one sine function multiplies a second sine function. From this we get three frequencies, two of which are the sidebands or combinational tones. If we have two frequencies and add them we have, $A \sin w_1 t + \sin w_2 t$. It is mathematically possible to assume that these two added frequencies can be represented by a sum and a difference frequency but finally, after all our mathematical juggling, we will end up with the two original frequencies and nothing more.

In the first case we have one frequency multiplying the second frequency or wave. This is known in radio as modulation. In the second case we are simply adding two waves.

Koenig added two sounds from tuning forks and did not find the combinational tones. Helmholtz and his followers used sirens, organs, or other wind instruments operated from a common air chamber. If we assume the sound produced by a siren is of the following form, $P \sin w t$, where P is the pressure, then if two sounds come from the same siren $P = P_0 + P_1 \sin w_2 t$ then the output has the form $(P_0 + P_1 \sin w_1 t) \sin w_2 t$. Thus we have a product term and we have combinational tones which will set tuned strings, forks, and resonators into vibration. Therefore, Helmholtz was right when he said he found combinational tones. Koenig tried to add two sine wave tones, and he was right when he said that he did not find combinational tones. No one seemed to sense the difference in the methods of experimentation. The listening observer hears the two extra tones in both cases. In Koenig's case the tones heard were pure beat notes produced in the ear. In Helmholtz's case the tones heard were a mixture of beat notes and combinational tones. The frequencies of the beat notes and combinational tones are exactly the same.

From experiments given later we are forced to the conclusion that our ears manufacture the beat notes we hear when two tuning forks are sounded.

Suppose instead of tuned strings, forks, or resonators we use an acoustical wavemeter. Connect a good microphone to a circuit which can be tuned in the same manner as a radio wavemeter. For audio frequency we must use relatively large inductances and condensers, otherwise the circuit is the same as a wavemeter with a radio ammeter attached.

Suppose we take two loud speakers energized by audio oscillators. With one set at frequency 300 cycles and the second at 700 cycles, the combinational frequencies should be 400 and 1000 cycles. If we explore with the wavemeter set to 400 and 1000 and there is no response the 400 beat note heard with the ear may be so loud as to be painful. Only the parent frequencies, 300 and 700 are found.

Take the same two audio oscillators, connect one to its loud speaker in the usual manner and connect the second so its output is fed into the field winding of the first loud speaker along with the DC magnetizing current. Explore with the wavemeter and it gives peaks at 300, 400, 700 and 1000.

In the first case we are trying to add two sounds; in the second, the response of the speaker is $H \sin w_2 t$ where H is the field of the speaker. In this case H is

$$H_0 + H_1 \sin w_1 t$$

or the response is

$$(H_0 + H_1 \sin w_1 t) \sin w_2 t$$

thus we have a product term, and the combinational waves are found.

If in the first case the two oscillator tones or tuning fork tones are picked up by a microphone and passed through a tube adjusted for detection or modulation, the combinational tones or sidebands are found. The combinational tones or sidebands, intermediate frequencies in case of the superheterodyne, are manufactured in the tube. Thus if we

* Author, "Experimental Radio" and "The Fundamentals of Radio".

add two sine terms through a non-linear device we manufacture the combinational frequencies. Sidebands exist in space in the case of the radio telephone because these frequencies are manufactured in the modulating tubes of the transmitter. In the case of the superheterodyne the first detector is needed to make the intermediate frequency. We add the two frequencies through the non-linear first detector. A product term is needed. The mathematical theory of detection or modulation will show how the product term is obtained.

Just a word about linear detection. The word linear would seem to imply the linear detector is mathematically a linear device. Linear in mathematics means a straight line, but this line has no ends. The line extends to infinity.

In the linear detector characteristic we assume we have a straight line but that the line stops short or bends suddenly at the point where the current becomes zero. An equation which will represent such a line is very complicated and has product terms. So there is no want for product terms if the detector is a "linear" detector.

Since our ears are able to listen to two simple sine wave tones such as are produced by tuning forks, and we hear beat notes, this suggests that our ears are some kind of non-linear device.

All the early experimenters with beat notes and combinational tones seem to have reached the right conclusion as far as their own experiments were concerned, but they did not realize that the two sets of experiments were fundamentally different.

In the early radio-phone broadcast from Arlington, in 1915, the voice frequency was superimposed on the DC field current of the Alexanderson alternator. It is stated in certain texts that the modulation was produced by the non-linearity of the iron in the fields of the alternator. The non-linearity perhaps helped, but it is not necessary to suppose a non-linearity. The combinational tones from the single speaker might be explained in the same way. The last crucial test in Hazel's work was a set-up, an experiment devised by the author—in which all apparatus is linear.

Two 1000 turn honey coils were connected in series opposition and placed about an inch apart with their axes on the same line. In this manner their fields opposed along the axis and a radial field was formed. The coils were connected to a 110-volt DC circuit in series with which was a small 450 cycle generator. The equation of the radial field was $H_0 + H_1 \sin 2\pi\, 450$. Between the two coils a light spider-web coil was mounted on the end of a light glass tube, the far end of which was fastened to the moving coil of a cone speaker.

By starting the 450 cycle generator the coils were adjusted so the response of the wave connected to this spider coil was practically zero. In this manner the straight induction or 450 cycle output was made small. The spider web coil was moved at a frequency of 200 per second by energizing the cone speaker with an audio frequency of 200. (Due to the heavy mass of the coil and connecting rod it was impractical to use frequencies above 200). In every case the wavemeter responded to the summation tone of 650. (Due to the construction of the wavemeter it was impossible to tune to 250). In this case the combinational tones or bands were formed by linear apparatus.

The E.M.F. generated in the moving coil was,

$e = kA\,(H_0 + H_1)\sin 2\pi\, 450)\ (\sin 2\pi\, 200).$

This can be shown by means of mathematics to be four frequencies—200, 250, 450 and 650.

The above experiment shows that combinational tones and sidebands are more than mathematical fiction. That they can be formed by linear apparatus provided a "product term" is at hand. Adding two waves or tones does not give combinational frequencies. Adding two waves or tones through a non-linear device gives combinational tones. It suggests that our ears must be non-linear.

Effects of A. C. Voltage Distribution

By E. E. OVERMIER*

A THOROUGH knowledge of the proper functioning of automatic volume control circuits in modern superheterodyne radios is of vital importance in receiver design. Many questions pertaining to automatic volume control have been raised, such as:

1. **How much a.v.c. is desirable?**
2. **To which stages should it be applied?**
3. **How is the noise level affected through application of a.v.c. voltage?**

To answer inquiries of this nature, an investigation was made to determine the effects of applying different percentages of a.v.c. voltage to the various stages on which control may be desirable.

The primary function of the automatic volume control circuit is to maintain as nearly as possible a constant signal to the input of the second detector. This is accomplished by utilizing the voltage developed across the resistor in the diode circuit of the second detector to add to the bias voltage that is applied in the preceding stages which are included in the a.v.c. circuit. Since this voltage increases in proportion to the input signal to the receiver, a strong signal automatically increases the bias on the control tubes; at the same time the gain decreases. When the input signal is reduced, the voltage across the resistor will decrease so that the bias is reduced and the gain per stage automatically increased.

The gain of the various stages preceding the second detector is not the same, and furthermore their functions are also different. The result of changing the bias of each stage may have several effects on the general operation of the receiver.

The set used for obtaining the data shown in curve form in Fig. 1 and Fig. 2 was a household receiver having a Type 78 as the RF tube, a Type 6A7 as the detector-oscillator, and a Type 78 in the first IF stage.

The curves shown in Fig. 1 indicate the changes in sensitivity which resulted by applying different percentages of a.v.c. to the individual stages of the automatic volume control circuit. For maximum output the sensitivity varies as much as ten to one.

HYGRADE SYLVANIA CORPORATION

FIG. 1

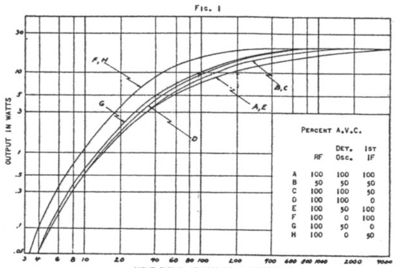
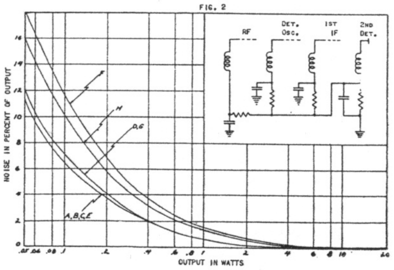


FIG. 2



High sensitivity is desirable in many radios, but it is sometimes gained with a sacrifice in noise level of the receiver. The set designer must arrive at some conclusion as to the best compromise which will be tolerated between sensitivity and noise level. A great deal of noise may be filtered from the output in the audio amplifier of the set, but only with a loss in output and some alteration in tone quality. Quite a large number of receivers depend upon the tone control to serve as a noise filter in conjunction with its normal purpose. The change in noise level using various a.v.c. circuits is illustrated in Fig. 2. Noise removed in this part of the receiver does not affect the audio gain so that more of the output for which the tubes used in the audio stages were designed may be realized. The tone control may also be designed for a single purpose with more satisfactory results.

Referring to Fig. 1, this study of the a.v.c. effect shows that too much automatic volume control has a tendency to decrease the sensitivity to a marked degree. Curve "A", where the full 100 per cent a.v.c. is applied to the RF, detector-oscillator and first IF stages shows that a very strong signal is required for maximum output of the set. However, the noise level under this condition is at a minimum. The sensitivity is the greatest with no a.v.c. on the pentagrid converter, but noise level is then highest as indicated by Curves "F" and "H" of Fig. 2. The percentage of a.v.c. applied to the first IF stage has very little effect on the noise level. A large number of sets employing an RF stage do not include the IF stage in the a.v.c. circuit, thereby gaining considerably in sensitivity with very little increase in noise level. Automatic volume control on the pentagrid converter is apparently an essential requisite. The degree to which the sensitivity is to be increased depends on the limiting factor of noise level to be tolerated.

A similar investigation taken with a more sensitive type automobile receiver checked the general results indicated by the curves here shown, although a much higher percentage noise level was inherent.

* Engineering Dept., Hygrade Sylvania Corp.

Battery-Operated Portable C.W. Transmitter

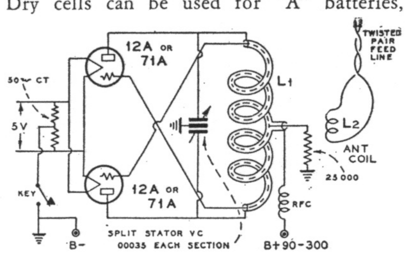
● There is a consistent demand for a transmitter for use in locations where AC current is not available. Attempts have been made to utilize the 2-volt series of tubes but it has been found, from the standpoint of "watts per dollar" and "dependability" that a pair of 12A or 171A tubes are far more satisfactory than any of the 2-volt series. The circuit here shown utilizes unity coupling, wherein the grid coil is wound directly inside of the plate coil. The plate coil can be made by threading a piece of No. 14 rubber covered wire through a length of 3/6-in. copper tubing, before the plate coil is wound. The coil and condenser should be designed for high-C operation at the required frequency, for two reasons: (1) stability requires that a large amount of circulating current must flow in the plate tank circuit; (2) some means must be found to keep the grid excitation down to a point where a good note can be obtained.

If a low-C plate tank is used, the grid excitation voltage becomes too high, will cause bad instability of the oscillator and an AC note will be radiated, even though batteries are used to supply the plate voltage. The antenna coupling should be quite loose, and at no time should the plates of the tubes show color.

The grid leak of 25,000 ohms, as shown, is satisfactory for use with 71A tubes, but it should be reduced to 10,000 ohms if 12A tubes are used. There is little difference between the two types of tubes. The 71As give a little more output, but the 12As give the best note and seem to have longer life. Twisted pair feeders, rather than Zepp feeders should be used because Zepp feeders cause somewhat more reaction from the antenna on the frequency of oscillation.

Every part in the transmitter should be rigidly supported and the leads should be short and symmetrical. The transmitter should not be placed on the same table on which the key is secured, because the mechanical impact or vibration caused by keying will result in frequency wobbulation.

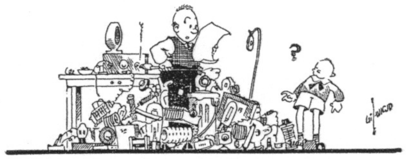
Heavy duty B batteries are more economical than the cheap, light-duty batteries, even though the original cost is somewhat higher. Dry cells can be used for "A" batteries,



provided a suitable dropping resistor is used to enable about 5¼ volts to actually reach the filaments of the tubes. A 10 ohm filament rheostat will serve the purpose. When in doubt, run the filaments high, rather than too low.

The best size for the grid leak will vary slightly, depending upon the tubes and the efficiency of the plate tank circuit. Lowering the resistance of the grid leak increases the power output, and increasing the grid leak resistance usually improves the note and frequency stability of the oscillator.

The use of a self-excited oscillator is undesirable, except where operation from B batteries is concerned, because a very serious compromise of power output must be made in order to get a good note and good frequency stability. On the basis of watts-per-dollar, the self-excited oscillator is uneconomical.



Ham Hints

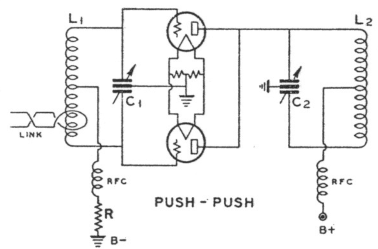
— — By JAYENAY ——

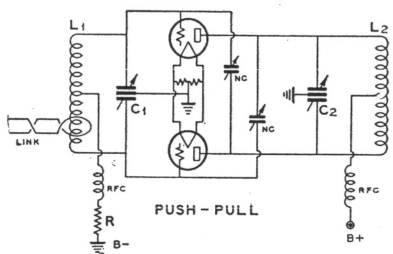
Quick Change From Push-Push To Push-Pull

● Many two-band transmitters use a single doubler stage, either as a doubler or as a straight-through buffer. Few operators who use the push-push doubler can change bands without the aid of a soldering iron. Here is shown a circuit arrangement which utilizes plug-in coils, mounted on standard 4-prong tube sockets. By merely arranging the internal connections in the plug-in coils it is possible to change the circuit from a push-push doubler to a push-pull neutralized amplifier.

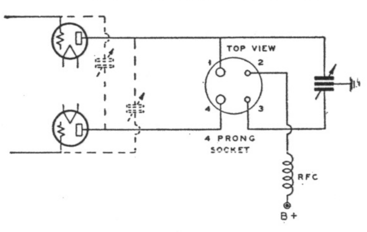
For example, the 40-meter coil can utilize the push-pull connection, while the 20-meter coil utilizes the push-push connection. Thus the circuit can be instantaneously changed-over by merely changing the coil, which must likewise be done in any circuit. The stage should be neutralized with the push-pull coil in place and the neutralizing condensers need not be touched thereafter, even though they serve no useful purpose in the push-push circuit. This circuit can be used with practically any type of tubes, although at plate voltages higher than 1000 volts it will be necessary to use a different type of coil form and socket.

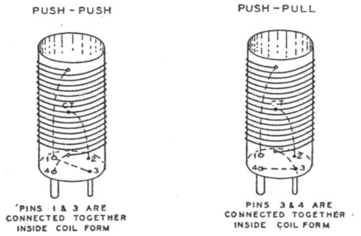
The power output when the push-push connection is used is somewhat less than that obtained in push-pull when the tubes are operating as straight amplifiers; thus some leeway in exciting the following stage should be provided.





AUTOMATIC PLUG-IN COIL CHANGEOVER FROM PUSH-PULL TO PUSH-PUSH





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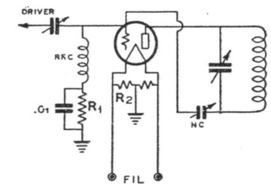
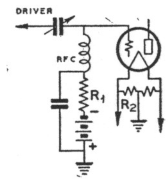
Bias Methods



GRID LEAK BIAS

FIG. 1

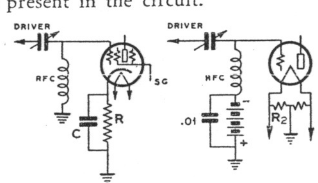
● Grid-leak Bias has the advantage in that the bias is automatically adjusted to the amount of radio-frequency excitation applied to the grid of the tube. More excitation automatically gives more bias, because there is more grid current drawn and therefore more DC drop across the grid leak. It has the disadvantage that if the excitation fails the bias disappears and excessive plate current is drawn through the tube. Thus it is usually desirable to use some other form of bias, such as battery or cathode bias, to supplement grid-leak bias.



COMBINATION BATTERY & GRID LEAK BIAS

FIG. 2

● Here is shown the combination of battery and grid-leak bias, mentioned above. This is probably the ideal bias system. The amount of battery bias required for any tube or amplifier circuit can be obtained by dividing the plate voltage, applied to the stage, by the amplification factor of the tube used. The amplification factor can be obtained from tube tables supplied by tube manufacturers. The purpose of the by-pass condenser across the resistor and battery is to provide a direct path to ground for the radio-frequency current present in the circuit.



CATHODE BIAS BATTERY BIAS

FIG. 3

● Cathode Bias is that type of bias obtained from the plate power supply by taking the drop across a resistor in series with the B-minus lead from the high voltage supply. It is usually more convenient to place this re-

(Continued on page 35)

EIMAC Tubes—*More Power, Less Grief*

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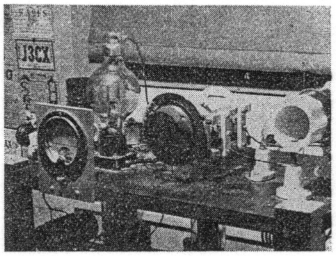

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W6CAL is WAC and has worked approximately 40 countries. He was SCM of his section for two years. He is planning a new transmitter which will allow somewhat more input and output on his final amplifier. He has used a wide variety of antennas on ten meters including a Johnson Q with a reflector. At the present time, however, he is using a standard 40 meter Zepp on 10, 20 and 40.

★ ★ ★ ★ ★ ★

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tubes are now being used by amateur, commercial and government stations all over the world. Various laboratories and instrument manufacturers have found many useful applications for the entirely new order of tube performance obtainable with EIMACS. Many leading doctors and hospitals are using EIMAC's in the new Diathermy fever machines which are proving to be highly useful and beneficial in the war against disease. To people like these, cost is a minor item . . . they cannot gamble . . . they can only use the best available. That the best also happens to be low in cost is fortunate and serves to explain why the new and modern EIMAC factory has only recently been able to catch up to within three weeks of its back orders.

We wish to apologize to those who have waited so patiently for their tubes, but no matter how many orders we get we will never permit the name EIMAC to stand for anything but the world's finest design and construction.

We expect to be caught up soon and all of our dealers will then be able to make immediate deliveries.

We could fill this column with enthusiastic phrases from EIMAC users.

No. 2 of a Series of 12

Your Problems—and Their Solution

NEUTRALIZING—

THE main source of grief in modern transmitters seems to be the difficulty of obtaining a satisfactory degree of feedback neutralization in the radio frequency amplifiers. This is particularly true of the high C tubes when used on 40 meters and below. The recent development of link coupling and split-stator balancing of the neutralizing tank circuit (either the grid tank or the plate tank) has served to minimize the former difficulties. However, the most important single factor in obtaining perfect neutralization is to use a truly low C tube together with extremely short, symmetrical and direct leads between the tank circuits and the tube elements.

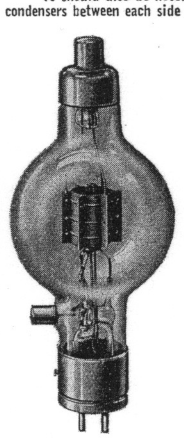
While the use of the split-stator neutralizing tank is generally more desirable than the use of the split coil type of neutralizing circuit, the latter is still quite popular. It should be remembered that perfect theoretical neutralization can be obtained only when the bypass condenser between the tank coil and the filament center tap bypasses the exact electrical center of the tank coil. The old practice of placing the ground tap on the coil, off center, is responsible for many cases of parasitics and imperfect neutralization.

PARASITICS

PARASITIC oscillations in a radio frequency amplifier can usually be attributed to the stray inductance and capacity in the leads between the tank circuits and the tube elements. Parasitics are of two general types. One type is usually below five meters and is something extremely hard to identify, except that the amplifier operates very inefficiently and the tube heats badly at low input. The best remedy is to be sure and use a low C tube, capable of short and direct leads to the various tank circuits. In most transmitters the final amplifier is placed at the top of the rack or cabinet, therefore it was assumed that the most desirable tube construction would bring the grid lead out of the side of the envelope and the plate lead out of the top, as in all EIMAC'S. Several mechanical layouts will occur to the constructor which will enable the leads between the grid and plate tanks and the tube elements to be kept down to an inch or two in length.

The other type of parasitic oscillation is due to what might be described as super-regeneration. It is evidenced by a series of RAC signals spaced perhaps 10 KC apart over a wide range in the neighborhood of the transmitter frequency. This trouble is particularly common with those tubes that must be biased somewhere between three and five times cut-off bias for efficient operation. The high transconductance of all EIMAC tubes allows very high plate efficiencies to be obtained without exceeding twice cut-off bias, thus eliminating this type of parasitic. This super-regeneration is further minimized in amplifiers using EIMAC tubes due to the fact that less capacity is required in the grid and plate by-pass condensers, than with practically any other tube. The capacity required in a grid or plate by-pass condenser is directly proportional to the plate-to-ground and the grid-to-ground capacity of the amplifier tube used. While no definite rule has been laid down, in general it will be found that best results are obtained when the by-pass condenser is about 100 times the tube capacity in the same circuit. Thus the lower the tube capacity, the smaller can be the associated grid or plate by-pass condenser.

It should also be noted that the five-volt filament used in all EIMAC tubes eliminates the necessity for filament by-pass condensers between each side of the filament and the center-tap.



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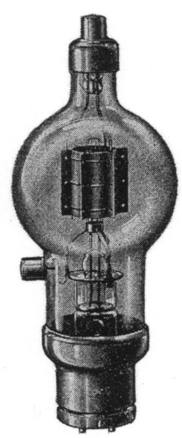

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Spokane, Washington. Spokane Radio Co.
Toronto, Ont. Canadian Tire Corp.
Tulsa, Oklahoma. Radio, Inc.

Grid-Modulated Phone

(Continued from page 13)

Several points should be emphasized in the construction of this transmitter. If a 1500 volt power transformer is used, condenser input type of filter is necessary in order to obtain at least 1700 volts DC for maximum output. **For c.w. operation the 2A3 tube must deliver sufficient excitation to the final stage so that the grid current will be about 20 mills under load.** This grid current can be increased by increasing the number of turns in the coupling link (within limits) or by increasing the plate supply voltage on the 2A3. However, the plate voltage should not be permitted to go above 500 volts. The grid blocking condenser in the 211 stage should have a rating of at least 2,500 volts DC working voltage because it has been found that lower voltage condensers will break down, due to r.f. surges. The lament by-pass condensers on the 211 tube should be .001 or larger, 1000 volt rating mica type. These condensers enable the lament of the tube to reach r.f. ground potential and sometimes these condensers are essential for complete neutralization.

Istead of using the Simplied PI Network Antenna Coupler shown in the circuit diagram, any of the other standard antenna coupling and plate tuning circuits can be used, either with plate neutralization or with grid neutralization.

The output for phone operation can be doubled by using two 211 tubes in parallel and by reducing the value of the cathode resistor to about 750 ohms. The c.w. output will only be increased about 40% to 50% unless a more powerful buffer stage is used. Caution in adding another 211 tube—be sure the neutralizing condenser has sufficient capacity to neutralize the two tubes. It may also be necessary to decrease the amount of inductance in the final tank coil, due to the increase in tube capacities. When two 211 tubes are used in parallel the plate voltage remains the same, but the plate current and grid current will be doubled. The same modulator system is used when two 211 tubes are used in parallel.

"Christmas in May"

(Continued from page 4)

ters has been locked up tightly and properly fumigated, it will doubtless be ready for habitation by the genius armachurus once more.

The next thing in our sock should be a retraction of this silly business of what members of the ARRL can vote and what ones can't. **All** members should be able to vote, and **only amateurs** should be members. That seems like rather a simple thing to us. Why should any commercial subscriber of "QST" object to this measure? Since they are not amateurs and it is an amateur organization they could have no possible reason for wanting to meddle in amateur affairs. All this is assuming that said commercial subscribers have nothing but a brotherly love for the ham, which seems to be open to some dispute. For our purposes, let's consider it as settled or something. Anyway, the "brotherly love" means without pecuniary interest (that's one for the R. I.). So let's take a vote on it. We will venture a timid guess, on the strength of which we will lay the contents of the baby's bank on the line, that every transmitting amateur will vote in favor of it. That way it'll be unanimous and nobody's feelings will be hurt. Isn't that nice? IF THE PERCENTAGE OF THE PRESENT MEMBERSHIP OF THE AMERICAN RADIO RELAY LEAGUE THAT WOULD VOTE AGAINST SUCH A MEASURE HAS ALREADY REACHED SUCH PROPORTIONS THAT IT COULD NOT BE CARRIED, THE LEAGUE, AS AN AMATEUR ORGANIZATION, IS NON-EXISTENT, AND THE SOONER WE FIND IT OUT, THE BETTER.

So let's have a vote, Mr. Director. The result will be self-explanatory.

Since our sock is about the same size as most of the hams we know, there's always room for one more thing or so, and this time it'll please be a solidification of the League's policy. In the March "QST", page 67, there was a group of questions whereby somebody attempted to prove something. Just what is the question. Every one of those queries was involving changes in the arrangement of our present frequency assignments. The obvious answer as to what we should do about it all should be obvious (or should we say "apparent")

(Continued on page 31)

A Pure 500-Cycle Oscillator

● An audio oscillator having an output which is relatively free from harmonics is very useful in a phone station or in an experimenter's laboratory. For oscillograph measurements, a sine wave oscillator is often quite necessary in order to really find the distortion characteristics of an audio amplifier of one or more stages. An ordinary audio oscillator has harmonics which prevent its output wave from being a pure sine wave. Most amateur phone stations suffer from amplitude distortion, more than from frequency distortion, and thus a single frequency oscillator is practically a necessity.

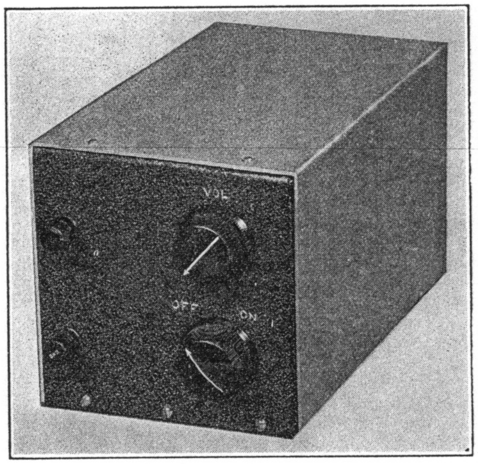
The unit here described consists of a standard circuit used by the telephone companies for many years in their measuring equipment oscillators. It is a resistance stabilized circuit which gives excellent wave form. The resistance between the plate and the LC circuit is a great deal larger than the plate resistance of the tube so that the total effective plate resistance becomes nearly a constant value. This means good frequency stability. If the resistance is high enough to just allow oscillation, the wave form is exceptionally pure. Variable degree of output can be obtained, as shown, by means of a potentiometer. The output varies from practically zero to about 3 volts peak, as measured by means of a peak V.T. voltmeter.

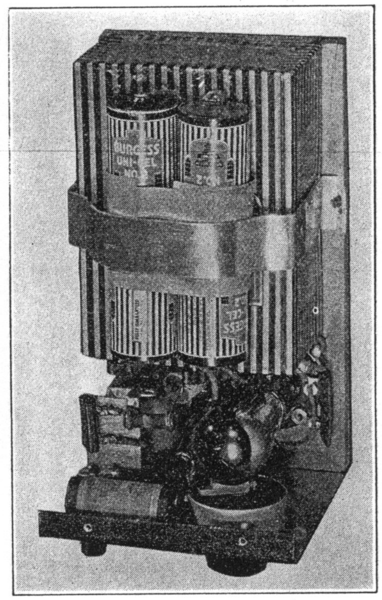
For convenience, the unit is built up with a type 30 tube, because battery operation eliminates the expense of a power pack. A portable type 45 volt B battery and four standard flashlight single cells are used for power supply. The latter are connected in series—parallel in order to obtain 3 volts for the filament. One set of batteries should last for many months of occasional.

The oscillator and batteries are built into a metal can, 5-in. x 5-in. x 9-in., of No. 14 gauge aluminum. Any other metal can be used. The parts are mounted on a wooden sub-base which simplifies construction and wiring problems. The can is exactly the same size as the one used for the Linear Rectifier previously described in this section. It is also of the same height and length as the Peak V.T. voltmeter previously described. These units make a pleasing appearance in any amateur station or laboratory.

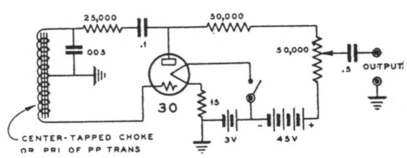
The plate resistor of 250,000 ohms will depend to some extent upon the type of transformer coil used. A push-pull output transformer, such as used on midget loudspeakers, makes a good coil for this use. The value of .005 mfd condenser across the plate section will, of course, determine the actual audio frequency. It is good practice to insert a piece of paper or thin cardboard in the air-gap at the butt joint of one of these transformers or center-tapped chokes. Lowering the inductance allows the use of a larger condenser across the plate winding, with better stability and wave form. The oscillator circuit uses a tuned plate circuit with practically unity coupling to the grid circuit, which is necessary in this type of circuit.

The output terminal should give a good loud audio tone into an ordinary pair of high impedance head phones when testing the oscillator. —C bias is provided for the oscillator by means of the one volt drop across the filament resistor.





The Pure 500-Cycle Oscillator is housed in an aluminum shield can, as illustrated above. The illustration to the right shows the interior view. The complete circuit diagram is shown below. Incidentally, this oscillator is also ideal for code practice work.



Circuit diagram of the pure 500-cycle oscillator

In using this oscillator, the output terminals can be connected to the input of the speech equipment either directly, or through a simple resistance network, and a vacuum tube voltmeter and attenuator can be used to measure the gain of each stage of a public address system or radiophone. By using either the linear rectifier or an oscillograph, the actual carrier signal can be studied and the distortion traced down for different percentages of modulation. Many an amateur phone station has the wrong grid bias on some stage, or other incorrect adjustments of either RF or audio excitation somewhere in the transmitter. Measurements are easily made and the faults remedied. The device used to study modulation on the carrier can either be a combination of the special V.T. voltmeter and linear rectifier previously described, or a cathode ray tube oscillograph which has a sweep circuit oscillator, can be used. The input of a good, steady, pure wave audio oscillator is much more satisfactory than whistling into the microphone.

Another use is in adjusting a phone station using controlled carrier modulation, especially if the set uses a class B linear RF stage following the modulated stage.

Occasionally a modulated test oscillator is needed for lining-up a receiver. This oscillator can be used to grid-modulate any low-powered RF oscillator, such as a receiving tube operated from 100 volts or less. An audio transformer can be used with the primary connected to the audio oscillator output and the secondary (step-up ratio) used as the grid-leak of the RF oscillator.

Still another use is that of providing a source of pure tone for Wheatstone bridge measurements of inductance, capacity and resistance.

T. R. McELROY
World's Fastest Telegrapher

T. R. McElroy's Chats

PART III

How to Conduct a Code Contest

"What about code contests, Mac, tell us something about how they run 'em and all the rest.'

Just as sure as I'm sitting here at my trusty Underwood, some hoarse voiced fellow in the center of the audience will throw that question at me every time I get before a group of hams for an evening's discourse on code and a code demonstration.

Not only that, but last week while I was visiting the New York office of American Radio Telegraphists Association, I found that a bunch of the commercial operators wanted to get the low-down on tournaments. So here goes. I don't feel eactly like writing this morning. My fingers are especially clumsy and my eyes more than customarily bleary. Must of been something I et!

Before I get going on the code business, however, I'd like to make mention of one observation I made on this trip I've just completed which will probably be interesting to a lot of hams. You'd be surprised at the large numbers of commercial men who are enthusiastic amateurs. I was. I'll bet I talked with a dozen ops at ARTA who wanted to know my ham call, explaining that they whiled away many weary sea hours listening in on the amateur bands. I don't know much about that racket—that ham band stuff. But I thought that a lot of those who read this sheet must be interested to know that so many commercials do listen and so many commercials agree that the proportion of good fists among the hams certainly equals that percentage among ships operators.

And now for the story. First of all—to the best of my knowledge there has never yet been run off on a large scale, a code contest the rules of which strictly limit contestants to amateurs! If there were I'd never have been admitted. I'd like, sometime, to see some section group of hams run off a contest with plenty of publicity and confine it to hams, and hams alone. I'd say that a ham might mean an active radio operator who is not employed as a radio or telegraph operator and who has not been a radio or telegraph operator for at least five years prior to the contest. If we did that, we'd have the real champion amateur radio code operator! Any clubs desiring further data on this, are welcome to write to me.

And now for contest rules. I think that the best run contest I ever participated in was the one at Chicago in 1933. I lost that one, too, by the way. An old pal of mine won. Feller named Joe Chaplin who is now with Press Wireless, and a crackerjack operator.

We started that one off at 40 w.p.m. and ran upwards in a kind of elimination series until the winner was selected. Here it is in detail:

Material for contests is selected by the president or secretary of the club running it. Or, in the case of a larger and more important contest, by a contest committee, or by the nearest radio inspector. It consists of easy reading, plain English press, selected out of any daily newspaper. Unusual words, peculiar names and figures are deleted. The material is, in brief, a very clear, smooth running, easy reading story with any words or phrases that might be difficult to grasp at high speed deleted and more common words and phrases substituted, to make it read smooth.

That part of the affair is perfect. But my objection has always been that the material has no punctuation and is usually copied on single-case mills. I would figure the ideal condition or rule to be that the material be considered plain English press, as it is, and that it be put down as press should be. With correct capitalization and punctuation. And my emphatic suggestsion would be that such rules be embodied in any important contest. That the material must be punched on a perforator with correct punctuation and that it be copied correctly punctuated and capittalized. That kind of copy could form the basis for the securance of aid of some local important newspaperman to be one of the judges, with the resultant better chance for greater publicity for the club.

After the material is selected, it is punched out on a perforator which is a machine similar to a typewriter, excepting that when a letter is hit, perforations are made in a paper tape, like a typewriter ribbon, corresponding with the dots and dashes of that letter. Later the tape is run through an automatic transmitter wherein tiny pins shoot through the perforations on the tape to make contact and translate perforations into dots and dashes at speeds governed by the motor running the transmitter.

The material is perforated by some organization having access to a perforator. These are made by Teletype Company in Chicago, and are used by Western Union or Mackay Radio or any of the larger communication companies. And they are always glad to have one of their men punch out material for a club contest, if they are approached right. In this connection I might add that I'd probably be glad to take care of things of this nature for clubs if other sources fail them.

The roll of perforated tape is sealed in an envelope with the contest material and the seal broken at the beginning of the contest.

Tournament room is provided for in occordance with the number of contestants, and in the larger cities typewriters are usually provided at no cost by the typewriter companies who figure this a form of good will or indirect advertising. Same with headphones.

The automatic transmitter used is a Creed automatic head or the more up-to-date and improved Boehme automatic head. There is a feller in Chicago, named Frank Borsody, who occasionally makes an automatic of his own design which functions very well and costs a small fraction of the commercial type. In fact I've used one of his heads for some time past. However, on these automatics if a club experiences difficulty in securing the use of one, I'd probably arrange that, too. This code contest racket is quite a hobby with me and I'm always glad to do whatever I can to help any clubs.

There is set up in the contest room an audio oscillator—either made up with tube and transformer or a General Radio 1000-cycle oscillator. The oscillator note is running constantly and the make and break in the phones is at the transmitter head. Another thought in this connection is that it would be a wonderful feature of any contest to have the signal on a good loudspeaker also, so that the audience could hear what the contestants were copying. This would not bother contestants because the phones on their heads keep out any disturbance.

Getting down to the beginning of the contest itself. The envelope is broken open by one of the judges. The roll of tape is placed on a spindle similar to a motion picture reel and beginning of the roll placed into the transmitter. Previously the transmitter has been adjusted to approximately 40 w.p.m. Words per minute are determined by five letters to the word. The tape is sent through at the opening speed of 40 w.p.m for five minutes, and then jumped to 42 w.p.m. and so on upwards. But here is where my ideas differ again.

Men in a contest are under a terrific handicap. The mental strain is great. As an example, I know a feller, Benny Sutter, who held the title some years back at something around 50 w.p.m., which is not fast at all. Benny can copy nearer 60 w.p.m. than 50. But like all of us, the nerves go to pieces in the strain of a contest. Benny is working for Press Radio now, with Joe Chaplin, and they both copy regularly, plain English press at better than 50 w.p.m., all in the line of a day's work.

I suppose, in connection with this mental strain angle of tournaments, that it is only fair for me to mention that an old time telegraph operator pal of mine, Candler in Chicago, deserves a lot of credit for his part in working with us toward the minimizing of the difficulties in this particular connection. The fact is, I'm really happy to have the chance to give full credit to him for his assistance to me along these lines.

To save time and to save razzing the nerves of all concerned, I would say start the tape at 40 w.p.m. and run for 2 minutes only. Then about 42 w.p.m. and then 45 w.p.m. and from that point upwards, increase the speed at about 1 to 3 words per minute at two-minute intervals, the judges picking up papers at each speed and disqualifying contestants on the basis of errors.

My idea on errors would be this: no such thing as errors. Typographical errors, all okay. All men can't be expert typists. But actual telegraphic errors, I feel, should throw a man out. Why, I can copy as high as eighty words per minute BUT with plenty of errors. What is the difference whether a man copies fragmatically at 80 w.p.m. or copies with a flock of errors at 60 w.p.m.? I would urge that the contest rules eliminate any contestant with more than, say, 5 per cent errors, and that the winner be judged on that basis. For example: they start at 40 w.p.m. That would be 80 words in a two-minute run. A man with four errors would have 5 per cent errors and would be okay. With five errors or more he would be eliminated. Errors mean each letter copied wrong. Although

T. R. McElroy's Chats

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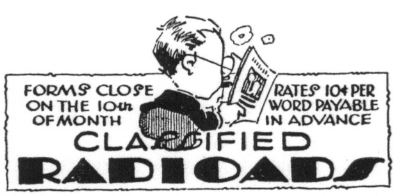
I would allow a contestant to type over to correct an error due to clumsy typing.

On the basis of those rules, let us say we get up to 60 w.p.m., which would be 120 words in two minutes. A man could have six errors and still be within the five per cent, and the contestant with the best copy at six errors would be the winner. But suppose a contestant, typing fast, failed to capitalize the word Chicago, and then realized his mistake and shot back and corrected his typographical error. I would say it is not an error. Because in press work for newspapers an operator is permitted such typographical corrections and it would be penalizing an operator on his typing alone to debit him with an error such as that, when he corrected it during contest.

On the basis of all my years of experience in code contests, I would say that the most desirable feature I can think of is the requiring of contestants to correctly capitalize and punctuate with the resultant greater publicity for all concerned through the fact that newspapers generally would recognize such copy as actually constituting real press copy. The next desirable feature is putting signals on a loud speaker for all to hear; and the next, keep it down to two minutes to save nerves of all concerned.

I'll soon give you a story on sending tournaments. Meanwhile, 73s to all.



Amateur News

The Amateur's Legion of Honor

This department is edited by the Secretary of the International Radio Fraternity, Kenneth Isbell, radio W6BOQ, KFI, KECA. All communications concerning the International Radio Fraternity as well as inquiries from any amateur as to the requirements for membership, should be addressed to IRF Headquarters, International Radio Fraternity, 2705½ St. Andrews Place, Los Angeles, California.

● IRF continues to grow daily and it is with pleasure that we note many new foreign amateurs entering our roster.. This will strengthen our ranks and will aid us in our endeavor to promote education along the lines of the coming Cairo Conference Convention. It is hoped that those who have their fone rigs going and who are able to join in this new fone network will contact headquarters as soon as possible so that we can attempt to route same and establish a real fone net. It has already been suggested that IRF assume the tremendous job of establishing a reliable fone network to more plainly bring before the lawmakers the necessity of qualified representation to the next Cairo Convention. Washington lawmakers must be made to see the logic of recognizing amateurs who have so well pioneered the field of radio. This work must continue, therefore we must have elbow room . . . not be curtailed and flimflammed as we have in the past. We should see through the veil that has covered our eyes. We can have representation if we go out after it. We can show the legislative bodies that we need it. We must show them that we are public servants, that we have earned the name.

To do this, IRF's plan will bear repetition: Influential citizens, mayors, governors, congressmen, etc., will be invited to talk over a nationwide fone network to their fellow legislators, and thereby establish a closer understanding of amateur radio conditions and realize the ability of the amateurs to equip and maintain a reliable source of communication that would be invaluable in the event of a national emergency. This alone should interest the lawmakers, especially at this time when Europe appears to be again boiling and spoiling for trouble. When Congressman So-and-So reappears at Washington, he will still be talking about the time he received first-hand knowledge of amateur radio and it will give him a broader knowledge when new radio laws are being framed. The comercial interests who are seeking to relieve us of our valuable frequencies in the hope that some day they may use them, will have to change their tactics when Congress learns more about the radio amateur.

So don't fail to notify headquarters as soon as you are ready to join with us in our phone net. Quality of output counts more than high power. Whatever your power, write headquarters immediately and let's get this valuable fone network going in full swing as soon as possible.

● Los Angeles Chapter raises funds by auctioning old parts no longer useful to members, yet still valuable to someone else. It is suggested that other chapters do likewise.

● Send us more information on what you are doing at your monthly chapter meetings. Send in your current report to headquarters quickly.

● Next month we hope to announce the winner of the 801 tube for the most IRF QSOs. It is hoped that all entrants in the contest have sent in copies of their logs of IRF contacts, just as written in same. All reports must be mailed to headquarters on or before May 31, 1935.

● Send in your station fotos and descriptions for future publishing.

● If you have moved and have not received your copies of our monthly bulletins, notify headquarters immediately of your change in address. Further information required by interested parties should be addressed to International Radio Fraternity, 2705½ St. Andrews Place, Los Angeles. If you are now a member and wish to pledge a friend who is eligible for membership, write a card to HQ and give us his name. All applications must be thoroughly checked by the membership committee before the applicant is actually accepted into the fraternity and a certificate issued to him.

Central Division News

● A large IRF representation is expected at the Convention during May at Minneapolis. The entire division of IRF men is looking forward to this great affair.

West Coast News

W6EJA is now using a new rack and panel transmitter.

W7NH, Nellie Hart, is now the acting SCM of Idaho.

W6FBW is busy handling traffic nowadays.

W6FFU is using pp 10s in final now.

W6CAL retires from SCM of San Francisco after serving for two years.

W6HDV worked VO, Newfoundland, on 7 MC recently.

W6LTI is busy working, so is off the air for a while.

W6JWW, a new member of IRF, has recently had his first K6 contact.

W6CUU is busy rounding-up traffic for Shanghai for his OM1TB sked.

W6CII has daily sked with KA1HR.

W6CXW is working plenty of European DX on 14 MC.

W6WO worked four new countries on 14 MC last month.

Conditions on 7 and 14 MC were very good for international DX contacts during the Seventh International Relay Competition. Many interesting contacts were had by our local gang with new DX countries. The "smart" DX hunter divided his operating time between the 7 and 14 MC band, thus enabling him to take advantage of the DX possibilities of both bands.

During the last week of March and the first week of April, the 14 MC band was unusually "hot" for European contacts. European signals were heard during the morning and noon hours. F8EX, F8EO, ON4UU, G6PY, PA0XF, and G6VP were the most consistent DX heard by W6WO.

Calls heard by W6WO, Leonard T. Robinson, 822½ West 42nd Place, Los Angeles, Calif., 14 MC CW band, March 4 to April 4, 1935: CE1AP, CE1AG, CE4AD, CE7AA, CX1BC, CX1BU, CX1CC, CX1FB, D4BBM, D4BIU, D4CAF, EI8B, F8EB, F8EO, F8EX, F8RJ, F8TG, F8WB, G2DX, G5SY, G6BB, G6PY, G6VP, HC1FG, HP1A, K4SA, K7GH, K7DVF, LU1CH, LU1EP, LU2FC, LU3DE, LU3DH, LU4DQ, LU4FO, LU5AG, LU5CZ, LU5FV, LU6DJK, LU6FB, LU7EF, LU9AX, LU9BV, LU9DX, LY1J, OE3FL, OA4AA, OA4M, OA4J, OA4Q, ON4OU, ON4HM, ON4RX, ON4UU, OC8LP, PA0CE, PA0XF, PY1AW, PY1DW, PY1IF, PY2BK, PY2CB, PY2CD, PY2EA, PY3AD, PY3AM, TG1AC, TI2KF, TI2TAO, VP2AT, VP4JR, VP4TF, VP4TG, VP5AB, VS1AJ, YR5AA, XZN2B. This is a FB report. Don't forget to send yours.

A very special invitation is extended to all IRF men from near and far to be the guests of the San Diego Radio Amateurs' Association, when a radio "Fiesta" will be held July 20 and 21, at the California Pacific International Exposition, in San Diego's Balboa Park. Railroads, shiplines, bus companies and hotels in San Diego have joined in making it financially possible to put the Fiesta over in a big way. During the two days' celebration, visiting radiomen and their families will be kept pleasurably engaged in seeing the extraordinary exhibits, and in doing the many things planned by the radio fiesta committee, such as a visit to naval ships in port, a visit to the North Island Naval Air Station (the largest government air field), breakfast, golf, and swimming at Agua Caliente. A visit to NPL, largest continental government station, and a visit to the Naval Radio-compass Station, and other activities.

W6USA, a modern powerful amateur radio telephone and telegraph transmitter, will be in operation and available for use of visiting licensed operators.

A thousand dollars' worth of prizes will be awerded. Door prizes, code-speed prizes, 56 MC contest prizes, prizes to the man from the most distant point in each district and from foreign countries are but a few of the many ways in which valuable equipment can be won. Visiting amateurs are invited to display AC and battery operated portable outfits. A prize will be awarded to the owner of each type which has the best design, workmanship and appearance. It may be of interest to those who intend to attend this gala affair to know that Balboa Park, the site of the Exposition and Radio Fiesta, comprises a very large area in the heart of San Diego, with beautiful buildings of Spanish, Mayan, and Indian Pueblo architecture, containing all types of exhibits. Also there are many concessions. The Zoo which is second finest in America. The two-day fiesta will finish with a bang at the gala banquet at which the many prizes will be awarded. Fiesta headquarters hotel will have accommodations for as little as $1.50 per day per person. Don't forget the dates, July 20 and 21.

The Southern California Chapter of the IRF is already making plans for many of the fellows who will make the trip to San Diego. Read your IRF Bulletin, "Lightning Jerker", for further details. Let's look forward to seeing our fellow IRF brothers in San Diego July 20 and 21.

Any member who wishes to obtain a fraternity pin should send $1.75 to IRF HQ.

These columns of IRF news are now edited by Lloyd M. Jones, W6DOB of Los Angeles, Calif.

10-Meter Contest

The renewed interests in the 10-meter band has prompted the Oakland Radio Club to conduct a contest, the rules of which are given here. Those who desire to participate are asked to communicate with W6GZT, Chairman of the Contest Committee, 921 Harrison St., Oakland, Calif.

10-METER CONTEST RULES!

1—Starts Noon, May 1st; ends Midnight, May 31.
2—Any licensed Amateur can participate, but only ORC members are eilgible for prizes.
3—Scoring as follows: Up to 500 miles, 1 point; 500 to 1,000, 2 points; over 1,000 miles, 1 point for each 1,000 worked.
5—Contacts can be made on CW or phone.
4—Fifty per cent additional credit for phone. or both.
6—Points will be allowed only once in every 24 hours for the same station worked.
7—Contestants' logs will be taken for official check.
8—The Committee's ruling will be final.
9—Prizes to be announced later.

Class B Audio

(Continued from page 20)

sufficient to give required output. This improves the regulation of the driver output voltage.

The same coil design considerations hold true for the output transformer, for coil symmetry.

The output transformer is much more simple in design because it works into a load of constant impedance, and the secondary is delivering both halves of the audio cycle to the same load.

The DC resistance of the primary should be very low so that the voltage drop is not great when the saturation plate current value is considered. For instance, a plate current in one-half of the primary of 500 MA and a primary DC resistance of 250 ohms (which is not uncommon in commercial transformers of this type), would cause a 125 volt drop in the signal voltage. The wire size may have been large enough to handle 500 MA without melting, and as long as the peak current was only there for a small fraction of a cycle the wire would not heat, but what about the wave form? A Class B output transformer should show little rise in temperature in operation and the wire size should be at least 1500 circular mills per amp., based on the peak plate current.

Most output transformers are designed to carry the current of the modulated stage, but this practice is not advisable if the best quality is to be had.

When the secondary is made to handle such high current, a large air gap in the core is necessary to prevent core saturation. This, in turn, necessitates increasing the number of turns on the coils, which increases the DC resistance, the leakage inductance, and the distributed capacity, to a point where good frequency response over the audio spectrum is hard to get. When the secondary carries no DC, the core can be assembled without an air gap, resulting in much better quality and greater power output.

It is very important, however, when this practice is followed, that the tubes have like characteristics and are adjusted to identical static plate currents. The output of a single tube working Class B consists essentially of a fundamental and a series of even harmonics, chiefly the second harmonic. If two tubes are properly balanced in a push-pull circuit, the output will be free from even harmonic distortion. A correctly designed output transformer has a core of such dimentions that the flux density at peak plate current will be close to the upper bend of the B & H curve, in other words, close to saturation. Unless this is done, the incremental permeability will fall to a very low value for low percentage modulation, with a resulting loss of low frequencies. The unbalanced plate current will swing the iron through different ranges of flux density on alternate half cycles, producing high amplitude harmonics. These harmonics can produce severe over-modulation and cause the carrier to splatter over a wide frequency band, even though the fundamental frequency is modulating less than 100 per cent.

Because it is desirable to get the peak audio power output necessary to modulate a given DC power input to a Class C amplifier, and because this power cannot be measured with the meters usually available, it becomes necessary to calculate the peak power output (without distortion). DC current meters read average current. Thermo-Couple AC current meters read effective current, or the equivalent heating power of a DC current. With a pure sine wave input of constant amplitude, the AC current divided by

(Continued on page 34)

"Christmas in May"

(Continued from page 26)

to the one who got up the questionnaire, i.e., e.g., viz., and to wit: NOTHING! The character of the questions shows our evident discontent with the existing conditions in our frequency channels. For the love of something-or-other, leave what we've got alone! It's bad enough now! We don't want a **change**: We want **more territory**! For some strange reason the officers of the League can't get it into their heads that the League—that is, the amateur part of the League—wants no compromise!

Let's quit shuffling the old cards around and call for a new deck. The game is called "Expand Or Nothing". The rules are simple. They're "Of, By, and For the Amateur!"

And we reckon as how that'll be about enough for this year, thanks.

* Reprinted from "QSA-5" (Marin County Radio Club).

Osockme, Japan,
March 23, 1935.

Hon. Editorial Editor
of "RADIO". Dear Sir Ed.:—

You make Hon. request from Scratchi to ask how radio ham club meetings here in Osockme, Japan, are conducted. I meet such defy with herewith copy of last meeting report, which are as follows:

Meetings will now please come to orders, with Hashafisti Scratchi in chair. Secretary report he will not read minutes of last happened meeting of Club because last meeting were skipped and one more meeting previous to such were adjourned because of failure of treasurer to appear on scene. He were last reported nine degrees south of the south pole. Appointment of new treasurer now become in order with eligibull candidates to become nominationed. There being no further nominations, it become necessary for chairman to draft honest person for treasury position. Scratchi find one man sound asleep in south-west corner of club room, with right hand over his heart and left hand on his watch.

He are business man person, methinks, and upon awakening himself when sound of police whistle outside on street are heard, he come to realization that he are unanimously elected treasurer of Osockme Radio Club. Entire club rise up on feet and congratulate new treasurer by etending usual sympathy. He are given ex-treasurer's report to read which show that there are a negative bias in treasury of 45 yen. "Make your statements more positive", Scratchi inform new treasurer. You have too much excitation, he inform me, and you make too much oscillation with your chin. Whereupon Scratchi discharge him from treasury position and it are then unanimously voted not to have treasurer in office until income taxes are reduced. Motion are carried away and protest sent to local senators in special delivery mail. It are later found that letter were dropped in wrong box by mistake and letter are returned at following meeting with take notice please and keep your mail out of fire alarm boxes.

Next order of business which are in order are announcement of new members which have join membership. First new member who are to be welcomed are Hon. Mr. Tankacoil Skinfecti Q. He are a ham who come to Japan from China, more recently. What were your occupation in China, Scratchi ask new member? Hereupon he jitter forth such information that he were Line-man by trade. He say he work as Line-man in Chinese Laundry. He hang wash on line. He are welcomed into club and immediate proclamation are signed that he become committee of no less than one, upon whom it shall be entrusted the duty to report at next meeting of investigation he make of baffling problem which ave disturbh club for many long year. Such problem are answer to question, "What Hertz worse than a Hertz Antenna?"

Next new member to become invited for membership are Hon. Mr. Lo See Hy Mu. He also are recent from China. He are inventor by trade, discoverer by occupation and originator by avocation. He hold famous patent for modern contraption machine which have four wheels and flies around. Such device are more comonly known as garbage wagon. He make plea to club membership for help in securing occupation in Japan as he are in immediate and more urgent need of employment. One member suggest to him that it should be most simple to make find employment here in Japan because new Codes have make provide positions for all in need of such. Whereupon he are given address of local Code Committee Office and upon going to such place he are asked under what code he make prefer to work. He answer and say he prefer work under Continental Code.

One more person remain to be sworn in as new club member. He refuse to make divulge of his name and address because he say he are a radiophone operator and he love his neighbor like he love himself. He volunteer forth with information that he are prominent industrial manufacturer here in Japan. He manufacture wire for wireless telegraph companies.

There being no further business before the house which are an open air meeting place here in Japan, meeting come to adjournment and report of committee members are ask for. Committee on "Tracing R.F. Paths To Ground" report that no further progress can be made because bottom have been struck.

Your Complimentary Subscriber,
HASHAFISTI SCRATCHI.

Class B Audio

(Continued from page 31)

the DC current will produce a factor of $\frac{\pi}{2\sqrt{2}}$ or 1.11, if no distortion is present. If the factor is more than 1.11, it proves that harmonic distortion is present. If the factor is less than 1.11, the wave form is flat-topped. A factor of 1 (one) would represent a square wave. The effective power output with a pure sine wave input is equal to the plate current, as read on a thermo-ammeter, squared times the load impedance and the peak power is exactly double this value. Also, the peak power is equal to the square of the peak-plate current times the load impedance, so the effective current to peak current can be converted by multiplying by $\sqrt{2}$ or 1.41; under the stated conditions the peak power output can therefore be estimated with a fair degree of accuracy. As an example let us estimate the modulating capabilities of a pair of the new 801 type carbon plate tubes. In a Class B circuit only one tube conducts at a time, so it is assumed that one tube is supplying all the power during ½ cycle and the other tube is supplying no power during that half cycle. The rated safe plate loss averaged over any audio frequency cycle is 20 watts, and this value is conservative. Considering that either tube is supplying no power one-half of the time, the plate loss can be increased to double the rated value during the half cycle it is working. This would mean an average loss during the half cycle of 40 watts. The maximum loss does not occur at maximum plate current but usually near zero grid voltage, so that the plate voltage, plate current curves of the tube must be consulted to determine the average plate loss. The average plate loss of the 801 is computed from the curves supplied by the manufacturer. The plate supply voltage is 750 V. and the peak or maximum plate current is 250 MA. The plate losses for the different grid voltages are given below:

Ep	Ip	Watts Loss	Grid Voltage
750	.004	3	—90
700	.020	14	—68
600	.058	34.8	—38
500	.097	48.5	—9
465	.110	51.1	0
400	.135	54	+20
300	.175	52.5	+44
200	.214	42.8	+70
150	.230	34.5	+85
110	.250	27.5	+100

Average loss 36.2 over ½ cycle or 18.1 watt loss over the whole cycle. This leaves a fair margin of safety below the rated 20 watt dissipation. Using the equation: $I_P\,Max^2\,R_L = PO\,max$, R_L equals load impedance and $I_P\,Max^2$ equals peak plate current. With the peak plate curent of .250A and a load of 2500 ohms, the result is 156.2 peak watts, or an effective power of 78.1 watts, which will modulate a DC input to a Class C amplifier of 156.2 watts.

This output is possible with a pure sine wave input of constant amplitude and with the tubes operating below rated plate loss. consequently, with normal voice or music input, the average or effective power being less than with constant sine wave input, the peak power can be increased to a value where the average plate loss is equal to the rated value.

It must be understood that when operating tubes under these conditions the input to the amplifier should be normal speech or music,

(Continued on page 35)

Class B Audio

(Continued from page 34)

not sustained tones of appreciable duration and high amplitude, which would cause an average plate loss above the rated value.

In a following article the design of a pair of transformers for Class B 801s to modulate 175 watts of DC input to a class C amplifier 100 per cent with less than 5 per cent harmonic distortion will be considered.

Ham Hints

(Continued from page 24)

sistor between ground and the cathode, or filament center-tap ,instead of physically placing it in the B-minus lead. However, the result is exactly the same in either case. The plate current is required to flow through this resistor; therefore there is a voltage drop across the resistor which can be determined by Ohm's Law. The voltage drop equals the current in amperes times the resistance in ohms.

● **Battery Bias** is quite simple and merely consists of placing the battery in series with the DC grid return of the tube. Care should be taken to see that the negative battery terminal goes to the grid of the tube; the positive terminal of the battery goes to ground.

Surveying the Radio Horizon

(Continued from page 18)

are concerned about this determination of ours and endeavor to discourage us in our demand for more frequencies. They regard it as utterly impossible in the present stage of the world's intensive use of frequencies and they assert that we shall only injure ourselves by such a demand. Their point of view is that the administrations have come pretty generally to the acceptance of the present amateur allocations as a sort of necessary nuisance to placate the United States and Canada, but that if we show we are discontented and demand more we put ourselves in the category of a danger that will have to be taken drastically in hand. They feel that, regardless of our numbers, the amateur service as a whole is not entitled to more than its present proportion of the total. I encounter again the suggestion, previously passed on to you, that we are not yet making the best possible use of our assignments and that we could do much to reduce our interference problem by such devices as segregating beginners on probation, subdividing different frequency bands by private arrangements between ourselves by zones, etc. Of course, I counter that every amateur is entitled to exercise all of the amateur privileges, but I don't know but what there is a great deal in what they say. I think we could make a great improvement. . ."

My guess is that Warner's policy has been to pacify the warlike desires of both the League members and the Board, because he has been told by the Commercials that if he didn't, there would soon be no amateurs to buy "QST" and keep the wolf from his door.

Lately, however, the lid has shown signs of blowing off. The membership can no longer be handled by telling us nothing in "QST," and by attempts to steer us completely away from worth-while traffic handling.

In any event, when it comes to FIGHTING for more frequencies, WARNER'S HEART ISN'T IN HIS WORK.

If it be true that the other Nations are allowing the Amateur to exist **because Canada and the United States have to be placated,** as Warner's letter puts it, **then the obvious thing to do is to tell the Amateurs of the United States and Canada to approach their respective governments, through their chosen representatives in the Dominion's Parliament and in the Congress of the United States, and cause those governments to become even more solicitous of the welfare of their many thousands of amateurs than they already are.**

And there is no reason in God's world to expect that **later on,** the world's use of frequencies will be any **less** intense than it is now. Nothing can be gained by delay on that score, certainly. The present looks like a particularly **favorable** time to strike; for any amateur listening on the high-frequency commercial bands knows that the air is simply cluttered by commercial stations sending "A B C" and "V V V" and almost never working anybody. I venture to say that we could make an improvement in the use which we make of our frequency assignments; but how about the Commercials? Are **they** so perfect?

We have a Democratic administration in Washington, and the United States has grown much more realistic in its dealings with other nations, by way of treaty, or otherwise. I believe that if Congress, by resolution, instructed the American representatives at Cairo to obtain more frequencies for the Amateurs, we would stand an excellent chance of getting them.

The Federal Communications Commission, and all the other administrative bodies set up by Congress, derive their powers from that body, and Congress is boss.

The Bible says that "The meek shall inherit the earth." Well, I won't dispute that—but you and I won't be on earth when the estate is settled and the assets distributed to the legatees.

I repeat to you what I told you last year: **You won't get anywhere until Warner is fired.** Tell your Director to tell him to "scram."

Radio Dealers and Jobbers who desire to advertise in these columns are invitec to write for rates.

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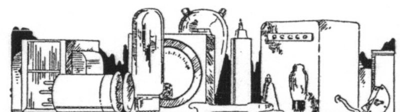

NEW PRODUCTS

Concentric Cable Transmission Line and Antenna Coupling Unit

A CONCENTRIC Transmission Line makes a very desirable circuit between the transmitter and the antenna when it is not convenient to locate the transmitter at the base of the antenna. Two common cases of this type are the directive antenna system and the antenna on the roof of a large building.

Since ground connections on the outer conductor have no effect on operation, a concentric cable may be run through bricks or concrete walls, in contact with conduits, around corners, or buried underground with a minimum of installation cost. There is no danger to anyone touching the cable.

Two sizes of concentric cable transmission line are being manufactured. Type C-1 is suitable for powers up to and including 1000 watts. The outer conductor is a copper tube ⅝-in. in diameter. Isolantite insulators are used. It is coiled for shipment and may be bent with a radius of 8-in. or more. The impedance is 81 ohms. The loss per 1000 feet is 0.6 Db at 500 KC, 0.8 Db at 1000 KC, 1.0 Db at 1500 KC, and 3.7 Db at 20,000 KC.

Type C-2 is suitable for powers up to and including 50,000 watts. The outer conductor is a copper tube 2-in. in diameter. This type is supplied in straight lengths of 12 feet. Connectors which permit sections to be soldered together very simply are supplied. It may be supplied with bends of radius of not less than three feet. The impedance is 125 ohms.

Both types are of rugged construction and have high quality insulating material. They are completely air tight except at the ends.

Type A Antenna Coupling Unit to couple Type C-1 Transmission Line to the antenna is recommended. The unit matches the transmission line to any antenna. It consists of coupling condensers, the antenna tuning inductance, and the necessary tuning meters, all housed in a weatherproof copper box. Larger coupling units for operation at powers greater than 1000 watts can be furnished.

Type C-1 or C-2 Concentric Cable in small quantities $0.50 per foot. Type 9 Antenna Coupling Unit $200. Manufactured by Doolittle & Falknor, Inc., 1306 West 74th St., Chicago, Illinois.

●●●

New Oak Vibrators

THE Oak Mfg. Co., 711 W. Lake St., Chicago, announces a new line of vibrators with several desirable features and advancements in design.

The outstanding differences in construction are found in the separate set of driving contacts and in the driving coil, which incorporates a shorted winding for prevention of arcing across the driving contacts. The consequent elimination of wear and oidation of the driving contacts assure starting under all operation conditions.

Longer use of the power contacts, because of the remova of the driving function from them, greatly increases the useful life of the unit.

The vibrator is available in both synchronous and non-synchronous types, both being only 3$\frac{1}{16}$-in. high by 1¼-in. in diameter. Standard 4-prong base mounting is used on the non-synchronous and standard 6-prong base mounting on the synchronous type.

A remarkable stability of output is assured as is evidenced by test runs in ecess of 1000 hours at 33 per cent overload.

●●●

New Catalog By Alden Mfg. Co.

THE Alden Products Company of 715 Center Street, Brockton, Mass., have recently issued their new sixteen-page 1935 catalog illustrated above which shows the most popular Na-Ald products: Analyzer Plugs and Asociate Adapters.

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Harrison 2276
Dependable Radio Equipment
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Bulletins on request.
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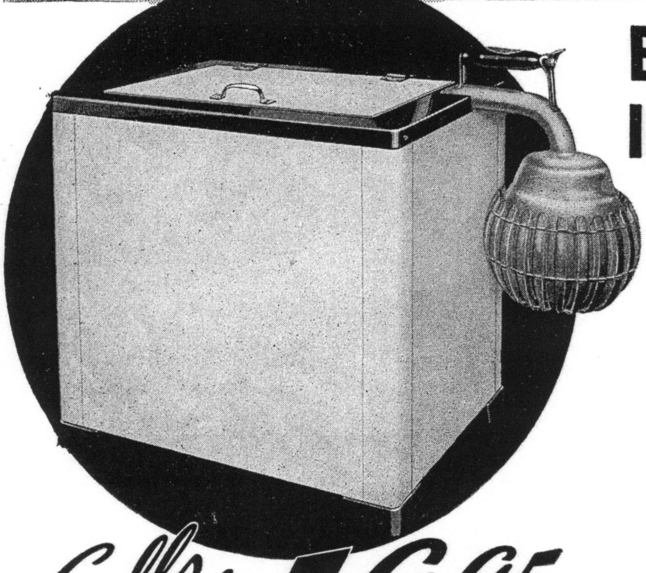

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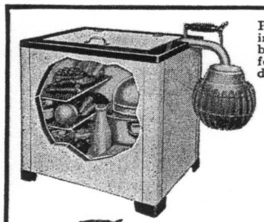
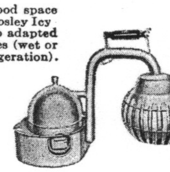


Plenty food space in the Crosley Icy ball. Also adapted for bottles (wet or dry refrigeration).



Icyball freezing unit and stabilizer.

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This for one to 1½ hours daily — and the Icyball gives refrigeration an entire day for only 2 cents.

Quality all the way through. Trouble-free operation. Complete silence. Unbelievable economy. Gross capacity 4.3 cu. ft. NET capacity 3.5 cu. ft. Freezing tray makes 14 ice cubes. Gleaming white lacquer exterior, black-trimmed. Thoroughly insulated. Rubber gasket under lid. Outside dimensions: 28-1/16" high (including hardware), 41½" wide (including ball), 24⅝" deep. Inside dimensions: 19-13/16' high, 23¼" wide, 17" deep.

Beyond reach of electric power lines . . . but within *your* reach, this enormous market for the new Crosley Icyball. A dependable, practical, amazingly economical (uses 2c worth of kerosene daily), refrigerator. As great a food-saver as any refrigerator made.

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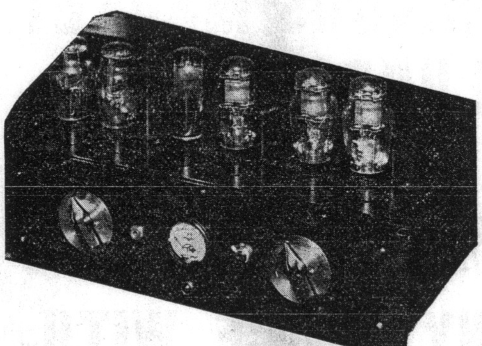
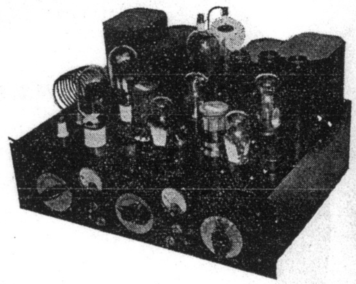


70 Watt Class B amplifier for 140 watt input controlled carrier transmitter. It has many exclusive features such as Variable fidelity Varitone control, variactor controlled regulation for power stage resulting in 25% more output, lower distortion, increased stability and low hum level. The input will match crystal, dynamic, velocity or carbon mikes. The output will match the 801 controlled carrier RF end. All the UTC audio, filter, power and Variactor components for this amplifier list at $86.50. Net price to hams $51.90.



140 Watt input Controlled Carrier RF stage. All the UTC filter, power, filament and Variactor components for this assembly list at $69.50. Net price to hams $41.70.

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		List Price	Net to Hams
CV-1	25 to 50 watts maximum input controlled class C	$ 7.50	$ 4.50
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CV-5	300 to 500 watts maximum input controlled class C	25.00	15.00
CV-6	500 to 800 watts maximum input controlled class C	33.00	19.80

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	List	Net
AV-1 for use with CV-1	$ 5.00	$3.00
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AV-3 for use with CV-3	7.00	4.20
AV-4 for use with CV-4	9.00	5.40
AV-5 for use with CV-5	12.00	7.20
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