Jan 38

DEVELOPMENT LABORATORY KEEP OUT!

ON THE WAY!!

Before long RME will announce a new development in **ultra high** equipment. This new unit will be a decided step forward in the adaptation of a radio circuit to the reception of frequencies below 10 meters (above 30 megacycles).

We are not quite ready to announce delivery on this unit or to give you any details, but from preliminary laboratory reports, you will be assured that the operation of the equipment is far in advance of anything now available.

And this is the best news — ALL owners of RME-69 Receivers will be doubly pleased that their selection of a receiver was a 69. They will be the ones to benefit most from the equipment to be announced. You will want to own a 69 in order to take full advantage of the ultra high frequencies.

In the meantime, if you do not have a 69, we would like to have you fully investigate this receiver if a new instrument is being contemplated. The 69 is **always** NEW, **always** UP-TO-DATE, **always** MODERN!

The RME-69 does the job—whether for phone or CW contacts. Full information will be sent on request.

RADIO MFG. ENGINEERS, INC., PEORIA, ILLINOIS, U.S.A.

RME-69

RADIO

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Chicago Office:
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Phone: JUNiper 5575

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

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BACK ISSUES (when available), 5c extra; they will not be included in subscriptions.

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

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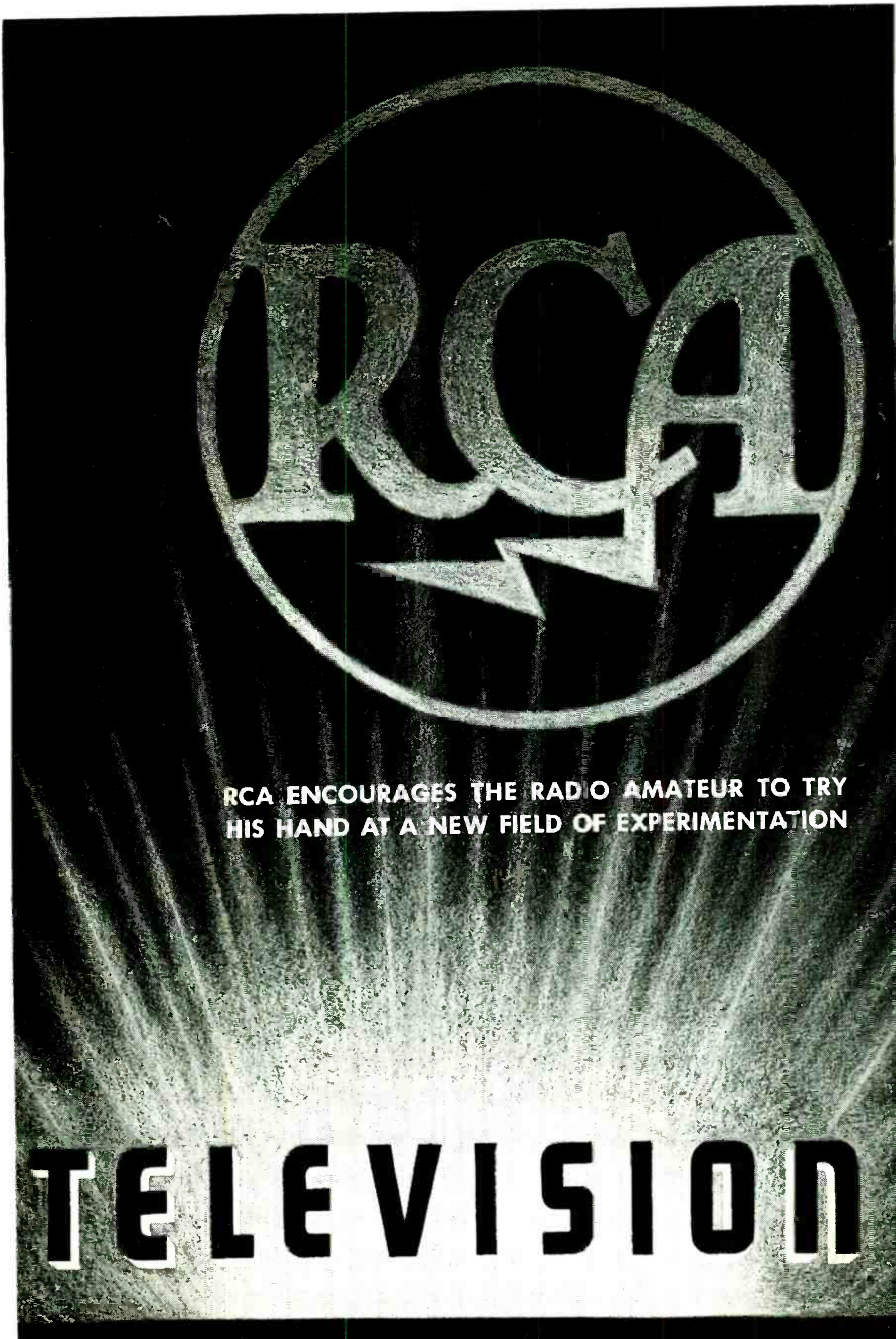

RCA
RCA ENCOURAGES THE RADIO AMATEUR TO TRY HIS HAND AT A NEW FIELD OF EXPERIMENTATION
TELEVISION

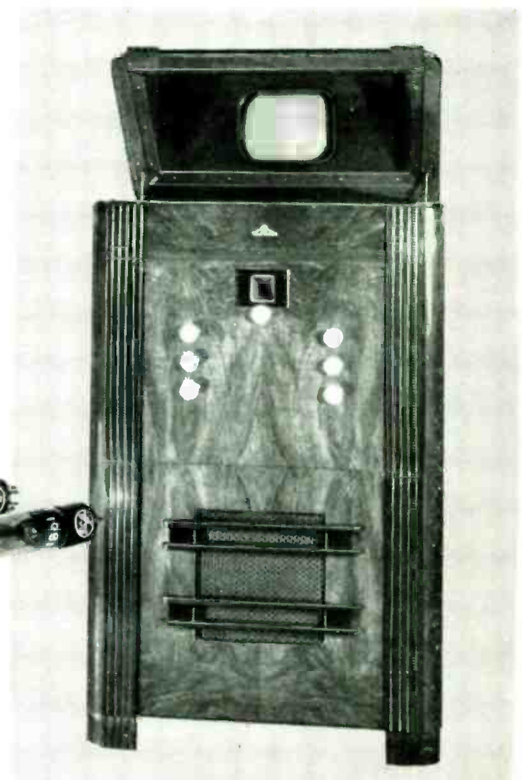
RCA ENCOURAGES THE AMATEUR IN

Two Television Kinescopes* Now Available for the Experimenter

RCA knows and is deeply appreciative of the radio amateur's contribution to the art of ultra-high frequency communication. The early development of television gave rise to problems best solved in the laboratory, but as the art slowly emerges from this status to the stage where field experiments can best answer the current problems, RCA believes that the amateur can and is eager to contribute to the perfection of this new art.

Right...Experimental RCA television receiver used in field tests.

Below...RCA Kinescope* tubes, 1800 and 1801.



Television Problems

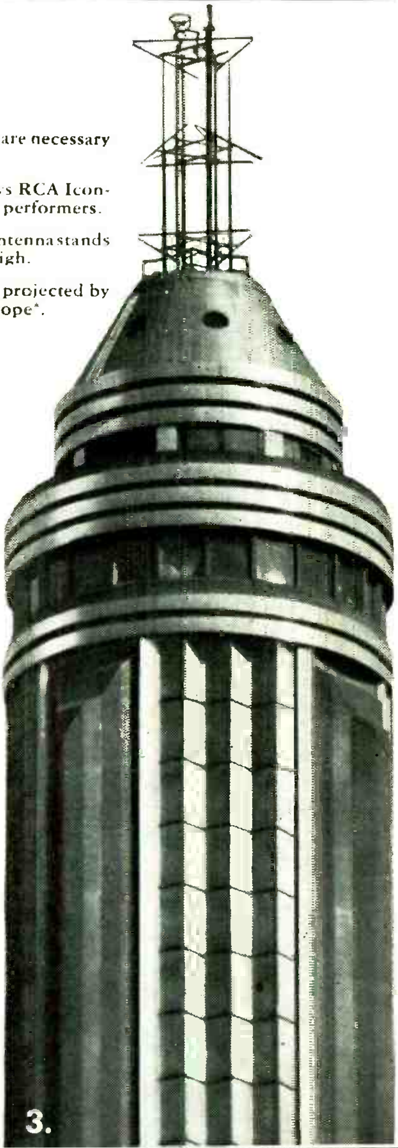
Definition...Before television for the general public becomes an actuality, the picture must be sufficiently clear and detailed to hold the public's interest. Briefly, it must compare favorably with good printed illustrations or motion pictures.

Geographic Coverage...Present television systems require exceedingly wide band widths—a channel six megacycles wide. Because space in the radio spectrum is not available at the low frequencies, ultra-high frequencies must be used. At present these are more or less limited to line of sight transmission distances, which means a multiplicity of stations to cover even one state. Building these stations and relaying television programs to them for broadcasting is a tremendous commercial problem.

Programs...There is no point in the general public buying television receivers until programs are provided. And there is no point in putting a program on the air until there is an audience. This "cat chasing its tail" situation must be ended before television is ready for the public.

Standardization...Television receivers must be designed to synchronize with the particular transmitter whose programs they receive. Transmissions employing different standards of definition than that for which a receiver is designed cannot be received. Thus no standardization should take place until satisfactory definition is achieved because no great change can be made in either the transmitter or the receiver without obsoleting the other.

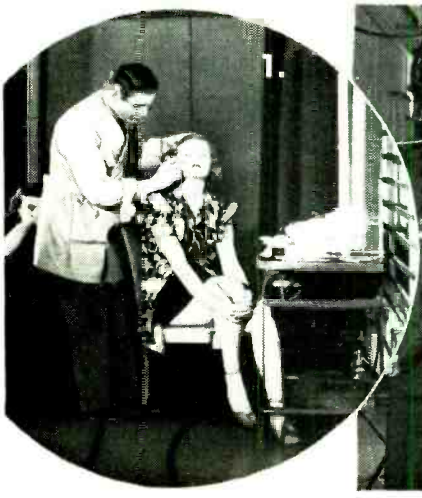
THE DEVELOPMENT OF TELEVISION

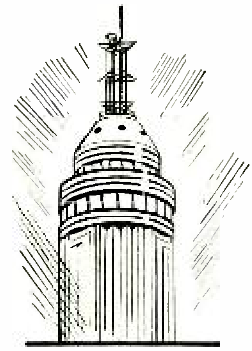


1. Make-up experts are necessary for television.
2. Stage scene shows RCA Iconoscope* "eyeing" performers.
3. NBC television antenna stands over 1,250 feet high.
4. Television image projected by new RCA Kinescope*.

Present Status of Television

RCA's field tests in New York area have been well publicized. Other investigators are conducting experimental transmissions in several parts of the country. However, there may be lack of standardization between these transmissions so that receivers suitable for one system may be unsuited for others. No regular program service is being offered since stations are frequently off the air redesigning and rebuilding their equipment. These constant changes in transmitters during the field test work may make receivers designed for receiving experimental transmissions obsolete—or otherwise may require corresponding changes in receivers.





In Radio and Television it's "RCA ALL THE WAY!"

RCA will continue field experiments in the New York area. These experiments look toward the solution of many and varied problems, such as a satisfactory standardization of definition, suitable transmitter and receiver designs, and acceptable program technique.

RCA has designed and is manufacturing a television system for the Columbia Broadcasting System. CBS will also conduct field experiments with a view of having adequate experience when television is ready for the general public.

What this Means to the Amateur

As television gradually steps out of the laboratory... as the number of experimental stations on the air increases... the radio amateur has the opportunity to experiment with an entirely new kind of apparatus. Even more important, RCA believes that the radio amateur now has an opportunity to contribute valuable technique to an art which has been hailed as one of the greatest cultural forces ever created for mankind's use.

What the amateur's contribution can or will be no one knows, any more than the early television experimenters could predict current technique. However, using the past to predict the future, RCA believes the amateur's contribution will be considerable.

To enable the amateur to begin television experiments, RCA announces

RCA-1800 and RCA-1801

two Kinescopes* for television reception. Full technical information will be sent upon request. We invite those of you who are located in areas where television experimental transmissions are in progress to try your hand at this fascinating art.

RCA-1800 Kinescope* $60.00
RCA-1801 Kinescope* $40.00

A deflecting yoke for the operation of either of these tubes is also available.

**Registered Trade Names of RCA Manufacturing Co., Inc.*

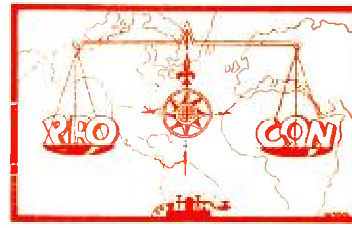
RCA for Amateur Radio and Television

AMATEUR RADIO AND TELEVISION SECTION

RCA Manufacturing Co., Inc., Camden, N. J. • *A Service of the Radio Corporation of America*

The . . .

OPEN FORUM



Reserve Band for DX?

Larchmont, N. Y.

Sirs:

For the 28 years that I have been actively engaged in "ham" radio, I have been content to sit back and peruse the various periodicals and listen to the other fellows' pet peeves and ideas of a ham Utopia. Discussions of the pros and cons for high or low power cause me to want inwardly to get something off my chest that has been bothering me for a long time. The urge has been too great and here I am, voicing not only my own thoughts but those of innumerable others with whom I have talked.

Primarily I am a "dx hound". For that reason most of my activities have been confined to the so-called dx bands, namely 20 and 10 with 40 thrown in when the ole VK's start rolling around. Why does a ham go to 20 meters? Generally to work dx. Why in heck is it, then, that so many hams, good operators and lids persist in using 20 meters as a means of comparatively short distance communication such as a thousand miles in the U.S.A.?

If the fellows who work within the boundaries of the U.S. would shift bands and use 40 or 80 where they can work all over the U.S. to their heart's content, 20 would be comparatively free of the unholy QRM that is apparent most any hour that the band is open. And I think almost any dx hound will agree with me that most of this heavy QRM comes from interstate QSO's.

With U.S.A. QSO's removed from the 20-meter band, what a *Utopia* it would be for those only interested in dx . . . !

Maybe band switching for these fellows involves too much effort. That is the only excuse I can see for it. Certainly with the ideas expounded in the various periodicals these days, it has been made more than simple. Nobody enjoys a good old rag chew any more than I do with a snappy op on the other end, and when I want that kind of a QSO, up I shift to 40 meters where I can work my 9's and 6's to my heart's content and know that I am not jamming anyone trying to capture that elusive dx.

Can't we try a little of this band reserving? I assure you that I firmly believe that there will

[*Continued on Page 12*]

"Radio" for Christmas

AN IDEAL GIFT

RADIO's annual Christmas gift rates will be in effect from November 15th to January 15th. To radio amateurs with a "fellow ham" to remember, to radio employees with a radio-minded employer who must not be forgotten, and to radio manufacturers and distributors who want to remind a favored customer repeatedly through the year of their appreciation of his business, a RADIO subscription is an ideal (and effortless) solution of that puzzling Christmas shopping problem.

ONE SUBSCRIPTION (one year)	$2.50
TWO SUBSCRIPTIONS, each	2.35
THREE or more SUBSCRIPTIONS, each	2.25
SIX or more SUBSCRIPTIONS, each	2.00
TWELVE or more SUBSCRIPTIONS, each	1.75

Subscriptions at $2.00 or less must be **cash with order**

Above rates apply for U.S.A., Canada, Newfoundland, Cuba and Mexico. To Pan-American countries and Spain, add 50c per subscription. Elsewhere, add $1.00 per subscription.

You May Enter or Renew Your Own Subscriptions at these Rates.

Rates for more than one subscription, as listed above, apply only on gift orders entered and paid for at one time by one individual or company. Unless otherwise requested, the subscriptions will be commenced with the January issue, which will be delivered as near Christmas as possible, together with an attractive card announcing the gift and the sender's greetings; those who are at present subscribers will automatically have subscriptions extended unless otherwise requested.

The Open Forum

(Continued from Page 9)

be much more sport for us dx hunters and certainly better 100% QSO's for the fellows interested in rag chews on the lower frequency bands. They will not only have the pleasure of contacting fellows with the same idea in mind but they will get away from trick fading and the like. How about it?

C. A. PORTER, W2OA.

•

"Schoolboy Mummery"?

Sirs:

It is my opinion that the letters of Messrs. Wellar and Link in the July Forum are worthy of considerably more than casual consideration by the amateur radio fraternity in this country, and, yes, in other countries, too.

This writer cannot lay any claims to finding it impossible to master thirteen words per. I have never attempted to learn code and I am ready to take issue with any misled bohunk who proposes to label me as lazy. The fact in the case is, with due regard for those hams who do enjoy c.w., I have never felt any interest in anything but phone. To my humble mind phone dx constitutes genuine technical achievement that justifies itself on any consideration. I am a busy individual and as such do not feel that I should spend time going through with the schoolboy mummery of learning something that can never be anything more, in my case, than a mere license requirement that reverts back to

[*Continued on Page 166*]

RADIO
Radio Digest

7460 Beverly Boulevard
LOS ANGELES

Christmas-time
1 9 3 7

Dear Reader:

A subscriber to RADIO and RADIO DIGEST recently wrote:

> "RADIO must be the most-borrowed radio magazine in existence. Hanging onto my copies is harder than neutralizing my final amplifier. And I hear it mentioned on the air oftener than any other, though I seldom see a copy when visiting."

Perhaps you, too, have had your copies borrowed—and maybe not returned.

Kill two birds with one stone. For Christmas, delight your ham friend with a subscription—and hang onto your own copies! RADIO is a foolproof gift for any radioman, and one which will remind him throughout the year to come of your thoughtfulness.

And what comparable gift could you unearth for $2.50, serene in the knowledge that even though "your best (ham) friend won't tell you" it's exactly what he does want for Christmas?

RADIO is easy to give; it's simple and quick, far from stuffy stores, milling crowds, jabbing elbows.

An engraved gift announcement bearing your name will be sent on request.

Add RADIO DIGEST to your order and you will also be giving the magazine which has overnight become the sensation of the radio world—you will be giving the whole radio world to watch, study, enjoy for only $1.00 yearly.

A convenient order blank and an envelope needing no stamp are enclosed for your convenience. Mail them TODAY!

Cordially yours,

M. M. Lamaugh

Speaking for
RADIO, LTD.

NOT ~~$12.50~~

NOT ~~$7.50~~

NOT ~~$6.00~~

NOT ~~$5.00~~

NOT ~~$4.00~~

NOT ~~$2.25~~

NOT ~~$1.75~~

BUT $1.50

TAYLOR LEADS

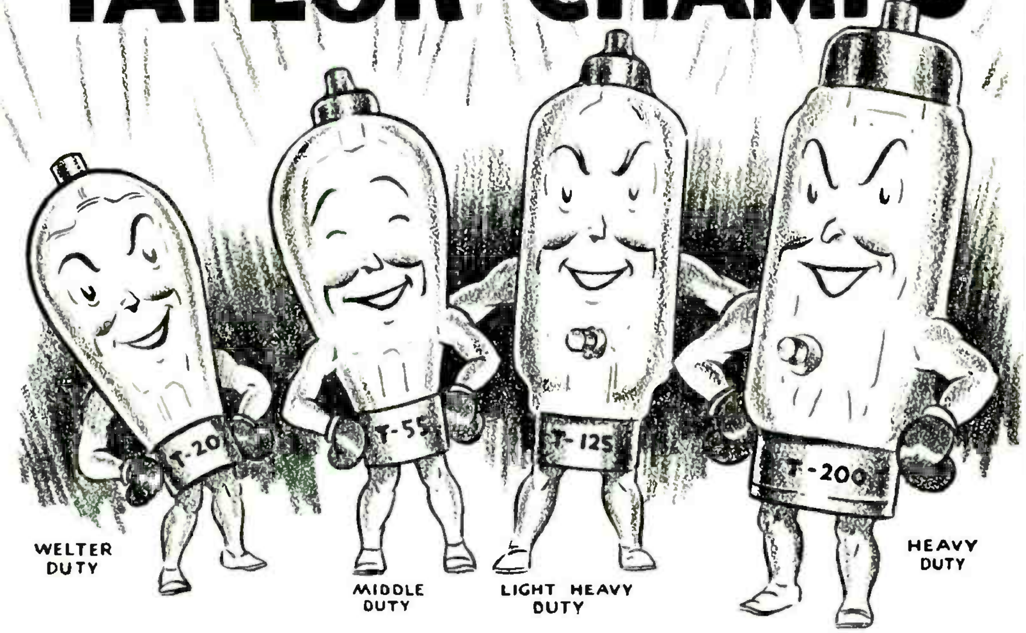
Read! Trace the history of the 866, most widely used amateur tube. *It proves Taylor leadership.* In 1932 Taylor Tubes smashed profiteering tube prices by announcing the sale of quality 866's at the then fabulously low price of $1.65. Naturally there were many who doubted the quality of this tube. Almost overnight, the bronx cheers of the doubters turned to wholehearted acclaim, when Amateurs — Engineers and Scientists, found Taylor 866's better tubes than all competitive makes. For five years the sales of Taylor 866's have led by a tremendous margin. And so it is with all other types. Taylor pioneered fair prices on all transmitting tubes. Due to Taylor's ceaseless effort, the prices on all types of amateur tubes have steadily decreased. At the same time, *a broader guarantee on transmitting tubes* has been established, through Taylor's aggressiveness. The result of this tireless fight for the Amateur is easily seen. *"More Watts per Dollar,"* has become the magic slogan to greater Amateur accomplishment. This fearless call for quality at a fair price has broken the tyrannic circle of profit-plus prices on all Amateur gear. Taylor Tubes is proud of its loyal Amateur friends. Taylor accepts and holds high its leadership in the fight for genuine value in all types of Amateur equipment. *Taylor Tubes will never fail in its trust.*

"More Watts Per Dollar"

Taylor HEAVY **CUSTOM BUILT** DUTY **Tubes**

TAYLOR TUBES, INC., 2341 WABANSIA AVE., CHICAGO, ILLINOIS

A Challenge by
TAYLOR CHAMPS



A Real Champion in every class! Open for a battle to a long-life finish in any Transmitter. Wonderful records with a long unbroken string of victories over Kid QRM, Socko QRN, etc. Easy to excite to full battling strength. Although they are the true Champs they will do their stuff for you at most reasonable prices. Guaranteed to please all. Let the Taylor Champions do your battling and you'll win—every time.

Get the best action from the Taylor Champions. Let the 866's supply the power. Over 25,000 doing valiant work in Rigs the world over. Insist on TAYLOR 866's.

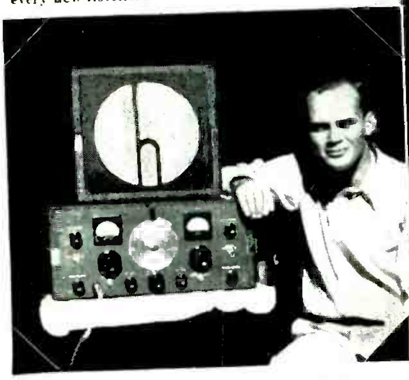
"More Watts Per Dollar"

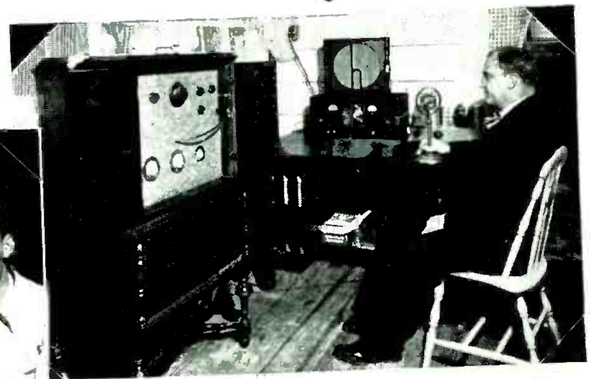
Taylor HEAVY **CUSTOM BUILT** DUTY **Tubes**

TAYLOR TUBES, INC., 2341 WABANSIA AVE., CHICAGO, ILLINOIS

Here's another page from the hallicrafters *scrapbook*

ENRIQUE HIDALGO—Ciefuegos, Cuba—Winner of second prize in the All-Wave B. C. DX contest with his new Super Skyrider. He says: "The receiver has created a sensation here where it has astonished every new listener."

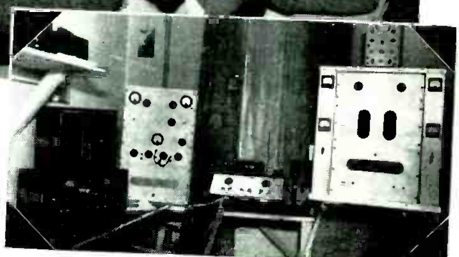




W3DTX—*W. W. KELLUM*, Washington, D. C., says: "I selected the Super Skyrider because it is one of the best receivers on the market today including price and performance. In a little over a month, I have worked more DX than ever before and have had good receivers in the shack."

W1KTG—*BEATRICE HOLMAN*, Belmont Mass.: "The more I operate the Super Skyrider, the better I like it and I am only too glad to add my word of praise. Am on 10 meters at present and have heard plenty of DX this morning that I never copied before."

W2AMJ—*FRANK LESTER*, Bergenfield, N. J., at the controls of his 1938 Super Skyrider.



The New 1938 Super Skyrider installed in the rig of W2AU, *MR. PAUL WANDELL*, Bayonne, N. J.

The very fact that Hallicrafters receivers figure so prominently in leading amateur and scientific stations is in itself a testimonial to the merits of these outstanding receivers.

the hallicrafters inc.

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WORLD'S LARGEST BUILDERS OF AMATEUR COMMUNICATIONS RECEIVERS

January · 1938 Number 225

RADIO

In this issue "Radio" presents:

ARTICLES

MISCELLANEOUS

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

Dr. F. E. Terman

THE NAME OF F. E. TERMAN is familiar not only to amateurs but to radio men everywhere as an old-time amateur, distinguished engineer and research worker, teacher, and eminent author. Active in both the I.R.E. and the A.I.E.E., he is perhaps best known as the author of the general radio text, "Radio Engineering", though he has written many other notable works and collaborated on still others.

■ At one time quite active in amateur activities, operating W6FT and W6AE, of late he has been too busy teaching radio to others, doing research, and writing books to pursue amateur radio.

■ At present Dr. Terman is professor of Electrical Engineering at Stanford University and executive head of the electrical engineering department.

The Compact Uni-directional ARRAY

By

WALTER VAN B. ROBERTS**

W3CHO

While the title of this article is too brief to indicate it, the antenna system to be described is believed to be not only just about the easiest rotatable beam to construct, but also one that probably gives more power gain and useful directivity "per unit of building trouble" than any of the more complicated structures. To be specific, the system may be adjusted to put out a signal equivalent to that from a simple dipole using 3.6 times as much power; in other words, the power gain of the system is about 5½ db. Furthermore, at a sacrifice of less than 1 db in gain, the system may be adjusted to have a signal in the backward direction that is about 17 db "down" with respect to the forward signal. These figures are calculated, but many listeners have verified them qualitatively by reporting that signals go way down or entirely out when the beam is rotated a full half turn, and that they are a maximum only when the beam is pointed within 45 degrees or less of the correct direction.

The theory of this antenna arrangement is based upon a portion of a paper by G. H. Brown in the Institute of Radio Engineers' *Proceedings* for January, 1937. Brown's discussion of the case of a single parasitic antenna is specifically directed to vertical quarter-wave antennae working against ground, but his conclusions appear to be applicable to horizontal half-wave dipoles except that his radiation resistance figures and reactances must be doubled when using half-wave dipoles.

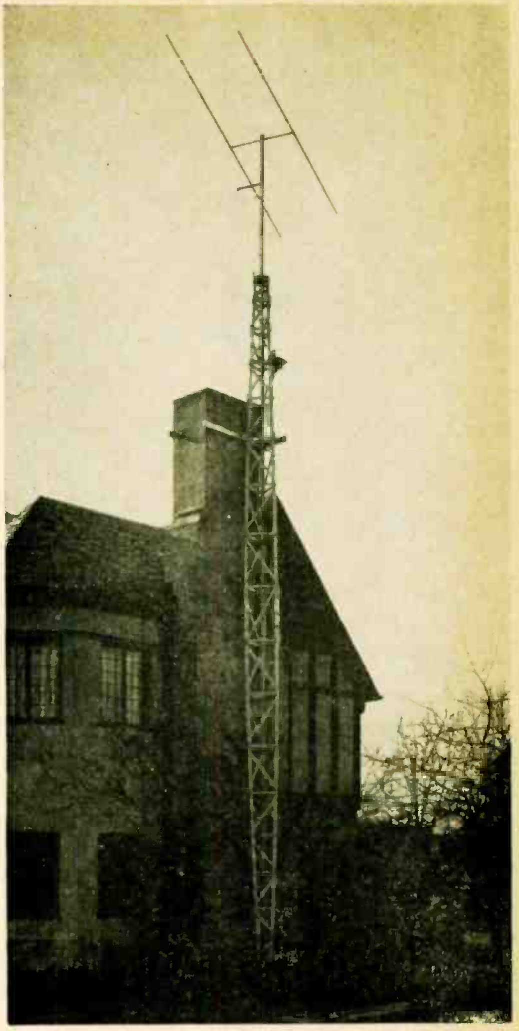


Figure 1. The 28-Mc. dipole radiator and close-spaced director. The driving motor and its rain cover may be seen just above the chimney.

Pages 103-108 of Brown's article contain the discussion of this parasitic antenna and the reader is particularly referred to his figure 28, which shows the results of varying the spacing between the driven antenna and the parasitic antenna and the tuning of the latter. The patterns shown in this figure are the horizontal directivity patterns for a vertical system, so that if horizontal dipoles are used, only the ratio of signal strengths in the straight forward and straight backward directions is applicable. For the benefit of those who do not have access to the I.R.E. *Proceedings* the main point of interest to the amateur is that when a single parasitic

*Patent Department Radio Corporation of America.

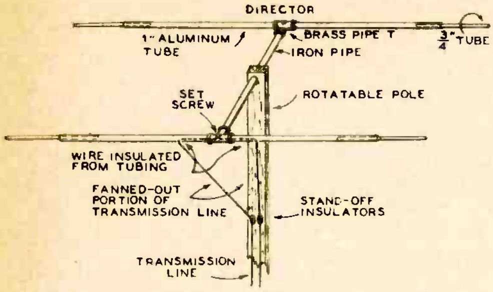


Figure 2

antenna is used, either as a reflector or director, the best spacing between the two is, contrary to general belief, only a little greater than a tenth of a wave length. To quote from some of the conclusions of the paper regarding reflectors:

> "It is interesting to note that nothing particularly exciting happens when the spacing is one quarter wave length."

And again:

> "In the case of a single parasitic reflector, it is found that the mysterious something that is supposed to happen when the spacing is one quarter wave length fails to materialize. Close spacings are found to be desirable in both the transmitting and receiving case. It is found that the parasitic antenna functions equally well as a director or reflector."

All of which is welcome news as it reduces the dimensions of the structure required for a beam antenna to a point where it is scarcely any extra trouble to add a director or reflector to a dipole. It should be emphasized, however, that the foregoing applies only to the particular case of a single driven dipole with a single parasitic dipole.

Construction

The general appearance of our present ten-meter beam may be seen in figure 1 and its construction is indicated in figure 2. It is unusual in that the radiators are aluminum tubes sufficiently stiff to be supported at the center only and since the centers are voltage nodes, no insulators are required. The dipoles in our antenna each consist of a twelve-foot piece of one-inch diameter hard aluminum tubing with a three-foot piece of three-quarter inch tubing telescoped in each end to permit tuning.

Another reason for the end pieces was that twelve feet was found to be the only length in which these two sizes were obtainable. In order to permit telescoping it was necessary to cut a slit in the outer tubing for a little more than the desired overlap. This was done with a small metal cutting saw on an ordinary little buzz saw. A ground clamp is used to squeeze the end of the outer tube tightly onto the inner tube. The dipoles are supported by brass ¾-inch pipe "T's" with the straight-through portion bored out to take the tubing and a set screw fitted to hold the tube firmly. Brass is used to minimize resistance to the large current flowing at this point. (It would be better to support the tubes by some means that would not break up the smooth surface of the tube any more than necessary.) The two "T's" are screwed onto the ends of a piece of pipe which is the cross piece and is a little less than a ninth of a wave length long.

The transmission line is connected to the driven dipole by "fanning" the line out into an approximate equilateral triangle about four feet on a side. This does not give a perfect impedance match by any means, and it is possible that a suitable alteration of the dimensions of this triangle would improve matters, but as pointed out by Seeley,[1] a moderate amount of standing waves on a short two-wire line is not noticeably harmful. Incidentally it should be noted that formulas giving dimensions for fanning out a transmission line to match an ordinary wire dipole do not apply here because of the large diameter of the tubing and the fact that the effective radiation resistance of the driven dipole is reduced to about 15 ohms by the reaction of the parasitic antenna. Further discussion of the elimination of standing waves will be found in connection with the description of the adjustment of the antenna and also in the section describing the proposed new rotating mast.

There is no objection to connecting the transmission line to the dipole by any suitable means, such as a small machine screw or even an ordinary ground clamp, provided a good contact can be assured. However, after several months of weathering, the contacts originally used appeared to be rather badly corroded, and a scheme for avoiding the use of any metallic contacts at all was substituted. While this scheme is by no means necessary, it should be of interest to anyone who wishes to connect a wire line to a hollow tubular radiator with assurance that no bad contacts will develop. The method is equivalent to changing from an auto transformer type of coupling to a unity-coupled arrangement. At each of the points where the

[1] *QST*, November, 1937.

connection would ordinarily be made, a quarter-inch hole was drilled in the aluminum tubing, and with a little fishing the transmission line was threaded in through one hole and out the other as shown in figure 2. Some spaghetti was first slipped over the wire to prevent intermittent contacts where the wire is pulled around the edges of the hole. With this arrangement the same mutual inductance between the transmission line and the dipole is obtained as if actual taps were used.

Theory of Adjustment

Although it is stated by Brown in the paper referred to that the parasitic antenna works equally well as a director or as a reflector, his figure 25 indicates that a trifle more gain may be obtained when it is used as a director. Furthermore, where the spacing is one tenth of a wave length, his figure 28 shows that maximum gain is obtained when the director is of such length as to be exactly self-resonant. This is, its length may be computed from the usual formula for a simple dipole. It is easier to determine the self-resonant length than to determine the length which would give exactly the amount of lag angle required if the parasitic element is used as a reflector. For these reasons it was decided to use the parasitic antenna as a director. The next question that arises is whether to adjust the director to exact resonance so as to obtain the maximum possible gain, or to make it a trifle shorter so as to minimize the radiation in the backward direction. The latter was decided upon. partly to avoid unnecessary QRM, but chiefly, it must be confessed, to reduce interference from southwestern stations when using the antenna for receiving European stations. An excellent compromise is obtained for the one-tenth wave length spacing condition by making the director a trifle shorter than the resonance length so as to produce the result shown in the second diagram of the top row in figure 28 of Brown's paper. In this case there is still nearly 5 db gain in the forward direction, yet the back signal is tremendously reduced. It should be noted that the ratio of forward signal to backward signal is determined only by the tuning of the director. This is fortunate as it permits adjusting the director length, once and for all, and then adjusting the driven dipole and the matching arrangement solely to reduce standing waves on the line to a minimum and produce maximum current in the antenna system.

First adjust both the dipoles to the normal length for a simple dipole and connect the driven dipole to the transmitter without regard to standing waves. Now have someone (nearby, if possible, to avoid any fading effects) listen or measure field strength in any other way while the beam is rotated, and compare the backward signal with the forward signal. Then shorten the director a few inches at a time until you get the greatest ratio of forward to backward signal. Don't worry if the forward signal happens to be weaker when the ratio is best, as this may occur as a result of altering the impedance match and thus taking less power from the transmitter. The final adjustments of the transmitter and the tuning of the driven dipole will take care of this later on. We now have the director adjusted to produce the desired field pattern and need not touch it again. Assuming that a fixed connection to the transmission line has been made, there remains only to adjust the length of the driven dipole to produce a minimum of standing wave on the line and maximum current in driven dipole. With a

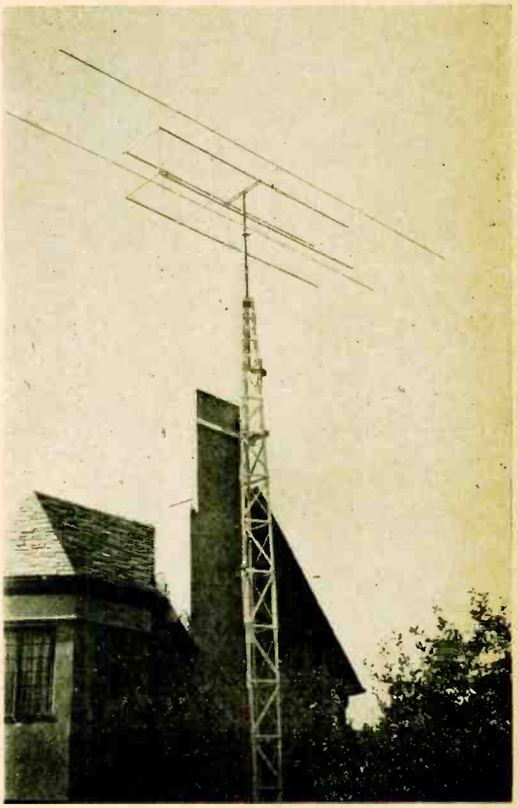


Figure 3. The original experiments were conducted with this 20-meter dipole and close-spaced director. The larger dimensions make auxiliary supports necessary.

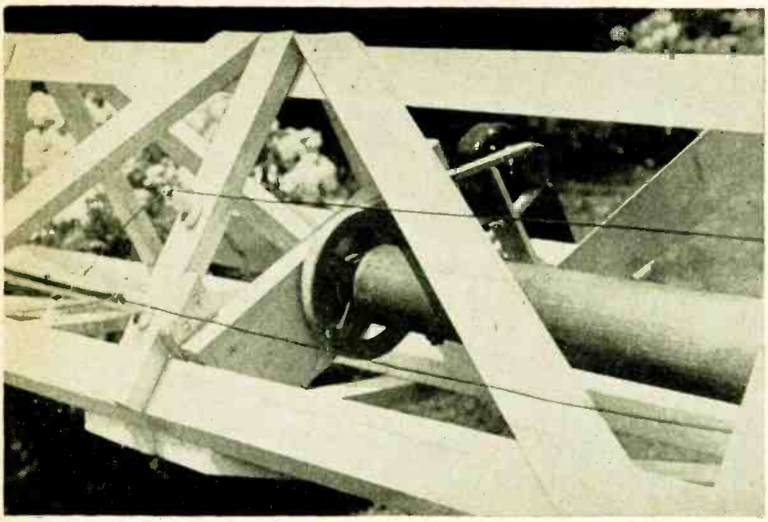


Figure 4. The rotating mechanism viewed at close range before erection. The pole rests on a ball bearing on the cross arm just below the large pulley. The motor is geared down internally.

frequency of 28,636 kc. the foregoing process led to a director length of 15′9″ and a driven dipole length of 17′, using 3½ feet separation between the two.

Rotational Arrangements

Figure 1, taken at the writer's home in Princeton, N. J., shows the general construction of the lattice mast with the rotatable pole extending out of the top. The entire mast may be let down by ropes and pulleys attached near the top of the chimney. When up, the mast is held in the angle between a couple of two-by-four's fastened to the chimney. Thus it is never necessary to do any climbing to make adjustments. The adjustments for obtaining a minimum of standing waves, as described above, were made with the mast partially lowered, the director being above the driven dipole and the latter being just low enough to be reached from a tall step ladder.

The rotatable pole passes through a hole at the top of the mast which is greased and acts as an upper bearing. Five feet farther down, the bottom of the pole rests on a ball bearing, and a ¾-inch steel rod extending out of the lower end of the pole passes through this bearing to take radial forces. This rod also carries a pulley which is driven through a V belt by a small motor internally geared down to about 7 r.p.m. The antenna rotates one full turn in 35 seconds. Figure 4 shows the lower end of the pole (which is a 2⅝″ pole used for rolling up a carpet) together with the pulley and motor. The ball bearing that supports the weight can be seen just below the pulley and rests in a socket in a wooden cross piece.

Figure 5 shows the pole coming out through the top of the mast and the transmission line slip rings that are necessary to permit continuous rotation. These rings are made of brass with a shallow groove turned in their outer surfaces. A piece of flat braided conductor, such as used for shielding wires, passes around each ring, one end of the conductor being fastened directly to a stand-off insulator while the other end is fastened to the same insulator through a small coil spring to maintain a small tension. The rings really should have been a little larger in diameter as there was scarcely room for insulating supports between the rings and the pole, but they have worked very well so far and there is never any noise from them, even during reception, while the antenna is rotating.

Although it cannot be seen in figure 4, the ¾″ rod that passes down through the ball bearing has a ¼″ hole in its lower end to receive the shaft of a 500-ohm potentiometer. The rest of the potentiometer is fixed to the mast, and the stops for the contact arm were cut off to permit continuous rotation. A pair of wires from the potentiometer to the operating table permits reading the position of the antenna in terms of ohms by an ohmmeter. This is a very simple and accurate indicator but it proved responsible for the only trouble encountered with the entire system so far. The trouble was that the potentiometer shaft was made of steel and rusted fast, preventing rotation of the antenna.

Notes on Previous Experiments

The first antenna based upon the teachings of the Brown paper is shown in figure 3. This is really just the same thing as the one in use at present except that its dimensions are doubled to provide 20-meter operation. In this case the dipoles were too long to be supported only at their centers; so a sort of box kite arrangement was made up of light wood with wire bracings to act as a support. The "kite" weighs only 17 pounds, although it is 16 feet long and 3½ feet on the side. This 20-meter arrangement operated very successfully and early in 1937 gave W3CHO its first European QSO on about 25 watts carrier power. However, the complicated support required makes it a much less attractive proposition to build than its little 10-meter sister.

Figure 6 shows the box kite supporting a pair of beam forming elements located a half-wave length apart and excited in phase. Each element is exactly like the one in figure 1 except for the vertical polarization. This array is capable of better gain and directivity than

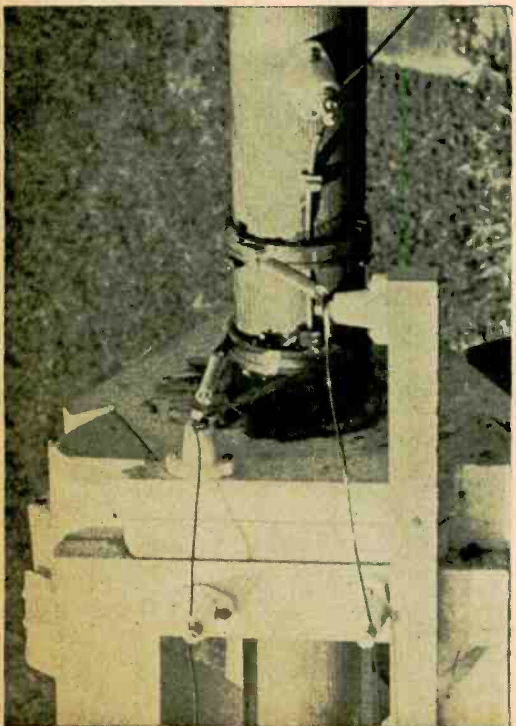


Figure 5. The upper bearing and the slip rings for connection to the feeders.

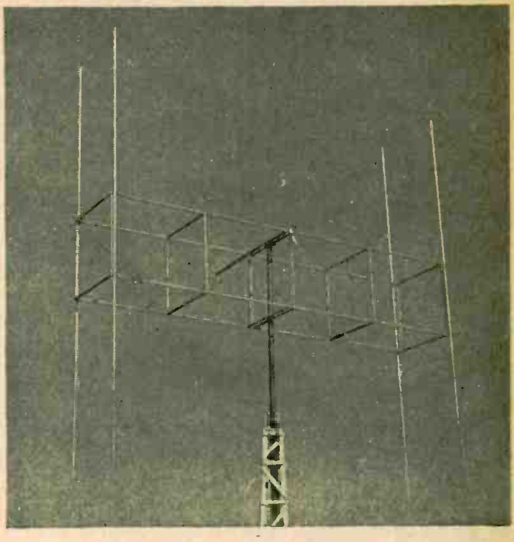


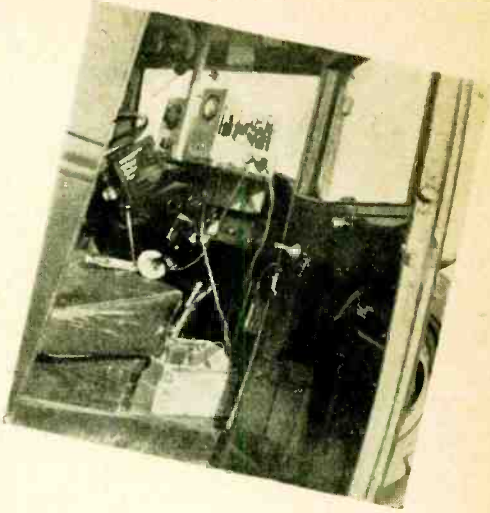
Figure 6. Using the supporting structure of figure 3 to support a pair of vertical dipoles and directors for 28 Mc.

the single beam element but again the constructional trouble is too great to permit it to be recommended for general amateur use. The transmission line in this case is fanned out both ways from the middle in long triangles that tap on to the driven dipoles of each beam element at points a couple of feet apart.

The Inevitable New Project

While the lattice mast and rotatable pole arrangement has worked all right so far, it probably will be frozen up with sleet before long and is so heavy that it takes two men and a boy to lower and raise it. Hence, we are hard at work on a much lighter outfit at present that can be hauled up and let down as easily as a flag on a flag pole. Constructional details on this new system will not be given until it proves satisfactory, but the general idea is that the entire mast is to rotate, a large bearing being provided to encircle the mast at a point near the top of the chimney. This bearing must also serve as the point of attachment for the lowering rope. The design of this bearing is the only difficult part of the scheme. The reason for rotating the whole mast is that the driving motor and slip rings and position indicator will then be close to the ground where they can be taken care of easily, and with so much weight brought down from the upper portion the new mast can be made very much lighter. Another advantage is that standing waves due to mismatch at the antenna may be

[*Continued on Page 173*]



By **WALTER A. PECK,* W1EFN**

A MILK-TRUCK MOBILE

Most of the five meter work here in the Berkshires is portable, as the hills limit our signals to very local work unless located up on a mountain. An ideal spot for portable work is Mt. Greylock, 3505 feet above sea level, which is the tallest peak in Massachusetts and rises above any of the hills in the direction of New York City. Five states can be seen from this mountain on a clear day. At the top is a war memorial 110 feet high, with a yellow beacon in it which lights up the mountain top at night so that it is as bright as day, fine for five meter work.

Many hams make the trip up there during the summer to give their rigs a try. Some from the Boston or New York area spend a week-end at it, staying overnight on the summit. Other hams from as far away as the Canal Zone have been met while sight-seeing there.

I have found July, August and September to be good months for this type of work, though I have been up there every month of the year, having made 58 trips in the last 17 months. During these trips I have had over 600 QSO's with about 150 different stations in seven states. I have hooked up with the most distant station heard, 160 miles away at Provincetown, Mass., in a lighthouse out on the cape. I hear many stations in the New York City area but the QRM there makes contacts almost impossible.

The antenna is a half-wave vertical zepp when parked, and a short rod when operated mobile. The rig is mounted on the dash of a milk truck, though it can be removed easily when not in use. The transmitter uses a pair of 71-A's modulated with a pair of 47's. The input runs from 3 to 4 watts, supplied from 130 volts or less of B batteries. No speech stage is used. The receiver is a super-regen using three 27-type tubes, one as an audio stage. It runs the speaker very well; many stations are R9 on the mountain even though they are over 100 miles away.

There is a "kick" to this five meter work that compares with the old days of one tube receivers. Although I am a milk man and must get up at 4:30 a.m., I have stayed on the mountain until 1:00 a.m., working until the band was about quiet before driving home for a short nap before going to work.

I would like to have the gang around Chi-

[*Continued on Page 172*]

*43 Plinn, Pittsfield, Mass.

A Modern Self-Contained

Kw. Phone

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***By* FRANK C. JONES,* W6AJF**

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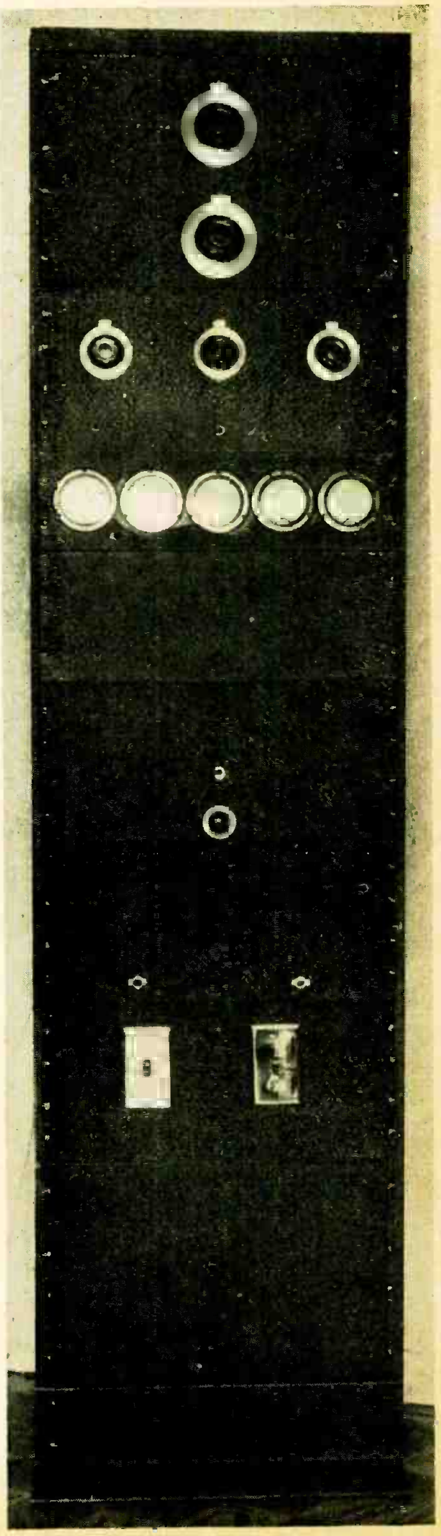
The accompanying illustrations show a relay rack phone transmitter which is capable of operating with one kilowatt input to the final r.f. amplifier. The set was designed to fit entirely into one relay rack and to be used primarily on 10 and 20 meters. An adjustable type of audio automatic volume control system was incorporated in the set in order to prevent accidental overmodulation.

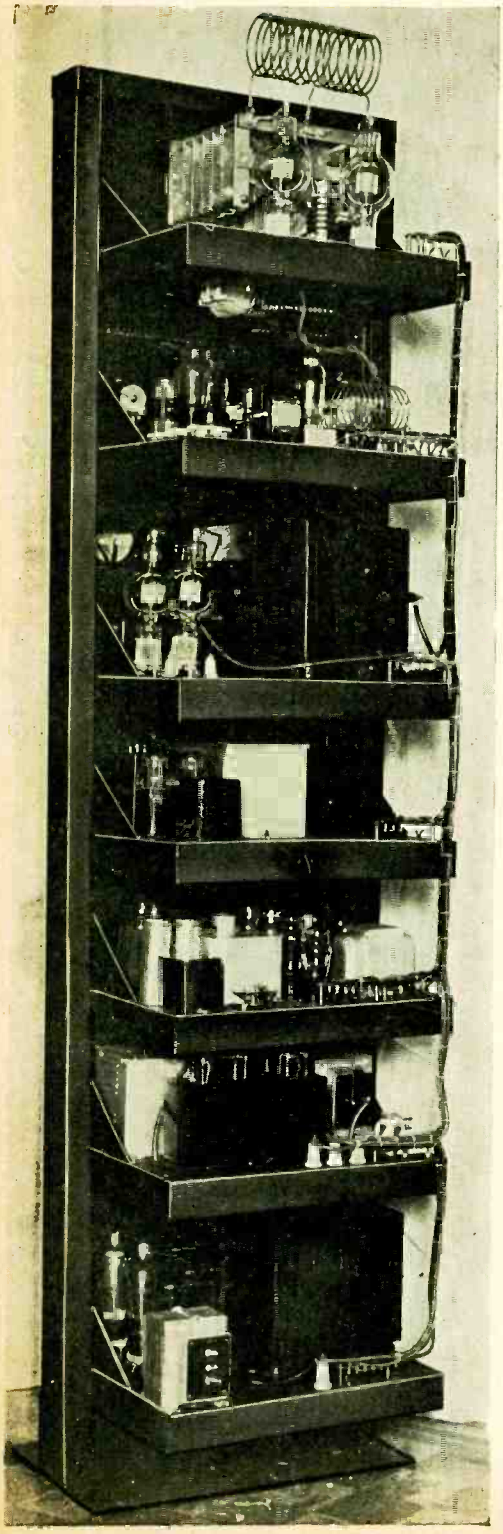
Plate modulation was decided upon in order to obtain as much output as possible with one kw. input to the modulated amplifier, which consists of a pair of 100-TH tubes in push pull. The class B modulator also utilizes 100-TH tubes and is capable of delivering over 500 watts of audio power. One kw. input to the final amplifier requires 500 watts of audio power for 100% modulation. The carrier output runs about 800 watts at one kw. input. The power output can be varied from about 200 watts up to 1 kw. input by means of taps on the power transformer. Since this same power supply is connected to the class B stage, the C bias clip has to be changed from 67½ volts down to 45 and 22½ volts for the different power transformer output voltages. Normally the set is operated at about 900 watts input in order to maintain a load of slightly less than full rating on the power supply, thus providing a safety factor.

The Harmonic Oscillotor

The radio frequency portion of the transmitter consists of a 6L6G harmonic oscillator, a 6L6G buffer-doubler, 35T buffer-doubler, and push pull 100-TH class C amplifier. The 6L6G oscillator has a regenerative plate-cathode circuit in order to provide either fundamental or second harmonic output from any crystal. 160 or 80 meter crystals can be used for operation in any band from 10 to 80 meters.

*2037 Durant Ave., Berkeley, Calif.





Regeneration at the output frequency of the 6L6G oscillator is obtained by having the cathode connected across part of the tuned plate circuit. This arrangement will allow oscillation at the crystal frequency with active crystals while the plate circuit is tuned to the second harmonic. The degree of regeneration is adjusted by means of a small 3-30 μμfd. mica trimmer condenser mounted between the plate and cathode terminals of the 6L6G socket. A .0004 μfd. fixed mica condenser is connected from cathode to chassis ground in order to complete the regenerative circuit. The ratio of these two capacities determines the amount of regeneration and power output on the second harmonic. A small 2 or 2½ mh. r.f. choke completes the cathode d.c. circuit.

The crystal current is quite low with this type of oscillator even with grid leak bias instead of cathode self bias, and the grid leak bias provides higher output when the plate circuit is tuned to the second harmonic. The cathode bypass condenser of .0004 μfd. is suitable for 160 and 80 meter crystals, but a smaller value, such as .00025 mfd., is desirable with 40 meter crystals. This particular exciter does not require the use of 40 meter crystals for 10 or 20 meter operation.

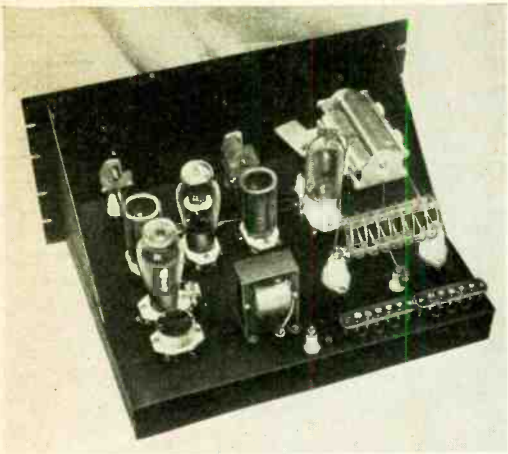
The 6L6 First Buffer

The second 6L6G tube is neutralized to prevent self-oscillation when this tube is used as a buffer. Normally this tube is used as a doubler, in which case the plate neutralizing circuit is not needed but does no harm. A combination of grid leak and cathode bias is used with this tube in order to provide high bias for doubler operation and to protect the tube in case the crystal oscillator is not functioning. The two 6L6G cathodes connect to a d.p.d.t. toggle switch which connects either one through a milliammeter to ground. One meter measures the cathode current in either stage without disturbing the other.

The 35-T Buffer

The 6L6G doubler is capacitively coupled to a 35-T buffer or doubler stage. The 35-T is a neutralized buffer on 20 meters and is used as a doubler for 10 meter output. The plate supply for this stage uses a 5Z3 bridge rectifier with a 1000 volt (total secondary) transformer rated at 275 ma. load when used in a full wave circuit. The load current should be halved in the bridge connection, or somewhat less than 150 ma., which is sufficient for the 35-T stage.

Three 5Z3 (or 83 tubes) are connected in

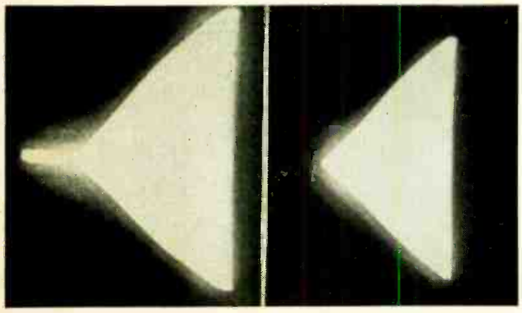


The exciter unit delivers sufficient output on all bands from 10 meters up for class C operation of the modulated stage.

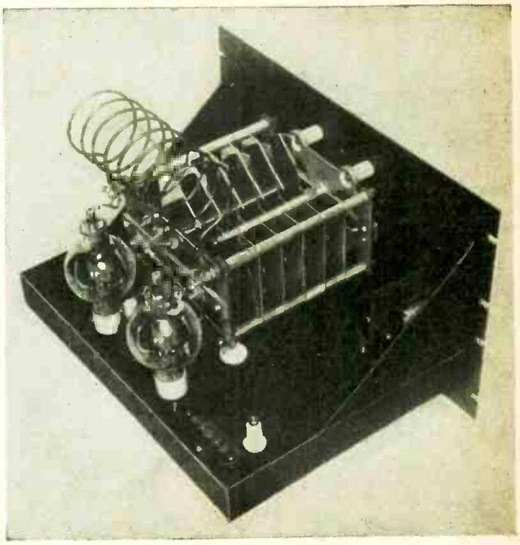
a bridge rectifier with choke input to the filter. A buffer stage which drives a class C final amplifier does not require as much filter as does a modulated stage; so one section of filter is enough. It consists of a 20 henry choke and 2 μfd. condenser. A slight hum ripple in the buffer output has very little if any effect on the output stage since the grid circuit of the latter is driven to saturation. Even a fairly strong ripple in excitation will not cause any hum modulation in this case, since it is nearly impossible to grid modulate the final amplifier when the latter is driven so hard.

The Modulated Final Amplifier

The 35-T stage is link coupled to the 100-TH stage by means of a single turn of heavily insulated wire around the center of the two tank coils. The final amplifier uses a special "propeller type" plate tank condenser which has the two neutralizing condensers built into the con-



Oscilloscope patterns of the one-kilowatt plate-modulated phone. The pattern on the left shows overmodulation, no a.v.c.; the right pattern depicts same audio input as the first, but with a.v.c. in operation.

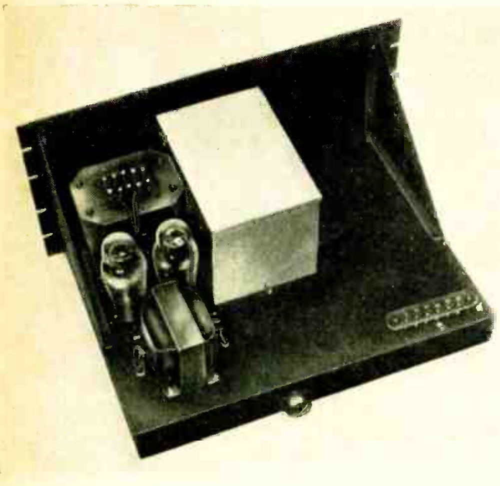


The modulated final amplifier utilizes a "propeller type" variable condenser

denser frame. The two stators in this condenser are end to end directly across the rotor shaft and the two end plates serve as the plate neutralizing capacities. Two circular plates mounted on screws through the Mycalex frame can be adjusted for neutralization. These two 2" diameter plates cross-connect to the two grids of the 100-TH tubes with the result that the neutralizing leads are very short.

The final tank coil mounts directly on the wing nut terminals of the tank condenser, which are close to the 100-TH plate cap leads. The net result is very effective operation even on 10 meters, and almost as high efficiency can be obtained at that frequency as on the lower frequency bands. The condenser used is rated at 16,000 volts peak break down per section which is suitable for plate modulated rigs using 2500 to 3000 volt supplies. The rotor connects to chassis ground through a 5000 volt .002 μfd. mica condenser.

The final tuned grid circuit is mounted underneath the top chassis. A parasitic oscillation present was cured by connecting a parasitic



The 6L6 drivers and associated speech amplifier (inside the shield can).

choke in series with one grid lead to the tuned circuit as shown in the circuit diagram. This choke consists of 10 turns of no. 14 wire 5/8" diam. and about 1" long, mounted on the through type insulator which also serves to hold the plug-in grid coil. A combination of fixed and grid leak bias is used on the final amplifier. All grid bias voltages are taken from two medium-sized 45-volt B battery blocks, Since the grid current is in the neighborhood of 100 ma., a 900 ohm resistor is connected across the 90 volt C battery in order to drain off this charging current. This resistor is connected across the battery only when r.f. excitation is applied, by means of extra contacts on the exciter cathode relay. This simple arrangement eliminates the need of a heavy duty C bias supply and has much better voltage regulation for the class B modulator grid circuit.

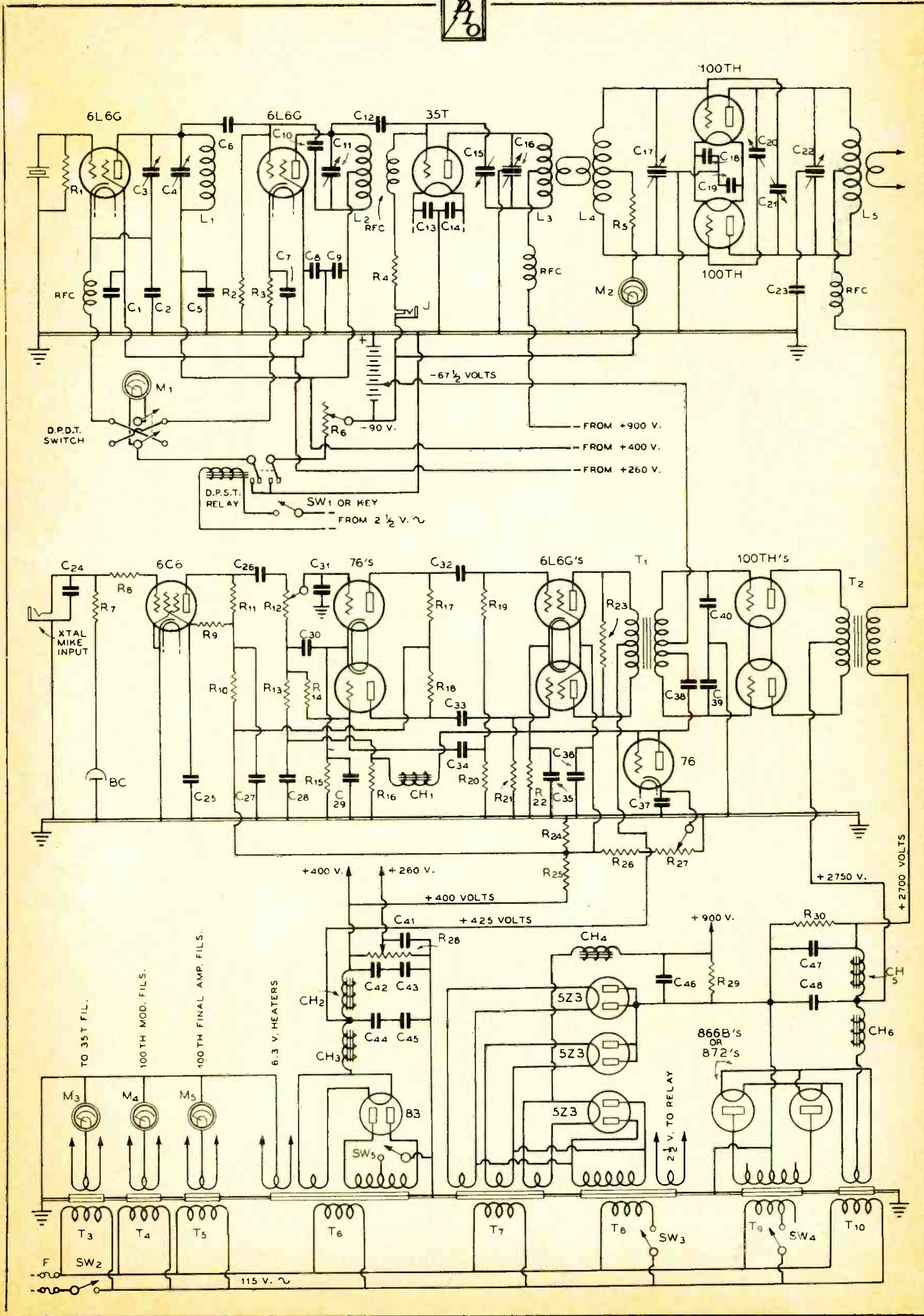
The Audio Channel

The audio channel consists of a 6C6 pentode high gain audio amplifier for connection to a crystal microphone. An r.f. filter is connected in the grid circuit of the first tube, and the entire speech amplifier and a.v.c. tubes are shielded to prevent r.f. pick-up. The 6C6 grid circuit r.f. filter consists of a ½-watt 25,000 ohm resistor in series with the grid lead and a .0001 µfd. mica condenser connected from chassis to grid.

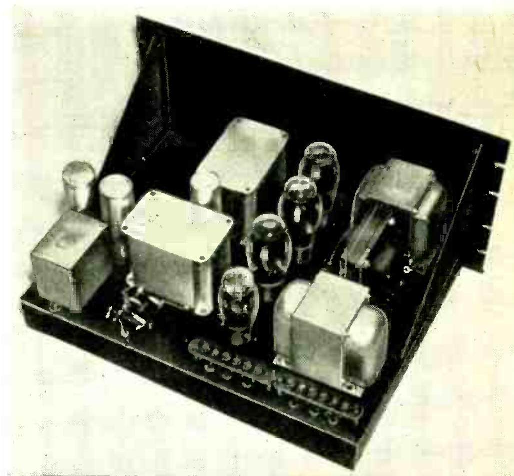
The second stage of audio has two 76 tubes connected as a resistance coupled amplifier and phase inverter for push-pull operation. These in turn drive the 6L6G class AB driver stage. The latter has a plate load impedance of less than a pair of 42 or 6F6 tubes connected as

GENERAL WIRING DIAGRAM

C_1—.01 µfd. tubular
C_2—.0004 µfd. mica
C_3—3-30 µµfd. mica trimmer
C_4—50 µµfd. midget
C_5—.01 µfd. tubular
C_6—50 µµfd. mica
C_7—.01 µfd. tubular
C_8—.01 µfd. tubular or mica
C_9—.01 µfd. tubular or mica
C_{10}—3-30 µµfd. trimmer with screw removed (see text)
C_{11}—50 µµfd. midget
C_{12}—50 µµfd. mica
C_{13}—.01 µfd. tubular
C_{14}—.01 µfd. tubular
C_{15}—3 µµfd. neutralizing condenser
C_{16}—100 µµfd. per section, 2000-volt spacing
C_{17}—50 µµfd. per section, 2000-volt spacing
C_{18}—.01 µfd. mica
C_{19}—.01 µfd. mica
C_{20}, C_{21}—Neutralizing condensers (see text)
C_{22}—50 µµfd. per section, 16,000-volt spacing
C_{23}—.002 µfd., 5000-volt mica
C_{24}—.0001 µfd. mica
C_{25}—0.1 µfd. tubular, 400 volts
C_{26}—.01 µfd. tubular, 400 volts
C_{27}—0.5 µfd. tubular 400 volts
C_{28}—0.25 µfd. tubular, 400 volts
C_{29}—0.5 µfd. tubular, 200 volts
C_{30}—0.25 µfd. tubular, 400 volts
C_{31}—.00025 µfd. mica
C_{32}, C_{33}—.01 µfd. tubular, 400 volts
C_{34}—.02 µfd. tubular, 400 volts
C_{35}—10 µfd. electrolytic, 50 volts
C_{36}—8 µfd. electrolytic 450 volts
C_{37}—0.1 µfd. tubular, 400 volts
C_{38}—0.1 µfd. tubular, 400 volts
C_{39}, C_{40}—.001 µfd. mica
C_{41} through C_{45}—8 µfd. electrolytics, 450 volts
C_{46}—2 or 4 µfd., 1000 volts (working voltage)
C_{47}—1 µfd., 4000 volts (working voltage)
C_{48}—2 µfd., 4000 volts, (working voltage)
R_1—150,000 ohms, 1-watt carbon
R_2—100,000 ohms, 1-watt carbon
R_3—300 ohms, 10 watts
R_4—1750 or 2000 ohms, 20 watts
R_5—2000 ohms, 50 watts
R_6—900 ohms adj., 20 watts
R_7—0.5 meg., 1-watt carbon
R_8—25,000 ohms, 0.5-watt carbon
R_9—2 meg., 1-watt carbon
R_{10}—50,000 ohms, 1-watt carbon
R_{11}—0.25 meg., 1-watt carbon
R_{12}—1 meg. tapered pot. a.f. vol. contral
R_{13}—0.25 meg., 1-watt carbon
R_{14}—1 meg., 1-watt carbon
R_{15}—2500 ohms, 1 watt
R_{16}—0.25 meg., 1-watt carbon
R_{17}, R_{18}—100,000 ohms, 1-watt carbon
R_{19}—0.5 meg., 1-watt carbon
R_{20}—35,000 ohms, 1-watt carbon
R_{21}—0.5 meg., 1-watt carbon
R_{22}—200 ohms, 10 watts
R_{23}—20,000 ohms, 20 watts
R_{24}—50,000 ohms, 2-watt carbon
R_{25}—5000 ohms, 10 watts
R_{26}—100,000 ohms, 2-watt carbon
R_{27}—25,000-ohm pot.
R_{28}—25,000 ohms, 50-watt adj.
R_{29}—100,000 ohms, 50 watts
R_{30}—100,000 ohms, 200 watts ("multi-ratio")
T_1—Tapped secondary class B input transformer, with C_{38} tapped down from one grid and ground (not particularly critical).
T_2—500-watt (a.f.) variable tap class B output transformer, designed to carry class C stage plate current
T_3—5.25 volts, 5 amp.
T_4, T_5—5.25 volts, 14 amp.
T_6—500 volts each side c.t., 75 watts. Also 5-v. and 6.3-v. filament windings.
T_7—Three 5-v. 3-amp. windings, insulated for 2000 volts.
T_8—500 volts each side c.t., 150 watts (c.t. not used) and 2.5-volt filament winding (used for relay)
T_9—3000 volts each side c.t., 1500 watts (tapped primary)
T_{10}—5 volts, 10,000-volt insulation, 10 amp. for 866-B or 20 amp. for 872 rectifiers.
CH_1—30 hy., 15 ma. or more
CH_2—20 hy., 200-ma. smoothing choke
CH_3—5-25 hy. 300-ma. swinging choke
CH_4—5-25-hy. swinging choke, 200 ma.
CH_5—20-hy. smoothing choke, 350 or 400 ma.
CH_6—20-hy. smoothing choke, 500 or 550 ma.
M_1—0-100 ma. d.c.
M_2—0-100 ma. d.c.
M_3—0-200 ma. d.c.
M_4—0-300 ma. d.c.
M_5—0-500 ma. d.c.
BC—Bias cell (or pen flashlight cell)


6L6G
6L6G
35T
100TH
100TH
RFC
M1
M2
D.P.D.T. SWITCH
-67½ VOLTS
-90 V.
FROM +900 V.
FROM +400 V.
FROM +260 V.
D.P.S.T. RELAY
SW1 OR KEY
FROM 2½ V. ~
6C6
76's
6L6G's
100TH's
XTAL MIKE INPUT
BC
CH1
76
+400 V.
+260 V.
+400 VOLTS
+425 VOLTS
+2750 V.
+2700 VOLTS
+900 V.
CH2
CH3
CH4
CH5
CH6
5Z3
5Z3
5Z3
83
866B's OR 872's
TO 35T FIL.
100TH MOD. FILS.
100TH FINAL AMP. FILS.
6.3 V. HEATERS
2½ V. TO RELAY
M3
M4
M5
SW2
SW3
SW4
SW5
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
F
115 V. ~

• The class B output transformer is necessarily a husky affair, taking up most of the space on the modulator chassis.



The 400-volt and 900-volt power supplies.

triodes, and has more gain than a pair of 2A3 tubes though not as low a plate to plate impedance. The class B input transformer has one side, or a tap part way up one side, connected back to a diode rectifier for a.v.c. The diode, a 76 with grid and plate tied together, has an adjustable bias in the cathode circuit in order to act as a delayed a.v.c. The amount of delay is adjusted to the point which will prevent overmodulation of the final amplifier.

When the audio voltage across the class B grid circuit is greater than the desired value which will produce 95 or 100% modulation, the diode bias voltage is exceeded and the diode begins to draw current. This current flows through a resistor which then furnishes additional grid bias to the grids of the 76 audio amplifier tubes. This added grid bias reduces the amplification of this stage and phase inverter with the result that the audio voltage is limited to a value which will tend to prevent overmodulation. The two oscilloscope pictures were taken with an excessive audio input, one with and the other without the a.v.c. system in operation. The long tail on one picture shows bad overmodulation, which would cause severe side band splatter and interference to other stations. The a.v.c. system prevents this effect except on sudden sounds in which the time lage of the a.v.c. filter is too great to allow negative grid bias voltage to reach the audio amplifier grids.

The filter will follow the voice envelope and work satisfactorily on average speech. There is some audible distortion for high inputs with this and several other a.v.c. systems tried, but it accomplishes the purpose of preventing accidental overmodulation and the voice quality is still understandable at very high input levels.

Coil Table for 1 Kw. Amateur Phone

Coil Tuning Band	6L6G Stages	35-T Plate	Final Grid	Final Plate
160	62 turns No. 22 D.S.C. 2″ long 1½″ diam.			
80	32 turns C.T. No. 22 D.S.C. 1⅛″ long 1½″ diam.	34 turns C.T. No. 14 4″ long 2½″ diam.	46 turns C.T. No. 14 4½″ long 2½″ diam.	24 turns C.T. No. 10 E. 4″ long 5″ diam.
40	16 turns C.T. No. 16 E. 1¼″ long 1½″ diam.			
20	8 turns C.T. No. 16 E. ¾″ long 1½″ diam.	10 turns C.T. No. 10 3½″ long 2½″ diam.	14 turns C.T. No. 12 E. 4″ long 2½″ diam.	12 turns C.T. ⅛″ copper tubing 6″ long 3″ diam.
10		7 turns C.T. No. 10 4″ long 2″ diam.	8 turns C.T. No. 10 4″ long 2″ diam.	6 turns C.T. ⅛″ diam. copper tubing 6″ long 3″ diam.

At normal input level there is no distortion and the a.v.c. simply acts as a safety device.

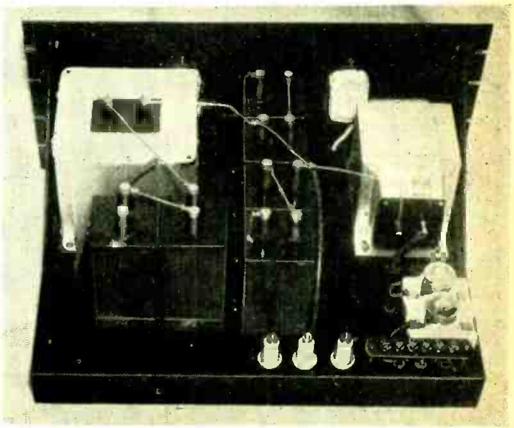
The transmitter was built into a relay rack having 71¾" of panel space. The chassis are all 17"x13"x2" of no. 18 and 16 gauge iron. The panels are standard sizes 19" long. The top, final amplifier panel is 12¼" wide as is the bottom high voltage power supply panel. All other panels are 8¾" wide except the modulator, which has a 5½" wide meter panel and a 7" panel to complete the 12¼" space needed for the large modulation transformer.

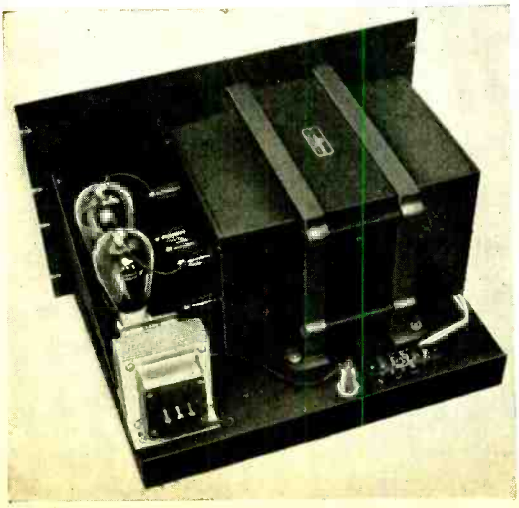
The bottom deck contains the multi-tapped h.v. transformer, 866B rectifiers, and 5 volt filament transformer. 872 rectifiers would be somewhat more suitable than 866B rectifiers. The second deck contains the high voltage filter and line switches. The third deck contains the 400 volt and 900 volt power supplies. Each r.f. and class B stage has individual 5 volt filament transformers mounted on the chassis in which the stage is operated. The fourth deck contains the speech amplifier, a.v.c. system and class B driver stage. The class B stage is mounted directly above it and the grid leads extend down to the class B input transformer on the speech amplifier chassis. The a.v.c. delay bias adjustment is at the rear of the speech amplifier chassis since it only needs adjustment once in connection with any particular input to the r.f. final amplifier. This adjustment can be made with any overmodulation indicator or with an oscilloscope for detecting the presence of overmodulation.

The exciter deck contains the two 6L6G and 35-T tubes and their tuned plate circuits. The 6L6G buffer neutralizing condenser is a small 3-30 μμfd. mica trimmer condenser with the adjustment screw removed and the top plate bent up about ⅛" away from the bottom plate. This condenser is mounted on no. 14 wire leads near the tube socket. The 35-T neutralizing condenser consists of two parallel plates about one inch square of 14 ga. aluminum. One plate fastens directly to one stator of the plate tuning condenser while the other is mounted on a ¼" diameter coil jack and plug. This allows rotation and adjustment of the neutralizing capacity. The two plates are separated about ⅜" when the moving plate is directly above the stationary plate.

[*Continued on Page 175*]

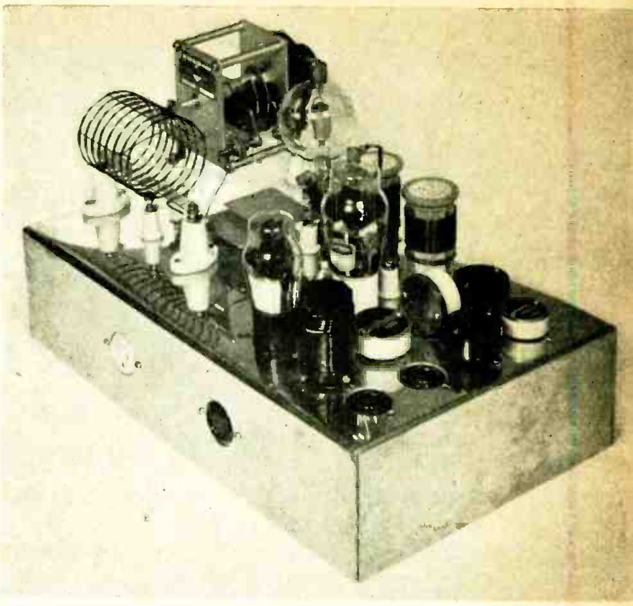
The high voltage filter system to the right takes up one whole deck in the rack.





The heavy duty, high voltage power transformer and the rectifiers are mounted on this deck, at the left.

This practically hits the ultimate in simplicity with medium power output. Having only one coil-condenser tuned circuit, this unit works on several bands and has provisions for quick frequency shifts to various predetermined frequencies within each band.



By
ROY RAGUSE,* W6FKZ

A MULTIBAND EXCITER *with instantaneous frequency switching*

The unit to be described measures 10"x 17" x 4", can be used rack mounted or breadboard style, uses 3.5-Mc. crystals (variable gap type if desired), operates on 7, 14, and 28 Mc., and requires only two power supplies. 250 watts input can be run to the final stage when used as a low-powered transmitter. Instantaneous frequency switching to any one of seven crystals is possible, giving constant output with no retuning except when changing more than 150 kc. at 14 Mc. This means no tuning circuits to adjust unless changing from one end of the band to the other on 14 Mc., *and then only one condenser.*

The tube lineup consists of a 6A6, RK-39, and an 808. An 807 can be substituted for the RK-39, and a 35T, T55, HF-100, etc., can be used instead of the 808. If this unit is used as an exciter, the output when doubling to 28 Mc. is just half of that obtained on 7 and 14 Mc.; but if a 100TH tube is used in place of the 808, the stage can be run at the same input of 250 watts on 28 Mc.

All coils except the 808 plate coil are untuned and are cut to resonate in the center of the band with no tuning condenser. This low C/L ratio makes the tuning so broad that these stages cover a complete band with *no change in excitation to the 808.*

The first section of the 6A6 is used as a Pierce oscillator with 250 volts on the plate. It requires no tuned circuits. (See November, 1937, RADIO, page 33.) The large .01 µfd. coupling condenser gives maximum drive to the doubler section, and in so doing keeps the r.f. crystal current down to 40 ma. The doubler section draws 30 ma. plate current at about 350 volts. This plate coil, L_1, is resonant on 7 Mc. and is capacity coupled to the RK-39 grid, driving 4 grid ma. through the 30,000-ohm grid leak.

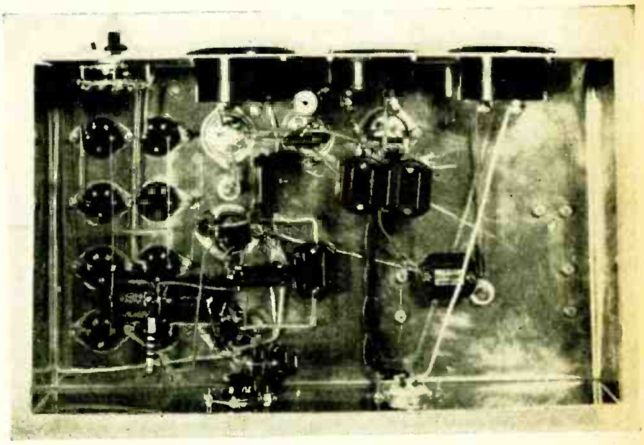
With 100 ma. at 500 volts on the RK-39, it drives 30 grid ma. through the 15,000-ohm grid leak on both 7 and 14 Mc. With 2000 volts on the 808, the unloaded plate current on 7 Mc. is 5 ma., on 14 Mc. 10 ma., and doubling to 28 Mc. it is 35 ma.

Looking at the bottom view of the unit, the left-hand row of 5-prong amphenol sockets is for crystals. The front three sockets of the

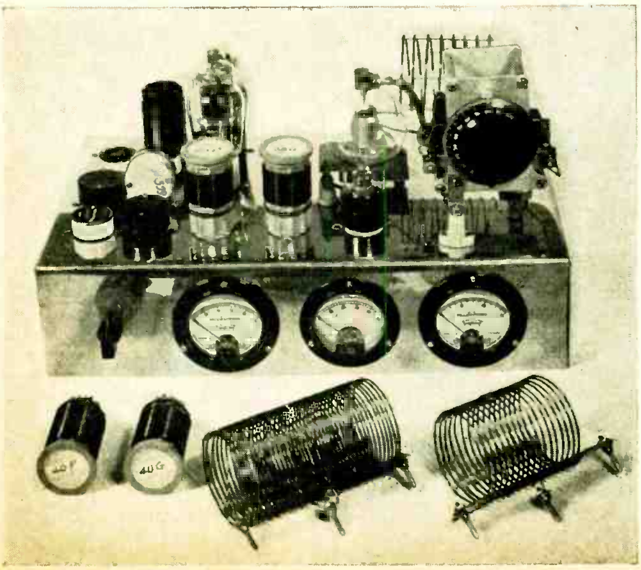
*5411 Barton Ave., Los Angeles, Calif.

second row are also for crystals, and the fourth is for the plate coil of the 6A6 doubler section. The third row has a 5-prong steatite socket for the plate coil of the RK-39; then a feed-through insulator for the plate lead of the RK-39; the second socket is a 5-prong amphenol for the RK-39; the third is a 7-prong amphenol for the 6A6. Next to the RK-39 plate coil is a 5-prong steatite socket for the grid coil of the 808, then a 4-prong steatite for the 808. Between the grid coil and the 808 is the feed-through jack insulator into which plugs one of the neutralizing plates. This plate can be pulled out if desired when doubling to 28 Mc. The hot side of the grid coil is connected to the grid connection on the 808 socket for 35T or T55 operation, and also to this feed-through insulator. This insulator carries the external grid connection for the 808. The only other unconventional thing is the plate tuning condenser for the 808. This condenser was rebuilt into a split stator type with only one stator and one rotor plate in each section, with ¼″ spacing.

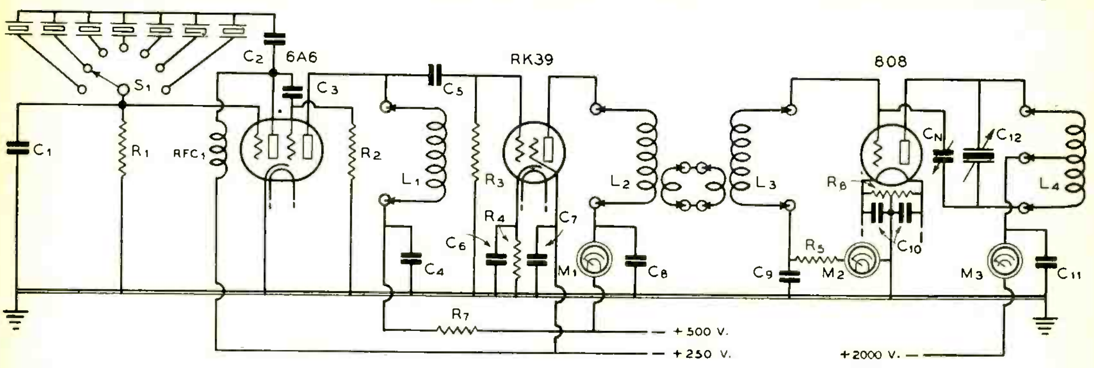
Complete information on the coils is given in the table for this layout. If different type tubes are used, or another material besides aluminum is used for the chassis, or the spacing of the coils to the chassis is changed, or the mechanical layout otherwise altered, the coils will more than likely be off resonance if wound to the specifications given in the table. In this case, add 10% to the number of turns specified and then remove one turn at a time until con-



Bottom view of the compact unit. The various parts shown are identified in the text.



The exciter ready for 10-meter operation. Coils for the other bands are shown in the foreground.



SCHEMATIC DIAGRAM OF THE MULTIBAND EXCITER

C_1—.00015 µfd. mica
C_2, C_3—.01 µfd. mica
C_4—.002 µfd. mica
C_5—.0001 µfd. mica
C_6—.005 µfd. mica
C_7—.003 µfd. mica
C_8—.001 µfd. mica
C_9—.0005 µfd. mica
C_{10}—.01 µfd. mica
C_{11}—.0015 µfd., 5000-volt mica
C_{12}—Rebuilt split-stator, see text
C_n—Aluminum-plate neutralizing condenser
R_1—50,000 ohms, 1 watt
R_2—50,000 ohms, 2 watts
R_3—30,000 ohms, 2 watts
R_4—250 ohms, 10 watts
R_5—15,000 ohms, 25 watts
R_6—100 ohms, c.t. res.
R_7—5000 ohms, 10 watts
RFC—2½ mh., 125 ma. chokes
S_1—Single contact, multi-position switch
Coils—See coil table
M_1—0-250 d.c. milliammeter
M_2—0-50 d.c. milliammeter
M_3—0-300 d.c. milliammeter

stant output is obtained over the full frequency range of your crystals.

When pruning the 808 plate coil, remove turns one at a time until you just hit resonance on your lowest frequency crystal with the condenser entirely unmeshed. Then neutralize, as this changes the tuning (due to the extremely low "C" in this tank circuit). Then, if necessary, remove one-half turn at a time, keeping the coil balanced to center tap, until the condenser covers the full frequency range of your crystals.

One other point: have the link coil in position and coupled to the next stage during the pruning, as the added capacity will detune this circuit considerably. For the best energy transfer at 28 Mc., use a link line of no. 12 or 14 wire spaced ¼", with three turns on the link coil to match better the higher impedance of this open-type line.

A little time is required to prune the coils to hit resonance, but once set, the ability to jump around the band without getting up to retune the rig each time should be a big factor in raising your score in the next dx contest, and be a big help in getting around the QRM 52 weeks a year.

When used to feed an antenna directly, an antenna with strong harmonic discrimination should be used; if this is not done, a tuned, antenna tank circuit should be incorporated to reduce the strength of radiated harmonics, especially when operating in the 40-meter band.

	L_1	L_2	L_3	L_4
7 Mc.	26 turns no. 16 enam. close wound on 1½ in. form	38 turns no. 16 enam. close wound at top of 1½ in. form 2 turn link.	32 turns no. 16 enam. close wound at top of 1½ in. form 2 turn link.	40 turns no. 14 enam. 5¼ in. long 2½ in. dia. Air wound.
14 Mc.		19 turns no. 16 enam. spaced to 1¼ in. at top of 1½ in. form 2 turn link.	16 turns no. 16 enam. spaced to 1¼ in. at top of 1½ in. form 2 turn link.	17 turns no. 14 enam. 3½ in. long 2½ in. dia. Air wound.
28 Mc.				8 turns no. 14 enam. 3½ in. long 2½ in. dia. Air wound.

HOW TO LEAVE HOME

in 5 easy lessons

1—"If we go right through the plaster instead of down to the window and up, we can keep the feeder short and straight."

2—But dear wifey does not seem exactly amenable. She has suffered in silence while the beautiful domicile has gradually been reduced to a near shambles. This is the last straw.

3—With a fiendish glee she seizes this opportune moment to release her pent-up anger and express her opinions of ham radio in general and its detrimental effect on the intactitude of her house and furnishings in particular.

☆

4—It looks as though the feeder is NOT going through the plaster. In fact, from the excitation on the broom, it looks as though the feeder is not even going into the house.

5—Holding the 354 and his hat with one hand and a bag full of radio gear in the other, our hero makes a hurried departure for more healthful climes, to the accompaniment of information to the effect that if he is ever seen again it will be altogether too soon.

ONE MAN'S STORY

•

By **KENNETH HECHT,* W6KBB**

•

Don't mention y.l. hams to me. Yes, I know—they're nice to chew the fat with across the country, but never mess around with them like you would any other y.l.

Take the case of Corrine. I met her on 160-meter phone one night a couple of years ago and liked the sound of her voice. In fact, I loved the sound of her voice. It sounded so cute talking about the things most beloved by me—how much current she ran to her 35T final, the antenna she was using, her best dx, how she had put 1500 volts on a 210 and got away with it, and other such familiar topics—that I longed to see her in person.

Since she lived here in town, I asked her if I could come over to her house. I asked her every QSO, and about the tenth one, she said I could come over because her folks would be out that night.

Now I wasn't expecting her to look like anything but a y.l. ham, and I thought of her as a sort of a tomboy. So when she came to the door to let me in, my plate current hit an all-time new high, and almost burned me out then and there. For a T9 sig she surely was. I saw a pretty little blonde with a pert, turned-up nose; blue, dollar-sized eyes with long eyelashes; a clear, healthy complexion, and a chassis of about 5 feet 4 inches that set a bachelor and a ham like me mentally raving.

She greeted me with a smile and looked straight into my eyes when I introduced myself.

"I am always glad to meet someone in person that I have met on the air," she said in her charming voice. "Come right into the shack and meet the others."

The others? I had expected to have her undivided attention and had looked forward to it since I had seen her in the flesh, but I followed her through the house and into her room. Here I saw many brother hams—all manner, shape and size—perched on the bed, the bureau, the operating desk, and even on the chairs. Some dope that I knew was yapping into the mike, and I gathered that there was a QSO under way. I found myself sitting room on the foot of the bed and greeted the gang. Corrine went to the mike and took over the conversation, and we all listened with rapt attention while she conducted a QSO with some guy. She talked enthusiastically, and I discovered that everything she was saying was the same stuff she had dished me in our gab-fests. Was I disallusioned!

While she was at the mike, I took a look at the transmitter. There sure were a lot of swell parts in that rig. I'll bet half of them were given her. It was all neatly built into a six-foot rack and panel and was an even better job than my own.

I asked a couple of the boys how they happened to be there that particular evening. They said that Corrine had told each one that he could come over that night because her folks would be out.

At ten o'clock sharp, she shooed us all out. There was no chance for me to get her aside and make a date, like I had decided to, so I left with the rest of the bunch and we all went down to the local beer parlor, chatting about the wonder y.l. Corrine.

I had a QSO with her the next night and made a date to take her to a dance the following Saturday night, after cautiously questioning her whether anybody else would be around.

On Saturday night, I managed to drag her away from a QSO with a lug that I knew would chew the fat all night, and got started to the dance.

"Gee, this will be fun," she said, "going to a dance with a ham!"

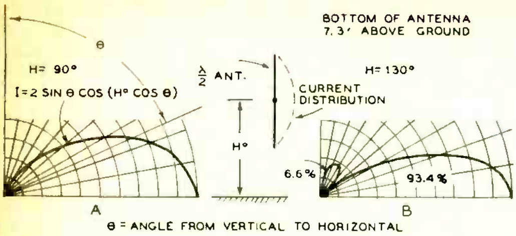
Those were ominous words, but I didn't realize it then, and I said, "Yeah, it sure will!"

All the way to the dance hall, Corrine chatted about her trouble in neutralizing her final, and I did my best to help her out with suggestions gleaned from my battles with the same thing.

When we got on the dance floor at the Dolomar, we really did some fancy clogging—until Corrine turned saucer-like blue eyes on

[*Continued on Page 154*]

*1929 N. Berendo, Hollywood, Calif.



The Story of a VERTICAL

By
W. E. McNATT, W7GEZ*
and
H. E. STEINER, W7DTJ**

PART I. CONSTRUCTION

"When I move," said Harley Steiner, "I'll put up a vertical for the new layout." That started the whole thing.

Having more spare time to devote to the subject than did my buxom partner, the writer delved into old files of every radio publication he could find in search of enlightening information on vertical antennas.

Several surprising points were brought out by that research. Among them were the facts that when a ham used a vertical, he always tried to get it as high in the air as two or three spliced 2x2's or 4x4's would put it. Another, that surprisingly few amateurs used verticals on any band lower (in frequency) than 28 Mc., most of them being used on 56 Mc. And, still another, that no matter who wrote on the subject, seldom did any two authors agree in the vertical radiation pattern produced by a vertical half-wave antenna operating under a given set of conditions.

However, two articles were found in which the authors agree in their results. Samuel Sabaroff, in the October, 1935, issue of "R/9", presents a graphical procedure which produces patterns checked by those given in an article by G. H. Brown (RCA), in the January, 1936, *Proceedings* of the I. R. E.

With these two articles as a starter, we proceded to draw up several patterns for a vertical half-wave antenna operating with its bottom on the ground, and at various heights above ground. Figure A shows the theoretical pattern given by an antenna operating with its bottom resting on, but insulated from, ground. Figure B shows the effect of raising the antenna 7.3 feet, or approximately 40 electrical degrees, above ground, to H = 130°. Insofar as radiation characteristics were concerned, we would much prefer to have had the antenna with its bottom on ground. However, we could not use it because of several reasons.

*ex-W6FEW; 709 Prospect Ave., Lewiston, Idaho.
**1011 15th Avenue, Lewiston, Idaho.

If you could but take a quick journey to Mr. Steiner's residence, it would be quite evident that a great portion of the city's rising generation lives within three doors of his home. (We spotted 12 kids, in a bunch, the other day!) These "little factors" played an important part in deciding to use an antenna with its base 7.3 feet above ground. It may seem rather strange to choose such an "odd" height; however, 7.3 feet corresponds to approximately 40 electrical degrees, on 14.5 Mc., and that even number was easier to use in calculating the pattern for H = 130° shown in figure B. Too, the chosen height was great enough to be far beyond the reach of the tallest member of the neighborhood "gang."

As is seen, the chosen antenna height causes a small lobe of radiation at a high angle to be produced. Being curious as to the relative percentage of the total radiation in this small lobe, we carefully drew a pattern to scale and measured the two areas by a planimeter. It was found that, theoretically, the large lobe contains approximately 93.4%, and the small lobe 6.6% of the total radiation. Not being "hoggish", we were well satisfied with this pattern. The antenna is well out of reach of "inquisitive hands", the radiation characteristic still being that desired.

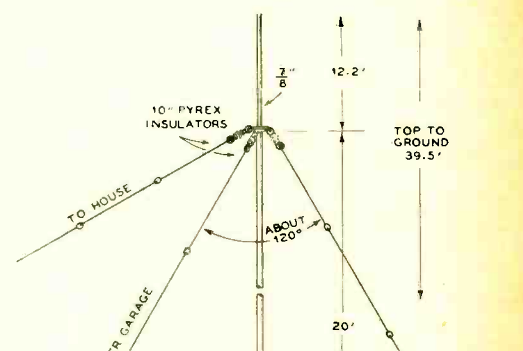
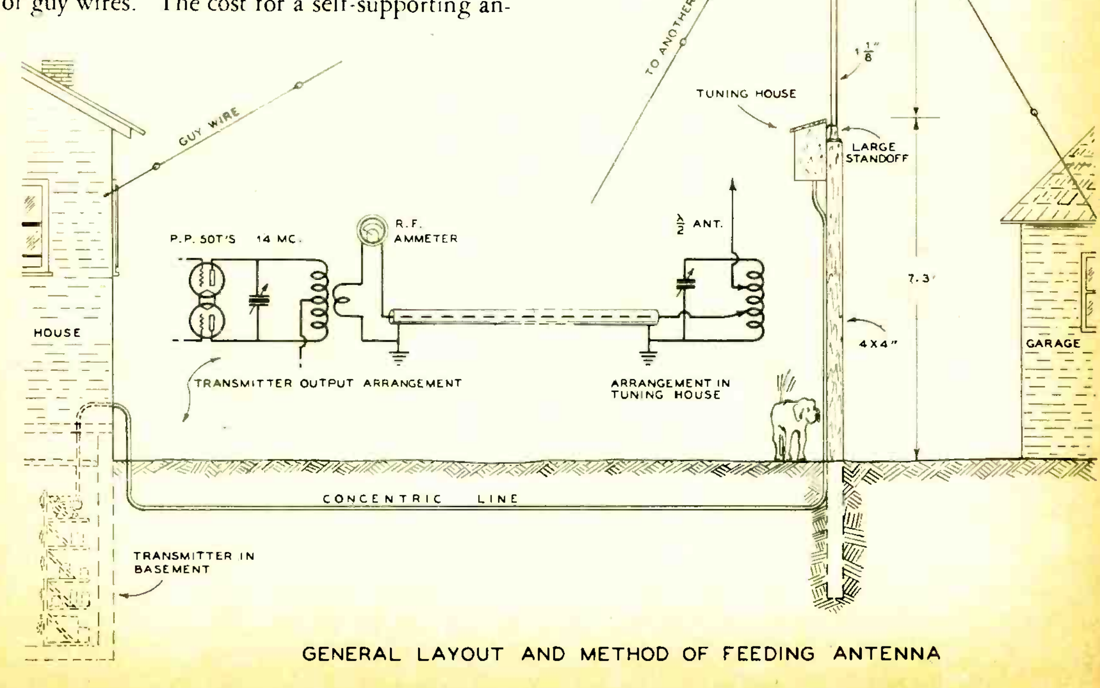
Theoretical Radiation Pattern

A word now concerning our use of theoretical patterns in choosing a height of the antenna. It must be remembered that ideal conditions are assumed for a theoretical pattern. In other words, it is assumed that the current distribution along the length of the antenna is uniformly sinusoidal; that the antenna is operating above a "perfect earth"; that there are no distortions to be produced by nearby reflecting bodies such as guy wires, telephone and power lines, neighboring b.c.l. antennas and, lastly, clotheslines. Naturally, these conditions are never met by anyone and are not even closely approached by amateurs who lack large quantities of time and money to spend in searching for a location. Commercials have those things; the ham must, and does, make the best use of the location he happens to have. We, of course, knew all these things before we started to consider theoretical patterns. However, we felt that it was far better to work from a *definite starting place,* even though it were theory, than to *just guess at something*. The practical operation of the antenna can be checked later. (This is being done, at the time of writing. Both vertical and horizontal patterns are being determined.

Co-Axial Feed

Having decided on the electrical and physical height of the antenna, the next problem that arose was that of feeding it. After much discussion, it was decided to use concentric line, or "co-axe" (as you prefer). The principal reason for using this type of transmission line was the undesirability of having a two-wire parallel line running up the side of the house and across to the antenna. The child-mind is a devilish device, at times, and we feared the use of such a line would cause it to be seen as a "swell little stepladder" by the ever-present youngsters.

The important electrical features of the layout having been decided upon, the mechanics of it arose. The first consideration was that of guy wires. The cost for a self-supporting antenna capable of resisting a 50 m.p.h. wind would be prohibitive for an amateur's station. It was then decided to make the antenna from two pieces of hard-drawn copper pipe. These pieces are, respectively, 7/8" and 1 1/8" in diameter and fit snugly together. They were sweated together by using a small torch and plenty of solder—and the grace of capillary action. If you'll recall your physics, capillary action occurs when a very small opening, or tube, is immersed in a fluid. The solder literally "flew" into the very slight space between the two pieces of tubing and another "headache" was over. The two ends were capped at the top to keep out water and at the bottom to provide a bearing at the insulator. The bottom cap was drilled in the center just slightly larger than the bolt extending through the top of a large

GENERAL LAYOUT AND METHOD OF FEEDING ANTENNA

Johnson standoff insulator. The antenna is supported by the insulator, but is in no way bolted or fastened to it, except by the action of gravity and the tension on the guy wires.

Guying and Support

Three guy wires were strung from a point just above the joint of the two sections and fastened to the very convenient corners of a house and two garages. As shown in the diagram, three large insulators break the guys at the antenna, thus reducing to a minimum any possible leakage. Small egg-strain insulators of the "airplane" type were used to break up the remainder of each guy, which was no. 14 galvanized iron. Incidentally, each piece of each guy was cut so as not to be a sub-harmonic of the antenna length; and, no two pieces of any of the three guys are of the same length.

For a bottom support, a 4x4x12 was sunk 4.8 feet into the ground; this was to allow for the length of the base insulator. In our case, a mistake was made in not setting the post in concrete. When setting it, it was thoroughly water-tamped into place after being set plumb. However, during strong winds, which are not uncommon in this particular area, considerable pressure is produced on the earth about the post. This is due to the moment action about the guying point, produced by wind pressure on the antenna. In this particular case, a total displacement of nearly one inch was observed at the surface of the ground. This is not good, mechanically; it may be avoided by setting the post in concrete or, if not set in concrete, by using a larger post. The larger surface area produces less unit-pressure on the soil, thus producing greater rigidity. Thorough tamping, when setting the post without concrete, is very essential.

Considerable swaying of the antenna above the guying point was observed during recent windblows. This caused no alarm, as the spring-like qualities of the tubing have been, and are expected, to continue to be great enough to resist permanent deformation. The greatest thus far observed, during windblows, was not more than 3 or 4 feet, total, of the top end. While "playing" with the antenna before installing it, as much as 10 feet total displacement (five feet, in one direction) was had without any deformation. This occurred with no guys on the tubing; hence our confidence in it.

The Antenna-Coupling Unit

The remaining constructional feature, that of housing the antenna loading unit, was a small one. The simple object being to protect it from the weather, the unit was mounted in a small wooden box which was, in turn, mounted at the base of the antenna. The concentric line runs up the post and is fastened thereto with small "U" strips of galvanized iron.

As shown in the sketch, the concentric line is coupled to the transmitter by means of a link at the final amplifier. The inside wire of the line is split to accommodate the r.f. ammeter; the outside tubing is grounded—both by being connected to the transmitter ground and also by being run underground to the antenna. At the antenna, tuning is accomplished by means of the circuit shown. However, in tuning up the transmission line and antenna, it is important that a correct match be obtained. One indication of a mis-match will be an excessive current in the line, shown by the r.f. ammeter. In order to have some idea of what the proper r.f. current should be, one may calculate it from Ohm's Law:

$$P = I^2R$$

where P is the power in the line, I is the r.f. current flowing and R is the impedance of the concentric line as stated by the manufacturer (usually 60 or 70 oms). The power may be assumed to be 30% less than that input to the final if you have designed and built a good final. Using that value, the proper line current may be approximated and will serve as a guide in obtaining the proper match. Another method is to set up a simple field-strength meter and, with another ham, make a number of tests on the coupling by keeping the power input constant and changing the position of the taps on the coil. After getting the proper match, either note them in your log; or make a new coil (after experimenting with the original) and solder the connections in place.

(NOTE: Due to recent bad weather, it was impossible to send photographs with this first part of the article. The second part will describe the author's experiences in getting horizontal and vertical radiation-patterns for the antenna just described.)

●

Another Vertical Feeding Arrangement

As an optional method of feeding a vertical-pipe antenna, may we suggest the method being used on the 14-Mc. one at RADIO's office.

The antenna itself is 33 feet long, made of three sections of ordinary water pipe, and is

[*Continued on Page 168*]

Measuring The Vertical Angle of SIGNAL ARRIVAL

Call	Location	Distance km	Arrival Angle Degrees	Layer Height km
W5FHJ	Ruleville, Miss.	1800	17.2	360
	Dallas, Texas	2340	8.9	282
W9YUD	Freemont, Nebr.	2040	14.1	378
W9DHO	Wisner, Nebr.	2090	13.7	358
W5CZZ	Terrill, Texas	2280	11.7	357
W5EYV	Refugio, Texas	2600	9.0	357
W9JWI	Independence, Mo.	1960	17.2	402
W6LUL	Los Angeles, Calif.	4050	11.6	302
W9GND	Grand Forks, N. D.	2070	12.6	331
W9DHQ	Wishek, N. D.	2200	9.5	290
W5FNH	Kerrville, Texas	2720	8.1	353
W5CZZ	Terrill, Texas	2280	10.6	332
	Kansas City, Mo.	1950	16.2	378
W7CKZ	Aberdeen, Wash.	4050	12.4	318
W9LKD	Wichita, Kansas	2180	10.9	332

Like the weather, the vertical angle at which signals are transmitted or received is something that everyone talks about but few do anything about. We must thank H. O. Peterson and D. R. Goddard of R.C.A. Communications, Inc., for some data on angle of arrival of 28 Mc. amateur signals, published in the October *I.R.E. Proceedings* in an article on field strength observations of transatlantic television signals on 45 Mc.

The vertical angle measurements were made to facilitate design of an antenna. For this work, three horizontal dipoles were erected at 16.7, 27.3 and 50 feet above ground, with equal length feeders to the receiver. The method of determining the angle of arrival by comparison of the signal strengths picked up on each of these antennas was described by Friis, Feldman, and Sharpless in *I.R.E. Proceedings* for January, 1934. The 45 Mc. television signals arrived close to 7.5 degrees above the horizontal. Measurements on amateur signals March 4, 1937, which were made in the 28-30 Mc. band, are listed on this page.

From the data in the table, it is found that the angle of arrival ranges from 8.1 to 17.2 degrees above the horizontal for what is assumed to be one-hop transmission, depending largely upon distance, and close to 12.0 degrees for the instances of two-hop longer distance transmission.

It might be mentioned here that angle of arrival measurements on a somewhat lower frequency have in the past suggested that South American signals come in on the East coast at a very low angle—about 3 degrees.

According to the National Bureau of Standards, there is little reason to expect that there is normally any difference between the angle of arrival and the angle above the horizon at which the same signal left the transmitting antenna.

It will be seen, therefore, that the average amateur antenna, operating in the higher frequency bands and radiating most of its power at angles above 20 degrees, is probably a better "cloud-warmer" than a communication device. Means of concentrating radiated power at lower angles are available (see "Antenna Gain Without Directivity," RADIO, May, 1937) which do not at the same time involve sharp horizontal directivity.

Although the material given above clearly indicates that it is the extremely low-angle radiation that "goes places" on 28 Mc., it does not (and cannot) indicate what percentage of the radiated power was leaving the transmitting antenna at these low angles. It could have been easily possible that only a small part of the radiated power was leaving the antenna at this low angle; however, it was this low-angle radiation that was being received and measured.

Almost any type of an antenna will radiate a certain amount of power at these desirable angles. For this reason almost any antenna will work, after a fashion, on 28 Mc. When real results are desired, however, a radiator that concentrates a *majority* of its radiation within the lower vertical angles is the one to use. Many excellent low-angle radiators have been described in recent issues of RADIO.

Y.L.'S ON THE AIR

RADIO breaks down and herewith proves that the hand which rocks the cradle can also pound brass. All except the most confirmed misogynist will have to admit to perking up and showing a bit more interest when the operator at the other end says, "Hi, o.m., it happens that I'm a y.l."

Although Dorothy H. Wilkins of W1FT divides her time between amateur radio and stamp collecting, the latter hobby runs second to talking with the gang on "80."

Rose Reiffin, W2TU, has had her call since 1932. Her rig is used only for c.w. on 10, 20 and 40 meters, while that of her husband is on 10- and 20-meter phone.

READING FROM LEFT TO RIGHT:

Station of Nelly Corry, G2YL.

Rose Zandonini, Nelly Corry, and Elizabeth Zandonini, W3CDQ.

Mildred McMaster, W9OIU.

Regina L. DeWageneire, W9ZTY, pictured with her three junior ops.

Mary Roth, W9TSV, and her transmitter.

The transmitter at W3CDQ.

Mary Tatro of W7FWK and her transmitter.

It's Not Entirely

A MAN'S GAME

Amateur radio . . . who said it was a man's game?

A glance through these pages will discourage the woman-hater who fled to amateur radio for security and the man-of-the-family who took to the air for peace.

So adept have some of these women become that they are occasionally guilty of conducting cooking and knitting QSO's over the air, with a W2 on one end instructing thusly: "Knit 1, purl 2, etc.", while a W9 or W6 responds, "Knit 1, purl 2; yes, yes, then what?"

Some of them, like Judy León of HC1FG and Elizabeth M. Zandonini of W3CDQ, carry their interest into professional radio. HC1FG announces at PRADO, one of the most popular South American broadcasting stations. In 1935, when Judy entered the A. R. R. L. International Relay competition between W and VE stations and stations outside of U. S. A. and Canada, she made 35,782 points—far more than any other person not in the W and VE districts. A member of the "Rueda del Oeste", she is captana of the Indo-Latin chain and captana of the Rueda Nacionalista.

W3CDQ is radio aid with the National Bureau of Standards and is well-known throughout the ham world. Elizabeth has been planning to put a new rig on the air this month to operate on 7, 14 and 28 Mc. She has a schedule with Nelly Corry, G2YL, for 28 Mc. work for correlation purpose.

Others are like Regina L. DeWageneire, W9ZTY, who manages to keep house, rear three junior ops, watch after the o.m. W9VWL, and maintain schedules. Mildred McMaster of W9OIU gave up newspaper reporting to become Mrs. W9LIV. She is so enthusiastic about radio that she insisted upon their son being named Harold Alan in order that his initials would be "HAM".

Then, there are some like Dot Wilkins of W1FTJ—the y.l. with the large brown eyes—who work for radio concerns by day and come home to pound brass half of the night. Dot is secretary to a wholesale radio firm and is active on 3.5 Mc. c.w. Her brother, W1BII, is responsible for her interest in hamming.

Clara C. Reger (W8KYR), on the other hand, is a piano teacher. Yes, she is the girl with the smile and the resemblance to merry Gracie Allen of the b.c. radio world. W8KYR, who sends and receives between 30 and 35 w.p.m., particularly favors traffic work and rag-chewing; she participated in the emergency nets of both 1936 and '37 flood catastrophies, as did other y.l. operators throughout the country.

The distinction of having been interviewed over NBC hookups twice and of writing several articles on amateur radio goes to Dot Hagerty, W6JMH (Mrs. W6JMI), whose appearance belies the oft-quoted statement that frowsiness and y.l. operators go together. Once upon a time she considered aviation the ideal hobby, but has changed her mind about that and sticks to hamming.

Who's to Blame?

No matter how loud a complaint he may make, the man in the amateur radio game is pretty much responsible for the feminine invasion. In most instances, he as brother, husband, or friend has consciously or unconsciously made radio an intriguing subject for the y.l.

For instance, Rose Reiffin, W2TU—the subject of the camera study on page 43—confesses that the reason she first took to amateur radio was to keep pace with the b.f., W2CWP, who insisted on breaking dates because of schedules with some brother ham. They are married now.

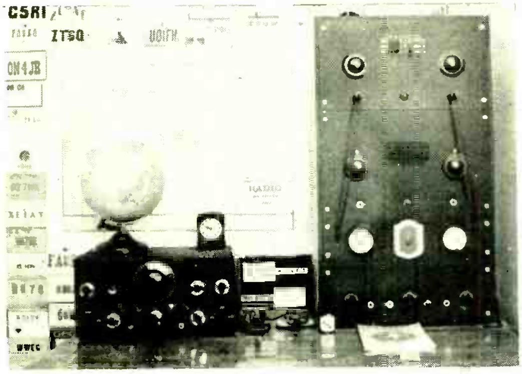
Another example of the masculine influence creeping in is that of Myrtle Long, who got her ticket in 1931 and liked her husband's call so well that she only asked for a license to operate W4KB. For the past seven years, in their home down on Choctawhatchee Bay, Valparaiso, Fla., Mr. and Mrs. W4KB have been host and hostess to several scores of hams at the annual hamfests in that district.

Mary Roth of W9TSV just couldn't help being a ham—there are four men and herself in the family with calls: VE4DF, W9RIA, W9TSV, VE4RN, and W9QBT. She was the third in the group to receive her license. Mary has no other hobbies since radio takes up most of her spare time. She has made herself quite

Helen Cook, W6MWO, is interested in the establishment in Los Angeles of a radio communications department of the Aerial Nurses Corps of America. Harriet Gilbert, W6HEG, heads the radio project in Los Angeles.

And Still . . . . .

Myrtle Long, W4KB, holds the same call as her husband. She has been a licensed operator for six years.



The receiving position at W6DOB and W6AET—Mr. and Mrs. Lloyd Jones.

Florence Jones, W6AET, likes amateur radio because she finds it both exciting and interesting.

MORE Y. L.'S

proficient in this field and managed to run away with the 1935 Illinois sweepstakes awards.

Little Mary Palmer, W5DEW, nicknamed the "dewdrop in Texas", keeps up with friend husband, W5BUZ, in radio. She is quite proud of the rotary beam antenna, better known as the "buzzard nest", which he designed for her.

Florence Jones, W6AET, admits too that her husband, W6DOB, was partially responsible for her becoming interested in radio. She's been on the air for about seven years—entirely c.w. Blonde Florence refuses to go on phone for fear that some one may accuse her of being one of the recipe-trading, knitting y.l. hams!

Occasionally, Helen Cook, W6MWO, takes time out to go golfing, but for the most part she is too busy with amateur radio to fuss much with other hobbies. She is w.a.c. on both 10- and 20-meter phone. Helen has had her ticket for about three years nows. Along with Harriet Gilbert of W6HEG, she has become interested in the establishment of a radio communication department in Los Angeles for the Aerial Nurses Corps of America.

Another W6 is Ruby Thompson, W6OJC, who plans to enter the field of commercial radio. Last year she studied various aspects of the work in school where she was the only girl in her class. In addition to hamming, she likes music; the trumpet is her pet instrument.

Mrs. Mary Tatro of W7FWR, from Athens Beach, Olympia, Wash., is one of those feminine hams who manages to find time for two hobbies: amateur radio and stamp-collecting. It's a toss-up which is her favorite, but we're betting on the former.

Jo Conklin's pet peeve is to work some fellow who says "OK, o.m." She tells him, "XYL here, not o.m." The answer is almost invariably, "OK, o.m."! W9SLG operates mostly on 40 meters. Her main hobby, outside of radio, is keeping the two-and-half-year-old son out of a power supply. Next in line is doing one thing and another at the local Methodist church in her city where her father is the preacher. After that, she enjoys taking motion pictures in color when she and friend husband, W9FM, go on trips.

One of the outstanding women on the air is Nelly Corry, G2YL, noteworthy for her activity on the 10-meter band and her serious study of radio. She was the first G to make w.a.c. on 28 Mc. (time, 6¼ hours, on Oct. 27, 1935) and has written for numerous publications. The propagation of radio waves and similar aspects of radio interest her more than does the technical side of the game. Her transmitter is a homemade four-stage crystal-controlled job which operates on 7, 14 and 28 Mc. c.w.

Nelly is one of five licensed British y.l. operators. The others are GM2IA, G6SF, G6YL, and G8LY, but at present Barbara Dunn, G6YL; Constance Hall, G8LY, and herself are the only ones active. Their numbers will probably be swelled in the near future, however, as three more y.l.'s have obtained "three-letter-call" licenses (for artificial aerial operation only), and there are half a dozen or so y.l.'s who are "British receiving station" members of the R.S.G.B.

W3CDQ and G2YL got together for a personal QSO this summer when the latter and her sister were traveling in Europe and England.

For the most part, the y.l. is perhaps not quite as rabid a hobbyist as the man. She can, for example, go to Europe and content herself with visiting only four or five hams; but the man, however, is extremely thorough about his personal QSO's. W3CDQ lived up to this contention by calling upon just a few amateurs, including G5LA, G2YL, and I1ER while abroad. The theory, however, breaks down there, for Elizabeth managed to take in as many large and worthwhile radio exhibits as she could find in Europe. In Paris there were the National Bureau of Standards radio section display and the scientific exhibits of the Germans which were highlights. In Milan, Italy, she was accompanied by I1ER at the annual fall radio show. She reports that one of the most interesting receivers at the show was a little three-valve affair, the "radio balilla", designed for the farmer in order that he could listen to agricultural hour programs. W3CDQ observes that the component parts of both the French and Italian sets are quite similar to the American brands.

Elizabeth is another who will not consider recipe-trading via the shortwave bands. But then, that is neither here nor there, anyway. There are both merits and demerits to this practice and it's not the editor's desire to start any hair-pulling over the subject. That's for the open forum department.

• Ruby Thompson, W6OJC

• Clara Reger, W8KYR

• Dorothy Hagerty, W6JMH

ON THE AIR...

• Mary Palmer, W5DEW

• Judy Leon, HC1FG

Left to right:
• Nelly Corry, G2YL
• Josephine Conklin, W9SLG

FADING. . . .

What can be done about it?

The most frequent comments on the subject of fading seem to come from phone operators, with a few occasionally from 28 Mc. code men. Like the weather, it is often a subject of conversation, with very little being done about it.

There are, however, a number of possibilities whereby fading can be reduced or eliminated. These, mainly, can be divided into those things which are done to the receiver, to the transmitting antenna, or to the receiving antenna. Everyone is familiar with the improvement that can often be obtained with automatic volume control on a phone signal, particularly on lower frequencies where the fading is usually general rather than selective as to frequency. This method involves holding the voice level constant, permitting the background noise to rise and fall, rather than to allow the voice intensity to fade up and down, with the gain and the background noise held constant. The method is not widely used on code where keying changes the average signal input to the receiver. It works reasonably well where the fading is not selective and where the swings are within the range of the a.v.c. action. But it is far from the last word in eliminating fading, particularly on the high frequencies.

In order quickly to dispose of methods which are of limited interest to amateurs, we might mention the subject of "diversity reception." This makes use of the fact that two antennas spaced about 2 wavelengths or more, whether broadside to or in line with the transmitting station, will receive the signal with fading that is substantially independent in each antenna. In commercial practice, three antennas are often used, each feeding a receiver. The relative signal level automatically switches the output circuit to the receiver enjoying the highest signal level. Because all three antennas are seldomly picking up the signal in the depth of a fade, usually one part of the system delivers a useful signal. A.v.c. operating on this system eliminates some additional variation.

We had the pleasure of seeing an amateur installation of this type, employing two receiving channels, in use at XE1G. A system similar to this could probably be reproduced now for little more than the cost of two receivers, not counting the labor of the builder. This diversity receiver at the time was using two horizontal antennas at right angles to each other, giving half-scale readings on the R-meter of one channel and a very low reading on the other, so the usefulness was considerably reduced from the theoretical maximum. Where space is not available to erect two receiving antennas spaced two wavelengths or more, one antenna may be made vertical and the other horizontal if ignition noises are not troublesome on a vertically polarized antenna.

Let us now consider other fading effects and methods of attacking the problems presented.

The Fading Wall

Where transmission is intended mainly for the area within a hundred miles or so from the transmitter, such as may be true on the lower frequency bands and on the normal broadcast frequencies, the useful working range is limited to the distance where bad fading is encountered. The antenna radiates at low angles and puts a "ground wave" signal directly into the receiver without a reflection from the ionosphere. Higher-angle radiation may also come down out of phase, or with shifting phase due to variations in the reflected path length, causing partial or complete cancellation of the "ground wave" at the receiver. This effect is shown in figure 1 where the curve OAB represents the relative field strength radiated at various angles in a vertical plane from an antenna O. Line OA represents the strength effective in a direction that is reflected by the ionosphere at point C and received at point P. OB represents the strength of the "ground wave" as received at point P.

The cure for the fading at P, obviously, is to eliminate one of the two possible paths, OACP or OBP, whereby the signal can be received. In broadcast practice, a concentration of radiation in a horizontal plane (OB) is used because this is readily obtainable to a degree, and nearby reception via the ionosphere path OACP is rare anyway. The current distribution on the vertical antenna is corrected so that the pattern more nearly approaches that of figure 2, in which the strength along OA is considerably reduced compared with OB. This treatment is only necessary where the power is high enough to produce a ground wave of useful strength extending to the point where the reflected path is received.

In amateur practice, horizontal antennas are generally used on the lower frequencies where this type of fading occurs, reducing the strength of the ground wave and likewise eliminating one path, even though the width of a skip distance zone, if one is present, is thus increased. The signal strength at nearby points is likewise reduced, often a beneficial effect in heavily populated sections when it is desired to work beyond the ground wave.

High Frequency Fading

On our higher frequency bands, fading is generally more rapid, and often selective as to frequency rather than general. Again this is due to interference between components of the signal following paths with different transmission times, but both paths are generally through the ionosphere. When these paths are due to radiation leaving the transmitting antenna at widely different angles, a change in the directive pattern in the vertical plane might be accomplished at the transmitting antenna to reduce the fading. This would be possible by the use of sharper vertical directivity such as results from the use of the V or the rhombic (diamond) antennas if horizontal directivity is also desired, or some method of holding down the vertical angle without appreciable horizontal directivity. The Kraus Flat-Top Beam[1] arrangement may be used (end-fire in the horizontal plane) with some improvement. Vertical stacking has also been used. These methods can give an actual gain as well as a reduction in fading. One station, W9SYD, has had particularly good results with stacked horizontal antennas. A general improvement of one R point is reported over any non-directional antenna used, and foreign phones now reply to CQ's though they are hard to raise on 20-meter phone with any other antenna. The change in pattern caused by stacking vertical antennas is roughly seen by comparing figures 1 and 2 while the result of stacking for a horizontal antenna one wavelength high was shown in the articles on the subject by E. H. Conklin in RADIO for May, 1937[2].

Improved Receiving Antennas

What is perhaps the most successful single method so far devised to reduce fading is one which may not appear to have a direct application for the average amateur, but an amateur version is nevertheless possible. We refer to "Directivity Steering" as suggested by Mr. E.

[1]"A Small but Effective 'Flat-Top' Beam," John D. Kraus, W8JK, RADIO, March, 1937.
"By Popular Demand," John D. Kraus, W8JK, RADIO, June, 1937.
[2]"Antenna Gain without Horizontal Directivity," E. H. Conklin, W9FM, RADIO, May, 1937.

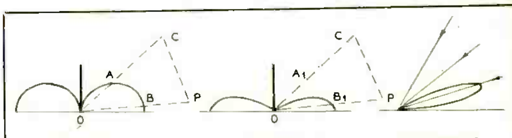


FIGURE 1 FIGURE 2 FIGURE 3

Bruce of Bell Telephone Laboratories, consideration of which may prove helpful to us[3].

In "general" fading there may or may not be appreciable angular separation between the multiple interfering waves at the point of reception. It has been determined that with selective fading, a material path length difference, with little question, must exist. If some method is devised whereby the antenna will receive waves from only one angle, fading will be considerably reduced. If this one angle should involve receiving one of the stronger waves, then the volume might be satisfactory.

Sharp, variable directivity itself may be difficult to obtain. However, a moderately sharp characteristic can be obtained if the vertical pattern of the proposed antenna has a steep edge and thereby discriminates against reception from some angles. This idea is pictured in figure 3.

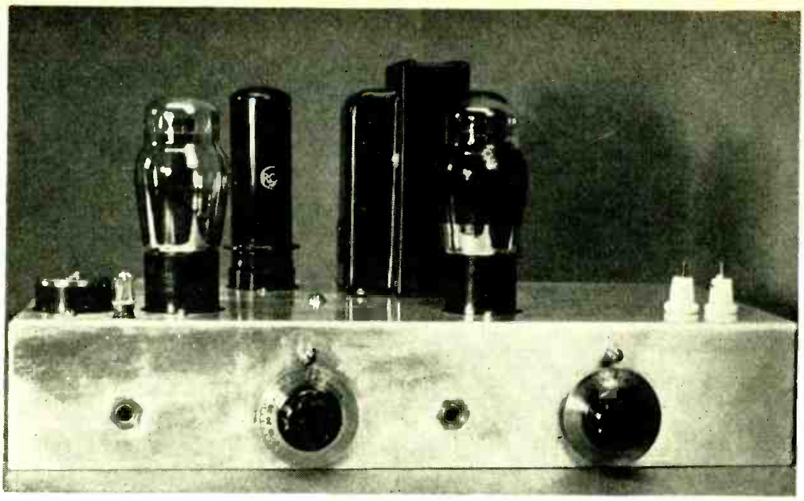
It is found that a discrimination of 10 db against one of two interfering adjacent waves will make improbable a fade deeper than 5.7 db from their sum. This is a relatively unimportant fade for ordinary speech transmission in the absence of strong interference.

When the received strength is low, the edge of the diagram in figure 3 should be advanced until a large amplitude wave is encountered. The system should not have minor lobes of appreciable size.

For his tests, Mr. Bruce used a rhombic antenna arranged so that the far end could be "pulled out", expanding the axis of the diamond in the direction of the transmitting station. This required only a relatively small change to alter the angle at which the steep upper edge of the pattern will just intercept a reasonably strong wave. With this antenna, a number of observations indicated that 51% of the measurements show no reduction in fading from a comparison antenna, but in 35% there was practically no fading present. However,

[Continued on Page 159]

[3]"Directivity Steering," E. Bruce and A. C. Beck, *Bell System Technical Journal*, April, 1935. The material which follows is discussed more fully in this reference.



● Front view of the transmitter—a 56 Mc. crystal-control job simplified with a 28 Mc. crystal.

COMPACT CRYSTAL CONTROL

on the ultra-high frequencies

By FAUST R. GONSETT,* W6VR

With the coming of the new regulations concerning the allocation of the ultra-high frequencies, frequency-stability requirements on the 56-Mc. band will be greatly increased. On one side of the band there will be two television channels (the low frequency side) while on the other end there will be government assignments. It will be a much more serious offense for off-frequency operation, either of the carrier or of the sidebands of a modulated-oscillator transmitter, when the interference is actually bothering some government service.

Sooner or later, preferably sooner, some means of frequency stabilization will be required for operation on 56 Mc. as well as on the lower frequencies. Until recently, crystal control on this frequency has necessitated the use of a large number of buffer and doubler stages to multiply and amplify the low-frequency output of the crystal. Recently, with the introduction of high-frequency crystals, this problem has been greatly simplified.

These crystals operate in a somewhat different manner than conventional crystals. They are known as harmonically-operated units. In other words, they are operated on odd harmonics of the crystal's fundamental-frequency output. Due to some peculiarity, the output frequency is not an exact multiple of the fundamental of the crystal.

The harmonics most commonly used are the third and the fifth. Thus, the fundamental of the 28-Mc. crystal used in the transmitter to be described is *about* 9300 kc., and it is operated on the third harmonic. (The crystal is of course marked with its 28-Mc. frequency.) A good crystal of this type may often be operated at as high a harmonic as the eleventh or the thirteenth. This allows quite high frequency operation to be obtained from a low-frequency crystal without the use of many stages of frequency multiplication. The power output, however, on these high harmonics is quite small and the r.f. crystal current is apt to be quite high. For these reasons it is advisable not to try to operate the crystal oscillator with too

*Laboratorian, RADIO.

much plate voltage. In the unit to be described, the oscillator is run at a plate voltage of about 200.

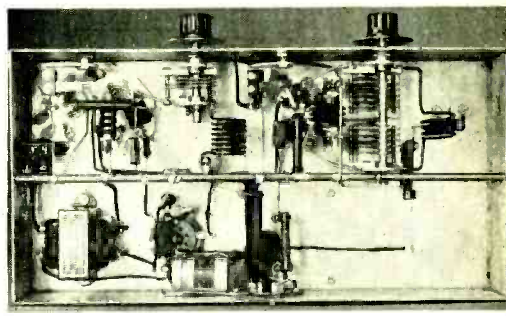
Construction

This transmitter is constructed in about as simple a manner as is possible. It is mounted upon a 7" by 14" metal chassis. If desired, to make portable operation more simple and convenient, a metal cabinet could be procured in which to mount the unit. A number of manufacturers make small metal cabinets that would be suitable for the purpose.

The tank condensers and inductances are mounted below chassis. The shafts of the two tuning condensers are brought out through the front drop of the chassis. The two small standoffs just to the right of the second 6A6 are the output leads of the rig. They are coupled by means of a link to the plate tank of the final amplifier and, by varying the number of turns, this arrangement may be used to couple to almost any type of antenna-feed system.

To the rear of the chassis are mounted the 6L6 modulator and the modulation choke. The choke illustrated is rather husky and is really more than ample for the job. If desired, especially for portable use, the size of this choke could be decreased materially.

No pre-amplifier stages for the speech amplifier were included since, for most uses, a good quality, high output single-button microphone will give ample drive for the 6L6. These microphones are capable of giving quite respectable quality and excellent intelligibility. However, if better voice quality and greater mike sensitivity are desired, it would be advisable to include one very high-gain stage or two medium-gain stages of speech amplification ahead of the 6L6. For all practical purposes, however, the 6L6 modulator can be driven to ample output by a good close-talking single-button microphone.

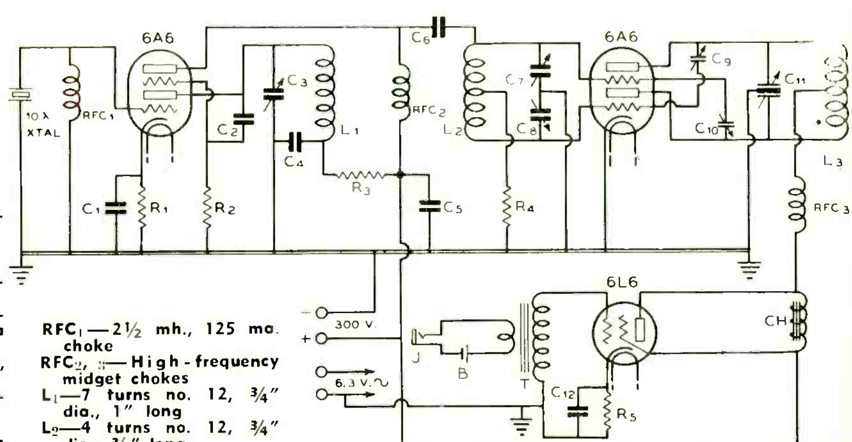


Under Chassis View, Showing Layout of Parts

Power Supply

No power supply was included on this chassis since it would detract from the versatility of the unit. For home-station operation a good b.c.l.-type power supply capable of delivering 350 volts at about 125 ma. will be ample. It can be built upon a small, separate chassis with a cable and connector to simplify connection to the transmitter.

For portable operation, almost any type of supply will work, the power capabilities of the supply determining the power output of the



SCHEMATIC FOR 5-METER RIG

C_1—.005 μfd. mica
C_2—.0001 μfd. mica
C_3—35 μμfd. midget variable
C_4, C_5—.005 μfd. mica
C_6—.00005 μfd. mica
C_7, C_8—3-30 μμfd. isolantite trimmers
C_9, C_{10}—3-30 μμfd. isolantite trimmers, mica removed
C_{11}—35 μμfd. per section, split-stator
C_{12}—10 μfd. 50-volt electrolytic
R_1—500 ohms, 5 watts
R_2—100,000 ohms, 1 watt
R_3—10,000 ohms, 5 watts
R_4—5000 ohms, 3 watts
R_5—250 ohms, 10 watts
RFC_1—2½ mh., 125 ma. choke
RFC_2, 3—High-frequency midget chokes
L_1—7 turns no. 12, ¾" dia., 1" long
L_2—4 turns no. 12, ¾" dia., ¾" long
L_3—4 turns no. 12, 1" dia., 1" long
CH—20 hy., 150 ma. choke
T—Midget mike-to-grid transformer
J—Mike jack
B—4.5 volt C battery

rig. The best type of a supply would be one of the 300-volt 100-ma. dynamotors now on the market. With one of these supplies, or with a good b.c.l. power pack, the rig will have an output of 3 to 5 watts at 56 Mc.; ample for all ordinary (and, since crystal controlled, for a good many out-of-the-ordinary) contacts.

With a lower-powered dynamotor or with one of the small vibrator supplies, the power output will be reduced. Still, the better locations available for portable operation will, in most cases, more than make up for the lowered power output.

Electrical Design

A 6A6 tube is used as a combined crystal oscillator and frequency multiplier. With one of the new ten-meter crystals, 56 Mc. power is available at the output of the second section of the 6A6. The plate voltage is dropped so that it will not exceed 200 volts or so on the oscillator section of the tube. The doubler section is operated at full power-supply output voltage.

The method of coupling the output of the 6A6 to the grid circuit of the final amplifier is of interest. Capacity coupling is used from the second plate of this tube to the push-pull grid circuit of the second tube. Instead of using a split-stator condenser to tune these grids, two of the midget "MEX-type", isolantite-insulated, screw driver-adjusted trimmer condensers are used to tune the circuit. Keeping the two condensers at approximately the same capacity, the grid circuit is resonated by turning both condensers at the same time (by a neutralizing screwdriver).

To keep the grid circuit more electrically symmetrical, the trimmer condenser across the side of the circuit that is loaded by the 6A6 plate-to-ground capacity should not be turned as far in as the one across the other side of the circuit. In this way it is possible to compensate for the loading capacity of the 6A6 tube's plate circuit.

Neutralization

The 6A6 in the final stage is neutralized by two more of the same type trimmer condensers, also with the mica removed. The amplifier is neutralized in the conventional manner; by removing the plate voltage and tuning the neutralizing condensers until there is no reaction between the input and output tank circuits of the stage.

Care must of course be taken in the use of these "mica-less" trimmer condensers that the two plates do not touch. If the possibility that they *can* touch is kept in mind during the tuning process, it will be much easier to keep them separated.

Tuning Up

The crystal oscillator can best be tuned by placing a small pickup lamp in the field of the plate circuit of the first section of the oscillator-doubler 6A6. The tank condenser for the oscillator is then tuned approximately to maximum output.

The plate circuit of the doubler section (which is, of course, also the grid circuit of the final stage) is resonated also by a pickup lamp, the two condensers being tuned as discussed under *Electrical Design*. The balance of the process is conventional.

The 6A6 amplifier should be loaded up to about 40 ma. for normal operation at 300-350 plate volts. For lower plate voltages, the current should be proportionately lower.

For portable operation, especially at lowered plate voltages, it will be advantageous to substitute a 6V6G for the 6L6. The lower filament and plate drain of the 6V6G will allow the unit to operate for a longer period before the storage battery begins its demise.

•

Angle of Radiation vs. Angle of Reception

There has been a feeling among amateurs that the vertical angle of reception of a signal differs from the angle of transmission above the horizontal. On this point, the National Bureau of Standards, in commenting on radio wave phenomena, had this to say:

"It is possible to have some asymmetry of the ray path of transmission by way of the ionosphere but it is difficult to think of cases where this would be very important. We see no reason for using a receiving antenna with directivity in the vertical plane different from that of the transmitting antenna when used for two-way communication over the same path."

•

Current simile—As monotonous as a police radio announcement.

•

Poet's Lament — There is no English word which rhymes with radio.

•

Recently heard on the twenty-meter band, "There is getting to be so much QRM that nobody gets on any more."

Dynamic Symmetry Applied to

PANEL AND CHASSIS LAYOUTS

An expert in the field of designing commercial radio equipment describes how, by following a few simple rules, the amateur can make his receivers and transmitters attractive in appearance.

By R. A. ISBERG*

Dynamic symmetry is the science of proper relationships of the areas making up a design. It is the type of symmetry found in nature and it comes from an old Greek term which means *commensurable in power.* It was used to describe the relationships between the sides and ends of dynamic rectangles. Dynamic rectangles are made up of lines which bear a root relationship to each other.

The principles of dynamic symmetry were known to the Egyptians as early as 5000 B.C., but they applied the principles only in their buildings. The Greeks elaborated on the Egyptian art and discovered that definite dynamic ratios exist in the bodies of humans, animals, and plants. They developed and applied this knowledge extensively in their statuary, buildings, jewelry, etc., and produced the most perfect examples of classic art known to civilization. This perfection of form and design was lost when the Romans conquered the Greeks in the second century B.C. The Romans interpreted the Greek art as being based on relationships of lengths rather than areas and they developed a "modulus" which they used in planning their creations. Thus the Roman art, and the art of the civilizations to follow until the present day, was based on static symmetry and lacked the vitality and realism peculiar to the Greek art.

For many centuries archeologists and historians tried to re-discover the secret of the Greek artists. It was only twenty years ago that Mr. Jay Hambidge, an art professor at Yale University, announced that the beauty of ancient Greek art was due to the application of simple geometrical formulae rather than to "born artists". His theories have been proven conclusively and are now generally accepted and practiced.

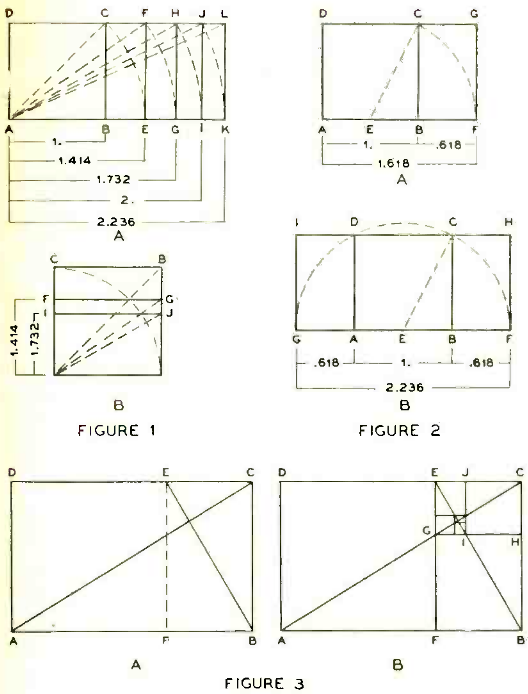
This article can only be a synopsis of this fascinating subject and is largely a review of publications, a complete bibliography of which is included. It will be of interest to those who design apparatus which must present a finished appearance. What little knowledge I have gained of the subject has been invaluable to me in panel layouts and cabinet design. It gives me a feeling of security when I begin a design to know that it will look right when it is finished. I am a sincere believer in the axiom that "function should dictate design", but I have yet to see a piece of apparatus that could not be improved by proper proportioning of areas and an orderly arrangement of components.

Probably the most useful and necessary application of dynamic symmetry to radio is in the design of cabinets and escutcheons for broadcast receivers. It would be advantageous for the engineer to understand the elements of dynamic symmetry in order that the fundamental and basic layout work could be completed before the design is turned over to the artist or cabinet designer.

A little knowledge of dynamic symmetry should be very helpful to the amateur who builds his own regalia, particularly if he is the type of "ham" who wants classy, commercial looking equipment that will be untiring to look at and a pleasure to show his friends.

All that is necessary to understand dynamic symmetry is a little elementary geometry and enough patience to draw some simple diagrams. A thorough knowledge of the elementary dynamic shapes is essential. Above all things do

*KOA, National Broadcasting Co., Denver, Colo.



Illustrating the Derivation of Root Rectangles and Whirling Squares (1.618 Rectangle).

not get the idea that it is complicated and too difficult to be worth while. The most difficult part of the mastery of the subject is to remember that one is dealing with relationships of *areas* rather than lengths; hence, one must learn to think geometrically rather than arithmetically.

While it is true that the 1.618 rectangle and the root 5 rectangle are preferred shapes, one is not by any means restricted to their use alone. In fact, many critics of dynamic symmetry have raised the objection that it is *too* flexible, because there are an infinite number of shapes that can be systematically subdivided into commensurable unit areas.

Root Rectangles

The fundamental dynamic shapes are simple to construct from a square. The square and its diagonal furnish the series of root rectangles. Figures 1A and 1B illustrate two methods of their construction. In figure 1A the square ABCD is assumed to have a side of unity. With the diagonal AC as a radius and using A as a center, describe the arc CE, extend AB and DC. Draw EF perpendicular to AE. AEFD is known as a root two rectangle because one side is equal to $\sqrt{2} = 1.414$. Then with AF as radius and A as center, describe the arc FG. Draw GH perpendicular to AG and the result is a root three rectangle because one side is equal to $\sqrt{3} = 1.732$.

The root-four and root-five rectangles are similarly constructed and the process could be carried out to infinity but for all practical purposes no rectangle beyond root five need be considered. The root-five rectangle and its divisions are the shapes most prevalent in nature.

In figure 1B, the same result is obtained in a different manner. Given the square ABCD, and using A as center and AC as radius, describe the arc CD. Draw diagonal AB, draw FG through E parallel to CB. Then ADGF is a root two rectangle within the square ABCD. Draw diagonal AG and the line IJ through the point H. ADJI is a root three rectangle within the square ABCD and so on.

"Whirling Squares"

The next fundamental shape that should be considered is the rectangle of the whirling squares. This rectangle furnishes the basis for the remarkable shapes found in plants and human figures.

In figure 2A, given the square ABCD, bisect AB at E and draw CE. Using E as center describe arc CF. Extend AB and DC. Draw FG perpendicular to AF. This rectangle AFGD is known as the rectangle of whirling squares or the 1.618 rectangle.

The next rectangle, and one of the most important, may be constructed in the same manner as the rectangle of the whirling squares. Draw a square ABCD as in figure 2B and bisect one side as at E. Using EC as a radius, describe the arc FCDG. Extend AB to F and G and draw FH and GI perpendicular to FG at the points F and G respectively. Extend CD to H and I. The result is a root five rectangle because the ratio of end to side is $1:\sqrt{5}$ or 1:2.236, hence it is known as a 2.236 rectangle and it contains 2.236 units of area.. It is evident from the diagram that the 2.236 rectangle is made up of a square plus two .618 rectangles; or a 1.618 rectangle plus a .618 rectangle.

The next construction is interesting not only because it explains how to construct a rectangle whose area is the reciprocal of the parent rectangle, but also how the "1.618 rectangle" became known as the rectangle of "whirling squares".

Figure 3A illustrates a 1.618 rectangle, ABCD; draw diagonal AC, then draw EB perpendicular to AC. Draw EF parallel to BC. The area of the rectangle EFBC is the reciprocal of the rectangle ABCD and is equal to $1/1.618 = .618$. This construction, of course, may be used for any rectangle to obtain its reciprocal.

It is apparent that ABCD was divided into a square and the reciprocal which is also a whirling square or 1.618 rectangle (the ratio of the side EC to CB is 1:1.618 even though the area is .618). Continued division of the reciprocals of the 1.618 rectangle will result in more squares and 1.618 rectangles even if carried to infinity.

Figure 3B is a reproduction of figure 3A with some of the continued reciprocals. The diagonals AC and EB enable us to readily draw these reciprocals. The diagonal AC intersects the line EF at G. Draw GH parallel to EC. The area EGHC is the reciprocal of the area EFBC and area EGIJ is the reciprocal of the area EGHC, etc. The numbered areas 1, 2, 3, 4, etc., are all squares. Thus the 1.618 rectangle is known as the rectangle of whirling squares because its reciprocals cut off squares arranged in a spiral whirling to infinity around a point. This spiral is very common in nature and is found in leaf and seed arrangement and in the shape of sea shells.

Another interesting feature of the 1.618 ratio is that it is derived from the *Fibonacci series*, which is a geometrical progression of the following numbers: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, etc. The series is derived by making each term equal to the sum of the preceding two terms. This series is true only as far as is representable in whole numbers. A much more accurate series is obtained with the following numbers: 118, 191, 309, 500, 809, 1309, 2118, 3427, etc. One term of this series divided into the next equals 1.618, which is the ratio underlying phyllotaxis in plant design and which has been referred to as the "Golden Mean" or the "Golden Section". The series is also interesting because each term is a dynamic ratio and is found abundantly in nature and ancient Greek art.

The following list of side to end ratios of dynamic rectangles will be useful for reference. The most important ratios are indicated by an asterisk.

An infinite number of shapes that can be systematically subdivided can be obtained from these ratios by simply adding or subtracting 1

SIDE TO END RATIOS OF DYNAMIC RECTANGLE

Ratio	Reciprocal	½ Ratio	½ Reciprocal
1.	1.	.5	.5
1.118	.8944	.559	.4472
1.1545	.8661	.5772	.433
1.191	.8396	.5955	.4198
1.2236	.817	.6118	.4085
1.236*	.809	.618	.4045
1.309*	.764	.6545	.382
1.382	.7236	.691	.3618
1.4045	.712	.702	.356
1.414*	.707	.707	.3535
1.4472*	.691	.7236	.3455
1.472	.679	.736	.3395
1.528*	.654	.764	.327
1.545*	.6472	.772	.3236
1.618*	.618	.809	.309
1.7135	.584	.856	.292
1.809*	.5528	.9045	.2764
1.854	.5393	.927	.2696
2.236*	.4472	1.118	.2236
2.309*	.433	1.1545	.216
2.4472*	.408	1.2236	.204
2.472*	.4045	1.236	.202
2.618*	.382	1.309	.191
2.764	.3618	1.382	.1809
2.809*	.3559	1.4045	.1779
2.8944	.3455	1.4472	.1727
3.236*	.309	1.618	.1545
3.427	.2918	1.7135	.146
3.618*	.2764	1.809	.1382

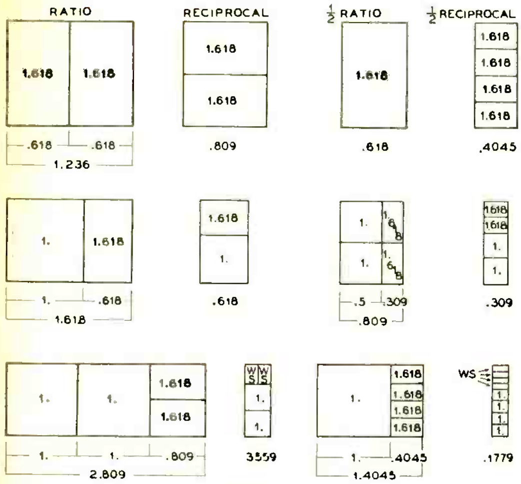
(a square), or adding or subtracting the reciprocal of the ratio, or half of the ratio. The possible ratios obtainable are too numerous to list and the more advanced student of dynamic symmetry can readily adapt them to his problems.

In figure 4 are a number of dynamic shapes and their reciprocals. Careful study of these examples and the list of ratios will be helpful when you are ready to apply dynamic symmetry to your own needs.

"Dynamic" Radio Cabinets

The following table gives the dimensions and dynamic ratios of a few of the cabinets available at radio supply houses. Those which are recommended as good dynamic shapes are indicated with an asterisk.

Height x Width x Depth	Dynamic Ratio of Panel (Side divided by End)	Nearest Correct Dynamic Ratio
60 x 19 x 13	3.16	3.236*
37 x 19 x 13	1.95	1.854
35 x 19 x 13	1.842*	1.854
26¼ x 19 x 13	1.383*	1.382
17½ x 19 x 13	1.086	1.118
10½ x 19 x 13	1.809**	1.809
8¾ x 19 x 13	2.17	2.309*
12 x 18 x 11	1.5*	1.5
9 x 15 x 11	1.668*	1.618*
8 x 16 x 8	2.00*	2.00
7 x 14 x 7½	2.00*	2.00
7 x 12 x 7¼	1.714*	1.7135
7 x 10 x 6	1.43*	1.4472*
7 x 7½ x 7½	1.07	1.118



Careful Study of These Dynamic Shapes and Their Reciprocals is Helpful in Applying Dynamic Symmetry to Panel Layout.

A Dynamically Symmetrical Receiver

There are two methods of approach to any design problem. In one we have a general outline of the problem, and we work inwardly locating and sizing the interior parts. This method is known as the *convergent* method and is the one followed by the amateur or engineer who must build his apparatus for a particular panel or cabinet. The other method, known as the *divergent* method, requires that the plan center around a certain part or requirement and work outwardly. This method may be used if a panel or cabinet is to be designed for a specific need.

An illustration of the divergent method is shown in figure 5, the design of a panel for a receiver. A rectangle enclosing the extremities of a National type N dial is used as the basic shape in this layout. The over all dimensions of the dial are 4.0625"x4.9375". A rectangle having these dimensions will have a side-to-end ratio of 1.215. This ratio is a poor one because it cannot be easily divided or expanded. Further inspection of the dial reveals that the center divides the rectangle formed by the outline of the dial into two smaller rectangles as shown in figure 5A. The top rectangle 4.0625"x 2.5" has the ratio 1.623 and the bottom rectangle 4.0625"x2.4375" has the ratio 1.668. These ratios likewise form poor dynamic shapes but they differ only a small amount from the basic dynamic ratio 1.618. The thing to do is to cheat a little by making a new basic rectangle using dynamic ratios and dimensions which will enclose the dial. This may be done by multiplying 2.5" (center to top dimension of dial) by 1.618. The answer 4.045" is the new width of the rectangle enclosing the dial. The error introduced is .0175" (1/64+) and may be neglected. By making the other small rectangle the same size, another small error of 1/16" is introduced but it is in the opposite direction.

The new basic rectangle, figure 5B, is made up of two 1.618 rectangles and has the ratio 1.236 and its dimensions are 4.045"x5.0". The small error introduced by the modification will not be detectable in the design. A slide rule will be very helpful in making modifications of this type or in figuring ratios. The index is set on the desired ratio, and the side and end dimensions appear under the hair-line indicator.

The next requirement is that the chassis be approximately 3" high to accommodate the plug-in coils (coils plug in front of panel). By dividing 4.045" by 1.236 we obtain the dimension 3.27" as the height of the rectangle bounding the space below the dial. We could have used any other ratio that is related to 1.618, such as 1.309, 1.414, 1.472, 1.809, etc., but the 1.236 ratio satisfies the requirement that the space for plug-in coils be approximately 3" high.

The areas at either side of the dial are dependent upon the space requirements of the controls which will be mounted in these areas. The actual controls, or pieces of paper cut to represent them, may be used in these determinations. The placement of controls should be governed by wiring and mechanical construction. The chassis and panel layouts should be considered simultaneously because they influence each other. One is utilitarian and the other artistic.

The controls to be mounted on the panel are (1) first detector trimmer, (2) oscillator trimmer, (3) first detector regeneration, (4) i.f. regeneration, (5) a.f. gain, (6) r.f. gain, (7) beat frequency oscillator switch and (8) a stand-by switch in the negative lead of the high voltage supply. The a.c. switch is mounted on the r.f. gain control.

The trimmers are located above the chassis and on either side of the dial in order to permit short leads to the tuning gang. The other controls were arbitrarily located, as in figure 5C, with sole regard to short leads and convenience in operation.

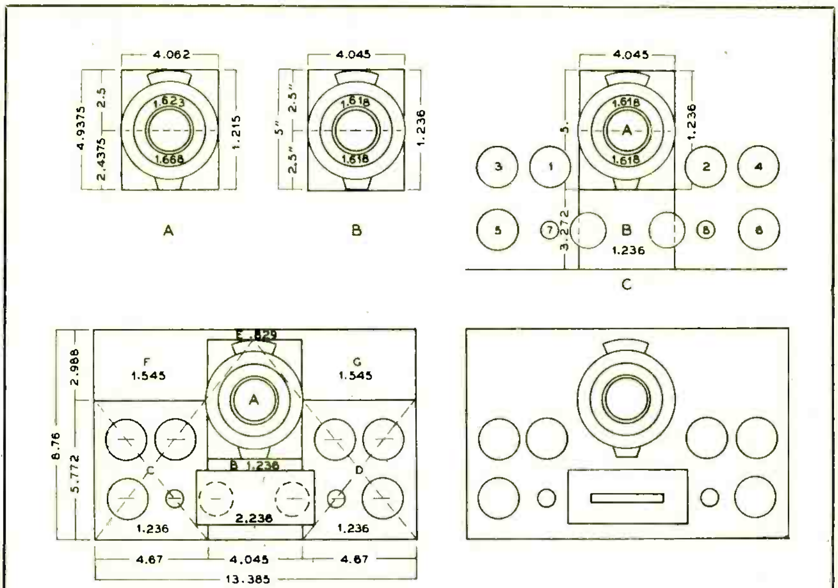


FIGURE 5

An examination of figure 5C reveals that the controls on either side of the dial can be enclosed in a rectangle, one side of which is made up of 3.272″ plus 2.5″. A rough measurement indicates that approximately 4.5″ is required for the other side of the rectangle. The ratio 1.236 divided into 5.772″ gives 4.67″, the correct width of the rectangle.

Diagonals are drawn in the rectangles C and D, as in figure 5D. One-half of the height of rectangle B (1.636″) measured from the top and bottom of rectangles C and D establishes the centers of the controls. Thus the centers of the controls form the corners of similar rectangles inscribed within C and D.

The location of the two plug-in coils in rectangle B is governed solely by mechanical and electrical considerations. The coil forms are 1¼″ in diameter and are spaced 3⅜″ between centers. The distance between the two coils, 2¼″, allows about 1/32″ between the windings and the baffle shield between them. This distance is about the minimum that should be used without a loss of efficiency due to a reduction in Q.

In order to facilitate changing of coils and also to carry out the design scheme, a cover plate is used. The dimensions of this plate are 5″x2.239″, forming a 2.236 rectangle.

Counter-sunk screws through the cover plate into wooden plugs fastened into the ends of the coils afford a good mounting for the coils. A small chromium plated drawer pull available at any hardware store sets off the panel and makes coil changing easy.

Only one dimension, the height of the panel, remains to be decided upon. This is governed by the distance from the top of the dial to the edge of the panel. An arbitrary value of one-half inch was added to 8.272″. The length of the panel, 13.385″, divided by 8.772″ gives the ratio 1.525. The nearest correct ratio, 1.528, was then divided into 13.385″ to obtain 8.76″, the correct height of the panel. The areas F and G are 1.545 rectangles and the area E is an 8.29 rectangle which can be subdivided into six 1.382 rectangles. Thus the panel is made up of a number of rectangles which bear a dynamic relationship to each other and to the panel as a whole. This gives the panel coherence and correctness which cannot be obtained by an unorganized arrangement of components.

The Convergent Method of Design

The convergent method is in some cases a little more difficult to apply because one has to find components which will harmonize with the dynamic ratio of the whole. However, this is usually not very difficult because such things as dials, meters, etc., are available in quite a variety of sizes and shapes and ordinarily are contained within the boundary lines of a square.

Application for Transmitter Construction

An example of the convergent method is shown in figure 6, in the design of the panels of a transmitter. The plan calls for an 807 oscillator, 807 doubler, and two 801's in push pull in the final modulated by push pull 6L6's. Meters are to be provided for measuring oscillator, buffer, amplifier and modulator plate current; grid current in the r.f. stages; and percentage of modulation. The oscillator plate, buffer plate, amplifier grid and amplifier plate tuning condensers will be mounted on the panel. The antenna is to be fed by a low impedance line, hence no antenna-tuning condensers or meters will be necessary at the transmitter. Two tap switches, one for selecting crystals and the other for connecting the grid meter in the grid return leads of the r.f. stages, a 60 ma. pilot light bulb to indicate crystal current, and a switch to open the plate circuit of the 801's are to be included on the r.f. panel. If space permits, a tuning card showing the dial settings for the various frequencies is also to be provided.

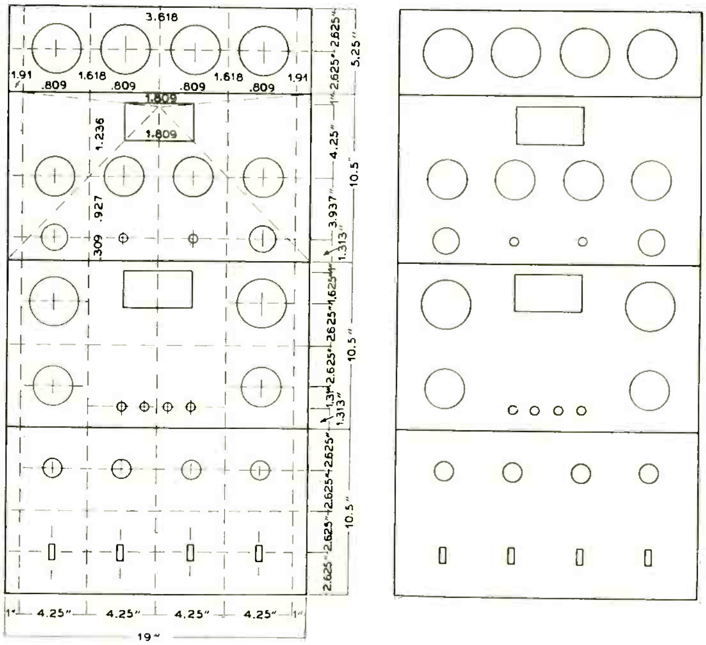


FIGURE 6

The audio amplifier and modulator unit will incorporate degeneration and a filter which will pass only the voice frequencies (300-3000 cycles). Two tapped controls, one for degeneration and the other for amplifier gain, a switch to short the secondary of the class-B output transformer when using c.w., and a switch for cutting out the filter are to be mounted on the panel. The purpose of the filter is to limit the side-bands and to achieve a greater percentage of useful modulation in the voice range. A low-range milliammeter used to measure percentage of modulation and two monitoring jacks, one for listening to the output of the audio amplifier and the other for checking the quality of the rectified carrier, complete the panel requirements for the modulator.

The two power supplies are to be mounted on one chassis. The panel must accommodate four switches and four pilot lights. The switches are to be the large tumbler type and will control the following power supplies; r.f. filament, r.f. plate, audio filament and audio plate.

The proposed transmitter is to be housed in a steel cabinet with the components mounted on standard relay rack panels. The choice of a desirable panel size is the first consideration in a convergent dynamic design. A good standard relay rack panel size is 10½"x19"—a 1.809 ratio. This panel is large enough for the r.f. unit, modulator, or the power supplies of the proposed transmitter. The standard meter panel, 5¼"x19", is a 3.618 ratio, which is two times the ratio 1.809. Three 10½"x19" panels and one 5¼"x19" panel require a relay rack or steel cabinet 19"x37"—a 1.9472 ratio. This ratio is not a vital one but it is at least dynamic.

A large sheet of wrapping paper or bristol board is useful in making the initial layout.

The first consideration is to get a rough idea of where the dials and meters are to be placed. The next step is a divide systematically the panels into suitable areas which will accommodate them.

Figure 6A shows the essential layout and sets up the requirements for the individual panels. The meter panel at the top is to have four 3¼" meters. This necessitates that the panel be divided into four equal areas and two smaller areas. Dividing the 5¼"x19" panel (3.618 rectangle) in the middle, we obtain two 1.809 rectangles having the dimensions 5¼"x 9½". Each 1.809 rectangle less one 1.618 rectangle, 5¼"x8½", leaves one .191 rectangle, 5¼"x1", at either end as a margin. This margin is sufficient for all the components to clear rhe sides of the cabinet or the I-beams of a relay rack. An interesting and helpful point about how the .191 ratio is derived from 5¼"x1" dimensions is that in dividing ratios, *always divide the same way*, i.e., height into width, or the results will be rather exasperating.

The two 1.618 rectangles are divided into four .809 rectangles having the dimensions 4¼"x5¼". The meters will be mounted in these areas.

The dividing lines of the .809 rectangles extended down the diagram divide the succeeding panels into dynamic rectangles. The 10½" panels, divided by horizontal lines through their centers, form a number of dynamic rectangles equal in area and ratio to the rectangles of the meter panel.

The mechanical layout of the r.f. unit requires that the tuning condensers be mounted at about the center of the panel. They are placed on the horizontal center line, in line with the centers of the meters.

The locations of the tap switches, pilot light, and final amplifier plate switch are roughly determined by the arrangement of parts under the chassis. About 1⅛" is the minimum distance permissible between the centers of the tap switches and the bottom edge of the panel. The .809 rectangle must be divided at a suitable point to locate the correct centers of the controls. This is easier if we consider its reciprocal, 1.236, because our division will be made on the long side of the rectangle. It is clear that the 1.236 rectangle is composed of a square plus a .236 rectangle. Since the square would be 4¼"x4¼" and the rectangles 4¼"x5¼" the .236 rectangle would be only one inch high. This height is insufficient, so after examining the table of dynamic ratios, we decide to try the ratio .309. This ratio, .309, multiplied by 4.25" gives us 1.313" as the distance from the edge of the panel to the center of the controls.

The best shape and size of a tuning card and its location is the last problem on the r.f. panel. The length of the tuning card frame is made 4¼" because that is the distance between the centers of the dials and meters. The upper edge of the tuning card was tentatively placed 1" below the upper edge of the r.f. panel and centered at this position. A simple geometric method of drawing a similar rectangle within a rectangle is used here for purpose of illustration because it will work in any rectangle, dynamic or static. Diagonals are drawn from the two upper corners of the r.f. panel through the upper corners of the tuning card frame intersecting the center line at A. Diagonals are drawn from the two bottom corners of the rectangle to the intersection A. A line drawn through the intersections of the lower diagonals and the sides of the rectangle is the proper location for the base of the tuning card frame. Of course, in this case it would have been almost as easy to draw a 1.809 rectangle having a length of 4¼".

The modulator panel is somewhat simpler. The two meters, modulator plate current and percentage of modulation, are located in the centers of the two outside .809 areas. The gain control and the degeneration control are respectively located below the meters. The radio and audio monitoring jacks, the filter switch and the phone-c.w. switch are grouped in line with their centers 1.313" from the bottom edge of the panel.

If desired, a plate of the same size and shape as that of the tuning card can be placed in the area between the meters. This card or plate could bear the call letters of the station or information relative to the gain and degeneration control setting and performance of the transmitter.

The power supply panel is simplest of all. All that is required is to locate the four pilot lights and switches. These automatically fall in line with the meters and dials in the centers of the .809 areas.

Each panel is a unit complete by itself and the combination of the four panels presents a correct and harmonious appearance. Dynamic design applied to apparatus mounted on relay rack panels is almost necessary if future panel additions are to harmonize with the original design scheme.

Dynamic symmetry can only serve as a guide in any design. How well it is applied and how good the results are depends upon the designer and the parts making up the design.

The principles of dynamic symmetry are most useful to those who cannot instinctively choose forms which are most pleasing. Though the work of such artists is not likely to be as effective as that of talented artists, it will be much more acceptable than if it were not guided by a basic plan.

Too much emphasis cannot be given to the statement that the time and effort spent in study of dynamic symmetry is well worth while even if the first attempts of its application are difficult and unfruitful.

Acknowledgment is made to the following publications and in particular to the works of Arthur Van Dyck and Jay Hambidge. Figures 1, 2, 3, 4 and their explanations have been reproduced by permission of the Yale University Press.

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[*Figures 1-4 Courtesy Yale University Press*]

DX CYCLES IN 1938

11-year and 27-day cycle forecasts

By **CHAS. D. PERRINE, JR.,* W6CUH**

Here are some general predictions of dx conditions for the coming year. It must be remembered that dx is much like the weather; hence cannot be forecast perfectly though quite accurately.

First, the progress of the 11-year cycle brings unfavorable news. The close of 1937 completed over 11 years of 14-Mc. amateur activity which began in earnest in 1926. The period of '26-'30 saw 14-Mc. conditions definitely on the downgrade, with 28 Mc. following suit. 1937 corresponded in general with 1926 (allowing for the difference in number of stations!) According to the 1927 log, 1938 will see extreme night 14-Mc. dx start later in the year and end sooner (April to August), while morning skip will lengthen. The spring and fall 28-Mc. periods will be much shorter (probably just March and September). 7 Mc. should improve as its peak seems to fall between the top and bottom of the 14- and 28-Mc. 11-year variation. 1936 seems definitely to have been the peak dx year—and the behavior of both 28 and 14 Mc. this past fall has proven that the dx decrease is accelerating as it nears the half-way mark to the minimum due in '41-'42 (last low was '30-'31).

The 27-day cycle has continued approximately on schedule through 1937, though its effect is not as marked due to the drop-off in general dx. Noted mostly in signals passing near the earth's magnetic poles, the 27-day cycle has least effect on trans-equator signals. As most of us would rather know when dx is good rather than when it is bad, the predictions for the first half of 1938 are the *weeks of peak conditions:*

January 13-19
February 8-14
March 7-13
April 2-8
April 30-May 6
May 26-June 1
June 22-28

Concluding, 1938 will find 28-Mc. dx greatly narrowed down, 14 Mc. also lower, but 7 Mc. somewhat improved. Yet, all will be mighty good compared to the barren wastes ahead in '41-'42, of which the dx'ers of '30-'31 need no description.

*421-25th St., Hermosa Beach, Calif.

CHASSIS CONSTRUCTION HINTS

By C. B. STAFFORD,* W9KWP

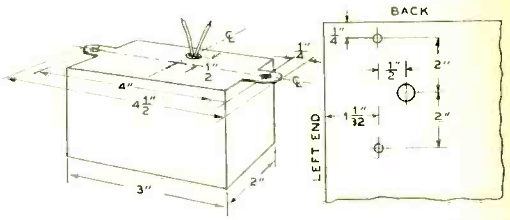


FIGURE 1

Looking through a recent copy of RADIO, I counted no less than 15 chassis portrayed in connection with the various articles. But I rarely see one to match them in the average ham shack. Most chassis seen in ham shacks look like a cross between a bread pan and an airplane crack-up. But the fact remains, there is very little necessity for the haphazard construction so frequently found, and a strong, neat chassis almost always pays dividends in r.f. output or received signal. There are a few simple rules which, if followed, make it possible for all of us to have commercial-appearing rigs.

Chassis Lay-out

The first step in chassis construction is the arrangement of the parts, and the transformation of their mounting holes to marking on the chassis. This may be accomplished in two general ways. The first way is to scratch the location of the mounting holes onto the chassis by direct transfer. This is the method most commonly used, and is the worst possible. While scratching a hole center through the hole, the part is liable to move. Then the other mounting hole will be out of line. When the completed chassis has had all of its holes reamed out so that the parts can be made to fit, one usually has to put washers on the screws to keep them from falling through the holes. The result looks like an effort to make a slab of Swiss look to be American Cream.

The other method in common use is to measure the distances between holes, and to lay them out in that way. Let us assume that we are to mount the choke coil shown in figure 1 on a chassis so that two of its sides are along the edges of the chassis. By inspection of the drawing, one can see that the mounting holes are centered with respect to the 2" side, and that the eyelet through which the leads are brought out is centered with respect to the 3" side. The mounting holes are 4" apart, and the overall length of the lugs is 4½".

First, scribe a line 1 1/32" in from the left edge and perpendicular to the back side. This will allow for one-half of the choke plus 1/32" for additional clearance. The center of the first mounting hole will be ¼" in from the back edge. This clears the lug. As the lead hole is halfway between the mounting holes, mark off a line perpendicular to the left edge and 2¼" in from the back. The other mounting hole will be 4¼" in from the back edge, and also along the first line drawn. The lead hole is also ½" off center; so you should mark off this distance in whichever direction you want the lead to come out from the center line. The same procedure should be used for laying off other parts. When a part is to be mounted in an oblique position, the first line should be its major axis, which should be laid off at the proper angle. Other locations can usually be found from this line as a base by drawing lines at right angles to it. As a rectangular system is used in the design of most of the equipment we use, one can always make a neater chassis by exercising care in laying out the various right angles.

Both of the systems for laying out a chassis require that one mark out the hole centers and guide lines on the metal. If the metal used is ferrous (iron or an alloy), the marking may be made to stand out more clearly by copper plating the material before attempting to scribe it. This is not as complicated as it sounds, as ferrous metals may be thus plated very simply, although the plating resulting is only a few molecules thick. Clean the metal with gasoline, alcohol, or lacquer thinner. Then brush it with a rag wet with copper sulphate solution. This leaves a thin layer of copper over the chassis which is easily scratched for marking.

Simplified Method

Some of us do not like to have our chassis covered with guide lines. This may be avoided at the expense of accuracy. Instead of marking guide lines on the chassis itself, lay them out on a sheet of paper to scale and then attach

*241 South Grant Ave., West La Fayette, Ind.

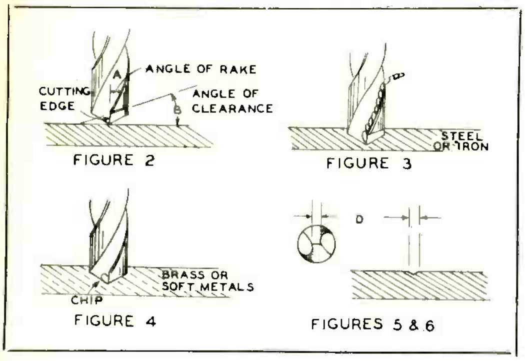


FIGURE 2 FIGURE 3 FIGURE 4 FIGURES 5 & 6

the paper to the chassis with rubber cement. The hole centers and other necessary markings can be punched right through the paper, and then it can be removed. The rubber cement rubs off easily and actually helps to clean the chassis as an eraser would. A further simplifying step is to use one-inch cross-section paper for this work. This automatically obviates the necessity for machinists- or T-squares for obtaining the right angles, and also eliminates the ruler for all but oblique lines and circles.

Drilling

Although most of us do not so consider it, a twist drill is nothing more than a modified jack-knife. It has a cutting edge, an angle of clearance, and an angle of rake, just as has a jack-knife (or a lathe tool). The technique to be followed in drilling is therefore a function of the type of material worked on, as well as the speed and accuracy desired. In figure 2 is shown in heavy lines one of the cutting edges of a drill normally used on steel. The angle B, between the cutting edge and the piece being worked on, is the angle of clearance. This determines to some extent how heavy a cut may be taken. Figure 3 shows the drill in action. Note that as the drill proceeds, the chip cut out is above the cutting edge. This has the effect of pushing the drill farther into the material. This is determined by the angle of rake, angle A, and the hardness of the material. If the material is hard at the point of cutting, the resistance to downward motion here is great enough to oppose that generated by the angle of rake.

Figures 2 and 3 show the shape of the cutting edge of a newly bought drill. This is satisfactory for steel or iron. The shavings which come out of the hole around the drill should be spiral and continuous as shown in figure 3. For softer metals, especially brass, the drill should have no angle of rake (or lip, as the forward projecting cutting edge is called). This is shown in figure 4. The shavings for this drill will be small chips. If this shape drill is not used, the drill will feed into the metal very rapidly and will usually jam. The result is a stalled motor, a belt off its pulley, or a broken drill. The latter is usually the case.

As the tip of a drill is not a point, but a straight line perpendicular to its major axis, a drill will usually waltz all over the piece before it starts to drill, unless a guide hole is punched at the point you wish to drill. The maximum diameter of this hole should be at least equal to the width of the drill tip. This is designated as "d" in figures 5 and 6, the latter showing a cross-section of the center-punch mark. With drills of over 1/4" diameter, this method of starting the drill is usually impractical, as the diameter of the center-punch hole is prohibitively large. This difficulty is avoided by first drilling a smaller guide hole which can be started with a center-punch hole.

A great deal could be said about drilling speeds and feeds, but it would be of little value to the average person. In drilling steel or iron, the drill point should be well lubricated with a medium grade of machine oil. The weight of oil commonly used in oiling lawn-mowers is about correct. This serves a double function for most machinists. The first, of course, is lubrication. The second is to keep the work cool. The oil flows from hot points to cold ones more quickly than heat flows from the hot points of the drill to the cooler ones. But for ham use, the oil assumes a third role, that of a temperature indicator. The oil should never evaporate visibly to form a cloud around the work (this vapor looks like steam). Another indicator is that you should be able to hold the end of the drill in your hand with no discomfort immediately after you finish the hole. These considerations are based on the assumption that most hams use the average carbon drill, and not one of the more expensive type designed to operate at high temperatures. Most tool steel will start to lose its hardness at a little over 100 degree C. At 600 degrees, it is as soft as mild steel, and must be heat treated and tempered again. That means that most hams would have to grind the softened portion off and then attempt to regrind the cutting edges.

Brass should always be drilled with no lubricant. For one thing, the brass slides readily against steel. Bronze is in the same class. Wit-

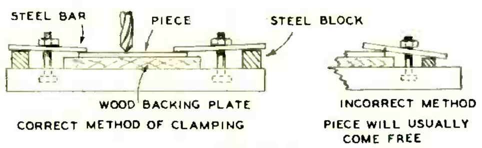


FIGURE 7

ness the large number of bronze bearings in current use. Almost all of the zinc alloys may so be treated. If a lubricant is used, it usually only makes the particles cling together and thus clog up the drill point. Aluminum is sometimes lubricated with kerosene.

The drilling speed (number of revolutions per minute of the drill) and the drilling feed (rate at which the drill is pushed into the work) are interdependent. The safe, simple way to determine them is to watch the temperature. If the drill is running too hot, decrease the feed. If it yet runs too hot, decrease the speed. In drilling, it is a safe practice never to feed the drill in a distance greater than the diameter of the drill without backing it off until the work is clear. This permits you to examine the point and permits the drill to clear itself of particles which may be clogging it at the point of cutting. This looks like a waste of time, but actually will be a time saver. You won't have to stop to replace broken and softened drills.

Danger

Most drill presses are equipped with some means of clamping the work. It is always wise to use these, unless the piece is large and the holes are small. A piece, especially of sheet steel, which gets jammed on the drill and tears out of the operator's hands, is a dangerous weapon. With small pieces, it is always best to clamp them in a tool-maker's vise. Larger pieces may be clamped as shown in figure 7. When working with sheet steel (as you usually are on chassis construction), if the piece is large you may hold it safely by hand. Wear gloves and hold the work *firmly* with both hands. The drill feed may be easily arranged to operate by foot for these operations. Figure 8 shows how this is done. The spring shown is a screen door spring. The distance "a" from the hinge determines the ratio between foot motion and drill feed. The illustration is otherwise self-explanatory. For any hams interested in cutting operations other than drilling, the same principles as set forth here apply.

Punching

In cutting socket holes, one formerly had to use a fly-cutter or a chisel. This was a laborious process, and the results were usually discouraging. But socket punches may be purchased so cheap now that there is little excuse for the conscientious ham having socket holes that look as if they had been shot out with a machine gun. These punches are easy to operate, and only a few precautions are necessary. The guide pin should fit snugly in the guide hole. This increases the accuracy of location of the socket. If this is not of great importance, one may well use a drill of 1/32" larger diameter than the guide pin. Some of the punches will operate without guide holes, but the latter always make

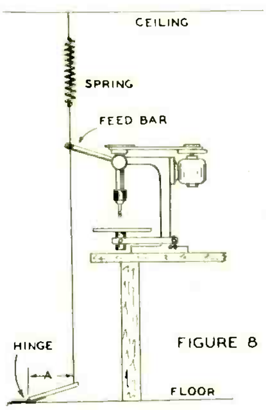


FIGURE 8

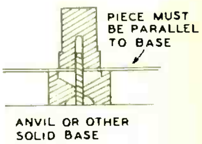


FIGURE 9

the punching operation simpler and easier. The only other precaution is to be sure the work is properly lined up before applying the hammer. If this is not done, the punch may slide sideways when you strike and thus not only shear the chassis but also take off part of the die. This is easily avoided by always making sure that the piece is parallel to the faces of the punch, the die, and the base. The latter should be an anvil or other solid base of heavy material.

Removing Burrs

In both drilling and punching, a burr is usually left on the work. There are three simple ways of removing these. Perhaps the best is to take a chisel (be sure it is one for use on metal, as the ones for wood are not much harder than the average chassis steel) and set it so that its bottom face is parallel to the piece (in other words, has zero angle of clearance). Then gently tap it with a hammer. This usually will make a clean job with a little practice, If one has access to a counterbore, this will also do a nice job. But few of us can find one to work with. A countersink will work, although it bevels the edges. A drill of several sizes larger is a much used arrangement. The third method is by filing off the burr, which does a good job, but scratches the adjacent metal surfaces badly. Any of these methods will work, but the first is quicker and does a neater job.

Transformer Cut-outs

Cut-outs for transformers and chokes are not so simply handled. There are devices on the market for this, but they have not yet come into common use. After marking off the part to be cut out, drill about a 1/4" hole on each of the inside corners and tangential to the edges.

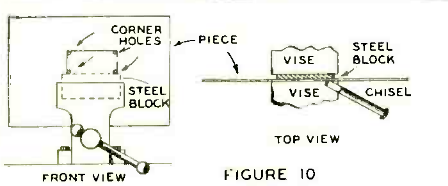


FIGURE 10

After burring the holes, clamp the piece and a block of cast iron or steel in the vise as shown in figure 10. Then take your burring chisel and insert it in one of the corner holes. Cut out the metal by hitting the chisel with a hammer. The blows should be light and numerous. The chisel acts against the block in the same way that the two blades of a pair of scissors work against each other. This same process is repeated for the other sides. A file is used to trim up the completed cut-out.

Folding

Folding the chassis may be accomplished either by hand or by machine (a "break" or folder). If it is done by hand, the work is set up in the vise just as it was for cutting out transformer mounting holes. But for this work, it is best to have a block on each side of the piece. These blocks should extend the width of the piece. It is then folded over by hand, being careful to have all of it bending the same amount at any time. If your hands aren't big enough to apply uniform pressure on all parts of the bend at once, they may be supplemented by a wooden block held so that it is parallel to the fold and extends the width of the piece. The fold is then completed by hammering. In this type of folding, the bend is very sharp. Therefore, you should add only the thickness of the metal to the measured distance between edges to obtain the overall dimension. Figure 11 shows this. The dotted lines indicate the positions of the block used in folding the piece. This overall dimension is frequently quite important, and care exercised here will produce a chassis which properly fits into its box.

If machine folds are made, this overall dimension is easily obtained. This is shown in figure 12. It is advisable to bend up a piece of scrap material first to be sure that the machine's stops are set properly to fold a right angle for the material you are using.

In bending sheet steel or iron, it is not necessary to watch for grain. But in rolling out sheet zinc, some brasses, aluminum, and softer metals, the strength of the metal perpendicular to the rollers is greater than that at right angles to this direction. This *grain,* as it is called, is very similar to that of wood. It is usually visible as stripes on the face of the metal. Therefore, one should be very careful in folding or bending materials which have this weakness. The folds should always be at right angles to the lines showing the grain. If this is not possible, the folds should have a somewhat larger radius of curvature, and should not be as sharp as they usually are made. In hand folding, this means that you cannot complete the job with a hammer as suggested, but must leave it as is. The receiver shown on page 12 of last February's issue was one of the author's early efforts and had to have several of its folds reenforced by solder after completion. The material was a zinc alloy. The best plan is to test out a sample of the material before folding the actual chassis.

Assembling

In chassis made of several pieces, and in construction in which the chassis must be fastened to the front panel, shielding partitions, etc., a knowledge of metal fastenings is useful. Metals may be fastened together by a number of common methods. These are rivets, nuts and screws, self-tapping screws or screws and tapped holes, and welding. These are listed in the reverse order of their general value to the ham for steel chassis. In riveting, the chassis usually gets warped. Nuts and screws are expensive and take time to assemble.

Tapped holes are a nuisance to make. But self-tapping screws are quick, cheap, and make a fairly good joint. Welding makes the best joint of them all, but has the disadvantage of being permanent. Many machine shops now have spot-welding equipment, and can usually be persuaded to weld up a box or chassis for little or nothing. For this work, it is usually best to have the work held together by C-clamps or similar means while it is being welded. The work should always be well cleaned with lacquer thinner or similar compounds.

For metals other than steel, spot welding is usually not very successful. And as most of the other metals commonly used in chassis construction are not hard enough to hold a good thread, nuts and bolts seem to be the only solution. Soldering is sometimes used, but is not to be recommended.

Finishes

There are a number of ways of finishing the chassis. Perhaps the best for steel is plating. Cadmium plating was once popular, but since one of the automobile manufacturers is reputed to have a corner on this material, it has been hard to get. Chromium plating is pretty, but is expensive and hard to solder to. Copper plating tarnishes, but can be covered with colorless lacquer and made to be a very beautiful finish. Other materials may be best treated by polishing them and then covering with colorless lacquer. A very pretty, dull gloss finish, almost velvety, can be put on aluminum by sand-blasting it with a very weak blast and fine particles (better try it out on a sample before you use it on a completed chassis) and then lacquering it.

There are also several brands of dull gloss black enamels on the market which adhere well to metals and make a nice appearance. Air-drying crackle finishes are sometimes successful, but a baked job is usually far better. Crackle finishes, properly put on, are very durable and pleasing to the eye. If you live in a large community, there is probably an enamelling concern which can crackle your work for you at a reasonable cost. A very attractive finish for panels especially is to spray a crackle finish with aluminum paint. In any painting operation (or plating either for that matter), the work should be very thoroughly cleaned of all greases and oils.

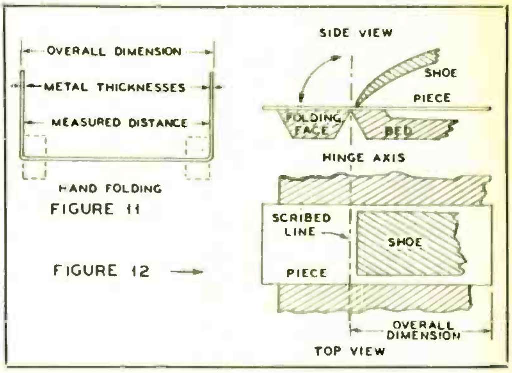


FIGURE 11

FIGURE 12

It doesn't take any genius to construct an attractive, well-built chassis. All it takes is a few fundamentals and a little care and experience. And your completed job can be made much more attractive by putting on a suitable finish.

●

Utilizing WWV Standard Frequency Transmissions

QRM in the amateur bands makes a difficult task of calibrating monitoring and frequency-measuring equipment from A.R.R.L. standard frequency transmissions. The transmissions sent out several times each week by the Bureau of Standards station WWV are on special frequencies and are not subject to such interference. The accuracy of these transmissions is considerably greater than is requisite for amateur work, so they are invaluable for all high grade calibrations.

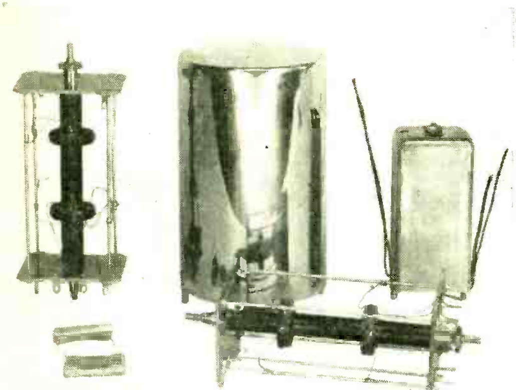
In handling amateur frequency meter calibration (where the meter tunes in the 160 meter band), a comparison may be made between the fifth harmonic of the 2000 kc. setting of the meter and WWV's 10,000 kc. transmission. Or, if a crystal or electron-coupled 100 kc. oscillator is the station standard, its 50th harmonic may be compared with the 5,000 kc. transmission from WWV.

WWV transmits standard frequency signals each Tuesday, Wednesday, and Friday, except holidays. Transmissions are made on 5,000 kc. from 10:00 to 11:30 a.m. e.s.t.; on 10,000 kc. from 12:00 noon to 1:3 p.m.; and on 20,000 kc. from 2:00 to 3:30 p.m.

—R. P. T.

Sharper I.F. Amplifiers to Reduce

PHONE QRM



A SYMPHONY IN HIGH Q SHARP

At the right is a typical i.f. transformer, good enough for most purposes but not for what we want. To the left is seen the type of transformer used to obtain the degree of selectivity described in this article. Note the large shield can. (Photo courtesy McMurdo Silver Corporation.)

Many are the new devices and circuits used to sharpen the response curve of an intermediate frequency amplifier. But in the quest for new methods of providing razor-edge selectivity and "rejectivity notches" we are apt to overlook the old and simple expedient, very effective nevertheless, of utilizing several cascaded circuits possessing very high "Q".

Present day radio reception involves three fundamental types of services, each service having different selectivity requirements:

Broadcast reception requires a minimum band width of 7 kc., in order to provide 3500 cycle audio tone range. This represents rather poor musical reproduction, and it would be more accurate to state that the broadcast receiver should possess at least two selectivity choices: an 8 kc. band width for general reception without adjacent channel interference, and a 12 to 16 kc. band width for high fidelity reception of high quality programs from local stations not bothered with adjacent channel interference.

Amateur phone work indicates a desirable band width of approximately 3 kc., sufficient to provide good intelligibility yet narrow enough to minimize interference from stations on adjacent frequencies. It is readily apparent that the interference present in the amateur phone bands dictates the narrowest possible admittance band compatible with good speech intelligibility. While land line telephone practice calls for 2300 cycle tone range (comparable to a 4.6 kc. band width), such a band width does not provide the most advantageous intelligence-interference ratio, and a 1500 kc. tone range (3 kc. band width) is distinctly to be preferred in amateur phone operation. Such an admittance band width will give a maximum of intelligibility and interference rejection through bad interference, and a minimum of noise in weak-signal reception.

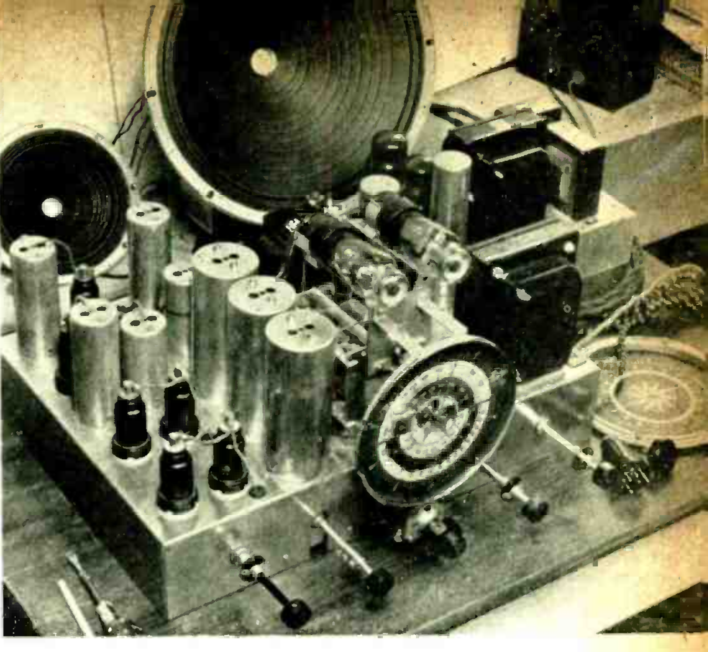
C.w. telegraph reception calls for a degree of selectivity so high that it would seriously impair intelligibility when receiving phone signals. A variable band width of from a few cycles up to possibly 200 cycles is ideal. This is nicely provided by most any i.f. amplifier by the incorporation of the popular single-signal quartz crystal filter.

The degree of selectivity desired for broadcast reception can easily be obtained with readily available components in commonly used circuits. And as mentioned above, a quartz crystal filter can be added to such an i.f. amplifier to obtain the degree of selectivity desired for c.w. telegraphy reception. But in between these two degrees of selectivity, the problem is more difficult. The 3 kc. band width desired for speech-modulated signals in the crowded amateur phone bands is not so easily obtained.

Inspection of amateur superheterodynes found on the market today shows that the customary practice is to utilize two i.f. stages using a total of three dual-tuned i.f. transformers. These transformers show an average coil "Q" of about 130, which, while not bad, is not as good as it could be. The selectivity of the sixth cascaded tuned circuit, and often the selectivity of the preceding (primary) circuit, are usually seriously impaired by being burdened with a low resistance diode detector; good audio quality is provided by such a detector, but the preceding circuit is so heavily loaded that the selectivity suffers.

Two good i.f. stages invariably provide more maximum amplification than is usable in an amateur superheterodyne boasting good signal-to-noise ratio and weak signal response. How-

[*Continued on Page 181*]



If you are strictly a dx or traffic man, this imposing receiver with its push-pull volume expansion, two-channel i.f. amplifier, and other special features may be more elaborate than your needs call for. But it is something the dyed-in-the-wool experimenter can "set his teeth in"; the doodads and refinements not common to ordinary amateur receivers make this one a standout for general short wave reception.

A DE LUXE SUPERHET

Volume-Expansion--- Two-Channel I. F.---

By **RAYMOND P. ADAMS***

This receiver — a somewhat unconventional all-wave job featuring push-pull volume-range expansion and dual i.f. channelling—was not what you might call objectively engineered. As a matter of pure fact, we had no intentions, at the start of this particular constructional adventure, of creating a finished and working instrument at all. The thing simply grew into being in the course of casual experimenting, took shape under the pressure of what might be called mere haphazard circumstance, and all at once—well, there it was: a job of no inconsiderable efficiency, a sort of "surprise package" piece of equipment which merits description.

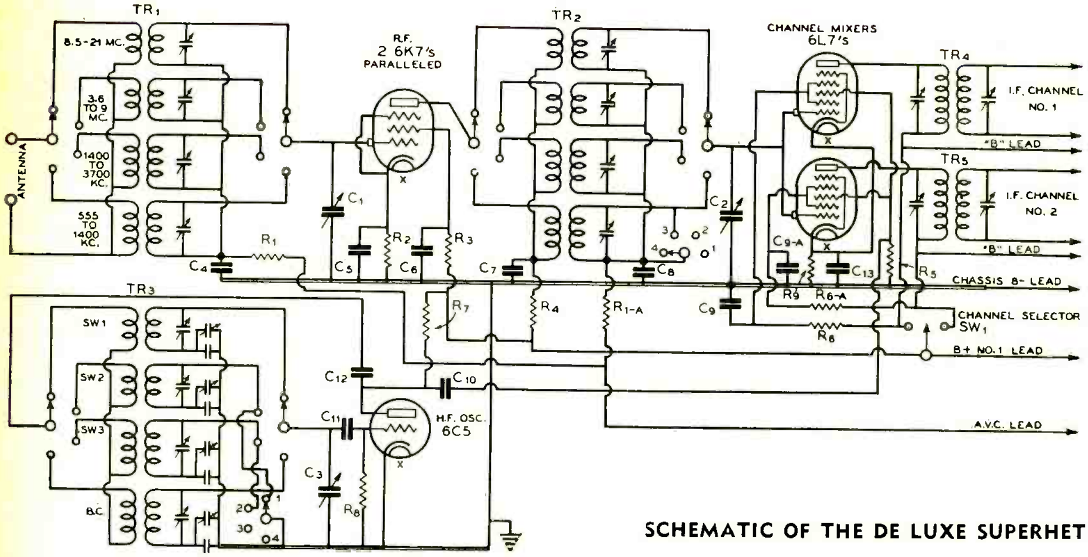
The subject job, if provided with a b.f.o. stage, a phone jack, a communications switch, and other refinements, would make a very efficient amateur receiver, if simply by reason of its exceptional selectivity and signal-to-noise ratio. Any ham who has the time and sufficient on-hand components to build one more-or-less physically and electrically similar may feel pretty sure in advance that he'll get a fine set for his trouble. But as it simply "grew" and as it may not suggest anything like economical design to some readers, we'll present it not so much as a finished model for exact reproduction but more as a sort of working proof that the odd applications involved remain astonishingly practical.

We had two particular thoughts in mind when we began this activity. The kind that get in your mental hair and make life altogether miserable until you get them out of the think-box and out of your system—and into some kind of proving or disproving practice.

Idea Number 1

For one thing, we wondered if it would not be possible to work out a dual-channel i.f. system using inexpensive transformer components —with one channel a single stage affair adjusted for low gain, wide-acceptance reception of high fidelity broadcast, and with the other channel a high gain, two stage, peaked job designed to provide maximum selectivity. Each

*1717 N. Bronson Ave., Hollywood, Calif.



SCHEMATIC OF THE DE LUXE SUPERHET

C_1, C_2, C_3—360 μμfd. 3-gang condenser
C_4—.05 μfd. 400-volt tubular
C_5, C_6, C_7, C_8—0.1 μfd. 400-volt tubular
C_9, C_{9A}—0.1 μfd. 400-volt tubular
C_{10}, C_{11}—.0001 μfd. mica
C_{12}—.002 μfd. mica
C_{13}—0.1 μfd. 400-volt tubular
R_1—250,000 ohms, ½ watt
R_{1A}—100,000 ohms, ½ watt
R_2—400 ohms, 1 watt
R_3—100,000 ohms, ½ watt
R_4—10,000 ohms, 1 watt
R_5—50,000 ohms, ½ watt
R_6, R_{6A}—40,000 ohms, 1 watt
R_7—50,000 ohms, ½ watt
R_8—75,000 ohms, ½ watt
R_9—600 ohms, 1 watt
$TR_{1, 2, 3}$—All-wave coil assembly
TR_4—Wide-range channel input i.f. transformer
TR_5—High-selectivity channel input i.f. transformer
SW_1—Channel-selector switch

channel could logically be designed to perform just as we wished it to; the one to pass an inordinately wide band, as we have said, with sensitivity relatively low, this for high-fidelity b.c. reception; the more selective one to cut off at about 2000 cycles to permit ample selectivity for operation on the crowded ham bands.[1]

Idea the Second

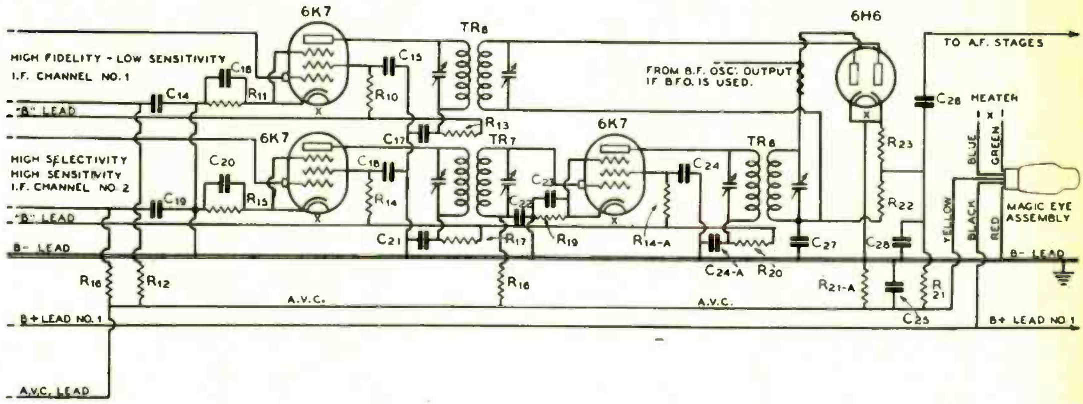
Our second "thought" had to do with volume range expansion. We had experimented time and time again with various accepted tube or resistor systems, and had applied them successfully in high fidelity designs. But never had we satisfied ourselves that any of the conventional hookups were sufficiently perfect to warrant completely the additional costs which their inclusion in a standard circuit involved. Why not, as an improvement on these earlier systems, a push-pull layout directly driving, through a resistance-capacity coupling network, a couple of push-pull high sensitivity output tubes? In other words, a balanced high-gain affair so worked out that very effective expansion might be had with a minimum of distortive effect on the signal? Here again a questionably sound investment seemed involved—and remains involved; but here again a thoroughly workable set-up makes it clear that our idea wasn't as half-baked and impractical as it at first seemed.

[1]An idea similar to this has been discussed by McMurdo Silver in the article "'Multiband' System of I.F. Selectivity," RADIO DIGEST, Nov., 1937; *All-Wave Radio,* July, 1937. EDITOR.

The Experimental Receiver—R.F. and I.F. Circuits

We dug out an efficient all-wave r.f. assembly for this job. Fortunately, it permitted a full 21 Mc. to 550 kc. coverage with the available "on hand" three-gang, .00037 μμfd. variable condenser. It may or may not be still in manufacture—but as jobbers have featured it for a couple of years, it is very likely available to hams who plan anything like a duplication of the receiver. Any type of all-wave unit designed for proper tracking with an i.f. frequency of 456 kc. would, of course, be satisfactory.

The r.f. circuit is conventional and follows the writer's "Band Switching, All Purpose Superhet" (April, 1937, RADIO) "front end" hookup more or less closely. We have used two 6K7's in parallel in the r.f. stage simply because we liked the idea, and because our power supply afforded the extra current required. The bias for the r.f. stage is fixed, by the way, this having been found desirable.



SHOWING THE R.F. PORTION, I.F., AND FIRST AND SECOND DETECTORS

C_{14}—.05 µfd. 400-volt tubular
C_{15}, C_{16}, C_{17}, C_{18}—0.1 µfd. 400-volt tubular
C_{19}—.05 µfd. 400-volt tubular
C_{20}, C_{21}—0.1 µfd. 400-volt tubular
C_{22}—.05 µfd. 400-volt tubular
C_{23}, C_{24}, C_{24A}—0.1 µfd. 400-volt tubular
C_{25}, C_{26}—.05 µfd. 400-volt tubular
C_{27}, C_{28}—.0001 µfd. mica
R_{10}—100,000 ohms, 1 watt
R_{11}—400 ohms, 1 watt
R_{12}—250,000 ohms, ½ watt
R_{13}—2000 ohms, 1 watt
R_{14}, R_{14A}—100,000 ohms, 1 watt
R_{15}—400 ohms, 1 watt
R_{16}—250,000 ohms, ½ watt
R_{17}—2000 ohms, 1 watt
R_{18}—250,000 ohms, ½ watt
R_{19}—800 ohms, 1 watt
R_{20}—2000 ohms, 1 watt
R_{21}, R_{21A}—500,000 ohms, ½ watt
R_{22}—50,000 ohms, ½ watt
R_{23}—500,000 ohms, ½ watt
TR_6—Wide-range channel output i.f. transformer
TR_7, TR_8—High-selectivity channel interstage and output i.f. transformers

Two 6L7's are employed as mixers. Screens, cathodes, and injector and signal grids are tied together, with the bias resistor R_9 of a proper value for a *single tube*. Their plates, on the other hand, are not paralleled but look into individual i.f. input transformers. The B-plus leads and the screen dropping resistor from these latter components TR_4 and TR_5 connect to the two-way channel selector switch SW_1. The mixers operate independently therefore, each receiving plate and screen voltage only when the particular i.f. channel is switch-selected.

The I.F. Transformers

Before working on the i.f. system, we combed through our supply of odd components to find two matched sets of inexpensive transformers—one for single stage, medium-gain, compromise selectivity service and consisting of two small air coupled units—the other set for two stage, extremely high-gain circuits and consisting of three transformers having series wound coils. Factory peak frequencies on both sets were 456 kc.

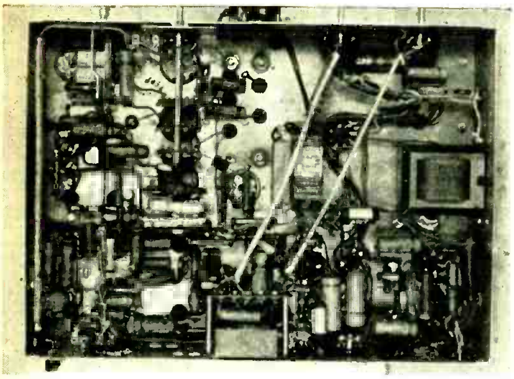
To get back to the circuit—tubes in both channels operate with fixed cathode-bias. 2000 ohms seems the best value of cathode resistance for the single 6K7 in the wide-acceptance stage. Here reduced sensitivity is naturally implied as the bias becomes much greater than the proper amount for maximum conductance, but the value is such as to prevent (with proper a.v.c. and screen supply) any possible amplitude distortion at 100% modulation when tuned to the strongest local broadcast carrier. The high gain channel's first tube has a three volt bias, with the second "K's" grid voltage somewhat higher than minimum to prevent any possible circuit instability. Of course, a.v.c. is applied to all the tubes in both channels. Also, the B voltage is connected only to the channel that is in operation at the time.

The Second Detector

The second detector is a 6H6, the individual sections fed by individual channels. Cathodes are tied together and grounded. Each diode output circuit connects through an audio limiting resistor to the high side of the common R_{21A} load, across which both the audio and a.v.c. voltages develop.

The Volume Expander Stage

A 6C5 was installed as first a.f. tube, a second 6C5 as expander bias-channel amplifier, and another 6H6 as bias channel rectifier. Two 6L7's were employed in the push-pull expander stage.



Under-chassis view of the receiver proper.

The circuit really is not at all basically original. It suggests, for that matter, certain commercial arrangements which have been used, with varying success, for a couple of years now. We have simply evolved a push-pull version of one of the conventional hookups—one which does seem to afford much better operation than the originals. The gain in the stage remains high, there is no noticeable distortion, the expansion action is really effective, and the set-up may be so adjusted that the 6L7's will amplify fairly well with the R_{25} expansion control set for minimum signal input to the bias-amplifier channel.

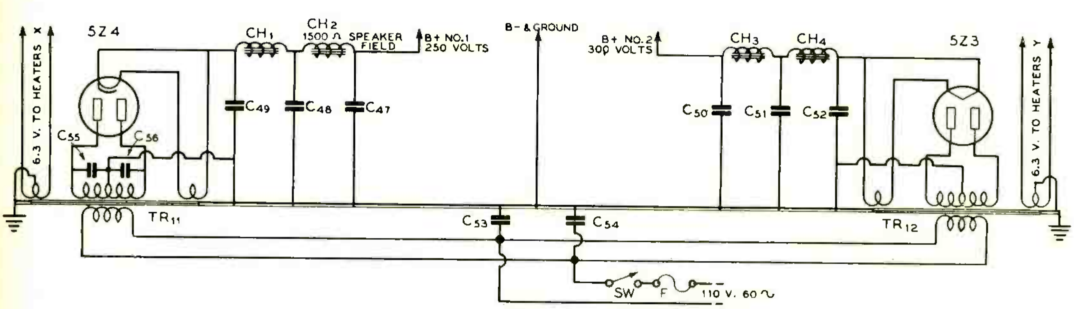
In the average system using the 6L7 as an expander, the tube must be biased fairly close to cutoff (where gain is naturally low or nil and where the distortion factor is, under best conditions, appreciable) if a proper expansion is to be effected. When low level signals—signals of insufficient strength, in spite of bias channel amplification, to cause much of any decrease in the 6L7 bias itself—are to be received, that bias must of necessity be switch-shorted down to a value which does let the tube amplify. This required an expansion-off switch and thus allowed expansion on nothing except high level locals.

With our push-pull set-up, it so happens that we can fix the low-gain limiting-bias at a value which keeps the 6L7 stage open for a fully adequate amplification of weaker signal inputs without distortion. This can be done, still retaining the advantages of having expansion on tap as a means of quieting inter-carrier noise level, with the limiting bias adjustment none-the-less fixed at a point permitting effective program expansion.

V_{11} and V_{12} are the push-pull expanders, adjusted, as we have said, for a low but nevertheless distortionless and adequate amplification of any signal which comes along. This is true whether or not R_{25} is opened to permit any appreciable portion of the signal to be rectified for expansion action. Signal grids are biased by a voltage determined by the value of R_{35} and the current drawn by the 6L7's. And, as the expander cathode circuit completes to ground through the semi-variable resistance R_{34}, the injector-grid limiting-bias is determined in amount by the value of R_{34}, the value of R_{24} resistance between tap and ground, and the 6L7 current. R_{33} and R_{32} are filtering resistors and R_{31} is the load impedance for V_{14} (across which the controlling "swing" voltage appears).

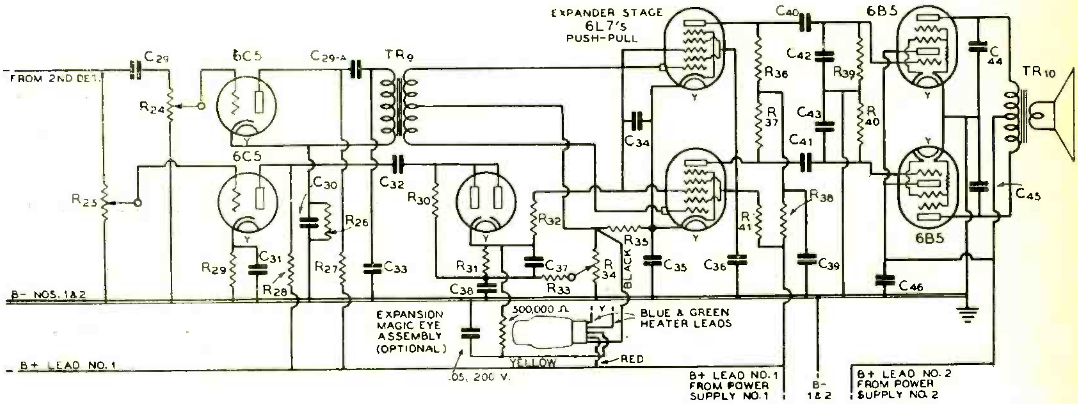
The Controlling System

The controlling voltage which appears across



THE TWO POWER SUPPLIES

C_{47}, 48, 49—8 µfd. 450-volt electrolytics
C_{50}, 51, 52—8 µfd. 450-volt electrolytics
C_{53}, C_{54}—.05 µfd. 400-volt tubulars
TR_{11}—Power transformer; 700 c.t., 85 ma.; 5 volts, 3 amps.; 6.3 volts, 3 amps.
TR_{12}—Power transformer; 750 c.t., 125 ma.; 5 volts, 3 amps.; 6.3 volts, 4 amps.
CH_1—12 hy. 85 ma. choke
CH_2—1500-ohm speaker field
CH_3—6 hy. 125 ma. choke
CH_4—12 hy. 125 ma. choke
SW—Main-line switch
F—2-ampere fuse



THE AUDIO AMPLIFIER AND VOLUME EXPANDER

C_{29}—.05 ufd. 400-volt tubular
C_{29A}—.25 µfd. 400-volt tubular
C_{30}—25 µfd. 25-volt electrolytic
C_{31}—0.5 µfd. 400-volt tubular
C_{32}—.05 µfd. 400-volt tubular
C_{33}—.005 µfd. 400-volt tubular
C_{34}—0.5 µfd. 400-volt tubular
C_{35}—10 µfd. 25-volt electrolytic
C_{36}—10 µfd. 50-volt electrolytic
C_{37}—0.5 µfd. 400-volt tubular
C_{38}—.25 µfd. 400-volt tubular
C_{39}—8 µfd. 450-volt electrolytic
C_{40}, C_{41}—.05 µfd. 400-volt tubular
C_{42}, C_{43}—.00025 µfd. 400-volt tubular
C_{44}, C_{45}—.006 µfd. 400-volt tubular
C_{46}—4 µfd. 450-volt electrolytic
R_{24}—500,000-ohm potentiometer
R_{25}—2-megohm potentiometer
R_{26}—3000 ohms, 1 watt
R_{27}—50,000 ohms, 1 watt
R_{28}—100,000 ohms, 1 watt
R_{29}—5000 ohms, 1 watt
R_{30}—100,000 ohms, ½ watt
R_{31}, R_{32}—500,000 ohms, ½ watt
R_{33}—100,000 ohms, ½ watt
R_{34}—2000-ohm slider-type resistor
R_{35}—2000 ohms, 3 watts
R_{36}, R_{37}—50,000 ohms, 1 watt
R_{38}—10,000 ohms, 1 watt
R_{39}, R_{40}—500,000 ohms, ½ watt
R_{41}—20,000 ohms, 1 watt
TR_9—Push-pull-input audio trans.
TR_{10}—Push-pull output from 6B5's to voice coil of speaker

R_{31} adds positively (when at increase) to the negative no-signal bias on the two 6L7 injector grids. This reduces the effective bias by the amount of the increase and causes an increase in tube conductance. The idea, as we all know, is simply to recreate the natural relative loudness relationship between shallow and deep modulation extremes, and the push-pull system does seem to effect this result with maximum flexibility of control and with minimum distortion. Actually, in the lab. model, with the R_{25} control closed left and with no a.f. input to the bias-change amplifying and rectifying channel, the two 6L7's still afforded sufficient signal gain to permit adequate swinging of the 6B5 grids for full loud speaker output with quite low signal input.

Expansion is removed from the amplifier simply by this closing of the R_{25} control, and no switch, as we have previously indicated, is thus required. We have not found it possible to effect any such result when using a single tube, and particularly when the injector limiting bias (for minimum conductance) is a manually inaccessible and semi-fixed item.

Expansion in an Amateur Receiver

Whether or not volume range expansion has a place in a straight communications receiver is a matter of individual opinion. Generally speaking, its use involves appreciable extra cost; the system here discussed calls for four tubes, a push-pull driving transformer, and several resistor and filter components. But it is practical and usable, in any event.

When conditions are tough, it is really nice to tune across a band and have even low-level phone or code signals pop up miraculously out of a fairly deadened background; and this effect *can* be achieved if the timing is such that the expansion will follow syllabic shifts in the modulation. Of course we can't speed up the action too much or noise peaks over and *above* signal level in strength will crack forth with the explosive and ear-rending violence of striking lightning bolts.

Dual I.F. in an Amateur Receiver

We do think the dual i.f. idea is well worth consideration by the amateur who proposes construction of a suitable all-band, all-service receiver. For one thing, it affords something really useful and reliable in the way of flexibility of control. Not that we don't believe in more simple means of effecting variable selectivity—such as through the manual shifting of coil coupling; but here we really have two sets in one, each receiver engineered to do a particular job well and efficiently.

A high gain channel—affording a maximum of fixed selectivity—would be entirely proper for both code and 20- and 80-meter phone reception. A low gain channel, on the other hand, would be just the thing for local phone work, for general work when conditions are good and the bands aren't over-crowded, and for the reception of certain high frequency signals of none too stable characteristics.

Simplifying the Author's Design

Our so-called De Luxe Super, with its eighteen tubes, two magic eyes (one measures volume expansion), two power supplies, and so on and so forth, makes a perfect custom all-wave job as it stands. With certain refinements, it should further appeal to any ham who wants both a communications and a broadcast job in one and isn't worried by the constructional complexities and the parts-cost involved. But for the average amateur it is, in its present form, a bit too much.

The thing *will* stand simplification, in any event. A single 6K7 may be substituted for the two in the r.f. stage. One power transformer, one filter system, one rectifier might be used—all mounted on the receiver or on a separate chassis, as desired. A suitable phase inverter might replace the 6C5 first a.f. tube, with the driving transformer eliminated. The 6C5—6H6 two-tube expander-bias rectifier channel is recommended and it cannot be conveniently simplified, and the two expanders in push-pull are of course necessary. But the set might be simplified down into a basic 13-tube design, if these various suggested changes are made and if the high gain or high selectivity channel is built up as a single stage affair using good iron core transformers. The addition of the inevitable b.f.o. stage would not involve the use of another tube if some means could be worked out for the use of a combination beat oscillator and expansion rectifier 6Q7 in V_{14} position. But the practicality of such a move is questionable to say the least, so that we might just as well figure on a full 14 tubes as being the least number we might possibly need for an amateur receiver which still retains the major laboratory-model features.

•

One early authority predicted laws against listening-in on commercial wavelengths when radiotelephony "should become commercial and widespread."

• Radioddities

When copying code on a typewriter, the second finger of the left hand will tire soonest.

•

To W8BDS, VE3IK, although located in Canada, is a southern contact.

•

The average commercial op copies code at 40 w. p. m.

•

Facsimile messages may be received on paper enclosed in an envelope, so that the addressee is the first to read the contents.

•

Ancient and honorable is the variable resistor. It has recently reached the age of 96 years.

•

One-way military communication by way of carrier pigeons travels at the rate of half to three-quarters of a mile a minute.

•

Thermometers were used as indicating devices in early wave-meters. We'll take a neon bulb for ours.

•

The powerful signals which we hear from so many of the short-wave diathermy sets make us wonder if any of the r.f. from these outfits ever reaches the patient.

•

One large electrical laboratory enforces the rule of keeping one hand in the pocket while working with high voltages. It is a simple yet effective safeguard against a circuit through the body, and is worthy of adoption by hams.

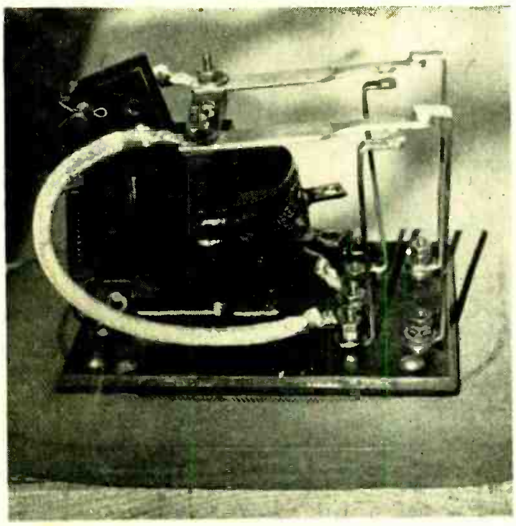
•

The phone companies' campaign to discourage the practice of "helloing" into telephones should have a counterpart in our own ranks to eliminate the inane "W9XYZ coming back to W2XYZ."

A. C. OPERATED RELAYS

...From 50c to $1.50

By **ROBERT H. FOX,* W6LRQ**



One of the home-constructed a.c. relays. This one is a d.p.d.t. affair and is used for feeder switching.

As my station installation became more complicated and operation more rapid, the need for circuit change-over relays became more pressing. They became almost a necessity when it was required to change over the receiver, the monitor and the antenna and, finally, to apply the plate power to the transmitter when "dah-dit-dah" was heard in the cans.

Previous to now, I had considered that the construction of an a.c. operated relay that would be chatter proof or chatter free was practically an impossibility for the average ham who had few tools even though he had plenty of ambition. However, through the fortunate discovery of an old motor-starting relay that was exceedingly noisy, I started investigating the possibilities of rebuilding it into an antenna change-over r.f. relay which I had been needing for more than a year. I readily found that such a relay could easily be made from this old action.

Power relays are made of two general types: the clapper type and the solenoid type. The latter will take up more room in general installation and, due to the weight of metal moved during the closing action, they are quite conducive to jangled nerves when the coil is juiced about 3 a.m. and a heavy crash is heard in the back of the rig. The clapper type of relay is the easiest to construct and to adjust for quiet operation.

This type of relay action is very simple and consists of no more than an ordinary small transformer, minus the secondary windings and with one leg of the core hinged and normally held open by a spring. The core is laminated with soft iron or silicon steel and each lamination is electrically insulated from its neighbor by shellac, rust or lacquer. The outside laminations are usually made of heavier-gauge iron cut to make the hinge pivots. The whole can be held together with copper or soft iron rivets. The coil is wound the same as the primary of a power transformer for the same core area (the winding information for this coil can be found in the RADIO *Handbook*). The ends of the winding are soldered to lugs so formed that the binding tape will hold the lugs firmly to the coil. In winding the coil, care should be taken to make it small enough, so that when it is in place it will leave about 3/16 to ¼-inch between the end of core and the top of the coil. Pieces of brass shim stock or wooden wedges can be used to hold the coil firmly in the core so it will not move due to the jar of the closing action.

The Shading Coil

The secret of chatter-free operation in an a.c. relay is in a small, seldom-noticed ring of brass or copper called a shading coil. Brass is generally used on 60-cycle current and copper is used on 50-cycle current. It is a small ring of metal used to shift the phase on the end of the core and to hold the magnetism a fraction of a second past the zero point in the a.c. cycle, in order that the following half-cycle will have an opportunity to take effect before the spring starts to open the action. This coil is formed on the end of the core and surrounds about 2/3

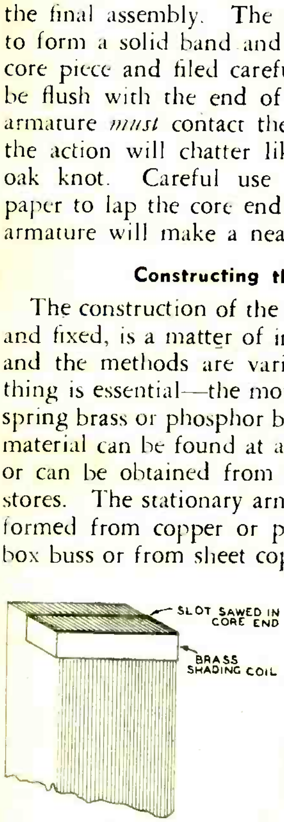
*1729 Orange St., Bakersfield, Calif.

of the area at the end. To meet these requirements, it is simple to cut a slot across the core that will just take the brass strip, then form the strip tightly around the end. This strip can be of 18 to 22-gauge and from 1/16 to 1/8-inch wide.

After the brass (or copper) is formed and the ends have been cut to a butt joint, it is taken off and about 25-thousandths of an inch cut off one of the ends to insure a driven fit at the final assembly. The ends are then brazed to form a solid band and it is driven onto the core piece and filed carefully so the brass will be flush with the end of the iron core. The armature *must* contact the core iron-to-iron or the action will chatter like a buzz saw in an oak knot. Careful use of emery or garnet paper to lap the core end to conform with the armature will make a neat job.

Constructing the Action

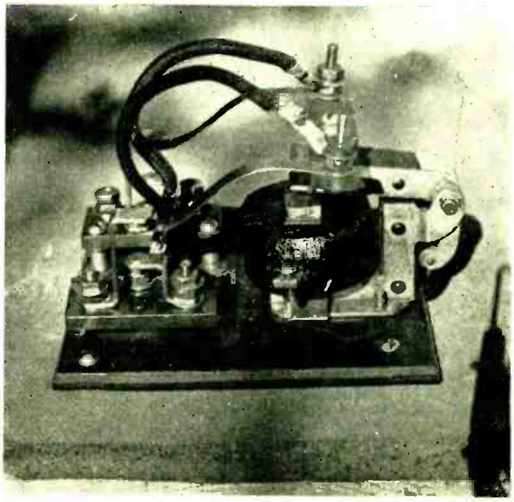
The construction of the contact arms, moving and fixed, is a matter of individual application, and the methods are varied and many. One thing is essential—the moving arms must be of spring brass or phosphor bronze. Suitable spring material can be found at any motor repair shop or can be obtained from most large hardware stores. The stationary arms can be cut out and formed from copper or phosphor-bronze fuse-box buss or from sheet copper. The points are



Detail drawing showing the method of placing the shading coil on the core end.

easily made from coin silver or from silver strip. If a piece of iron is drilled with a 9/32 hole and slotted with a hack saw using two blades, a 1/4-inch punch will cut out the points. The local silversmith, jeweler or chemical supply house (See Buyer's Guide) can furnish a strip of metal to do the job.

In the photographs, relay no. 1 is a highly-insulated r.f. relay with self-wiping contacts for antenna change-over. The insulation is victron and all machine screws are of brass to reduce r.f. heat. The shunts are of flexible wire as found on heavy duty motor brushes. The whole relay assembly is bolted to a 4-by-5-inch piece of tempered-masonite base. The action is from an old-style Allen-Bradley motor-starting relay.



D.p.d.t. power-control relay—constructed from an old oil-switch action.

This relay was installed in the antenna feeders of the transmitter belonging to Bill Whiting, W6EQI. The transmitter delivers about four hundred watts output and the relay handles this power perfectly.

Relay no. 2 is constructed from a low-voltage circuit-breaker oil-switch action. The coil is a 220-volt one and works fine on 110 when a short throw is used as it is in this relay. This one controls the primary line to the transmitter, the B negative to the receiver, and the B negative to the monitor and speech amplifier. The base is of 1/4-inch masonite, the same as for the r.f. relay. This material gives ample insulation for the voltages found in these circuits. Both relays are mounted vertically to allow the weight of the armature to augment the return spring in holding good contact on the open position. Sponge rubber, obtained at the ten-cent store, is used as sound insulation against telegraphing the hum and the closing snap.

Through the use of these two d.p.d.t. relays, my station is controlled by a single switch for change-over from transmit to receive. Only the 110 is on the operating table. The pleasure derived through their use far exceeds the time and effort spent in constructing them. Also, the cost was very low, about $1.50 for the r.f. job and 50 cents for the low voltage one.

Obtaining these two actions simplified the work in my case. However, I now have one more job under way, and I am using a burned-out midget-receiver power transformer for the

[*Continued on Page 162*]

A FIFTY-WATTER *in Parade Dress*

By JAY C. BOYD,* W2ISI/6

Here is a story of a transmitter that was built with more than the average attention to details. The first requirement of any transmitter is that it produce good signals, of course. But the virtues of good appearance, "bugless" all-band operation and reliability are too often ignored. Even among commercially-built rigs we can count the really fine jobs on our fingers and have several fingers left over.

Some fifteen months ago, an ambitious s.w.l. came to the writer with a burning desire for a phone transmitter—hadn't the gods decreed that someday he, too, would be a ham? He wanted something that would bring forth "ahs!" and "ohs!" from the visiting gang.

It was then customary for all new phone hams to start with a pair of 46's—but we felt it would be well worth the extra shekels for a pair of 10's in the final, in view of their much superior performance.

Then came the job of laying-out the new rig. Plans for a new r.f. unit had been floating around loose in the writer's cranium for some time. We might use this idea and then work out the rest of the rig around it.

Front view of transmitter. Antenna condensers and tuning chart on top panel; r.f., modulator and power supply panels below. The bottom panel is blank, affording space to keep extra coils and empty beer bottles.

The Attractive Panel Layout

The panel layout for this unit was carefully drawn several times until it looked right and then the other panels were laid out to match. Most hams lay out their chassis first and then let dials and meters fall where they will. But in this case the panels, dials and meters were laid out first and then the condensers, etc., were placed wherever the dials dictated.

This required the mounting of the doubler and final grid tuning condensers in cut-outs, half above and half below the panel. It also required a link-and-lever arrangement to place the crystal switch near the crystals and have the knob where desired on the panel.

It was preferable to have the gain potentiometer and c.w.-phone switch under the modulator chassis, which would place their controls so low on the panel as to spoil its appearance. Hence, the panel was allowed to hang 1¾ inches below the chassis, giving enough margin below the dials to prevent a crowded appearance.

In addition to the position of each object,

*2119 Longwood Ave., Los Angeles, Calif.

the choice of every item on the panel had to be given careful consideration if the controls were to harmonize with each other.

Four-inch dials were too big and three-inch ones looked too small. But fortunately, National had just brought out some three-and-a-half inch dials with nice husky knobs, which were just the thing. However, there were no appropriate dial markers to be found. These were made by slotting General Radio type 138-C switch contacts with a jeweler's saw and filling with black paint.

Two-inch meters were chosen for their neatness. We preferred to use plenty of them, eliminating messy patch cords.

The modulator labels were by Gordon Specialties Company. The two 3-position switch plates were Crowe's no. 564; the others were made by Bud. The long label underneath the power switches was made to order for $3.50. A strip of aluminum was lacquered, then engraved with a fine router by a label maker. He also engraved the round c.w.-phone plate. A dial similar to that used for "gain" was used for the blank. The reverse side was polished and then engraved as ordered. These special labels cost six dollars but made the difference between good dress and patchiness.

Some other unusual features of this rig were: a built-in overmodulation indicator, a safety interlock switch which breaks the power circuit when the top door is opened, a dummy antenna built-in and always available for testing, and an inspection light above the r.f. unit, in order that coils may be changed and crystal frequencies read without an external source of light.

Cardboard Model Made

Before buying any parts, scale drawings of the entire transmitter were made and these were followed by a carefully-scaled cardboard model. This was made by working up the cabinet from heavy black paper. Dials and meters were carefully drawn on white bristol board, then cut out and pasted onto this cabinet. Nameplates were drawn with white water color and a fine camel's hair brush. The result was a model that would show up any defects in appearance and perhaps save spoiling some good panels.

If a rig is to look well, the dials, etc., must be aligned with respect to the entire rig; merely making each panel symmetrical in itself is not enough. Also note that everything was aligned on its center and not its outside dimension.

It was planned to use a standard cabinet, but

CAPTION FOR CIRCUIT DIAGRAM

R. F. Section

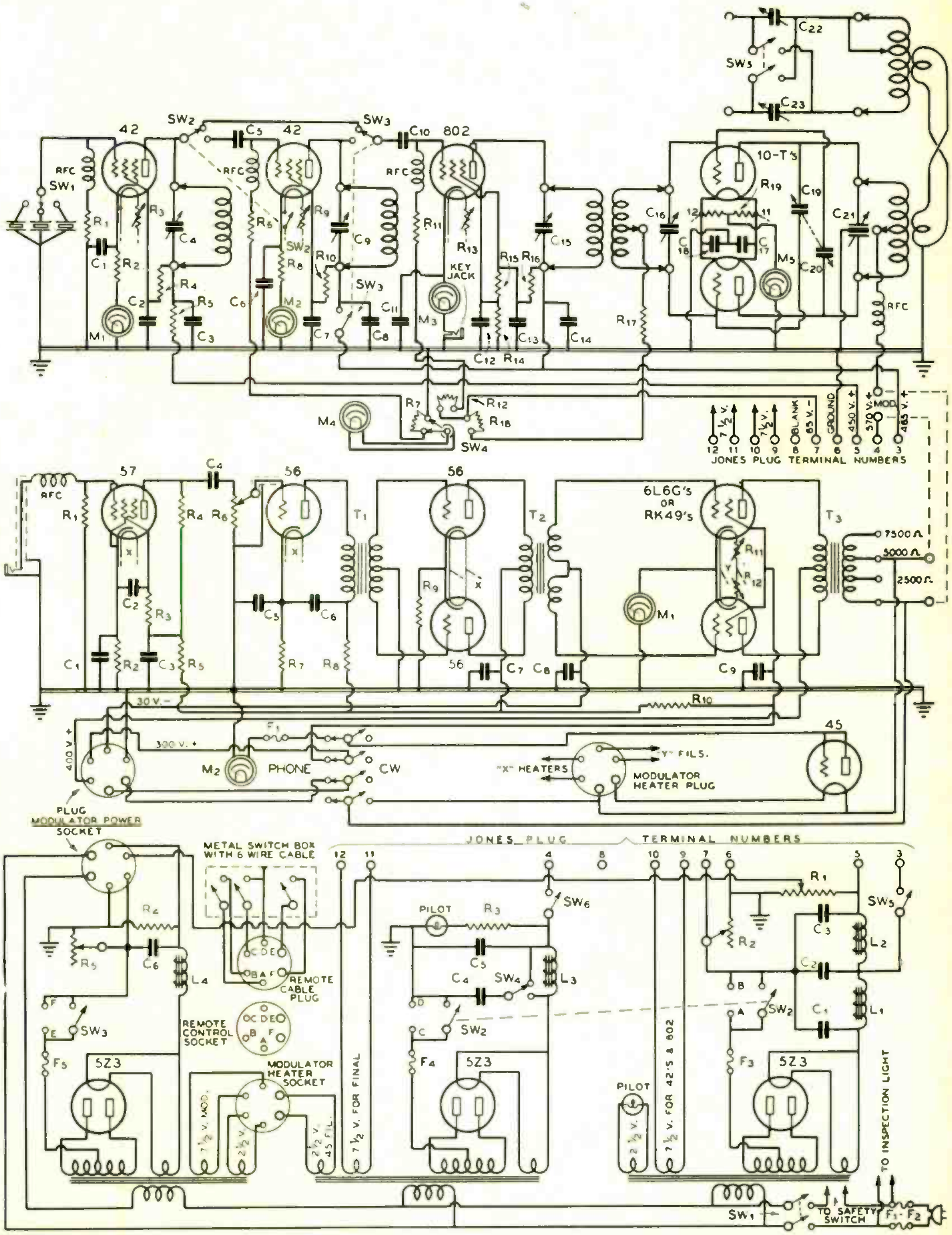
C_1,C_2,C_3—.002 μfd. mica
C_4—100 μμfd. midget variable
C_5—.00005 μfd. 1000-volt mica
C_6,C_7,C_8—.002 μfd. mica
C_9—50 μμfd. midget variable
C_{10}—.00005 μfd. 1000-volt mica
C_{11},C_{12},C_{13},C_{14}—.002 μfd. mica
C_{15},C_{16}—140 μμfd. midget variable
C_{17},C_{18}—.002 μfd. mica
C_{19},C_{20}—15 μμfd. neutralizing condensers, 2-gang
C_{21}—210 μμfd. per section, 3000 volt spacing
C_{22},C_{23}—220 μμfd. variables
R_1—15,000 ohms, 2 watts
R_2—250 ohms, 1 watt
R_3—2-ohm, 2-watt rheostat
R_4—50,000 ohms, 2 watts
R_5—6000 ohms, 10 watts
R_6—20,000 ohms, 2 watts
R_7—Meter shunt, see text
R_8—500 ohms, 1 watt
R_9—2-ohm, 2-watt rheostat
R_{10}—50,000 ohms, 10 watts
R_{11}—20,000 ohms, 2 watts
R_{12}—Meter shunt, see text
R_{13}—2-ohm, 2-watt rheostat
R_{14}—20,000 ohms, 10 watts
R_{15}—50,000 ohms, 10 watts
R_{16}—20,000 ohms, 20 watts
R_{17}—5000 ohms, 20 watts
R_{18}—Meter shunt, see text
R_{19}—50 ohms, 2 watt c.t.
RFC—2½ mh., 125 ma. r.f. choke
M_1,M_2,M_3—0-100 milliammeters
M_4—See text, special meter
M_5—0-250 milliammeter
SW_1—Single-ckt, 6 pt. switch
SW_2,SW_3—D.p.d.t. toggle switches
SW_4—Two-ckt., 5-pt. switch
SW_5—D.p.s.t. knife switch

Modulator

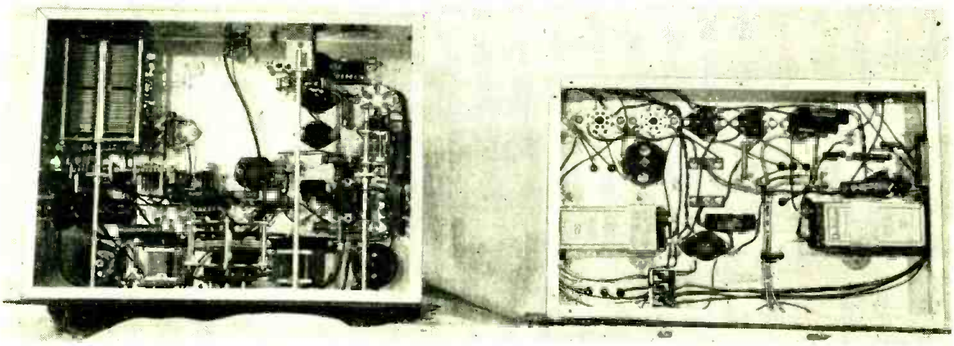
C_1—10 μfd. 25-volt electrolytic
C_2—0.5 μfd. 600-volt tubular
C_3—2.0 μfd. 450-volt paper
C_4—0.25 μfd. 400-volt tubular
C_5—10 μfd. 25-volt electrolytic
C_6,C_7—2.0 μfd. 450-volt paper
C_8—10 μfd. 50-volt electrolytic
C_9—2.0 μfd. 450-volt paper
R_1—5 megohms, ½ watt
R_2—4000 ohms, ½ watt
R_3—1 megohm, ½ watt
R_4—250,000 ohms, ½ watt
R_5—50,000 ohms, ½ watt
R_6—500,000-ohm potentiometer
R_7—2500 ohms, ½ watt
R_8—10,000 ohms, ½ watt
R_9—1250 ohms, ½ watt
R_{10}—2500 ohms, 2 watts
R_{11}, R_{12}—1.35 ohms for each tube. Made from old 4-ohm rheostat
RFC—2½ mh. r.f. choke
T_1—3:1 p.p. input transformer
T_2—Class AB input transformer
T_3—Modulation transformer for 6L6's to 5000-ohm load
M_1—0-250 d.c. milliammeter
M_2—0-10 d.c. milliammeter
F_1—1/16-ampere Littelfuse
C.W.-phone switch—See text

Power Supplies

C_1—2 μfd. 1000-volt filter
C_2,C_3—4 μfd. 800-volt filter
C_4, C_5—2 μfd. 1000-volt filter
C_6—4 μfd. 400-volt filter
R_1—40,000-ohm, 50-watt slider-type resistor
R_2—500-ohm, 25-watt slider-type resistor
R_3—40,000 ohms, 50 watts
R_4—10,000 ohms, 50 watts
R_5—200-ohm, 25-watt slider-type resistor
SW_1,SW_2—D.p.s.t. toggle switches
SW_3—S.p.s.t. toggle switch
SW_4—S.p.d.t. toggle switch
SW_5,SW_6—S.p.s.t. toggle switches
F_1,F_2—5-ampere Edison-base fuses
F_3,F_4,F_5—½-ampere Littelfuses
T_1,T_2,T_3—Power transformers; 1250 c.t., 150 ma.; 7.5 volts, 3 amps.; 2.5 volts, 5 amps.
CH_1,CH_2—15-hy., 150-ma. chokes
CH_3,CH_4—12-hy., 250-ma. chokes



SW2
SW3
42
42
802
RFC
SW1
C5
C10
C22
C23
SW5
10-T's
R19
C19
C21
C20
M5
C16
C15
KEY JACK
R13
R15
R16
C14
C13
R17
C12
R14
M1
M2
M3
M4
R7
R12
R18
SW4
7½ V.
BLANK
65 V. -
GROUND
450 V. +
570 V. +
MOD.
485 V. +
12 11 10 9 8 7 6 5 4 3
JONES PLUG TERMINAL NUMBERS
57
56
56
6L6G's OR RK49's
T1
T2
T3
7500 Ω
5000 Ω
2500 Ω
30 V. -
300 V. +
400 V. +
R10
45
PHONE
CW
"Y" FILS.
"X" HEATERS
MODULATOR HEATER PLUG
PLUG
MODULATOR POWER SOCKET
JONES PLUG
TERMINAL NUMBERS
METAL SWITCH BOX WITH 6 WIRE CABLE
REMOTE CABLE PLUG
REMOTE CONTROL SOCKET
MODULATOR HEATER SOCKET
PILOT
SW6
SW4
SW2
SW3
SW5
SW1
5Z3
5Z3
5Z3
F5
F4
F3
L1
L2
L3
L4
7½ V. MOD.
2½ V.
2½ V. 45 FIL.
7½ V. FOR FINAL
7½ V. FOR 42'S & 802
TO INSPECTION LIGHT
TO SAFETY SWITCH
F1 - F2



Bottom view of r.f. unit and modulator. Note crystal switch mounted on bracket and operated by link-and-lever arrangement from long shaft.

during shopping we ran onto a couple of RCA-ACT-40 cabinets which were picked up quite reasonably. The top of one and bottom of the other were cut out with a hack saw and the two bolted together. A cross member, cut from the scrap, was run across the center of the back, filling-in the two-inch space between the doors as well as stiffening the cabinet. This brace was removed for the photographs but its brackets are visible.

The panel screws were another headache. Nickel-plated screws and finishing washers were readily obtainable but using them would have given the rig a gaudy appearance. Some bronzed ones came with the cabinet but we needed more. They were obtained at the cost of 41 cents in cash and several dollars worth of correspondence and red tape. Although manufactured just a hundred miles from New York, it took five or six weeks to get them. Moral: Buy brass ones and paint them black!

The R. F. Unit

Any number of tube line-ups had been studied but none looked quite so desirable as W6BHO's "common sense" exciter.[1] However, we wanted to include a crystal switch and several holders, which made it necessary that the first tube always be the oscillator. Hence, a switching arrangement was made to jump the second stage when not in use, rather than drop off the first one as was done by Harwood. Although this rig was built more than a year ago, during which time many 6L6 exciters have appeared (and some very good crystals cracked), I still prefer this exciter. A straight pentode oscillator is hard to beat.

With four straightforward stages, the oscillator has nothing to do but oscillate. While the rig has four stages, only three are used when operating on the three lower-frequency bands, all four stages being used on ten and twenty meters only.

Most rigs have the exciter on one chassis and the final amplifier above. It isn't difficult, though, to build four stages on the same unit if properly laid out. It was planned to place a shield box over the first two stages but when tested there was no interaction, tricky tuning, nor frequency modulation on any band; hence, it was omitted.

This chassis was made by buying a sheet of 1/16 x 26¾ x 30¾-inch aluminum and having a *good* sheet-metal worker do the bending. The finished chassis measured 13 x 17 x 6⅜ inches and had a half-inch flap at the bottom. It is advisable to make a cardboard model—or at least a *good* sketch of what is wanted, so the bender will make a workmanlike job of it.

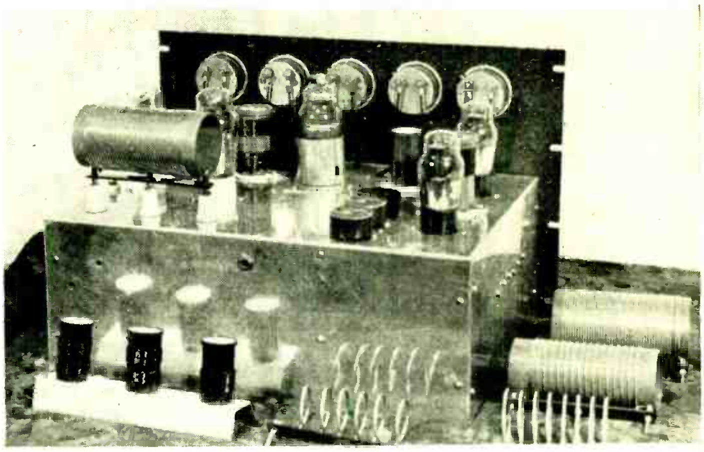
The circuit started in one corner and progressed around in the form of a "U," giving the benefit of a chassis twice as long. The oscillator, buffer, final and neutralizing condensers were underneath the chassis, protected from dust. This placed all wiring below deck, giving shorter leads, as well as leaving the top clean.

The 42-oscillator performed beautifully. Because of the cathode resistor, it started easily and worked perfectly—even with a crystal that caused plenty of trouble in a conventional 47 circuit. And you can be sure the crystal current is low! Only 40- and 160-meter crystals were used.

As the doubler was always tuned to 20 meters, only one coil was required for this socket. Don't try to work this stage straight-through! Either use it as a doubler or switch it out.

If one is interested in 20-, 40- and 80-meter

[1] R/9, December, 1935.



Back perspective view of r.f. unit, showing all coils required for five-band operation. Note that buffer plate-final grid coil is directly in front of one 10-T.

operation only, he can work all these bands with 80-meter crystals. This will require winding an 80-meter oscillator and 40-meter doubler coil which will never be changed.

The buffer and final tuning condensers were large enough and the coils trimmed, so as to reach two bands by simply turning the dials. This eliminated two coils. The 802 had a skirt placed around it, although leaving it off produced no ill effects. The available voltage for this stage was lower than one might desire, and it was necessary to run the suppressor about 35 volts positive to get enough output to double to ten and drive the final with sufficient reserve. If more than 500 volts are obtainable, the suppressor may be tied to cathode and the screen fed through a 20,000-ohm dropping resistor instead of the divider shown. A positive suppressor made the tube drive much easier, although it drives very easily either way.

The final neutralizing condensers were ganged to simplify adjustment. They have been set and screwed down tight, though.

In the photograph the coil sockets appear to be on top of the chassis. They are really mounted in holes cut to their exact size and shape and supported by cross strips at either end.

The final grid leads were not of equal length,[2] due to locating the coil in front of one 10-T, instead of centering it between them. The short lead to the socket was compensated for by being the long lead inside the coil form.

Capacity coupling was used in the first three stages. Variable coupling condensers were first used but found not at all critical on any band, so were replaced with fixed ones.

Inductive coupling was used from buffer to final, with both circuits tuned on all bands. Tuning is just like link coupling—without the link.

All by-pass condensers for each stage were returned to a single point. This was done by stacking them on a no. 6 screw, bringing all common condenser terminals to a common ground point.

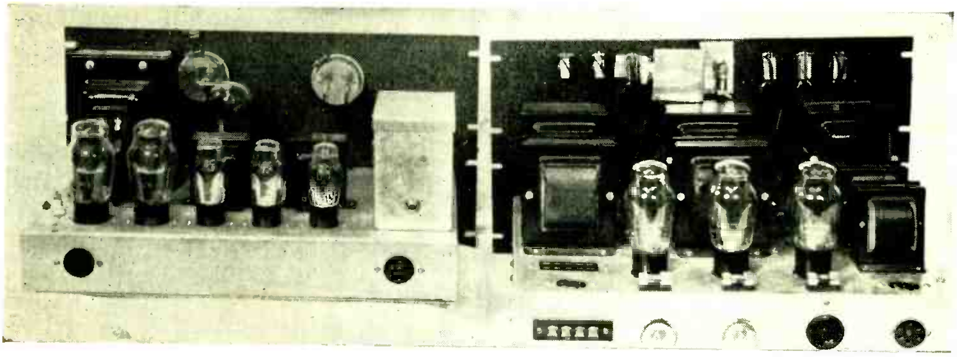
All meters were placed in the negative leads to keep the panels cold. Readings then showed cathode currents (sum of plate, screen, suppressor and grid currents), which were a little higher than plate currents.

The grid meter was switchable to read current on any amplifier stage. This meter had a regular 10 ma. movement but was specially ordered with a 30-ma. scale. Its resistance was about five ohms so it required shunts of just half that value. Old 4-ohm rheostats were trimmed in order that this meter would read properly by placing another meter and battery in series.

Bias and Excitation

The final amplifier was biased partly from the power pack and additionally from the 5000-ohm grid leak. It was designed to operate with 15 ma. grid current on all phone bands except 10 meters, where the grid current was 12 ma. On this band, the doubler drew more plate current, creating more fixed bias on the final; therefore, these 12 ma. across the grid leak and the additional fixed bias produced the same bias as on other bands. For c.w. operation, 5 ma. of final grid current gave just as much output and was less likely to generate

[2]See "Notes on Class-C Amplifier Design," RADIO, March, 1936.



Back view of modulator and power supply chassis. The tube by the modulator transformer is the type 45 negative-peak rectifier. The 57 amplifier lives in the little steel house.

harmonics. Incidentally, reducing the final grid current to as low as 5 ma. on phone failed to show any distortion either on the oscilloscope or monitor; however, it is not recommended for obvious reasons.

The doubler and buffer drove very easily. The 42-doubler grid current was 5 to 7 ma. The buffer took only a milliampere or two when working straight-through. Doubling to 80 meters, the 802-grid current was about 5 ma.; doubling to 10 it drew 5 to 7 ma. Exceeding this latter figure only resulted in *reduced* output.

Tuning

Tuning was smooth and straightforward on all bands. The final tank coils were cut so that the condenser was about three-quarters-in for 160 meters, being progressively less on each band down to 10 meters, where it was just 5 divisions in mesh. Ten-meter tuning was smooth but dial settings were rather "sharp."

The Antenna Tuner

A simple antenna coupler was used, permitting series- or parallel-feeder tuning by opening or closing a switch. Opening this switch and shorting one condenser will allow series tuning for a Marconi antenna.

The final tank coil was coupled to the antenna coil by one or two turns of no. 14 rubber-covered wire. One side of this link should be grounded for the suppression of any harmonics that might exist, although push-pull operation cancels the even ones to a large extent.

A dummy antenna, consisting of an ordinary 50-watt Mazda bulb, was simply clipped across a few turns of the final tank for testing, at which time the outside antenna was disconnected. If more dummy antennas were used, there would be fewer dumb signals on the air!

Output was fifty watts on the three lower-frequency bands, forty-five watts on 20 meters and around forty watts on ten.

COIL SPECIFICATIONS

Band	Oscillator Tank	Doubler Tank	Buffer Tank	Final Grid	Final Tank
160 Meters	54 t. no. 26 en. on 1½" form. Occupies 1 3/32 in.	Doubler stage not used	38 t. no. 26 en. on 1½" form. Occupies ¾ in. Leave ¾" between windings	40 t. no. 26 en. on same form. Occupies 13/16 in.	45 t. no. 14 wire on 3" form Spaced to 4½ in.
80 Meters	Use 160-meter crystal and above coil	Doubler stage not used	Use above coil, doubling in buffer stage		30 t. no. 12 wire on 2½" form Spaced to 4¼ in.
40 Meters	17 t. no. 18 en. on 1¼" form. Occupies ¾ in.	Doubler stage not used	10 t. no. 18 en. on 1¼" form Occupies 15/32 in. Leave ⅜" between windings	11 t. no. 18 en. on same form Occupies ½ in.	16 t. no. 12 wire on 2½" form Spaced to 3¾ in.
20 Meters	Use 40-meter crystal and above coil	8¼ t. no. 18 en. on 1¼" form Spaced to 19/32 in.	Use above coil, operating buffer straight through		8 t. no. 10 wire Air wound, 2½" dia. Spaced to 3½ in.
10 Meters	Same as above	Use above coil, doubling again in buffer	5 t. no. 18 en. on 1¼" form Spaced to 17/32 in. Leave 5/16" between windings	4¾ t. no. 18 en. on same form Spaced to 17/32 in.	6 t. no. 10 wire Air wound, 1¾" dia. Spaced to 3½ in.

Buffer plate and final grid coils are both wound on same form. Note that some forms are 1¼" diameter while others are 1½" diameter. Plate coil is on top of form. Antenna coil is 25 turns of no. 14 wire on 2-inch form, spaced to 3 inches.

The Modulator

The modulator was quite conventional, except for its overmodulation indicator and the c.w.-phone switch. Inclosing the first tube in a separate shield box and the liberal use of shielded cable up to the second grid eliminated any r.f. feedback, while plate decoupling networks prevented any tendency toward motorboating. There was plenty of gain for close-talking with a diaphragm-type mike.

The negative-peak type overmodulation indicator was chosen because of its simplicity and positive action. The meter remained at zero as long as modulation was less than 100% but kicked upward any time this figure was exceeded.

A type-45 tube was used as the negative-peak rectifier because only a 2½-volt filament winding was available. This tube remained burning for c.w. and the meter kicked up, probably due to some leakage; hence, it was necessary to break its plate circuit for c.w. operation.

The c.w.-phone switch was of Eby manufacture. In one position it opened four circuits and closed four other circuits. Any three-pole double-throw would do or even a d.p.d.t. if the overmodulation tube is cut out for keying.

For c.w. this switch shorted the secondary of the modulation transformer and broke the overmodulation indicator circuit. In the phone position, the modulator power supply (which also supplies its heater current) was turned on, as well as the plate current to the speech amplifier.

Modulator bias was furnished by a resistor in the negative lead of the modulator power supply. Since the tubes operated "AB," and because of the heavy bleeder on this power supply, the variation of bias with modulation was but slight. The modulator had to supply only about 40 watts so the quality was unaffected. Quality reports on the air were very flattering in fact. If a full 60 watts of audio were required, fixed bias would be necessary.

This unit was built on an 11x17x2½-inch cadmium-plated chassis. It had a bottom plate to prevent r.f. from getting into it.

If one cared to try the overmodulation rectifier as an overmodulation preventer, it would be easy to change the second tube to a 58, add a "B" battery, and work out the resistance-capacity network.

The Power Supplies

Three complete power supplies were mounted on the lower chassis. Each of these used a Thordarson T6878 transformer. These had three filament windings as well as the high-voltage windings, so it was decided to use them and save the cost of extra filament transformers. A heavy cadmium-plated chassis, 13x17x3 inches, was used for these power supplies.

Plate voltages were cut off by breaking the h.v. center taps. While this practice is usually frowned upon, it is quite satisfactory if the following precautions are observed: (1) Don't try to use 83 rectifiers. They won't stand up with broken center taps because there is still some 1200 volts from plate to plate. 5Z3's are ok. (2) Break these centers *only* with inclosed switches. When open, there is some 800 volts

[*Continued on Page 162*]

Back view with doors and brace strip removed. The dummy antenna may be seen in the upper left corner with safety interlock switch below. The inspection light is shown in upper right corner under its shade.

Revised F. C. C. Rules

● Since Rule 376 has been amended to allow radiotelephone operation in the band from 28,500 to 30,000 kc., it became necessary to repeal Rules 375 and 403, Class B, and to substitute revised rules for them. To quote from the F.C.C. report:

It is ordered, that Rule 375 and Rule 403, Class B, be and the same are hereby repealed and the following substituted in lieu thereof:

'375. Types of Emission—All bands of frequencies so assigned may be used for radiotelegraphy, type A-1 emission. Type A-2 emission may be used in the following bands of frequencies only: 56,000 to 60,000 kilocycles; 400,000 to 401,000 kilocycles.

'403. Class B—Unlimited radiotelegraph privileges. Limited in the operation of radiotelephone amateur stations to the following bands of frequencies:

1800 to 2000 kilocycles; 28,500 to 30,000 kilocycles; 56,000 to 60,000 kilocycles; 400,000 to 401,000 kilocycles.

In other words, no changes are made in the regulations as they actually apply; the changes have been made in the wording of the rules to adapt them to the recent shift in the ten-meter phone band.

Radio Spectrum Re-Allocated

● Heretofore, the rules of the Federal Communications Commission with respect to the use of radio for practical purposes have been confined to that portion of the spectrum from 10 kilocycles to 25,000 kilocycles. All frequencies above this upper limit of 25,000 kc. have been classed as experimental and have been allocated as such. Recently, with the much wider development of the ultra-high frequencies by radio amateurs, the television services, police systems, and those concerned with the development of frequency modulation systems, the Commission has felt the need for definite and systematic allocation of these ultra-highs. Hence, the legally-useful spectrum has been increased from 25,000 kc. to 300,000 kc.

In commission order no. 19, the new allocations, to become effective October 18, 1938, are set forth. Little change has been made in the assignments for amateur use. As a matter of fact, the amateurs have had the least revision in their allocations. Previous to this time, all frequencies above 110 Mc. have been open to any licensed service. With the new allocation, definite bands have been assigned in both the 112 Mc. and 224 Mc. range. Each of these bands is 6 Mc. wide. The former is from 112 to 118 Mc., the latter from 224 to 230 Mc.

Federal Communications Commission

Television Assignments

Television assignments have been made throughout the newly-allocated spectrum. Each of these new channels has been made 6 Mc. wide to allow ample room for the wide side-bands required for this service. Television assignments have been made in the close vicinity of the 56 Mc. band. As a matter of fact one of these new assignments is from 50 to 56 Mc.; the high-frequency limit of the television channel and the low-frequency limit of the 5-meter band are therefore coincident.

The implication is obvious; amateur operation on 56 Mc., will, within the next year, necessarily be confined to that of frequency stabilized transmitters.

It is with this thought in mind that we are this month presenting a crystal-controlled 56-Mc. transmitter.

General Communication

To return to the re-allocation of the spectrum other than that assigned to amateurs, no change has been made in those assignments between 10 kc. and 25,000 kc. The band between 25,000 kc. and the lower limit of the 10-meter band, 28 Mc., have been re-allocated as have all frequencies above 30 Mc. From 25,000 kc. to 27,000 kc. has been assigned for broadcast and government use; 27,000 to 27,975 kc. for general communication and government use.

Police Services

The police services have been given definite frequencies in the 30- to 40-Mc. range. This is in contrast to the previous experimental licenses held by all u.h.f. police stations. These police frequencies fall into four general classifications; those for low-power stations up to 15 watts, which will more than likely be used for mobile units; those for medium-power stations up to 250 watts; those for stations in excess of 250 watts, and those for state police use. Frequencies are given for each of these classifications throughout the 30-40 Mc. band. Also assigned to police service are frequencies in an experimental band from 132 to 144 Mc.

Broadcasting has been given a large number of the frequencies throughout the newly-opened u.h.f. range. In addition to the seven 6-Mc.-wide channels assigned to television, there have been channels assigned to the other broadcast services: facsimile, relay (for standard broad-

F. C. C. Notes

cast stations), regular high-frequency broadcasting and experimental stations.

Also assigned frequencies or bands of frequencies in the new range were the aviation, forestry, fixed and experimental communication, press, geophysical and motion picture, coastal harbor, marine fire, and special emergency services.

F. C. C. Re-Organizes

Effective November 15, 1937, the three divisions of the Federal Communications Commission: Broadcast, Telegraph, and Telephone, which have functioned since July 17, 1934, are abolished. All power vested in these separate divisions will now be exercised by the Commission. The proposal for reorganization received the unanimous approval of the Commission.

The handling of Commission business by the entire Commission, Chairman McNinch informs, will destroy the divisive effect created by the separate divisions, will restore co-operation and mutual understanding, and will permit the aggregate judgment and wisdom of all seven minds to be brought into play in all matters where previously only the two Commissioners constituting a division had a chance to work.

Amateur Radiomen Complimented

Commissioner Thad H. Brown of the Federal Communications Commission, in an interview conducted and broadcast by WGAR at Cleveland, paid glowing tribute to amateur radio and its men. The fact that the radio amateur has served his community and the world at large with unstinted effort, was brought out well in Mr. Brown's reply to questions on ham radio.

Briefly, Commissioner Brown said, "The heroic service performed by radio amateurs in every major national emergency is enough to assure you of our continuing deep interest in the amateur and his problems. The Commission's amateur license holders distributed throughout the States, Territories, possessions

[*Continued on Page 166*]

For the fellows who want controllable directivity and who are not satisfied with the results obtained with the smaller "Squishers" or "Squirters", last month Radio presented "Rotary Flat-Top Beam Antennas", by J. D. Kraus. This month we are describing three more arrangements whereby controllable directivity may be had with less extensive outlays than that used by Mr. Kraus. That was indeed an unusually fine installation, but a bit above the constructional capabilities of the majority of us.

The first is by Mr. Kraus, W8JK, again, and by R. R. Sprole, W8QJT, and concerns a method whereby optional end-fire directivity may be obtained from a flat-top beam in addition to its broadside characteristics. The second, by N. C. Stavrou, W2DFN, is an adaptation of the RCA model-C antenna and allows concentrated directivity in two horizontal planes; the final directivity pattern obtained is similar to the one mentioned above.

The third is a rotatable affair, a rotary flat-top beam with a somewhat more simplified construction and a different system of rotation than that of Johnny Kraus' array. We very seriously doubt if it would stand up under the weather conditions that are experienced in the East, but under the gloriously semi-tropical sunshine (?) of Southern California it's really very convenient; two beams are used, one for twenty and one for ten, both mounted upon the same rotary structure.

Controllable Antenna Directivity

(Part 1)

OPTIONAL END-FIRE DIRECTIVITY

with the Flat-Top Beam

By **ROBERT R. SPROLE,* W8QJT and JOHN D. KRAUS,** W8JK**

It is an inherent property of an effective beam antenna to produce a gain in certain directions at the expense of the radiation in others. Thus, a flat-top beam antenna[1] has a substantial gain broadside over a fairly large angle but the signal off the ends is small.[2] This effect is present both receiving and transmitting.

If a flat-top beam could be made, at will, either directive broadside or off the ends, the usefulness of the antenna would be much increased. A very simple scheme for doing this is shown in figure 1A. By throwing the single pole switch, S, to position 1, the antenna is operated as a conventional flat-top beam with maximum signal broadside. With the switch in position 2, the whole antenna plus feeders is operated as a long wire radiator, with the radiation a maximum essentially off the ends.

The "end-fire" directivity will obviously be most effective on end-fed flat-top beams having 3 or 4 sections. An end-fed flat-top of 2 sections can also be used, but with less pronounced "end-fire" effect. The flat-top beam used on 14 Mc. at W8QJT has 3 sections end-fed by a zepp. line one wavelength long. A double-pole-double-throw switch connects the antenna to either the transmitter or receiver. Figure 1B shows a switching system which has been used on the receiver at W8QJT. The length of the feeders was adjusted until the line appeared to be principally resistive at the station end. The receiver coil is grounded at the center and is linked by a 1-turn loop to the "doublet" input terminals of the receiver. The coil has about 16 turns of no. 22 enameled wire spaced to cover 1½ inches on a 1½ inch form. With the switch in position 1, the feeders are across the entire coil, and the antenna functions as a flat-top beam with maximum response broadside. With the switch in position 2, the antenna works against ground through half the coil, giving maximum response off the ends. This circuit arrangement works well since the impedance of the long wire antenna at the station end is considerably less than the impedance

[1] "Small but Effective Flat-Top Beam," J. D. Kraus, RADIO, March, 1937, p. 56; and June, 1937, p. 10.
[2] See horizontal radiation pattern, "Rotary Flat-Top Beam Antennas," figure 10, RADIO, December, 1937, p. 16.

*121 Maple Ave., Ithaca, New York.
**Arlington Blvd., Ann Arbor, Michigan.

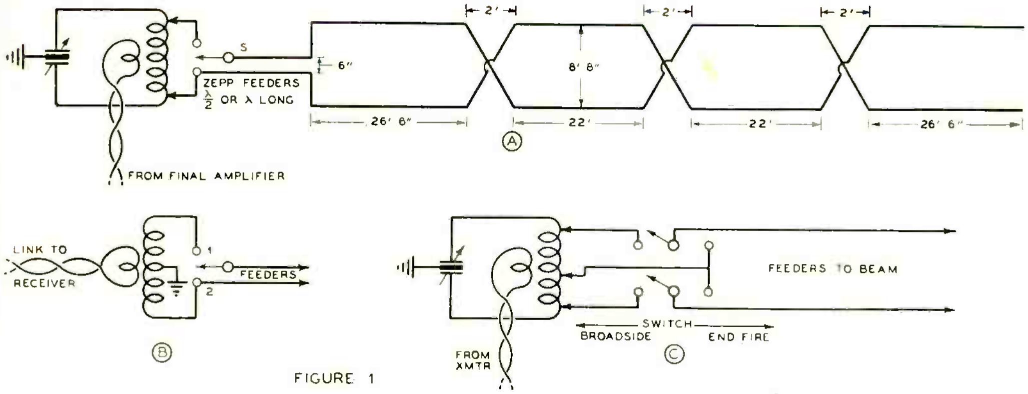


FIGURE 1

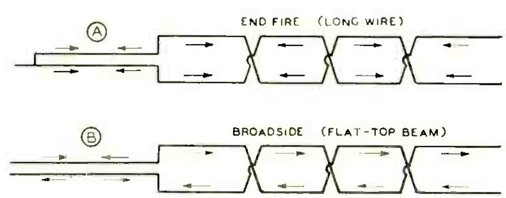


FIGURE 2

of the feeders when the antenna is used as a flat-top beam.

The performance of the antenna, when receiving, is very striking. By a flip of the switch, one can determine the general direction of the station being observed, i.e., whether it is broadside or off the ends of the antenna. The effect is generally very clear-cut, and visitors to the station, knowing nothing of the details of the system, can operate the switch and tell for themselves the direction of the station being received.

When transmitting, the arrangement of figure 1A is used. A modification of this circuit is shown in figure 1C. This makes use of a double-pole-double-throw switch and no retuning of the condenser is necessary when changing from the broadside to the end-fire condition, provided the length of the feeders is proper. That is, the feeder length should be such that they appear approximately resistive (feeders and antenna resonant) at the antenna tank. The twisted pair links the antenna circuit to the final-amplifier tank.

In figure 1A the recommended dimensions for an end-fed 4-section flat-top beam are given for operation in the 14-Mc. band. The two end sections are 26½ feet long. Since the center sections have cross-overs at both ends, they are shortened by an extra 4½ feet. With a 3-section flat-top, the end sections should be 26½ feet and the middle section 22 feet long. If a 2-section flat-top is used, both sections can be made 26½ feet long. The spacing between sections of these antennas can be about 2 feet. It may be noted that the dimensions given in figure 1 differ from those for a 4-section flat-top beam when fed at the center.[3] In this case (center fed) the dimensions may be either those of figure 1, or each of the sections, center ones included, may be made 26½ feet long. The dimensions are not critical, however, since the antenna is tuned-up at the station end of the feeders to the particular frequency being used. For use on 10 meters the dimensions of figure 1A should, of course, be halved, although the 14 Mc. antenna will work nicely in the end-fire condition on 28 Mc.

When the antenna is used as a long-wire radiator, the currents in opposite wires of one section of the flat-top are *in* phase. This is shown in figure 2A. The currents in the antenna and feeders when the antenna is used as a flat-top beam are shown in figure 2B. In this case the currents in the opposite wires of a flat-top section are in *opposite* phase. When the antenna is used end-fire, it is evident that the system is no longer working as a flat-top beam but rather the same as a long single-wire antenna. Accordingly, the horizontal and vertical radiation characteristics end-fire will be different than broadside. Also, the gain end-fire will probably not be as much as broadside. The orientation and length of the feeders will, of course, affect the radiation pattern when the antenna is used as an end-fire system, but the general effect will probably not be greatly changed. For the best null broadside, when the antenna is used end-fire, it would appear that an even number of flat-top sections plus half wave-lengths of feeder would be prefer-

[*Continued on Page 164*]

[3] RADIO, June, 1937, p. 11.

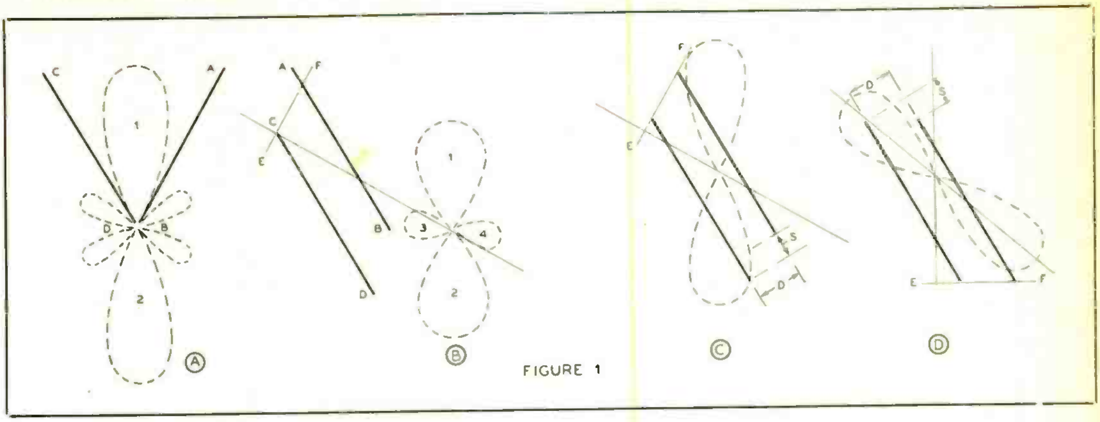


FIGURE 1

Amateur Application of MODEL C ANTENNAS

A DX antenna for four-point world coverage without physical rotation

By **NICK C. STAVROU,* W2DFN**

The majority of amateurs have read or heard of the excellent results obtainable with V-beam and rhombic antennas and have wondered if they would ever be located in a spot with plenty of territory to try one. To those who have the length for a long wire array but not the required width, there is an alternative that can be used with an added advantage of changeable directivity.

The classifications of model B, C, and D are designated to these long wire arrays by the RCA engineers[1] who designed them, and they are completely treated in a paper that is a classic on the subject.

The model D is the now well-known and justly recognized V-beam (figure 1A), which has been treated in amateur publications many times. However, models B and C have rarely been mentioned in amateur work.[2] The reason for their little use is probably because they require mathematical computation of the position of the radiators. They are, therefore, a little more critical than the V-beam or model D. We have endeavored to simplify their mathematics to a simple table which can be used for any amateur band normally used for dx, and to show a simple means of getting four-point coverage.

A V-beam is good for any two opposite directions. If any other direction is desired, it means another V-beam and the real estate required for two V's is—well! The model C, however, requires only slightly longer length and only a fraction of the width of an equivalent model D. (When the expression "equivalent model D" is used throughout this discussion, it will imply a V-beam, each leg being the length of a single radiator of the model-C antenna.) An additional advantage is the ease with which radiation lobes may be exchanged.

In figure 1A is shown a simple V-beam with each leg two wavelengths long and fed in phase. The model D is nothing more or less than two harmonic antennae broadsided to cause lobes 1 and 2 to be additive while the others more or less cancel. Now, if we place the radiator AB parallel to CD, as in figure 1B,

*51 South Orange Avenue, Newark, New Jersey.
[1]Carter, Hansell, and Lindenblad, "Development of Directive Transmitting Antennas by R.C.A. Communications, Inc." *Proc. of I.R.E.*, Oct., 1931.
[2]E. H. Conklin, "Antenna Gain without Horizontal Directivity," RADIO, May, 1937.

T A B L E (Refer to Figure 2A)

Length of radiators in wavelengths	α	D	S	Length of halfwaves $\frac{\lambda}{2}$ in feet
1½	42°	$.746\frac{\lambda}{2}$	$.67\frac{\lambda}{2}$	7150 kc. = 68.8 feet 14200 kc. = 34.7 feet 29000 kc. = 17. feet 58000 kc. = 8.5 feet
2	36°	$.85\frac{\lambda}{2}$	$.62\frac{\lambda}{2}$	
3	29°	$1.03\frac{\lambda}{2}$	$.57\frac{\lambda}{2}$	
4	25°	$1.18\frac{\lambda}{2}$	$.55\frac{\lambda}{2}$	
5	22.5°	$1.3\frac{\lambda}{2}$	$.54\frac{\lambda}{2}$	

$$\text{Length of radiators} = \frac{984{,}000\ (K - .025)}{F\ (_{KC})}$$

$$S = \frac{\sin \alpha}{\sin 2\alpha} \qquad D = \frac{\cos \alpha}{\sin 2\alpha}$$

NOMENCLATURE

K = Number of wavelengths

α = Angle of radiation from harmonic wire

D = Distance separation of wires in feet

S = Stagger distance in feet

stagger it in such a manner that CD is a half-wave to the rear of AB with respect to lobe 1, and then feed the two radiators 180° out of phase, the array will radiate as shown, with lobes 3 and 4 poorly cancelled (the dimensions of the lobes in the diagrams are rough approximations). This occurs since the wave front of lobes 3 and 4, represented by line EF, does not have a corresponding point of opposite phase on both wires. Since complete cancellation of lobes 3 and 4 cannot occur, some power must be subtracted from the desired directions of radiation.

Figure 1C indicates the proper correction of staggered distance. This clearly shows that model-C antennas are two harmonic radiators in an end-fire arrangement. Figure 1D depicts the radiation pattern with the stagger reversed. The gain of the arrangement in figure 1C is not quite so good as an equivalent V; the ratio of power gain of the two arrays is about 1 to 1.15 in favor of the V. The lesser gain of the model C is a fault common to all end-fire arrays with half-wave separation between elements[3].

Probably the best methods of feeding this long-wire array are shown in figure 2. As long as the stub or the feeders from the transmitter connect to the exact center of the jumper be-

[3]E. J. Sterba, "Aspects of Directional Transmitting Systems," *Proc. of I.R.E.*, July, 1931.

tween radiators, they will always be fed 180° out of phase even if the wires themselves are not of the correct length for the frequency of operation. Figure 2A is for ordinary zepp. feed, while figure 2B is shown for a fixed impedance non-resonant line with a ¾ λ matching stub.

The model-B antenna is identical to the model C except that the plane of the wires is vertical, whereas in the latter they are always horizontal. Model B is vertically polarized and has a fault common to all end-fire arrays thus polarized in that the vertical directivity is quite sharp while the horizontal directivity is broader than model C. This in itself is no disadvantage[2], but getting the angle of radiation low

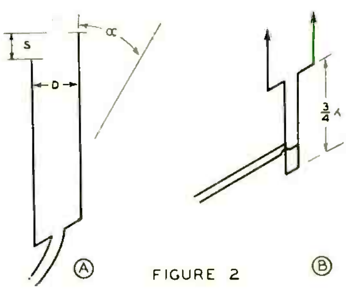


FIGURE 2

Showing two methods of feed for the model-C array; zepp-feed on (A) and stub match on (B). (A) also shows the relation of S, D and α.

enough in medium length arrays requires unusually high towers. Figure 4 shows what we mean. A reflector is also shown in this figure. This will help the gain but makes the towers still higher.

Using the Table

The table is quite handy and practically self-explanatory. Given, for example, a two wave array for 14 Mc., the length of the radiators will be:

$$L = \frac{984000\ (K - .025)}{F\ (kc.)}$$

$$L = \frac{984000\ (2 - .025)}{14200} = \frac{1933400}{14200}$$

L = 136.2 feet

The separation distance D from the table is found to be 0.85 times a halfwave which is given at the right hand side as 34.7 feet.

D = .85 x 34.7 = 29.5 feet

The stagger distance:

S = .62 x 34.7 = 21.5 feet

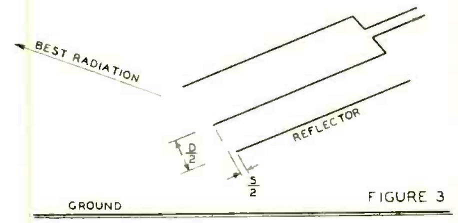


FIGURE 3

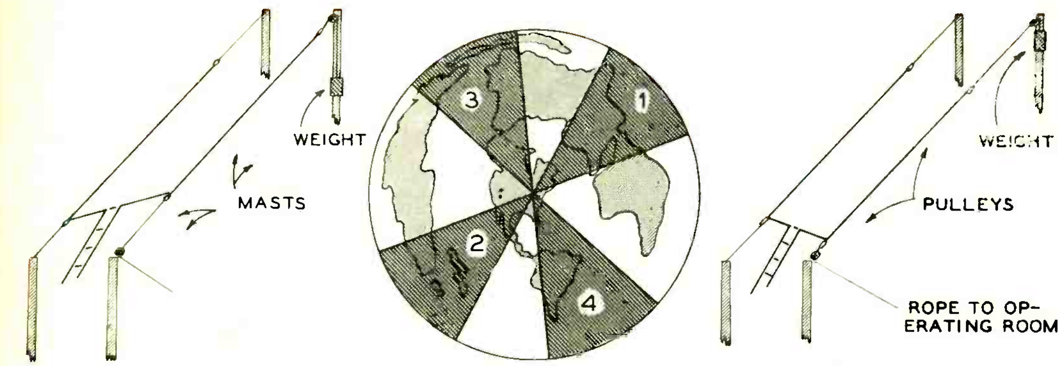
Another long-parallel-wire antenna system, the model-B which radiates vertically-polarized waves as compared to the horizontal polarization of the model C.

Figure 4 depicts how full use may be had of all lobes by simply drawing harmonic antenna radiations on tracing paper and orientating the latter on an azimuthal projection of the earth similar to the ones given in RADIO for January, 1937. Figure 4 shows great circle directions centered on the eastern U.S.A. with a two-wave array. It will be seen that all the continents are fairly well-covered with the exception of Africa and western Australia; since attempts to place a lobe in Africa left out Europe or Asia, our own personal preference is shown.

The method of changing the directions of radiation is shown graphically at each side of figure 4. The array is suspended from four poles, the placement of which is roughly shown in this diagram. The left hand wire is supported rigidly between its two poles. The right hand one, however, is movable and is supported by means of ropes and pulleys. The far end of the wire is attached to a rope which goes through the pulley on the pole and hangs down toward the ground. This wire is kept tight by means of a substantial weight (a bucket of concrete would be suitable) which hangs from the end of the rope. The rope which connects to the other end of the movable radiator is brought over to the shack or to some convenient position.

Since the movable wire will have to be moved through a distance of 2S, twice the stagger distance of the wires, it is necessary that the rope be capable of considerable movement and that the weight attached to the other end be capable of movement through this distance. In the antenna cited above, 2 wavelengths long on 14 Mc., this necessary movement would be about 43 feet. Two loops could be placed in the rope about 43 feet apart to indicate the two proper positions of the movable wire.

As is the case in all long wire arrays, the longer the wires, the more sharply directive

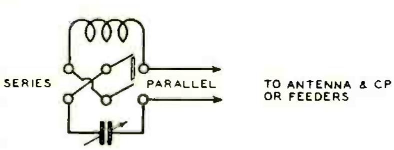


FOR LOBES 1 & 2 FIGURE 4 FOR LOBES 3 & 4

is the radiation pattern in both the horizontal and the vertical plane. Also, the greater is the power gain in the favored directions of radiation. Hence, if good coverage is desired, the array had best not be made too long. But if unusually strong coverage of certain sections of the world is desired, the longer the wires the better.

This Switching from Series to Parallel

Two of our readers have sent in these suggestions to help the struggling amateur in that always inconvenient problem of switching something from series to parallel. Both may have been published previously (to our knowledge they haven't, but there is seldom anything very new it seems) but that certainly will not detract from their usefulness.



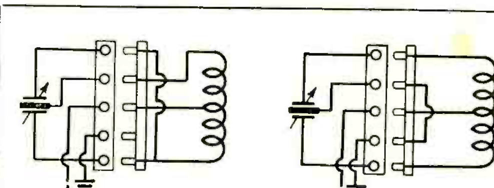
This one was suggested by P. J. Eubanks, W8VK, of Cleveland, Ohio. To quote from his letter:

"On numerous occasions contemporary publications have shown circuits for switching from series to parallel where two condensers were involved, but insofar as I can remember, I have never seen a circuit of the series-parallel variety with but one condenser. For this reason I am attaching one herewith."

This arrangement should really simplify the procedure of switching one condenser from series to parallel when resonating a tuned feeder system such as a Zepp.

The other one—

"In designing my rig this fall, I wanted to be able to use the same final on both 10 and 160 meters, but I didn't want to have to use two tank condensers. So, by making my coils on five-contact mounting strips, I figured out this arrangement whereby the conventional split-stator method of tuning is used on ten meters, and on 160, where a much higher tank capacity is needed, the two stator sections of the condenser are paralleled. This gives four times the tuning capacity on 160 as on 10—with the same tuning condenser." — L. B. Boles, W9VZP, Goshen, Indiana.



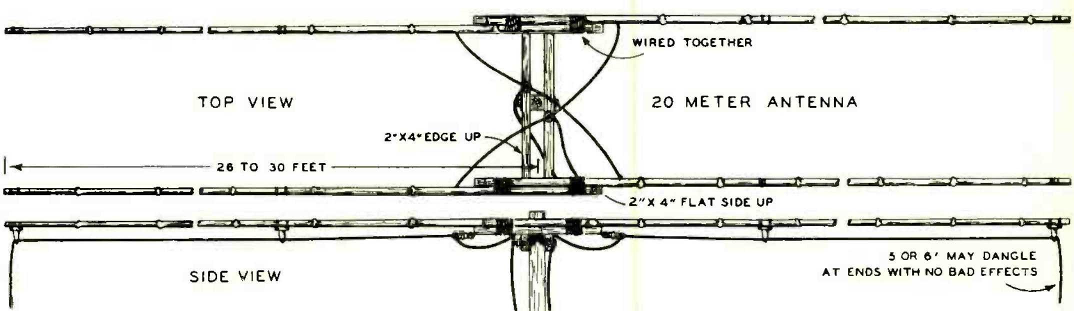
STATORS PARALLELED FOR HIGHER C ON 160 METERS

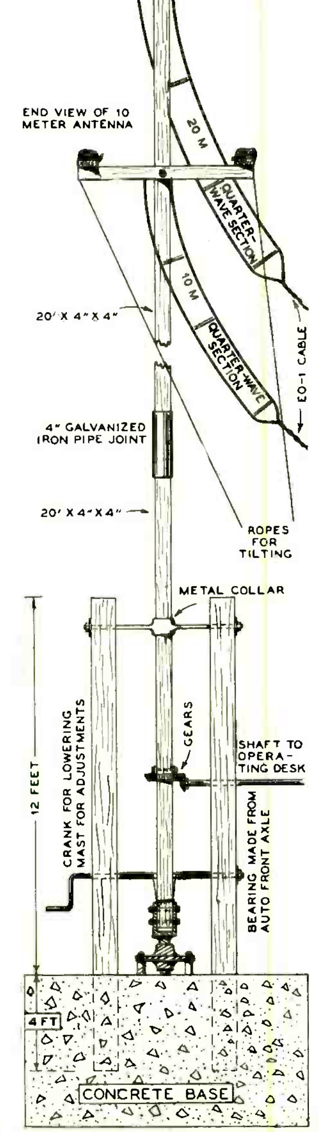
SPLIT STATOR & ROTOR GROUNDED FOR 10 METERS

A Simplified Flat-Top Rotary

Controllable Antenna Directivity (Part 3)

By FORREST DONKIN,* W6MZD, and ROD RICHARDS, W6FKK**





Kraus really had something there when he developed the flat-top beam antenna. And you'll have something there, too, if you'll put one of these wave shooters on a pole and rotate it.

You can easily erect a rotatable four-by-four pole about forty-feet in height for one of the twenty-meter flat-tops, and if you want to work ten meters, just put one for that band on the same pole. We have that construction in use here and it works out fine.

Transmission checks made with distant U.S. stations using R-meters on the receiving end show that our signals fall from R9 in the line of the beam to R3 with the beam 90° off in the horizontal plane.

As can be seen from the sketch, the flat-tops can be tilted. Variation in the vertical orientation of the beam is liable to give different results at different times and often introduces fading otherwise absent. A drop of from three to four R's is usually the result of tilting more than 20° above or below the horizontal position.

In addition to getting R reports on our transmissions, we have directed the beam at a fixed flat-top about one-wavelength distant which has a 2.5-volt flashlight globe in series with zepp. feeders. The directivity of the array is shown by the fact that the globes will burn out with the beam full on and will die clear out with the beam at right angles. This is for rotation in the horizontal plane.

To find the position for the shorting bar, or, as in our case, the position for attaching EO-1 cable, we connected the transmitter to our fixed flat-top and slid a shorting bar with a flashlight globe in series up and down the stub of the rotatable array to find the point of maximum brilliancy at resonance. The light would show color at a distance of about eight inches either side of resonance and would light up quite brilliantly at resonance.

The Ten-Meter Beam on the Same Pole

When we mounted the ten-meter antenna under the twenty-meter flat-top at a distance of about twenty-four feet off ground and parallel to it, we discovered that it was directional off the ends. However, when we mounted it at right angles to the twenty-meter wires, we found very little interaction.

With the ten-meter antenna tuned up for 28,770 kc., the field strength drop when changing

[*Continued on Page 160*]

*1409 Coldwell Ave., Modesto, Calif.

**Route 4, Box 1485, Modesto, Calif.

Lafayette 5B40W

Collins 32G

"Radio's"

REVIEW OF

• In the January, 1937, yearbook issue of RADIO, there was presented a section devoted to the technical and mechanical specifications of the more popular amateur communications receivers. In this, the enlarged January, 1938, issue, we are presenting, in addition to the section devoted to the receivers, a review of the current lines of manufactured amateur communications transmitters.

An increasing number of the amateur fraternity are purchasing commercially manufactured transmitters. For these amateurs, this section will afford a comparison between the features of the various makes.

However, since the majority of amateurs prefer to build their own, this section will afford an excellent insight into the better features of some of the commercial designs. There are features in all these manufactured units that are worthy of note.

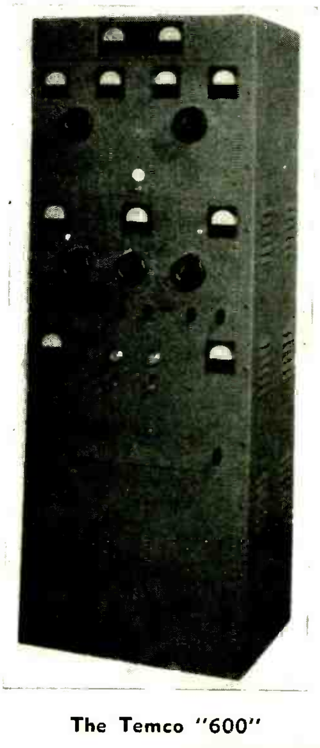
The transmitters that follow are given in alphabetical order with respect to the manufacturers; the transmitters with power ratings and specifications most suitable to the amateur's needs are given for each manufacturer.

The Collins 32G

The power output rating of the 32G is 40 watts both for radiotelephone and c.w. operation. It is capable of operation from 1600 to 40,000 kc. although higher and lower frequencies are available on special order. Shielded plug-in coils are used in the various oscillator and doubler stages. These coils can be seen in the foreground of the top view of the transmitter.

The r.f. lineup is as follows: C100D oscillator, 6L6 first frequency multiplier, 6L6 second multiplier and a pair of 6L6's in the final modulated stage. A 6J7, a 6C5 and four 6L6's constitute the audio complement of the transmitter. A 5Z3 and a pair of 83's are used in the power supplies.

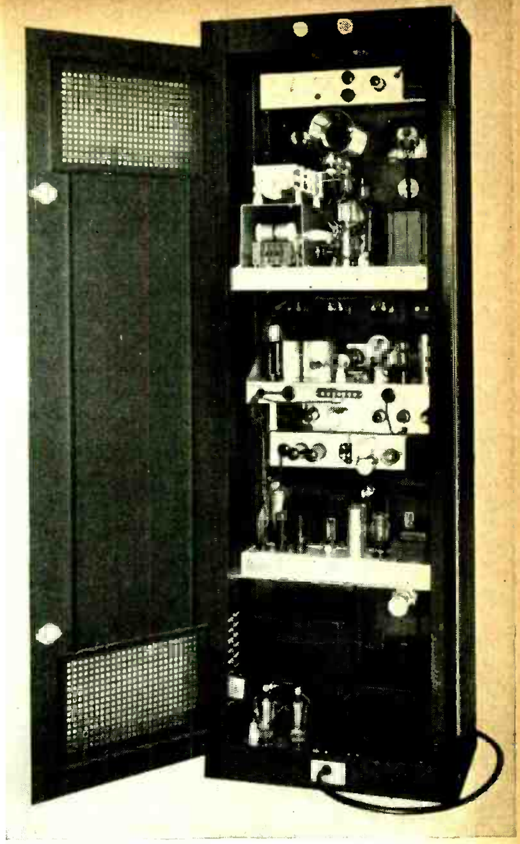
The four 6L6's in the output of the audio channel are used in push-pull parallel class AB to plate modulate the pair of 6L6's in the output r.f. stage. A pi network is used as a universal antenna coupling system. The cabinet



The Temco "600"

ACT-20

TRANSMITTERS *for 1938*



Harvey 700-R

dimensions are: width, 20", depth, 16" and height, 10½".

The Collins 30J

The 30J transmitter is indeed a well designed unit from both the electrical and mechanical standpoints. The photograph shown herewith attests to the former statement, and the electrical specifications given for the rig would indicate that the latter is not an overstatement.

The rating is 250 watts output, phone and c.w., over the frequency range of 1.5 to 30 Mc. On special order, the unit may be designed for any frequency from 500 kc. to 60 Mc. The power source is 110 volts, single-phase a.c., and it draws about 1200 watts from the line when fully modulated at full input.

The tube complement is as follows:

1—C100D oscillator
1—807 first buffer-doubler
1—807 second buffer-doubler
3—807 third buffer-doublers
2—C101 final amplifiers
2—6J5G audio amplifiers
2—6F6G audio drivers
2—C120 modulators
2—C249B rectifiers, mercury vapor
2—C866A rectifiers, mercury vapor
1—5Z3 low-voltage rectifier

The audio frequency input is direct from the microphone to the input of the speech amplifier. High-level class-B modulation of the two C101's in the final amplifier is accomplished by the C120 modulators.

The Harvey UHX-10 Transmitter

The UHX-10 is a multi-purpose, multi-band transmitter having a power output, 100% modulated for radiotelephone, of from 7 to 12 watts depending upon the band of operation. It is unusually compact, making it very suitable for mobile use under the conditions of operation encountered in police service. Its frequency range is from 1.5 to 60 Mc. and this range is covered by means of plug-in coils. C.w., i.c.w., or phone operation may be selected by means of a switch mounted upon the front panel.

A 6L6 is used in the oscillator stage where it may be operated either as a straight pentode oscillator, a tri-tet, or as an electron-coupled oscillator when crystal control is not desired. This tube is followed by another 6L6 that is always used as a neutralized amplifier on all bands. 20 watts input is run into this second 6L6 under normal operating conditions.

A 6N7 is used as a class-B modulator for the final stage, and this tube is driven by another 6N7 acting as a driver. The microphone is coupled directly into the grid of the first 6N7.

The UXH-10 may either be powered by a dynamotor for mobile use or by an a.c. operated power supply for fixed station installation. The drain, 150 watts from the a.c. line or 17 amperes from the 6-volt storage battery, is quite reasonable for a unit of this size.

Two meters are provided to facilitate the tuning-up process. However, for operation in automobiles, trucks or in other services where remote control is desired, a special model is available. This unit is shock-proof mounted, carries no meters, and is designed to be controlled from the steering post or some other remote point. A meter board is then provided which can be temporarily inserted in the circuits for tuning-up.

The Harvey 80-T and 700-R

The 80-T is a phone-c.w. transmitter designed to operate within the range from 1.5 to 30 Mc. There are only two tubes in the r.f. section, a 6L6 oscillator and an RK-20 amplifier. The oscillator is provided with a series output tank arrangement which allows it to operate very well either as a fundamental or a harmonic oscillator. Due to the low excitation requirements of the RK-20, ample excitation is obtained for operation on all the bands specified.

A speech amplifier is provided for the suppressor modulation of the RK-20 for phone use. This amplifier is comprised of a 6J7 high-gain first stage, a 6C5 and a 6F6, the latter pentode connected. The amplifier is available with inputs either for double-button carbon or crystal microphones.

The output of the transmitter is rated at 18 watts nominal for radiotelephony, and 80 watts nominal for c.w. The power supply for the final stage utilizes a pair of 66's and is mounted at the bottom of the rack as shown in the illustration.

The 700-R transmitter uses all the equipment of the 80-T as an exciter for an amplifier, the 700-A, which uses a pair of Eimac 250-TL's. This stage is used as a class-C amplifier for c.w. use and is easily capable of its rated output of 750 watts. On phone, the amplifier is operated as a class-B linear, and provides an output of 250 watts to the antenna.

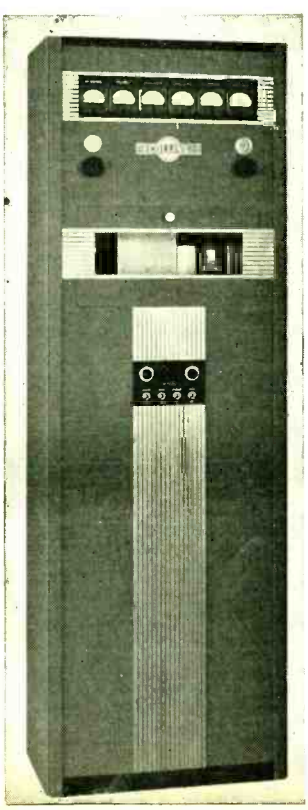
The final power supply, using a pair of 866A's, supplies 2000 volts to the 250TH's at a current up to 500 ma. This power supply is mounted at the bottom of the rack and is electrically interlocked by means of a door switch to insure that it is disconnected from the line when the rear door is opened.

Also mounted in the rack is the stabilized bias supply for the final stage, using a pair of 6L6's in parallel, and a modulation monitor. The latter can be seen at the extreme top of the rack.

The back view of the 700-R shows the various units of this transmitter as well as those comprising the 80-T. Those that are used in the 80-T can be identified by the front-view photograph of this transmitter.

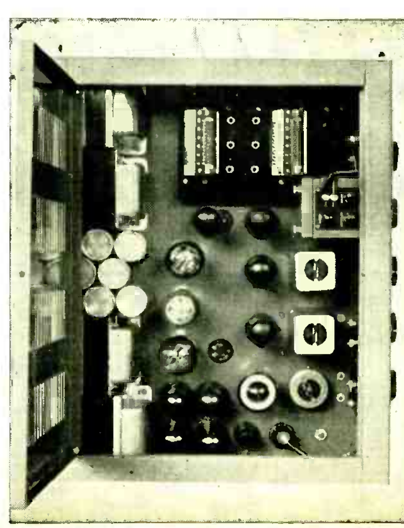
The RCA ACT-150

The ACT-150 is a 150-watt phone-c.w. transmitter designed for operation on the amateur bands from 1.7 to 30 Mc. The entire transmitter is self-contained within the modern-design rack shown in the photographs. The speech



• **Collins 30J—A well-designed unit from both electrical and mechanical standpoints.**

• **This shows the neat internal arrangement of the Collins 32G.**

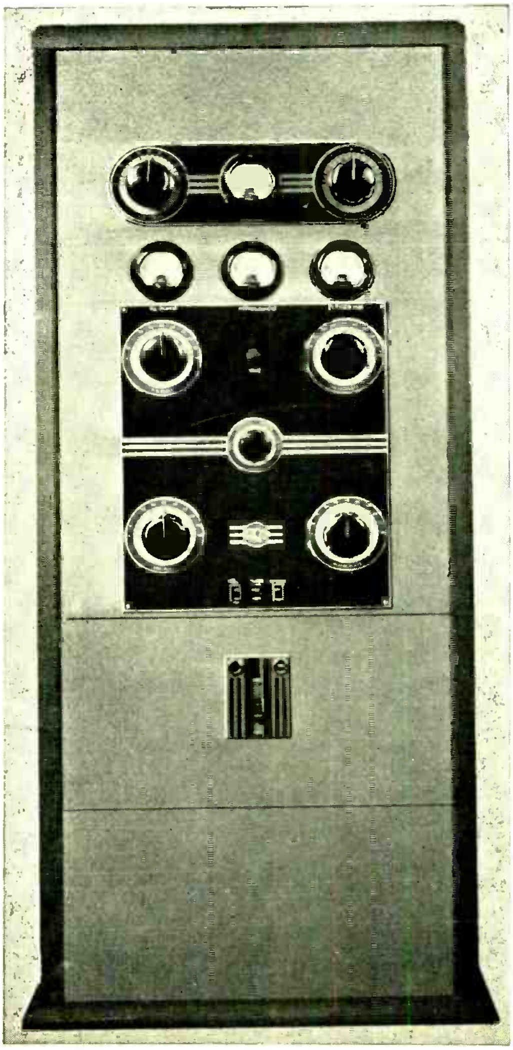


amplifier, however, is external and can best be mounted upon the operating table.

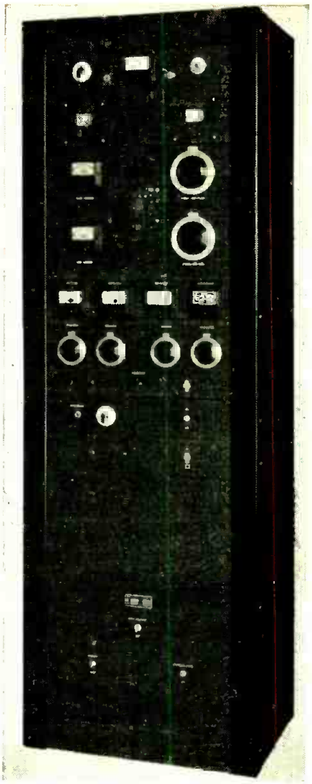
The tube line-up of the r.f. section is: an 807 crystal oscillator, an 802 frequency multiplier, a pair of 807's in push-pull in the buffer amplifier, and a pair of 808's in push-pull in the final stage. An antenna coupling network, with an antenna ammeter, is provided to facilitate the antenna-tuning process.

The speech amplifier, as mentioned before, is external. It consists of a 6J7, a 6C5 and another 6C5 feeding into a 500-ohm line. Inverse feedback is used to improve the response of the amplifier. A 250-ohm input is provided to the amplifier to facilitate the use of a dynamic microphone. A crystal mike may be used, provided a slight change is made in the input of the amplifier. The power supply for these tubes is self-contained.

The 500-ohm line comes into the transmitter



Front Panel View of the ACT-150



• Front view of the Harvey 700-R.

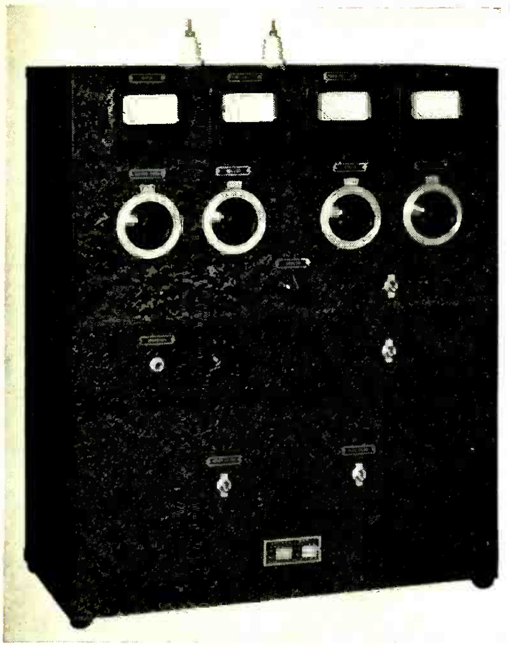
and feeds into a pair of 2A3's which act as drivers for the modulators, another pair of 808's. The 808 modulators are coupled to the final r.f. amplifier by means of an autotransformer.

One 1250-volt, 500-ma. high-voltage power supply is used for both the final amplifier and the modulator. A pair of 866's and a swinging-choke-input filter are used on this supply. An electrical interlock is provided to disconnect the plate voltage when the rear door is opened.

The RCA ACT-20

This low power amateur transmitter has several interesting circuit features which will appeal to many amateurs. The transmitter is completely housed in a cabinet similar to that used for a radio receiver, and will supply 16 watts of carrier output in any band from 10 to 160 meters. The c.w. output is 20 watts on any band.

A tetrode crystal oscillator is employed, using an RCA-807 with a small external capacity between the control-grid and plate for feedback at the crystal frequency. The plate circuit includes a split-coil arrangement, with the plate of the crystal oscillator connected to one end of the coil, and the grid of the RCA-802 connected to the other end through a blocking condenser. This arrangement tends to balance the capacities across the two halves of the split



Front view of the Harvey 80T transmitter.

The Harvey UHX-10 with microphone in the center. To the right and left are shown the battery-operated and the a.c. power supplies for the transmitter.

plate coil and, in effect, is the same as connecting the grid circuit of the buffer stage across half of the tuned plate coil. An 802 serves as a buffer or doubler stage which does not require neutralization. The final amplifier is neutralized because the 807 is not perfectly screened and would be regenerative without the neutralizing circuit. This stage must not be regenerative because it is modulated for phone operation. Combined plate and screen-grid modulation is applied to the final amplifier from a 6L6 class AB modulator.

A double-button carbon microphone can be connected to the input transformer of the speech amplifier. The circuit is arranged so that the transmitter supplies current to the carbon microphone, which should be capable of a level of —35 db.

Interior view of the Harvey UHX-10

The speech amplifier consists of a 6F5 high μ triode, resistance coupled to a 6F5 triode-connected driver stage. This tube drives a pair of 6L6's as modulators. The c.w. switch removes the plate voltage from the speech amplifier, and from the screen of the modulator, in addition to connecting across the power supply to maintain good voltage regulation under keying. A single power supply furnishes plate voltage for the entire transmitter.

The Temco 100 Transmitter

This is a 100-150-watt phone-c.w. transmitter designed to operate in the range from 1500 kc. to 30 Mc. The r.f. section is built upon a single chassis and employs a 6L6 as a crystal oscillator and harmonic generator. An RK-25 pentode operates either as a buffer amplifier or as a frequency multiplier. A T-55 is used in the class-C power stage. The crystal oscillator and buffer amplifier are completely bandswitching from the front of the panel. Provision is made for the use of four crystals and selection is made by a front-of-panel switch. Proper excitation is insured by an excitation control that is mounted upon the front panel.

The speech amplifier-modulator is mounted upon another chassis and consists of the following: a 6F5, a 6C5, a pair of 6C5's in push-pull, and a pair of 6L6's in push-pull, class AB_2, as modulators. The unit has an overall gain of 110 db thus providing ample amplification for the operation of all low-level high-impedance microphones.

Two power supplies are used for the r.f. section; both are mounted upon the bottom chassis of the transmitter. One, using a pair of 866's, supplies 1000 volts for the T-55 stage. The other supplies 550 volts to the buffer and 350 to the crystal oscillator. A safety switch is employed to protect the operator from an accidental application of the plate voltage when the rear door is opened. Provision is made for remote operation and control of the transmitter.

The Temco "600"

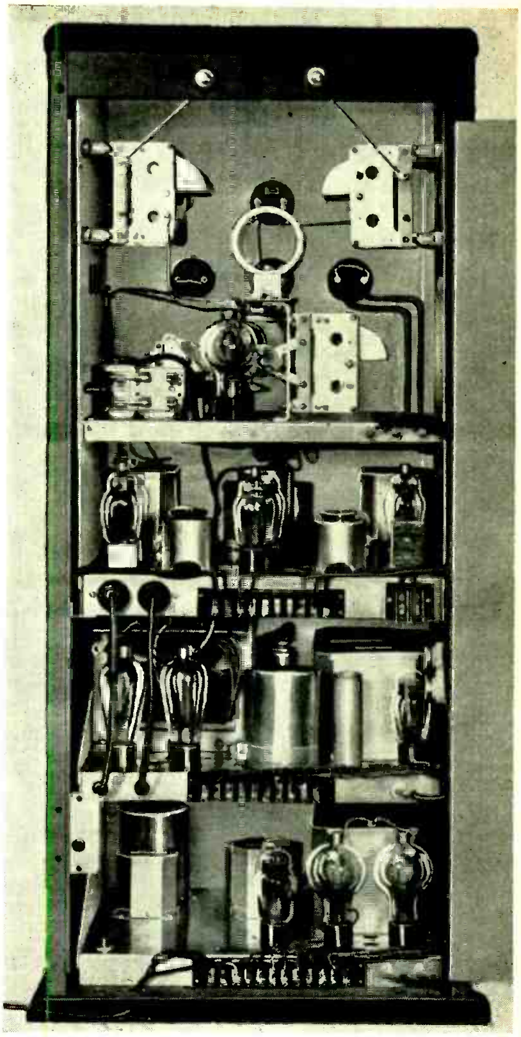
This 600-watt phone-c.w. transmitter is also designed for operation within the range from 1500 kc. to 30 Mc. The crystal oscillator, frequency doubler and buffer stages employ band-switching and this is accomplished from the front panel. The intermediate and final amplifiers employ low-loss plug-in coils. The transmitter is furnished complete with all coils for five-band operation.

The r.f. line-up of the "600" is as follows: a 6L6 crystal oscillator, an RK-25 frequency multiplier (which is switched into the circuit only when additional frequency multiplication is needed), another RK-25 buffer-doubler, and an RK-20 power buffer. A pair of RK-38's or 100TH's are used in the final stage as a push-pull power amplifier.

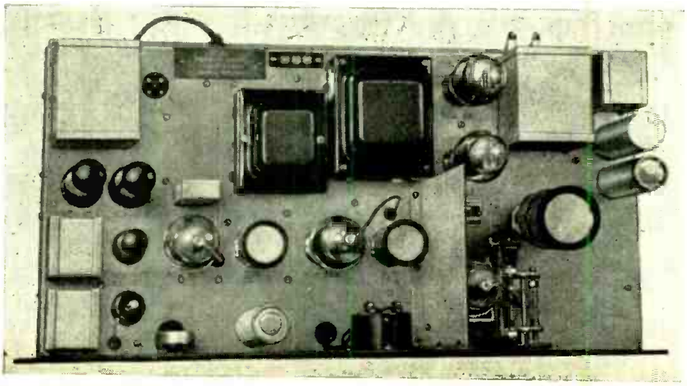
The speech amplifier is furnished in a separate desk cabinet and consists of a 6J7, a 6N7 electronic mixer, a pair of 6C5's in push-pull and a pair of 2A3's in push-pull feeding into a 500-ohm line over to the transmitter proper. Control buttons are incorporated in this unit for the remote operation of the transmitter. The speech itself is flat within 2 db from 60 to 10,000 cycles. A pair of RK-38's or 100TH's, mounted within the transmitter, are used to class-B modulate the final stage of the rig.

A built-in cathode-ray oscilloscope is used to provide continual monitoring of the transmitter's output. A 913 tube is used.

Four separate power supplies are used for the transmitter. One supplies plate voltage to the exciter unit. The second supplies voltage to the RK-20 intermediate amplifier. The third supplies high-voltage to the final stage and the



Rear view of the RCA ACT-150.



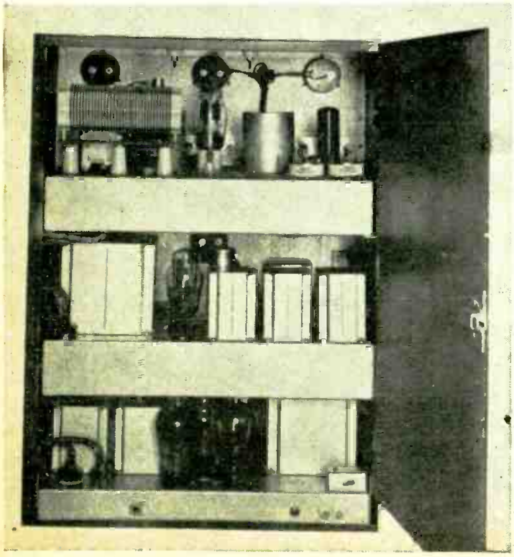
Looking down on the "works" of the ACT-20.

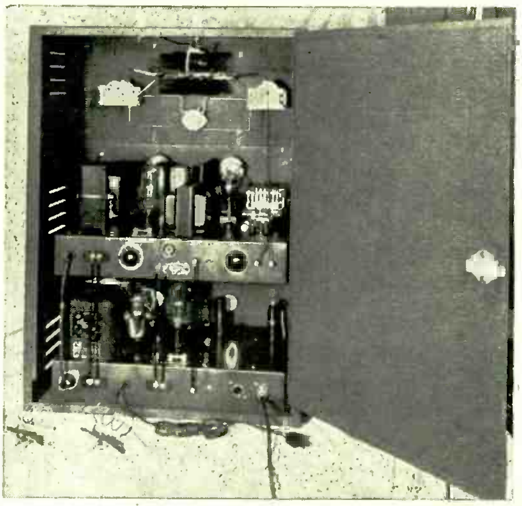
Rear view of the Temco "600" with the doors opened.

modulators, while the fourth supplies C-bias to all stages.

The Lafayette 5B40W

The ratings of this transmitter, manufactured by the Wholesale Radio Service Co., are given



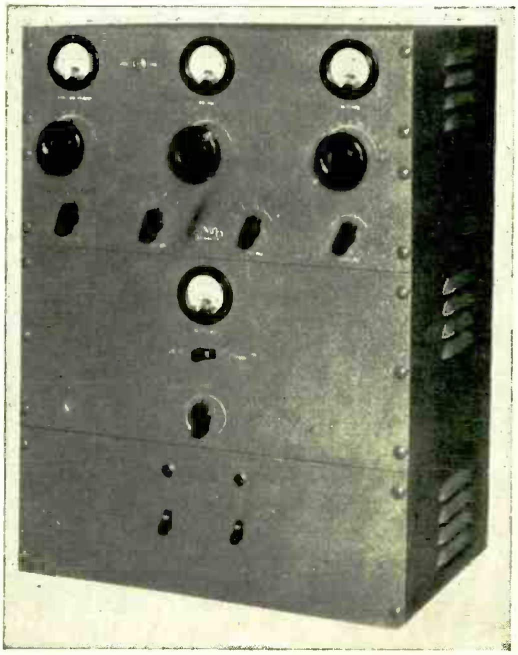


Back view of the 5B40W Lafayette.

in condensed form in its title: five bands, 40 watts.

It is a phone-c.w. job, plate modulation of the final stage being used when phone operation is desired. An interesting feature for a rig so comparatively small in power-handling capabilities is the built-in cathode-ray oscillo-

[*Continued on Page 156*]



Front and rear views of the Temco "100" transmitter.

A Glance at

THE 1938 RECEIVERS

As the majority of you will probably remember, in the January, 1937 issue of RADIO a special section was devoted to the more popular of the communications receivers that are available to the amateurs. It is of great assistance to the prospective purchaser of a receiver if it is possible for him to refer to a condensed tabulation of the specifications and to a brief discussion of the features of the various receivers in which he is interested.

It is to this end that we are presenting the 1938 models for your consideration. Some have had only slight improvements made in them while five are more or less of new design. At any rate, the prospective purchaser has a very good selection, both as to price range and as to features of design, from which to make his choice.

The tabulation of condensed specifications follows the same format as for 1937. Two columns have been dropped; the one "D.c. isolated from phones," because in all the new receivers, the d.c. is isolated from the phones, and the one "Approximate h.f. oscillator drift at 14 Mc." This latter column has been dropped since, while it would be an excellent means of comparing the general design of the receivers, there are too many variables that come into the picture. For one thing, there is a great deal of difference between the drift experienced from different oscillator tubes of the same type number. For another, the conditions under which the receiver is measured have a great deal to do with the drift experienced; if the cabinet were well ventilated externally the drift would be considerably less than it would be if the same receiver were mounted in a confined space.

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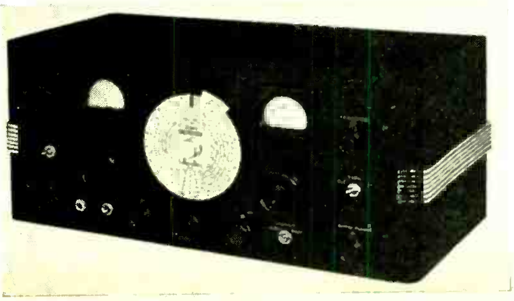
The Hallicrafters Super Skyrider SX-16



A rather recent addition to the "Hallicrafters" line, the Sky Challenger embodies many of the features of the larger Skyrider yet is well within the medium-price range. It is a nine-tube superheterodyne and covers the range from 545 kc. to 38.1 Mc. in five bands.

Bandspread is available anywhere throughout the range of the receiver through a separate electrical-bandspreading condenser system with a control brought out to the front panel. The two-stage i.f. amplifier, using a pair of 6K7 tubes, employs iron-core transformers to insure maximum gain and high selectivity. To assist in keeping the r.f. stages in proper alignment, all the r.f. coils are air trimmed.

Crystal filter is available for this receiver. As a matter of fact, the title "SX-15" indicates that this particular receiver has a crystal filter incorporated in it. The type number of the same receiver without the crystal filter is the "S-15".

The power supply is self-contained as it is in all the Hallicrafter receivers. The audio channel uses a 6Q7G detector and first amplifier into a 6F6G which supplies about 3.5 watts to the loudspeaker. The receiver has an optional output provision for either 500 or 5000 ohms; this is an advantage when it is desirable to operate the receiver into a source of load other than the loudspeaker.

Hallicrafters has indeed incorporated a number of worthwhile features into their 1938 Super Skyrider. It is an eleven-tube superhet-

The Hallicrafters Sky Challenger SX-15

erodyne and covers the entire range from 545 kc. to 62 Mc. One stage of r.f. amplification is used on all the ranges of the receiver; there are six of them in all, 545 to 1555 kc., 1545 to 4300 kc., 4.2 to 10.2 Mc., 9.8 to 20.5 Mc., 19 to 36 and 35 to 62 Mc.

The receiver uses a comparatively new principle—inertia tuning. Heavy inertia flywheels are used on the shafts of the various tuning controls; it is only necessary to spin the control and to stop its spin when the desired section of the dial comes into view. Greatly increased ease of tuning is the result of this feature. Optional high and medium selectivity is available from a knob mounted upon the front panel. The two ranges of selectivity are indicated under the SX-16 in the receiver chart.

A pair of 6V6's in the output of the audio channel supply 13.5 watts to the external load or to the loudspeaker. Output impedances of 500 and 5000 ohms are available from the output transformer. There is an especially-designed 12" permanent-magnet dynamic speaker that is available, at slight extra cost, for the receiver. It is mounted in a combination metal and wooden cabinet.

The tank circuits and tube sockets are all ceramic insulated to improve the high-frequency operation of the receiver. Crystal filter is optional as in the Sky Challenger; the "X" in the type number indicates that the crystal is incorporated.

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The Hammarlund Super Pro

Hammarlund now has available two models of the Super Pro, the SP-110 which is the one that was described before and shown in the previous chart, and the SP-110S which is different in that it covers the range from 20 to 40 Mc. instead of the broadcast range from 540 to 1160 kc. In other words, the Super Pro may be obtained to cover the range from 540 kc. to 20 Mc., or from 1160 kc. to 40 Mc. In either case the entire range is covered by automatic plug-in coils and in five wavebands.

The receiver has a separate bandspread dial mounted to the right of the regular frequency-selection control. Another feature of the Super Pro is continuously variable selectivity in the i.f. channel—from 3 to 16 kc. wide. The receiver employs sixteen tubes in all, eight of the metal variety and eight glass ones. The power supplies are mounted externally; the plate supply uses a 5Z3, the one for bias an 80.

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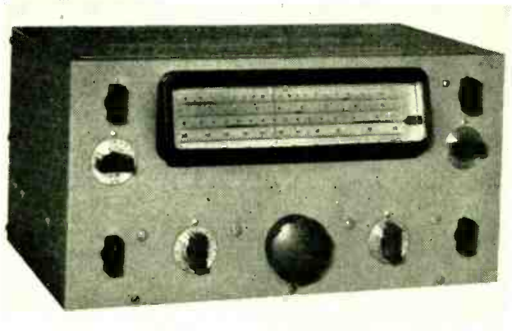
The National NC-81X



The NC-80 series of National receivers is quite a bit different in design from the general run. In the first place, they use a high intermediate-frequency amplifier, 1560 kc. to be exact. Due to the use of this high i.f., the first repeat frequency is placed 3120 kc. away from the desired signal. This allows ample signal-to-image ratio to be obtained without the use of a preselector stage. For this reason the antenna is coupled directly into the first-detector grid circuit.

Also due to the use of the high i.f., the crystal may be left in the circuit for both phone and c.w. use. The selectivity of the i.f. amplifier is continuously variable from 300 cycles to 7 kc. wide.

Another thing, there is no power transformer to supply the plate and filament voltages. The filaments are in series and run directly from the 110-volt a.c. or d.c. line. Plate voltage is obtained through a 25Z5 rectifier and a conventional filter system. The receiver may be run, as intimated above, either on 110 volts a.c. or d.c., or a special battery model is available which operates from 135 volts of B bat-

MAKE AND TYPE	BAND SPREAD	TUNING RATIO: BAND	TUNING RATIO: KC./KNOB ROTATION	TUNING RATIO: KC./SCALE DIVISION	I.F. BANDWIDTH IN KC. (TIMES RESONANT INPUT VOLTAGE): 2	10	1000	10000	FREQUENCY RANGE EACH BAND		IMAGE RATIO EACH BAND	CRYSTAL FILTER	A.F. OUTPUT 7% DISTORT.	SPEAKER OR OUTPUT PROVISION	TUNING PROVISION	ANTENNA PROVISION	NOISE SILENCER	I.F. FREQUENCY	HIGH R.F. STAGES ON EACH BAND	DIAL MECHANISM
HALLICRAFTERS SKY CHALLENGER SX15	ELECTRO MECHANICAL	2 MC.		1.2		2.5	12		1	545-1230 KC.	8000 / 1	OPTIONAL	3.5 WATTS	TERMINALS 500 & 5000 OHMS	NONE	DOUBLET OR MARCONI AGAINST GROUND	NO	465 KC.	ONE	DISC CALIBRATED
		3.5 MC.		2					2	1180-2850 KC.	290 / 1									
		7 MC.		3					3	2.75-6.82 MC.	180 / 1									
		14 MC.		8					4	6.57-16.4 MC.	22 / 1									
		28 MC.		19					5	15.4-38.1 MC.	11 / 1									
HALLICRAFTERS SUPER SKYRIDER SX16	ELECTRO-MECHANICAL	2 MC.	1.8	.12	SHARP POSITION				1	545-1555 KC.	10300 / 1	OPTIONAL	13.5 WATTS	TERMINALS 500 & 5000 OHMS	CALIBRATED METER IN "S" UNITS	DOUBLET OR MARCONI AGAINST GROUND	NO	465 KC.	ONE	LOADED GEAR INERTIA
		3.5 MC.	15.5	1.	2.2	5.2	12.8	19.5	2	1545-4300 KC.	411 / 1									
		7 MC.	12.5	.77					3	4.2-10.2 MC.	262 / 1									
		14 MC.	20	1.2	BROAD POSITION				4	9.8-20.5 MC.	24.1 / 1									
		28 MC.	72	8.8	7.3	14.5	26.1	42.5	5	19-38 MC.	35.4 / 1									
		56 MC.	142	8.8					6	35-62 MC.	5.2 / 1									
HAMMARLUND SUPER-PRO SP-110S	ELECTRICAL	2 MC.	250	20	MAXIMUM SELECTIVITY				1	1160-2500 KC.	65000 / 1	YES	10 WATTS	SEPARATE TERMINAL STRIPS ON BACK	METER	DOUBLET 115 OHMS	NO	465 KC.	TWO	TRANSLUCENT CALIBRATED SCALE. DISC FRICTION DRIVE
		3.5 MC.	100	4		5.5	11.5	14	2	2.5-5 MC.	34000 / 1									
		7 MC.	75	5	MINIMUM SELECTIVITY				3	5-10 MC.	9800 / 1									
		14 MC.	100	5		15	25	29	4	10-20 MC.	1900 / 1									
		28 MC.	400	20					5	20-40 MC.	150 / 1									
NATIONAL NC-81-X	ELECTRO-MECHANICAL								1	1.7-2 MC.		YES	2.5 WATTS	PLUG-IN SEPARATE SPEAKER	NONE	DOUBLET OR MARCONI AGAINST GROUND	NO	1560 KC.	NONE	DISC
									2	3.5-4 MC.										
									3	7-7.3 MC.										
									4	14-14.4 MC.										
									5	28-30 MC.										
NATIONAL NC-101-X	ELECTRO-MECHANICAL	2 MC.	34	.7					1	1.7-2 MC.		YES	10 WATTS	PLUG-IN SEPARATE SPEAKER	"ELECTRIC EYE"	DOUBLET OR MARCONI AGAINST GROUND	NO	456 KC.	ONE	DISC
		3.5 MC.	63	1.1					2	3.5-4 MC.										
		7 MC.	38	.67					3	7-7.3 MC.										
		14 MC.	50	.88					4	14-14.4 MC.										
		28 MC.	250	4.4					5	28-38 MC.										
RCA ACR 111	ELECTRICAL	2 MC.	61	5.2	5	10	26		A	540-1600 KC.	100000 / 1	YES	5 WATTS	PLUG-IN SEPARATE SPEAKER	"ELECTRIC EYE"	DOUBLET OR MARCONI AGAINST GROUND	YES	460 KC.	TWO	SELECTOR TYPE DISC-FRICTION BELT DRIVE
		3.5 MC.	55	4.75					B	1600-4000 KC.	40000 / 1									
		7 MC.	100	8.9					C	3000-8000 KC.	2000 / 1									
		14 MC.	168	14.9					D	6-16 MC.	400 / 1									
		28 MC.	430	38.8					E	16-32 MC.	10 / 1									
RME 69	ELECTRICAL	2 MC.	12.5	1.4	2	16	18	37	1	500-1500 KC.	2 2500 / 1	YES	2.6 WATTS	SEPARATE PLUG-IN NO D.C. 4000 & 600 OHM OUTPUT	CALIBRATED METER DB & R UNITS	DOUBLET OR MARCONI AGAINST GROUND	OPTIONAL	465 KC.	ONE	LOADED GEAR BALL-TYPE PLANETARY
		3.5 MC.	25	2.8					2	1.4-3.1 MC.	3 1000 / 1									
		7 MC.	30	3.3					3	3-6.4 MC.	4 500 / 1									
		14 MC.	72	8					4	6.2-13 MC.	5 200 / 1									
		28 MC.	200	22					5	12-20 MC.	6 50 / 1									
									6	17-32 MC.										
RME 69 + DB 20 (ONE UNIT)	ELECTRICAL	2 MC.	12.5	1.4	2	16	18	37	1	500-1500 KC.	2 MC. 100000 / 1	YES	2.6 WATTS	SEPARATE PLUG-IN NO D.C. 4000 & 600 OHM OUTPUT	CALIBRATED METER DB & R UNITS	DOUBLET OR MARCONI AGAINST GROUND	OPTIONAL	465 KC.	THREE	LOADED GEAR BALL-TYPE PLANETARY
		3.5 MC.	25	2.8					2	1.4-3.1 MC.	4 MC. 100000 / 1									
		7 MC.	30	3.3					3	3.6-4 MC.	6 MC. 75000 / 1									
		14 MC.	72	8					4	6.2-13 MC.	10 MC. 60000 / 1									
		28 MC.	200	22					5	12-20 MC.	15 MC. 50000 / 1									
									6	17-32 MC.	30 MC. 2500 / 1									

tery and a six-volt storage battery or filament transformer.

The NC-80X covers the range from 540 kc. to 30,000 kc. with no breaks by a system of automatic plug-in coils similar to that used in the NC-100. The NC-81X gives full-dial coverage of the 160, 80, 40, 20 and 10-meter bands but covers none of the territory between. This, of course, is similar in coverage to the NC-101X receiver. The receiver employs ten tubes in all, eight metal ones in the r.f. section, a 25L6G in the audio amplifier and the 25Z5 rectifier.

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The National NC-101X

This receiver is very similar to the NC-100 as described in the January, 1937, issue, except that, as in the NC-81X, it employs a crystal filter and covers only the amateur bands.

To cover briefly the balance of the specifications that are not covered in the table: it is an eleven-tube superheterodyne, covers the 160, 80, 40, 20 and 10-meter amateur bands, and uses automatic plug-in-coils.

The receiver uses two 456-kc. i.f. amplifier stages, one stage of preselection on all bands and has an "electric-eye" tuning indicator.

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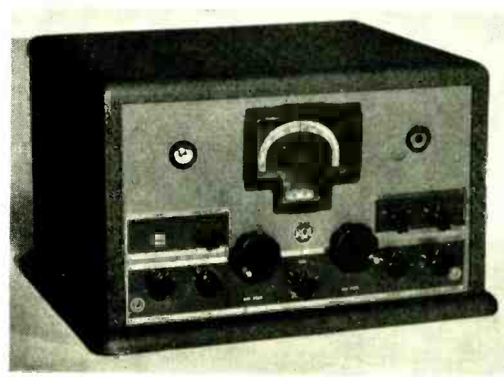
The RCA ACR-111

The ACR-111 employs a single-signal 16-tube superheterodyne circuit with two tuned r.f. stages on all bands. Constant-percentage electrical bandspread is employed to spread any portion of the range of the receiver. Two i.f. amplifier stages with an integral crystal filter are used to provide high selectivity for both phone and c.w. use. The power supply, using a 5W4, is built into the receiver cabinet.

The '111 employs both a noise limiter and a noise suppressor. The second diode of the 6H6 second detector is connected with an associated circuit to raise the bias on the first diode unit when a strong noise pulse comes through, thus acting as a noise limiter.

The noise suppressor consists of a 6J7 whose plate circuit effectively shunts the input circuit of the audio-driver stage, and a means of making the shunting plate impedance very high for desired signals and very low for undesired noise impulses. The use of these two types of



noise attenuation circuits greatly assists in reducing the interference caused by both man-made and natural static.

The receiver covers the band from 540 to 32,000 kc. in five ranges selected by a front-of-panel switch. The main-tuning and bandspread-tuning capacitors are arranged in a series-parallel circuit to avoid high minimum and maximum capacitance effects. Greater uniformity of bandspread is thus obtained throughout each tuning range.

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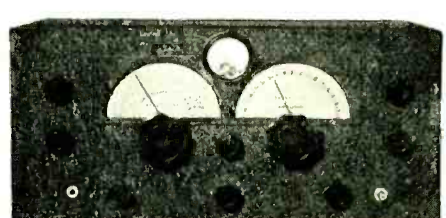
The RME-69



The RME-69 is a nine-tube communications receiver combining a number of convenient and desirable features. The range from 550 to 32,000 kc. is covered in six steps and the set employs a one-stage pre-selector throughout. Bandspread is obtained electrically through a separate dial mounted to the right of the regular tuning dial, driving a ganged bandspread condenser.

[*Continued on Page 156*]

THEORY OF ANTENNA OPERATION

Sugar-Coated Antenna Theory, from A to Z

By **E. H. CONKLIN** *

While talking with several amateurs who have become interested in the game during recent years, we have been impressed by their lack of familiarity with the way an antenna operates. Without this knowledge, these newer "hams" are penalized by being unable to apply theory to a practical situation, such as designing an efficient antenna for a specific location or purpose. A review of the available literature on the subject suggests that the elementary information is not sufficiently clear for those who do not readily understand drawings, and particularly those who cannot easily picture three-dimensional space from a plane drawing. It is no wonder that one amateur understands radiation patterns to be something like smoke rings puffed out by a smoker. To this man, "doughnut-shaped pattern" might have meant that the power was radiated in the shape of doughnuts tossed out at random, one here and one there!

In this article we hope to present new illustrations to clear up confusion in the minds of those who do not now understand why an antenna has a characteristic radiation pattern. But let it not be a war to end all war, a last word on the subject. If our readers can suggest better illustrations, let us have them so that the subject will be made still less complex for the next neophyte.

The Elementary Pattern

Let us reach up to a transmitting antenna and clip out an inch or so of wire—almost anywhere in the antenna—and take it off into space to examine it. At least, we can assume having done so and with a little imagination take a match from the kitchen stove without ruining the nice copper wire in the yard.

This short length of wire would have been carrying a current, I, when it was a part of the antenna in operation. For most purposes we can assume that the current in such a short piece was just the same at any point in its length. Hold the piece at arm's length broadside to you and turn it slowly end over end. What do you see? A shorter length of wire when it is turned away from the broadside position, and only a point when it is end-on to your eye (one eye—two won't work). This is pictured in figure 1. The visible length of wire is easily represented by the angle at your eye, E, which in geometry would be called the angle AEB. It isn't hard to picture the shorter length as seen from other points E_1, E_2, and E_3.

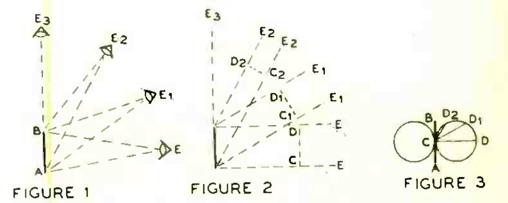


Figure 1 shows apparent change in length of a piece of antenna wire at various angles of viewpoint. Figure 2 shows the same except from an infinitely distant viewpoint. CD, C_1D_1, etc., represent relative apparent lengths of wire AB. Figure 3 shows construction of figure-of-eight pattern from angles and relative lengths of figure 2.

No matter how far the eye is from the wire, there is a similar relationship between the apparent length for various angles from the broadside position. Thus, it would be possible to go away almost an infinite distance and look through a telescope. At an infinite distance, the lines AE and BE become parallel—which doesn't change the picture much, as shown in figure 2, but permits drawing the lines CD to represent relative intensities at various viewpoints. Now it is only necessary to show how these relative intensities, which decrease toward the end-on position, can be used to plot intensities in some kind of a graph or chart.

*Associate Editor, RADIO.

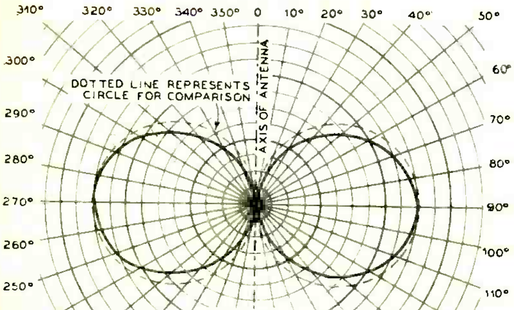


FIGURE 4
SHOWING TRUE FIGURE-OF-EIGHT PATTERN FOR A HALF-WAVELENGTH ANTENNA IN FREE SPACE

The position E was taken as broadside to the wire, while the angle EAE_1 is for some other position. At this latter angle, the relative intensity[1] was shown to be C_1D_1 as compared with the full length, CD, of our piece of wire AB. In figure 3 we have placed the lines CD so as to touch one point, C, but each to lie along a line representing the original angle of viewpoint. By connecting the outer ends D, D_1, D_2 (and D_3), we have produced a chart showing the relative radiation of the wire at various angles. This pattern is nothing but a circle touching the point C, and of course includes a similar circle on the other side as drawn for viewpoints over on that side.

As a practical matter, the circles D, D_1, D_2 of figure 3 are really best drawn as infinitely larger than the piece of wire AB, inasmuch as they show relative field strength at a long distance from the wire. More charts showing this characteristic pattern draw in an antenna giving the misimpression, such as we did in figure 3, that the wire is appreciable in size compared with the directional diagram. Really, AB should represent the axis of the wire, the wire itself being a very small dot at point C.

[1] Most everyone has seen pictures of a "sine wave." A cosine wave might be defined as a sine wave 90 degrees out of phase, for it is unity at 0° and zero at 90°, whereas the sine curve is zero at 0°, rising to unity at 90°. If the angle Θ is measured from the broadside direction, the radial equation for the pattern under discussion, two tangent circles, is $\varepsilon = \cos\Theta$. The complete equation is:

$$\varepsilon = \frac{60\pi \quad (\delta l) \; I \cos\Theta}{d\lambda}$$

in which d is the distance to antenna in meters, λ is wavelength, (δl) is length of wire in meters, and ε, the field strength, in volts per meter.

The Half-Wavelength Antenna

Before we drop our small piece of wire in the waste basket, let us consider what would happen if we take a lot of these small pieces and put them end-to-end until we have a half-wavelength at our operating frequency. We would now have a half-wavelength, or fundamental, antenna. In fear of complicating the "simple explanation" at the outset, let us assume that there would be a standing half-wave of current and voltage on this wire when properly fed power.

It is now very obvious that there will be a different amount of current flowing in one of our pieces near the end than in another near the center, because after all, that is what we assumed when we said without proof that there was a "wave of current" lying along the wire. So the simple two circles in the pattern of figure 3 may need adjustment for the fact that some parts of the wire carry more or less current than others. Through use of a little mathematics[2] and assumption as to the shape of the "wave of current," we can put together the pieces of wire and calculate the net result on the directional pattern. We find that it is still much the same, the circle having been flattened just a little as shown in figure 4.

The Solid Pattern

So far we have dealt only with the pattern in a single plane. If a piece of paper is held vertically with its edge along the wire AB of figure 1, similar eyes can be drawn on the new sheet of paper, illustrating the apparent shortening of the wire in the new plane. The "broadside" intensity is still the same. The reduced intensity at E_1 will be the same in the new plane as in the old, if taken at the same angle

[2] The equation for the radiation pattern from a wire in space, taking Θ as the angle from the *wire*, for lengths of an odd number of half-waves, is

$$\varepsilon = \frac{60\,I}{d} \cdot \frac{\cos(\pi L/\lambda \cos\Theta)}{\sin\Theta}$$

and for an even number of half-wavelengths,

$$\varepsilon = \frac{60\,I}{d} \cdot \frac{\sin(\pi L/\lambda \cos\Theta)}{\sin\Theta}$$

Because the factor 60 I/d is a constant in calculating patterns, it may be neglected. The factor $\pi L/\lambda$ is 90 for a half-wavelength antenna, 180 for a full wavelength, etc.

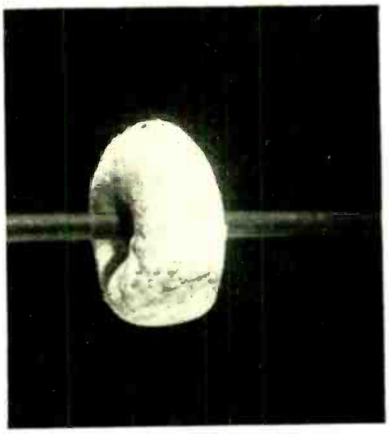


Figure 5. "Doughnut-shaped pattern in space"—$\lambda/2$. Length of line from center of doughnut to outside edge represents field strength in that direction.

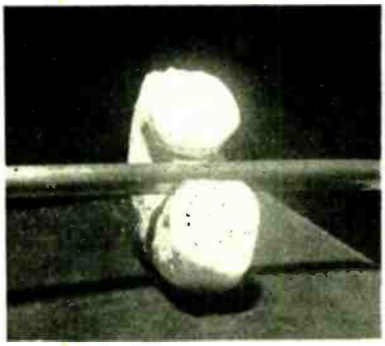


Figure 6. Slice the doughnut and you get the familiar figure-8 cross-section pattern in one plane.

from the broadside or the perpendicular direction.

If the intensity in every direction were represented by a certain length of pin stuck in the center of the wire AB, the other ends of the pins would fall along a surface shaped exactly like a doughnut with a very small hole. The pattern in figures 3 and 4, when rotated in space about the axis of the antenna, describes the same doughnut shape. For clarity, we have pictured in figure 5 such a doughnut, strung on copper tubing to represent the axis of the antenna. In figure 6 we sliced the doughnut along the axis of the wire to show that the cross-section of the doughnut-shaped solid pattern is the old familiar "figure-of-eight" pattern of figures 3 and 4. By calculating this directional pattern in one plane, cutting it out and rotating it, we have prepared the photograph of figure 8a.

Please keep in mind that these figures refer only to one thing—a line drawn from the center to the surface of the figure represents the relative intensity in the direction of the line. The actual waves go out one after another as expanding spheres, but are just weak in some directions. Also remember that all this is in free space—which we mortals cannot use for our antenna systems.

Simple Interference Patterns

Now if we have fixed firmly in mind the rapidly expanding concentric "soap-bubbles" of radiation with the antenna at the center of the bubbles, even though the *strength* of radiation is not uniform like the spherical shape of the bubble (see figure 9), we can go on to the subject of two half-wavelength wires in the same bit of free space. Let us start with two parallel wires a half-wavelength apart. These might be fed "in phase"—which can be done by connecting them, zepp-fashion, to each end of a "Y" in the feeder so that a wave gets to both wires at the same time. We can study the pattern in a most important plane—the one perpendicular to the wires, such as the earth's horizontal surface for vertical wires.

It is obvious that any point equidistant from the two wires will have the benefit of receiving the waves from each antenna at the same time. Such a point would be "broadside" to the wires, or, more accurately, if all vertical angles were being considered, it would lie in a plane passing through the midpoints of the wires and perpendicular to the plane in which both wires lie. Any point on the line FG in figure 7a would satisfy this condition.

The two dots represent the antennas fed in phase, solid circles represent waves of one polarity leaving the wires, and dashed circles indicate waves of opposite polarity. It is clear that the waves act together, adding to double the electrical field strength when they reach FG, while off to the side, the arriving waves are of opposite polarity from each wire, having traveled distances which differ by ½-wavelength, and complete cancellation takes place. At intervening angles, the cancellation is partial. It is necessary to add waves of different

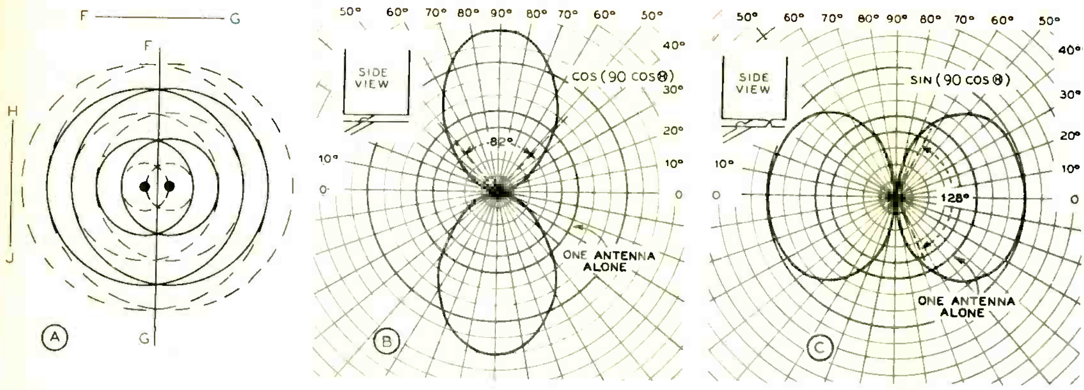


Figure 7. (A) shows wave interference pattern of broadside antenna array. (B) shows horizontal pattern of two-element broadside array compared to the circular pattern of a single antenna. The gain exceeds that of a single antenna over an angle of 84°. (C) shows horizontal pattern of two-element end-fire array compared to the circular pattern of a single antenna. The gain is only 1.6 times that of a single antenna and is better than the latter over an angle of 128°.

phase, giving the pattern[3] of figure 7b, which is sharper than the half-wave wire in space pictured in figure 4, even disregarding the broadening effect of high angle radiation off the ends of the latter.

The pattern of field intensity as produced by two-phased antennas comes not from any restriction upon the growing spheres of waves leaving each wire, but simply from the result of phase relationship at the point of reception. Just as many waves reach HJ in figure 7a as reach a point along FG, but in the former case the intensities are of opposite polarity and cancel, while in the latter, the addition of waves of similar polarity reinforce each other.

Gain Over Single Antenna

It is useful to be able to calculate the gain of the two-phased wires as compared with the same power in one wire alone. Figure 7 suggests that the power is double in the favored direction, but really indicates that the field intensity has been doubled—representing four times the power—based on the same current in each wire as there would be in one alone. In amateur practice it is of interest to know what happens when the transmitter output is held constant and the power is divided among the half-wavelengths of wire in the antenna.

A given power might produce 2 amperes of current at the center of one wire, which at a theoretical radiation resistance of about 73 ohms means $2^2 \times 73$ or 292 watts. (Did you ever measure *your* antenna current to find if the power gets there?) If two antennas are fed in phase, half or 146 watts should be radiated from each wire. Going back to the I^2R formula and the 73-ohm figure for R, we find that the current in each wire corresponding to 146 watts will not be 1 ampere but 1.414 amperes—the square root of 2. It is this current which lays down the field strength along FG in figure 7, and from both wires the effect is as if 2×1.414 or 2.828 amperes were flowing in one wire alone. But 2.828 amperes would have required $2.828^2 \times 73$ or 584 watts in only one antenna, which is twice the 292 watts actually consumed. This may seem to be a round-about way to figure the gain but it requires only Ohm's law and a pencil.[4]

One might well ask why a similar gain would not result if the two wires were right next to each other rather than a half-wavelength apart. Here enters another factor—current induced in one wire by the other (mutual coupling). If the two wires were close together, there would

[3] Adding the waves, we arrive at the equation for the horizontal pattern from two vertical wires fed in phase, which is 2 cos (90 cos ϕ) if the wires are a half wavelength apart, and 2 cos ($\pi d/\lambda$ cos ϕ) for any separation, in which ϕ (Greek letter "phi") is the horizontal angle measured from the line of antennas toward the broadside, and this factor $\pi d/\lambda$ is 90 if the antennas are separated a half wavelength, 180 if separated a full wavelength, etc. If the wires are fed out of phase, the first equation becomes 2 sin (90 cos ϕ) with a similar change of sine for cosine in the second equation.

[4] Sterba, in I.R.E. *Proceedings* for July, 1931, points out that, assuming no coupling between elements, an array of *n* wires requires $1/n$ of power consumed by one antenna in laying down the required field. The field intensity where reinforcement is complete is $\sqrt{n}$ times that for one antenna alone.

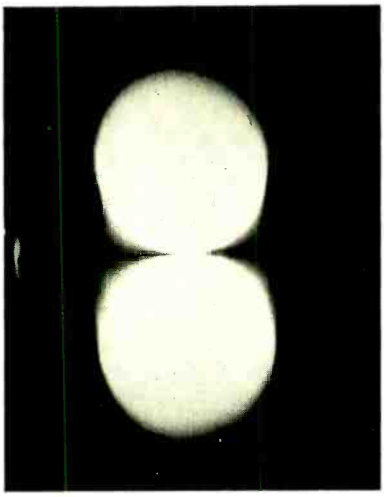
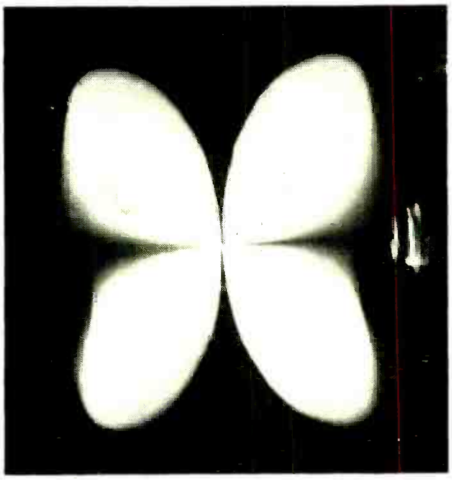


Figure 8A. Half-wave antenna in space showing figure-8 cross-section and dough-nut-shaped three-dimensional pattern.

Figure 8B (below). One wavelength antenna in space showing that there is radiation at some angles except at right angles to wire.



be just one ampere in each wire and no gain at all. The best gain from such wires occurs at nearly ¾-wavelength separation, a compromise between the effect of this mutual coupling between the wires and the loss of power in spurious lobes, at larger spacing.[5] The power gain is slightly over 3 for this spacing as compared with 2 at one-half-wavelength spacing and 1.25 at one-quarter-wavelength spacing.

An arrangement of a larger number of wires fed in phase can be treated similarly, even if stacked in other ways. It is evident that the power gain is roughly equivalent to the number of wires or "dipoles" used, but inasmuch as 8 is only twice 4, it may soon be cheaper to double the transmitter power than to buy enough land to double the number of half-wavelength wires in the antenna, even neglecting the increased sharpness of the beam which will reduce the area over which one can use the antenna. It is true, however, that the first few decibels of gain from improvement in the antenna system are obtainable so cheaply that the matter should be given consideration before increasing power. This is not to mention the reduction in QRM in the unfavored direction, helpful to "the other fellow."

At this point we might mention that figure 7a can also be drawn to cover the same wires fed "out of phase," in which case it is necessary only to transpose the dashed and solid lines for one antenna, allowing the signal to add toward HJ and cancel along FG. This type of feed requires only that one antenna be connected to the opposite feeder wire. The resulting pattern[3] is shown in figure 7c. It is considerably broader and is only 60% better than for a single antenna, compared with the 100% gain for the broadside case.

The Double Zepp

Let us now consider half-wave dipoles placed end-to-end. If a wire a full wavelength long

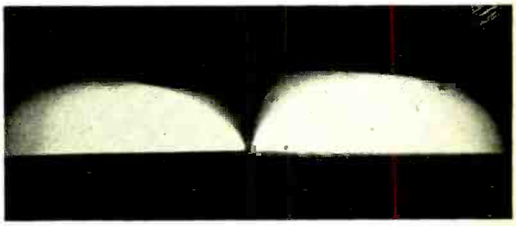


Figure 8C. Vertical half-wave antenna at ground level showing concentration at low angles—no horizontal directivity.

[5] For charts showing gain of various arrays, neglecting mutual coupling, see Southworth, "Certain factors affecting the gain of directional antennas," *Proc.* I.R.E., September, 1930. For charts and additional data on effect of mutual coupling, see "Directional Antennas," G. H. Brown, *Proc.* I.R.E., January, 1937.

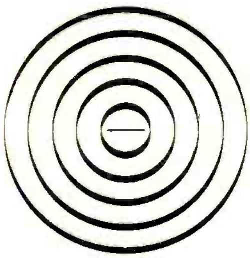


Figure 9. Showing expanding "soap bubbles" of radiation leaving a half-wave antenna. Note that waves actually are circular but are simply stronger in broadside direction. This method of representation was suggested by John Kraus, W8JK, of flat-top beam fame.

is cut in the center and fed with a two-wire feeder, one-half-wavelength of the antenna will be "in phase" with the other. Inasmuch as the two feeder wires are of opposite polarity, the antennas are in phase because the antenna wires run in opposite directions from the feeder. It is a case of a positive wave going north and a negative wave going south being just about the same thing.

One doublet alone would have the pattern of figure 4, while the effect of having two wires—pictured in figure 7—is to force the power still more into the broadside direction. It is necessary to multiply one effect by the other[6] to get the resulting pattern in any plane in which the antenna lies. The horizontal pattern is therefore sharper than that of the phased antennas in figure 7b, while at right angles to the wire, in the absence of ground effects, there is a maximum of radiation at all angles up to the vertical (assuming a horizontal double-zepp) which is not true of the two-phased wires. The solid pattern is doughnut-shaped, as with a single horizontal antenna, but considerably flattened.

The Full-Wave Antennas

With the above approach via "beams," we are ready to study the full wavelength antenna—a more difficult arrangement to analyze but more often found in back yards. This type of antenna consists of a full wavelength of wire without a break at its center. It differs from the double zepp in the preceding section in that its two half-waves are 180 degrees out of phase rather than in phase. The effect of feeding two such half-wavelength wires is the same as illustrated in figure 7a but with the dashed and solid circles of one antenna transposed, as was the case for the end-fire array already discussed. However, there is an uneven distribution of power in the horizontal plane using a horizontal wire, as shown in figure 4, and therefore, one effect must be multiplied by the other, as with the double zepp. This time, the maximum due to interference between the two half-wavelengths and the normal broadside directivity mentioned at the beginning of this paper occur at right angles to each other. The zero for each effect gives a null point in the horizontal plane both off the end and broadside. At some angle between, radiation reaches a maximum, giving the familiar X pattern of intensity in one plane,[7] pictured in figure 8b.

The true null is the one broadside to the antenna because it occurs at all vertical angles. The null off the end occurs only in the horizontal plane in which the wire lies, while at vertical angles above this plane, radiation will be found. The writer does not agree with those who say that in practice the null predicted to occur broadside to the wire is not found. A test with a horizontal full-wave antenna and a field strength meter using a vertical rod antenna, showed zero field at right angles to the antenna even though a full-scale deflection could be obtained 15 feet away. This test was made with the coöperation of Harry Carr, W9LBK. It emphasizes the importance of aligning a full-wave antenna so that the nulls at right angles to the wire do not cover important land areas.

[6] To obtain the equation for the pattern of a "double zepp." in a plane in which the wire lies, multiply the pattern for a half wave wire, $\frac{\cos(90\cos\Theta)}{\sin\Theta}$ by the effect of placing two such radiators broadside, spaced a half wavelength between centers, $2\cos(90\cos\Theta)$. This same equation covers the single vertical half wave antenna and its reflection from perfect ground, plotted in figure 11 and pictured in figure 8c.

[7] Multiply the equation for a half-wave wire, $\frac{\cos(90\cos\Theta)}{\sin\Theta}$ by the effect of placing two such radiators end fire in the same plane, $2\sin(90\cos\Theta)$, to obtain the pattern for a full-wave-length wire in a plane in which the wire lies. The combined equation simplifies:

$$\frac{2\sin(180\cos\Theta)}{\sin\Theta}$$

In considering the gain of this full-wave antenna over one-half-wave alone, notice that the maximum radiation occurs at an angle that does not coincide with either the maximum broadside or end-fire effects, so does not have the benefit of building up field strength as well as the types of antennas previously discussed. The gain is only a little better than for one antenna alone.

This discussion has dealt with the pattern in one plane in which the antenna wire falls, the pattern being the same for any other plane which can include the whole antenna (as was the case with the double zepp, and the simple half-wave wire). The solid three-dimensional pattern is much like two ice-cream cones held point-to-point. The insides of the cones represent the end nulls caused by the natural directivity of a half-wavelength wire, while the space outside the cones represents the null due to interference and cancellation of the waves from the two half-wavelengths in the broadside direction. Actually, the walls of the ice-cream cones should be about two inches thick halfway between their points and the outer ends, gradually tapering off either way.

Long Wire Antennas

If more "phased" half-wavelengths are added to the double zepp, the pattern becomes sharper; but if additional wire is added to the full wavelength antenna without use of stubs or phasing coils to alter the normal reversal of phase at each half-wavelength, the pattern changes considerably. The cone-shaped radiation patterns become narrower and get closer to the axis of the wire, while as the antenna becomes an odd number of half-waves long, a new, shorter and thinner lobe appears in the broadside direction; and as an additional half-wave is added to make the total an even number, the central lobe splits into two which work toward the large lobes as the length of wire increases.[2] There is a power gain in the direction of the major lobes, but this gain is still much less than in the case of "phased" wires.

Ground Effects

If our readers understand the reason for the elementary directional pattern of a simple antenna in free space and the manner in which wave interference between several antennas alter this pattern, we can come back to earth and study the effect of the presence of ground. To eliminate one variable and complicating factor, we shall have to make another assumption—that the ground is a perfect conductor. What happens when this is not so, is a separate study.

The Vertical Antenna

Let us first select the vertical half-wavelength antenna, mounting it so that its bottom end is just above the ground. This antenna is represented by the line AB in figure 10. We already know that this wire in free space would have a characteristic directional pattern, in a plane in which the wire lies (vertical, in this case), similar to that shown in figure 4 and reproduced in the dotted line in figure 11. The pattern is altered by the presence of the perfect conductor, the ground.

Radiation of waves from any point on the wire, C, will directly reach a distant point in space, P, in figure 10. However, there will be another path followed by radiation downward from C, reflected at E, which will also go out at the same vertical angle, following the line EP_1. This radiation has been delayed because of having gone via E, just as if it had started from the underground point C_1. It is, therefore, somewhat out of phase with the direct radiation along CP, and partial reinforcement or cancellation between the direct and reflected waves can take place upon arriving at P which, at a large distance, can be taken as the same as

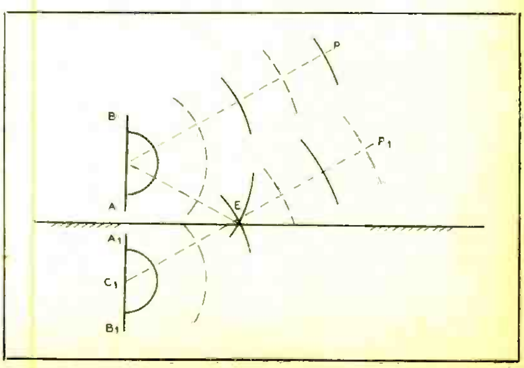


Figure 10. Showing interference between direct and reflected waves from a vertical antenna above ground. A_1B_1 indicates the apparent position of the antenna-of-reflection, AB is the actual radiator.

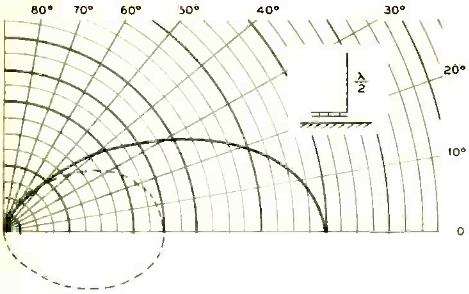


Figure 11. Showing vertical radiation pattern of a half-wave vertical antenna. Dotted line shows pattern in free space; solid line shows pattern above perfect ground.

P_1. When P is close to the ground or, more properly, the horizon, the paths are nearly identical and, in the case of vertical antennas, reinforce to double the field strength; while at high angles the reflected wave has gone more out of its way and mainly cancellation takes place. The result is as if a vertical double zepp. had been used beyond the influence of ground. The resulting pattern in the vertical plane is shown by the solid line in figure 11. A photograph of this pattern in rotation to show the three-dimensional effect, is depicted in figure 8c.

As the vertical antenna is raised above the ground, the horizontal radiation becomes more concentrated at low angles, and additional relatively small high angle lobes make their appearance.[8]

If the antenna is longer than a half-wavelength, the effect of the ground is still to increase horizontal radiation, but a full wavelength antenna in free space has a null in the broadside direction as already discussed. Inasmuch as twice nothing is still nothing, theoretically there is no exactly horizontal radiation from this type or from any vertical antenna an even number of half-waves long.

Full wavelength vertical wires are seldom used in amateur radio because the angle of maximum radiation is somewhat high for the higher frequencies, though the angle is no worse than for a horizontal wire a half-wavelength high. Verticals longer than a full wavelength are often impractical because of the height required. The number of lobes in the vertical plane increases with antennas longer than one wavelength, in a manner quite similar to the lobes between one end and the broadside of long horizontal antennas.

Verticals tilted so that a lobe is roughly horizontal off one end have been used to obtain some gain and directivity in a simple vertically polarized antenna at the ultra-high frequencies.

Effect of Average Ground

Vertically polarized waves, radiated by vertical or tilted antennas, are considerably affected by poor ground conditions, particularly at the lower angles where this type of antenna should have most of its radiation. It is readily seen that if the ground does not reflect 100% of the waves striking it, the field intensity cannot reach twice the "free space" value. Also, a shift in phase at the point of reflection can reduce the amount of reinforcement due to the ground and thus shift the angle of maximum radiation upward. Further, many vertical objects such as pipes, trees and gutter pipe, may be excited and may inefficiently re-radiate the energy so that power at angles very close to the horizontal may be largely absorbed. Such things should be expected at the average amateur location. However, where low angle radiation is desired and where the antenna is not used for receiving in a noisy location, the vertical antenna has its uses.

The Horizontal Antenna

We have already discussed the pattern for wires in free space. These patterns give the "top view" patterns for a horizontal antenna. It remains only to discuss the effect of ground upon the radiation.

The effect of ground upon a horizontally polarized wave differs from that upon a vertical. The ground can be considered perfect if it is either a good conductor, such as salt water or marsh, or a good dielectric such as quartz sand. In fact, the agreement between practice and theory is close enough to consider the ground "perfect" in the case of almost any horizontal wire. Upon reflection, however, the phase is reversed compared with a vertically polarized wave, as if there were an out-of-phase antenna radiating from a point as far below the ground as the true antenna is above ground. The result is that radiation at exactly the horizontal is always cancelled by the interference of the direct and reflected waves.

[8]Raising an antenna above ground is in effect separating it twice as far from its reflected image. The equation for the vertical plane pattern for antennas fed in phase is given in footnote 3 if looked at from the side. For a half wavelength antenna whose center is more than a quarter wavelength high, use the equation of footnote 6 but change the second term for the new height in accordance with footnote 3.

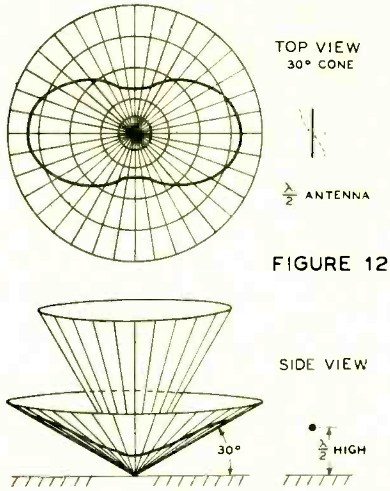


FIGURE 12

Figure 12. Portraying radiation from half-wave antenna a half-wave above perfect ground, for fixed vertical angle of 30°. Top view gives relative radiated power in various horizontal directions. Side view shows cones along which all horizontal directions at a given vertical angle lie.

It is well to note two distinct differences between vertical and horizontal antennas over a perfect conductor. As previously shown in figure 11, the effect of perfect ground on radiation from a vertical antenna is to increase radiated power at low vertical angles (near the horizon) and cancel it at some higher angle, with additional angles of reinforcement and concellation for antenna heights greater than a quarter-wavelength (measured from the midpoint). On the other hand, in the case of the horizontal, the ground reflection always cancels radiation at the lowest angles while at higher angles it alternately reinforces and cancels the radiation, the number of "lobes" depending on antenna height[9]. For an antenna with its midpoint at or below a half-wavelength above ground, therefore, perfect ground lowers the vertical patterns for a vertical wire and raises it for a horizontal. Were it not for the more serious effects of poor ground conditions upon vertically polarized waves, the vertical antenna would give outstandingly better results for a good many amateur purposes.

The second point of difference is the pattern of the antennas in free space upon which the above ground effects operate. The pattern for verticals is always the same for any vertical plane and involves a more or less complex pattern with one or more lobes; the pattern for the horizontal in a vertical plane is different for different planes, but the ground effect is the same on any of them. In a vertical plane perpendicular to the wire, which shows broadside radiation, the pattern in space is circular and the pattern above ground is simply that

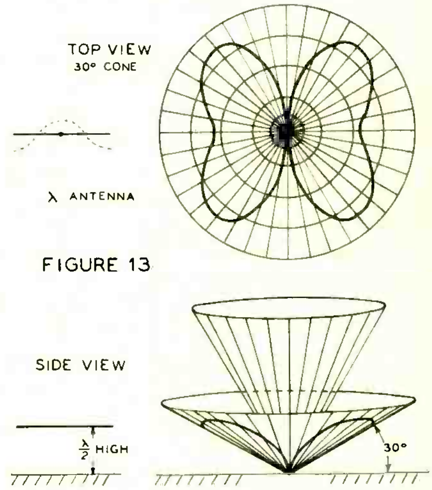


FIGURE 13

Figure 13. Same as figure 12 but for a full-wave antenna.

for the ground effect; though in the vertical plane in which the wire lies (showing radiation above the end), the radiation is zero in the horizontal direction even without the ground effect and rises to a maximum depending on the length of the antenna (maximum at 90 degrees or vertical for a half-wave wire, 54 degrees for a full wavelength, etc.)

When the height of a horizontal wire is an odd number of quarter-wavelengths, the ground effect is to reinforce in the vertical direction, while when an even number, it causes cancellation in the vertical direction.[9] This should not disturb the amateur, however, because the wasted power at high angles in a half-wave horizontal antenna does not reduce the strength

[*Continued on Page 158*]

[9] The equation for the vertical pattern of a horizontal antenna is similar to that for a vertical antenna, as given in footnote 8, except that the first function, cosine, becomes sine. This change was also encountered in footnote 3. The result is that perfect ground has exactly opposite effects upon vertical and horizontal antennas; if both antennas are the same height, the nulls of one will fall at the same angles as the maxima of the other, and no signal can come in at a vertical angle that would be a null in both cases.

HIGH FREQUENCY RECEIVERS

• *Improving Their Performance*

By GROTE REBER,[1] W9GFZ and E. H. CONKLIN[2]

During the last fifteen years as we have attempted to extend upward the range of useful communication frequencies, the problems of creating power and detecting it have always presented difficulties. Developments have had to keep pace; that they have is attested by the fact that amateurs no longer find it necessary to remove the bases from receiving and transmitting tubes in the 80-meter band.

Satisfactory tubes are now available to create power down to a wavelength of a few centimeters, but there are certain limitations in the receiving apparatus. Many present day receivers are not free from set noise even at 14 Mc. when adjusted for maximum sensitivity; at much higher frequencies most receivers have a very loud "sh-h-h" noise which limits the ability to reach down to the outside noise and pull out a readable signal, while many preselectors are useless without regeneration.

The Noise Problem

Set noise is a cumulative thing; a given tube amplifies the signal and noise of preceding stages, adding a bit of noise itself, but the higher the signal level, the smaller the percentage of noise in the output. A standard approach to the problem, at any frequency, is to obtain as large a noise-free input as possible by improving the antenna and transmission line, then to deliver this signal to the first stage in the receiver through efficient coupling. At the higher frequencies, possibly 28 Mc. and beyond, the ability of the tube to give satisfactory amplification is limited by the "electron-transit time" or element spacing, although the acorn and other types of tubes now available provide a means of obtaining gain well beyond the present commonly-used amateur bands.

There remains one very important unit of the receiver between the antenna feed line and the tube—the first tuned circuit. It is this circuit together with the associated tube which should provide a high gain so that the signal

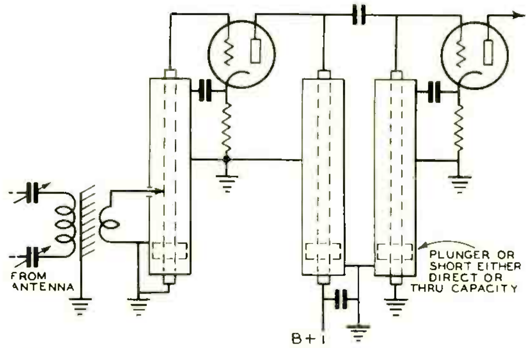


Figure 1. Concentric line r.f. amplifier with balanced antenna feeder and double interstage coupler, arranged for cathode bias. Note that plate lead must not have d.c. contact with outer conductor unless whole coupler is insulated and grounded through a mica condensor. Screen and suppressor grids not shown.

delivered to the second stage will have a high level without a great deal of noise having been added in the process.

We shall discuss general applications of a method of improving present receivers, then pass on to the gain obtained in specific units constructed for the ultra-high frequencies.

Concentric Line Couplers

An improvement over the usual coil and condenser circuit involves the use of a quarter-wavelength section of concentric line.[3] These and parallel rods have been applied to high frequency oscillators, but have not been generally accepted for use in receiving. However, substantial gain can be obtained by replacing the coil and condenser with a section of concentric line. On 28 Mc. it is only necessary in the average receiver to remove the first tube's grid clip, connect the center conductor of a quarter-wave of line to the tube grid, short and ground the far end and match in the antenna. The resulting circuit is shown in the first part of figures 1 and 2. The most difficult part will probably be adjusting the line length to resonance with the tube and wiring capacity across the

[1] W9GFZ, 212 W. Seminary Ave., Wheaton, Illinois.
[2] Associate Editor, RADIO.

[3] See article in August, 1937, issue of *Proceedings* A.I.E.E. by Reukema; also, see F. E. Terman, "Resonant Lines in Radio Circuits," *Elec. Eng.*, July, 1934.

open end of the line. A small trimming condenser of a very few micro-microfarads maximum across the line should simplify tuning and allow some adjustment within an amateur band. The line can be coiled up behind the receiver if it is of small enough diameter to be bent.

Matching the antenna is simple enough when the feeder is unbalanced, such as with a concentric line. The outer conductor is grounded, while the inner one is brought through a hole or slot in the quarter-wave line, at such a position from the shorted end that the impedance is matched and the signal is a maximum. A balanced feeder, such as a two-wire line, can be inductively coupled to a grounded coil, the free end of which is tapped into the quarter-wave coupler.

Interstage Couplers

Where additional stages are to be coupled using these lines, there are two general methods of approach. The first, possible with commercially available line with a solid inner conductor, involves using two sections of line to avoid the necessity of using chokes. This is illustrated between the tubes in figure 1. With this type of coupling it is possible to secure good gain and impedance match even at ultra-high frequencies. The second method eliminates one line by using a hollow inner conductor through which the plate lead of the tube is brought. It is thus capacitively coupled to the inner conductor to provide "unity coupling," yet insulated from it to permit bringing plate and bias voltages up through and on the inner conductor, as in figure 2. In either case, it is necessary to bring the plate lead down without a direct current ground, by-passing the line at the bottom end with a mica condenser, and shorting the line through a capacity rather than directly.

At the highest frequency amateur bands, the tube and wiring capacity is sufficiently large to reduce substantially the length of line necessary in the couplers. The first circuit, with no tube plate across it and in the absence of reactance in the antenna feeder, will be slightly longer than interstage couplers. When a single line is used between stages and there is 2 to 4 μμf. stray wiring capacity together with some 6 μμf. for the grid and plate of the tubes, it requires only about 12 centimeters of line instead of the full 31 centimeters at a wavelength of 1¼ meters (240 Mc.) With common tubes, this differential would be greater but at five or ten meters, the shortening of the line will not be as substantial a percentage. In one such receiver, the lines were not a full quarter-wave long but 27 per cent of a quarter-wave at 300 Mc., 50 per cent at 170 Mc., and 58.7 per cent at 100 Mc. The shortening of the first coupler depends upon the position of the antenna tap.

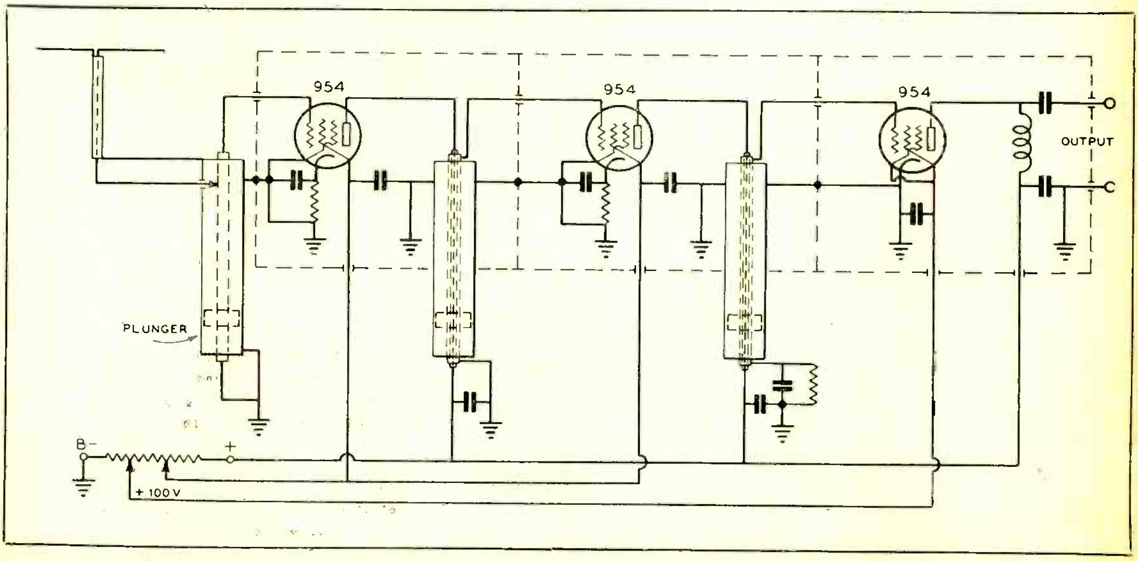


Figure 2. Concentric line receiver or converter (if oscillator is added) shown with unbalanced antenna feeder, single interstage couplers with hollow inner conductor for plate return, and grid leak at bottom of detector coupler.

Bandspread Tuning

Tuning over the band can be accomplished using a small condenser across the top end of the line, as mentioned. The required capacity for band-spread coverage is so small that a small copper disc on the end of a machine screw, threaded through the outer conductor so as to approach a similar disc on the inner conductor, may be sufficient after the line has been adjusted to the proper length. For adjusting, however, a wider capacity range should prove advantageous though it may reduce the gain of the stage. It has also been suggested that control over the frequency can be accomplished by shorting the lower end of the line with a regular tuning condenser, which will have some tuning effect. We understand that this method has been found practical in ordinary rod oscillators, substituting the variable condenser for the shorting bar.

The concentric line coupler can be added to the first circuit of the receiver now in use, whether it is a superhet or super-regen. It should permit some gain in preselectors that previously had no gain unless regenerative. It can be used in a radio frequency amplifier ahead of the present receiver, in a new receiver designed for one-band or ultra-high frequency coverage, or in a u.h.f. converter to go ahead of a broadcast or shortwave receiver. When used as a converter, the detector output coil L_1 in figure 2 can be a choke effective at the intermediate (receiver output) frequency, or can be a coil resonated at that frequency with a tuning condenser.

The concentric lines themselves can be sections of commercially available line, or they might be made up of copper (or copper-plated metal) tubing or bent sheet. Theoretically, more gain due to greater Q should be achieved with a ratio of outside conductor inside diameter, to inner conductor outside diameter, that is comparable with that used in commer-

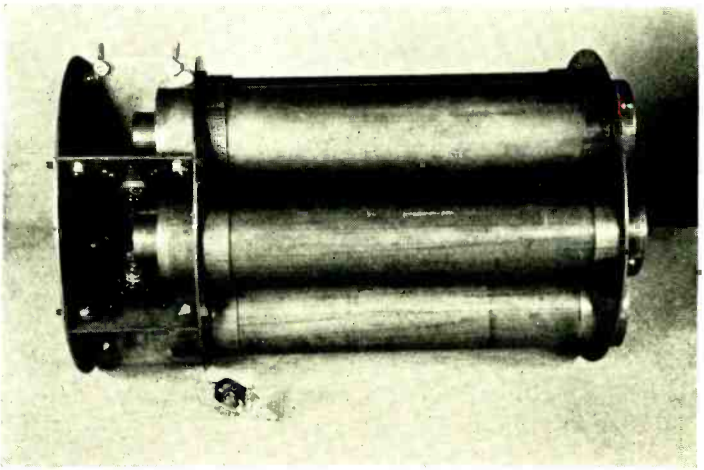


Figure 3. Here are shown the constructional details of a partially assembled 1¼-meter receiver using ten-inch concentric line couplers. Rods to actuate plungers will extend from the right hand end.

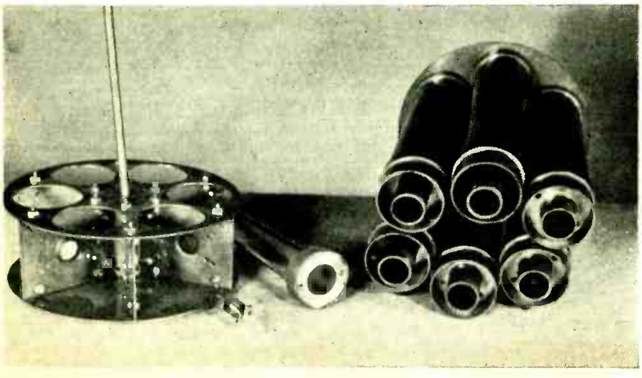


Figure 4. Parts of the 1¼-meter receiver are illustrated in photograph on the left. Note paper insulated plungers for wide frequency range. Tubes are to be mounted on thin mica in order that clips will have a large capacity to the copper shield so that an efficient by-pass will be provided.

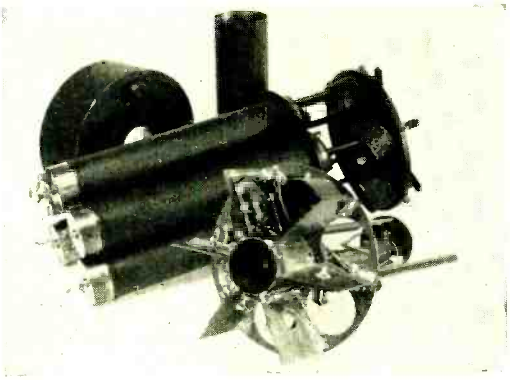


Figure 5. Dismounted view of the experimental u.h.f. receiver of F. W. Dunmore, National Bureau of Standards, showing method of assembly.

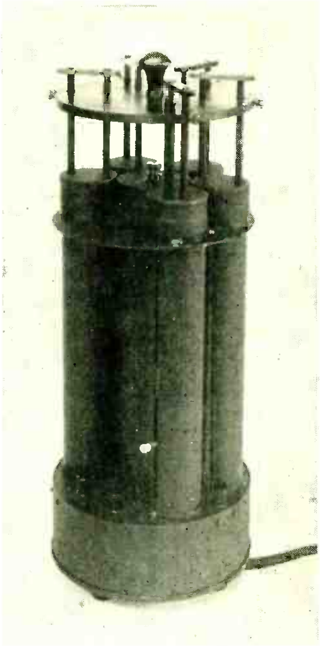


Figure 6. View of the completely-assembled Dunmore receiver. The power-supply cable can be seen coming out of the rear.

cially built line, but measurements made at 300 Mc. in lines with a ratio of 3.6 did not show this effect compared with lines having a ratio of 9.2, probably due to the predominance of lead and tube resistance over the concentric line equivalent series resistance. The ratio, therefore, is not critical.

A U. H. F. Receiver

Mr. Dunmore of the National Bureau of Standards[4] designed a receiver to cover the range of 175 to 300 Mc. by using plungers in concentric lines, having four amplifier stages and a detector. One concentric line per stage was used with the direct current plate supply lead running through the center line. The plungers in the line were capacitively connected to the outer line through a layer of paper insulation in order to avoid noise due to a friction contact. The capacity between plunger and outer conductor is calculated to be approximately 156 μμf. The plungers are controlled by rods extending through the bottom of the lines and ganged with set screws at the point of passing through a disc which is used as a common tuning handle for unicontrol.

The line in the first stage was slotted nearly its whole length, an insulated contact passing through the slot and sliding on the inner conductor to permit adjusting the connection between the coupler and one side of the transmission line from the antenna, as shown in figure 2. The high voltage end of each coupling line ends in a shielded box through the sides of which pass the 954 acorn pentodes.

In this case the detector was arranged for heterodyning to a broadcast frequency so that its output can be further amplified by a broadcast receiver, the whole set-up becoming a "double superhet." The r.f. amplifier couplers are directly grounded, grid bias being supplied by a cathode resistor. The detector output is tuned to the output (demodulated or heterodyne) frequency.

A central brass tube contains a voltage divider but is not necessary to the operation of the receiver.

Figures 3 and 4 show a similar receiver designed by one of the authors using six lines with a much smaller ratio between the sizes of the inner and outer conductors. Much of the mechanical work, and the idea of extruding the shield holes to form tube shields, is due to Stephan W. Jucius, W9AWO. In this receiver, instead of running the plate leads directly through the inner conductor, with the

[*Continued on Page 161*]

[4]F. W. Dunmore, "A Unicontrol Radio Receiver for Ultra-High Frequencies using Concentric Lines as Interstage couplers." *Proc.* I.R.E., June, 1936. Also published in Research Paper RP856 as part of the Journal of Research of the National Bureau of standards, Vol. 15, December, 1935 (for sale at 5 cents by Superintendent of Documents, Washington, D. C.)

THE STORY OF EL2A

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By **H. W. GOULD,*** **W8BIS**

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"Hank" Gould, W8BIS, ex-EL2A

Liberia, West Africa, is an independent nation established under American protectorate, whereby the negro could have an opportunity in a country which he might call his own. Liberia was established shortly after the Civil War days as a haven for the American negro slave.

Due to economic and financial conditions, the country has made but little progress during the years that have gone by. Liberia has no seaport whereby ocean freight can be easily handled. The Atlantic Ocean unmercifully beats its stony coast. The fact that ocean-going vessels are forced to anchor three miles from its coast seriously hampers the shipment of merchandise.

Monrovia, the capitol of Liberia, is a town of approximately three thousand natives and fifty white people. The town, if you can call it one, is void of picture shows, restaurants, amusements and stores. In the dark, dingy alleys along its waterfront, there are twenty-five or more trading posts which can supply the buyer with a few of his needs.

Approximately ten years ago, Harvey Firestone, Sr., in search for an independent supply of rubber, created a plantation division for the Firestone Tire and Rubber Company. The plantation is located deep in the tropical forests of West Africa, thirty-eight miles up the Junk River and approximately thirty miles from Monrovia. Mr. Firestone's dreams of having a source of supply independent of British monopoly have been realized.

Radio communication is and has been maintained daily with WTF/WPF, Akron, Ohio: traffic is handled by the U. S.-Liberia Radio Corporation, a subsidiary of the Firestone Tire & Rubber Co. Approximately 5000 words on c.w. are passed daily between Duside, Liberia, and Akron, Ohio, usually on 18,460 kc. and sometimes 10,310 kc., at 500 watts input. The commercial transmitter at ELF is a one-kw. Collins job, but seldom is it wise, in tropical countries, to put more voltage on the plates than necessary to get through. Transformer insulation is a real problem with the humidity at 86, and we don't mean maybe! A new V-beam was installed in July, 1936. Each leg of the beam was made approximately 720 feet long, and approximately thirty-five feet above ground at the station end, the apex of the beam. The V-beam had an advantage over the old vertical half-wave in that the signals were not only slightly stronger, but were much more consistent over a long period of time. Static on the higher frequencies in the tropics is practically nil even during a tropical storm; however on 600 meters, the QRN is terrific even when there is no storm. Radio schedules were kept daily with Cape Palmas, approximately 250 miles away, on 89½ meters. Ship schedules were kept on 600 meters for incoming freight traffic. Radiotelephony schedules were kept with Monrovia by means of a low-powered job.

All amateurs should be interested in the above lesson: namely, maintaining a daily schedule covering 4,298 miles, 365 days out of a year, year after year, with interruptions of not more than half a dozen times with equipment similar to that in possession of hundreds of American radio amateurs.

Efforts to obtain an amateur license from the Liberian government were at first emphatically refused with the information that no one had any rights as an American citizen when he came to Liberia to work for the Firestone Tire and Rubber Company. Requests to interview the American legation were absolutely refused! Permission was finally granted by John Cooper, Chief of the Staff, Liberian Government Radio Station, providing said station was operated in accordance with the Madrid Radiotelegraphic

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*869 Gorge Blvd., Akron, Ohio.

"And that's the dope on that, O. M." Jocko, the pet chimp, lamented the fact that we were not on phone so he could shoot the breeze with some of the boys.

Convention, 1934, to which Liberia was a signatory.

To John Cooper, an American negro educated at Ohio State University, and the New York Wireless School, we are indebted for the kind assistance in helping us put Liberia before the amateurs. Mr. Cooper and his entire staff are some of the finest fellows the writer has had the pleasure of knowing.

The first experiments from Liberia were under the arbitrary call UN2A on the 20-meter band. "UN" are the first two letters on an Underwood typewriter; hence the UN. Many American amateurs will remember having worked a "ship off the Gold Coast, West Africa". This was later to be EL2A at Duside, Liberia, West Africa. The station was not a ship but fixed in the tropical forests. The equipment consisted of four 852's in push-pull parallel with a vertical radiator 18 inches off ground at the bottom end. It certainly was a real thrill to send "CQ USA de UN2A" and listen to the boys come back.

Upon receiving permission from the Liberian government radio station to use EL2A, the equipment was dismantled, rebuilt, then operated as EL2A with two 852's in push-pull at 3600 volts, 250 milliamperes load.

The first problem was to put up a decent antenna. In looking over some magazines, we noted a thing called a "Yagi" vertical beam. Someone had taken rather extensive engineering data on the radiator at 2½ meters or less. We further reasoned, that if said antenna appeared to work so well on 2½ meters, it ought to be a "whiz bang" on 14 Mc. We wanted a sharp, high-gain beam from Liberia into U. S. A. Therefore, it was decided to build a 20-meter Yagi vertical beam, set it 47° west of north and see what could be done. The antenna was erected using three reflectors and five directors.

TOP: Du river, bordered by impenatrable jungle growth on either side.

CENTER: The natives enjoy having their picture taken. Many have never seen a mirror. These boys are better dressed than usual, most wearing nothing but a loin cloth.

BELOW: A native village or camp on the Firestone plantation. In the background are rubber trees.

All measurements were in exact accordance with their theoretical values. A resonant line connected between the tank of the 852 and ran to the bottom end of the voltage-fed vertical dipole. Tests were made to see how much "soup" was at the bottom end of the antenna. Since it delivered a 2-inch arc when touched with a lead pencil, it was evident that the antenna was plenty "hot". Shortly after midnight, upon completion of the commercial schedule, it was decided to give the Yagi beam a test. So once again, "CQ USA de EL2A". Then a moment of suspense. My goodness! the whole American band was calling EL2A. So many of them answered, they started to QRM each other! One after another was contacted with "you're R9+ and too dang loud to be in Liberia. You're a fluke in USA. Who are you anyway?" We still have to laugh about the time W6QD was trying to get us lined up with W6CXW. The signals were so loud Henry passed us up for 20 minutes, thinking it was a local. He was looking for an R3 signal! Night after night and month after month, the same results were duplicated. The signals were apparently R9 from Georgia, north through to the Hawaiian Islands. To the Yagi beam, all credit is given! The transmitter with its input power at 900 watts was not equal to many American amateur c.w. stations, especially those west of the Sierra Nevadas. The straight line section of the beam was 80 feet high, 45 feet off ground, and suspended from the 700-meter antenna.

The transmitter consisted of a 47 oscillator, two 46 push-pull doublers, a 203A buffer, and 852's in the push-pull final stage. Input was 3600 volts at 250 ma. The receiver was a homemade super with a window screen as its receiving antenna.

Radio schedules were maintained with W8ZY and W8DLD over a period of many months. Frequent schedules by phone were held with my wife and baby through the kindness of Al Prescott, W8DLD. Many of these phone schedules lasted as long as four hours at a time.

To W8DLD must be credited the loudest c.w. signals. Ninety-nine per cent of the time he was too loud to be QRM'd by any other American c.w. station. W8DLD was using three or four half-waves in phase with the nose of the beam passing over Liberia. To my friend W8ZY goes the credit for exceedingly clever and intelligent operating. Using the vertical radiator described recently in RADIO and four crystal frequencies, he would handle messages of 500 or 600 words at 30 w.p.m. with seldom a repeat. Many of the messages "homeward" bound were somewhat confidential; so the messages were sent in plain English, each word sent backwards. If you don't think it makes a fair method of coding, then try copying it at 30 w.p.m. and see for yourself.

As all of us know, any five-watt job will get into a foreign country under most favorable conditions; however, these jobs seldom come through for more than a few moments out of each day. With due appreciation to all of the American amateurs for their splendid co-operation on 14,400 kc. side of the 20-meter band, our sincere thanks are again offered. A few of the outstanding signals which could easily be copied for 8 to 10 hours at a stretch were: W1SZ, W1LZ, W2FAR, W3BBB, W4DHZ, W6QD, W6GRL, W6CXW, W7EKA, W8ZY, W8DLD, W8DFH and W9FS.

The last night of operation at EL2A with the equipment described was January 24, 1936. During that evening, steady contact was maintained with W8ZY and W8DLD for four hours. Immediately after the Ohio schedule was finished, 128 North American stations were worked in one hour and ten minutes, an average of over two stations a minute during that time. It was a common occurrence to hook up the bug, send the letter "V" a dozen times with "QRZ?", never once signing, and have 20 or more W stations reply by starting to call EL2A.

As a general rule, American signals are very loud in Africa. They can easily be copied, night after night, month after month, on either the 20- or 40-meter bands. Past experience on the commercial circuit clearly demonstrates that dx to any country can be worked consistently providing someone there has a little equipment, an antenna which will do tricks, and stays on the air consistently. These facts are substantiated by the fact that before putting the new commercial high frequency transmitter into operation, Duside, Liberia, handled approximately 1000 words a night with Akron on 39.5 meters with a half-wave vertical radiator, three feet off ground at the bottom end, a power input of 300 watts operating at 30% efficiency, yet with no more than two or three breaks in schedule over a period of some thirty months.

The native life in Liberia is much the same as that covered by ON4CSL in writing of the Congo in RADIO. Every known form of bug,

[*Continued on Page 182*]

PUTTING THE "B" IN BEAM

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By **IRVING W. PINKERTON,* W6LY**

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Probably more words have been written about antennas, about the proper length for feeders, their spacing and so on during the last few years than upon any other single phase of amateur radio. Even back in the days when the wire coming into the shack was called the "Lead-in", articles were being published about how long to make the flat-top and what to do with the counterpoise. Widespread use of the high frequency bands and beam antennas only served to complicate the whole matter, until today there is a divergence of opinion among amateurs as to the practical results to be expected from a radiating system that is not exactly "on the nose", one that is plus or minus anywhere from a few inches to a couple feet in any dimension.

There are those who say it doesn't make any difference, that the main thing is to get the old sky wire up in the air and let fly with a CQ. Maybe they are right, especially on c.w., where a little stray r.f. floating around does no particular harm. But to the phone man it's a different story; one of the surest cures for that old bugaboo, r.f. feedback, is a properly adjusted antenna and feed system.

Take the case of the doublet, probably the easiest of all to adjust. All you need is a self-excited oscillator (a Hartley is easy to get going) that will tune to the frequency of the antenna. Loosely couple the doublet feed-line to the oscillator and then while watching the plate milliammeter, tune the oscillator through its range. No doubt a number of rises of plate current or "peaks" will be observed.

There is a very good reason why this is likely to happen, especially on 20 or 10 meter antennas. In the first place, it is very likely that the test oscillator you are using covers a fairly wide frequency range, and not only are peaks observed for the fundamental but also some harmonics of both the flat-top portion and the feed line as well. It must be kept in mind that the line will *not* act as a non-resonant line except when terminated in something like its own characteristic impedance. Of course this condition of match would not exist if our test oscillator were tuned to, say, 20 or 30 meters while trying to adjust a 40 meter doublet. Only at a point of current maximum (in a half wave antenna, the center) will the impedance be such that it terminates properly, or matches, our low impedance transmission line. In so doing it prevents the line from having any effect upon resonance of the radiator.

We can, for the purpose of our test, eliminate this line resonance at any frequency by simply terminating the line at the antenna end with a fixed resistor of 75 to 100 ohms. Now while tuning our test oscillator through its range we will have only the peaks introduced by the flat-top resonance. It is really remarkable what a little one watt carbon resistor can do. Next turn on the receiver and find out where your test oscillator comes in when it is set at the peak nearest or in the band you are heading for. It is a comparatively simple matter to add on or cut off a little wire from each end as the case may require, until you have moved the antenna resonance to your favorite spot on the dial. One more thing. Don't forget to take out the little resistance after you are all through. It won't take a kilowatt for long.

The procedure for lining up the "J" type of antenna is somewhat different but involves exactly the same principle. The first thing to do is to disconnect the quarter wave stub from the antenna portion in order to resonate the stub at the working frequency by itself. Let us assume that the stub is to be fed with a low impedance line, and that we want it to tune to 14,200 kc. The first thing to do is to put the 100 ohm resistor across the line so as to be sure the line won't be resonant and throw us off the track. Next, couple the line to the stub very close to the shorting bar. Probably an inch or so away will give enough coupling to obtain an indication of resonance on the oscillator plate milliammeter.

Check that frequency on your receiver and see if it is near the 14,200 kc. we wanted. If not, add or cut off some wire on the open ends of the stub until it lines up right in the center of the band.

*3959 Brunswick Ave., Los Angeles, Calif.

Now, if the length of the flat-top of this "J" antenna is correct, when it is attached to one leg of the stub there will be no de-tuning. The receiver will still show the test oscillator to be on 14,200 kc. when the latter is resonated to the antenna system. If, however, the receiver shows that the resonant frequency has shifted to say, 14,050 kc. for resonance, we know that the antenna must be too long. Shorten it until you have the resonant point in the center of the band. When the length of the antenna is correct there will be no detuning of the resonant frequency when it is connected to or disconnected from the stub, and everything should now be ready to go. Oh yes, don't forget to take out that resistor.

The adjustment of a phased array may be carried out in almost the same way as for the J antenna. For example, in the case of two half waves in phase which are being fed off the stub, the procedure would be identical with a half wave J except that there would be one more half wave element to deal with. Just take them one at a time and everything should turn out okay.

In the case of a "three half waves in phase" array which is to be fed in the center of the middle half wave section, the better procedure would be to line up the center half wave and its line alone. After this has been done the two end half wave sections and their quarter wave stubs should be adjusted to frequency exactly as the J antenna was, one at a time, by themselves, and then connected to the center section without any further adjusting.

Four in phase would be adjusted the same as would be two in phase with a "J" added to each end.

So far we have only spoken of low impedance lines, but of course exactly the same principle would apply to open wire lines, the only difference being that the terminating resistor would of course be 500 ohms or so, depending on the line spacing and wire size.

If you are feeding an antenna by means of a non-resonant line coupled to a quarter wave stub and you wish to know the proper point at which to attach the line on the stub, it is a simple matter if you are not running too much power. Simply terminate your line in its characteristic impedance with a couple of three watt carbon resistors. The line is of course disconnected from anything else at the far end.

With 500 volts or so on your final amplifier, increase the coupling to the feeder until the amplifier draws approximately normal plate current for the plate voltage used. (If you normally run 400 ma. at 2000 volts, load it up to about 100 ma. at 500 volts.) Noting the exact plate current reading, disconnect the resistors and attach the line to the matching stub, moving it along the stub until the final amplifier draws exactly the same plate current as it did with the resistors. The coupling at the transmitter end is not touched for this comparison. After the correct point of feeder attachment is found on the stub by this method, the feeder should be soldered to the stub to keep its position from being changed. Then increase your plate voltage to normal and make any slight changes necessary in the coupling at the transmitter end in order to make the amplifier draw the desired plate current.

Do not worry about the resistors. They will dissipate 100 watts apiece for a short time without damaging anything but the paint. However, they are a little more accurate when not allowed to get too hot, and for that reason it is preferable not to run too much power to the transmitter when making the tests.

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Notes on a Rare and Fearful Malady, an Epidemic of Which Has Lately Claimed Over Forty-Thousand Victims from among the Populace:

The pestilence, still unnamed, is carried among the people by a bug, by name *pestus radioticus,* which fastens itself to its victims with incredible tenacity. It has smitten down all ages and both sexes with like intensity. The attack is presaged by a peculiar shrill cry, *dit-dit-dit-dit dit-dit,* which the pest lets out in in wild glee, beginning at a piercingly high pitch and following through to a coarse, low-pitched cough. The cry strikes terror to the few who escape, but the stricken ones listen with fiendish delight. They forthwith exhibit the first symptoms—building up all manner of strange instruments, with which they affect communication with brother incurables at distant points, and casting aside their given names for odd letters and numerals. The attack continues until the victim is bereft of sound mental and physical health—and money.

It never kills; its is a mission of torture. The victim's demise is occasioned by some other superinduced condition such as starvation, walking into the path of a moving vehicle, or homicide.

WHY *Some Beams Don't Work . . .*

By **ELMER H. CONKLIN***

Have you ever erected a simple beam antenna, then upon testing it on the receiver or transmitter, found that its directional properties were not at all pronounced? If you have, you may now be among those who say, "Beams are the bunk; give me a good nondirectional antenna any day." We don't wish to argue with the second half of this statement, but with the first half. In so doing, we may be able to explain why some simple beams just don't act as predicted.

Back in the "200-meter" days, the only type antenna widely used was the Marconi, operated against a counterpoise, or against a good ground if one was available. That the arrangement did work will be seen from the fact that our signals occasionally were reported all over the world.

Some of us now are using Marconi-type antennas without knowing it. Let us examine, for instance, the ordinary zepp which is pictured in figure 1A. The feeder has some capacity coupling or unbalance to the amplifier-tuned circuit. Leaving out all of the nonessentials for our problem, the antenna can be represented as in figure 1B, which is simply a Marconi antenna. We don't mean that the zepp doesn't operate as a "Hertz," but that both types of radiation can take place depending on the amount of power transferred to the antenna by the two types of coupling.

In some cases, feeder current unbalance, in a system in which the antenna is exactly in resonance and the feeder wires are the same length, may be due to the part of the current flowing in the same direction in both feeders, resulting from this operation as a Marconi radiator.

Now let us suppose that a vertical two-element broadside beam has been erected, as shown in figure 2. Theoretically, this should have the pattern of the figure-8 solid line in figure 3, compared with the circle which indicats the theoretical pattern of a single vertical radiator. Now, if as much power reaches the antenna through capacity coupling as through the proper inductive coupling, thus tending to make the antenna operate as a "bunch of haywire" with no phase differences between the feeder wires or antennas, then the result would depend on the polarity of the two types of coupling. If we first assume that the two effects aid each other, the resulting pattern is indicated by the dashed line in figure 3. If they buck, then the pattern is that of the broken line in the same chart. These resultant patterns are of course not of relative size, because only part of the transmitter power reaches the antenna through either type of coupling.

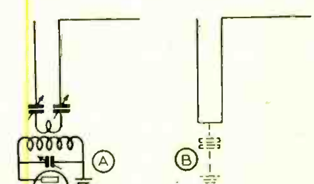

FIGURE 1

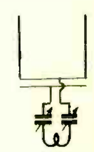
FIGURE 2

With a different amount of antenna power due to each kind of coupling, the resulting pattern will change.

It should be easy to see from this why an antenna used on a receiver does not always reject signals from the "wrong" direction. This is particularly true when the feeders have not been tuned with the receiver input circuit attached, therefore reducing the power resulting from the phase relations in the beam elements.

With an electrostatic screen between the primary and secondary of the antenna coupler, or with split coils carefully placed to balance out the capacity coupling, only inductive coupling remains. The best properties of the beam are then obtainable.

Occasionally, in a noisy location, it is desirable to use a horizontal receiving antenna, which will bring in distant signals well but which will discriminate against vertically polarized local noise. Capacity coupling or feeder pickup will at least partially defeat this purpose. A method of testing an antenna for this trouble was suggested by Ralph Billings, W9AFO, who was using a horizontal doublet

*Associate Editor, RADIO.

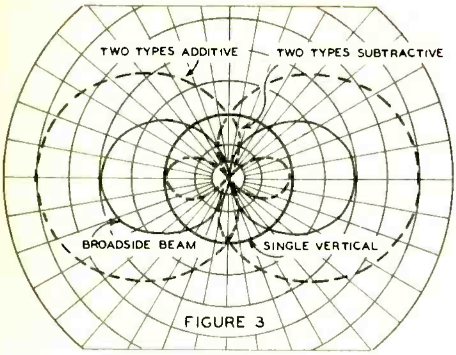

FIGURE 3

receiving antenna with a twisted-pair lead-in. After listening to the strength of signals on a high-frequency band, he lowered the antenna, shorted the twisted-pair feed at the antenna, and raised it again. On returning to the receiver, he heard not silence but reasonably loud signals and plenty of noise. Obviously, this pick-up was not from the horizontal antenna because the lead-in was shorted. Kruse has suggested a similar test, simply shorting the receiver input terminals with the antenna attached to the set. The receiver primary could not conveniently be grounded at its center, nor could a Faraday screen be installed without a bit of rebuilding. Instead, a small coil was placed across the receiver antenna terminals, and the coil center-tap grounded, as suggested by Kruse in an article in RADIO for December, 1936. Signals then disappeared, and so did the noise, but the signals came back when the short was removed from the lead-in. Noise pickup was reduced. This method has the mild advantage of being most effective on the band for which the balancing coil is wound, requiring additional coils for other bands.

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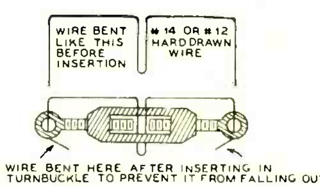
An Effective TURNBUCKLE LOCK



Turnbuckles are an invaluable aid in making small adjustments in guy length and in keeping the guys taut after these adjustments have been made. If these turnbuckles would stay in the adjustment at which they were left, everything would be fine. But they do not. Witness the statement that is almost always made in antenna pole construction articles, "Do not use turnbuckles in the guy wires; they have a very insidious way of coming apart under the continual strain and vibration of the wires. The results, in a large number of cases, are disastrous."

From Karl White, W5WR, Tulsa, Oklahoma, comes the following very timely suggestion for a simple turnbuckle lock.

"For several years I have been using this turnbuckle lock, a sketch of which I am enclosing (above). I can assure you that it is effective because I have purposely removed them from a couple of turnbuckles in my antenna system just to prove their effectiveness. In all cases the unlocked ones came apart in a couple of months while the remaining ones (on which the locks had been installed) remained as they had been left."

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No More, Please

We *do* like to get contributions in response to our request for photos, but we wish the contributors would show a little originality. The first few pictures we ran were of various towers and masts. Consequently, we have been deluged with 4873 snaps and photos of various and sundry beams, rotating clothes lines, towers, masts, poles, and other antenna paraphernalia. The figure is by courtesy of our exasperated photo editor. Personally, from observation of the incoming mail, we don't believe that the figure would be much over a hundred. But even so it is too many.

Some of them were very nice; but we can't run towers forever. Consequently all were returned.

P.S.: We suggest you don't send in any pictures of your brand new 84-foot lattice mast.

SIMPLIFIED SINGLE SIGNAL

By HARRY G. BURNETT,* W1LZ

For those to whom the crystal filter presents a difficult problem, because of financial reasons or alignment and circuit intricacies, several means of obtaining single-signal results by utilizing regeneration in the i.f. amplifier have been suggested. The two most popular types employ a ticker coil or a cathode coil for obtaining regeneration. That there are objections to these two methods may explain why more amateurs have not taken advantage of these comparatively simple means of increasing selectivity and gain. For one thing, the tickler system necessitates operating upon the first i.f. transformer to insert the tickler coil. Also, the adjustments are often affected by a change to a new tube, because of slight differences in tube characteristics. The cathode-coil method leaves the i.f. transformer undisturbed, but is sometimes a bit difficult to adjust.

Dynamic vs. Static Single Signal

Perhaps, if there were a still simpler means of obtaining the necessary regeneration, more amateurs could be induced not to pass up the opportunity to get results nearly comparable to those derived from the use of a crystal filter. Admittedly, the s.s. effect acquired by regeneration is not quite as good as that of the crystal filter. However, although regeneration is dynamic and, therefore, has inherent possibilities of instability, in practice the instability is slight and encountered only when working barely below the oscillating point. To counter-balance this very minor defect, the dynamic properties of regeneration send the i.f. gain up by leaps and bounds. The advantage of regeneration over the crystal filter, which is passive and, at best, does not decrease signal strength, despite its extra stage of i.f., is noticeable on dx. Although the s.s. effect with regeneration decreases with very loud signals, this defect can be diminished greatly by retarding the r.f. gain control. If an easy method of adding the desired regeneration can be devised, more "Missourians" may be persuaded to prove to themselves that i.f. regeneration "has something there". We should like to suggest that they try the two-ultra-simple systems discussed below.

Plate-to-Grid Feedback

Some time ago W8UD proposed an absurdly simple means of obtaining regeneration in the i.f. (see page 40 of "QST" for April, 1934). He twisted one end of a small piece of pushback wire about the control-grid cap of the i.f. tube, and then inserted the other end of the wire between the i.f. tube and its shield can. The length of the wire inside the shield-can determines the amount of grid-to-plate capacity and, therefore, the amount of feedback. We were unable to use this very simple procedure with a metal tube.

However, the same effect can be produced with a metal tube. A piece of push-back wire about six inches long was procured. The insulation at the ends was pushed back about a quarter of an inch, and a quarter of an inch of wire cut off each end. The insulation was then pulled back to its former position covering the bared ends. One end of the wire was then twisted a couple of times about the i.f. control-grid cap. The other end was next coupled to the plate circuit by pushing it into the vacant hole in the top of the second i.f. transformer (this hole is normally used for bringing out the control-grid connection from the top of the can when the can shields a first i.f. transformer). The amount of plate-to-grid coupling was then controlled by the length of the wire pushed into the top of the second i.f. can. The i.f. was realigned, of course, after the wire was in place.

Although this type of regeneration is super-simple and sure-fire in operation, its disadvantage when only one stage of i.f. is used, is that the i.f. gain control must be left fixed at a point just below oscillation. There is the possibility of inserting a trimmer condenser in the wire coupling the grid to the plate circuit, and varying the plate-to-grid coupling by this trimmer, but, still, this system will remain inflexible.

A search was made for a method which would be just as simple but more flexible. Mr.

*16 Windsor Rd., Somerville, Mass.

Dana Bacon suggested an ingenious idea which led to the adoption of the following circuit.

Variable By-Passing

If a variable resistor is placed in series with a bypass condenser, the larger the amount of resistance employed, the less is the bypassing effect of the condenser for any given frequency. This is due to the fact that the impedance to r.f. is increased as more resistance is placed in series with the reactance of the condenser. The relationship is expressed mathematically as follows:

$$Z = \sqrt{R^2 + X^2}$$

where Z equals impedance of condenser and resistor in series; R equals the resistance; and Z equals the reactance of the condenser. Therefore, a potentiometer in series with a bypass condenser permits smooth, variable adjustment of the bypassing action.

This idea can be applied to the screen-grid bypass condenser in the i.f. stage. A 50,000-ohm potentiometer is connected in series with the screen bypass. As the resistance of the potentiometer is increased, the impedance of the condenser and resistor to r.f. is increased. The impedance may easily be increased to the point where the bypassing effect of the .01 condenser is very small and the screen is "floating" above ground. With the screening effect poor, plate-to-grid coupling will take place between the elements and regeneration will result. Of course, if the impedance is made too high, oscillation will take place.

Advantages

Advantages of this form of regeneration are: The amplifier circuit remains undisturbed, except for the addition of the potentiometer. The screen-grid potential remains constant. The i.f. gain control can be adjusted within wide limits, and the regeneration control reset at the proper value. Regeneration can be removed at will by setting the potentiometer at zero resistance. The regeneration control is smooth, and can be adjusted to a point just below oscillation where a ringing sound similar to that produced by a crystal filter will be heard. By careful adjustment this ringing sound can be made to enhance the signal strength (this effect can be made more pronounced if the frequency curve of the phones has a peak around a 1,000 cycles). If the regulation of the power pock is fairly good, no trouble will be experienced in working barely below the point of oscillation after the i.f. tube has warmed up to its normal temperature.

Tube Selection

The 6J7 appears to be the best tube to use for the i.f. in this circuit. The shielding of the 6L7 and the 6K7 seems to be a bit too good to permit smooth control of regeneration over a wide range of i.f. gain control settings. This involves no hardship, especially for the dx man, because the 6J7 is the logical choice for this position anyway, as pointed out by W6AUX on page 63 of RADIO for March, 1937.

A refinement may be added in the form of a 35 μμfd. variable condenser connected from the cathode tap of the beat oscillator coil to ground. This will give a vernier control of the b.f.o. frequency and will permit the rejected audio image to be shifted from one side of zero beat to the other directly from the front panel.

Although no novelty is claimed for the two systems of i.f. regeneration discussed above, it is hoped that their simplicity may recommend them to others. I am sure that they will discover for themselves selectivity and amplification galore that they have been missing.

•

More on Stamp Collecting

Here are a few more names for our roll of stamp collectors:

W6OFD, N. W. Sue Co. Bldg., corner 8th and G Streets, Modesto, Calif.

Mrs. Mary Tatro, W7FWR, R.F.D. 1, Athens Beach, Olympia, Wash.

Alphy L. Blais, VE2AC, P. O. Box 89, Thetford Mines, Quebec, Canada. VE2AC collects U. S. and British Empire stamps.

Leroy Fry, W6LQN, 1331 Berkeley St., Santa Monica, Calif.

W. G. Stunden, VE4HQ, 404 Public Bldg., Calgary, Alberta, Canada, who would like to exchange current unused Canadian stamps for those of any other country of the world.

T. A. Lonergan, W1JQH, 23 Codman Hill Ave., Dorchester, Mass.

In connection with a notice appearing in an earlier issue of RADIO, to the effect that the Los Angeles post office maintains a mailing list for stamp collectors interested in learning of new issues, W6CHU informs us that said list has increased over one hundred names following publication of the notice.

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Regular broadcast stations licensed by our F. C. C. radiate power which totals three and a quarter million watts — over four thousand horsepower.

HAMS ACROSS THE SEA

—VS3AE—

Tengku Temenggong Ahmad, VS3AE, was first initiated into amateur radio in 1917 while studying in England and staying at the home of the author, William Le Quex, in Surrey, England. He accommodated the colonel by talking into the microphone of the "wireless" transmitter while the colonel would drive off a few miles to see how far he could hear the signals.

After returning to Johore, he took but a perfunctory interest in amateur radio, and was keener on polo as a hobby until 1932, when VS3AC and VS1AD managed to convert him into a full-fledged amateur. Thus duly initiated, he became as rabid an amateur radio enthusiast as the next fellow, and proceeded to work stations all over the world and make many friends in far away lands.

Besides amateur radio, VS3AE is interested in photography as a hobby. He also expresses more than a casual interest in stamp collecting, but does not take the latter so seriously as he does his cameras and radio transmitter.

His many duties as Acting Deputy Prime Minister of Johore, Malaya, do not permit him as much free time to devote to his hobbies as he would like. He gives this as one of the reasons for his being somewhat behind in answering QSL cards, but says that those who are patient will eventually get a card from him.

•

Remote Control Systems

It is a shame that some of the amateurs that use remote control systems do not make more general use of low-frequency "wired-wireless" as their control medium.

With a local oscillator on say 110 kc., at the operating position and feeding into the a.c. power line, it is very easily possible through the use of various modulation frequencies upon the carrier to control completely the transmitter; to start, stop or stand-by, to modulate it for phone and to key it for c.w. Of course this is also possible by running two or three pairs of wires between the two positions, but in some cases, such as when the transmitter is located two or three blocks away but still on the same power line, it would be much easier and less expensive to control the rig by some means such as mentioned above.

The details of such a control system are not very complicated; no great difficulty should be experienced in working them out.

•

Fix-tuned receivers, pre-set to one broadcast station, are now in vogue in India.

•

One-way military communication by way of carrier pigeons travels at the rate of half to three-quarters of a mile a minute.

SOMETHING ABOUT

. . . Constant-Resistance Lamp Loads

Many amateurs are puzzled as just how to calculate the values (wattage) lamps to use when paralleling carbon and Mazda lamps in order to obtain a resultant resistance that is fairly constant with changes in wattage dissipation. By following the simple rule given below, the right proportion between the resistance of the carbon and tungsten components can easily be determined.

For any given value of 110-volt carbon lamp, the parallel Mazda lamp (115-125 volt) should be rated at just half the wattage. The resistance will remain fairly constant from the full total wattage rating of the two lamps down to about 1/10 of this wattage. For instance, a 120-watt carbon lamp (110-volt) would be used in parallel with a 60 watt Mazda lamp (115-125 volt). The resulting resistor would be practically non-inductive, dissipate a maximum of 180 watts safely, and maintain a resistance of approximately 70-75 ohms so long as more than 18 watts is being dissipated.

. . . Chokes in the Minus Lead

It seems to be standard amateur practice to place the iron-core chokes of the plate-supply filter in the positive leads, the negative being taken directly from the rectifier to the chassis or filaments.

This isn't by any means the universal practice in commercial transmitters, which not infrequently put the chokes in the minus lead of plate-supply systems. The advantage of this arrangement is that there is little voltage between the windings and the core of the filter-chokes; hence the insulation strains are less. This isn't important up to perhaps 1500 volts but above that it really means something. Besides, there's less "hot" stuff around then.

If your transmitter blows up chokes, try making the change. The minus lead *beyond* the filter can go to chassis as usual.

In a grid-voltage supply the same case does not come up because the more modest voltages make winding-to-core punctures improbable. Accordingly it is safe to put the choke in either lead as you see fit. We are no longer as sure about the right lead as we were before trying to prove that there is a difference. Maybe there isn't.

But for B supply at high voltage both safety and cost call for chokes in the minus lead.

When using chokes in the minus lead (when the minus is grounded at the output of the filter instead of the centertap of the transformer), one should bear in mind that the distributed capacity of the plate transformer windings to ground appears as shunt capacity across the filter choke. If the transformer has much distributed capacity this factor becomes of considerable importance, particularly if the filter is counted upon to reduce high frequency hash from mercury vapor rectifiers.

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If the 160-meter phone hams between 1950 and 2000 kilocycles who live in large cities would call CQ "160" it would save some of the 75-meter fellows from wasting a lot of breath. Of course after one memorizes all the 160-meter harmonics one knows better than to answer one of the CQ's from these 160-meter stations except when they CQ 75 meters. But in the meantime the 75-meter fellows waste lots of time trying to "raise the harmonics".

NEWLY RELEASED TUBES

This month the tube manufacturers have done right well by us as far as bringing out new, interesting-design tubes is concerned. RCA has released two new types, Gammatron, one; all will be of widespread interest to the majority of amateurs.

The RCA 809

The RCA 809 is a triode transmitting tube of the high-mu type and is designed for use as an r.f. amplifier, oscillator, or class-B amplifier. It has quite a high transconductance and for this reason is capable of high plate efficiency at comparatively low plate voltages and with low driving power. The plate connection is brought out through the top of the envelope to provide high insulation and to contribute toward low inter-electrode capacities. The internal structure of the tube is such that it may be operated at full maximum ratings at frequencies as high as 60 Mc. Operation may be had at still higher frequencies providing the plate voltage and plate input is reduced proportionately. The maximum plate dissipation is 25 watts, under normal operating conditions, and the tube is equipped with a ceramic base.

TENTATIVE CHARACTERISTICS

Filament voltage	6.3 volts
Filament current	2.5 amps.
Amplification factor	50
Direct interelectrode capacities	
Grid-plate	6.7 μμfd.
Grid-filament	5.7 μμfd.
Plate-filament	0.9 μμfd.

TYPICAL OPERATING CONDITIONS

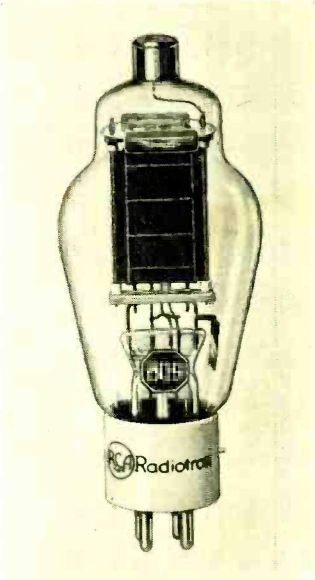
A.f. Power Amplifier and Modulator—Class B

D.c. plate voltage	500	750	volts
D.c. grid voltage	0	—5	volts
Peak a.f. grid-to-grid voltage	135	140	volts
Zero-sig. d.c. plate current	40	35	ma.
Max-sig. d.c. plate current	200	200	ma.
Load resistance (per tube)	1300	2100	ohms
Effective load resistance (plate-to-plate)	5200	8400	ohms
Max-sig. driving power	2.4	2.4	watts
Max-sig. power output	60	100	watts

As R.F. Power Amplifier—Class B Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

D.c. plate voltage	750 *max.*		volts
D.c. plate current	50 *max.*		ma.
Plate input	37.5 *max.*		watts
Plate dissipation	25 *max.*		watts
Typical operation:			
D.c. plate voltage	500	750	volts
D.c. grid voltage	—5	—10	volts
Peak r.f. grid voltage	35	40	volts
D.c. plate current	50	50	ma.
D.c. grid current (approx.)	6	5	ma.
Driving Power (approx.)	1.4	1.5	watts
Power output (approx.)	7.5	12.5	watts



As Plate-Modulated R.F. Power Amplifier—Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

D.c. plate voltage	600 *max.*		volts
D.c. grid voltage	—200 *max.*		volts
D.c. plate current	83 *max.*		ma.
D.c. grid current	35 *max.*		ma.
Plate input	50 *max.*		watts
Plate dissipation	17.5 *max.*		watts
Typical operation:			
D.c. plate voltage	500	600	volts
D.c. grid voltage	—160	—160	volts
Peak r.f. grid voltage	250	250	volts
D.c. plate current	83	83	ma.
D.c. grid current (approx.)	32	32	ma.
Driving power (approx.)	7.2	7.2	watts
Power output (approx.)	30	38	watts

As R.F. Power Amplifier and Oscillator—Class C Telegraphy

Key-down conditions per tube without modulation

D.c. plate voltage		750 *max.*	volts
D.c. grid voltage		—200 *max.*	volts
D.c. plate current		100 *max.*	ma.
D.c. grid current		35 *max.*	ma.
Plate input		75 *max.*	watts
Plate dissipation		25 *max.*	watts
Typical operation:			
D.c. plate voltage	500	750	volts
D.c. grid voltage	—50	—60	volts
Peak r.f. grid voltage	135	140	volts
D.c. plate current	100	100	ma.
D.c. grid current (approx.)	20	20	ma.
Driving power (approx.)	2.5	2.5	watts
Power output (approx.)	35	55	watts

Just a glance at the above specifications will leave no doubts as to the healthy capabilities of this little tube. All this is especially good considering the reasonable price that has been placed upon it. One interesting feature is the husky filament employed—6.3 volts at 2.5 amperes, 15.75 watts of filament power. A filament such as this should really last a long time at the rated current of 100 milliamperes. Also, the 6.3-volt rating allows the tube to be operated from the same transformer as any 6L6's, 42's or other tubes used in the exciter.

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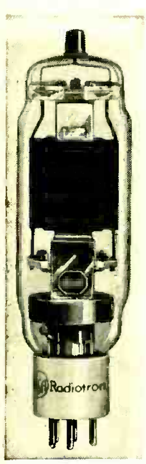
The RCA 814



The RCA 814 is a filament-type power tube incorporating new design principles involving the use of directed electron beams. Features resulting from the use of these principles in the 814 are that the screen absorbs little power and that efficient suppressor action is supplied by space-charge effects produced between the screen and the plate. The resultant high power sensitivity makes this tube especially suited for use as an r.f. amplifier or high-level frequency multiplier. The plate is brought out through the top of the envelope to assist in the realization of low interelectrode capacities. Further to reduce losses, the tube employs a ceramic base. The 814 may be operated at maximum ratings at frequencies as high as 30 Mc. in all classes of service.

TENTATIVE CHARACTERISTICS

Filament voltage	10.0 volts
Filament current	3.25 amps.
Transconductance (for plate current of 39 ma.)	3300 μmhos
Direct interelectrode capacitances:	
Grid-plate (with external shielding) max.	0.1 μμfd.
Input	13.5 μμfd.
Output	13.5 μμfd.

OPERATING CONDITIONS

As Grid-Modulated R.F. Power Amplifier

Carrier conditions per tube for use with max mod. factor of 1.0

D.c. plate voltage (max.)		1250	volts
D.c. plate current (max.)		60	ma.
Plate input (max.)		75	watts
D.c. screen voltage (max.) (grid no. 2)		300	volts
D.c. grid voltage (grid no. 1) (max.)		—250	volts
Screen input (max.)		6.7	watts
Plate dissipation (max.)		50	watts
Typical operation:			
D.c. plate voltage	1000	1250	volts
D.c. screen voltage	200	200	volts
D.c. grid voltage	—100	—100	volts
Peak r.f. grid voltage	129	129	volts
Peak a.f. grid voltage	64	64	volts
Beam forming electrode voltage	0	0	volts
D.c. plate current	60	60	ma.
D.c. screen current	2	1.4	ma.
D.c. grid current	3	2.8	ma.
Driving power (approx.)	2.5	2.3	watts
Power output	25	29	watts

As R.F. Power Amplifier — Class-C Telegraphy

D.c. plate voltage (max.)		1250	volts
D.c. screen voltage (max.)		300	volts
D.c. grid voltage (max.)		—300	volts
D.c. plate current (max.)		150	ma.
D.c. grid current (max.)		10	ma.
Plate input (max.)		180	watts
Screen input (max.)		10	watts
Plate dissipation (max.)		50	watts
Typical Operation:			
D.c. plate voltage	1000	1250	volts
D.c. screen voltage	300	300	volts
D.c. grid voltage	—70	—80	volts
Peak r.f. grid voltage	150	165	volts
Beam-forming plate voltage	0	0	volts
D.c. plate current	150	144	ma.
D.c. screen current	17.5	22.5	ma.
D.c. grid current (approx.)	10	10	ma.
Screen resistor	40000	42000	ohms
Grid resistor	7000	8000	ohms
Driving power (approx.)	1.35	1.5	watts
Power output (approx.)	100	130	watts

The beam-forming plates should be connected to the center-tap of the filament transformer when a.c. is used, or to the negative end of the filament when a d.c. filament supply is used.

The unusually high power sensitivity of this new tube should suit it very well to use as a high-gain or frequency-multiplying amplifier. Due to its high gain, no trouble would be experienced in exciting it to full output from a comparatively low-power crystal oscillator or doubler stage. It would be very convenient to use this tube in a multi-stage bandswitching transmitter or high-power exciter.

The Gammatron 54

Another new tube in the Gammatron series has been announced. It is very much similar in power rating and external appearance to the tubes of the 35T and 808 type. It employs a 5-volt filament that draws 5 amperes; its 25 watts of filament power make it intermediate in filament drain between the 808 and the 35T. It is, however, rated at the same maximum plate current as the other two tubes.

ELECTRICAL DATA

Filament voltage	5.0	volts
Filament current	5.0	amps.
Normal plate dissipation	50	watts
Maximum average plate current	150	ma.
Maximum average grid current	30	ma.
Average plate impedance	2000	ohms
Average amplification factor	27	
Average interelectrode capacities:		
Grid-plate	1.9	μμfd.
Grid-filament	1.9	μμfd.
Plate-filament	0.3	μμfd.

TYPICAL OPERATING CONDITIONS

Radio-Frequency Amplifier—Class C

D.c. plate voltage	1500	2000	volts
D.c. grid voltage	—150	—269	volts
D.c. plate current	135	130	ma.
D.c. grid current	20	20	ma.
Effective excitation voltage	230	330	volts
Load resistance	5600	7800	ohms
Driving power	7.0	9.0	watts
Power output	156	210	watts
Plate efficiency	77	80.5	%

Radio Frequency Doubler

D.c. plate voltage	1000	1500	volts
D.c. grid voltage	—291	—338	volts
D.c. plate current	100	85	ma.
D.c. grid current	20	20	ma.
Effective excitation voltage	328	350	volts
Load resistance	5900	9250	ohms
Driving power	9.0	10.0	watts
Power output	57.0	64	watts
Plate efficiency	57	59	%

Audio Amplifier or Modulator—Class B (Two Tubes)

D.c. plate voltage	1000	1500	volts
D.c. grid voltage	—25	—45	volts
Grid-to-grid peak-signal voltage	295	300	volts
Plate-to-plate load resistance	8500	16,800	ohms
No-signal plate current	40	40	ma.
Max.-signal plate current	233	198	ma.
Peak driving power	10.0	8.0	watts
Power output	141	200	watts
Plate efficiency	60	67	%

The tube employs a tantalum plate and grid, and the single-spiral filament is supported by a vertical rod through the center in a similar manner to the method of support used in the other tubes of this classification. The filament leads come through the conventional pins on the socket of the tube. The plate lead enters through the top of the envelope and the grid lead enters through the side.

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The RCA 884

Designers and builders of cathode-ray equipment will be very gratified to learn that there is now available a new gas triode, the 884, electrically identical to the 885 with the exception of filament voltage. The heater voltage on the new tube is 6.3 volts as compared to the 2.5—volt heater of the older tube.

Since the majority of the sweep-amplifier, oscillator, and other tubes used in the equipment accessory to the cathode-ray tube are designed to operate from a 6.3—volt supply, the introduction of the 6.3—volt 885, the 884, will greatly simplify the filament voltage requirements of the accessory equipment.

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Cathode-Ray Tubes

RCA has announced two new cathode-ray tubes especially designed for television reception. Both use electromagnetic deflection and both have a new type of viewing screen which gives a yellowish image instead of the now common greenish one.

The 1800 has a nine-inch screen and the 1801 has a five-inch screen. The tubes are both experimental types and are to be known under the new term "Kinescopes."

•

Approximately one-half the ham stations in India are owned by schools or military organizations.

VU2LU, located in a telegraph school, is operated by a man named *Keys*.

An F. C. C. order requires that thousand-watt *T-20* lamps be installed in rotating aviation beacons.

A New, Simple

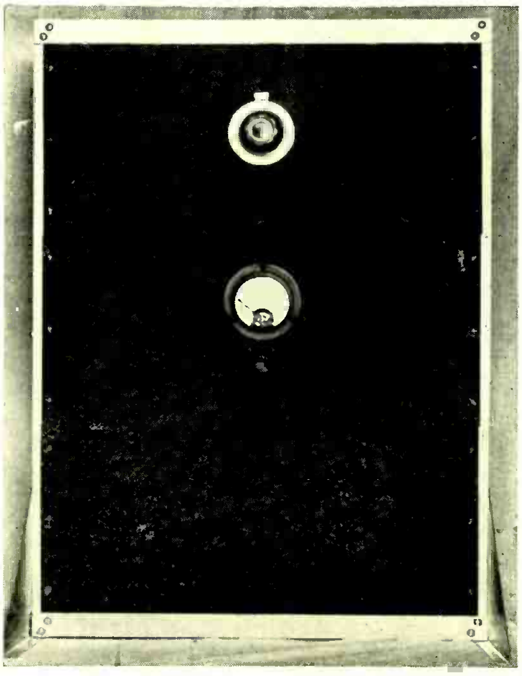
160-METER PHONE

By **FRANK C. JONES,* W6AJF**

A modification of one of the first crystal oscillator circuits provides a single-dial control 160- or 75-meter phone. The untuned crystal oscillator furnishes enough power to drive a screen grid tube such as an 807, RK25 or 802. An 807 tetrode is used with a tuned plate circuit, which has the only tuning control in the set.

The new ratings for the 807 allow the application of plate-screen modulation with a plate supply of from 400 to 500 volts. This gives us a phone with an input of about 40 watts and a carrier output of at least 25 watts. This can be fully modulated by any amplifier which will supply at least 20 watts of audio output, such as 46 tubes in class B, paralleled class B 6A6 tubes, or 6L6G tubes. The latter were chosen in order to utilize one power supply for the whole transmitter.

The 6L6G tubes as used are capable of putting out somewhat more than 20 watts, and in order to prevent overmodulation, a negative peak rectifier was connected to act as an automatic audio volume control. This diode rectifier, a 45 with grid and plate tied together, generates a negative voltage which is applied to the suppressor grid of the first stage of speech amplification. Any tendency for overmodulation causes an automatic reduction in audio amplification in the speech amplifier without objectionable distortion. In order to have the diode peak rectifier operate before 100% modulation is actually reached, a small 45-volt battery is connected into the diode return circuit. Since this 45 volts is connected with the positive terminal towards the diode plate, current will flow in the diode circuit as soon as the negative peak audio voltage exceeds 455 volts (for a d.c. supply of 500 volts at the plate of the modulated r.f. amplifier). Thus the device begins to work when the modulation percentage exceeds 90%, and therefore actually has a chance to prevent modulation peaks exceeding about 100%. There is some unavoidable time lag in the diode output filter, which requires that the diode have a "running start" on the overload voltages in order to prevent excessive modulation in the output.

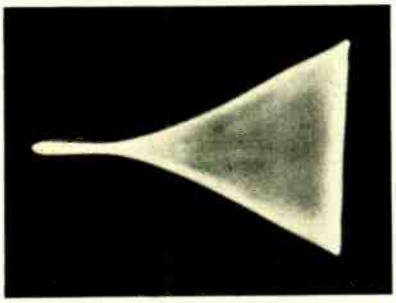


The front of the transmitter is simple but attractive. It delivers approximately 25 watts of carrier on 160-meter phone.

One oscilloscope picture shows the effect of bad overmodulation with the 45-tube diode removed from the socket and excessive audio input applied to the speech amplifier. This is shown by the long tail to the triangle in the oscilloscope pattern. The other picture was taken with the same excessive audio input but with the 45 tube in the circuit. It greatly minimizes overmodulation, with its attendant sideband splattering and interference in nearby receivers.

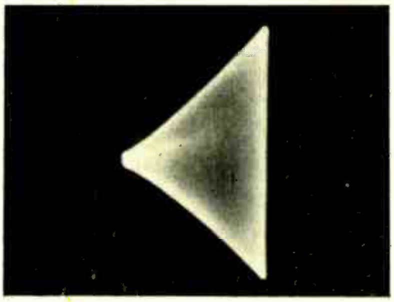
The 807 is a screen grid tube, and while

*2037 Durant Ave., Berkeley, Calif.



Too much audio input with the peak limiter tube removed from its socket. Bad overmodulation is indicated.

Same audio input with the peak limiter tube inserted in its socket. Overmodulation is prevented.



it will work fairly well with just the plate modulated, both plate and screen must be modulated to obtain linear modulation up to 100%. The plate supply of 500 volts required a 20,000-ohm screen dropping resistor to reduce the voltage to a little less than 300 volts. This large value of resistor does not allow enough audio voltage to be applied to the screen, since the d.c. resistance of the screen circuit is about 30,000 ohms and it is shunted by a .01 or .005 μfd. r.f. bypass condenser having a reactance of somewhat similar value at the higher voice frequencies. A .01 μfd. condenser was shunted across the series resistor in order to obtain the proper amount of screen modulation as shown on the oscilloscope. This value in conjunction with a .005 μfd. screen r.f. bypass seemed to be about right.

The transmitter is entirely contained in these three chassis in the homemade rack.

The higher frequencies are passed through the .01 μfd. condenser more easily than the lower voice frequencies; however, the latter are not by passed to ground as easily by the .005 μfd. screen bypass condenser and the result is uniform screen modulation at all audio frequencies. A peak voltmeter showed 495 volts of audio applied to the plate and 260 to the screen of the 807 at 100% modulation. With the over-modulation preventing diode removed from the socket, the peak voltage rose as high as 700 across the plate and 350 on the screen, which produced terrific over-modulation with a 500-volt plate supply.

A small 5-inch permanent magnet loudspeaker serves as a microphone in this transmitter. The usual output transformer is connected as a microphone step-up transformer into the grid circuit of a 6D6 pentode. This transformer was mounted on the speech amplifier chassis rather than on the PM speaker. The latter makes a very good microphone, comparable to a diaphragm crystal type when properly equalized to remove a high and low frequency peak. The low frequency peak is more troublesome but can be easily removed by using a small cathode bypass condenser of some value between .01 and .05 μfd. across the 6C6 cathode resistor. A bypass condenser across the output of the modulator removes the high frequency peak as well as removing an objectionable "tunable" hum introduced by the filament circuit of the 45-diode rectifier. This tunable hum is completely removed by shunting a .005-μfd. mica condenser across the secondary of the output transformer. A smaller condenser, of .001 or .002 μfd., made the hum worse in this particular transmitter.

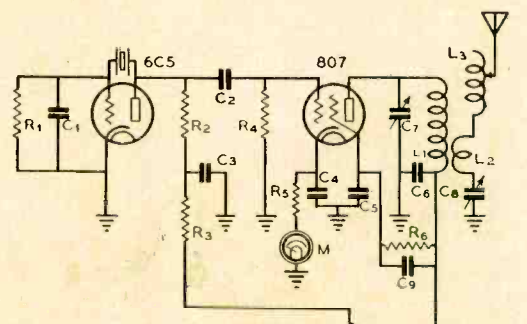
The 6D6 stage operates at moderate gain due to cathode reverse feedback and low value of plate resistor. Even so, there is more gain than necessary. A manual gain control is connected in the grid circuit of the second stage, a 76 tube. An increase of negative suppressor grid voltage to the 6D6 tube reduces the gain automatically. Excessive input can be prevented by varying the value of resistor connected across the grid circuit of the 6D6 tube. For very sensitive PM "microphones" a value of 10,000 ohms instead of the 100,000 value shown might be more desirable.

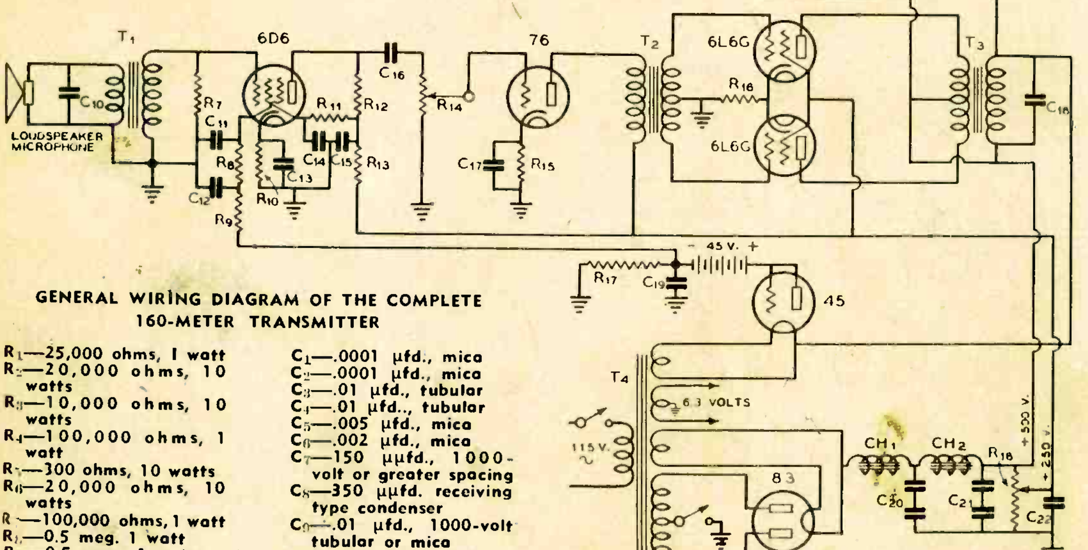
The Power Supply

One power supply which delivers 500 volts d.c. at 200-ma. load furnishes power for all tubes in the transmitter. The 500-volt plate supply to the 6L6G tubes is above their ratings but seems to be permissible where cathode bias is used and the grids are not driven hard. It is also necessary to keep the screen voltage down. The modulation transformer should have a 1 to 1 ratio and be capable of handling at least 20 watts of audio power and the d.c. plate and screen current of 75 to 90 ma. through the secondary. The 6L6G input transformer can be any type of interstage push-pull transformer having a low step-up ratio of primary to secondary.

The Pierce Oscillator

The crystal oscillator uses a 6C5 triode in a modified Pierce circuit in which the quartz crystal is the oscillator tuned circuit. The crystal is connected between grid and plate in



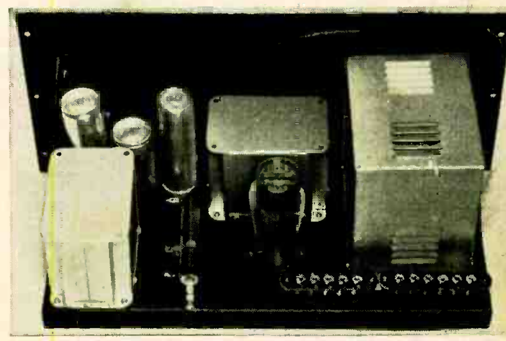


GENERAL WIRING DIAGRAM OF THE COMPLETE 160-METER TRANSMITTER

R_1—25,000 ohms, 1 watt
R_2—20,000 ohms, 10 watts
R_3—10,000 ohms, 10 watts
R_4—100,000 ohms, 1 watt
R_5—300 ohms, 10 watts
R_6—20,000 ohms, 10 watts
R_7—100,000 ohms, 1 watt
R_8—0.5 meg. 1 watt
R_9—0.5 meg., 1 watt
R_{10}—3000 ohms, 1 watt
R_{11}—1 meg., 1 watt
R_{12}—100,000 ohms, 1 watt
R_{13}—100,000 ohms, 1 watt
R_{14}—0.5 meg., 1 watt
R_{15}—1500 ohms, 1 watt
R_{16}—200 ohms, 10 watts
R_{17}—0.25 meg., 1 watt
R_{18}—25,000 ohms, 50 watts

C_1—.0001 μfd., mica
C_2—.0001 μfd., mica
C_3—.01 μfd., tubular
C_4—.01 μfd., tubular
C_5—.005 μfd., mica
C_6—.002 μfd., mica
C_7—150 μμfd., 1000-volt or greater spacing
C_8—350 μμfd. receiving type condenser
C_9—.01 μfd., 1000-volt tubular or mica
C_{10}—.01 μfd., tubular
C_{11}—0.1 μfd., tubular
C_{12}—0.1 μfd. tubular
C_{13}—.05 μfd. tubular
C_{14}—0.1 μfd., tubular
C_{15}—0.1 μfd., tubular
C_{16}—.01 μfd. tubular
C_{17}—0.5 μfd., paper
C_{18}—.005 μfd., mica
C_{19}—0.1 μfd., tubular
C_{20}—8 μfd., electrolytics in series
C_{21}—8 μfd., electrolytics in series
C_{22}—8 μfd., electrolytic
L_1, L_2, L_3—See text
M—150 ma., d.c.
T_1—Speaker output transformer (see text)
T_2—P.p. interstage transformer: 1:2 step up
T_3—25-watt modulation transformer (1:1 ratio pri. to sec.) capable of carrying plate current in secondary.
T_4—Power transformer delivering 600 volts each side c.t. at 200 ma. Should contain 5-v., 2.5-v., and 6.3-v. filament windings.

The 25-watt speech system is equipped with a device for preventing overmodulation.



This one power supply feeds the whole transmitter.

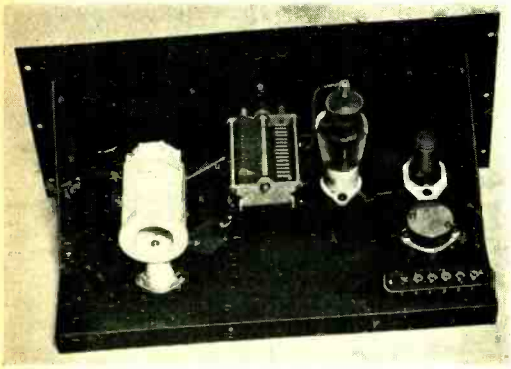
place of the tuned circuit of a Colpitts or ultra-audion oscillator. A .0001-µfd. mica condenser from grid to cathode provides the correct amount of feedback in the oscillator circuit. (It depends upon the total effective grid to cathode and plate to cathode capacity ratio.) The plate circuit is resistance coupled to the 807 grid. The plate resistor was split and by passed as shown in the circuit diagram in order to avoid any undesired r.f. feedback. The actual plate voltage on the 6C5 tube is about 250 volts and the output is sufficient to light a small neon bulb or to drive the 807 grid circuit hard enough for class C operation. This simple oscillator circuit is sure-fire with 160- and 80-meter crystals of any kind.

The transmitter was built into a small, homemade relay rack. Three panels 8"x16"x14" gauge iron, support the three 8"x16"x1" iron chassis. The top chassis include the complete r.f. unit and its single tuned circuit. The 150-µµfd. double spaced tuning condenser is mounted on the front panel and the rotor frame connects to the tuning coil through a .002-µfd. 2500-volt mica condenser. The 160-meter coil consists of 36 turns of no. 16 d.c.c. wire close-wound on a $2\frac{1}{4}$" diameter, and a 75-meter coil was made on a similar tube with 18 turns of no. 14 e. wire wound to cover $2\frac{1}{2}$" of space. These coil forms were drilled and fitted with two small banana type plugs, one near each end, for the coil terminals. Ordinary bakelite tubing could have been used instead of the ribbed form shown in the photograph.

The audio channel is mounted on the middle chassis with the speech input transformer at the end farthest from the power transformer which is mounted on the bottom chassis. A heavy duty but inexpensive power supply occupies the complete lower deck. All output leads to or from each chassis are brought out to terminal strips at the rear of each chassis. A toggle switch, preferably high voltage type, is connected in the center tap lead of the high voltage winding in order to turn the plate voltage on or off. Another switch controls the primary winding in the 115-volt a.c. line circuit. These two switches, pilot lamp, the microphone gain control, milliammeter and dial are all that appear on the front panels. The microphone lead is run in a flexible rubber insulated wire which has metal braid shielding over it.

The relay rack was built of two pieces of 1" dural angle 26" long, with two 18"x1"x$\frac{1}{8}$" straps of dural across the top and bottom. Two 10-32 screws, nuts and lock washers at each of these four corners are sufficient to provide a strong frame for mounting the front panels. Two feet for the relay rack were made from a piece of 16-gauge sheet iron 9"x10". This was cut in two to form two triangular pieces with the long edge, upon which the rack rests, bent over $\frac{1}{2}$". Three 10-32 machine screws hold each "foot" in place and a coat of aluminum paint to the whole rack provides a neat appearance. It is necessary to drill and tap the front side members of the rack for three holes per panel on each side. Dural is easily drilled and tapped and the complete rack was built in less than an hour.

The set is simple to operate. The filament power switch is first turned on and about 30



The r.f. section contains only one coil and tuning condenser. The tank is link coupled to an external antenna coupling or loading coil as described in the text.

seconds later the h.v. switch can be operated. The 807 plate circuit is tuned to greatest dip in cathode current and the antenna coupling increased to a value which will raise this "greatest dip" value to at least 50 ma. Antenna coupling sufficient to cause about 80 ma. of plate current will provide greater carrier power and should be used if possible. A phone monitor or field strength meter is a valuable aid in checking the tone quality and also the antenna tuning.

The simplest method of antenna tuning is a .00035-μfd. condenser in series with a loading coil, an antenna wire of from 60 to 130 feet long, and a ground or counterpoise. The 807 tank coil can be link-coupled with a few turns over each coil, or a series "link" as shown in the circuit is suitable. The antenna is resonated by choosing the proper loading coil tap and setting of the series condenser to draw power from the 807 tank circuit as indicated by a flashlight lamp tuning loop coupled to the loading coil. The number of turns in the loading coil will depend upon the length of antenna. An antenna wire 135 to 170 feet long would require no loading coil. A shorter wire would need one and the coil may consist of about 60 turns of no. 16 d.c.c. wire on a 2" form tapped at every 10 turns. The pick-up coil around the lower end of the 807 coil should have just enough turns to load the 807 cathode current up to about 80 ma. at resonance in both antenna and 807 circuits. From 2 to 10 turns will be needed, wound with push-back hook-up wire over the 807 coil near the "cold" end (the end to which the B+ connects).

• After the Halyard Breaks

By **CHARLES PERRINE, W6CUH**

Pulling down a mast to replace a broken halyard is no fun, so here is a foolproof, single-handed method of getting a new rope atop the pole. The writer has used it on several 65-ft. sticks, as did W6MR when he found his two 60 footers up but the rope and pulley on each forgotten.

The essential process consists of hooking a new pulley (and rope) over the top of the mast by pushing it up on the end of a very light stick which uses one of the mast guys as a guide. The light stick is made up of odd lengths of ½"x1" stock nailed together. The pulley is fitted with a loop of heavy wire formed to the shape of the mast top and just large enough to drop over it easily. Then a top guy wire is removed from its regular anchorage and tied off firmly at the base of the mast. It thus serves as a guide for the light pole, and due to being vertical, any strain insulators in it will not interfere with the guide loops on the stick.

The actual operation is best performed from the top of a small ladder placed against the mast. The stick with the pulley on it is slowly pushed up the mast, and a wire guide loop around the vertical guy wire attached every 15 ft. or so. At first most of the stick will be lying on the ground, but due to its flexibility can be started vertically up the pole. Once the pulley reaches the top of the mast, a little maneuvering will drop the loop over the top of the mast, after which a sharp jerk on the stick will free it from the pulley—though before the jerk it is best to examine the pulley with binoculars to see that the loop has completely dropped over the mast top. The pulley thus remains at the top of the mast, being prevented from sliding down by the guy wires normally attached at that point.

The whole job takes only a short time, and was once done in less than a half hour despite a heavy wind.

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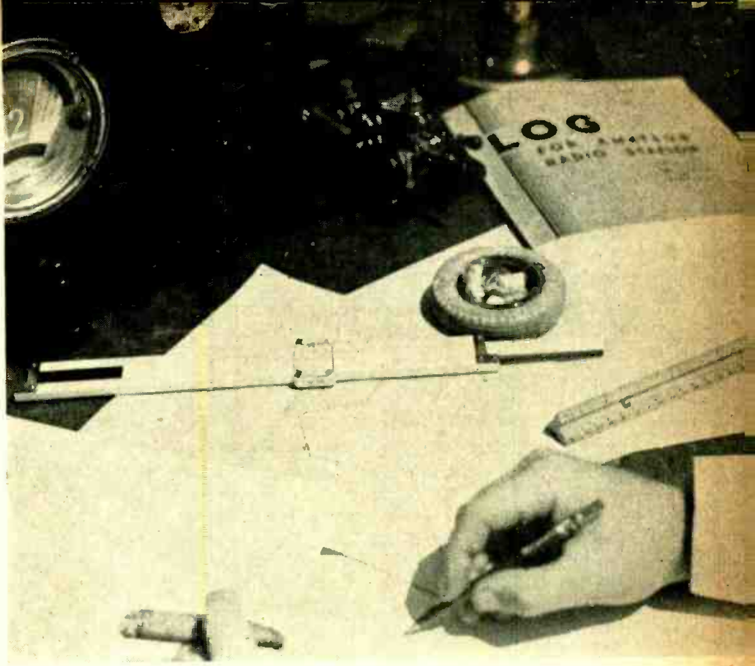
As commonplace an occurrence as the blackening of an electric light bulb led to the discovery of the basic operating principle of radio tubes.



DEPARTMENTS

- Dx
- Calls Heard
- Postscripts & Announcements
- Question Box
- Radio Literature
- Yarn of the Month
- 56 Megacycles

COUNTRIES OF THE WORLD AND PREFIXES

Last year this column presented a list of countries for the dx men, to be used as a means to determine how many countries they have worked. It was realized at the time that eventually there would be more countries added to it. During the past year we have had a good opportunity to "go into it" and while the dx men have suggested some changes and additions, it is good to see that the new list is fundamentally the same. We have made quite a study of the revisions suggested by dx men the world over, including especially John Hunter, G2ZQ, and H. A. M. Whyte, G6WY. Recently, when By Goodman, W1JPE, was out here we collaborated with him and tempered the list from an eastern viewpoint.

When we finished we finally arrived at the country list which we are now presenting. It is not only our hope but By Goodman's as well, that we now have a list that will be a satisfactory standard of "countries worked" not only in this country, but universally.

Aden	
Aegean Islands	
Afghanistan	YA
Alaska	K7
Albania	ZA
Aldabra Islands	
Algeria	FA
Andaman Islands	
Andorra	
Anglo-Egyptian Sudan	ST
Angola	CR6
Argentina	LU
Ascension Island	ZD8
Australia	VK
Austria	OE
Azores Islands	CT2
Bahama Islands	VP7
Bahrein Islands	VS8
Balearic Islands	EA6
Baluchistan	
Barbados	VP6
Bechuanaland	
Belgian Congo	OQ
Belgium	ON
Bermuda Islands	VP9
Bhutan	
Bolivia	CP
Borneo, Netherlands	PK5
Brazil	PY
British Cameroons, see Nigeria	
British Honduras	VP1
British North Borneo	VS4
Brunei	
Bulgaria	LZ
Burma	XZ
Cameroons, French	FE8
Canada	VE
Canal Zone	(K5)
Canary Islands	EA8
Cape Verde Islands	CR4
Caroline Islands	
Cayman Islands	VP5
Celebes and Molucca Islands	PK6
Ceylon	VS7
Chagos Islands	VQ8
Channel Islands	G
Chile	CE
China	XU
Chosen (Korea)	J8
Christmas Island	ZC3
Cocos Island	TI
Cocos Islands	ZC2
Colombia	HJ
Comoro Islands	
Cook Islands	ZK1
Corsica	
Costa Rica	TI
Crete	
Cuba	CM-CO
Cyprus	ZC4
Czechoslavakia	OK
Danzig	YM
Denmark	OZ
Dominican Republic	HI
Easter Island	
Ecuador	HC
Egypt	SU
Eritrea	
Estonia	ES
Ethiopia	ET
Faeroes, The	OY
Falkland Islands	VP8
Fanning Island	VR3
Federated Malay States	VS2
Fiji Islands	VR2
Finland	OH
France	F
French Equatorial Africa	FQ8
French India	FN
French Indochina	FI8
French Oceania	FO8
French West Africa	FF8
Fridtjof Nansen Land (Franz Josef Land)	
Galapagos Islands	
Gambia	ZD3
Germany	D
Gibraltar	ZB2
Gilbert & Ellice Islands and Ocean Island	VR1
Goa (Portuguese India)	CR8
Gold Coast (and British Togoland)	ZD4
Gough Island	
Great Britain	G
Greece	SV
Greenland	OX
Guadeloupe	FG8
Guam	K6
Guatemala	TG
Guiana, British	VP3
Guiana, Netherlands (Surinam)	PZ
Guiana, French, and Inini	FY8
Guinea, Portuguese	CR5
Guinea, Spanish	
Haiti	HH
Hawaiian Islands	K6
Hejaz	HZ
Honduras	HR
Hong Kong	VS6
Hungary	HA
Iceland	TF
Ifni	
India	VU
Iran (Persia)	EP
Iraq (Mesopotamia)	YI
Ireland, Northern	GI
Irish Free State	EI
Isle of Man	G
Italy	I
Jamaica	VP5
Jan Mayen Island	OY
Japan	J
Jarvis Island	K6
Java	PK
Kenya	VQ4
Kerguelen Islands	
Kuweit	
Laccadive Islands	
Latvia	YL
Leeward Islands	VP2
Liberia	EL
Libya	
Liechtenstein	
Lithuania	LY
Luxembourg	LX
Macau	CR9
Madagascar	FB8
Madeira Islands	CT3
Maldive Islands	VS9
Malta	ZB1
Manchukuo	(MX)
Marianas Islands	
Marshall Islands	
Martinique	FM8
Mauritius	VQ8
Mexico	XE
Midway Island	K6
Miquelon & St. Pierre Islands	FP8
Monaco	
Mongolia	
Morocco, French	CN
Morocco, Spanish	EA9
Mozambique	CR7
Nepal	
Netherlands	PA
Netherlands West Indies (Curacao)	PJ
New Caledonia	FK8
Newfoundland and Labrador	VO
New Guinea, Netherlands	PK6
New Guinea, Territory of	VK9
New Hebrides, British	YJ
New Hebrides, French	FU8
New Zealand	ZL
Nicaragua	YN
Nicobar Islands	
Nigeria (British Cameroons)	ZD2
Niue	ZK2
Non-Federated Malay States	VS3
Norway	LA
Nyasaland	ZD6
Oman	
Palau (Pelew) Islands	
Palestine	ZC6
Panama	HP
Papua Territory	VK4
Paraguay	ZP
Peru	OA
Philippine Islands	KA
Phoenix Islands	
Pitcairn Island	VR6
Poland	SP
Portugal	CT
Principe & Sao Thome Islands	
Puerto Rico	K4
Reunion Island	FR8
Rhodesia, Northern	VQ2
Rhodesia, Southern	ZE
Rio de Oro	
Roumania	YR
St. Helena	ZD7
Salvador	YS
Sardinia	
Samoa, U.S.	K6
Samoa, Western	ZM
Sandwich Islands	
Sarawak	VS5
Saudi Arabia	
Scotland	GM
Seychelles	VQ9
Siam	HS
Sierra Leone	ZD1
Socotra	
Solomon Islands	VR4
Somaliland, British	VQ6
Somaliland, French	FL8
Somaliland, Italian	
South Georgia	VP8
South Orkney Islands	VP8
South Shetland Islands	VP8
Southwest Africa	ZS3
Soviet Union	
European Russian Socialist Federated Soviet Republic	U1-3-4-7
White Russian Soviet Socialist Republic	U2
Ukranian Soviet Socialist Republic	U5
Transcaucasian Socialist Federal Soviet Republic	U6
Uzbek Soviet Socialist Republic (Uzbekistan)	U8
Turkoman Soviet Socialist Republic	U8
Asiatic Russian S.F.S.R.	U9-0
Spain	EA
Straits Settlements	VS1
Sumatra	PK4
Svalbard (Spitzbergen)	
Sweden	SM
Switzerland	HB
Syria	
Taiwan (Formosa)	J9
Tanganyika Territory	VQ3
Tangier Zone	
Tannu Tuva	
Tasmania	VK7
Tibet	
Timor, Portuguese	CR10
Togoland, British, see Gold Coast	
Togoland, French	FD8
Tokelau (Union) Islands	
Tonga (Friendly) Islands	VR5
Transjordan	ZC1
Trinidad and Tobago	VP4
Tristan da Cunha	ZU9
Tunisia	FT4
Turkey	TA
Turks and Caicos Islands	VP5
Uganda	VQ5
Union of South Africa	ZS-ZT-ZU
United States	W (N)
Uruguay	CX
Venezuela	YV
Virgin Islands	K4
Wake Island	K6
Wales	GW
Windward Islands	VP2
Wrangel Island	
Yemen	
Yugoslavia	YT-YU
Zanzibar	

DX

HERB. BECKER, W6QD

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

This is the month when you fellows are running around getting together all of your spare socks, to hang them up ready for Santa Claus to drop a plate transformer, tubes, 80-foot poles, condensers, or what have you, into them. Yessir, and I can just picture the fevered rush at the last minute for some of you to get those "spare" socks all darned up by the xyl in time for Santa to take a fling at them. It's going to look funny to see an 80-foot pole sticking out of W8CRA's sock, but then I don't suppose it will look any funnier than to see a huge plate transformer bulging the sides out of W6CXW's. I'll let you draw your own picture of how the following will look: W4DHZ wants another Georgia "peach", G2ZQ and ON4AU want Zone 43, W6GRL wants 6 more VEE beams. W1JPE wants resonant filter, W7AMX a microphone, W8BTI wants a monitor, W6ITH more KA skeds, W6CUH bigger and better dx cycles, G2PL, Ginger Rogers, ZL1FT more 201a's, W8ZY another Gammy, W6BAX wants QRP for everyone, W9ALV a heavier foot for his key, and W6QD wants "40 meters or bust". Santa Claus has a large order to fill and you 'guys' better have large socks.

This is really getting away from our mutual subject of dx, but on the other hand dx in the evenings on 20 has done an "el floppo" during the past month. 14 Mc. at night sounds just like it did about four years ago with VK and ZL stations predominating.

VP3THE in British Guiana

W5BB gives some information on VP3THE. It is the Perry-Holden expedition for the American Museum of Natural History. The explorer McMillan is with them also. Bill Hungerford is the operator and they are using an ACT-200 transmitter with an RCA super. Just conventional antennas are used and no beams. There are about 40 men on the expedition and they will be down there for several months. The station is on phone only and is usually on 14,300 kc. although when QRM is bad he shifts to 13,740. Hungerford says that he will QSL and that for all you fellows who QSO him to send your cards as follows: NBC, RCA Bldg., Rockefeller Center, New York City, "Care of Bill Hungerford."

W5BB has been doing some nice work on c.w. as well as on phone. He has 38 Zones while his next door neighbor has now accumulated 36 zones with 96 countries. W2GT, an old timer who is back on the air after an absence of three years, turns in a nice bunch of zones totaling 38 with 95 countries. He has worked a lot of swell stations, including YI2BA, FI8AC, HZ5NI, HS1BJ, PK1RI, VS7RF, VS7RP, VU2AN, KA1AN, KA1SP, KA1YL, and all districts in USSR. W6LCF says he is increasing his power to a baby California Kw . . . whatever that is. He has 33 zones and 71 countries so far with no more than 100 watts input.

W9VDQ ex W2AFV has been on 20 meters at this QRA for about 16 months. In this time he has totaled 38 zones and 79 countries for himself. Rig is an RK20 with 100 watts. G6GH has added a few new countries VP5, HH, CN1, and FQ8. Now has 88 countries and 36 zones.

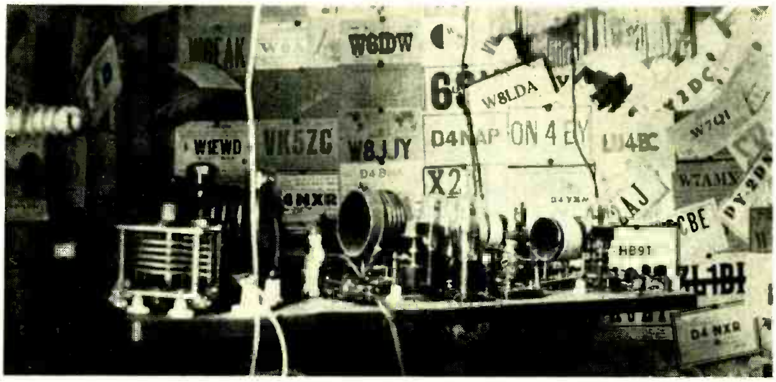
Dorothy Hall, W2IXY has been on the air for just one year, 20 phone, and she gives some interesting data on the year's operation.

From November 4, 1936 to November 4, 1937.

Power input, 250 watts. Number of contacts is indicated for each continent; all are on two-way phone.

Australia	158
Africa	48
Europe	751
South America	232
North America	466
Asia	31
United States	296
Total contacts	1982

Four well known European hams, left to right: OZ2M, LA4R, OZ3FL, and OZ2HA.



ZL1FT AND HIS STATION

Most of you will remember a short time ago this column put in a letter from ZL1FT, giving the troubles experienced in Auckland, especially in getting a.c. It seems as though there is a certain district in Auckland that is wired with d.c. and the boys naturally do not like it. Well, in this letter of Norm's he pointed out that they would probably have a.c. within 21 years. Now then, I have another letter from him saying that wonders will never cease because with the next few months all of the d.c. district will be changed over to a.c. Norm says whenever any of the gang meet one of the fellows around town, that instead of the usual, "How's dx" it has changed to, "Has a.c. reached your street yet?" They're pretty happy about it, and it will no doubt cause a bit of QROing to be done in the future.

Country Confirmations

Occasionally the question is raised about sending in cards for confirmation on the countries worked, as shown in the WAZ and Country Honor Roll. We do not require any cards to confirm the *countries* you have worked; that is, when you send in the number of countries to be placed after your Zone total, we do not ask that you send the cards. It is thought that while it might give a chance to "fudge" a little, sooner or later the fudgers will be known. All in all I think that the gang has been honest and if it ever came to a showdown there would be but very few figures if any that were "padded".

With Zones it's a little different. When you first submit your zone totals for publication, we ask that you simply send in a list showing the total Zone number and the calls of one or two stations in the zones you have worked. This list is checked before your call is entered in the WAZ Honor Roll. Whenever you work a new Zone it is not necessary to send in a complete list again, but just the station in the new Zone. You are then credited with this Zone the next time the list is corrected, which is every other month. We ask that you have confirmations on your Zones, as a little later on we may have a pleasant surprise for you, and confirmations will be necessary. More on this later. For you who reach WAZ, which is 40 Zones, it is still more important that you have confirmation or proof.

There are a number of W stations who are on the verge of making WAZ. They need just one Zone. For many it is Zone 23. One of these days some ham will pop up in Zone 23 and we'll all sit back and say, "Remember when we were all gunning for no. 23 and look at it now, all sorts of stations there to work."

Through the Mailbag

Pat Jessup, W2GVZ, worked his first J the latter part of November and that makes him 95 countries now. It was J2JJ, and GVZ says, "I hooked him on a rainy, lousy foggy afternoon." He should squawk on what kind of a day it was . . . after trying for three years to hook up with a J. Of course that was a new Zone for him, making a total of 35 . . . And then he kicks about the wx!

W8LEC worked HS1BJ for his 38th Zone, then hooked up with YS1FM on 7 Mc. for his 100th country. W9WCE is in favor of working some dx on 40, and started out by contacting his first ZL on 40 and then hooked his first K6. W9WCE uses a T20 in the final and adds . . . "Down with high power." W2GW knocked off FI8AC for his 38th Zone and 104th country. W8DFH now has 38 and 119. This boy is really doing swell work and some of the newer stuff is CN1CR, 14,410 T7 (QRA is Box 95, B.P.O. Tangier Zone), FI8AC, ST2CM, FQ8AB, HS1BJ, HZ5NI, VQ8AS, U8IB, U8ID, XU7CK, K6LHA, K6TE, LX1AS, VS1AA, VS1AF and VS6AF.

W6MLG, the eminent Hollywood dentist, runs a medium powered phone rig. He has been doing quite well . . . in fact he has just snagged his 29th Zone . . . on phone . . . and has 54 countries. Doc says the next step is to QRO, then will go after the other Zones. W9CWW got VU2FH which gave him his 36th. Al Cross, W3TR, landed YI2BA and OY1B . . . now 80 countries. W9ARE hooked OX2ZA in Greenland, 14,030 T6. W8OSL has been having a heck of a time getting Zone no. 26 and then all of sudden he turns out of bed one a.m. and works both XZ2JB and FI8AC. Guess that really cinches no. 26. W6BAM catches SU1CH for his 36th Zone and says that he and W6NSA have worked YK7AA, who claimed he was on Bell Island, off the coast of Greenland. What does anyone know about him? W8DWV worked OX2ZA, but thinks he's a phony, because he never tosses out any messages or anything. He might be a "phoney" but on the other hand we hope not. W8OQF has increased his score to 37 and 97. New ones are U6ST, U6AN in Zone 21, and FI8AC in no. 26. Other new countries are CR7AU, SV1KE, HR4AF, PK4MK, K6TE, TF5AG, FQ8AB. Incidentally, FQ8AB told W8OQF that he didn't know of a station there signing FQ8A. So that's that.

Speaking of bootleg stations or "phonies", I think it would be a swell idea of having a contest sometime to see who could work the greatest number of bootleggers. We could make it that to qualify you would have to work at least ten. That would practically include everyone, anyway. It's getting to a point that a guy never knows whether he is working something worth while or just some lug off for a weekend jaunt. We should put this energy that has been expended to some good somewhere. Only trouble with that idea is that pretty soon the boys will start into hunting out "phonies" purposely to increase their score and then what will the poor ol' legitimate stations do. And it might encourage bootlegging. Mebbe we had better skip it.

The other night while QSO with VR2FR I found out that he is on Canton Island, which is in the Phoenix group. He said the population on the island was there. VR2FR and his two pals were the population. They are there for the purpose of taking magnetic readings of one sort or another, and will be there for a month or so yet. He ordinarily operates on 13,300 kc. However, every now and then they dash into the ham band for more QSO's, such as they did for ours. Their frequency is about 14,320 kc. if the wind isn't blowing, but if the wind is blowing, their frequency (or I should say, frequencies) cover from 14,300 to about 14,360 and the note is a pip . . . between T3 and T6, a rasping buzz saw signal. Evidently they were experiencing a young gale on this particular evening because their signal just galloped up and down the band. Some fun. Anyway I suppose under the circumstances they have to be excused.

W1ZB reports that the Yacht *Yankee*, with W8IGQ aboard, is now back on sked with him after a lapse of six weeks. The *Yankee* is around the Chagos Archipelagns. W1ZB has now 112 countries and 36 Zones, while his pal W1CC has 38 and 108. W1CC says that OX2ZA is in Shro, Greenland, and his frequency was 14,125 T8. Getting back to W1ZB . . . Carl reports that he sent a letter to HZ5NI and it came back wth some sort of a notation on it. He couldn't make it out and neither can I. Anyway, I guess the QRA once given in RADIO is now n.g. for HZ5NI . . . Has anyone a nice new address for him that we can try?

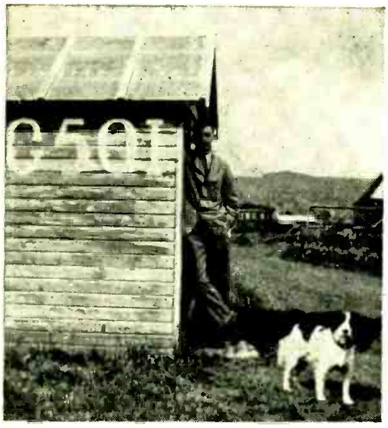
W1RY is a new one to the WAZ list with 33 Zones and 92 countries. W6MVQ worked FI8AC and VU2FX and now has 29 Zones and 54 countries . . . one more Zone and he's on the list. Ol' Keat Crockett, W9ALV is still at it. He hooked up with the *Yankee* while at anchor at Diego Garcia Island, which is in the Chagos group. W8IGQ was at the key. Call used was B2A. Keat worked his station UPOL, the Soviet "drifting expedition."

W7AMX thinks that VU2CV is a "foney" because he worked him at 4:40 p.m. p.s.t. W8AU heard

Dick Hansen, K6LHA (left) and Bill Breuer, K6TE show what they use to poke out a signal in the ham bands from Wake Island.

AMX working him and he thinks he's ok. W7AMX adds a few new countries to his list and now has 104 . . . CR7AW, VS4CS, SV1RX, HH4AS. Other good contacts are HA3Q, VU2FX, U5OF, LY1S, U9MF, U6AN, YU7XX, FI8AC. W8AU writes that he heard QD on fone . . . ooh, gee gosh didja really? Also, his friend W2BMX dittos it. Well, I happen to know that W2BMX, the ol' brasspounder, is not so slow and already has his fingers on a mike. A new one to the 'phone zone list is W2IUV with 21 zones and 38 countries. He gives VO6L as operating on Saturday afternoons on 14280 kc. VO6L is in Labrador and in Zone 2. G6QX says that G2ZQ is bringing up his y.l. the right way, says she knows how to wear a mean pair of 'phones. G2PL won a cup for outstanding work on 80 meters. G6QX got the jitters when he visited G6DH and saw all of his antennas.

W6DRE with his flea power and good antenna systems is still doing his stuff. Now using 25 watts to an 801 final he is working ZU6B, ZT6U, PK1BO, ZU6AD, KA1SL, ZS6K, ZU5J, ZS6H, ZT6Q, ZS5T, ZU6AN, KA1YL, ZS1AV, G5BD. On 10 meters a few of 'em hooked are EI5F, F8RR, G5BJ, G2XC, G6NZ, ZL1DV, and some VK's. CR7AW is in Mozambique and VQ4CRI is chirpy d.c. around 14370 kc. YK7AA on 14430 kc., T8, is off Greenland somewhere. Bill Short, W9EF adds a few in VR2FF and K6TE, PK1BO, PK1MF, U9AC, U9AW, U9MF, SU1DX and OX2QY. Our friend G6GH now has a couple more zones after hooking HS1BJ and HC1JW making a total of 35 zones, 84 countries. Did you know that UK8IA is coming thru on about 14340 kc. and is located in Russian Turkestan, and did you know that there is a station on 7 Mc. near the border of Tibet in Inner Mongolia signing UT3AC . . . and this my friends is in Zone no. 23. Low frequency end of 40. W7AYO had a visit from W6LYM, that ol' dxer from Orange, Calif., who uses so much wire in his antennas that



G5QI and his dx hound.

the wire companies come to him when their supply runs out. Getting back to W7AYO . . . while home from U. of Washington this summer he did some mighty fine dx some of which is ES5D, YR5AA, ZS6J, ZU2D, ZU6AJ, ZS2X, ZT5V, ZU5G, UK3AH, ZS5U, CE7AA, FY8E, YU7XX, OH6NN, SU1WM, ZS2F, SP1KM, VQ8AS, FT4AG, I1IR, and many other good stations. Stan now has 33 zones and 73 countries.

VQ8AS is helping plenty of the boys add a new country as he is on the Solomon Island in the Chagos Archipelagos . . . about 1000 miles from Mauritius. While I think of it last week while chewing the rag with FB8AB he said that there was a revolt on the Island where VQ8AS is located and after getting the alarming news from VQ8AS, Paul gave it over to the government of Madagascar, who in turn notified the Mauritius officials. When they arrived they arrested the leaders of the revolt and restored order. I guess then "all was quiet on the western front" but that was a good piece of relay work. FB8AB is sending VQ8AS his old "FB8C" rig as a gift. Incidentally, Paul tried his fone out and was about R5 so there's another FB to go after on about 14380.

YU7XX not YT6MEN

Last month we showed the rig of YT6MEN that he used while on a trip through Jugoslavia. The catch was that most of the information came through different sources, and by the time I received it they had him starting out over there with YT6MEN and then changing to YU7XX later on. It turns out that YT6MEN, who of course is W6MEN, is back in this country now, and I just received a letter from him in New York. He grabbed a copy of RADIO and noticed the error. Everything in the paragraph, including the photograph, is authentic . . . The only part in error is that he never used the call YU7XX. As a matter of fact YU7XX is an entirely different station in Jugoslavia, which W6MEN visited while on this trip. So . . . you fellows who work YU7XX, do not QSL to W6MEN. Those who have worked YU6MEN may send their cards to the QRA of W6MEN.

40- and 80-Meter Dx

So far during the month of December, 40-meter dx seems to have thought we all wanted it next year instead of this one. However, the month is yet young and maybe something will blossom forth. Some of the gang locally have been on 7 Mc. quite a bit and they report nothing outstanding. Some of the gang whom I've hooked up with around the country seem to think the latter part of December and January will be better, as far as conditions are concerned. The only thing we can do is to keep plugging away and we will hit that cycle yet.

W5KC is new to the honor roll . . . 30 Zones and 81 countries. Bill Shuler, W7GEW, and at one time op at the famous W6BC, blew into town the other day. You know, after Bill left W6BC he wasn't on the air very much. Reason was he has graduated from Caltech and then went to West Point. While there you probably remember he was captain of Army's football team, and played end. That took care of most of his time but now that he is stationed at Fort Lewis, Washington, he has taken out a license up there, call is W7GEW. Bill took a little rig up with him . . . a 6L6 osc. into an RK-20 final. Receiver was a 58 and 59. He raves about the dx he hears up there. In seven months so far he has worked 23 European countries and 167 different Europeans. He is taking back a NC-101X and says "Watch my smoke now."

Jim Magee, W8CNC, that ol' 80-meter dxer, says he and several others are all for giving 80 a shot. Jim has been at it on 80 for years and probably is better qualified on conditions for that band than many others. W8CNC is WAC on 80 and has worked 49 countries up there. He says G6RB and D4ARR need only South America for their WAC on 80. Jim has prepared a little chart for 80-meter work and it covers the months from September to March inclusive. This chart has been taken from data for the past six years and 8CNC says it will hold fairly accurate.

	G.M.T.
Europe, Africa, South America	0400-0800
Central America	0000-1200
K6	0800-1100
K7	0700-1100
New Zealand	1000-1200
Australia	1030-1230
Asia (Japan)	0900-1230

(Asian stations vary in time considerably, but time mentioned above will cover the high spots.)

Let's hope this chart will help you fellows locate some 80-meter dx. You might just as well get going in January on that. A lot of you are probably all set with your rigs on 80 and it won't be any trouble to give it a whirl. Even Doc Stuart, W6GRL, will be cranking his new rig up on 80 by that time. Doc has a brand new transmitter. He and his friend W6FET built it and three of its circuits utilize the turret coil system of changing tanks. It's a little bit too involved to go into here but we'll get a story on it later. More on Doc later. We were talking about 80. Anyway gang, I'll still see you on 40, and for those who can get on 80 . . . try it and after the month of January is over please drop me a line and let me know how 40 and 80 turned out. At least we can learn something about the present phase of the 11-year cycle.

Following is the frequency list for c.w. stations, although there are a few 'phone frequencies listed too, as marked. We do not guarantee the exact accuracy of these, as no two hams report a station exactly the same. However, this is more or less an average taken from all the reports received. This first appeared in the December "Radio" and is being re-published upon request.

7 Mc.

FP8PX	7020
VP2LA	7135
VP3BG	7012
PK1MF	7018
ZE1JI	7012
YS1FM	7028
UT3AC	7028

14 Mc.

UPOL	13995
CN8AG	13990
U1AP	14425
U8ID	14405-14430
U9AW	14420
U9ML	14390
U9AC	14416
U6SE	14418
U3FB	14410
U5OF	14430
U6AN	14445
U9MF	14435
U9AX	14390
U9MI	14000
U5AH	14430
CR7AW	14300
VU7FY	14380
ZC6AQ	14275
AA5CN	14450
F2AQ	14420
TG1S	14430
PF2DB	14300
FA8DA	14035
XU3MA	14070
VU2FH	14150
VQ8AS	14230
VO6D	14400
VO6JQ	14300
YV2CU	14400
YI7C	14400
XU8HM	14015
EA7AV	14420
VQ8AF	14350
VQ8AB	14300
HS1BJ	14070
FB8AB	14260
UX1CR	14420
HH3L	14320
FI8AC	14300
FY8E	14425
YV5AB	14250
PK1RI	14380
UK8IA	14300-14370
YS4CS	14265
YU7TE	14410-14445
CN8AR	14320
HB9CE	14300
YR5CF	14420
LY1S	14410
SU2TW	14400
FP8PX	14300
SV1RX	14280
HH4AS	14325
HA3Q	14415
VU2CV	14290
SU1DB	14300
ZE1JN	14360
ZE1JI	14375
VU2LJ	14300
ES2D	14350
SV1KE	14270
YM4AD	14415
YR5HC	14415
MX2B	14300
LA3I	14310
OK3TW	14310
OK3TW	14380
VQ8AE	14000
VS7RS	14320
YI2BA	14280
ES8D	14350
VU2AV	14415
ZS4A	14385
VP2LA	14030
VQ8AG	14430
ZS3F	14330
ST2CM	14360
ST2CM	14360
CT1ZZ	14005
HB9AZ	14390
OX2QY	14360
VE5LD	14030
FF8AH	14320
J2OY	14140
ZA4X	14420
XZ1S	14260
VR2FF	14140
YS2B	14410
HZ5NI	14410
XU8AZ	14440
VQ8AE	14015
FR8VZ	14420
XU8RL	14320
KA1CS	14325
HC1JW	14400
HP1AA	14300
FT4AZ	14010

28 Mc.

VO3X	28115
PA1PN	28060
ON4AU	28020
G2XC	28025
GM6NX	28100
G6RB	28100
G2PL	28160
ON4RX	28050
ON4HC	28040
OK1PK	28040
D3DSR	28060
G5BJ	28225
PA1AZ	28010
EI7F	28200
EI6G	28310
EI5F	28300
F3CX	28060
G6IR	28030
OK1AA	28010
F8EO	28100
F3KH	28080
G5QY	28175
G6YL	28180
ONFT	28150
G6WY	28100
GM6RV	28050-28250
F8TQ	28150
PA1GN	28400
TF5C	28175
G2TK	28215
GW6KJ	28110
VU2AU	28075
U9MI	28200
VU2CQ	28200
U3FB	81500
U9AW	28160
U9ML	28120
U9ML	28120
SV1RX	28190
LA4P	28160
ZS1AH	28050-28092
ZT1J	28330-28550
ZE1JJ	28230
ZT6Y	28100-28330
ZT6AU	28200
ZT2Q	28070
ZT6AK	28100
ZU6P	28325 (fone)
ZS6T	28120
ZS6AJ	28085 (fone)
ZE1JR	28175 (fone)
F8WK	28135
F8BS	28130
F8GQ	28075
G8HS	28470
F8RR	28200
G5BD	28500
OK2MV	28125
OK3VA	28135
OK1FF	28040
CT1KH	28210
CN8AV	28530
K5AY	28050
HR4AF	28050
EI9J	28220
D3BMP	28000
D4FND	28075
YL2CD	28170
OH2NB	28075
OH2NM	28300
YR5CF	28040
I1KN	28260
YM4AA	28000
PY1BR	28320 (c.w.fone)
PY3BY	28290
LA4P	28240
J3FJ	28050
OA4J	28300
LU6AX	28200
LU5AN	28030
LU7AZ	28200
ZL1DV	28125
ZL1MR	28100
ZL4DQ	28200
FQ8A	28000
LU3DH	28180
GM5KF	28200
VU2CQ	28320
VK5KO	28000
K5AG	28170
TI2RC	28115

Here are the latest additions to the frequency list, compiled just as "Radio" was going to press.

VP3THE	14300 (fone)	FA8ZZ	14405	VU2AN	14100
	14100-13740	FY8B	14430	CT2BJ	14280
CR7AU	14260	FY8E	14430	VS1AA	14040
PK4MK	14140	VS3AE	14350	K6TE	14050
TF5AG	14260	VR2FR	14300-13300	TG2II	13985
FQ8AB	14280	YU7AY	14420	UK1CC	14000
CN1CR	14400	VQ4KTC	14360	OQ5AE	14300
VO6B	14400 (fone)	ZE1JV	14335	VS7RF	14340
U8IB	14400	ES4D	14355	VP1AA	14360
LX1AS	14280	HK3AL	14280	VP2TG	14280
CT2BO	14430	HH3L	14325	XZ2DY	14300
AC4AA	14100	YR5VV	14100	U1NP	28150
ZS3E	14150	VU2FH	14140	K5AN	28112

W4DCZ in Tampa, Florida, has 30 zones and 80 countries. He has been doing right well with his 300 watts. W6DFE in Arizona has been on 40 quite a bit and says there are plenty of J stations as well as KA, K7, VK, ZL and VP2. W8AAJ is back on after a little layoff. Running 500 watts to a pair of 50T's he has added 9 new countries.

Gets on LU at Last

W2HCE has been trying to raise an LU on phone for over three years and has at last succeeded. It was LU1QA and now W2HCE enters the zone list with 21 zones and 51 countries. There are three hams in Bakersfield who are having a little fun amongst themselves. They are W6OFC, W6MEK and W6ORT. OFC has 27 zones and 50 countries, W6MEK 26 and 47 and W6ORT 27 and 43. All of their rigs are QRP.

After March 1st, 1938, all of the South African stations will have calls in ZS prefix. They are changing all the ZU and ZT prefixes to ZS. If this is true, it is a good move as there apparently was no reason for three prefixes.

England is now issuing calls in the G3 division. Those G's surely are going to town in getting new hams. W2IXY reports that ZL2BI is coming through fine on 20-meter phone. His frequency is 14,200 kc. W5DQ is another phone station reporting for the first time and he has 27 zones and 52 countries. He gives a good one to hook . . . VS6AG on 14,125 kc. W5DQ uses a W8JK beam.

This is taken from VK2NO's column in the "Bulletin": A letter from Wau, New Guinea, says that the station signing VK9BB is W. Brown, formerly VK3BB. He now has a crystal-controlled rig ready for the juice, and will be using two 852's in the final. Americans on the lookout for the Australian ninth district should have no trouble in copying VK9BB in the near future. He is a radio operator with N. G. Airways, and uses the amateur bands for relaxation."

Still Looking for VK9BB

As yet no one has reported VK9BB but it would be well to keep your ears open for him.

G2ZQ has 124 countries and has been giving 7 Mc. a whirl. As yet nothing outstanding has been worked in the way of dx but he did hear CR6AF which he didn't raise. Speaking of G2ZQ and G6WY we surely want to thank them for the cooperation they gave in suggestions for the new country list.

G6BW's rig consists of a 6L6 into a 6L6 into a T55 feeding a Johnson "Q". For receiving he uses an RME69 with preselector.

Quits 5-Meter Dx

W7AMX, Art Bean, has quit his 5-meter dx for a while and it's a good thing; otherwise he would have missed CT2BO and LX1AS. This brings his countries to 106. Art is still chasing UK8IA. So am I. Other new contacts for him are YU7AY, VQ4KTC, ZS3F, ZE1JV, ES4D, and OX2QY and TF5C on 28 Mc. W7AMX just recently hooked his 230th station in England.

The "Drifting Zone"

For the fellows who have worked UPOL. There is only one way you can tell what Zone it is in and that is by getting their position report at the time of the QSO. They are drifting and it is pretty hard to tell just where they might be at any given time.

W2AAL now has his 38th . . . FI8AC did the trick. W2AAL says VO3Z is at Belle Isle, Labrador. All QSL's should go through G. Francis, 41 Henry St., Halifax, N. S. VE5ACS is in Zone 2, and send your QSL's via Mr. H. L. Baxter, P. O. Box 937, Yarmouth, N. S., Canada. W4IO says 10 meters is hot and that Europeans are looking for W6 and W7 QSO's. Most of them seem to come through between 28,050 and 28,150 kc. Best time is from 1430 to 2000 g.m.t.

"WAZ" HONOR ROLL

	Zones	Countries
ON4AU	40	
G2ZQ	40	124
W8CRA	39	135
W6CXW	39	122
W6ADP	39	119
W6GRL	39	116
ON4FE	39	110
W6FZY	39	101
G6VP	39	
W8BTI	39	
W7BB	39	
W3SI	39	
W3ANH	39	
G6WY	39	
W4DHZ	39	
W8BKP	38	132
W6CUH	38	122
W1BUX	38	120
G5BJ	38	120
W8DFH	38	119
W8OSL	38	112
W1CC	38	108
W2GW	38	104
W2GTZ	38	105
W9ALV	38	102
W6AM	38	101
W8LEC	38	100
W2AAL	38	94
W5BB	38	91
VE4RO	38	85
W9VDQ	38	79
W2GT	38	95
XE1BT	38	69
W9TJ	38	
G5YH	38	
W8HWE	38	
W8ZY	37	114
W1ZB	37	113
G2LB	37	111
W6KIP	37	109
W6QD	37	109
W6HX	37	107
W7AMX	37	106
W6GAL	37	104
W9PTC	37	103
W8KPB	37	100
W9AJA	37	99
ZL2CI	37	97
W8OQF	37	97
W2HHF	37	95
W8AU	37	92
W3EXB	37	90
W6LYM	37	82
W6GCB	37	81
W2BSR	37	
W2GWE	37	
G6NJ	37	
W2DTB	37	
LY1J	37	
W4AH	37	
W6VB	37	
W9AFN	36	105
W8DWV	36	107
ON4EY	36	97
W5VV	36	96
ZL1HY	36	95
W6BAM	36	92
W9KA	36	92
W6FZL	36	95
G2UX	36	83
G6GH	36	88
W4AJX	36	
W8KKG	36	
G6RB	36	
W9ARL	36	
W3EDP	36	
W2OA	36	
W6KBD	36	
VK3EO	36	
U1AD	36	
W9CWW	36	71
W2BJ	35	105
W8CJJ	35	98
W1AQT	35	96
W9EF	35	94
ON4FQ	35	92
ON4FT	35	92
W1GDY	35	89
W3AYS	35	85
W6FKZ	35	83
W6ITH	35	78
G6QX	35	75
W6DOB	35	71
W9UBB	35	71
K6AKP	35	
W6NHC	35	
W6GRX	35	
W2AIW	35	
W3BBB	35	
W2IOP	35	
W9PK	34	
W7BYW	34	
W8AAT	34	
W6TI	34	
W8CNZ	34	
W3EVW	34	95
W2GVZ	34	94
W6FZL	34	91
W3EVT	34	90
LU7AZ	34	89
ON4SS	34	80
W6HEW	34	86
W6GHU	34	83
W6LHN	34	71
W8JK	34	
W3EMM	34	
W3EGO	34	
W2FAR	34	
W1RY	33	92
W9LQ	33	84
W3TR	33	80
G2IO	33	76
W7AYO	33	73
W6LCF	33	71
VE4LX	33	69
OK2HX	33	66
W8LDR	33	
K6JPD	33	
W6LDJ	33	
W9LBB	33	
W5AFX	33	
ON4TA	33	
G6CL	33	
VK2VQ	32	99
ON4VU	32	86
W6JBO	32	81
W9FLH	32	80
ON4NC	32	79
W3CIC	32	75
W6AX	32	74
W3GAP	32	70
W6JMR	32	70
W6KZL	32	67
W9DEI	32	66
W6KRM	32	62
W8HYC	32	
W8BTK	32	
W5EHM	32	
VE2EE	32	
OK1AW	31	86
W8HGA	31	83
W9LW	31	82
W6LEE	31	57
W6IES	31	57
W6MHH	31	54
K6CGK	31	
W3DCG	31	
W5CUJ	31	
W6HXU	31	
I1TKM	31	
W4MR	30	90
W5KC	30	81
W4DCZ	30	80
W6DRE	30	78
W3UVA	30	76
W6GNZ	30	73
W2WC	30	72
W3GAU	30	72
W6CEM	30	69
W4DTR	30	68
W9PGS	30	63
W6KEV	30	58
W8PHD	30	57
W6LCA	30	46
W6JJA	30	
W2BXA	30	
W8MAH	30	
W7AVL	30	
W6KWA	30	
W8DED	30	
W9IWE	30	
W6DIO	30	
W1APU	30	
W3RT	30	

PHONE

W6ITH	33	57
W6LLQ	33	68
W6AM	31	
W4AH	31	
W4DSY	30	
W6NNR	29	58
W6MLG	29	45
W6OCH	28	60
W9ARA	27	53
W9BBU	27	45
W2HUQ	27	
W5DBD	27	
W9NLP	26	48
VE2EE	26	
W6BGH	26	
W9TIZ	25	36
VK2ABG	25	
W3SI	25	
W1BLO	24	50
W2IUV	24	41
W6FTU	24	35
W8JK	24	
W3EMM	24	
W9NLP	24	
VE5OT	24	
W9QI	24	
W6AAR	23	
W2IXY	22	61
W7AO	22	
XE1BT	22	
W2HCE	21	51
W3FAM	21	36
W6MVK	21	22
YV5AK	20	45
W5ASG	20	38
W8QDU	20	33
W6GCT	20	26
W7ALZ	20	25
W1COJ	20	
W6GRX	20	

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

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

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

Here is something of interest from W9EUZ on what we hope is a legitimate Siam station:

Sirs:

Early this morning, Dec. 10 at 1:15 a.m. c.s.t., I was QSO a station whose call was given as HS1EL, and who was purported to be in Bangok, Siam. His frequency was approximately 6990 kc., and he was s7 to s8 here in Chicago.

The complete QTH he gave me was: 7116 Ruels Ave., Bangkok, Siam.

Because Asia is so hard to work from here, and because I was using only a 10 final with 40 watts input, I figured he must be a phoney. So I spent the next hour and a half copying him as he worked other fellows, in order to get more data on him if possible.

He claims to be using a rhombic antenna pointed at N.Y.C., and 850 watts input. He stated that he was employed in building roads in Siam.

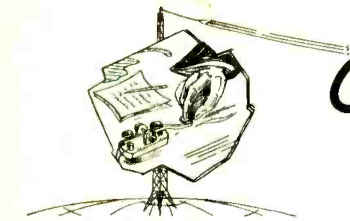
Do you hany any dope on whether this is a legitimate station? If he is genuine, I have done some nice 40-meter dx on low power. If he is a phoney, then I am verra, verra sad.

Thanksgiving eve I QSOed in succession VP2LA (7000 kc.) and VP2LB (about 7080 kc.) with 40 watts. VPLB is s8 and s9 many mornings with his 25 watts. I have worked him several times. Other dx is coming through on 40, but I haven't worked any except as noted above.

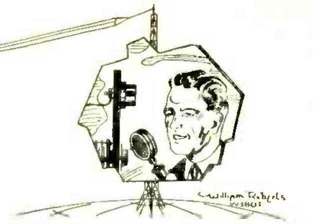
73

George W. Chinn, W9EUZ

[*Continued on Page 180*]



Calls Heard



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

Vic C. Besancon, RM3C U.S.N., W6OLU-NABF (EX-W5CD), U.S.S. Ranger, San Diego, Calif.

(Calls heard at Anchor Bahia Callao, Callao, Peru, S. A.)

W 1ACI; 1CH; 1IOZ; 1JHM; 1KOF; 1LZ; 2BC; 2BRV; 2GO; 2GVR; 2HYV; 2INA; 2JT; 2KBM; 2KHX; 2MB; 3ASJ; 3AXG; 3BXC; 3CI; 3COZ; 3DAL; 3DJZ; 3ENG; 3FKF; 3GXK; 4DOC; 4DJT; 4ZCZ; 4ZZ; 5AHK; 5CJZ; 5ENZ; 5EUL; 5EXS; 5FHJ; 5GVM; 5JC; 5ZS; 6ADP; 6AVV; 6BXL; 6DOB; 6HFF; 6OVK; 7ADO; 7ENW; 7FRS; 8AGK; 8ANZ; 8BDY; 8BTI; 8BVP; 8BYA; 8CPC; 8EVI; 8FAR; 8HA; 8IIR; 8JMP; 8LIR; 8NAH; 8MHL; 8NUW; 8NNZ; 8NOT; 8OIV; 8OQF; 8OR; 8QIZ; 8VDD; 9AIC; 9CFI; 9DHO; 9DOP; 9FZP; 9HV; 9HHQ; 9HLF; 9MWH; 9RBI; 9RQG; 9SIV; 9WNN; 9ZAU; 9ZUW. — F8ED; F8EX; FT4AG; G5UX; G8FZ; HA4C; K4EVC; K6EO; K6GVN; K6NCW; OA4AQ; OA4J; OA4M; ON4FQ; ON4KM; OK1DX; OK2MM; OK2HK; OK2RS; OK2ZB; OZ7CC; PY2HN; RX1S; SU1KG; ST2CM; VE1EA; VE1EX; VE3JT; VE3WX; VE5LS. — **VK** 1CC; 1QL; 2AE; 2AEZ; 2BR; 2FJ; 2IA; 2 IP; 2MH; 2NO; 2OQ; 2QM; 2UC; 2VA; 2XT; 3BV; 3IW; 3KR; 3KX; 3QR; 3JV; 3XN; 3XP; 3XU; 3ZL; 4BD; 4SD; 4SG; 4VJ; 5BD; 5II; 5LU; 5PS; 5XA; 7QS. — VQ8AS; VR5CD; XE1CM; XE2KX; YU7TE; YV5AN; YV5AP; YR5CF. — **ZL** 1LZ; 1LS; 1MB; 1MR; 2FX; 2MU; 2PM; 2SM; 2 SF; 3JA; 3KB.

•

Al Miller, VE5KC, 4961 Hoy St., Vancouver, B.C.

(October 1)

14 Mc.

CM2FA; CM7AB; D3SNP; D4NRF; EI6G; G5DF; G5OV; G6VQ; G6WY; G8IL; G8MW; HB9T; HK4RM; HS1BJ; K5AC; K5AG; LA5N; ON4AU; OZ3D; OZ7A; OZ7SS; SM6QN; VS1AA; VU2FX; XTF5Q; XZ2DY; YR5TP; ZS1AH; ZS1G; ZS5P; ZS5P; ZS6AM; ZT2Q; ZU1T.

•

R. Brandt, W2CQB, 712 Greene Avenue, Brooklyn, N. Y.

(Calls heard in Capetown, South Africa)

(August 11 to 19)

14 Mc. phone

W 4BWH; 4DSY; 4SW; 6AH; 6AL; 6BKY; 6FDN; 6ITH; 6LLQ; 6LYM; 6NNR; 9CUM; 9LLX; 9YGC; K6BRN; K6OQE; KA1ME; LU1HI; PK1RI; XE2AH.

7 Mc.

W 1BMA; 1IZO; 2ASY; 2JHE; 3ELN; 3FFY; 3GGP; 3GRV; 5AWN; 5EJT; 8ADV; 8KNP; 8KYR; 9OHM; K4AAN; PY2ES.

•

F. Kostelecky, OK-RP173 Mlada, Voleslaw, Smetanova 834, Czechoslovakia

(September 11 to 21)

28 Mc.

W 1IAS; 1TVK; 3CJM; 3CKO; 3DTB; 3EXB; 4DMB; 4MR; 5ALK; 8ANO; 8BLP; 8CLS; 8IWG; 8KTW; 8OQF. — CN8AR; F8EO; G5FV; G6GF; GW8CT; OA4J; ON4NC; U2NE; VK2GO; VK5KO; VS1AA; VU2CQ; ZE1JJ; ZS1C.

*George Walker, Box 355, Winston-Salem, N.C., U.S.A.

Donald W. Morgan, 15 Grange Rd., Kenton, Middlesex, England

(July 1 to August 1)

14 Mc.

W 1ADL; 1AKR; 1APU; 1BQQ; 1CH; 1CUX; 1BH; 1GUX; 1HXU; 1IGZ; 1KHE; 1KK; 1PEA; 1RR; 1TW; 2BUF; 2DUE; 2GVX; 2HQA; 2ISZ; 2IZO; 3BCU; 3EYB; 3GIH; 4MR; 8MMC; 8OCC; 8OR; 8QCH; 8QUH. — CM2AA; CN8MI; CT1CB; CT1CX; CT1DD; CT1DT; CT2AB; CT3AB; CX1BG. — **D** 3CUR; 3DFU; 3DLC; 3DXF; 3CSA; 3DDA; 3DHE; 3DUL; 4GBG; 4HCF; 4HNG; 4HWG; 4JXK; 4QAT; 4SBG; 4SNG; 4SNP; 4XJB; 4XQF; 4XVF; 4ZRA. — CI8M; ES1E; ES5C; ES5D; ES6D; ES7D. — **F** 3DN; 3DV; 3MN; 3NE; 8BS; 8DJ; 8EB; 8IZ; 8NR; 8NV; 8QD; 8UI. — FA8BG; FA8RY; FT4AE; FT4AG; FT4AY. — **G** 2KU; 2NP; 2TH; 2UV; 5BQ; 5CV; 5JM; 5LI; 5LY; 5MX; 5WW; 6CO; 6VP; 6WN; 6XP; 6YP; 8DR; 8GX; 8IL; 8QC; 8SB. — GM5YN; HA1J; HA2J; HA3B; HA5C; HA5D; HA5O; HA6A; HA7N; HA7P; HB9YF; I1EDT; I1GA; I1IT; I1KK; I1KN; I1LD; I1LT; J5CC. — **LU** 2AM; 2NB; 3HB; 4BH; 4BQ; 4DH; 4DJ; 4NB; 5AN; 7AZ; 8EN. — LY3A; LY3I; LY5P; LY5S; LY6P; OE1EK; OE1AK; OE7EJ; OH2OB; OH2OI; OH2PS; OH3ND; OH6ND; OH6NQ; OH6NW. — **OK** 1CW; 1FD; 1NX; 1RS; 1WJ; 2BA; 2DX; 2KL; 2KW; 2MM; 2PN; 2RR; 3CF. — ON4AW; ON4EJ; ON4HF; ON4MD; ON4OU; ON4QZ; ON4UX; ON4VV; ON4WB; OZ1L; OZ3D; OX5B; OZ5P; PA0CX; PA0GN; PA0KV; PA0WG; PK1RL. — **PY** 2AL; 2BO; 2CT; 2HM; 2HT; 2KT; 2KX; 2LA; 3CM; 4AG; 5AF; 5QD. — SM5TA; SM5UP; SM5UR; SM5UW; SM6JC; SM6PN; SM6UQ; SP1AB; SP1AT; SP1DE; SP1KE; SP1LM; SP1MP; SP1MX; SP1NJ; SP1AL; SU1DX. — **U** 1AN; 1BU; 1DV; 2FX; 3BC; 3BX; 3CY; 3DC; 3DX; 3FB; 3NE; 5DS; 5HC; 5KS; 5ON; 5OR; 8EC; 9MF; 9MN. — UE3EA; UK1CC; UK5RA; VE1EK; VE2KI; XE8XQ; YL2BQ; YL4IC; YR5AA; YR5EC; YR5HC; YR5IG; YR5MV; YR5VI; YT1AI; YT7TJ; YU5RC; YU7VU; ZA1F; ZB1L.

•

W6JCH, 1226 Sherman Street, Alameda, Calif.

14 Mc. phone

CO2OG; KA1EP; KA1ME.

14 Mc.

D3CDK; D3FZI; D4GAD; D4NRF; D4PKV; D4YBF; G2GO; G6ZQ; G5SO; G6DL; G6IF; G6YR; HK4EA; HS1BJ; J5CC; KA1AN; KA1FM; LU4BQ; LU8EN; LU9BV; LY1S; OE1ER; OH5OD; OK1ZB; OK2OP; ON4AU; ON4BW; ON4FE; ON4NW; ON4OU; OZ9A; PK1RL; PK4OA; SM5ZF; VK2AGJ; VK2HP; VK2LP; VK2QI; VK3KK; VK4MW; VK5HD; VK6FL; VQ8AS; YL2BB; YM4AA; YR5KW; YR5HC; ZE1JG; ZL1DA; ZL1GI; ZL2BI; ZL2MU; ZL2BC; ZL3FZ; ZL4AC; ZL4AF; ZL4CS; ZS3E; ZS5Q; ZU5J; ZU5L; ZU5P; ZU5Q; ZU6AF; ZU6V.

•

Cecil Davies, W9XCR, 826 Fry Street, St. Paul, Minn.

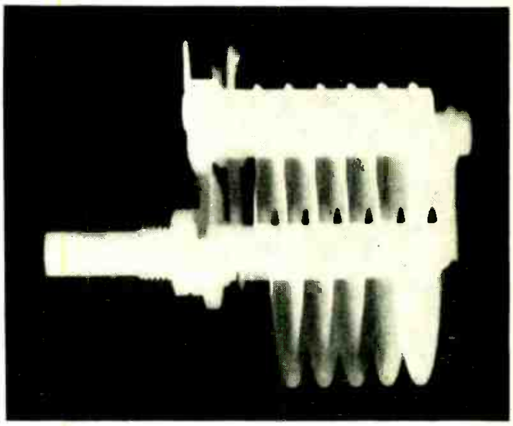
14 Mc.

CM ..2AG; 2AV; 2BY; 2DO; 2NA; 2OP; 2RZ; 6AA; 7AB; 4DLC; 4GJC;4GPF; 4PCU; 4SNP; 4SZK; 4WXD. EI7F; EI8B; 7AI; 7LR; 8FH. CP1AA. — D 3BXK; 3CUR; 3DBN; 3FZI; F3KR; F8AI; F8IZ; FA8BG; FA8DA; FB8AH; FP8PX; FT8AG. — **G** 2HX; 2SN; 2YK; 5AN; 5JM; 5YV; 6DT; 6WB; 6YO; 6YU; 8DB. GM2DI; HA2D; HA6H; HC1JW; HH5PA; HI5X; HI7G; HK3AL; HK4EA; HP1C; J2CC; J2JJ; J2LU;. — **K** 4CVV; 4DRN; 4DUZ; 4EGZ; 4EJF; 4ESH; 4EVE; 4RJ; 4SA; 4UG; 5AA; 5AC; 5AE; 5AG; 5AL; 5AM; 5AY; 6BHL; 6BNR; 6CRW; 6DTR; 6DV; 6EO; 6FAZ; 6HOO; 6IJH; 6ILT; 6LNW; 6NXD; 6OAR; 6OJG; 6OJI; 6OLT; 6SO; 7BGE; 7ENA; 7ENZ; 7NG. LU4BH; LU4DQ; LU5AN; LU7AZ; OA4AQ; OA4J; OE3AH; OE7EJ; OH5NF; OH5NR; OH5OD; OK1ZB; OK2OP; OK2RM; OK2RS; OK2SO; OK6HO; ON4HK; ON4IF; ON4NW; OZ4H; OZ7CC; OZ8E; OZ9NH;

[*Continued on Page 179*]

POSTSCRIPTS...

and Announcements



This interesting shadowgraph picture was sent in by H. E. Elsen, W6KMQ, of Berkeley, California. It shows a small midget variable condenser and was made by casting the image of the condenser on a piece of sensitized paper. Subsequent development produced the positive (or negative, which ever you want to call it) shown above.

Those Greek Letters

Bill Conklin suggests (and he is probably quite correct) that there is probably a large number of the gang who do not know the correct names for the Greek characters used in the various formulas in RADIO and other technical magazines. To help these (and those to whom they look vaguely familiar from some dimly-remembered college course), we are showing some of the more commonly used ones with their correct names and what they are more commonly used to represent in RADIO.

- α, alpha—coefficients.
- β, beta—coefficients.
- γ, gamma—coefficients.
- Δ, delta (capital)—decrements, increments, variations.
- δ, delta (lower case)—same as capital delta.
- Θ, theta—angles, phase displacement.
- λ, lambda—wavelength.
- μ, mu—amplification factor, prefix micro-.
- π, pi—3.1416, circumference divided by diameter.
- ϕ, phi—angles.
- τ, tau—time constant, coefficients.
- ω, omega—resistance in ohms, 2π times frequency.

•

QSL Card Contest

RADIO'S second annual QSL card contest is scheduled for January and February, with the owners of the two most outstanding cards receiving a Taylor 814 and a 4 μfd., 600-working volt, oil-filled condenser as first and second prizes, respectively. Turn to page 165 for full details.

Correction

In a recent letter from Johnny Kraus, W8JK, he mentions the fact that there was a slight error made in the text of his article "Rotary Flat-Top Beam Antennas" as it appeared in the December, 1937, RADIO. The error appeared on page 14, column 1, paragraph 2 and in the second sentence: The stub will be an odd multiple of one-quarter wavelength long (about 35 feet).

This sentence should read: On 14 Mc. the stub will be an integral multiple of one-half wavelength long (about 35 feet).

Thus, the stub for the 30-foot rotary when used on 14 Mc. will be about 35 or 70 feet long and on its second harmonic (28 Mc.) about 8 feet either longer or shorter. In other words, the single-section flat-top is current fed at the center on its fundamental frequency and voltage fed on its second harmonic the same as a 2-section flat-top beam.

Incidentally, to those of you who are interested in research in physics in addition to your ratio diversions, Mr. Kraus is quite prominently identified in the physical-research field. While recently at the University of Michigan, he did a good deal of work with the cyclotron in connection with the nuclear bombardment of palladium. In collaboration with Professor J. M. Cork, the work was written up and published in the *Physical Review*, October 15, 1937, under the title "Radioactive Isotopes of Palladium and Silver from Palladium."

Question Box

Will you kindly advise me as to the relation between field-strength reading as taken on a milliammeter and diode detector, and power gain or decibels?

An ordinary field-strength indicating device (a tuned circuit, diode rectifier, series resistor and milliammeter) shows the field strength in volts. The meter scale may not be calibrated in any particular units but the indications as shown on the meter will be proportional to the voltage field strength.

If the unit is linear, and linearity is fairly easily obtained by using a reasonable size resistor in series with the milliammeter, power increase is proportional to the square of the increase in meter reading.

Field-strength increase in decibels may be obtained through the use of this formula:

$$db = 20 \log \frac{E^1}{E}.$$

In other words the field-strength increase in decibels is equal to 20 times the logarithm (to the base 10) of the ratio of the new to the old voltage.

For an example, if the field strength is doubled the radiated power has been increased fourfold. Also, since the logarithm of 2 is about 0.3, 20 times this is about 6, hence the field strength is up about 6 db. A 6-db change in field strength will result in a change of about one "R" at the receiving location.

●

In the article by John D. Kraus, "By Popular demand," in the June, 1937, issue of RADIO, *references are made to the feeding of an array at a low-impedance point by means of zepp feeders or a matching stub. I do not quite see how this could be accomplished. To me, a zepp feeder or a matching stub is used to feed voltage; how can one be used to feed power to an antenna at a voltage node?*

A zepp feeder can just as well be used to feed current as voltage. The misconception that you mention is carried by a number of people since, in the past, the zepp has almost always been used to feed the end of an antenna. This, of course, is always a voltage peak. However, consider the "center-fed" zepp. This antenna is only a half-wave long but it is fed at the center (a voltage node) by zepp feeders. This type of antenna could also be fed by means of a matching stub of the proper length.

There are some important differences, however, between the matching stub as used to feed voltage and the one used to feed current. A stub used to feed voltage must be an odd number of quarter-waves long and shorted at the end, or an even number of quarter-waves long and open ended. The former of these two types is almost universally used since it is shorter, more convenient, and capable of considerably lower losses.

Now, a stub used to feed current is just the opposite of the above. It must be an *odd* number of quarter-waves long and *open,* or an *even* number of quarter-waves long and *shorted.*

Thus a ¼-wave *open-ended* line may be used to feed the array, mentioned at the first, at a current point. Or, as Mr. Kraus suggested in his article, a ½-wave long closed stub could alternatively be used. In the former case, the low impedance transmission line would be connected to the matching stub very close to the position where the stub connects to the antenna proper. In the second case, the transmission line would connect to the stub a short distance above the short, almost ½-wave away from the antenna itself.

●

NEW BOOKS

AND REVIEWS of CATALOGS

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

The Cinaudagraph Corporation, of Stamford, Connecticut, has just announced the release of catalog no. 937 describing in detail their new line of permanent-magnet speakers. These speakers, utilizing the magnetic steel alloy "Nipermag" in their construction, are amply illustrated and described in this book. Graphs and tables are given to show the frequency response of the various units. Copies may be obtained by addressing the Cinaudagraph Corporation, Stamford, Connecticut.

●

The Hammarlund Mfg. Co., Inc., 424-438 West 33rd Street, New York, has just announced their new 1938 catalog. It covers the company's complete line of receiving and transmitting equipment, receivers, etc.

A number of new additions to their lines are completely listed and discussed along with their well-known products of the past. Notable among the new additions to their products are a series of "micro" condensers, both in single-section and split-stator models, and two new neutralizing condensers of the movable-plate, high-voltage type.

These two neutralizing condensers should be of especial interest; both have the shafts that hold the plate mounted in a horizontal position so that the plates themselves are vertical. Thus, the capacity-to-ground of both the plate is very small and equal in magnitude. One plate is movable to allow a capacity adjustment. The two sizes are 2-10 μμfd.; and 2-20 μμfd.; the former has 1 13/16" dia. plate and those of the latter are 4" in diameter.

A number of other interesting items, the new Hammarlund receivers, etc., are covered in the catalog. It

[*Continued on Page 179*]

YARN *of the* MONTH

CHAOS IN THE TELEPHONE EXCHANGE

The following is a true experience. It is as nearly accurate a description as is possible of a rather humorous incident that occurred just a few weeks ago. By way of introduction, may it be said that the author is operator in charge of radio-telephone equipment at the Butedale end of the recently established Butedale-Vancouver radiotelephone circuit.

On a certain sunny morning your hero, nonchalantly smoking his pipe, was idly awaiting the routine nine o'clock "test call." Minutes ticked by and the only sound that issued from the loudspeaker was an occasional rattle of static. The hands of the station timepiece crawled onward, and presently stood well past the "zero hour," but still silence prevailed. Something wrong somewhere. Soon the look of nonchalance changed to one of annoyance.

With a telephone call already placed and waiting to go through, I finally lost patience, and, taking the monophone off the hook, began to intone monotonously "Butedale calling Vancouver", over and over again. Several minutes of this produced exactly no results, so I paused, glanced at the meters, made a few elementary checks, and half-heartedly convinced myself that all my equipment was functioning normally.

Another call, but the results were the same. By now, visibly nervous, I called another halt and made a few more checks on the equipment. Finding nothing wrong, I started in calling again.

Well, to make a long story short, the calls were repeated at intervals for well over an hour and still contact with Vancouver had not been established. I was, by now, not only slightly hoarse, but also quite "peeved". So, as a means of calming my fiery temper, I took to whistling gently into the "mike". For no particular reason, the piece I hit upon to whistle was the then popular "The Merry-go-Round Broke Down". It seemed to have a soothing effect on my ruffled nerves, so the tune was continued, and the volume increased as time went on.

Finally, however, I tired of this diversion, shut off the transmitter, and sat back to await, as calmly as I could, the restoration of the circuit. I had not long to wait, as the trouble at the Vancouver end was soon fixed, the circuit restored, an explanation given, and our somewhat delayed call completed.

I thought nothing more of the incident until about a week later, when, upon opening a letter from an acquaintance of mine who serves on the long-distance exchange in Vancouver, I read the following:

". . . and Butedale came roaring in like a lion, with us unable to answer. The climax came when your now famous whistled rendition of 'The Merry-go-Round' began to echo throughout the building. The supervisor came rushing in, loudly inquiring as to the cause of the disturbance, and demanding to know why the loudspeaker had not been silenced. For, despite all our efforts, we had been unable to 'plug' the speaker, with the result that that eerie tune continued to float through the room.

"Soon the office was in an uproar, with employees from far and near gathering to enjoy the excitement. A few of the more daring ones joined you in the choruses, and, despite the presence of the supervisor, a rousing cheer greeted the conclusion of your little ditty, so that the building fairly shook on its foundations. . . ."

And some people think that telephone operators lead a monotonous life! Ho hum. . . .

By Don G. Murphy, VE5EU

56 Mc. . . . *Contests, Transatlantic Dx*

• By ELMER H. CONKLIN,* W9FM

The Radio Society of Great Britain sends us news of a 1938 transmitting contest, to be held on the five-meter band, designed to promote knowledge of conditions and development of equipment. The cup for the first 28 Mc. contest went to B. J. Kroger of XE1AY and is shown in the picture on page 35 of the July, 1937, issue of RADIO. Quite imposing, what?

E. H. Swain, G2HG, says: "Actually the cup is practically bound to find its resting place over on your side of the pond." We agree with this prediction in view of the rules. For one thing, contacts over 200 miles will count. This means transmission of the "extended ground wave" or low atmosphere bending variety, giving an advantage to someone just over 200 miles from the populous Boston-New York-Philadelphia area. If the lower limit had been 400 miles, the contest would have been confined to Sporadic E layer (400-1100 miles) or F_2 layer (beyond 1000 miles) propagation. Even so, there remains an advantage in this country for one located 700 to 1000 miles from the Chicago-New York-Boston path where at least one end of most Sporadic-E-layer contacts have taken place during the summers. Where the contest is more equal is in F_2 layer transmission, largely confined to winter for

*Associate Editor, RADIO.

FIRST INTERNATIONAL 56 Mc. TRANSMITTING CONTEST

Following its successful 28 Mc. International Contests of 1935 and 1936, which did much to popularize operation on this band of frequencies, the Radio Society of Great Britain is pleased to announce its first 56 Mc. International Contest.

The rules are as follows:

1. The Contest will commence on January 1st, 1938, and conclude on December 31st, 1938.
2. The Contest will be open to any radio amateur who is licensed to operate his station in the 56 Mc. band.
3. The winner of the Contest will be the operator of the station scoring the most points based on the following system:
   - 1 point for each contact over a distance between 200 and 1000 miles,
   - 5 points between 1001 and 2000 miles,
   - 10 points between 2001 and 3000 miles,
   - 15 points between 3001 and 4000 miles,
   - 20 points between 4001 and 5000 miles, and so on, at the rate of 5 extra points for each additional 1000 miles or part thereof.

   All distances to be calculated by the great circle path.

   To count for points the readability, strength and tone (both incoming and outgoing), must be logged, together with date, time and call sign.
4. In addition, and in order to collect current data, each contestant must send to the Radio Society of Great Britain, a monthly report of stations *heard* and/or *worked,* together with notes concerning conditions, power used for contacts, etc.
5. The Radio Society of Great Britain will present a suitable trophy to the winner of the Contest, whilst certificates of merit will be awarded to the leading station or stations in each country.
6. No entrant may employ interrupted continuous waves, modulated continuous waves, telephony, or any other form of modulated carrier, for contacts claimed in this Contest.
7. At the time of a contact both stations must be operating on 56 Mc. from their fixed station addresses.
8. Only one contact with a specific station may count for points in any 7-day period.
9. Entrants must adhere to the terms of their licenses.
10. Final entries must be received by R.S.G.B., 53, Victoria Street, S.W. 1, London, not later than February 28, 1939.
11. The decision of the Council of the R.S.G.B. shall be final in all matters relating to the Contest.

Note. In the above rules the term 56 Mc. refers to the amateur frequency band, 56 to 60 Mc.

FIRST INTERNATIONAL 56 Mc. RECEPTION CONTEST

In conjunction with the International 56 Mc. Transmitting Contest, and in order to encourage non-transmitting amateurs to collect and tabulate phenomena relative to the 56 Mc. amateur band, the Radio Society of Great Britain has decided, provided sufficient entries are received, to offer a suitable trophy to the non-transmitter whose log covering the period January 1st to December 31st, 1938, is considered by the Council of that body to contain the most valuable information.

Certificates of merit will be awarded to those submitting the most valuable information at the conclusion of the Contest, irrespective of the number of entries received.

Logs must be received by R.S.G.B. not later than February 28th, 1939.

Note. For the purpose of this Contest a non-transmitter shall be regarded as a person who did not hold a radiating permit on January 1st, 1938.

While monthly reports do not seem to be required in the receiving contest, the decision will be upon the *value* of the information in the log. To be safe, therefore, monthly reports may be advisable.

It will be helpful to RADIO if copies of the logs of either contest are sent monthly to E. H. Conklin, Associate Editor RADIO, 512 N. Main St., Wheaton, Illinois. Through publication of data on interesting contacts, five-meter dx can be encouraged.

The prohibition upon modulation is without doubt a rule intended to force the development of receivers capable of picking up weak carriers when the modulation would be inaudible. Some fading reduction might have been possible with tone modulation had this been permitted.

Considerable data on the time for long distance 56 Mc. contacts have appeared in RADIO in past months, and additional comments should appear in the future. As developments of interest come to our attention, we shall be glad to bring them to you in future issues.

east-west long distance contacts, though long north-south communication may prove to be possible in any season.

56 Mc. Dx Tests

All of which brings us to a test that has been proposed to take place in January and February. Indications are that F_2 layer, long distance, five-meter contacts in an east-west direction are most probable during the winter and up to possibly the middle or end of March. The basic schedule for the transatlantic path is to concentrate operations in the hours between 10:00 and 11:00 a.m. E.s.t. on Saturdays and Sundays from January 15 to February 27 inclusive. Fifteen minute transmitting and listening periods have been suggested, with the dx stations to transmit and the W's to listen during the first fifteen minutes, as follows:

Dx transmit 10:00 to 10:15 a.m. Eastern time
W's transmit 10:15 to 10:30
Dx transmit 10:30 to 10:45
W's transmit 10:45 to 11:00

We personally fear that signals may go in and out again in a fifteen-minute period, which might lend some advantage to a shorter transmitting period such as five minutes. However, G2HG says that in his experience ham clocks never agree closely enough for that.

Attempts at earlier and later hours are encouraged. The W2KHR report shows that reception earlier is a possibility, while data provided by W3GLV and other sources indicate that the best time may actually be an hour or so later, particularly for the middle west. Similarly, an extension of the test to week days may well be productive of results, although few British stations will be active at this hour during the week, the basic time being just before they return home from work.

If any QSO's become possible, the schedule should be abandoned and the contact completed without delay.

Transmissions should largely involve sending the call of the transmitting station. The more letters you send, including CQ, TEST, etc., the more chance that your call will not be properly copied.

Along with this test we have advised CN8MQ, ZS2A, ZS1H, LU1EP, XE1AY, and

VK2NO to participate. A similar schedule at about 4 p.m. local time for the U. S. may be about best on Saturdays for the VK's, and on Sundays for the South Americans.

Ionosphere Broadcasts

No doubt our readers noticed the article in the November issue of RADIO on the subject of the ionosphere and the weekly broadcasts of the National Bureau of Standards. The broadcast for November 24 was particularly interesting, including as it did this comment:

> At 11:30 this morning the normal incidence critical frequency for F_2 layer extraordinary ray was 15,200 kc. This is the highest value ever observed at Washington.

At noon that day when the F_2 critical frequency was down a little to 14,900 kc., and at midnight when the F layer critical frequency was down to 5,700 kc., the maximum usable frequencies shown in the following table were theoretically possible.

Maximum Usable Frequencies

Distance in kilometers	Noon F_2 layer	Midnight F layer
400	15,400	5,700
700	18,500	6,000
1000	22,300	6,700
1300	26,400	7,700
1600	30,600	8,600
2000	36,000	10,100
2500	41,000	11,600
3500	47,000	13,900

These figures show that conditions are just about ripe for winter long-distance 56-Mc. communication via the high F_2 layer, such as across most of the U. S. or across the Atlantic. The Washington data may not prove to be exact for all paths, particularly in a north-south direction which involves a large change in latitude. Historically, higher frequencies can be used between the U. S. and South American countries than over the Atlantic.

Receiver Improvements

We shall continue our policy of mentioning in this column interesting experiences and developments of which we read and hear. In regard to receivers, we point out that often it may be possible to pick up a weak dx carrier when modulation cannot be understood. The British stations are unlikely to use any modulation due to the contest requirements for unmodulated c.w., but some may use a tone until a contact is established. Super-regenerative receivers, if used, should be adjusted for good weak signal sensitivity. Possibly an external oscillator can be provided so as to make d.c. c.w. audible. In any event, there is much to be said for using a quarter-wavelength concentric line as the first tuned circuit in order to obtain increased gain, particularly in an r.f. stage, so that weak signals will be boosted up out of the tube and circuit noise. This possibility has been discussed elsewhere. We learn of one 56-Mc. receiver, using concentric line couplers and two 954 acorn pentodes, that gives an unbelievable gain.

Some of the boys are trying to operate standard ham-band receivers on a higher-frequency band by using a new grid coil and condenser clipped between the ground and the grid of the first detector, using the second harmonic of the oscillator, which is tuned with the usual tuning dial. W3GLV points out that W3RL cut down the detector coil in his FB-7 and gets good results on stabilized signals but has trouble with 28-Mc. signals riding in due to using the ten-meter coil in the oscillator. That is where the high Q of a quarter-wavelength concentric line used as the detector tuned circuit might be a great help due to its improved selectivity which should strongly discriminate against 28-Mc. signals when tuned to 56 Mc.

W3GLV pared down his HRO r.f. and detector coils and gets good image rejection but thinks that the second harmonic output of the oscillator is too low to give really good gain. Incidentally, we have never been able to confirm the previously published report that W2JCY has some five-meter HRO coils, as reported by W5EHM, and National will not supply them on order.

Antennas

The vertical-vs.-horizontal and the nondirectional-vs.-beam controversies continue. We can add a bit of fuel on both sides this month. RCA engineers reported in the October issue of I.R.E *Proceedings* the results of London television reception at Long Island and at Le Roy, Indiana, from January 21 to late March, 1937. The 41.5 and the 45-Mc. signals have both come through. There were several stretches of about two weeks when one or both of these signals were heard daily. The usual time was from 9:45 to 11:00 a.m., Eastern time, with a transmission lasting until noon on one day.

Television Observations

Observations were first made at the Frequency Measuring Laboratory at Riverhead, using several short-wave fishbone antennas variously directed. All of these were tried, and it was frequently noted that when the signal was weak, best reception could be obtained by using an antenna directed toward the west coast. On several occasions the signal was inaudible on antennas directed toward Europe but of reasonable strength on the west coast antenna. However, during periods of strong signal the European antenna gave the best results.

A Five-Meter Diamond

With this curious result as a starting point, the vertical angle of signal arrival was measured by comparing the signal received on each of three horizontal half-wave antennas at various heights. The angle was 7.5 degrees. A horizontal rhombic beam was then designed for this vertical angle and placed on the great circle path to England. Two transposed feeders were run to the ends, with relays to throw each end to a feeder or to a terminating resistor, making it possible to reverse the directivity with a toggle switch at the receiver. The terminating resistor reduced the back-end sensitivity about 28 db.

The rhombic antenna gave results similar to the fishbone, except that at no time did this antenna show an improved signal from the southwesterly direction. Usually during periods of weak signal the normal direction gave from six to twelve decibels better signal than the reverse direction. However, on two occasions of several minutes each, the signals from both directions were of equal strength.

Vertical vs. Horizontal

Toward the end of the observations the front-to-back ratio arrangement was dismantled and the remotely controlled antenna switches were arranged to transfer the receiver to either the rhombic antenna directed toward England or to a sloping wire antenna designed to receive vertically polarized waves arriving at a vertical angle of 7½ degrees, also directed toward England. The few times that it was possible to compare this new antenna with the rhombic indicated *no* instances of better results with the vertically polarized antenna. The fact of the polarization of the received signal being independent of the (vertical) polarization of the transmitting antenna supports the conclusion that propagation was by refraction phenomena in the ionosphere much the same as in the case of lower frequencies.

Ionosphere Comparisons

Monthly averages of F_2 layer critical frequencies, supplied by the National Bureau of Standards, show rising values during the last several years, in phase with the increase of sunspots in the present cycle of solar disturbances which is due to reach a maximum about 1939. However, using a daily graph of F_2 layer critical frequencies averaged from 10:00 a.m. to 4:00 p.m. E.s.t. each Wednesday, the correlation with the transatlantic reception is not perfect. Ionosphere data for a latitude more nearly equal to the average for the signal path was not available at the time.

Palomar Mountain Observations

Over a near-optical path from Pasadena, California, to Palomar Mountain, the problem was approached differently. This is discussed in Radio Digest for November, taken from the Bell Laboratories *Record* of October, 1937.

Both horizontal and vertical half-wave antennas were tried. The results showed that both the signal strength and the automobile noise were lowered by about the same amount with the horizontal, so that there was no decided preference between the two orientations for this work. We are not informed if the horizontal was coupled to the receiver in a manner that eliminated all chance of capacity coupling which, of course, would have some effect upon the comparison.

Simple 56-Mc. Beams

For dx beyond several hundred miles, we favor horizontal antennas because of the possible reduction in outside noise. The Kraus flat-top beam, used horizontally, the V, or the rhombic should all work satisfactorily for this purpose. The advantage is probably with the rhombic because of possibly better low-angle radiation, however, unless several of the other types are stacked one above another and operated in phase, to lower the vertical angle of transmission or reception.

Time for Dx

During the winter, we expect that the best time for transmission or reception will be when the middle of the path is at noon or a little thereafter. That is, Europe and Africa should be best in the late forenoon; Australia in the late afternoon. South America may be best in the middle afternoon but time may not be as important for this north-south path.

In the summer, dx to South America may continue to be possible but most work will probably be between 400 and 1100 miles, at almost any time in the day or night. There may be somewhat greater chance for contacts in the late forenoon or early evening.

42 Mc. Band Gets Across!

One of Great Britain's most consistent "five and ten meter" observers, G6DH, advised that long distance conditions on 56 Mc. have improved. On November 1, he heard a number of W stations on the third harmonic of their 14-Mc. fundamental — 42 Mc. Among them were W8ISN and a W9 whose call couldn't be made out, together with W2XSN on about 41 Mc.

W3AIR says that on November 7, at 7:30 a.m. Eastern time, GM6RG's 56-Mc. harmonic was reported heard at W2KHR.

W3GLV, in Leesburg, Va., has been listening regularly since September 1, and finds the band open between 30 and 45 Mc. almost every day. (We still wish we had a few kilocycles at 42 Mc. for experimental purposes.) Quite a number of commercial and 14-Mc. third harmonics, both code and phone, come through. Some of them are: W6KIP, RST 599x, up to 7:15 p.m., Eastern time; W6KIP calling VP9R on October 18 at 4:50 p.m.; W7BUX called by a W6 phone, but auto ignition prevented identification; W6ORT, RST599x; W6NRD, RST589x; OK1CX, RST589x; and numerous others, many of them weak and hard to identify positively. However, many 14 Mc. transmitters do not put out a great many watts of power on the third harmonic (we hope).

Bill Martin also hears W6XKX in Pasadena, California, and W6XKY on Palomar Mountain (the latter always loudest though nearly off the back end of the simple beam), using 40-watt transmitters as described in *Radio Digest* for November. They have daily schedules at 1:30 and 6:30 p.m. Eastern time. W6KXY on the mountain has interference from the tone modulated signal on the Empire State building in New York.

Bill says that the foreign-television audio channels have been coming through weak for some time. On November 2, they were all weak, about R1 to R3. On the 4th, they were up to a full R9, blocking the receiver (revamped 1-10) for 20 dial divisions and interfering with each other. They were on from about 9:00 a.m. and didn't fade until around 1:00 p.m. British, French and German stations all come through. On November 5, signals up to 51 and 52 Mc. came through, bringing in third harmonics of English and German 19-meter broadcast stations between 10:30 a.m. and noon. On November 6, a c.w. signal came through on about 57 Mc. for about 30 seconds. November 7 was the last day in the series during which the foreign television came through in such volume, about three times as loud as around January 1, 1937.

G2HG gives us some more news. On October 17 at about 1445 G.m.t., he heard OH5NK calling a GM station. On October 18, G8JV while testing a new vertical antenna heard "CQ dx de SU1FT" at 2132 G.m.t. Egypt to England is a long haul. The signal was RST449. On the 23d, G8JV heard "CQ de D3ADI" somewhat weak.

W8HQC, in Buffalo, N. Y., received a report from E. C. Hatch in West Medford, Mass., of hearing W8HQC's five-meter signals R8 to R9 at 8:30 p.m. E.s.t. October 3. The transmissions were verified by reference to the log. This looks like an off-season Sporadic-E-layer reflection as compared with longer F_2-layer refractions which probably caused the transcontinental and transatlantic reception recorded above.

W6 and W7 Heard in Australia

VK2GU recently told W9RUK during a 28-Mc. contact that W6 and W7 five-meter harmonics have been getting through, but no W9 or W5 signals. This looks good for the tests.

W2JCY Hears G6DH

G6DH reports that his five meter signals were heard twice by W2JCY during the first week in November.

On November 14, G6NU heard OH7NC whose 56 Mc. signals were only R2 to R3.

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G8JV	56.53 Mc.
F8CT	56.33 Mc.

[*Continued on Page 170*]

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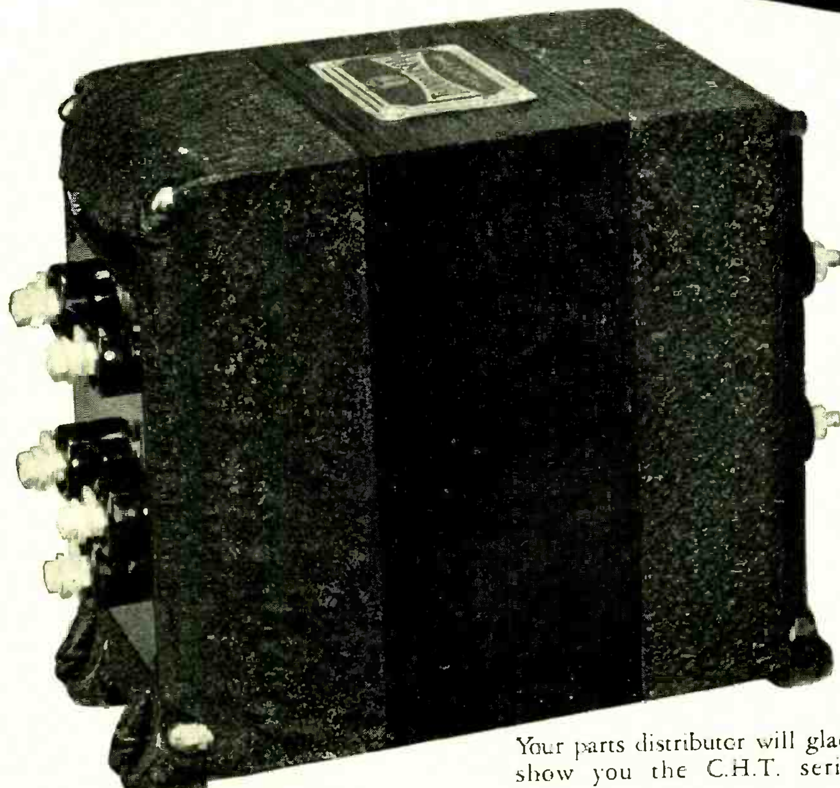

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One Man's Story

[*Continued from Page 37*]

mine and kept them there while we danced. It was like sticking one fist on my final tank coil and hanging on to the modulator chassis with the other. After several minutes of the dynamic potential, I said, "Golly, you sure have kilowatt lamps!"

"Thanks, Bennie," she came back in a tender voice.

"And you're darn pretty, too," I blurted out. "Tell me, what were you thinking about just then?"

The music hit a crescendo, and I put her through a tricky maneuver before she replied. "I was thinking that if I put up an antenna north and south, I might work some real dx, like San Francisco, maybe."

I was prepared for anything but this. I gave in, and the rest of the evening was devoted to the discussion of ham topics only. "There's still the ride home," I thought.

But when I parked the car in a secluded spot on the way home, and started to get romantic, Corrine said, "Hey, what's the idea? I thought we were going home. I've got a sked in half-an-hour."

It was then that I almost gave up. The worst of it was, I had fallen in love with the gal, in spite of her carrying a good thing like ham radio too far. So I took her home, and we kept her sked together. After that, I got wise to myself. If it was ham radio that she wanted, I would capitalize on that. I put a five-meter outfit in the car and did my courting on the hill tops while we worked the five-meter band together. Maybe you heard us or even worked us. If you did, you will remember that we had to QRX often, and during these waiting periods, you probably heard (if you listened hard) me whisper three words, followed by a gentle "smack."

I think all the hams that Corrine and I had ever worked or known were at our wedding. I forgot to say that she was quite a c.w. op too, and she swung a neater fist on the key than I did. So they came from far and wide. We even had a couple of ZL's there that happened to be in town and had remembered working Corrine. As the preacher tied the final knot, some wise guy that had brought his convention horn along blasted out "sk".

But that didn't finish ham activity for Corrine. Imagine, she insisted that we take my half-kw. rig with us on our honeymoon, and she was offended when I asked her to forget radio for a while, so we could enjoy ourselves.

Well, I decided that it simply was no use, and when we got back, Corrine and I built an

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If you should hear her call on the air about 3 o'clock some morning, you will know that she has climbed out of bed, snuck downstairs, and left the o.m. snoring away while she works you and a few VK's. I tell you, if you like hamming, and want to get the most out of the game, stay away from the y.l. hams.

●

The 1938 Receivers

[*Continued from Page 102*]

Two handy features are the built-in modulation monitor for checking your own transmitter and an optional noise-silencer unit that can be installed inside the cabinet with the controls brought out to the front panel. A signal-strength meter calibrated in both "R" and db units, and a variable-selectivity crystal-filter unit are included in the standard receiver. Output provision is made for either a permanent-magnet dynamic speaker or a 600-ohm external load.

The high-frequency oscillators for the six medium and high-frequency bands that are covered by the receiver are electron-coupled.

The RME-69 is also available from the manufacturers with a DB-20 pre-selector built into the same cabinet. The DB-20 is a high-gain, two-stage unit that covers all the bands covered by the RME-69, from 550 to 32,000 kc. The inclusion of this pre-selector as an integral part of the receiver greatly increases its gain and image rejectivity. The startling increase in image rejection accomplished by the inclusion is evidenced by the figures shown in the accompanying receiver chart on page 101.

●

Transmitters for 1938

[*Continued from Page 98*]

scope for continual carrier monitoring. A 913 tube is used; it can be seen at the center of the bottom panel of the front view of the transmitter.

A 6C5 and 6L6 are used in the direct-coupled crystal oscillator-frequency multiplier. It is possible to operate the 6L6 either as an amplifier or a frequency doubler without resorting to neutralization of the tube. The five bands that are covered are from 10 through 160 meters. By operating the final amplifier

as a doubler, approximately 25 watts output may be obtained on the 56-Mc. band.

The speech amplifier-modulator may be removed and used as a high-power public address amplifier should this be desired. In the top panel is mounted the antenna-coupling unit through which it is possible to couple the output power to almost any type of antenna system.

The tube line-up consists of a 6C5, a 6L6, and an RK-37 in the output stage. The speech amplifier consists of a 6J7, a 6N7 with two channel input, a 6N7 phase inverter, and a pair of 6L6's in the output stage. Two inputs are provided to the speech; one, into the 6J7 with a gain of about 125 db, and another, into the second grid of the first 6N7, with a gain of 88 db. A multi-match output transformer is provided at the output of the speech to provide for the matching of various types of loads.

●

Theory of Antenna Operation

[*Continued from Page 111*]

of lower maxima; it only causes the lobes to be narrower, which brings about no reduction in signal strength if the radiation occurs at useful angles. When horizontal antennas are stacked one above the other[10] though, the higher angle power is diverted to strengthen the low angle lobes.

Horizontal wires have a lobe at right angles or broadside to the wire both in the vertical (if not cancelled by ground effects) and the horizontal directions if an odd number of half-waves long, and a null if an even number of half-waves long,[2] as discussed in connection with free-space patterns. In a vertical plane perpendicular to the wire, the ground effect for long wires is clearly the same as for a simple half-wave horizontal, though there is radiation in such a plane only if the length is an odd number of half-wavelengths. On the other hand, off the ends of the wire where a long antenna will have its important maximum a number of degrees above the horizontal, at a certain height the ground effect may be to cancel radiation at that same angle. Therefore, there is much to be said for adjusting the

[10] When computing the radiation pattern for antennas stacked vertically, use as the first term of the equation, the equation for the antennas in free space; as the second term, show the ground effect upon such a pattern located at a height equal to the *midpoint* of the stacked system. Thus, for a horizontal antenna a full wavelength high and a similar antenna one-half wave high fed in phase, the first term is $2 \cos (90 \cos \Theta)$. Multiply this by the ground effect upon a system *three-quarters* wavelength high (the mean between one-half and one), $2 \sin (270 \cos \Theta)$. The resulting equation is $4 \cos (90 \cos \Theta) \times \sin (270 \cos \Theta)$.

height of a harmonically operated antenna so that the ground effect will reinforce rather than cancel the important low-angle lobe in the endwise direction.

For the higher frequency bands, a height of one or two wavelengths gives promise of good long-distance efficiency because of increased low angle radiation, as well as providing full-strength higher angle lobes which are important for sky wave communication over shorter distances; this generally means a mast height about 60 to 70 feet for most amateurs.

The Solid Pattern

It is extremely difficult to illustrate the solid pattern of a horizontal antenna above actual ground, because no plane diagram can be rotated to build it up. The general shape of the horizontal plane patterns shown in figures 8a, 8b and 8c are nearly accurate for angles just a little above the horizon—that is, along a nearly flat vertical cone whose apex points down. The pattern in a number of planes, rotated with the antenna as an axis, can be drawn to illustrate radiation at various angles, but radiation along lines in one such plane would be at varying vertical angles. A more useful picture of the solid radiation pattern is given by showing the strength of radiation in various horizontal directions but for a constant vertical direction, which would be along the sides of a cone pointing downward. In figures 12 and 13 we show the side view of such cones and also top view pictures of the radiation patterns for several such cones, each drawn for a given vertical angle.

Complex Arrays

Multiple element beams made up of a number of individual half-wavelength wires can be studied along the lines suggested in this discussion. "V" beams are simply long wire arrays in which a "left hand" major lobe for one of the two wires is made to coincide with the "right hand" lobe for the other wire; the other lobes tend to cancel.

●

Fading

[Continued from Page 49]

in 89% of the more severe types of fading, when it was most troublesome, there was a measured improvement. In only 4% of these cases could the fading be made equal to or worse than on the comparison antenna by deliberately steering to an unfavorable angle.

Although high antenna output level is a problem entirely separate from fading, some comments will be of interest. Bruce's work with signals from GBW on 21 meters indicates that the maximum signal[4] often occurs at an angle only 10 or 11 degrees from the horizontal[5]—much lower than is generally assumed among amateurs. The particular diamond used normally had a peak at 13° and a null at 26° above the horizon.

While we can't all put up a lot of flexible rhombic beams, fading may be reduced if our receiving antenna is made sharper than average in the vertical plane, particularly if concentrated at relatively low angles. Because the rays generally are stronger if they have followed a path requiring fewer "hops," the lower angles usually include the strongest waves. It therefore follows that the moderate sharpening of the pattern suggested above in the discussion of transmitting antennas will be helpful on receiving as well, even though this falls far short of the vertical directivity that can be expected of the diamond when carefully built.

The antenna arrangements discussed by Conklin in the May RADIO[2] will, due to their sharp vertical directivity, effect a worthwhile reduction in fading when used as receiving antennas.

[4]Sample measurements made by Friis, Feldman and Sharpless show angles of 12° to 21° on 24.41 meters; 14° to 25° on 33.28 meters and 20° to 25° on 43.45 meters for reception of transatlantic signals. See *Proceedings I.R.E.*, January, 1934.

[5]See article elsewhere in this issue, "Vertical Angle of Signal Arrival."

Simplified Flat-Top Rotary

[*Continued from Page 91*]

to 28,220 kc. was quite noticeable in our flash-light-globe field-strength meter.

Using EO-1 cable, we found much greater field strength when using a one-turn coupling link on the cable around the final tank coil than by first going through the usual antenna-tuning network. The losses in the network, when working into this low impedance load, must be quite high.

We were very skeptical about the use of EO-1 cable, especially on ten meters, where the length goes much over fifteen or twenty feet. We had previously found by the light-globe test and by actual field-strength measurements that the loss is considerable in longer lengths at high frequencies. However, in our installation, it is possible to use short lengths, short enough so that the losses are negligible, and its use does simplify construction.

These rotary antennas should by all means be used for receiving as well as for transmitting. This procedure enables you to get the proper lineup of the beam for transmission without constant reference to an azimuthal map.

No particular constructional details will be given since the array is easily constructed and since the constructional diagrams given herewith will answer almost any question that might arise.

Some oscillating crystals are fluorescent when in operation.

Except for one of those strokes of the hand of Fate, your quartz crystal might have been a spoonful of sand.

One prehistoric version of the triode ran on illuminating gas; another had cathode, grid, and plate immersed in acid.

High Frequency Receivers

[Continued from Page 115]

wire covering as a dielectric, copper bands have been placed around the tops of the inner conductors, with mica insulation, to by-pass the tube plates directly to the inner conductors through efficient condensers. Being available, solid copper was used, though with higher metal prices, heavy copper plating of cheaper materials will probably be more economical.

Measured Gain

Mr. Dunmore has provided data on the gain of his receiver. At the highest frequency, 300 Mc., a gain of 2 per-stage was obtained with a screen voltage of 100, though it was later raised to 3 by increasing the screen voltage on the r.f. tubes. At 200 Mc., the gain was 6, while at 175 Mc. it was 9. By calculation from this data, the gain at 120 Mc., or 2½ meters, would be around 18. The overall amplification for a four-stage amplifier is approximately the fourth power of the per-stage figure above. The step-up in the antenna coupling impedance is approximately 1.5 to 1. The effective amplification is further increased by the nonlinear operation of the detector. By actual measurement, the overall effective amplification of the four stages and detector is 125 at 300 Mc., 93,000 at 200 Mc., and over a million (about 120 db) at 170 Mc. This should be multiplied by detector conversion efficiency and by the amplification of the intermediate frequency in the following receiver to obtain the amplification of Mr. Dunmore's complete set-up.

With that many stages, the sharpness of resonance of the concentric line coupled stages should be such as to permit receiving signals over a band of between 1 per cent and 2 per cent without retuning. That would mean only one-half to one megacycle in the five-meter band, so if five tuned circuits are used, small tuning condensers or moving plungers will have to be provided unless one is interested in signals in a narrow part of the band. With only one or two tuned circuits of the concentric line type, however, a large part of the band should be covered without readjustment.

•

While we covet two-letter calls, 21 countries have *one-letter* tags.

•

Sometime ago we opined that WIRE and KOIL were the only radio parts present in the broadcast station log. Now, we are corrected by a ham who says we forgot WIND—essential in ham phone stuff.

•

White Plains, New York's *Soundview* Ave. should be the tops as a television QRA.

Fifty Watter in Parade Dress

[*Continued from Page 81*]

potential difference between the center tap and ground. (3) Provide an electrical connection from the switch frame to chassis ground so if a switch should short or arc to its frame, you won't get knocked across the room.

Current to the r.f. supply was taken through a 9-wire cable equipped with Jones plugs, while current to the modulator was taken through a pair of 6-wire cables and ordinary speaker plugs.

A 6-wire cable and switch box, containing duplicates of switch 2 and switch 3, was provided for remote operation. These switches were located as closely together as possible in order that they might be both turned on with the thumb and pulled off with the first finger. Note that this box was grounded through the wire *d*.

One knotty problem encountered was how to operate a pilot light from high voltage. A 3-watt Mazda bulb in series with the r.f. power supply bleeder did the trick.

Taken as a whole, I believe this little rig well worth copying. At least there have been presented some very helpful suggestions for metal-rack enclosed transmitter construction.

•

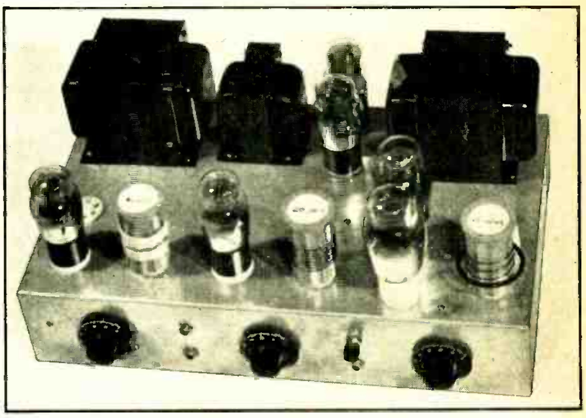
A.C. Operated Relays

[*Continued from Page 74*]

core iron and am building up from that. Whenever it is possible for the amateur to get his hands on an old starting-relay action, his work is half done. If care is taken in the work and proper plans are made before starting out, any type of circuit or group of circuits can be controlled with an easily-constructed a.c.-operated, chatter-free relay.

THE BIG "3" FOR 1938

• The "BI-PUSH"



This Bi-Push exciter, or transmitter, is the most outstanding unit of its kind introduced in 1937. It was originated by W. W. Smith, Editor of "RADIO", and brought out in the April issue.

The Bi-Push has a good 40 watts output on 3 bands (with one crystal). It is being acclaimed by amateurs the world over. Its popularity will be even greater in 1938.

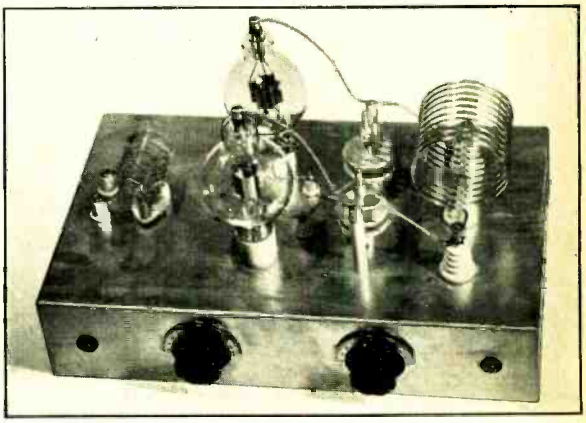
These are just a few of the Bi-Push users taken from our files: W1GZG, W1EWF, W1KPP, W2ECT, W2KIT, W3GGE, W4EFB, W4DTU, W4CPT, W5FQH, W6NNR, W6GRL, W6DYG, W6OTR, W6PER, W6NGA, W6MLG, W6LS, W6CD, W6OIS, W6LIP, W6HI, W6AM, W7GK, W8RGH, W8JBI, W8BJO, W9YNR, W9YKH, W9WZO, K6OFW, K6MVX, K6KGA, K6KMB, K6MVV, VE3AIU, VE5FI, G6QX.

Bi-Push and Power Supply
Chassis 10"x17"x3½" With tubes .... **KIT $41.75**
Wired and Tested 56.75

Bi-Push (RF portion only)
Chassis 5"x17"x3½" With tubes .... **KIT $23.75**
Wired and Tested 33.75

Power Supply
Chassis 5"x17"x3½" With tubes .... **KIT $18.75**
Wired and Tested 23.75

• "10-20" FINAL



The "10-20" is a neat and efficient layout. It is primarily for 10 and 20 meter operation. Beneath the deck is mounted the filament transformer, plate and grid tank condensers, bias resistors, etc. The "10-20" Final makes an ideal companion for the Bi-Push, or any exciter with similar output. It is especially adapted to tubes such as the 35T, 100TH, 808, T-55, RK-37 and RK-38. The Kit includes four coils for the 10 and 20 meter bands.

The "10-20" Final
Chassis 10"x17"x3¾" Less tubes .... **Kit $32.50**
Wired and Tested **37.50**

• RT-25A, RT-50A

Amplifier or Modulator

The RT-25A and RT-50A have outputs of 25 watts and 50 watts respectively. The output transformers of both are of a universal type, and various voice coil impedances can be had as well as a 500 ohm line. For modulating the Bi-Push, a modulation transformer is provided in place of the output transformer.

RT-25A-Modulator or Amplifier
Chassis 7"x14"x7½" With tubes .... **KIT $29.50**
Wired and Tested **44.50**

RT-50A-Modulator or Amplifier
Chassis 9"x14"x7½" With tubes .... **KIT $42.50**
Wired and Tested **57.50**

ON OUR STAFF

W6CUH W6QD W6JWQ
W6CGQ W6LFC W6DUX
W6NOF W6NYU W6FMK

DESCRIPTIVE BULLETINS AVAILABLE

Bulletin No 15 .... Bi-Push Exciter
Bulletin No 16 .... "10-20" Final
Bulletin No 17 .... RT-25A, RT-50A

RADIO-TELEVISION SUPPLY COMPANY

"WHERE HAM SPIRIT PREVAILS"

1701 So. Grand Ave. **Los Angeles, Calif.**

Keeping Up With the F.C.C.

[Continued from Page 84]

from Maine to Samoa, and from Alaska to Porto Rico, comprise approximately three-fourths of the radio amateurs of the world.

"The Cairo Conference will, undoubtedly, give much time and attention to the problems of amateurs. The United States has been more notably the defender of the amateur against the invasion of his particular field than any other nation in the world and I assure you that our delegation will stand ready to further defend them should the need arise at the Cairo Conference." R. P. T.

•

An amendment to Rule 175 makes it necessary for a broadcast station now to announce its call letters only once in each half-hour period. The amateur rule has not been amended, however, it still being compulsory for hams to announce their call letters once in each fifteen-minute period.

The F. C. C. has authorized international broadcasting on four additional frequencies on a temporary basis and subject to cancellation at the discretion of the Commission without advance notice. They are 0550, 11730, 15130, and 21500 kilocycles.

•

Open Forum

[Continued from Page 12]

a day when amateur radio was a spark coil and helix pastime. Hence, my license is not written and the dealer still has my transmitter. And I am not alone.

Like Mr. Wellar, my interest in technical radio covers several years. For the sake of my selfishness I would like to see a genuinely rigorous examination issued, the successful passing of which would earn a license for the purely phone amateur. Then, for the sake of the dear boys who like to dabble in the dit-dah business, let this examination stand fully as rigorous in a technical sense but with the addition of the thirteen w.p.m. clause. In other words, let the amateur's field of activity be recognized. Of course such measures would add "pertaters" to the already thickening soup in the phone channels, but list a while—I have yet more pow-wow to make.

Mr. Link's viewpoint on proper authoritative supervision of the amateur bands seems most commendable, also his suggestion for attaining such supervision. His suggestion of a $2.50 minimum annual fee for all amateur stations seems logical enough. It seems also reasonable enough to expect that anyone who can afford to operate over 250 watts can as well afford one cent per watt extra. However, on one point, Mr. Link, I do take issue. That is, for my strictly phone activity I do not want to be limited to a half kilowatt input. I think the present power limitations are o.k.

And now, while the general discussion is open, let me add a word that is more original. Having obtained, purely on technical merits, a license to operate a strictly phone station and having become assured of adequate supervision in our channels—let it become prohibitive for any amateur phone station to employ anything but a directional array or beam radiator. Let it be rotatable to the heart's desire but at all times directional. I do not believe *broadcasting* has any place in amateur phone and I am convinced that there are many who will agree with me.

So, though I cannot propose to define a radio Utopia, I do feel that three steps are needed to improve our amateur conditions and above all to permit yours truly to get his ticket and transfer certain hard-earned shekels to the till of yon merchant in the radio business, viz.—

1.—Establish a special phone license based on thorough technical examination.

2.—Establish an adequate supervisory program for amateur bands, supported by taxation proportional to power used.

3.—Require that all modulated amateur radiation be directional on the 14 and 28 Mc. bands.

H. O. POLAND.
Wilkinsburg, Penna.

"Way Down There"

Hugo, Okla.

Sirs:

Here are a few things that I would like to get off my chest.

I've been in this thing called "ham radio" and, before it, "wireless", since way back in 1912, having had a station on practically since then with the exception of the time off during the war.

Up until last year I fought the QRM on 20-meter phone (yes, I can remember five years ago when you could have a 100% QSO on 20), and last year I moved down to ten and

[*Continued on Next Page*]

it was swell, but work did not let me get on very much. This fall, I have just built a new medium-powered phone job and arranged my work so that I could be on the air more. What did I find??? QRM!!! Was I disgusted!

The F.C.C. felt sorry for us and gave us all the way to 30,000 kc. to mess up; so I went to 29,672 kc., called my head off, and had a few QSO's. Now that two months are about gone down there, I'm wondering why the fellows on the other end of the band, after calling a CQ, don't listen to the high frequency end. It's the truth—they seldom do it, and it seems that the few of us that are down there have a band all to ourselves. If you want to work someone on the high end of the band, you had better call one of the fellows you hear down there. Seems to me that most of the fellows on ten today have graduated from 20 and just naturally like to work a fellow with four other stations on top of him, in order to feel at home, I guess. The dx stations are all up on the low end, and if they would listen some on the extreme high end of the band, they would have a few more contacts. I have been hearing Z's and ZE phones R8 to 9 here; have called them continually with no success. We went to the trouble of erecting a beam for South Africa. Believe it or not, I received five listener cards from "Way Down There" but not a single QSO! Why don't they listen there? Can you tell me?

Tonight, I heard a TI calling CQ and put the beam on him and called. What do you think happened? He did not get a contact and called CQ again. After 45 minutes (6 times) of calling him, I gave up. Why didn't he cover the whole band?

Three minutes later I contacted another TI that is on the high end of the band and got R8, but TI's are not dx for us fives, as they are about the same distance as you 6-7's.

Better tell the world that there are a few hams operating down on the 30 Mc. end of the 10-meter band.

Another thing is this antenna problem: If you want to work a variety (and who doesn't)

[Continued on Page 174]

Another Vertical Feeding Arrangement

[Continued from Page 40]

supported by a large Pyrex thrust insulator at the bottom end. Actually, the vertical is made from four sections instead of three; three 10-foot sections of pipe are used (the pipe happened to be easily available in 10-foot lengths from a local hardware store), connected to each other by reducing nipples, and on the end of the three is placed a 3-foot piece of brass welding rod. Total length, 33 feet.

The bottom piece is 1½" i.d., the next 10-foot one is 1" and the top one is ¾" i.d.; the appropriate reducing fittings are used to couple them together. The top is capped and the brass welding rod is welded into the center of the cap.

The vertical is guyed at two places, at the junction of the first and second section and at the junction of the second and third. Three guys are used at both positions. They are spaced 120° with respect to each other and are attached to three guying points on the roof.

The feed system, in that it is somewhat different from the conventional, is interesting; especially so considering the excellent results obtained.

Two ¼-wave Q-section matching transformers are used to give the match between the end of the antenna and the 600-ohm transmission line. The impedance is first stepped down by the four-wire section and then stepped up to the terminal impedance of the antenna by the second one, the two-wire line.

Calculating the Matching Sections

In order to calculate properly the characteristic impedances of the two matching sections,

[*Continued on Page 176*]

If we only could dash around the right corner, we would be sure to find Christmas, prosperity, and television all cuddled up together.

56 Megacycles

[*Continued from Page 152*]

W9UAQ says that his frequency should have been listed as on 56.672 instead of 56.58 as given in the December issue, but that he is probably that broad anyway! However, he is now using 56.080 in a "beacon" transmitter, automatically keyed.

W9UAQ "Beacon"

Al Cox, W9UAQ, and Vic. Ruebhausen, formerly W2HXD but now W9QDA, have built up a 125-watt transmitter to be on 56,080 kc., automatically keyed, running continuously. It may be shut off for a few local contacts with the 1 kw. rig on 56-67 Mc. occasionally. At this time, a vertical antenna is being used with two half-wave wires in phase for Europe and the southwest in the mornings, and out of phase for the northwest and southeast, broadly, in the afternoon and evening. Tone modulation is intended, but may have to be removed evenings if local QRM is severe. This transmitter is in Oak Park, Illinois, just west of Chicago.

VE3ADO "Beacon"

Arnold Ely, W8IPD, advises that VE3ADO will run his transmitter week-day evenings from 6:30 to 7:00 p.m. e.s.t. until about February 1. A horizontal antenna is used on top of a 19-story building in Toronto. The transmitter is a three-stage parallel rod job ending in a pair of 35T's with 175 watts on their plates. An 800-cycle tone modulation is used. The tape gives the call letters, VE3ADO.

W3DBC Moved

Blair Barghausen, W3DBC, has moved from Washington, D. C., to a mountain top, U. S. Airways Station, Curwensville, Pa., 2400 feet elevation. He will be on the air with 300 watts any day now and is all set to blow holes in the air.

Sporadic E Again?

David Naylor of Cincinnati, Ohio, states that on November 28 at 7:40 p.m., Eastern time, he heard a weak signal on five meters testing and signing W1JKI. The receiver was a single "19" transceiver. This could have been an "off season" Sporadic E-layer reflection, inasmuch as the December first Bureau of Standards ionosphere broadcast indicated some Sporadic E-layer transmission.

That Wales-Australia Report

VK2NO has received more complete data on the report of his 56-Mc. signals by Mr. Cecil Mellanby of Pwllheli, North Wales. Mellanby copied several fragments of speech, enough to indicate that VK2NO was putting 100 watts in a pair of 35T's and using a rotary beam antenna. Mellanby's receiver is a three-tube regenerative battery set using an r.f. pentode regenerative detector, with two audio stages. A large tuning condenser is shunted by a small 15 μμfd. condenser for band-spread.

ON4AU 56 Mc. Schedules

We hear that ON4AU's five-meter transmissions are on 56,080 kc. He is using a t.r.f. receiver with acorn tubes and listening for carriers or c.w.

Australian 56-28 Mc. News

Early in December we received this interesting letter from Don B. Knock, VK2NO, who is Radio Editor of *"The Bulletin."*

"My 56 Mc. c.w. telegraphy got to ZL on October 23 last, when my automatic transmissions were heard by a Mr. P. A. Morrison, of 7 Essex St., Wellington, New Zealand. His report is Q4, R5 and his reception checks with my log.

"Regarding the North Wales report, there is not a shadow of a doubt about it. It checks with my log faithfully. That F_2 layer is playing tricks all right. Incidentally, the receiver used in Wellington by Mr. Morrison, is a straight t.r.f. three-tube set, and the antenna is once again a Reinartz circular. The aerial for transmission at my end this time was different, being a vertical W8JK flat-top designed for 57 Mc. I was very interested in your long and complete record of 56 Mc. dx in October RADIO.

"I am flat out on 'five' now, with auto c.w. running for hours in all directions, but will have to try horizontal polarization for a change, I think. Have a beauty of a receiver going now, a t.r.f. job with 956 acorn ganged to electron coupled 954 detector, followed by a 41 audio. I have a separate triode for interruption when I want supering, but seldom use it. This receiver is so good that I can copy harmonics from the 14 Mc. gang all over the place, and those that are on 28 Mc. might just as well be on 56 Mc. They have a wallop on their second harmonic. Incidentally, Mr. Morrison of Wellington tells me that he has heard the 56 Mc. harmonic of VK2GU on phone when he has been working W's on 28 Mc. 28 Mc. is wide open here at night now, and from 9 p.m. to midnight, Europeans roar in. At the same time, I can hear VK4UL and VK5KO—rather unusual conditions.

"My own 56 Mc. dx work now covers the following: Two-way QSO with VK2ZC in Newcastle, 70 miles through mountains. Signals logged by VK2DN in Deniliquin, 360 miles distant. These occasions were in June and July this year. Phone logged by Mellanby in North Wales November 22, 1936, and now c.w. logged by Morrison in New Zealand on October 23, 1937. Am trying hard for long dx contacts all the time, and have lost hours of sleep so far."

Kindest regards,
DON B. KNOCK, VK2NO.

August 17 Report

Somehow we get a lot of kick out of publishing corrections to old data, as compared with a policy of forgetting old errors and leaving them in print to mislead anyone with a historical interest in things. This one may not be a correction but more an explanation. We reported that the 56-Mc. band was open from Chicago to the East on August 16, 17 and 18. The report for the 17th was a single one from

W8QOL, who reported hearing W9CLH in the morning. His postcard was timed and dated that afternoon, but he didn't put down the date of hearing W9CLH. The reception, therefore, may have been on the 16th, but in either event the band was open an additional time because the many other reports for the 16th were for the evening.

Arizona Five-Meter Expedition

On the first Sunday in November, a group of Arizona five-meter enthusiasts went on a "mountain top" expedition. In the party were W6OFU, W6OZM, W6OSD, W6LJP and W6LYG. The destination was Mt. Mingus, at the exact center of Arizona. Plans called for the use of a rotatable antenna pointed in the direction of various stations in surrounding states.

The field day started off on schedule. The gang arrived at the tower, where the rig was to be set up, in a fog. At 3:00 p.m., when the fog finally lifted, the line thought to be north and south turned out to be almost due east and west! The antenna was then changed, and a station at Gallup, New Mexico, (200 miles) was raised on schedule. This was the only contact of any distance, though several were made in the district.

56 Mc. Test Sked

W8OKC in Shamokin, Pa., plans to run a series of tests during February at 3 p.m. e.s.t. daily, using 57.0 Mc. crystal-controlled c.w. The final amplifier uses a pair of T55's with 450 watts input. Two receivers will be doing duty when listening for replies.

August Dx Again

Recently we mentioned that W8PTG in Springfield, Ohio, heard a New York City station on five meters at 4:20 p.m. on August 18. The operator's name was distinctly heard as "Marvin". It now comes out that W2JUW had just then heard W9CLH in Elgin, then worked W2IQD who had also heard W9CLH, and in the course of the QSO had spelled out his first name, "Marvin". Well, it all checks. Even to W9CLH being heard all over the East at that time.

The Milk Truck Mobile

[*Continued from Page 24*]

cago and the Middle West know that the high frequency end, 58 to 60 Mc., is the most active, and most of the high power boys are found there. I was listening on 14 Mc. the other day and heard a W9 say that he had a five meter rig running at 800 watts, that almost all the boys out there worked between 56 and 58 Mc., and that he seldom listened on the high frequency end. If most of the gang out there do that, they will miss out on a lot of dx. Many stations are on the very high end; W1BCR runs close to a kilowatt on 59,988 kc., and many others are close to him, though the whole band is active.

•

Oscillate and Live Long—a recent Brisbane headline.

•

A 40-meter crystal vibrates through a distance of 10-8 centimeter.

•

The fixed condensers in the average communications type super contain enough tinfoil to wrap 51 packages of cigarettes — enough glassine paper to wrap 11 lunches.

The Easiest Uni-Directional Array

[*Continued from Page 23*]

tuned out by a stub line attached above the slip rings, so that through the slip rings and thence to the transmitter there will be a really non-resonant line. The effect of a small amount of standing waves above this stub is negligible. Furthermore, the stub can be one with a shorted end, thus providing a potential node where a permanent lightning ground can be attached. The required length and point of attachment of such a stub can be read from the upper graph on page 703 of *Radio Engineering* by Terman, 2nd edition.

Results

Since every ham story ends up in a bit of more or less restrained bragging about performance of the particular brain child described, it will be only conventional to mention a few of the operating features of the close-spaced director beam. First of all, there is the remarkable absence of QRM from the backward direction. Secondly, European QSO's indicate that the lowly 25 watts radiated by this beam put a signal across the water that more than holds its own with the average U. S. station on 10 meters, and finally, there has been a most interesting reaction from nearly everyone who has listened while the beam rotates. Before such a test it would be "O.K., O.M., go ahead and we'll listen" in a tone of voice that means that they are resigned to this sort of thing and don't expect anything particular to happen. After letting the beam rotate a few times to average fading out effects, however, they come back with something like this: "Say, old man, you sure have got something there and I don't mean maybe," followed by renewed and real interest in the plumbing-like arrangement of dipoles and support.

In conclusion, the writer wishes to admit that the structures shown in the various photos might never have been completed but for the very helpful assistance of Frank South, W3AIR, and Phil Robinson, W3EUQ, the latter having done most of the chimney-top work. Unfortunately, and perhaps significantly, just after he heard of the new mast project, 3EUQ moved several hundred miles away. But it is hoped that the new mast will be completed before 3AIR can arrange to leave town too.

•

During the year ending June 30, 1937, ham stations came into existence at the rate of 1.6 per day.

•

Recent headline — *Dr. Ham Receives Keys.* (Dr. Ham assumed the presidency of Mt. Holyoke College.)

Open Forum

[Continued from Page 168]

of stations, don't put up a stationary directive antenna. If it works as it should, it will spot your signal way over yonder somewhere and will be there every time you turn it on but nowhere else. It's a good thing that most of us can't get a stationary beam to work as it should; we get a few other stations that are out of the conventional pattern. Put up a rotary and put your signal on the fellow that you call. I put up a Bruce folded array once and could work Los Angeles R9. Fellows 100 miles either side of L. A. got me R2-3. Wouldn't it be fine if someone would invent some kind of a white tracer wave that you could see?

What I've said about beams may not be true for you fellows that live on the coast, but it sure is for us fellows that live here in the Southwest.

So here's my headache in a nutshell: there is too much QRM for a QSO, and in the clear spaces, the fellows don't seem to ever listen. Why? Maybe we have two different acting bands on ten, the first half acting as one, and the higher half acting as a different band at the same time. Have any of you fellows noticed that? Sometimes I think the high end of our 10-meter band is acting up while the low end is good for contacts and vice versa.

If I've said too much, and the QRM moves to the high end of ten—well, I can always move back down again.

Ed Harris, W5TW.

•

This SWL Problem

Chestnut Hill, Philadelphia.

Sirs:

The letter on page 68 of your October issue from Harry O. Jones, entitled "SWL on QSLing," has another side which the s.w.l.'s don't consider.

Why should s.w.l.'s self-appoint themselves as necessary adjuncts to amateur work? If they wish to collect cards, let them pay for them as they must for commercial QSL's. Most amateurs probably would oblige on receipt of a *stamped* self-addressed envelope *plus 10c in coin:* it would not be worth while for anything less.

I have received as many as a dozen requests in one month, without even so much as a stamp to cover return post. Now why should I spend my money on this racket? It is quite pointless and a definite pest. Cards cost money, and I expect to use them for what they were intended—QSL of QSO's.

The s.w.l. is presumptive in believing that just because he hears amateurs phoning, or just because he has learned enough code to copy call letters, those stations *must* send him cards if he asks for them. Nix, nix! the amateur need feel no such obligation. When such requests come here they are relegated to the waste basket.

Answering another of Mr. Jones's allegations, the *amateur doesn't ask for s.w.l reports.* Therefore, why should he bother to announce that he will not reply to any? The amateur's desire is actual QSO's, and, if the s.w.l. wants legitimate cards for his wall, let him study and obtain a ticket and he will find the percentage of QSL's from QSO's is very high.

Therefore, I suggest that the s.w.l. stay out of the amateur field unless he is willing to pay his way.

John B. Morgan, W3QP.

•

Chula Vista, Calif.

Sirs:

The writing of the following was prompted by the reading of Harry O. Jones' contribution to the October "Open Forum."

All in all, Harry, your attitude is well taken, and I don't doubt a minute but what you have voiced the opinion of a good many of your "fellow sufferers." As you said, a really conscientious s.w.l. puts himself to considerable trouble "in sending accurate reports of signals heard." Thus far do I agree. However . . .

You say that you consider it a common courtesy for a ham receiving your "dpe on sigs hrd" immediately to shoot you back one of his QSL's, or at least in some way to acknowledge same. Naw, as far as you and many other s.w.l.'s of your kind are concerned, I have no doubts whatever that, maintaining "good communications receivers" (maintenance expense, incidentally, would hardly amount to enough to be classed as such) like you do, the reports that you would, therefore, be able to give would be accurate, comprehensive and, no doubt, of some technical value. And what's more, any real honest-to-gosh ham is gonna certainly appreciate same as evidenced by the many replies and QSL's which you have already received, but failed to mention.

You stated further, by way of a solution for both sides, that: ". . . if those amateurs who do not care for s.w.l. reports would mention this on their transmissions . . ." Jeepers Creepers, fella! I said before that I thought your lament was generally well taken; but this is carrying it a bit too far. I sure don't wish to seem blunt in the matter, but this applies to all s.w.l.'s, conscientious and sincere as they may or may not be: . . .

"Nobody sez you *gotta* send out your s.w.l. reports."

Like I said, I honestly believe that any up-and-coming "regular fella" ham really appreciates a good s.w.l. report, and said such ham will certainly acknowledge same with the return of one of his QSL's.

I often wonder just what percentage of real genuine QSL's sent to and by hams actually contacted are ever answered. Even this business of swapping QSL's, ham to ham, is purely optional. "Common courtesy" perhaps, but still optional.

CARL O. BOLTZ, W6FTT.

•

We are indebted to the French language for the word *amateur*.

•

WLW radiates ten-thousand kilowatt-hours during one of its regular broadcast days; enough soup to keep a pocket flashlight burning continuously for 23 years.

A Modern, Self-Contained Kw. Phone

[*Continued from Page 31*]

The illustrations indicate the layout of parts for each chassis. Terminal strips were used for all medium or low voltage leads to each chassis.

The final tank condenser has a maximum capacity of 50 $\mu\mu$fd. per section, which is a little low for 75 meter operation. Theoretically the plate current to the final amplifier should be reduced considerably for 75 meter band operation in order to maintain sufficient fly-wheel or "Q" in the tank circuit of this modulated stage. This should be done by decreasing the antenna load, not by lowering the plate voltage. The final tank coil should be link coupled to an external tuned antenna circuit of any conventional type.

Beer Glass Coasters

Charlie Perrine, W6CUH, informs us that those little composition "coasters", once designed to support one glass of beer, work very well as separators for the wires in a four-wire transmission line. He uses a quarter-wave line of this type as a Q-type impedance-matching element between his transmission line and a half-wave antenna.

Another Vertical Feeding Arrangement

[*Continued from Page 169*]

an assumption must first be made as to the terminal impedance of the end of the antenna. Previous experience has indicated that the impedance at the end of a half-wave doublet is in the vicinity of 2200 ohms. But, since only *one* end of the last matching section is connected to the antenna, we must make allowances for this. However, due to the coupling between the two sides of the last matching section, it would not be proper to figure the load into which the section is working as 4400 ohms. Better, some value between these two extremes should be taken.

In making the calculations for our particular installation, a compromise value was taken as 2750 ohms; subsequent operation has proven that our assumption was not far from correct. (Anyway this value worked out well for the wire and insulators at hand.)

Now, knowing that the impedance of the first line section (the one nearest to the antenna) is 600 ohms (no. 12 wire spaced 6″), and assuming that the terminal impedance of the antenna is 2750 ohms, we know (using the familiar Q-bar formula) that 600 ohms is the geometric mean between 2750 and the impedance at the end of the section. Then, to calculate this impedance:

$$Z_q = \sqrt{Z_s Z_r}$$

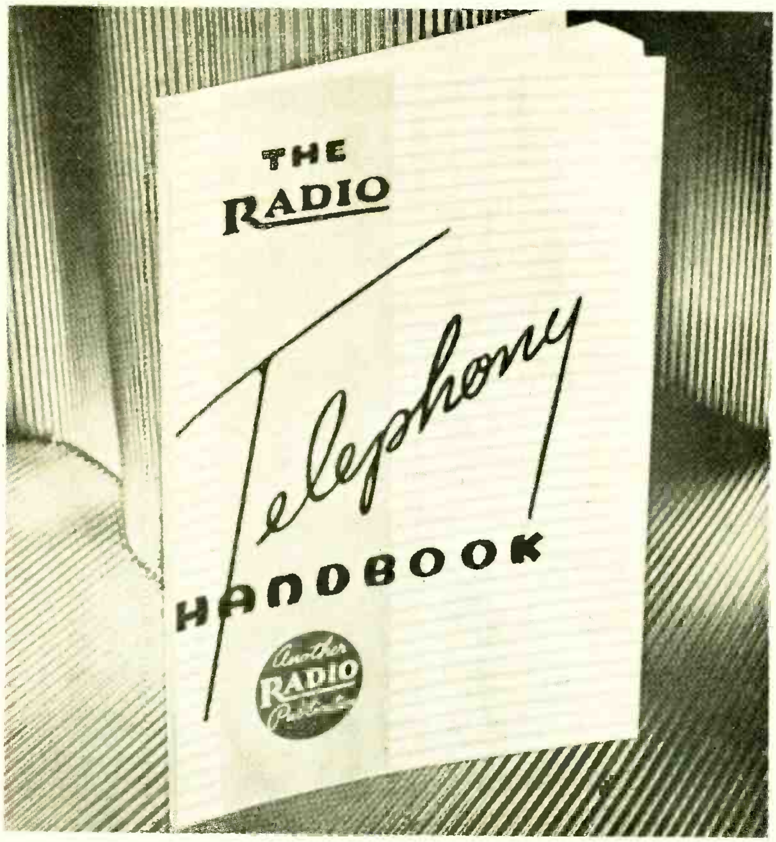
$$600 = \sqrt{Z_s \; 2750}$$

$$Z_s = 600^2/2750 = 130 \text{ ohms}$$

Now, the second section, the four-wire line,

[*Continued on Page 178*]

It's the "phone man's 'bible'"!



THE "RADIO" TELEPHONY HANDBOOK

Note: copies of the first printing are entitled "Amateur Radiotelephony"; the text is the same.

This book has been written expressly for the "phone man" and the amateur interested in getting on phone. The art of radiotelephony requires more care, more equipment, more knowledge than that of radiotelegraphy.

This clear yet concise work devotes itself particularly to the intricacies and technicalities peculiar to this field, and makes them more understandable to the greater number of experimenters.

A dozen complete transmitters are described from the tiny, ten-watt size up to one kilowatt. Each has been laboratory built and tested, then tested on the air.

It is more comprehensive than the radiotelephony data to be found in any "general" handbook. It is rapidly becoming the "phone man's bible". None of the transmitters described are found in any other work by "Radio".

All systems of modulation are covered, also class BC amplifiers, inverse-feedback systems, modulation measuring equipment, and the like. Over 100 illustrations show how to construct and adjust all items describ

52 typic uestions for the special-privilege Class A license examinat are answered in detail.

The best single investment you can make in your phone transmitter is represented by the purchase of this book at

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Helpful Hint

A ham in college told us of his safety valve which limits the amount of time he spends with ham radio. It seems that his rig is powered by a vibrator unit driven by one of those diminutive motorcycle storage batteries. The battery runs down after two hours of operation, and it takes all night to get it back up with his trickle charger. So the ham goes back to his studies.

Another Vertical Feeding Arrangement

[*Continued from Page 176*]

must match this impedance (130 ohms) to the characteristic impedance of the transmission line from the transmitter, 600 ohms. Using the same formula as above:

$$Z_q = \sqrt{130 \times 600}$$
$$Z_q = 280 \text{ ohms.}$$

An impedance of 280 ohms can be obtained through the use of ¼-inch copper tubing spaced about 1¼", or through the use of a four-wire line. The latter expedient was chosen in our case. Looking at the chart given by Madsen in the April, 1937, RADIO, we see that to obtain this impedance the wire will have to be spaced 150 times its radius. Using no. 14 wire, radius 0.032", the spacing will be 4.8". The diameter of the circle in which the wires are mounted will be $\sqrt{2}$ times this or 6.7". Six pieces of bakelite panel ¾" wide were cut to this length, the ends slotted for the transmission line and drilled for the holding wires, and a hole drilled in the center of each so two of these pieces could be bolted together to form a cross. These three crosses were placed as spacers at each end and at the center of the four-wire line section.

•

Our spies report that certain 56 Mc. hounds recently loaded up their equipment and drove some ninety miles in heavy Sunday traffic. After lugging various apparatus up a high hill, then to the top of a fire tower, setting it up and erecting an antenna, they discovered that the modulator and microphone were still reposing very comfortably on a front veranda back home. Strange as it may seem, no benefits were derived other than a lot of fresh air and relaxation. Well, anyhow, they saw some beautiful country. (heh heh! They might have used c.w.)

Book Reviews

[*Continued from Page 146*]

is available direct from Hammarlund or from your favorite jobber.

•

The Capitol Radio Engineering Institute, Washington, D.C., has released its new catalog, "A Tested Plan for a Future in Practical Radio Engineering." The booklet, discussing the Institute and the many home study and residence courses that it offers, is available to any radioman that aspires to a more general and better founded knowledge of radio engineering.

•

Calls Heard

[*Continued from Page 144*]

PA0CE; PA0KG; PA0KZ; PK1MF; PK1M0; PY1CI; PY2AK; PY2BY; PY2FY; PY2HU; PY2KT; PY80G; SM7YC; TI5CV; TI2RC; U1AP; U3BC; U3FB. — **VK** 2ADE; 2ADF; 2ADR; 2AEZ; 2AFJ; 2AFM; 2BR; 2CI; 2CP; 2DA; 2DG; 2DK; 2IP; 2J0; 2NP; 2NQ; 2RX; 2TZ; 2VA; 2VN; 2XJ; 2ZW; 3EH; 3GP; 3HY; 3IW; 3JX; 3ML; 3NG; 3RJ; 3UX; 3VF; 3VH; 3WY; 3XD; 3ZZ; 4CG; 4EL; 4GK; 4JD; 4KC; 4KX; 4RF; 4RT; 4RY; 4SD; 4UL; 4UR; 4WL; 4WU; 5AW; 5DA; 5FM; 5GA; 5HG; 5JB; 5JP; 5LD; 5LL; 5QR; 5WG; 5WC; 5XB; 5ZX; 6AA; 6KB; 6M0; 6SA; 7HB. VP1AA; VP1WB; VP2TG; VP5PZ; VP5TG; VP7NA; VP9R. — **XE** 1AA; 1AG; 1AK; 1AM; 1BC; 1CM; 1DA; 1DD; 1FY; 1IM; 2N; 3AR; 3Y. EX8RL; ZE1JN. — **ZL** 1DV; 1FE; 1JY; 1MQ; 1QS; 2BM; 2G0; 2GQ; 2HM; 2II; 2IW; 2MN; 2PM; 2P0; 2QR; 3DJ; 3GR; 3MQ. ZS6S; ZT6Y; ZU6V.

•

R. J. Petermann, W2FXZ, 85 Beverly Rd., Oradell, N. J.

(September 1 to October 3)

14 Mc.

CX1BG; D4DLG; D4GKF; F8AB; F8RC; F8YI; F3HK; F3MN; — **G** 2FT; 2LB; 2XL; 2XN; 2UV; 5JM; 5SY; 5VX; 6AV; 6DX; 6KS; 6MK; 6UX. GM6BM; GM6NV; GM6XI; GM6FB; GM6CV; HH1L; HH4AS; HA6H; HK3AL; HK5FL; HI60; J2EE; LU4DJD; K5AA; ON3ANV; ON4IF; ON4RV; ON4RX; ON4SK; ON4SAU; OE7EJ; PY2AC; PY2HM; PA0EV; PA0EB; PA0ON; SV1RX; SP1NN; U1AD. — **VK** 2AEZ; 2BR; 2DA; 2DG; 2DG; 2HZ; 2N[illegible]; 2QE; 2Q0; 2TF; 2XT; 3BG; 3EG; 3HE; 3HF; 3JK; 3MR; 3PA; 3PE; 3QR; 3SE; 3VF; 3VU; 3XP; 3XU; 3ZC; 4GJ; 4TK; 5FL; 5JS; 6MW. VP5AC; VP5PZ; YU7DM; YR5HC; ZL1CH; ZL4GM.

•

Dr. Tug. Mario Santangeli, I1ER. Milano, Italy

14 Mc. phone

W 2IXY; 2SYY; 3AII; 3CRG; 3PAM; 3SAM; 4DCQ; 6ICH.

28 Mc. phone

W1C00; W1IXT.

14 Mc.

W 1ADM; 1AFB; 1APU; 1AXA; 1BFT; 1BGY; 1BZ; 1CGM; 1CGY; 1CH; 1DA0; 1DBG; 1DHE; 1DJA; 1DUK; 1DUJ; 1DZE; 1EAQ; 1ET; 1EVE; 1EWD; 1EYY; 1EX; 1FAU; 1FTR; 1FUY; 1GKJ; 1HER; 1HIC; 1HM; 1IBL; 1ICI; 1IGR; 1ISX; 1IWC; 1IXE; 1IZY; 1JDE; 1JLT; 1JLY; 1JVX; 1LZ; 1MP; 1NA; 1PL; 1SZ; 1ZI; 2ADP; 2AGW; 2AHC; 2AIR; 2AIW; 2ALB; 2ALD; 2ALK; 2AL0; 2ARB; 2AWF; 2BCK; 2BEF; 2BHW; 2BHZ; 2BNX; 2BYK; 2CJM; 2CMX; 2CTC; 2CT0; 2CUQ; 2DJB; 2DJT; 2DNU; 2D0E; 2DSB; 2DX0; 2EMJ; 2EWD; 2F0H; 2GRA; 2GUD; 2GUM; 2GUX; 2GVR; 2GYM; 2HFP; 2HHF; 2HVM; 2HXT; 2I0P; 2IUV; 2IY0; 2KL; 2JAB; 2JN0; 2JT; 2LI; 2MJ; 20A; 20C; 2SE; 2UK; 2ZA; 3AIU; 3ANH; 3ANS; 3ANZ; 3APJ; 3BAL; 3BDI; 3BEK; 3BEN; 3BLI; 3BQP; 3BSB; 3BSY; 3BXG; 3BZ; 3CDQ; 3CGV; 3CHE; 3CUB; 3DAJ; 3DAL; 3DMQ; 3DYS; 3ECS; 3EGN ;3EIL; 3EMM; 3ENX; 3EV; 3EVT; 3EYS; 3FDJ; 3FGJ; 3FKK; 3FQP; 3FRE; 3FWH; 3GAD; 3GAP; 3GEH; 3GIP; 3GMS; 3GRP; 3PC; 3UVA; 4AEL; 4AGB; 4AGI; 4AH; 4AQU; 4BWZ; 4CBY; 4CPZ; 4CRA; 4CZS; 4CZS; 4DCZ; 4DQH; 4DQX; 4DV; 4DYB; 4DZ0;

4DZS; 4ID; 4LX; 4NC; 4NN; 4TO; 4YC; 4YCW; 4ZS; 4ZH; 5BXN; 5DEW; 5DM; 5EHM; 5EKK; 5FNA; 5FYN; 5HJT; 5JC; 5VV; 6AM; 6AZS; 6BAM; 6CD; 6CDQ; 6CQI; 6CXW; 6EW; 6FOY; 6GRB; 6GRL; 6GRX; 6HJT; 6JBO; 6JCH; 6JKH; 6JJA; 6JWT; 6KQH; 6KRI; 6KUT; 6KWA; 6LAC; 6LKO; 6LYM; 6LWP; 6MHH; 6MUO; 6MYS; 6NSA; 6PZL; 7AMQ; 7AMX; 7AVR; 7AYJ; 7BAC; 7BD; 7BVI; 7BYW; 7EK; 7FWD; 7LEC; 8AAT; 8ARO; 8AV; 8BAI; 8BDY; 8BLP; 8BNX; 8BQJ; 8BTI; 8CDV; 8CLM; 8CJJ; 8CMB; 8COK; 8DAE; 8DGP; 8DLT; 8DML; 8DOD; 8DQU; 8EMW; 8FCB; 8FJN; 8GHN; 8GWT; 8HYC; 8HWE; 8IIL; 8IOT; 8KCM; 8KO; 8JDB; 8JFC; 8JFN; 8JIN; 8LAP; 8LCN; 8LEC; 8LIR; 8LUQ; 8LZK; 8MAH; 8MCY; 8MQ; 8MTY; 8NIK; 8NUY; 8NV; 8OKC; 8OQF; 8OTO; 8QDU; 8QMY; 8TOE; 9AFN; 9AFO; 9AGM; 9ARL; 9BPU; 9CWW; 9DGT; 9DMA; 9DNP; 9EH; 9EZW; 9FDO; 9FS; 9FYY; 9HFJ; 9HXM; 9KYU; 9JFB; 9LKI; 9LJU; 9MV; 9MWH; 9NST; 9PLM; 9PSQ; 9PST; 9PV; 9RCQ; 9RH; 9SZQ; 9TB; 9TPI; 9UM; 9UOX; 7USZ; 9UTT; 9UYF; 9VIN; 9VQW; 9WKS. K5AA; LU2AX; PY2DN; VE1AX; VE1EC; VE2AX; VE2BK; VE3JT; VE3QH; VE4RO; VK2FM; VK3AH; VK3JT; VK4LE; VK4RX; VK5XJ; YV5AA. — **ZL** 1CC; 1BC; 1DA; 1DM; 1FE 1JY; 1LM; 2CW; 2FA; 2II; 2MV; 3AX; 3TR; 4AF; 4AO.

28 Mc.

W 1ADM; 1AS; 1BUX; 1CGM; 1CGY; 1DA; 1DFR; 1DZB; 1DZE; 1EWD; 1GDY; 1JIZ; 1ME; 1SZ; 1TH; 1TR; 1TW; 1TWH; 1ZB; 2AOG; 2AUT; 2BHZ; 2BQK; 2CBO; 2CDL; 2CHE; 2CPA; 2CTO; 2DSB; 2DTB; 2FHI; 2GUM; 2HYT; 2UME; 2MB; 2ZA; 3AIR; 3AXU; 3DDX; 3EMM; 3EVT; 3FKK; 3FQP; 3KT; 3MWY; 3PC; 4AH; 4AUU; 4EDQ; 4YC; 5VVW; 6IHT; 8ANB; 8CYT; 8DMK; 8DYE; 8FJN; 8HRD; 8KKM; 8IFD; 8IIL; 8IOT; 8IWG; 8JFC; 8JMP; 8LDA; 8LEC; 8LUQ; 8MWY; 8NJP; 8OK; 8OKC; 8QDU; 8QY; 9ADN; 9ARL; 9CVI; 9GIL; 9KA; 9IWX; 9JDD; 9LDL; 9LQE; 9MXW; 9PST; 9PWZ; 9TJF; 9TPF; 9TPI; 9UHM; PY2AC; VE3KF.

•

Joe Da Vanza, W2KHR, 100 West 94 St., New York City

(28 Mc. band during October)

(28 Mc. c.w.)

GECO, TK, IN, G5BP, PP, GM6XI, GW6MS, PA0AZ, D4QET, F8RR, KA1SP, ZL4AK.

(28 Mc. phone)

G2KU, CO, IT, VM, G5VM, OJ, CY, BY, WP, KH, BM, BP, NL, G6QL, WU, BW, DH, VX, GS, GO, HL, LC, G8SA, GM6RG, GM8CN, GW2UL, GW5TW, F2HL, HM, KH, F8KI, LX, LZ, QD, VO1J, VO3X, PA0WN, AZ, ZS6AJ, ZS6P, ZS6J, ZT2G, ZU6P, ZU6E, ZE1JR, ON4FE, HC, OH1MP, VK2GU, ABJ, K4EPO, EJG, EZR, SA, K5AT, K6MVV, MVX, K7PQ, CO2SE, WM, OK, CO6OM, HI7G, OK3VA, VP5BY, SP1HH, VE4AW, BD, JW, SR.

Dx

[*Continued from Page 143*]

More About 40

W6LIF in Palms, Calif., has been on 40 a long time and reminds us not to pass over some of the fones in the 40-meter band. They are not all Mexican, but many of them are in South America. The other night he heard a fone station calling a "CQ dx" and it turned out to be LU2CA. W6LIF raised him on c.w. and then the LU changed to c.w. His frequency was around 7298 kc. and the time worked was 5:30 p.m. p.s.t. LIF picked up a couple of dx stations and their frequencies from VE3AEJ. I1EC, 7297; OK1BC, 7180. How about it gang . . . let's have more frequencies of 40-meter dx stations.

Howland, Jarvis and Baker Islands

W6LYM, Norol Evans, the celebrated orange grower, breezed in and passed some swell info along

[*Continued on Page 182*]

Reducing Phone QRM

[*Continued from Page 66*]

ever, as pointed out above, the selectivity falls short of what we are looking for in our search for something that will dig intelligible signals out of the crowded amateur phone bands. We don't want more amplification; hence we do not add more i.f. stages to increase the selectivity. We can use two transformers between each pair of tubes. This, however, is far from ideal. Aligning such an amplifier is quite a feat, and the expense of the extra transformers is considerable.

Suppose, instead of adding more transformers, we improve the ones used, and then give the last of the three transformers a high impedance to work into, something that will not ruin the selectivity of the last transformer.

After considerable experimentation and research, i.f. transformers with a "Q" of 205 have been developed and placed on the market. Let's use them. The diode second detector is forsaken for the "infinite impedance" linear second detector that is becoming popular. The results are surprising. With nothing unusual about the i.f. amplifier except the exceptionally high "Q" of the i.f. transformers and the incorporation of the infinite impedance second detector, the rejectivity is 1000 times at 2.5 kc. off resonance, and 10,000 times at 7.5 kc. off resonance. The curve possesses a 3 kc. band width nose, showing a sufficiently wide flat top for intelligible speech reception. Thus, without resort to any trick schemes or large outlay of extra components, we have obtained the 3 kc. bandpass which we were so anxious to obtain.

Such an i.f. amplifier, with the addition of a crystal filter for c.w. reception, and a means (there are several easily adaptable ones) of broadening the nose for broadcast or high fidelity broadcast, for amateur phone reception, and for single signal c.w. reception.

The Story of EL2A

[*Continued from Page 118*]

ant, rat, cockroach and mosquito is present in Liberia, along with some unknown ones. Copying messages on a typewriter with malaria mosquitoes chewing one's ankles and bugs by the hundreds trying to get inside one's shirt is enough to drive one mad. As a matter of fact, a cup of coffee did not taste right unless it had at least six little red ants in it, the ants getting into the sugar first.

So, if I ever pass the Statue of Liberty again, the old girl will have to turn around and wave at me.

Dx

[*Continued from Page 180*]

for "youse guys". Usually, Norol is a c.w. man but then too, he gets out of the ordinary sometimes and goes over to phone. This time he was out of the ordinary, and while QSO a K6 he squeezed this information out of him. K6BAZ, Kenny King, is now located on Howland Island. He will be there for a few months yet, but at present he is off the air due to being "out of gas". The gas generator he is using is on the equipment of the expedition and until the next Coast Guard cutter arrives, he will do no haming. When he is on, which may be by the time you read this, he will be on the high frequency of the 14 Mc. c.w. band, and the high frequency end of the phone band.

K6OGD is an active ham on Jarvis Island and is c.w. only, 20 and 40. There they are fellows, go get 'em . . . they should add a couple of new countries for most of you.

G2YL Writes

Following is a report from Nelly Corry, G2YL, on 28 Mc. activity. This article, which appears in the November and December issues of the *T. and R. Bulletin*, covers a period from October to December and a stdy of it should prove very interesting to most of you. Here it is:

> Two years have now elapsed since VK and W signals first broke through on "ten", and it is remarkable that, taking into consideration the enormous increase in activity, conditions during the past month were not very appreciably superior to those of October, 1935. Signals were heard from 47 countries in all continents and plenty of dx was worked, particularly at week-ends, but there was usually very little to be heard before 11:00 or after 19.30 g.m.t., and on a few days conditions were definitely poor.
>
> Nineteen Australians in VK2, 3, 4 and 5 were re-

ported, the greatest number being active at week-ends during the VK/ZL contest periods. G2XC heard them at times from 07.30 to 14.30 g.m.t., and on September 9 worked four stations in 35 minutes. VK5KO, in the course of an hour's ragchew with G6YL on October 15, said he had had 130 Europeans QSO's since September 12, and over 1000 W QSO's this year.

VU2AU Most Consistent

VU2AU was the most consistent Asiatic station and had many G QSO's on 'phone and c.w. Others worked were J3FJ, U9AV, U9AW, U9MI, U9ML, VU2AN and VU2CQ. G2DH reports hearing "HS1BC", S8 at 18.00 g.m.t. on September 28, but probably this was a bogus call. VS1AA reported on October 8 that he had worked D, G, GM, PA, VK2, 3, 5, VS7, VU, W2, ZE, ZS1 and 6 between September 19 and October 3, since when conditions had fallen off somewhat, only an occassional signal being heard. VS2AK is also active now and has worked VK and K6.

Over 20 different African stations were heard, in CN, FA, FQ8, SU, ZE and ZS1, 2, 3, 5 and 6, and G2XC made first contact with ST2CM at 09.10 g.m.t. on October 29. Of the South Africans, ZS1AH was the most often heard, and there were five Southern Rhodesians audible on the band, viz., ZE1JJ, 1JN, 1JU, 1JR and 1JY, the two last using telephony.

North American signals were heard from all W and VE districts and VO4C, and innumerable West Coast stations worked G on 'phone and c.w. The only South Americans reported were LU3DH, LU5AN, LU7AZ, PY1BR, PY2AC and HI7G who was worked on 'phone by G6DH. Signals from Central America and the West Indies included HR4AF, K4EIL, K4EJG, K5AC, K5AG, K5AY, TI2FG, VP2AT and VP6YB. G2TK made the first contact with HR4AF, who is a genuine but unlicensed Honduras station, on October 6, and G6DH had a 'phone QSO with TI2FG.

23 European Countries Logged

Stations in 23 European countries were logged during the month and a good many G's added to their totals of "countries worked on ten" by contacts with CT1KH, ES5D or TF5C. G6DH answered the "Seekewten mittafone" of U3FB and had what is believed to be the first 'phone QSO with a Russian on this band. G2XC logged 37 different G's, and stations in all parts of the country reported hearing "distant G's regularly."

Receive Trophies

Congratulations to D. W. Heightman, G6DH, and T. A. Iserbyt, BRS 25, who have been awarded the Powditch 28 Mc. transmitting and receiving trophies for 1938. G6DH is still far the most indefatigable worker on the band and finds time to keep numerous graphs as well as to make plenty of dx contacts daily. BRS 25 has probably done more listening on "ten" than any other receiving station as he started in October, 1928, kept it up through the lean years of sunspot minimum, and is still hard at it!

November started off with excellent conditions, but by the end of the month they had deteriorated considerably, dx signals being weaker and less consistent, and the band going dead comparatively early in the evenings. This corresponds exactly with conditions at the same time last year, and we shall probably have to wait till February before there is any definite improvement. During the month signals were heard from 46 different countries, and 2 new ones have been worked, both on 'phone, viz. VP6YB, QSO by G6LK on October 22 at 15.30 g.m.t., and YV5AK, QSO by G6DH on November 19 at 09.30 g.m.t., and by G6YR on the 21st.

Ship stations now using 28 Mc. include OH3NQP, S. S. "Maria Thorden", trading between Finland and U.S.A.; "W6BOY Mobile", bound for Florida from Newfoundland when last heard, and "CZ7G" heard by G5BM giving his QRA as "Ship off Labrador".

Australians Heard

Australian stations were heard throughout the month, and on November 1 G2XC worked 7 in succession. Those active included VK2ADE, 2GU, 2HZ, 2RA, 2TI, 2UD, 3CP, 3YP, 4RY, 4WH, 5FM, 5HG, 5KO, and 5YM, and another signal from the same continental division was K6MVV, heard by G6DH.

BRS 1173 heard ZL1HY on October 10, G2XC worked ZL2AL on October 30, and G6YL heard ZL2AL, ZL3AS, ZL3DJ at the end of October, and ZL3AB in November. G6DH worked ZL3AS at 09.30 g.m.t. on November 16.

In Asia the three active stations were joined by VU2FV, and other stations were J3FJ, worked by G2XC on November 14; PK3BM, worked by G2TK and G6YL, and U9AV, U9ML in Siberia. African

[*Continued on Next Page*]

BUYER'S GUIDE

Where to Buy It

CALIFORNIA—San Francisco

I. S. COHEN'S, Ltd.
1025 Market Street

ILLINOIS — Chicago

CHICAGO RADIO APPARATUS CO., Inc.
Established 1921
415 SOUTH DEARBORN STREET
(Near Van Buren Street)

ALL SUPPLIES FOR THE SHORT WAVE FAN AND RADIO AMATEUR QUOTATIONS FREELY GIVEN ON ANY KIT OR LAYOUT

Short Wave Receivers Taken in Trade
Get our low prices

IOWA—Sioux City

WARREN ELECTRIC CO.
647-655 Water Street

MASSACHUSETTS—Boston

RADIO SHACK CORP.
46 Brattle Street

MASSACHUSETTS—Boston

BRATTLE RADIO CO.
42 Brattle Street

NEW YORK—New York City

TERMINAL RADIO CO.
81 Cortlandt Street

NORTH CAROLINA—Asheville

FRECK RADIO AND SUPPLY CO.
38 Biltmore Avenue

TEXAS—Dallas

SOUTHWEST RADIO SUPPLY
1905 Commerce Street

PARTS REQUIRED FOR BUILDING EQUIPMENT SHOWN IN THIS ISSUE

The parts listed are the components of the models built by the author or by "Radio's" Laboratory staff. Other parts of equal merit and equivalent electrical characteristics usually may be substituted without materially affecting the performance of the unit.

A.C. OPERATED RELAYS

Silver strip for the making of low-resistance contacts may be obtained from the Calkins Co., 934 S. Main Street, Los Angeles. Chemical supply houses in other cities will undoubtedly also be able to supply strip silver.

A DE LUXE SUPERHET

All tubular by-pass condensers—Aerovox 484.
All mica by-pass condensers—Aerovox 1468.
Filter condensers—Aerovox PM-5, GM-8.
Cathode by-passes—Aerovox PR25.
TR_9—General Transformer 2209.
TR_{11}—General Transformer 1685.
TR_{12}—General Transformer 1686.
$C_{1, 2, 3}$—Radio Condenser Co. variable.
Resistors—Continental Insulated.

COMPACT CRYSTAL CONTROL

Fixed Condensers—Aerovox 1467 and Cornell-Dubilier 1W
C_1—Bud 902
$C_{7, 8, 9, 10}$—Hammarlund MEX
C_{11}—Bud 913
C_{12}—Aerovox MM50 10 μfd.
Resistors—Aerovox
RFC_1—Bud 920 choke
$RFC_{2, 3}$—Ohmite h.f. Z-1
CH—Thordarson 74C29
T—Thordarson 23A57
Dials—Bud 711
28-Mc. crystals — Bliley HF-2 or Monitor C B

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TO

RADIO

For The Year 1937

ISSUES 215 TO 224

A. R. R. L.

(see also *Editorials*)

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Antennas, Feeders, and Masts

(See also *Ultra High Frequencies*)

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Book Reviews and Catalogs

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Calls Heard

Conventions and Hamfests

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Contests

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● INDEX TO ADVERTISERS

"Tiny Tots Corner"

A recent letter from H. A. Maxwell Whyte, G6WY, informs us of an error that appeared in Reuben Wood's article in the November RADIO, "Through Europe with a Call Book." To quote from Mr. Whyte's letter:

"With reference to Mr. Wood's article in November RADIO, I wish to draw attention to an error on the writer's part. On page 45 he states that I am the Manager of the R.S.G.B. Research and Experimental Section. This could not be further from the truth. Mr. H. C. Page, G6PA, holds that position.

"I am Manager of the QRA Section and the DX Section of the Society. This latter is known in certain circles as the "Tiny Tots Corner", being the antithesis of the Research and Experimental Section."

●

"RADIO" BUYS ACCEPTABLE STORIES AND IDEAS

Even with one of the best staffs in the world, "Radio" realizes that variety and pep and sparkle in a magazine can only come from many and varied sources of material.

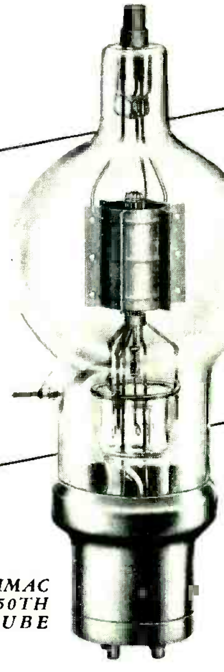
Thus, we solicit more and better contributions from "outside" (for which, incidentally, we pay cash).

At present an "average" full-length constructional article brings about $30.00 if accepted; the exact amount varies with many factors. All technical items except shorts are paid for.

Have you a transmitter, receiver, or other item with a novel slant, perhaps not brand new, but one about which your fellows might like to know? Many of the most interesting ones come from fellows who hardly realized that they've "got something there". And have you a friend who's hiding his light under a bushel? Let's smoke him out!

(Note: If you wish to send us a detailed outline of your proposed story, we'll be glad to comment on it before you finish the manuscript; we cannot, however, obligate ourselves to accept the final product until we have had a chance to see it.)

Another Eimac Triumph!



EIMAC
250TH
TUBE

A NEW TYPE
Thoriated Filament
(Gives Greater Performance)

Tube failures led radio engineers to believe that high plate temperatures and high plate voltages placed certain limits upon filament emission. Eimac engineers exploded this myth by proving that** poor vacuum **was the cause for emission failures. The Eimac exhaust technique and proper use of tantalum, long ago lifted these limitations from thoriated tungsten filament.

But Eimac was not satisfied with this discovery, alone. Certain other negative characteristics still existed in the thoriated filament . . . low ratio of usable to "peak" plate current . . . "cranky" filament voltage . . . tubes going "flat" for no apparent reason. With the issue at hand, unclouded by "erratic getters" and poor vacuum, Eimac engineers soon discovered the "what and why" of these problems. Result . . . the *new type* Eimac thoriated filament, found in 35T, 100T, 250T, 450T, 750T and 1000UHF tubes. This filament, found in the many thousands of Eimac tubes produced during the past year, has definitely eliminated "premature" emission failures.

The unusual properties of this new type thoriated filament, allow Eimac tubes to carry higher ratings, more conservatively, than any contemporary tube of equal physical size. Specifically; the *new type* filament operates at a lower temperature than that employed previously, and all other forms of "cheating," such as under-processing, are avoided. This results in the highest possible thermionic efficiency plus longer filament life and uniformity. In addition, Eimac filament assemblies are distortion proof. Special construction makes it impossible for filament displacement to alter the characteristics of Eimac tubes.

Distortion proof filament assembly of Eimac 250TH.

Remember the "radical" Eimac design of three years ago? (Now copied by leading tube manufacturers.) And the use of tantalum? (An Eimac development now used by practically all tube companies.)

Well, this** new **thoriated filament** still is **exclusively Eimac, and is just one of the subtle engineering triumphs that make Eimac tubes so unusual in performance and stamina.

Eimac TUBES

EITEL & McCULLOUGH, INC. • San Bruno, California

LOOK AT THE *New RCA 809!*

LOOK AT THE CONSTRUCTION

Husky electrodes, ruggedly supported in a large envelope assuring maximum heat radiation. Ceramic base and plate lead out of top for maximum insulation. Large plate cap for easy and low-loss connections.

LOOK AT THE RATINGS

	CLASS C TELEGRAPHY	
D-C Plate Voltage	750	max. volts
D-C Plate Current	100	max. milliamperes
Plate Input	75	max. watts
Plate Dissipation	25	max. watts
Full input to 60 megacycles		
Filament Voltage	6.3	volts
Filament Current	2.5	amperes
Amplification Factor	50	

LOOK AT THE PERFORMANCE

New design provides high efficiency and low driving power at moderate plate voltages. High-mu grid means low bias requirements. Heavy duty filament and large electrodes provide for safe, conservative ratings.

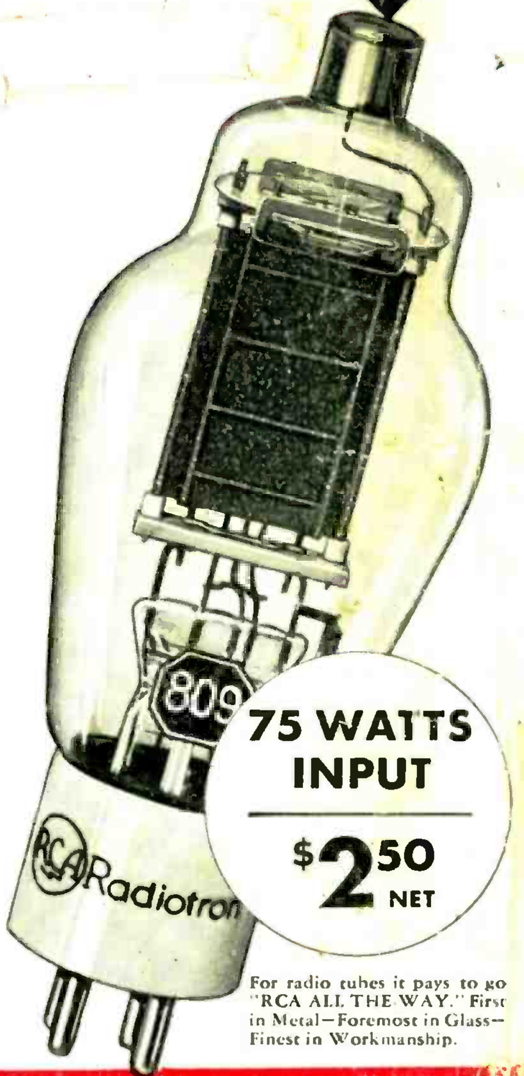
LOOK AT THE PRICE

Only $2.50 *Net!*

AND THEN YOU WILL BE SATISFIED ONLY WHEN YOU OWN A NEW RCA-809

Your distributor has them in stock. See him or write us for full technical information.

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



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For radio tubes it pays to go "RCA ALL THE WAY." First in Metal—Foremost in Glass—Finest in Workmanship.

RCA

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