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RADIO

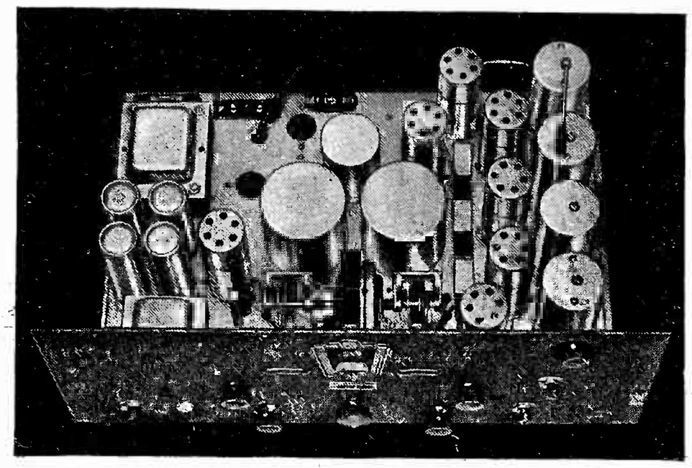
REG. U. S. PAT. OFF.

ESTABLISHED 1917

SHORT-WAVE AND EXPERIMENTAL

...IN THIS ISSUE...

5-Meter Portable Radiotelephone, An Aid to the Bridge Builder. See Page 16.



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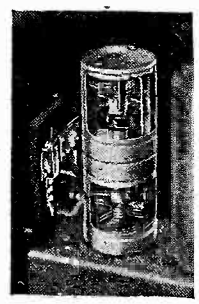
The World-Wide Receiver *with* World-Wide Reputation

New

CRYSTAL UNIT



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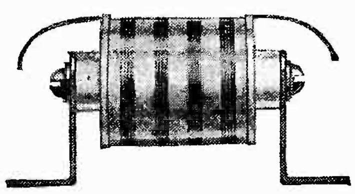

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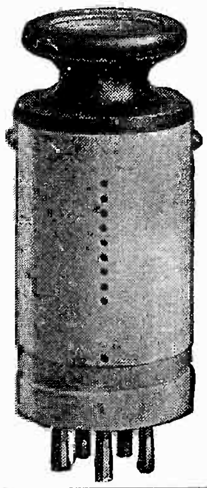

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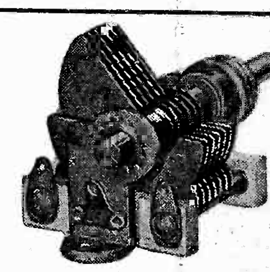

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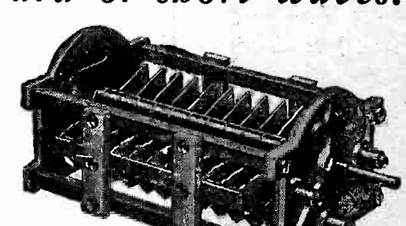

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Vol. 15 DECEMBER, 1933 No. 12

RADIOTORIAL COMMENT

Christmas . . . and the Amateur

IT'S almost here again . . . the "MX" of radio (Merry Christmas). Soon will follow HNY (Happy New Year) . . . sent from thousands of amateur keys the world over. You will hear it everywhere—MX, HNY, exchanging glad greetings between brother hams. The operator presses the key, a little tube sputters forth its signal to encircle the globe, none knowing from which direction it comes.

Contrast this with commercial practice of a few years ago. A gigantic high-power station in the East, another on the California shores, another in the Hawaiian Island and still another in Japan. 2000 meters and more. Several-hundred-KW spark transmitters. Power houses. Steam turbines. More than a dozen steel antenna masts, some 600 feet high. A hotel to quarter the operating and engineering staffs. Miles of ground. Perhaps a crew of forty to man the station. All this, and more, for the purpose of getting a signal into the receiver at the other end of the line, only a few thousand miles away.

Let's turn back the pages of history to the Christmas week of 1917. The high-power spark station at Bolinas had the hook filled with hundreds of Christmas and New Year greetings for residents of the Hawaiian Islands and Japan. The static was terrific. KIE, at Kahuku, in the Hawaiian Islands, was to receive the traffic and deliver it on Christmas day. The Bolinas operator struggled through the day to get a few messages through to KIE. He would send one letter at a time, repeat it a hundred and more times, until the operator at KIE pressed his key, denoting that ONE letter had been correctly received.

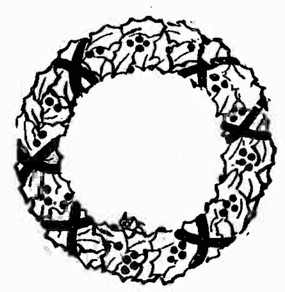
Relieved from duty after a four-hour watch, the receiving operator was about ready for the insane asylum. But that was in 1917 . . . with a few hundred kilowatts, steam turbines with huge rotary spark gap discs on their shafts, and 2000 meters, plus. Contrast this with present-day amateur radio. Here we sit with watts, not kilowatts; 20 meters, not 2,000; one lone operator, not a crew of forty. A 66-foot wire for an antenna, not one that covers two miles of ground space. We call "CQ", and a brother ham in South Africa comes back. PROGRESS!

Amateur radio has made possible reliable short-wave communication for the commercials. Christmas . . . 1933. What a change has been wrought. Radio's Santa Claus . . . the amateur . . . the man whose enterprise saved millions for the commercials, will sit before his Christmas tree lamenting that the wide bands of 200 meters which once encircled his trees, are torn to shreds, with but a few tattering pieces remaining of what once was a brilliant spectacle for any amateur to behold.

He turns his eyes to Wall Street's Christmas Tree. It will glitter with its wide, gold bands . . . almost encircling the tree . . . bands the amateurs once possessed, then played Santa Claus and presented them to the commercial interests.

Here we sit, on Christmas day, before the ham-tree of radio, hoping that Santa will bring back just one or two of those bands that now adorn the commercial tree. We will sit here until Sitting Bull stands up, so long as we continue only to wish instead of act. Let us resolve on New Year's day to work together, wholeheartedly, without malice, and carry on this campaign to regain some of the ground that has been lost. Perhaps next year at this time we can gaze upon a tree with a few more bands around it, instead of the sordid spectacle we now behold.

MX-HNY to you, all amateur radio.



You Can Make a Brother Amateur Happy On Christmas Day . . .

Give something practical to your fellow radio workers this Christmas . . . something lasting. We suggest a $1.00 subscription to "RADIO". Why not send such a subscription to one or more of your fellow radio workers?

An appropriate Christmas Greeting Card will be mailed by "RADIO" to those for whom you wish to subscribe . . . informing the recipients of your gift.

Each time the magazine reaches your friend he will again be reminded of your thoughtfulness.

"RADIO" makes an acceptable gift, because it is liked by all. Send the names and addresses of one or more friends to whom you desire to send "RADIO" as a Christmas Gift . . . send $1.00 for each gift subscription . . . and we will send "RADIO" for six months to each person for whom you subscribe.

This offer good only for the holiday season. The special reduction of 33⅓% on the subscription price will be withdrawn on December 24th.

A Bit of House-Cleaning Is In Order

SOME radio clubs are ruled by Kings, men who say "we" when they speak only for themselves. They fail to represent the thoughts of the group over which they preside. A "we"-man is worse than a "yes"-man, for he misrepresents the wishes of the majority, distorts vital issues, and leads others to believe that his followers are in accord with suggestions which are solely his own.

Let it be here repeated that prior to Lindbergh's immortal feat there were but three classes of men who could rightfully call themselves "WE" . . . first, Kings; second, Editors; and third, men with a tapeworm.

Now we get to the point. Some radio clubs are dominated by "we"-men, who force small boys to swallow bitter pills, who pull the wool over the eyes of an unsuspecting majority, belittling efforts of men who are fighting the battle to bring about better conditions for amateur radio.

Some of these "we"-men are called censors, others succeed in having themselves elected presidents (not of the United States but of a radio club) and by sheer dominance and soapbox oratory they swing the membership into the line that forms at the left, instead of the right . . . leading the entire flock astray, because they have not the vision, the foresight, to see beyond the brink of their noses.

The wishes of the majority must be respected at all times, for this is no occasion for any individual to assume false pride and make light of a situation which is rapidly drawing to a climax.

More than 100 radio organizations have already sent protests to their senators against ratification of the Madrid Treaty with its objectionable third-party clause. Some narrow-minded individuals have spread vicious propaganda, libeling the efforts of sincere men who have nothing but the interests of amateur radio at heart.

What is needed in some unfortunate radio clubs is a thorough house-cleaning. If your president does not respect your wishes, OUST HIM! . . . before he ousts you from the air.

COL. FOSTER'S COMMENT

Something New in the World

The Public Gets Something for Nothing

THIS is a great Christmas. We common people are getting the best break we ever had in our lives. There is far less cause for worry over the future than there was at Christmas-time in 1928 when every third stocking held an automobile. We ragged individualists have great cause for rejoicing.

Even if that were not true it would do us no good to worry. Job said, "The thing that I greatly feared has come upon me." Now, Job, by and large, was a pretty wise guy. He didn't mean that his fears and his realization of them were a mere coincidence; he meant that because of his fears the things he feared had overtaken him. Job was no common wise-cracker. He was very wide between the eyes. He wasn't like Shakespeare, the fellow who made a living by thinking up things for other people to quote. Job lived in an age when Christmas held a deeper significance than a headache the morning after. His counsel should be of value to us. He had a big advantage over us, in that he lived in a simple age when a feller could think abstractly; we live in a complex and highly mesmeric age where we mostly think abstractedly. He lived in an age when making a living consisted in rendering services that justified a return; we live in one where the chief aim has been to chisel it out of the other fellow. And the more you could chisel without being caught with the goods the more likely you would be called to Washington to help formulate laws to restrict the other fellow. Take it from me (or if not from me then from the billions who have regarded Job highly), his advice is worth following.

Our present period of business depression will pass. Many such periods have preceded this one. Some of them were worse than this one. They all passed. They went so completely out of view that few of us now recall that we had such periods before. Prosperity will return; but, thank God, it won't be the faked "prosperity" that caused the present debacle. It will not again be the kind of "prosperity" that provided the few with opportunities to plunder the many.

We don't need to worry about the gold content of the dollar. We can leave that to the monetary experts. They comprehend no more of the factors that control the answer than we do. But it's their game; let them play at it while we play ours. Ours is to concern ourselves with the content of our own and our neighbor's pantry. It is every fellow's duty to see that the other fellow eats. If you don't like that word, duty, then make it "self-interest", to accord with the age in which we live. It is to the personal interest of every man who wishes this depression to end that he see that his neighbor's pantry does not go empty.

We are all governed to a greater or less extent by self-interest. We can't help it, we were born that way. But in later years self-interest has literally run riot, until we now have the horrifying spectacle of our biggest custodians of other people's money fattening their private purses out of it enormously. All informed persons knew of this dishonesty in high places but it took the courage of one man to turn the limelight on it. One man had the courage to go at this concentrated and entrenched self-interest with the only weapon it fears. He took a big stick and went at it with the aim of clubbing some sense of respect for the interest of the other man into Big Business, into little business, and into all the rest of us self-seekers.

And that is why President Roosevelt is the outstanding figure in the world today. Not so much for what he is doing as for what he personally IS. All men before him had his opportunity; some before him had his vision and consecration to the people; none had his exalted courage. Whether we like it or not, whether it "works" for your and my personal benefit or not, this NRA thing is truly the noble experiment. It does not aim to destroy the profit motive, but it does aim to force us in the present emergency to do something that no amount of reasoning has been able to bring about—a decent regard for the rights of our fellow men. Don't worry if big lawyers do point to piffling precedents to prove that NRA isn't "legal". These same lawyers invoke similar precedents when they pull down big fees for getting known crooks out of jail and turning them loose again on society. NRA rests on a sounder law than any made by man.

Now, there is just one big business in America that does not need this force applied to it. It has been flourishing for 20 years without profit motive. It is an active, going concern, including in its partnership some 40,000 citizens of the United States. Their plant has cost them millions of dollars out of their own pockets. This big business has no watered stock and not one penny of its capital was obtained from the public. It is the body of radio men who are licensed to operate non-commercial stations—the "Amateurs". Their interest is in research, experiment and service to the people. In all these departments they have been outstandingly successful. In fact without these amateurs there would have been no such achievement as radio shows us today. It is the amateurs who have always made the discoveries and developments, and the commercial people cashed in.

This big business of the amateurs did not start as a philanthropical institution, although it is altruistic in the extreme. It did not start in the interest of religion, although it observes more than any other business the foundation of all religion—the Golden Rule. It is one of the assets of our nation. It is one of the greatest schools that ever was known for education, patriotic and otherwise. The amateurs constitute a reservoir from which trained operators and technicians must come in times of national emergency. They are working in close cooperation with our Army and Navy radio departments. They and their stations are a public utility of untold value in times of flood, storm and earthquake when all other means of communication are disrupted. They are transmitting and delivering countless messages for our people throughout the United States; they have provided a great domestic communications service. They render innumerable services that commercial stations could not perform if they would, and would not if they could. They are handling thousands of messages for our people in foreign lands who would not otherwise be able to communicate with their families and friends in times of illness, in times of tragedy and in times of rejoicing.

So here we have a body of men (whose technical education and training has cost them much, whose stations have cost them millions of dollars, and whose time and labor have an enormous money value), running a great public-service business absolutely free of cost to its beneficiaries. Now, isn't this something new on earth!

These non-commercial radio men, being pioneers in both thought and action, have blazed the thorny path that is the fate of all pioneers. Big Business has resented this, and tried systematically to deprive them of their resources. It, and its supporters, are declaring that amateur stations should not transmit messages for the public. The amateurs therefore have been systematically forced from the air and left with only narrow bands for their activities while great areas of the air are being held by Big Business but lie wholly unused. And all because somebody wanted to transmit messages by radio and charge for the service. Which is just like saying that non-commercial automobiles should have only meagre use of the public roads because trucks and motor-stages might at times wish to use them for profit. The amateurs have had the same experience as all other people who ever came into even remote or fancied competition with Big Business.

But Big Business is now having the law laid down to it. It is being forced, willy-nilly, to have regard for something besides its great, greedy, impersonal self. The public is aroused as never before; and when the people themselves feel impelled to act in their own behalf special interests get short shrift. Therein lies the hope of the amateurs, for they have the support of the people. Forty thousand amateurs (and the number growing by the minute), banded together by the ties of partnership and fellowship, all of their families and friends, and the thousands of the public who are the beneficiaries of amateur message service, make up a staggering

(Continued on page 19)

Cathode Ray Television

By ARTHUR H. HALLORAN

PART III

Fig. 2 is a diagram of a typical receiving tube and should make any further explanation unnecessary. There are slight differences in the different makes of tubes which will be sold to accomplish the same purpose. Some of them employ a different form of electron gun. Some of them use electrostatic instead of electromagnetic deflection of the cathode ray. In one type the image on the end of the tube is so brilliant that it can be projected as a bright image on an external screen of the size ordinarily used for home movies. But in most, if not all, of the first receivers to be put on the market the image will appear on the end of the cathode-ray tube, covering an area of about 50 square inches.

Synchronization

Each receiver is automatically synchronized with the transmitter by means of 24-cycle and 6000-cycle pulses which are mixed with the picture currents at the transmitter. These pulses are generated at the transmitter by means of specially designed vacuum tube oscillators. Part of the oscillator output is fed to the scanning coils of the pick-up tube and part of it is used to modulate the carrier.

Part of the received picture current is fed directly to the grid of the cathode-ray tube, where it is effective in varying the intensity of the cathode ray, as already described, and part of it is used to control local 20 and 6000 cycle oscillators in each receiver. Control is exercised through an auxiliary grid in a special four-element tube. Three of the elements with their associated circuits generate a sawtooth current of either 20 or 6000 cycles, approximately. The fourth element controls the oscillator output so that it is exactly 20 or 6000 cycles, as the case may be, and is exactly in step with the scanning current at the transmitter. The 20 and 6000 cycle currents are then fed to the vertical and horizontal deflecting coils respectively.

The receiver oscillating circuits are so designed that they not only supply sawtooth current to the deflecting coils but also supply a practically uni-directional high voltage to the anode of the cathode ray tube. This obviates the need for a separate high-voltage rectifier system for the cathode-ray tube and insures that the cathode ray is not acting unless the deflecting currents are acting at the same time. Otherwise there is a possibility that the stationary ray might burn a spot in the fluorescent screen.

This all-too-brief outline of the working principles of tomorrow's television equipment necessarily touches only the high spots of the subject. It omits all reference and credit to the individual scientists and inventors who have patiently been working to this end for many years. Long ages before man was able to see what was happening at distant places he invoked the aid of magic mirrors and supernatural powers to satisfy his innate desire. But he made no actual progress, and it remained for the modern physicist, first to exercise his imagination about the real nature of the forces and substances which he harnesses to do his will, and then to prove by experiment that his hypotheses are correct. Guided by the knowledge of a possibility, he devises the mechanisms for making it an acuality. Instead of magic mirrors he employs far more wonderful types of vacuum tubes. Instead of invoking supernatural powers, he utilizes the power developed in the modern research laboratory.

The present equipment is only a beginning. Patents have already been granted for the production of pictures in natural colors instead of black and white. It is not unreasonable to believe that means will be devised for narrow-band transmission of multi-element pictures, thus making long-distance reception possible either over wires or through radio channels in the short-wave rather than the ultra-short-wave portion of the spectrum. We are on the verge of a new era where today's science is being engineered for tomorrow's sales.

That "tomorrow" of television has been as elusive as the "tomorrow" of prosperity's return. We cannot say just when tomorrow will become "today,' but believe that the two the time can now be measured in months rather than in years.

WITH television so close at hand, many radio men are interested in preparing themselves for its advent. While there are as yet few picture-broadcasting stations on the air and the expense of installing an amateur television transmitter is prohibitive, even if the amateur possessed the requisite technical knowledge, there are several ways in which an amateur can perfect himself in this subject.

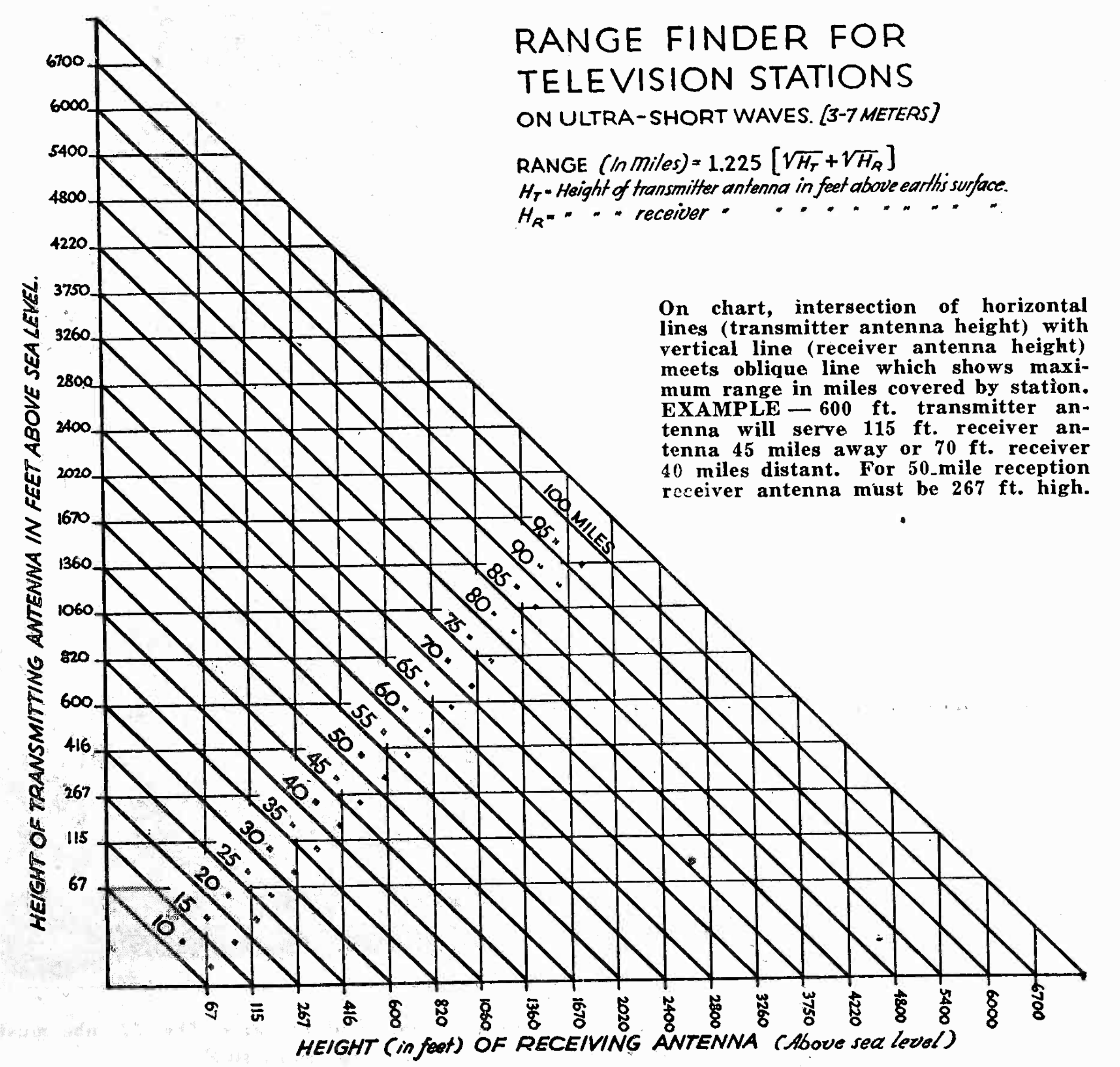
The greatest immediate contribution that he can make to the art is in experimenting with ultra-short wave transmission and reception, for the first service to the public will be along the broad channels which are available only in the ultra-high frequencies in the neighborhood of 60 megacycles (5 meters). Past experience and theory tend to indicate that such transmissions cannot be received beyond the horizon which is established by the tops of transmitting and receiving aerials. This fact places a premium on a high antenna, as indicated in the accompanying diagram or range-finder for television stations.

Yet there have been enough "freak" longer-distance receptions to raise some question as to the validity of horizon-limitations of 5-meter transmissions. While these are fully in accord with the accepted theory and results, it is worthy of the investigation which amateurs can so successfully conduct. Furthermore such investigations can aid the further extension of amateur code and phone transmission into the ultra-short wave region.

Nothing but the equivalent of the knowledge imparted during a specialized college course in mathematics and physics will suffice for a complete understanding of all the principles which underlie the operation of television equipment employing cathode-ray tubes. Knowledge of the principles of radio is helpful, in fact essential, but this is only a beginning. Television signals consist of transients of extremely short duration. This nature and their action in circuits, especially filter circuits, cannot be predicted by the mathematics ordinarily employed for radio calculations. So a more advanced type of mathematics is required.

The general subject of optics, including especially the laws of photoelectric action, must be completely mastered both as to theory and practice. Then there is the technique of

(Continued on page 15)



Modern 1934 Two-Tube Receiver

Complete Details for Building a Hum-Free AC Receiver In Which Is Combined All of the Many Features That Make for Better Results

By CLAYTON F. BANE, W6WB

A MISTAKEN opinion exists that the simple little detector and one audio receiver is markedly inferior in sensitivity to the superheterodyne and TRF types. This may have been true of the small receivers a number of years ago, when high-gain tubes were not available, but it does not hold true today. Certainly, no one can question the superiority of the super from the standpoint of providing a degree of selectivity impossible to obtain with any other type of receiver. The super, with its RF gain after the detector circuit, is also the answer to the phone reception question. In this regard, our simple receiver can claim no laurels; the gain going to smash as soon as the set is operated below the regeneration point. However, a super is "out", in many cases, because of the cost, to say nothing of the difficulty of getting it to work properly. It is therefore the purpose of this article to present a small, compact two-tuber that incorporates several excellent features.

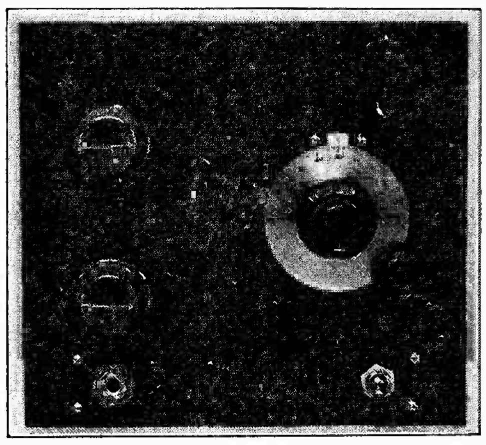
At this point, a comparison of receivers using tuned-radio-frequency and those not using it, may be in order. In the writer's belief, the small receiver is really better off without TRF ahead of the detector. In a receiver of this type, grid-leak detection is practically essential. A little thought will show that when the detector is so operated, it will work best on weak signals and not so good on strong ones. If the receiver of this type is desired for use in a location where there are no strong locals to cause trouble, undeniably, TRF might be of real worth. Such an ideal situation rarely (if ever) exists. What is more likely to happen is that a half-dozen strong locals are on the air at almost every moment of the day. With a TRF stage running wide open, the resulting strong signal from the RF stage will cause the detector to block-up over a large portion of the band. The solution for this condition is to put a gain control in the RF stage to keep the gain down to the grid of the detector. Logically now, why add additional gain and then add a control to cut that gain down, or even completely out? Admitted that the RF stage acts as a coupling tube, and also prevents re-radiation, yet it will do both when operated as an untuned stage. Why tune it at all?

Tubes

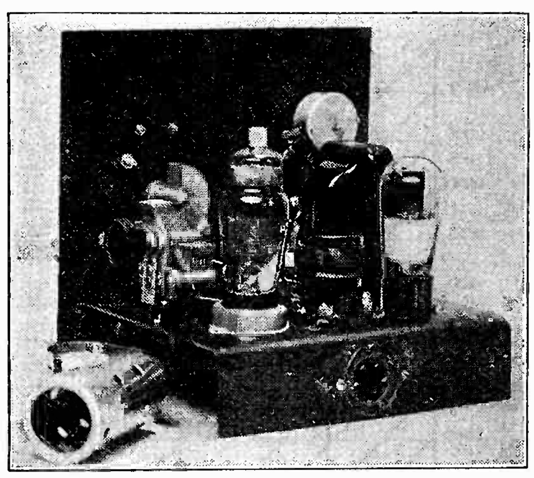
TUBES of the type 57-77 are admirably suited for detectors, and their audio output is so much greater than their predecessor, the '24, that their use is almost equivalent to the use of an additional stage of audio. This feature, coupled with the fact that they have a greater sensitivity to weak signals, allows the use of a single audio stage, while still providing so much audio output that a gain control is necessary for comfortable ear-phone reception.

Stability

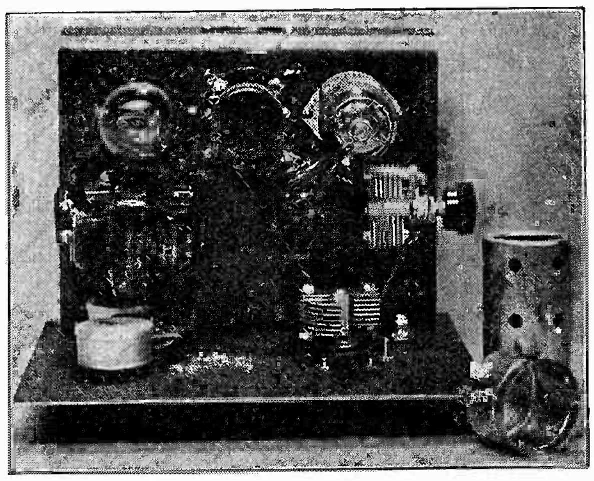
LACK of stability has made the use of the conventional autodyne circuit undesirable. This circuit had very little, if any, stability as an oscillator. Quite naturally, no signal can be more steady than the detector itself, and much of the creeping sometimes blamed on the transmitting station originated in the receiver. A separate electron-coupled oscillator to be at the incoming signal is, without question, the best solution to this particular problem. It is, however, not the simplest. If the detector circuit itself is made an electron-coupled circuit, practically all trouble from creeping will be removed.



Front view, showing Vernier Tuning Dial and Volume and Regeneration Controls. The regeneration control and phone plug must be insulated from the front panel by use of conventional insulating washers.



Rear view. Note placement of Band-Spread Condenser. This condenser must be insulated from the metal chassis deck



Correct placement of parts. The '57 tube must be totally shielded

Sensitivity

THERE is not a great deal that can be done in the autodyne detector to increase its selectivity, but most certainly some methods of adjustment and operation are infinitely superior to others. The condition that will help the most is proper adjustment of the antenna coupling to the detector grid circuit. There is little need for using close coupling in any case, the best results being obtained by the use of a large antenna and very loose coupling. Even the use of a two-plate midget was found to be excessive in a number of cases. The coupling condenser finally adopted was the simple expedient of twisting the antenna lead about an inch-and-a-half along the lead coming from the grid circuit of the tube. Both wires were, of course, insulated. Also contributing to the effective selectivity is the grid condenser. It has been found that the value ordinarily used (.00025), is somewhat in excess of the proper value. The larger value causes the detector to block very easily on loud signals, but this trouble disappeared, to a great extent, when the condenser was replaced by one with a value of .0001. If the receiver is to be completely shielded, the use of a tuned trap in the antenna circuit will sometimes be very effective. This stunt is a good one to use for reducing QRM from locals, but has the disadvantage of having to be tuned, thereby adding another control. In our receiver, grid-leak detection is greatly to be preferred over power detection, because with grid detection, the response to weak signals is considerably greater than with plate detection. Power detection is, in reality, the best type of detection for all-around use, but must be preceded by a stage of tuned RF in order to bring up the gain on weak signals.

Regeneration

VARIOUS systems of controlling regeneration have been tried, but the time-proven method of varying the screen voltage has been found to be more satisfactory than any of the others. In the circuit used for the receiver here described, this method of regeneration control has one slight disadvantage, in that changing the screen voltage changes the oscillating frequency of the receiver by a very small amount. This change is really negligible. It was felt that the smoothness of control more than off-set the slight shift. The regeneration control in this receiver works so smoothly that it hardly has to be touched while tuning over the amateur bands.

Band-Spreading

BAND-SPREAD of some sort is an essential refinement for any short-wave receiver. This receiver uses a condenser in series with the main tuning condenser to obtain proper spread. It allows the use of a large tuning condenser (.0001), which is somewhat of an advantage because the average run of condensers is around this size. The use of a large tuning condenser is of a further advantage in that the band-spread condenser may be shorted out, and the large tuning condenser used to cover a large amount of territory. This would hardly be possible if the tuning condenser were a very small one, such as is generally used for band-spread. With the series arrangement, the bands can be covered up to 100 dial degrees, with no difficulty whatsoever. The only thing to bear in mind is to follow the table shown for the coil windings. These coils have been designed to allow up to about 60 degrees dial spread, while still covering the amateur bands on the scale. Remember that the band-spread condenser is above ground, and must be insulated from the chassis. A small bakelite block to hold the condenser and fasten it to the sub-base will do the job very nicely. (See illustration for details).

The Audio Stage

EITHER a 56 or a 37 can be used for the audio tube, but the 56 will give somewhat better results due to its slightly higher gain. The 37 has practically identical characteristics with our old friend, the 27. Either the 56 or the 37 will give ample gain for earphone reception. This is a conservative statement, because at the writer's location, stations three and four thousand miles away were brought in on the speaker with good volume. Of course, a larger tube could be used for the audio, to allow real speaker reception, if desired. Some tube such as the 2A5 might have been used, but this was not considered advisable, because this tube requires some sort of an output transformer, and this refinement was not considered economical or at all necessary. A 250,000 ohm resistor from the audio tube grid to ground serves as the volume control, in addition to providing a path for the C-Bias. Do not consider using a higher resistance than that recommended, because it will allow the very bothersome fringe howl to pop up, yet the gain will show no increase.

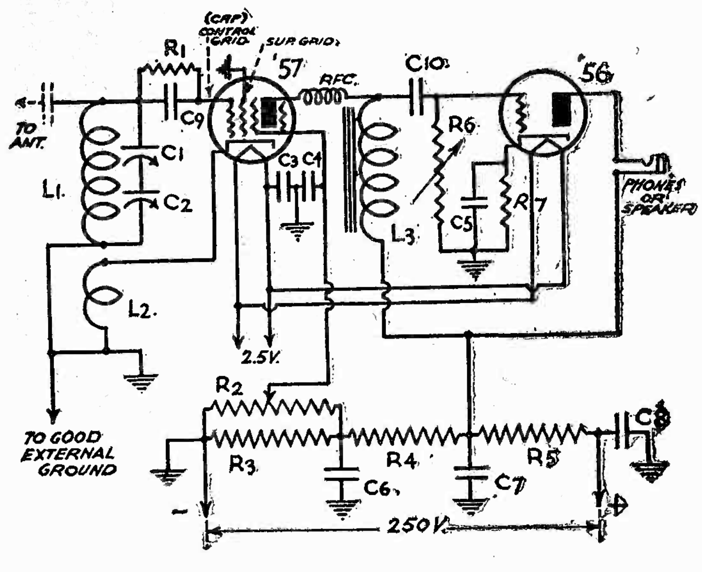
Filament and Plate Supply

THIS type of receiver can be operated with AC on the filaments and B supply on the plates, without the slightest trace of hum. In the first place, the detector tube must be completely shielded. I do not mean the use of the type of shield that merely covers the tube to the top of the plate structure. The shield must completely cover the tube; grid and all. All grid leads must be kept away from AC leads, and it is a splendid idea to make every effort to keep the length of these leads down to an absolute minimum. It is well to remember that the various leads from the B strip must be by-passed to ground with a good-sized condenser, not forgetting the by-pass from the positive end of the strip to ground. Since this positive end has no lead from the output socket to the tube socket to the set it is very apt to be overlooked, with the result that the hum may persist, even when all other sources are run to earth (figuratively and literally!). The filament leads should, of course, be twisted in the conventional manner. It is also well to use a center-tapped resistor across the filament leads, with the center tap going to ground. The final step in hum elimination is to provide a good external ground to the chassis of the receiver. This is extremely important. Assuming that the power supply is properly filtered, no hum whatsoever should be experienced.

A switch in the negative lead will save the operator many a nasty jolt when he has his hand down in the "works", making minor changes and adjustments. This switch is practically indispensable to the transmitting man, because it is used to cut-off the receiver when transmitting.

As the illustrations show, the volume control, regeneration control, main tuning dial, switch and phone jack are all brought out to the panel. This panel is seven inches high and eight-and-one-half inches long. The sub-panel is seven inches long, six inches wide, and the flanges are one-and-three-quarter inches deep. The material is black iron, 16 gauge, and can be cadmium plated. The panel and chassis can be cut and bent by your favorite sheet metal shop; the cadmium plating is not at all expensive.

In conclusion, perhaps the most important point to remember is to follow, exactly, the arrangement of parts as shown in the various illustrations. A great deal of time and consideration was devoted to this phase, and the author believes that the extremely successful performance of this little receiver is due in no small part to this minute attention to small details.



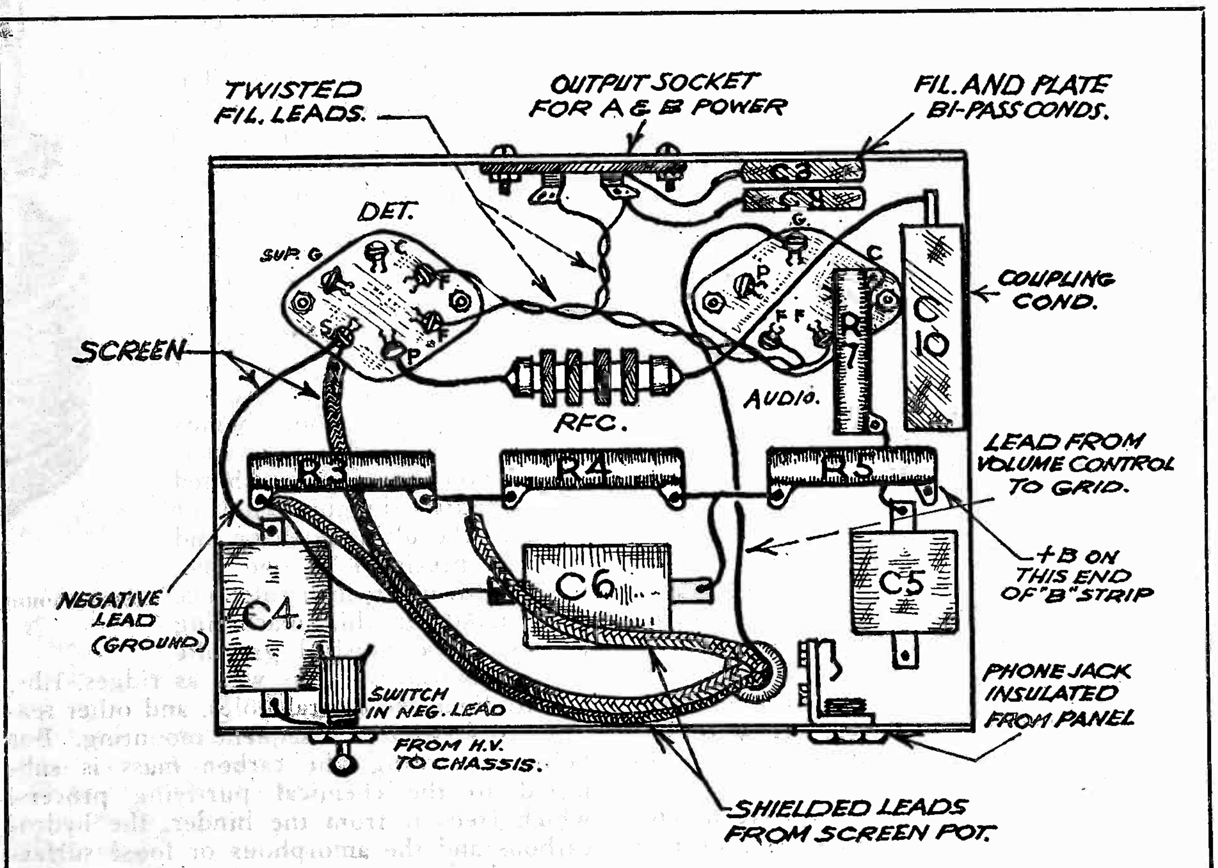
C1 = 100 mmf. variable, Hammarlund
C2 = 100 mmf. variable, Hammarlund
C3 = .01 mfd.—300 v.
C4 = .01 mfd.—300 v.
C5 = 0.1 mfd.—300 v.
C6 = 0.1 mfd.—300 v.
C7 = 0.1 mfd.—300 v.
C8 = 0.1 mfd.—300 v.
C9 = .0001 Sangamo-Mica
C10 = 0.5 mfd.—300 v.
R1 = 1 meg.—this can be 2 meg. to suit tube.
R2 = 50,000 ohm Potentiometer, Electrad
R3 = 10,000 ohm—1 watt. Ohmite
R4 = 10,000 ohm—1 watt Ohmite
R5 = 5,000 ohm—1 watt. Ohmite
R6 = 250,000 ohm—variable, Electrad
R7 = 2000 ohms—1 watt. Ohmite

Wound on standard 4-prong tube base:
L1 = 20 meters, 7 turns, #22 D.C.C.
40 meters, 15 turns, #22 D.C.C., close wound
80 meters, 30 turns, #22 D.C.C., close wound
L2 = 20 meters, 4 turns #22 D.C.C. spaced 1/8" from L1
40 meters, 4 turns #22 D.C.C. spaced 3/8" from L1
80 meters, 4 turns #22 D.C.C. spaced 3/8" from L1
(Space closer if necessary to overcome antenna or R.F.C. resonance)

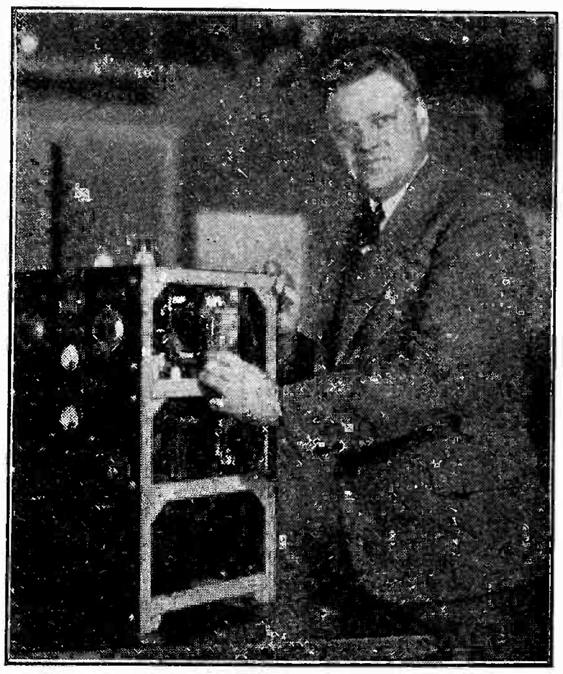
R.F.C. = Any good short-wave choke
L3 = 100 henry audio impedance

Antenna coupled to grid coil through small condenser made by twisting antenna lead into grid lead, the length of twist to be determined by desired selectivity and avoidance of antenna resonance (dead spots). Both wires to be insulated separately and from each other.

1—Dial. General Radio 502, with vernier
1—56 Tube, National Union
1—57 Tube, National Union
1—Tube Shield, Insuline Corp.
1—G.R. above Panel Mount Socket, 4-Prong
2—5-Prong Cinch Wafer Sockets
1—6-Prong Cinch Wafer Socket



Showing proper placement of small parts under the chassis deck. This arrangement should be rigidly adhered to if best results are desired.



Mr. D. E. Replogle, Chief Engineer, Electronics Department, Hygrade Sylvania Corporation, has in his hand a new Sylvania thoriated tungsten 210 tube which uses the new graphite anode. He has just taken it from a Sylvania ultra high frequency (3240 mcs.) portable transmitter used for police work.

The Graphite Anode Tube

Practical Application of Perfect Black Body for Greater Heat Radiation Introduces Several Striking Improvements in Transmitting Practice

By D. E. REPLOGLE
Chief Engineer, Electronics Department, Hygrade Sylvania Corporation

BY substituting pure graphite for the nickle or molybdenum usually employed for the anode, a new tube construction is contributing several striking improvements to transmitting practice. The graphite anode tube now available in all standard types of air-cooled Sylvania transmitting tubes, from the small 210 oscillator and amplifier to the large 851 modulator or audio-frequency amplifier, marks a distinct advance in the tube art; indeed, it is one of the outstanding developments since the introduction of the thoriated tungsten filament several years ago.

The primary object of the pure graphite anode is greater heat dissipation. Carbon presents that perfect black body which, in theory at least, is regarded as the ideal heat radiator. When used for the anode or plate of the transmitting tube, the graphite mass dissipates, more rapidly than is the case with the usual metal, the intense heat generated by the impact of electrons on its surface. There are secondary objects, too, discussed further on.

Tube builders have long realized the advantages to be gained by incorporating a satisfactory graphite anode, yet many practical problems have interfered with theoretical gains. Some of the attempts to introduce carbon for the anode have been along the line of coating a metal plate with graphite, producing the so-called carbonized plates. Certain receiving set amplifier tubes are of this category. However, due to the retention of a mass of metal for the graphite coating support, the theoretical advantages of a pure black body have not been fully realized.

Other attempts have been along the line of a solid carbon anode, usually assembled from several sections or segments. High contact resistance between such sections or segments has proved objectionable. But of greater import has been the impurities and loose or amorphous carbon particles deposited on the inside of the glass bulb, actually reducing the heat radiation of the tube and consequently defeating the very purpose of the carbon anode. Also, the impurities and amorphous carbon particles have been deposited on the glass press and spacers, causing serious leakage troubles.

Ordinary carbon anode tubes have heretofore proven impracticable for the reason that the carbon mass introduced impurities and carbon dust in the tube during bombardment and exhaust, as well as in subsequent service.

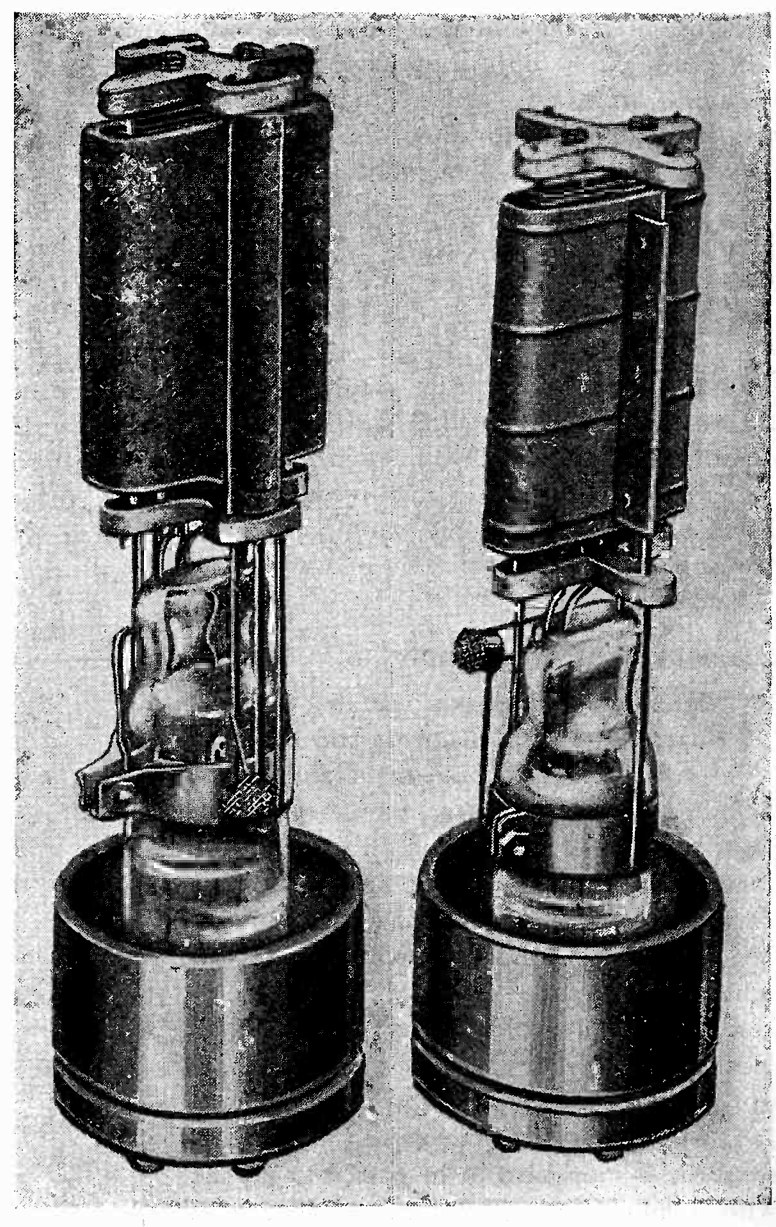
Quite obviously, it is essential to purify the carbon mass to remove the binder, the hydrocarbons, and the amorphous carbon or loose surface layer, before mounting the anode in the tube. How to purify the commercial carbon has, until quite recently, remained a chemical riddle.

When deciding upon a complete line of transmitting tubes, we sought to make some outstanding contribution to the tube art. The anode seemed to be a troublesome element, hence we concentrated our research and development efforts on that feature. A carbon anode was decided upon, and the problem of purifying commercial carbon prior to mounting in the tube was assigned to our assistant chief engineer, Victor O. Allen, who has long specialized in filaments, oxide coatings, getters and other tube chemistry features. The subject was not altogether new to Mr. Allen, although he had never concentrated on the problems involved. Putting in solid weeks of tireless research on carbon purification, however, he soon announced a practical method of purifying commercial carbon, reducing it to the graphite form. Experimental tubes were built and subjected to gruelling laboratory tests. The proof that Mr. Allen had really solved the problem and that a new milestone was being passed in tube development history, was fully established. Subsequent reports from broadcasters, amateurs, government stations and others employing the regular production graphite anode tubes have fully borne out our original laboratory findings.

The graphite anode begins with a solid block of commercial carbon, which is machined by specialists in this kind of work to the ultimate shape and size. A precision of one one-thousandth of an inch tolerance is attained in this machining process. The finished graphite anode has thin walls as well as ridges, ribs, longitudinal and lateral holes, and other features to facilitate subsequent mounting. But before mounting, the carbon mass is subjected to the chemical purifying process, which frees it from the binder, the hydrocarbons and the amorphous or loose surfacing carbon, converting it into the graphite anode.

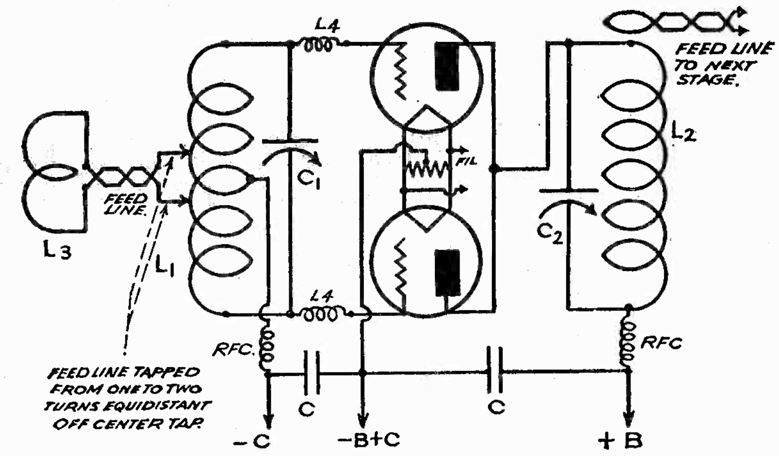
The graphite anode is mounted in the tube stem assembly by means of rods, screws and nuts, in a thoroughly mechanic-like manner. A minimum of supporting metal is required, since graphite even at glowing temperatures will not warp or get out of plane, as contrasted with nickel or molybdenum plates which must be rigidly braced in the effort to overcome the warpage. During bombardment, the pure graphite anode gives off only the occluded gases and water vapor which may still reside in its pores, there being no impurities left. Also, because of the exceptionally high volatilization point of graphite which is not attained in customary bombardment, there is no spattering of anode material as is frequently the case with metal anodes. Thus the inside of the glass envelope remains absolutely clean and free to transfer heat through the glass to the surrounding air. Upon cooling,

(Continued on page 31)



Stem mount of the old and new type 211 tube. The graphite anode structure is shown at the left.

Double or Nothing



Circuit Diagram for Extremely Efficient "PUSH-PUSH" Doubler

Practical Application of the "Push-Push" Circuit for Maximum Efficiency

By CLAYTON F. BANE, W6WB

NO stage in a crystal controlled transmitter can cause more trouble than the frequency multiplying stage, when it is not working properly. The output from doubler stages very largely determines the amount of excitation to the final amplifier, so it is extremely important that they are designed to work properly. Just what does the term "Doubler" mean?

A "Doubler" is an amplifier stage, so operated that the frequency applied to the grid circuit appears in the output plate tank at twice or "Double" this frequency. In other words, "Doublers", "Triplers", or "Quadruplers' are merely frequency multiplying amplifiers. They do not have to be neutralized, because the voltage in the plate circuit is at a different frequency from that in the grid circuit, and feedback cannot occur. These frequency multipliers fall into two general classes: Grid Distortion and Plate Distortion amplifiers. There are a dozen variations, but all of them are based on the use of one or the other system. Let us now devote a few remarks to clear up these evil sounding names.

For purposes of illustration consider our old friend, the characteristic curve. Assume that the voltage applied to the grid is a pure sine wave, and is of such amplitude that the plate current will be confined to the straight portion of the curve. In other words, pure Class A. The output of the plate circuit will also be a pure sine wave, showing a linear relation between the grid voltage and the plate current. This pure sine wave will have no harmonic content and is utterly useless for our purpose, as we will presently see. If we now bias our vacuum tube to a value somewhat below cutoff, while still maintaining the pure sine wave in the grid excitation voltage, we will see that our output wave shape bears not the slightest resemblance to the grid wave shape. We have destroyed the linearity between the two and our output is now strong in harmonic content. It is this very harmonic content that we use in our plate system frequency multipliers. A tank in the plate circuit, offering a maximum impedance to the desired harmonic, will be given a "kick" at intervals corresponding to the desired harmonic, and will consequently be set into oscillation at the harmonic frequency. Grid multiplying takes advantage of the nonlinearity between the grid current and grid voltage. That is to say, if the grid excitation voltage is allowed to go into the positive region by a small amount, grid current will flow. This grid current flows in a series of impulses, none of which flow for more than a fraction of a half cycle, and consequently is extremely rich in harmonics. If a tank is inserted in the grid circuit which offers a maximum impedance to the desired harmonic, a voltage will be set up across this tank at the harmonic frequency. If the plate tank is also tuned to this same frequency, the tube may work as an ordinary amplifier. This system is particularly efficacious where the harmonic to be obtained is of a high order; as for instance, the fifteenth. Appreciable power can be obtained on harmonics well up to the thirtieth. This system, however, is not well suited to amateur practice, because the amount of power obtainable is, at best, not very great. The plate system is to be preferred for low-order harmonics, such as the second and third; the power being greater than that obtainable with the grid system. However, neither is ideally suited to furnish large amounts of power, due mainly to the fact that the plate dissipation incurred in the production of the harmonics is such as to be prohibitive. Efficiencies in the order of 20 or 25% are the rule rather than the exception. All of which brings us to a consideration of the various adaptations suited to amateur use.

CONSTANTS FOR "PUSH-PUSH" CIRCUIT

(See Diagram at top of page)

L1—For use with an 80-meter crystal, doubling to 40 meters, wind 30 turns of #14 wire, spaced diameter of wire, on a 2½" form. For use with a 40-meter crystal, doubling to 20 meters, wind 16 turns of #14 wire, spaced diameter of wire, on a 2½" form.

L2—For 40 meters, wind 16 turns #14 wire, spaced diameter of wire, on a 2½" form. For 20 meters, wind 8 turns #14 wire, spaced diameter of wire, on a 2½" form.

L3—Two turns coupling coil, wound with #18 rubber covered wire, 3" diameter.

L4—Parasitic Chokes, 5 turns #18 wire on ½" form, spaced two diameters of wire.

C1—50 to 100 mmf.
C2—50 to 100 mmf.
C —.006 Sangamo mica condenser.
CT—Center-Tapped Resistor, 50 ohms each side of center tap.
RFC—Three section, scramble wound.

A doubler in most amateur stations operates in about the worst possible manner to give its maximum amount of output. Quite a broad statement, but only too true. For instance, does your doubler draw grid current? It should draw practically none. You can't combine grid, plate and goodness-knows-what-other, doubling systems. If you are going to use plate doubling, here are the necessary requirements. The crystal oscillator plate circuit should have a fair amount of "C" in order to suppress the harmonics. The doubler should not be allowed to draw more than the few mills grid current necessary to show that is being properly excited. The plate voltage of the doubler should be as high as the tube insulation and dissipation will permit. The tube should be biased to a point slightly below cutoff. It should be remembered that if you want to triple or quadruple, the bias must be considerably greater than when working as a doubler. The higher order harmonics increase as the bias is increased, but of course the amplitude is correspondingly less as the order increases. If possible, do not use shunt-grid-feed, but rather some sort of inductive coupling with series-feed. While on this subject, let us mention that the tuned tank in the grid circuit, should be tuned to the fundamental frequency of the exciting source. If you want to use grid multiplying, tune the grid tank to the desired harmonic. Remember, in this case, both the grid and plate tanks are on the same frequency, and oscillation is inevitable unless neutralization is provided. Suitable tubes for these two systems are the 865, 841, 46, 210, 59 and 47, listed in the order named, according to their ability to do a good job, and their power handling ability.

Any frequency multiplier circuit will do a much better job if it is neutralized. By the same token, it will do a still better job if made regenerative. This can be done in a number of ways, though perhaps the simplest is to adjust the so-called neutralizing inductance and capacity until the maximum output is obtained. A variation of the ultra-audion circuit is being used with considerable success. More often than not, this ultra-audion effect is present in many doublers, and explains why Jim Smith's doubler apparently works rings around Henry Blotzs' . . . Some doublers show an aptitude for taking off on their own account for no apparent reason. The reason may lie in this previously mentioned effect, or may well be caused by a resonant choke in the grid circuit. Watch both!

The electron-coupled circuit is particularly adaptable to doubler circuits because of its inherent ability to give very strong harmonics. This was taken advantage of in the little ten-meter phone described in September "RADIO", and has lately come in for a great deal of favor for use as a crystal oscillator with high harmonic output. It is the opinion of the writer that if the harmonic content from the crystal oscillator could be made to approximate 60 to 80% of the fundamental, doubling would practically be obsolete. In this case, the buffer could be excited directly from the second harmonic of the crystal and the doubler eliminated entirely. Until such time as new tubes are developed for use as crystal oscillator tubes, with very low radio frequency grid current (across the crystal), and large power handling ability, this idea is

(Continued on page 28)

A 5 to 200 Meter Receiver that Has a Novel Power Supply, Unique Detector and Audio System, and Other Innovations

By FRANK C. JONES

Analysis of the new "Western Wireless" Product

THIS new receiver was designed to meet several requirements which have always seemed desirable to the writer. In the first place, few amateurs are able to make use of more than one or two of the short-wave bands which are at their disposal, thus missing a great deal of pleasure. Amateur activity on the different bands from 5 to 175 meters varies with the seasons of the year, and also to a great extent on the so-called "11 year cycle" period. A desirable set would be one that is simple to operate and could be used satisfactorily on any and all of the six amateur bands from 5 to 175 meters.

The above requirements are met in a new receiver herein described. Since this receiver functions on all of the bands, it is more universal in its applications for amateur use. It is possible to QSY to any amateur band by means of plug-in coils, one per band. The circuit is such that either regeneration or super-regeneration can be used on the 5 and 10-meter bands, and regeneration on the 20, 40, 80, and 160-meter bands. Band-spread tuning is available on any of the bands, or between bands from 10 to 200 meters, since the tuning coverage is complete.

In designing a receiver for use on all of these bands, there are several considerations involved. A super-heterodyne set, with or without a quartz crystal filter, is usually desirable in the 40 and 80-meter bands because of its superior selectivity. However, the cost is high and the receiver cannot be used successfully on the 5 and 10-meter bands for general amateur work. T.R.F. sets can be used on the longer wavelengths to obtain more sensitivity, and they give slightly greater selectivity than can be obtained with a plain regenerative detector. However, on 5 and 10 meters the gain of an RF amplifier is practically nil; usually true even on 20 meters. On 40 and 80 meters a T.R.F. (tuned-radio-frequency) stage can be more troublesome than it is worth, unless precautions are taken. A volume or sensitivity control is necessary to prevent strong signals or key clicks from overloading and locking up the regenerative detector. Variation of this control always has a slight effect on the tuning of the detector. The actual signal selectivity of a T.R.F. stage is about nil; in general an RF stage is liable to be undesirable and in most locations it is unnecessary.

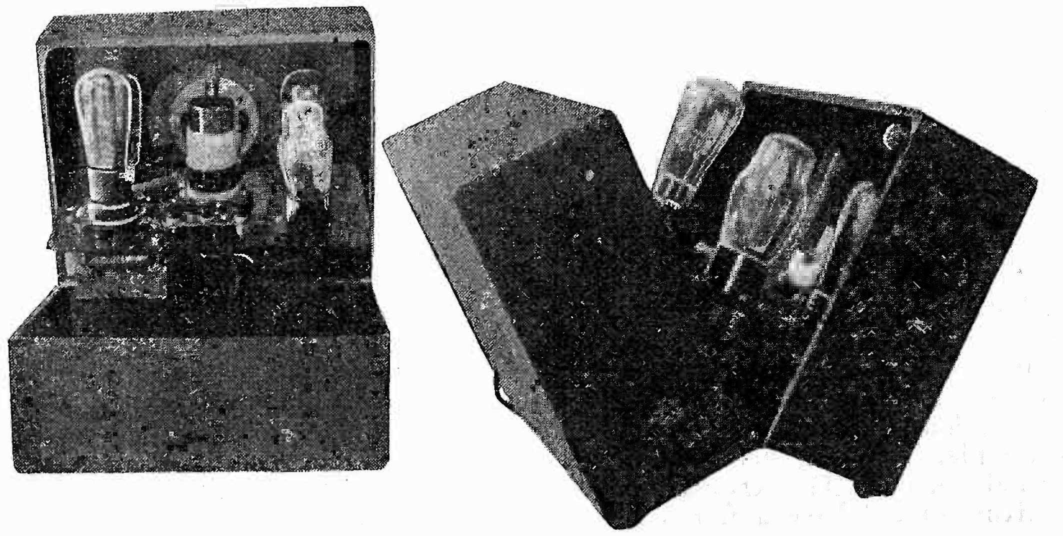
A really good regenerative detector has a gain of several thousand times on weak signals and thus a gain of 5 or 10 through an RF stage is usually unnecessary, unless the noise level is exceedingly low. Raising the RF gain usually means automatically reducing the detector sensitivity, so there is nothing gained. A good regenerative detector can be made to super-regenerate and thus give a great increase in sensitivity on 5 and 10-meter phone signals. A good regenerative detector can make about 4 out of 5 superheterodynes appear sick when it comes to receiving weak CW signals on 10 and even 20 meters. It will give a super a good race even on 40 and 80 meters, and many DX records are made with regenerative detector sets. The fellows that really hear those foreign DX stations in most cases depend on practice and ear sensitivity to weak signals, rather than the use of a multi-tube receiver with high noise level and loudspeaker output.

Another desirable feature is complete AC operation of the receiver; that is, no batteries of any kind to worry about. AC operation means special precautions must be taken to eliminate AC hum, and to eliminate variation of signal strength or CW beat note when fluctuations occur in the AC line supply. Elimination of AC hum means good filtering and careful placement of transformers and chokes. In this receiver no audio transformers or filter chokes are used, and the current drain is low enough so that a very effective resistance filter can be used. The cause it proved to be more satisfactory than any other type, even a screen-grid tube. Analysis of a screen-grid tube detector showed that in the usual form of electron-coupled detector there is a triode tube detector coupled electronically to the tetrode audio amplifier part of the tube. In other words, the reason for the supposed superiority of a grid-leak type screen-grid detector was in the fact that there is more audio amplification in the tube itself. In grid leak detection, the detection is in the grid circuit and the tube acts also as an audio amplifier. The screen-grid type gives more audio amplification and possibly slightly better detection efficiency than a type 27 or 37 triode tube.

Practical tests seem to show that the type 56 tube has a better grid-leak detection efficiency than even a screen-grid tube, but not as much audio amplification. This condition was easily remedied by using an additional resistance-coupled 56 audio amplifier. The detector circuit is rather novel in that the plate is grounded by a .006 mfd. condenser and the cathode is tapped part way up the grid coil, as in an electron-coupled oscillator. This type of oscillator gives a much more uniform regenerative control over a large tuning range than the more usual form of a separate plate tickler winding. It also adapts itself readily to 5 and 10-meter super-regeneration. The tuning condenser rotors are at ground potential, even on 5 meters, which is desirable both electrically and mechanically.

From about 13 meters up to 200 meters, the plug-in coil connections are such that the cathode tap gives regeneration . . . not super-regeneration, and the 100 mmfd tuning condenser, C2 is shunted across the band-spread tuning condenser C3. The latter is the main tuning control, and C2 is set at whatever band is desired within the coil range. The use of C2 allows the reception of commercial CW or phone stations between any of the amateur bands with, of course, vernier tuning by means of C3. By proportioning the coil turns properly, C2 is set for the amateur bands so that C3 tunes nearly over the whole scale to cover the band. Since nearly the whole 100 mmfd of C2 is used on the 20 and 40-meter bands, the detector circuit is fairly high C, which has certain advantages. The detector stability is much better than with high L (inductance) and low C so that pure CW notes sound pure and not wobbly. The detector oscillation is stabilized so that a strong signal does not tend to pull the tube into zero beat, as with low C circuits. This effect is the familiar "detector locking effect" and is nearly absent in this receiver. By disconnecting the antenna lead it is possible to use the set as an actual monitor even on a powerful transmitter.

On 5 and 10 meters the plug-in coils automatically disconnect the padding condenser C2 and reduce the coupling to the antenna. C2 should be set at zero or minimum capacity. The antenna coupling has to be very loose on these bands. Thus there is an additional series capacity to the grid end of the coil,



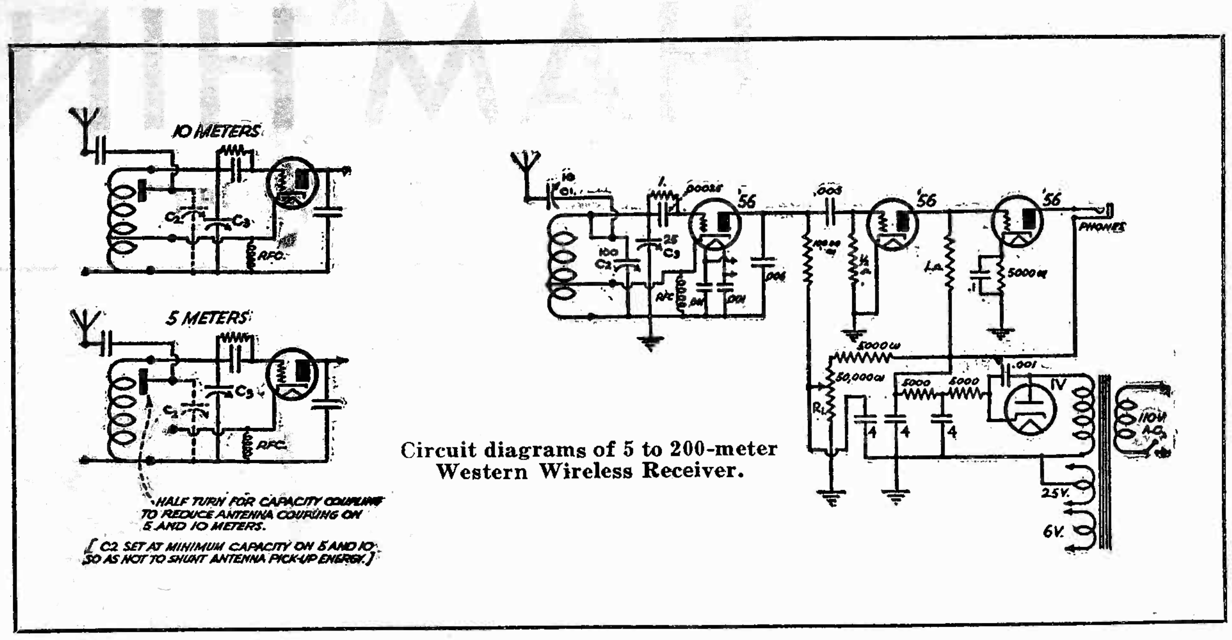
Interior views of the new Western Wireless 5 to 200 meter short wave receiver and monitor. It is housed in a ¼-in. cast aluminum case, so constructed that it opens like a purse, thus making for simplicity and rapidity of coil changing.

result is practically no hum at all, even with the set and power pack enclosed in a small cast aluminum cabinet 6-in. x 7-in. x 9in.

The receiver consists of a regenerative detector, two low-gain audio stages and power pack. The detector uses a type 56 tube, be- which reduces the antenna coupling so that the detector will properly super-regenerate. On 5 meters the coil has no cathode tap, the tube capacities giving the necessary feedback for super-regeneration. The small radio-frequency choke from cathode to ground provides a path for the plate current and grid-leak returns. On the 10 meter and higher wavelengths, the cathode tap shorts out the radio-frequency choke and thus there are no troublesome resonant effects from this source.

Grid-leak type of super-regeneration is used because of its simplicity and the ease of obtaining efficient regeneration or super-regeneration on either 5 or 10 meters by means of the regeneration control. Super-regeneration is obtained by means of high RF feedback, which condition is brought about by the selection of proper values of grid condenser and leak and plate by-pass condenser. The type 56 tube functions extremely well in this circuit at moderate values of plate voltage; 19 volts at 5 meters in one instance. Type 27 or 37 tubes haven't a high enough amplification constant, apparently, to function well in this circuit at 5 meters, unless plate voltage in excess of 100 is used. In this form of super-regeneration the feedback control R1 should only be advanced sufficiently to obtain a loud hiss, not a howling whistle on 5 and 10 meters. On good phone signals the carrier signal reduces the hiss or roar to practically zero.

Resistance coupling is used between the detector and first audio tube to prevent fringe howl. The latter usually takes place if the plate load of a regenerative tube is inductive, such as with transformer coupling, but doesn't if it is resistive. The second audio tube is direct coupled to the first because of its simplicity. With this form of direct coupling, variations of tubes, etc., seem to have no effect, as it is possible to use a 27 and a 56, or two 27 tubes, or an old and a new tube. Variation of plate voltage over wide limits has no appreciable effect either, since the values of the resistors and operating characteristics of the tubes are chosen to overcome such well known effects of direct coupling. These two audio tubes drew less than 5



Circuit diagrams of 5 to 200-meter Western Wireless Receiver.

milliamperes at 100 volts from the plate supply. This form of audio amplifier is efficient, simple and free from fringe howl effects, and has the proper amount of audio gain for headset operation from the detector circuit.

Still another novel feature, and a very practical one, is the use of a resistor type power pack filter. The total plate current drain is less than 10 milliamperes, consequently small 5000 ohm resistors can be used in place of two iron-cored filter chokes. This effects a savings in cost and space, since the power transformer doesn't have to be placed at a definite distance from an audio transformer or filter chokes. The inductive reactance of a 30 henry choke at 60 cycles (half wave rectifier) is only 1130 ohms, so this resistive filter of three 5000 ohm resistors provides better filtering than three filter chokes in the same circuit. With resistance and direct audio coupling, the filtering needs to be good.

The 4mfd. condenser across the regeneration control quiets this control in operation and also aids in AC hum filtering in the detector plate circuit, where it is most needed. The resistor input from the rectifier and .001 mfd. condenser from cathode to plate of the rectifier eliminates the usual "tunable hum" problem so often encountered in AC operation of short-wave receivers.

The receiver is housed in a cast aluminum cabinet which has much more beauty of appearance than a sheet-iron or wooden cabinet. It makes the set quite rigid and free from twisting torque or warping when tuning, with the result in the latter case of detuning on some desired weak signal. It also allows the set to be used as a first-class monitor when the antenna is disconnected, due to the excellent shielding and rigidity. Since the cabinet is hinged at the bottom and stands on rubber feet or supports, it swings open in the middle as shown in one of the illustrations. This allows coils to be readily changed without a person having to be a contortionist. The set is small, being only 6 x 7 x 9 inches, but is heavy enough to allow a good grip on the tuning knob without moving the whole set on the table or shelf.

The performance and sensitivity to weak signals has made even old-timers enthusiastic about the receiver in tests around San Francisco bay. Since it covers the whole short-wave spectrum in use at present, it makes an excellent standby receiver for persons wishing to listen-in on some exploring expedition or short-wave phone or CW stations outside of the amateur bands. Without an antenna it can be used as a good monitor for either a phone or CW transmitter to check the quality of the output signal.

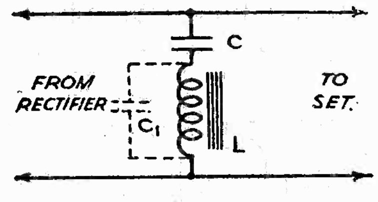
An ordinary aerial can be used for reception on all short-wave bands or a doublet receiving antenna can be utilized. In the latter case the doublet should preferably be tuned by a shunt tuned circuit with the antenna and ground leads from the set connected across the doubler tuning circuit.

P.D.C. for Six-Bits!

By CHAS. PERRINE, W6CUH, and HERB BECKER, W6QD

"Six-bit PDC!" Sounds impossible, yet what could be more welcome at the present time, especially in view of the F.R.C.'s new regulations? The fact is that with this method, a one "mike", or even a half "mike" filter condenser, plus a trip to the junk box, will filter that final to excellent DC, if not PDC. The whole trick is in making the filter resonant—not a new idea, but certainly worth money now. An equivalent brute-force filter would cost several times as much, particularly at high voltages.

The diagram shows the simple circuit. The choke is connected in series with the filter condenser, being on the negative side for safety. This then forms a series resonant circuit—various choke and condenser combinations for different supply frequencies are given in the table. The combinations using more capacity will give a somewhat better note, and will step-up the rectifier voltage a bit more. In any case, the values are not critical; the primary of any small 110 volt transformer can serve as a choke, but a regular choke



The New RESONANT FILTER

C	L (50~)	L (60~)
.5 mfd.	5.0 H.	3.6 H.
1.0 mfd.	2.5 H.	1.8 H.
2.0 mfd.	1.2 H.	0.9 H.

C_1 MAY BE 2-4 MFD. WITH ABOUT ONE SIXTH THE VOLTAGE RATING OF "C."

is, of course, better—about 250 ma. rating when using 3000 volts or less and 500 ma. for higher voltages (the condenser charging current increases with the voltage). A little experimenting will aid in finding the best combination.

The resonant filter can cause trouble in some cases, in that it will sometimes give rise to a weak low-pitched buzz that rides along with the main PDC note. This holds true only with certain single tube full-wave rectifiers—but with the conventional two tube full-wave rectifier it has not appeared. The condenser C1, shown in the dotted lines, will help to cure this condition. In any event, the note should be checked **carefully**.

This filter system has been in use at W6QD-W6CUH for some time on the power supply that feeds the last two stages of the transmitter. Other local hams are using this series resonant filter with similar success. Results have been really astounding. In fact, at first it seemed magical to us, yet the extra cost was nil—so-o-o-o-o—who's afraid of the big bad wolf?

HAM HINTS

By "JAYENAY"

Resonant Or Non-Resonant Antenna Feeders?

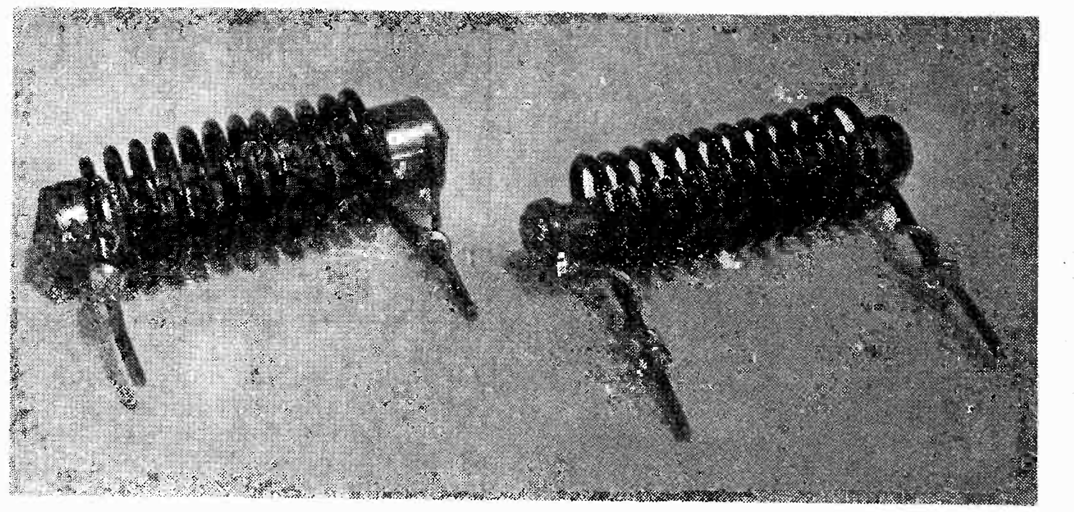
BY resonant transmission lines I refer to feeders of the Zepp or Doublet type. By non-resonant lines I have reference to the Matched Impedance lines, either single wire or two wire types. In general, the Hertz antenna, fed by some form of non-resonant line, is believed to be the more efficient radiator. provided the antenna proper is cut to **EXACTLY** the frequency that is emitted by the transmitter that feeds it. By exactly the frequency I mean within about 1% of the emitted frequency. None of the usual formulae for determining the length of a Hertz radiator are exact enough for this purpose, because the height of the antenna above ground has a slight effect on the optimum length . . . as has the presence of nearby houses, trees and other objects which affect the antenna's capacity to ground.

In view of this fact, it is advisable to cut the antenna slightly "too long" and then gradually prune a few inches at a time until the maximum load is drawn from the final amplifier. (Care should be taken to see that the feeder is properly located on the antenna, and antenna coupling coil, to prevent, or at least minimize, feeder radiation). Ordinary soft-drawn copper wire shows an annoying habit of stretching, which upsets the accuracy of our pruning operation after a short time. Hard-drawn wire helps, but the best cure seems to be copper-clad steel. (Copper-clad steel is just as efficient a radiator as ordinary copper, and is usually much cheaper.)

Now for the Zepp. All forms of resonant feeders simply represent folded portions of the antenna itself, and strictly speaking, they are not feeders at all. Because this folded portion of the antenna is brought into the shack, it becomes a simple matter to adjust the electrical length of this antenna by means of one or more variable condensers. Thus we can tune the antenna as a whole to the exact frequency emitted by our transmitter, without the necessity of pruning bits of wire and moving feeder taps.

The Zepp antenna has certain drawbacks which have caused many amateurs to abandon it in favor of the non-resonant line-fed Hertz, in spite of the tedious process of tuning by pruning, associated with this latter type of antenna. The main drawback of the Zepp is that the feeders always radiate more power than is wasted by the non-resonant types of feed lines. This feeder radiation is almost a total loss, and sometimes affects the neutralization of one or more amplifiers in the transmitter. The feeder separators also are a source of grief during wet weather unless they are made of a non-hygroscopic material, such as Isolantite or glazed porcelain. While a Zepp antenna as a whole can be tuned over a fairly wide range, the radiation efficiency of the flat-top portion suffers, unless its ELECTRICAL length is exactly right for the transmitter frequency. This necessitates, for maximum efficiency, the same pruning process that is necessary for the Hertz antenna, fed by a non-resonant transmission line.

The single-wire-fed Hertz works fairly well on its harmonics when the feeder is located 16⅓% from the current loop, rather than the optimum point for one band operation which is located 14% from a current loop. The two wire type is not desirable for multi-band operation.

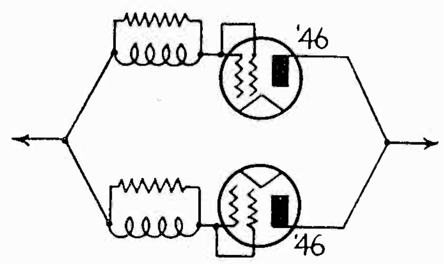


PARASITIC SUPPRESSORS

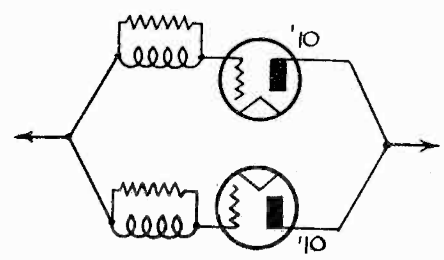
WHERE transmitting tubes are connected in parallel, ultra-high-frequency oscillations causing erratic operation, loss of efficiency and interference, will occur unless steps are taken to suppress such oscillations.

The resistance-shunted chokes shown above, constructed by Paul E. Griffith, W9DBW, of the University of Iowa, accomplish this suppression nicely. Twelve turns of No. 14 enameled copper wire are wound on a ½-in. form, then spaced by "screwing" the 12-turn coil through a short, straight piece of No. 14 wire. The resistor should have a value of 100 ohms.

The one-watt size resistors are large enough to handle tubes of the '46, '10 type; but for higher power, resistors of 50-watt rating are most easily adapted to the addition of a 12-turn coil over them. In case of overload, the resistors burn out first. The metallized type of resistor (shown on left, above) has a better temperature co-efficient than the carbon type (at right). It is absolutely necessary for the resistor to be non-inductive and for this reason wire-wound resistors are not useful.



The suppressors are connected as closely to the grids as possible, as shown here in the diagrams.



Filament Voltage Compensation

MANY transmitters which draw upwards of 500 watts from the 110-volt line have caused the line voltage to drop slightly when the key is down. In some instances this drop can amount to as much as 10 per cent. When the line voltage drops, it is evident that all the filaments in the transmitter also have their voltage reduced. This reduction shortens tube life, and causes mercury vapor rectifiers to fail even when lightly loaded. However, if we raise all the filament voltages so that they are correct when the key is down, we are then subjecting them to overvoltage when the key is up. The circuit shown in Fig. 1 avoids this difficulty and costs practically nothing. An auxiliary coil of a few turns is wound over the present windings on the filament transformers and is connected in series with the 110-volt side of the plate supply transformer. Thus, when the key is down, the filament transformers are aided by this auxiliary winding which is energized only when needed. It is impossible to forecast the exact number of turns necessary on this extra winding. Experiment until the filament voltmeter reads the same with the key up or down. The wire used must be large enough to carry the current drawn by the primary of the plate supply transformer.

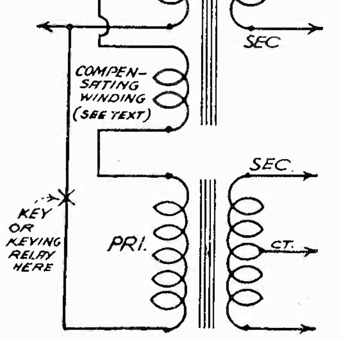


FIG. 1—Filament Voltage Compensation. The compensation winding consists of approximately 5 turns of No. 14 wire, wound directly over primary winding or on the core of the filament transformer.

A Truly Quiet Power Supply

FIG. 2 shows a power supply suitable for a high gain receiver or low level audio amplifier (condenser mike amplifier). The exact amount of ripple will depend somewhat on the quality and size of the chokes, but usually will be below 1/10 of 1 per cent. The two .002 MFD condensers shunted from each plate of the rectifier to ground are very important. They help to prevent the bothersome interference sometimes called tuneable hum, but more properly termed "impact excitation.) These condensers also help to remove line noise from the DC output. The use of four 30 henry chokes instead of two 60 henry chokes is desirable (although more expensive), because their total distributed capacity is less, and high audio-frequency noise is more completely filtered. This power supply is not recommended for a class B audio amplifier because its regulation is not too good, due to the high resistance of the four chokes in series. However, regulation is unimportant for receiver and low-level audio use.

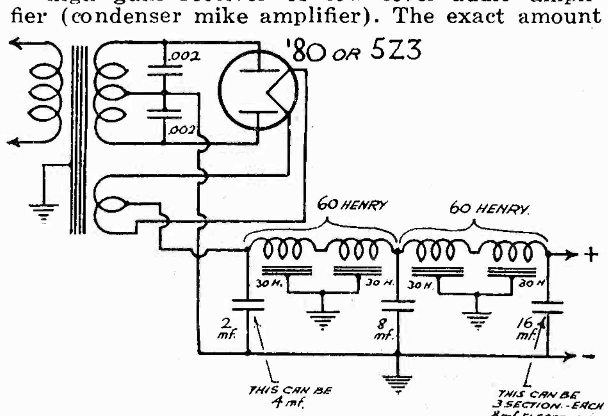


FIG. 2—Hum-Free Power Supply for Short-Wave Receivers as used by W6AWT

Iron Cores In New RF Transformers

IRON has long been recognized as the ideal magnetic material for use in DC and low-frequency inductances. Its use is desirable at high frequencies, but the eddy current losses become so great as the frequency is raised that air has long been considered more desirable as a core at frequencies above 50 kilocycles.

Lately, several experimenters have succeeded in reducing the eddy current losses in iron by grinding the iron into a very fine powder and then insulating each individual particle by means of a non-conductive binding material. The powdered iron is mixed with this more or less liquid insulating compound and then compressed under high pressure into the exact shape desired. This type of highly laminated core has been used successfully on frequencies as high as 25,000 KC, although it is doubtful if iron core coils can compete with air core coils, from the standpoint of electrical efficiency, at frequencies above 5,000 KC. However, the main advantage of this type of coil lies in its compactness and its small external magnetic field, which minimizes shielding difficulties in a high-gain receiver. With the high permeability materials that are used for the coils, less wire is necessary and it becomes possible to use Litz (with its attendant benefits) at medium frequencies.

Whence the Name "Zepp"

ZEPP FEEDERS derive their name from the type of feeder that was developed in Germany for use on Zeppelin dirigibles. The tremendous amount of metal in this type of aircraft made it necessary to make that portion of the trailing antenna (close to the ship) non-radiating so as to avoid losses and also to minimize the danger of sparks between metal joints in the structure, which might result from shock excitation if the radiating portion of the antenna were located nearby.

●●●

How To Calculate the Optical Range Between Any Two Altitudes

$$D = 1.2 (\sqrt{A_1} + \sqrt{A_2})$$

WHEN planning tests on 56 MC or 400 MC it is sometimes helpful to know whether or not any two suggested mountains are within optical range of each other. This can easily be determined if we know the altitudes of the mountains. The approximate optical distance in miles, for points on the earth equals 1.2 times the sum of the square roots of the two altitudes in feet. Assume that one station is at the top of a 10,000 foot mountain and the other is at an altitude of 900 feet. The square roots of these two altitudes are, respectively, 100 and 30. Therefore we add these square roots and multiply by 1.2. This gives 156 miles as the optical range between these two points (provided, of course, that the intervening country is flat. If hills intervene, the calculation becomes somewhat complex. In other words, ask your local math instructor).

●●●

Formulas

OHM'S LAW can be remembered by the fact that the three symbols appear in alphabetical order and the "equals sign" follows the first letter. Thus, $E = IR$. Impedance of an AC circuit, when X_L equals inductive reactance and X_C equals capacitative reactance.

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Resistors in parallel.

$$\text{Total resistance} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \text{ etc.}}$$

Capacities in series.

$$\text{Total capacity} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \text{ etc.}}$$

The total capacity of a group of condensers connected in series is always less than that of the smallest condenser in the group.

Micromicrofarads MMF		and Microfarads MFD
1,000,000.	=	1.0
100,000.	=	.1
10,000.	=	.01
1,000.	=	.001
100.	=	.0001
10.	=	.00001
1.	=	.000001

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How to Calculate Transformer Primary Rheostats

When seeking to control the voltage of a transformer secondary, the most efficient method is to install a rheostat in the line leading to the primary winding. Many of us become confused when we try to calculate the size and resistance value of this rheostat. The following procedure outlines how to figure the correct resistance and wattage of the rheostat.

This method is perhaps the simplest way . . . let us assume that we want to control a '211 type radio transmitting tube filament from a transformer whose secondary voltage is 12 volts when 110 volts is impressed on the primary. The filament of this tube operates at 10 volts and draws 3.25 amperes. For efficient control, a voltage variation of four volts is sufficient; that is, we will be able to vary the secondary voltage from eight to twelve volts. We find that the transformer ratio is 9.17 (110 divided by 12), and as the loss in the transformer is very small, we can assume that the wattage of the primary and secondary is the same. Thus we can assume that the currents in the primary and secondary will vary inversely as the voltages and will follow the same ratio. The primary current will then be 3.25 divided by 9.17, or .355 amps.

If we are to get a four volt variation in the secondary, we must have 9.17 times four volts, or a 37-volt variation in the primary. To find the resistance needed for this voltage drop, divide 37 volts by the current (.355) which gives a resistance of 104 ohms. When a rheostat is to be used where the air circulation is restricted, the unit should not be required to carry more than about one-half its rated current. For this reason the No. 0320 Ohmite rheostat will be ideal here. This unit will safely carry a current of .630 ampere in the open air.

Interference Filter for Supers

MANY users of high frequency superheterodynes have complained that ICW signals can be heard no matter where the set is tuned. This, generally, is not image interference, because it is not tunable. It is usually caused by the fact that ship signals between 400 and 500 KC ride through the first detector and are amplified by the intermediate frequency amplifier, whose frequency is usually somewhere in this band. This interference can come through even if the oscillator tube is removed from its socket. The best remedy for this type of interference is a wave trap in series with the antenna, and improved shielding around the high-frequency portion of the set. A wave trap is shown in Fig. 3. It can be an IF coil identical with those used in the intermediate transformers. The condenser can be any type with a capacity of about 100 MMF. and is used to tune

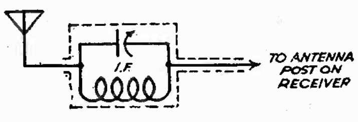


FIG. 3 Keep the lead as short as possible.

the coil to resonance with the IF amplifier. The presence of this trap in the antenna circuit will not affect high-frequency signals, but will present a high impedance to undesired low-frequency signals of approximately the intermediate frequency.

●●●

Foresight

IN 1911 the chief engineer of one of the leading companies in the Radio field resigned his position and accepted an executive position with a manufacturer of sewing machines at a reduced salary. He made a statement which follows . . . "Wireless communication has about reached its peak and only a few minor improvements are possible. On the other hand, the Sewing Machine industry is growing rapidly and within twenty years every household in the world will own its own Sewing Machine."

●●●

A High Gain Audio Amplifier

FIG. 4 shows a simple audio amplifier which delivers an honest six watts of audio power and does well as a modulator for a portable 5 or 10 meter phone. This amplifier will allow the use of a ribbon or dynamic mike, which represents a welcome improvement over the noisy single button carbon mikes usually associated with portable gear. While a pair of 42's are specified in the output stage, it is possible to substitute 41's, 38's, 6A4's or 89's with only minor changes to the diagram as shown. When a low-level, high-quality double button carbon mike is used with this circuit, the talker can remain from four to six feet away from the mike and still drive the output up to six watts. If CH_2 is replaced by a suitable transformer this amplifier will drive a class B stage consisting of two or four 46's or 59's.

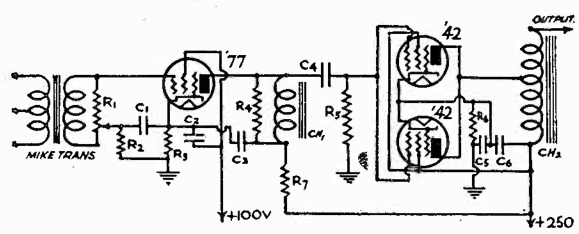


FIG. 4

R_1—500,000 ohms	C_1—.5 mfd.
R_2—100,000 ohms	C_2—.1 mfd.
R_3—1,000 ohms, 1 watt	C_3—.5 mfd.
R_4—200,000 ohms	C_4—.01 mfd.
R_5—500,000 ohms	C_5—10 to 25 mfd. (low voltage)
R_6—200 ohms, 5 watts	
R_7—5,000 ohms, 1 watt	C_6—2 mfd. —2 mfd.

CH_2—Modulation choke or 3500 ohm load
CH_1—400 to 800 Henries at 5 M.A.

●●●

Finding and Removing Set Noise in a Super

MANY SUPERS have been cursed because of the tremendous noise level. While there is always a goodly amount of noise floating around the atmosphere waiting for some unsuspecting super, there is also a lot of noise produced in the receiver itself. With the antenna disconnected, turn the set upside down so that you can get at all the leads located under the chassis. Then place a couple of leads on a non-inductive ½ microfarad condenser and go hunting. Ground one of the leads and, with the set going wide open, touch every socket contact and lead available. You will be surprised at the reduction in noise possible by this method. Of course, when you find a circuit which can stand additional by-passing, a condenser is permanently installed.

Filament Transformers for a Bridge Rectifier

A GLANCE at the circuit of a bridge-type single phase rectifier will show that at least three separate filament windings are necessary for the rectifier tubes. Many hams are using four 83's in bridge circuits to obtain 1000 volts at 250 milliamperes. This is OK, but DON'T try to improve on the circuit by putting all the 83's on the same filament winding. It just can't be done . . . not on weekdays.

●●●

A Low Level Amplifier

MANY inquiries have been received for data on a high-quality, low-level amplifier suitable for use with a condenser microphone. Such an amplifier is shown in Fig. 5. This amplifier is also highly suitable for use with the new moving coil microphones, such as the Ribbon or Dynamic types. With these microphones an input transformer is necessary, so we can connect the secondary of such a transformer directly from grid to ground across the 2 megohm resistor, R3. With the addition of the input transformer we would eliminate R1, R2, C1 and C2 whose purpose is to supply and isolate the DC polarizing voltage which places an initial charge on the "hot" plate of the condenser head.

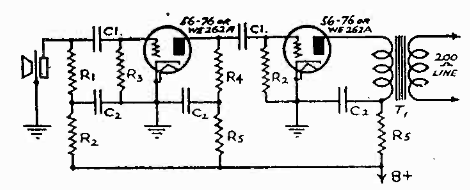


FIG. 5

CONDENSER MICROPHONE AMPLIFIER

R_1— 20 meg.—Metallized
R_2— 1 meg.—Metallized
R_3— 2 meg.—Metallized
R_4—25,000 ohms—Wire wound
R_5— 5,000 ohms—Wire wound
C_1— .01 mf.—Mica condenser
C_2— .5 mfd.—Filters
T_1—Tube to line transformer

Note that these tubes operate without bias. This is possible because of the small magnitude of the voltages involved. The output of a condenser head rarely exceeds one one-thousandth of a volt. The gain of this amplifier is in the neighborhood of 40DB and the output can be connected to an amplifier designed to amplify the output of a double button carbon mike.

This amplifier should be well shielded, especially if used in the neighborhood of a transmitter, and it should be at least two feet away from any power supply apparatus, to avoid hum pick-up. If it is used with AC on the heaters, the filament supply should be by-passed with about one MFD. and first one side and then the other should be grounded. The ground should be left on the side that shows least hum in the output. Occasionally it is found that a center-tapped resistor across the heaters with the center grounded provides the least hum. The plate supply should be well shielded and usually twice the normal amounts of inductance and capacity are found necessary in the filter. This circuit is based on one developed by Mr. A. A. Collins, W9CXX.

●●●

QSY with Crystal Control

ALL OF US, at one time or another, have wished that we might shift our frequency slightly to avoid being blanketed by another station on our frequency. The most commonly used method to obtain this shift with crystal control is to use an air-gap holder whose gap is variable. However, air gap holders are expensive and few have an adjustable gap. It has been found that two thicknesses of writing paper, placed between the crystal and the top plate, can shift a 3500 KC crystal about 2½ KC. If we are doubling twice to 14,000 KC we can obtain a 10 KC shift, which is sufficient to get away from one of those foreign self-excited phones.

Another method of shifting frequency is to shunt a .0001 MFD. condenser across the crystal.

●●●

Powers vs. Signal on 56 Megacycles

IT has been found that as long as the transmitter and receiver are within optical range, the difference between 15 watts and 600 watts of carrier is only about one point on the "R" scale. The 15 and the 600 watts phones were both connected to the same antenna and the receiver was not altered between transmissions. However, as soon as the receiver was taken behind a hill the superiority of high power became evident and the 15 watt transmissions dropped from R7 to R2, while the 600 watt signal dropped from R8 to R7. These tests were carried out over a distance of 95 miles and the modulation in each case was about 85 per cent with MOPA transmitters.

Making Doublets Pay . . .

By LOUIS R. HUBER *

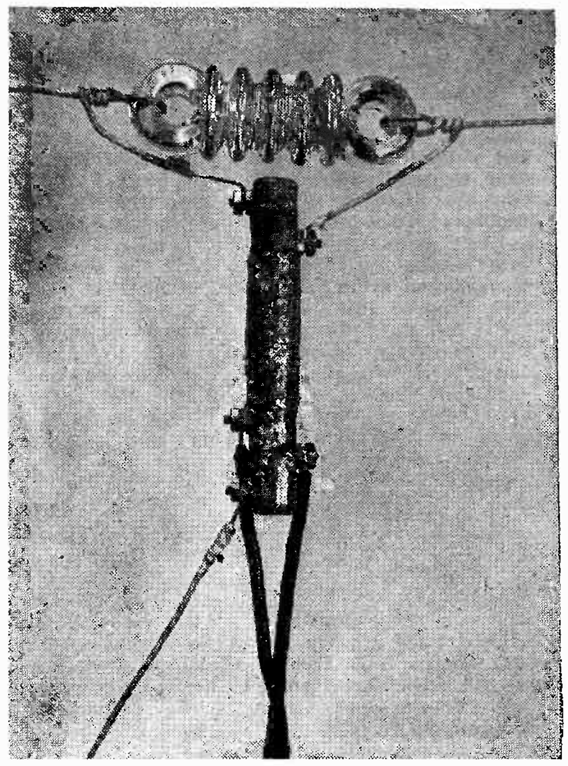


FIG. 5
The coupler attached in the center of the antenna. The wire running from the electrostatic shield connection to ground is not absolutely necessary, and can be omitted—although with some detriment to the efficiency of the system. The closer the ground is to the antenna coupler, the more worthwhile it becomes.

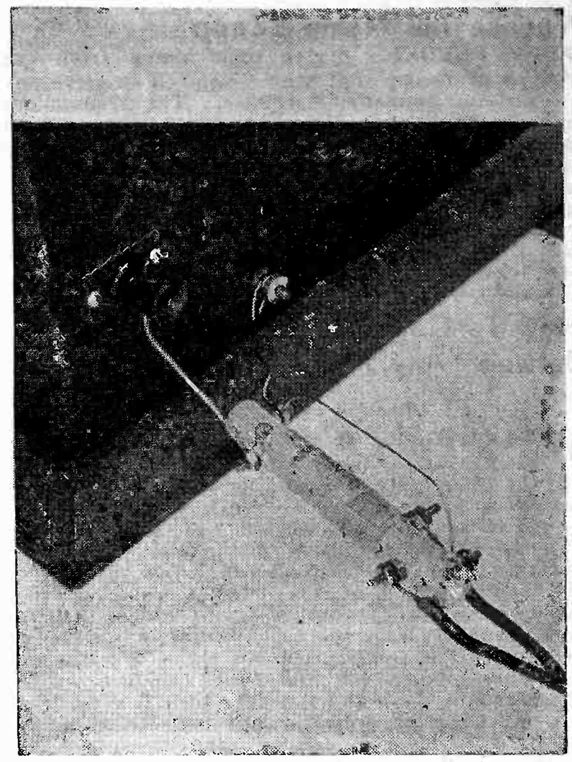


FIG. 4
The most important part of the system—the receiver coupler. The lead from the coupler to the receiver's antenna post is the only part of the system that picks up any appreciable amount of interference and therefore must be very short.

TO anyone who has had to operate through interference coming from such infernal devices as oil burners, vacuum cleaners and dirty commutator generators, any contraption laying claim to interference-elimination is going to be of considerable interest. The writer, having been a sufferer of long duration from these hells which beset us poor operators, resolved about a year ago to investigate the doublet receiving antenna, which seemed to hold the most promise.

From the beginning, the garden variety of doublet receiving antenna contained so many constructional hindrances that it appeared this "dodge" would be about as bad as erecting a Zeppelin antenna. So a minor rebellion was staged.

It was concluded that it just wasn't worth while to erect the usual rigid-dimension system as shown in Fig. 1, in which the transposed line C has to be of a certain length—133 feet for 80-meter work, for example. Our back yard didn't fit, unfortunately. Also we didn't like the two tuning condensers. Our receiver already has six controls too many. With these outcries against orthodoxy singing hurrah in our brain, we joyously crossed off the possibilities of Fig. 1 and proceeded on our quest.

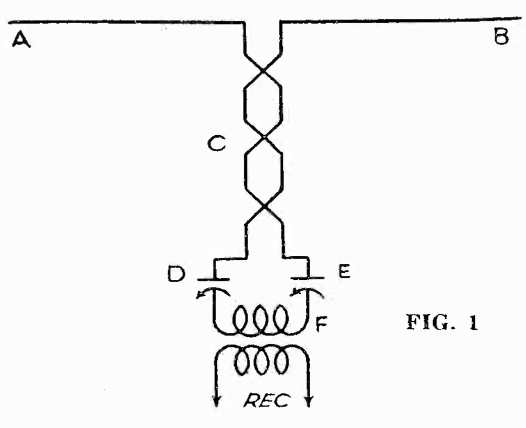


FIG. 1

NOW, Fig. 1 is not a self-tuned system at all. The tuning begins at one end of the antenna AB, at A, runs to the center and down one side of the transposed line C, through D, F and E, back up C again and so out to B. The only interference-eliminating possibility is through the canceling factor of transposition. The reason, presumably, that such a system has been widely used in preference to that shown in Fig. 2, which is nothing more than an adaptation of the broadcast-band 200-550-meter antenna coupling system that has been in use for some time, is that the business of hanging a transformer in the middle of the antenna is rather baffling, due to weight considerations, ground connection, weatherproofing difficulties, etc. Also, it seemed that the concentric cable lead of the broadcast system just didn't work well for short wave reception.

*W9SU—K7AHK—W7CRJ, 517 East 4th St., Tipton, Iowa.

The obvious thing to do was to have an intermarriage of the broadcast system and the short-wave tuned system and produce a new offspring, which turned out rather happily to be that shown in Fig. 2, in which the transmission line can be of any length. Thus having brought the back yard into good repute once more, the only remaining problem was to hang something in the middle of the antenna that wouldn't weigh a ton and that would eliminate the tuning condensers on the receiver end, while leaving a tuned wire out in the clear to snaffle signals as they come along.

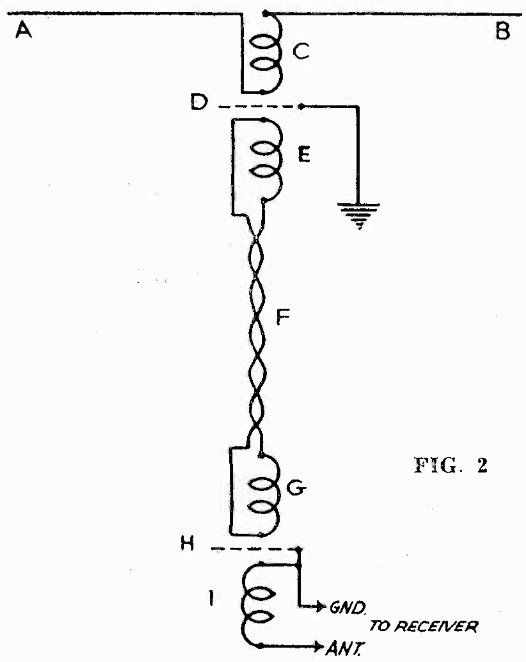


FIG. 2

THE tuned system goes no further than the coupling transformer in the middle of the antenna. It is ACB in Fig. 2—merely a Hertz antenna with a coil in the center, the point of lowest voltage in a half-wave antenna. Coupled to this coil is the system EFG, which is nothing but a link coupling system to the coil I, which connects to the regular antenna-ground terminals of the receiver. This leaves the whole lead-in system at low voltage and untuned, allowing unusual latitude in the selection and arrangement of the feed line.

The very best of course will be number 14 copper enameled, used with the excellent transposition blocks which are now on the market, designed for use on the old system, where they had to be good or you didn't get signals. Transposing every two feet is good practice. If the depression is still hampering your finances, telephone drop cord, known as "POD" to linemen, is a good substitute, well weatherproofed and easily managed. Ordinary lamp cord will do, but is not good for many months in the weather.

Now, having theorized so beautifully, it is necessary to get down to practical considerations. We still have to hang that transformer in the middle of the antenna, and we can't be bothered with tin cans such as the broadcast listeners tack on to their masts. The only thing we can do is to make a mysterious looking object (Fig. 5) which appears to be a cross between a strain insulator and a voltage-dividing resistor, but which is nothing like either.

The mystery is neatly solved by regarding Fig. 3, which shows us that we have made a radio-frequency transformer with an electrostatic shield between the coils to "ground" any stray intreference that has no legitimate business getting into our receivers. One of these transformers, or "couplers," constitutes either CDE or GHI of Fig. 2.

The matter of matched impedances from the antenna through coupler, feed line, coupler and into the receiver is of considerable importance. Several coil ratios were tried before finally arriving at the combinations given here, the object being to provide the feed line with enough energy to transmit received impulses to the receiver, without raising the impedance so that the feed line itself picked up interference. It is quite possible that the specifications here shown could be improved; however, they operate well in practice and the problem of bettering them is cheerfully handed to the laboratories.

FIG. 3 shows the constructional details. It was found to be quite important to place the coils end-to-end as close together as possible. They could be wound one on top the other, but this would add structural difficulties, and end-to-end coupling seems to be quite sufficient. It was found to be eminently practical—though perhaps not scientifically most efficient for all types of feed line—to use the same number of turns for all four coils (two couplers) designed for a given receiving wave length. Tin foil serves admirably for the electrostatic shield. It is necessary to "split" the tin-foil cylinder so that it does not form a one-turn absorption loop about the coils.

The coil in the center of the antenna, of course, adds inductances to the antenna and destroys the well known formula for cutting a Hertz antenna "to fit." The approximate proper lengths for the antenna, used with the coils here described, are as follows:

160-meter band—80 feet (each half 40 feet)
80-meter band—86 feet (each half 43 feet)
40-meter band—60 feet (each half 30 feet)
20-meter band—30 feet (each half 15 feet)

The length of the antenna can be varied to reach special wave lengths. For example, the 40-meter couplers will work fine on 49 meters for press, merely by lengthening the antenna about 20 feet.

It is necessary, of course, to build a separate antenna system for each wave length on which interference-free reception is desired. There is enough latitude in these systems, however, to make operation over the entire band uniform. In fact, the larger couplers will work on the lower wave lengths, but will not cut out interference well except on the waves and with the antennas for which they are designed. The smaller couplers, of course, will not work well on the higher wave lengths.

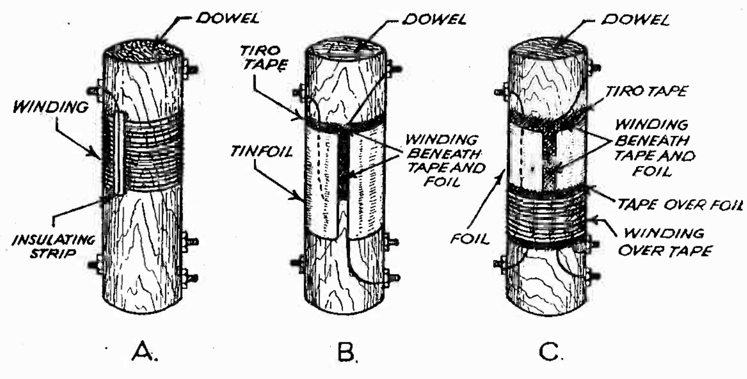


FIG. 3

Showing steps in construction of couplers. A shows first winding, directly on dowel. B shows first winding and electrostatic shield. C shows first winding, electrostatic shield and second winding. One layer of Tiro tape separates each winding from the electrostatic shield. Use tiny brads to hold windings in place. These must not be allowed to "short" the windings to the electrostatic shield: a tiny patch of tape can be used on these pegs for the second winding, so as to insulate the wire from the peg. It is best to cut the brads to a length of about ¼-in. before driving.

Soldering lugs for the binding posts consist of No. 18 bare copper wire bent horseshoe-shape around the posts.

Detail of windings for 160, 80, 40 and 20-meter couplers are as follows: No. 36 enameled copper wire is used for all windings. Totals of turns are respectively 130, 30, 14 and 7. The 160-meter winding is "solid", while the 80, 40 and 20-meter windings are spaced as shown.

The 160 and 80-meter couplers are constructed on maple dowel stock measuring 3⅝-in. x ⅞-in., with windings ¾-in. long. The 40-meter coupler is constructed on ½-in. stock 3⅜-in. long, with windings ⅜-in. long. The 20-meter coupler is constructed on ½-in. stock 3⅛-in. long, with winding ⅜-in. long.

Round-head brass machine screws, size 4/40, ½-in. long, are used for binding posts, with soldering lugs made from No. 18 bare copper wire bent in the form of a horseshoe around the post. Spacing between binding posts and between end of dowel and binding posts is about ¼-in. To mount binding posts on dowels, a No. 6 twist drill (wire size) is first used to bore within ⅛-in. through the dowel; then the hole is finished with a No. 33 drill.

Edges of the dowels are slightly rounded with a file to facilitate taping and varnishing. This illustration, of course, shows the couplers only partly constructed. "Bond" writing paper is used to insulate the cross lead on each coil, and each coil, as soon as made, is varnished with airplane "dope".

CONSTRUCTION of the couplers is shown in Fig. 3. Three materials important in the construction are (1) ariplane "dope," (2) bond paper and (3) Tiro tape. Airplane "dope" is the material used to cover airplane wing fabric after it has been stretched. It is, of course, thoroughly waterproof and is excellent stuff to have around radio-frequency currents, when it is necessary to have something in such places. Airplane "dope" is available commercially at paint stores under the name of "duco," and is used in pigmented form on automobiles. The "clear" variety is best for radio use. In a pinch, collodion (obtainable at the corner drug store) can be used in place of airplane "dope," but is not very desirable on account of its hygroscopic (water-absorption) characteristic. Bond paper for insulation where wires cross each other is easily obtained by robbing your monther's stationery drawer. Tiro tape is a grey tape which comes in ½ and 1-inch widths and is similar to adhesive tape, having "stickum" on one side only. It contains nothing deleterious to the passage of radio-frequqency currents at low voltage. In case you cannot obtain Tiro tape, "armature" tape is good, or you can even use surgical adhesive tape.

The finished coupler (Fig. 5) is completely taped with Tiro, and varnished several times with airplane "dope." The "dope" dries quickly, so the varnishing job is not a long-drawn-out affair. The taping of the whole coupler after it has reached the constructional stage of C in Fig. 3 is a matter calling for great ingenuity, and the more care exercised in the taping, so as to provide a smooth surface for the application of "dope," the longer-lived will be the coupler in its career in the sun, wind and rain. Unless you live in Pittsburgh, you need not worry about high resistance between binding posts. The "dope" is just as effective as a duck's back. It is important that all of the wood surface of the coupler be covered with tape before doping, as the dope will peel from the wood surface, whereas it sinks into the tape and holds firm.

It is not necessary, of course, to prepare the receiver-end coupler for weather, unless you wish to do so. It is useful and provident, however, to have both couplers fit for outdoor use so that the outdoor one can occasionally undergo repairs by substituting the receiver-end coupler temporarily. Since the two couplers for each band are identical, this entails no confusion. The coupler shown attached to the receiver was not prepared for weather, but could easily be so prepared by patching on Tiro tape over the exposed wood surface and applying airplane "dope."

PLACING of the antenna is the last, but not least, consideration. It should be in the clear as much as possible, should not parallel light lines, and should be situated as far as possible from the chief source of interference. Fifty feet of separation between the antenna and the interference source usually is ample. It is not absolutely necessary to use the shield connection on the antenna coupler, although this is helpful when a good ground connection is situated nearby. Most of the interference-eliminating is done right at the receiver coupler.

As to results, the writer has used these couplers chiefly on 40 and 80 meters to eliminate local interference which would have caused a virtual shut-down even when using just a six-foot receiving antenna. Interference sources have been (1) an electrol oil burner that blanketed the 80-meter band, (2) a d. c. generator which killed all but R8 signals on all bands, and (3) a vacuum cleaner that killed all signals on all bands.

With the doublet systems here described, the interference in every case was cut down so low that signals of R2 and R3 strength could be received easily, except in the case of the vacuum cleaner, with which R4 signals could be received without difficulty. The receiver was a National SW-5, and it was found that selectivity was probably twice as good when using the doublets as when using an ordinary antenna. Local amateur stations do not cover so much territory on the dial when using these doublets, either. Break-in operation becomes easy with them, and one can quit worrying about burning out volume controls, blocking tubes, and so on, in the receiver.

Signal strength seems to remain about the same, and in some cases increases, when using the doublets as against the short receiving antenna formerly used. The writer had no instruments for measuring signal-to-noise ratio in either case, but he does know that communication has been possible with these doublets which would have been absolutely impossible without them.

CATHODE-RAY TELEVISION (Continued from page 5)

greatly amplifying very small electric currents uniformly throughout a band width of 900 kilocycles or more, as compared to the 5-kilocycle band that suffices for sound. And before he can be considered proficient the television engineer must have a working knowledge of the quantum theory and wave mechanics.

This broad foundation is, of course, not necessary for the man who intends only to service or repair television receivers. But it is essential to the man who intends to conduct research in this fascinating new field. It is the kind of knowledge possessed by those who have made commercial television possible and which must be gained by those who would further advance the art.

These fundamentals are explained in the author's forthcoming textbook on the principles of television with cathode ray tubes. But even in this simplified exposition pre-

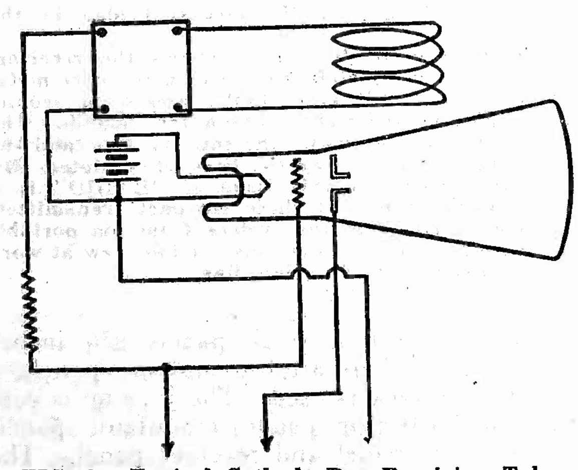


FIG. 2. Typical Cathode Ray Receiving Tube

paratory to the detailed description of the mechanisms and circuits which are employed, it has been necessary to assume that the reader already understands elementary trigonometry and mechanics. Otherwise valuable space would be wasted in teaching what is adequately taught elsewhere.

So the best advice that can be given to one who is ambitious to take up the study of television is to review the subject of mathematics and physics as taught in the high schools. Then, and only then, will he be prepared to understand this new art.

Editor's Note' January "RADIO" will continue this series with feature articles by Mr. Arthur H. Brolly of Television Laboratories, Inc., where the Farnsworth system was developed.

5 Meters . . . and the World's Largest Bridge

Detailed Description of Ultra-Short Wave Transmitters and Receivers Used For Communication By Bridge Builders

By FRANK C. JONES
Ultra-Short Wave Editor of "RADIO" and Designer of the Bay Bridge Equipment

THE new San Francisco-Oakland Bay Bridge is a gigantic undertaking which will cost about $78,000,000 and require about four years to complete. It will be the world's largest bridge. The purpose is to provide better transportation facilities between San Francisco and the cities located on the eastern shores of the bay, and it will replace the present ferry-boat systems. The total length of the bridge will be $8\frac{1}{4}$ miles and Yerba Buena Island will serve as "midway" anchorage. The main bridge structure will have two decks, the upper with six lanes for passenger cars and light trucks and the lower of three lanes for heavy trucks and two interuban train tracks. The clearance above water will be 200 feet in order that any ship may pass.

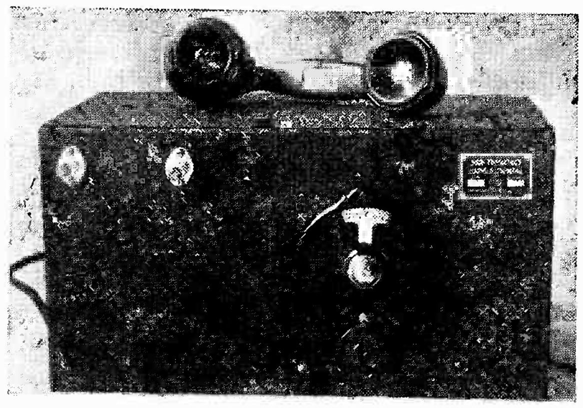
Five-meter radiophone sets will be used for communication during the four-year period of construction. The work started a few months ago, and five-meter sets are in use at present as an aid in serving the most practical system of communication under the conditions involved. Communication is necessary between offices and piers of the various portions of the bridge, and between those points and the various kinds of boats used in the work.

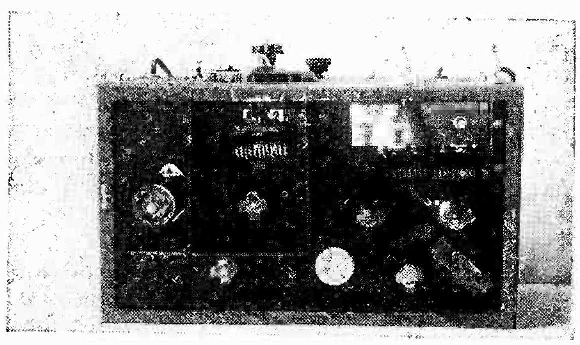
Five-meter waves are semi-optical in their behavior and are good for relatively short distance communication, such as on this construction work, and yet will not interfere with radiophone services on the same wavelengths in other localities. The same frequencies may be used at other points which are about a hundred miles away, without mutual interference. Amateurs have been exploring this region below ten meters for the past 10 years and have aided in developing circuits and apparatus which will allow practical use of these ultra-high frequencies.

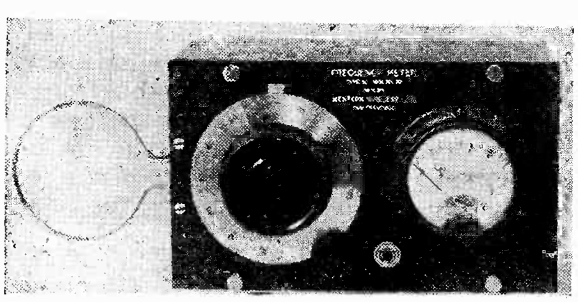
The apparatus used provides simplex voice transmission . . . that is, talk or receive on the same frequency channel between points of construction of each bridge contractor. For this reason there are three networks in operation at present, employing from five to ten stations each. The frequencies used are 41, 61 and 63 megacycles, values near the so-called five-meter band. The amateur five-meter band is from 56 to 60 megacycles.

The radiophone sets consist of three general types, supplying a carrier output of approximately two to ten watts. On the boats that have no AC power available, battery operated sets are used. The small AC and DC sets are quite similar except for power supply and type of tubes in the transmitters and receivers. The battery operated jobs use 180 volts of heavy duty "B" batteries and six volt storage battery, the latter usually having a charging unit driven from the boat's engine, where such is possible. The tubes used in the battery operated sets consist of a pair of 12A push-pull oscillators, a 41 pentode combination modulator and standby calling amplifier, a 37 audio amplifier, a 37 gridleak super-regenerative detector and a 39 RF amplifier. The corresponding AC set uses a pair of type 45 tubes as oscillators, a 2A5 pentode combination modulator and loudspeaker amplifier standby, a 27 audio amplifier, a 27 gridleak super-regenerative detector, a 58 RF amplifier, and an 80 rectifier.

The larger AC set consists of a pair of 2A3 push-pull oscillators with about 40 watts input. This is modulated by a class B system using a pair of 46 tubes in class B, and a class A 46 tube as a driver stage. The output voltage from a telephone handset mike is sufficient to swing the grid of the class A 46 driver stage. This large set is built into







5-Meter radiophone equipment used for communicating between various units of the gigantic San Francisco-Oakland Bay Bridge, now under construction. It will be the largest bridge in the world.

The uppermost illustration shows the receiver-transmitter, completely housed in a compact metal cabinet. The unit is portable, uses a telescopic-tube antenna and weighs but a few pounds. The center illustration shows the interior view and the lower illustration shows the Frequency Meter. On the front cover of this issue of "RADIO" is a photograph of one of these compact transmitter-receivers. He is giving orders from his portable station on the pier to the construction crew at work on a barge in San Francisco Bay.

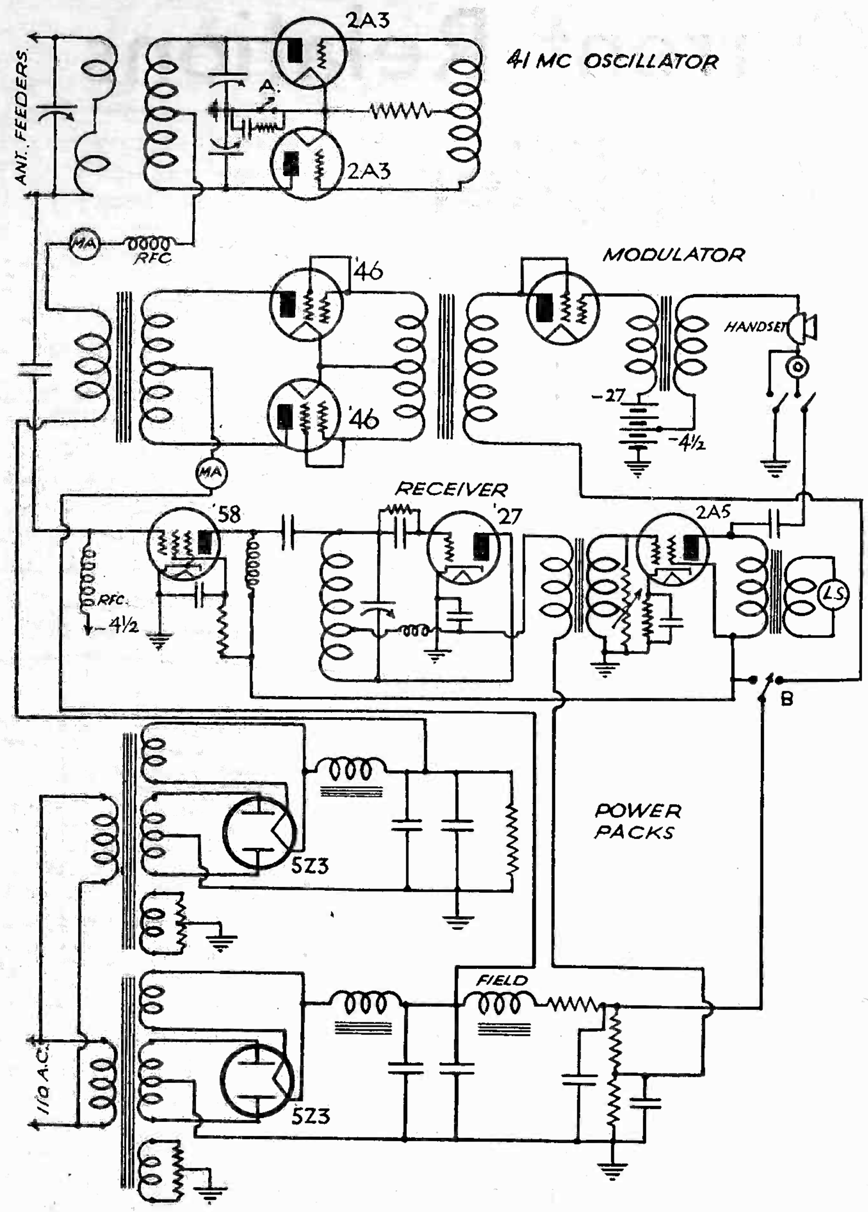
standard size relay rack panels $8\frac{3}{4}$ inches wide. Since there are four units or panels, a short relay rack is used. The four units consist of oscillator panel, modulator panel, power pack panel and receiver panel. The latter consists of a 58 RF amplifier, 27 super-regenerative detector, and a 2A5 audio amplifier which operates either the handset low impedance receiver or a small dynamic loudspeaker. The handset cradle switch turns on or off the microphone battery supply and also switches from the monitor loudspeaker to the receiver in the handset. The low impedance receiver effectively short circuits the loudspeaker, and since a pentode audio tube is used, the receiver volume is reduced to the proper value automatically without an appreciable increase of distortion.

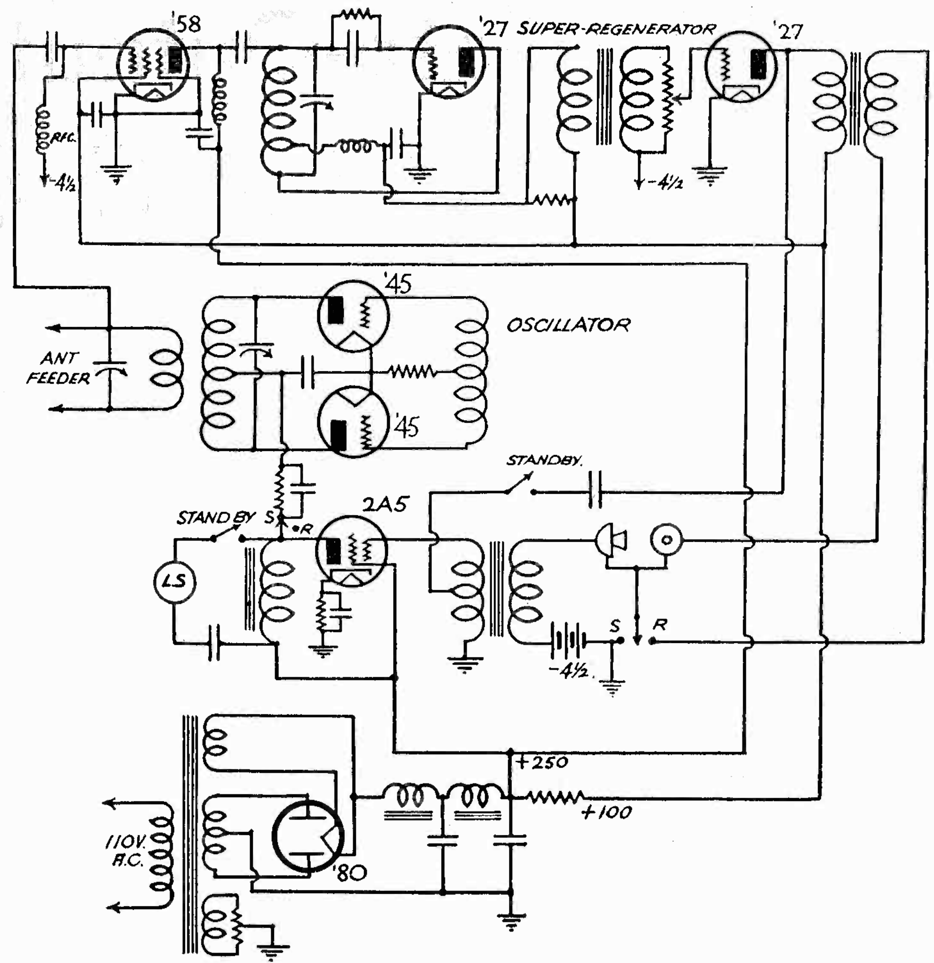
This transmitter is operated at any remote point by means of a 110 volt AC control circuit and a three-wire circuit for the hand telephone set and its cradle. The control circuit allows talk or receive by means of a push button operating an AC relay in the relay rack. The relay cuts off the RF amplifier and pentode audio tube plate current, and turns on the modulator and oscillator plate supplies when talking, and vice versa when receiving. Since all filaments are left on, the switching is extremely fast and there is no time delay for talk or listen.

This larger set is used in offices of the engineers in San Francisco with the antenna system located on the roof of an eight-story building. The antenna is half-wave with a reflector behind it, spaced a quarter wave from it. A 500 ohm RF two-wire feeder is used to feed the antenna from the transmitter and receiver. This line is matched to the antenna by fanning it out like a Y to connect across about 1/7 each side of center of the antenna. At the set end a shunt tuned circuit is used, coupled to the oscillator plate tuned circuit. This feeder arrangement has been quite satisfactory in all of the installations, as some elevation is desirable to overcome 5 meter shadow effects of passing boats. Some shadow effect has been noticed from Yerba Buena Island, but not as much as was expected. Satisfactory 5-meter communication has been carried on while the boats were directly behind the island and quite close to it. Fortunately, two of the networks function only from the island to the two shores, but the third one has to cover the whole bay because it is used by the State Engineer's office.

The smaller sets put out about two watts of carrier power which has been sufficient to knock down the background noise in the super-regenerative receivers. All of the sets have a standby loudspeaker so that the other stations may call without a pre-arranged schedule. Some of the receiving locations are very noisy, due to boilers, motors or other machinery, so that two audio stages with a pentode second stage are necessary for good loudspeaker reception of calls. A standby switch cuts the pentode tube over to be used as a modulator when the set is used for communication.

Some interesting problems were encountered, such as detector overloading when the stations were close together. Most super-regenerative detector circuits are subject to this difficulty. However, it was overcome in this case by running the grid leak back to a





The circuit diagram at the left is of the Model 10-W 5 meter receivers and transmitters for the San Francisco-Oakland Bay bridge. Switches (A and B) are D.P.D.T. AC Relay for remote operation of send or receive.

The diagram above shows the circuit for the Model 3-A Transmitter and Receiver combination for 61 and 63 megacycles. The numerous portable installations use the above circuit.

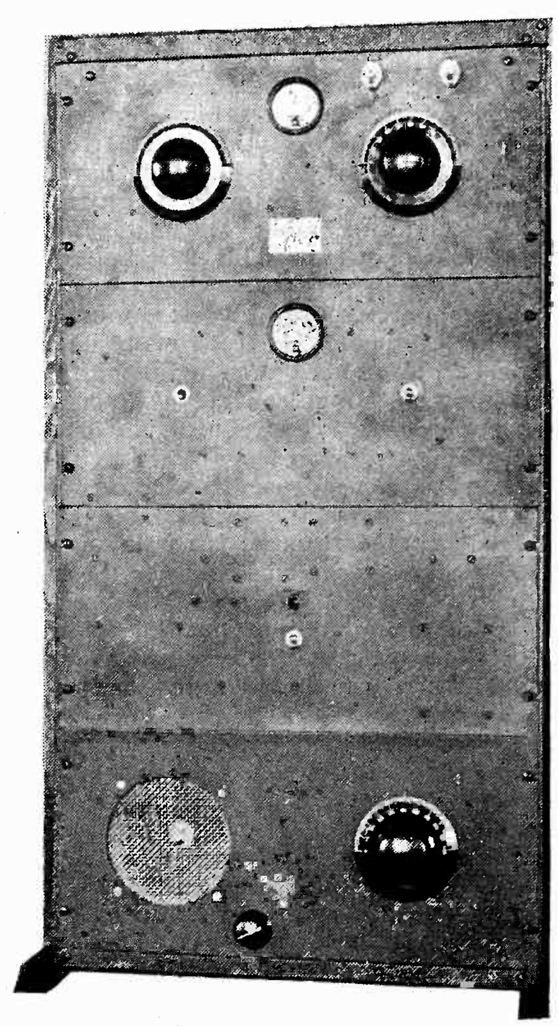
fairly high positive voltage. This form of super-regenerator is sensitive and economical and, in this connection, a strong signal will not paralyze the detector. The action is similar in effect to a receiver with automatic volume control, so that nearly all signals are received at the same volume and only an audio volume control is necessary.

Frequency stability is maintained by using push-pull oscillators in order to series connect the tube capacities and impedances across the tuned circuits. For the same reason, moderate plate voltages and percentage modulation is employed, and a fairly high value of C to L is used in the plate tuned circuits. Proper channel operation is maintained by monitor stations and a frequency meter calibrated from the broadcast band by a harmonic method. The transmitters are either locked in position or have no controls available except from the inside of the set. The receivers were made with a variable tuning control as it was expected that over-loading distortion or noise interference might warrant the need of such adjustment. Apparently, under ordinary conditions of operation, no receiver tuning adjustment is necessary.

Because most of the radiophone sets are in use 24 hours a day, 7 days a week, the frequency stability should be good, since the operating temperature of tubes and circuit parts soon reaches a stabilized value. Regular inspection and replacement of tubes and batteries are, of course, necessary. Some frequency modulation takes place because a modulated oscillator is used, but this is minimized by using moderate values of modulation percentage.

Any type of super-regenerative detector is an excellent radiator of "hash" or whistles, the grid-leak type being two or three times as bad as a separate interruption frequency coil type detector. The method used in all of these receivers was to employ an RF amplifier stage using a screen grid tube. This effectively minimizes receiver radiation and does not cut down the signal strength appreciably. As can be seen from the circuit diagram, the grid circuit is partially tuned by the antenna tuned coupling coil. The plate coil or RF choke is tuned approximately to the desired frequency and a small capacity coupling is used to the tuned detector circuit. Exact tuning of the RF plate coil or greater coupling capacity increases sensitivity, but causes instability in the detector circuit when used in regular service.

Some of these sets have never had the power turned off since their installation, which means over 700 hours continuous service a month. The antennas and sets were installed by D. Reginald Tibbetts who also has charge of the service maintenance and licensing situation. The sets were designed by Charles L. Watson and the writer, and built by Western Wireless, Ltd., of San Francisco.



Right: Relay Rack 5-meter S. F. bay bridge radiophone transmitter installed in the offices of the state engineer, from where reliable communication is established with any of the bridge building units.

ANNOUNCEMENT!

TEN years ago Mr. G. M. Best and the laboratory staff of "RADIO" developed the original 45,000-cycle Superheterodyne. It revolutionized set building and design, for it was the first practical superheterodyne in the popular field.

It is estimated that 1,200,000 of these receivers were built by radio fans the world over. It created a sensation in radio circles. It was the most widely copied and imitated receiver in field. Manufacturers who supplied parts for its construction reaped a golden harvest of profits. The laboratory staff of "RADIO" has an infinitely greater surprise in store for you.

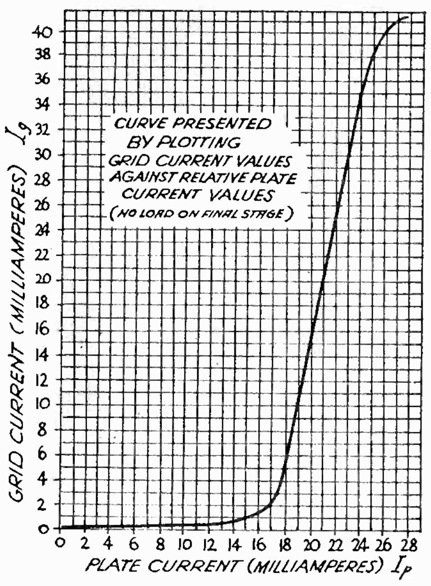
Beginning in the next issue of this magazine, details will be disclosed for the design and construction of amateur and BCL superheterodynes in which are embodied altogether new and advanced principles.

The series will be continued in each issue for one year. It will make radio history.

Grid-Plate-Output Current Relations In the Final Amplifier

By W. E. McNATT. JR.* W6FEW

MANY methods of obtaining a graphical representation of the performance of a final amplifier of a radio transmitter have been devised, but the majority of these systems have the disadvantage in that they require equipment that is not always available, and, when it is possible to obtain it, the prices are far beyond the pocketbook of the average amateur. The author does not claim that the following procedure results in a high-



accuracy reading of the last stage's efficiency. It merely presents a graphical representation of the relation between the Grid Current (Ig), the Plate Current (Ip) and the Output Current, (Irf). The last mentioned is merely "Indicated Output Current" and is not indicative of a definite value. This will be explained below.

The apparatus used in determining the relations can be found in many amateurs' "shacks", those parts required being two 0-50 milliammeters of reasonable accuracy and one 0-3 amperescale radio-frequency current meter, (any R.F. meter of a scale larger will suffice) and a variable condenser of such capacity that it can vary the excitation available, from the preceding stage, from zero to maximum.

First, however, let us consider the purpose of this procedure. We know, of course, that tubes can stand so much loading before one, or all of its elements are ruined. The causes for this are, usually, an unreasonable power input, which results in the tube becoming "soft" or "flat", over-excitation sometimes results in melting the grid, (a rare occurrence) as well as drawing an excessive amount of electrons from the filament, thereby shortening the filament life, and lastly an overloaded filament. Too much voltage on this important element results in its burning out, as many "hams" have discovered, or seriously shortening its life. The amateur usually operates his tubes at an overload in order to obtain what he believes to be the greatest output the tube can deliver, and rarely is certain that his tubes are being treated as they should. In this article is presented a method of determining the conditions under which the tube of the last stage of a crystal controlled transmitter is operating. This article deals with the procedure and results encountered with the last stage, or final amplifier.

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Following the diagram in Fig. 1, connect the variable condenser in series with the excitation lead from the preceding, or buffer stage, to the final amplifier, which, in this test used a de Forest 503-A as "VT" in the circuit and operates at class "C". The Plate Voltage (normal) was 1,150 volts, DC and the Negative Grid Bias was 145 volts DC. (The transmitter is owned by W6FFN who found his "C" Bias some 20 volts low when the above value was determined.) Next, connect one of the 0-50 milliammeters in the "C" Bias lead, as indicated, and the other in the plate lead to the amplifier. Disconnect, or remove, the antenna load from the amplifier

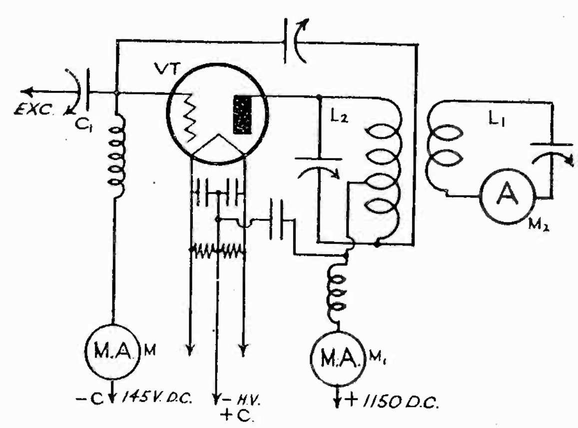


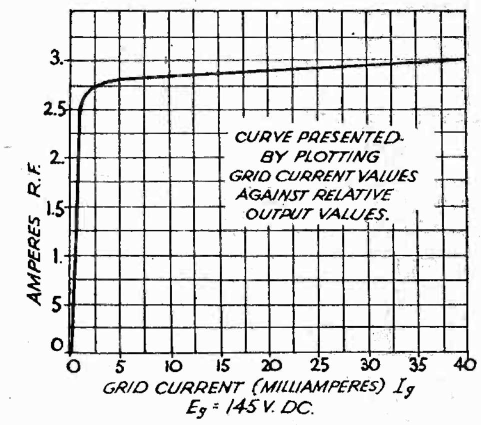
FIG. 1.—CIRCUIT USED IN DETERMINING PLATE-GRID-OUTPUT VALUES

M—0-100 MA. Milliammeter
M_1—0-200 MA. Milliammeter
M_2—0-3 Amp. RF Meter
L_1—Circuit Resonant to L_2
L_2—Final Stage Circuit.
VT—503-A Triode
EXC—Excitation Lead from Buffer
C_1—Grid Exc. Var. Condenser

tank circuit. Prepare a tuned circuit, consisting of a coil and condenser with the R.F. meter in series with one lead, as per diagram. (This circuit is simply a wavetrap with the R.F. meter in series with the condenser lead to the coil.) These instructions having been completed, the procedure follows which tells us an interesting story.

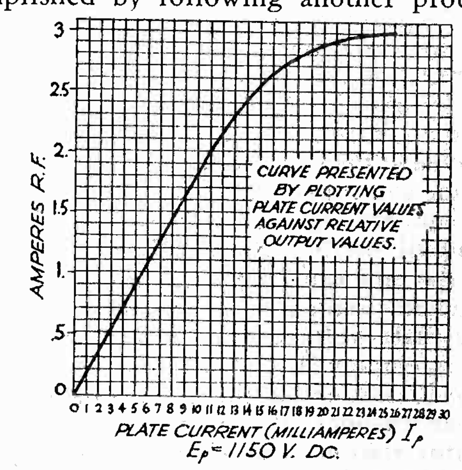
Place the transmitter in operation, and, after tuning all stages for maximum output, bring the tuned circuit (L1) into resonance with L2 by varying the condenser capacity. (Note: DO NOT COUPLE THIS CIRCUIT TOO CLOSELY TO THE AMPLIFIER TANK CIRCUIT AS THE R.F. METER IS LIABLE TO BURN OUT.) The coupling of this circuit to the tank circuit of the final amplifier should be adjusted so that a full scale reading is obtained on M2.

For convenience sake, we shall vary the grid excitation condenser so that the Grid Current drops in tens, on the meter scale. (An insulated shaft should be used to vary the condenser capacitance to avoid body capacity.) Before proceeding, jot down the Plate Current value (Ip), the Grid Current value (Ig) and the Radio Frequency ammeter value (Irf), and after every step in obtaining the resultant values, peak and then note the readings on paper. Now vary the grid excitation condenser so the Grid Current drops 10 mils, peak the final amplifier tank, note the respective meter values, record them systematically with the first readings, repeat the whole process until accurate readings are no longer possible, or until no Plate Current flows. It is understood that the main object is to decrease the Grid Current in ten milliampere steps and record the values of the respective meters, until the last reading is zero on all meters. Towards the last of the procedure, the author found that it was necessary to read the Grid Current meter, from 10 mils, in 5



mils and then 1 mil. The Grid Current-R.F. Current curve explains this. It might be well to repeat the test in order to check the original set of values.

After we have our values for the respective currents, the next problem is to make them mean something to us. This can be accomplished by following another procedure



known as "Curve Plotting". This will make our numbers show their true relations. Only the simplest knowledge of the process and slightest experience is necessary to plot a curve. Many of the readers have done this when calibrating frequency meters. The materials for this are inexpensive, three sheets of cross section paper, or "graph paper" as it is commonly known, a ruler, pencil and a French curve, or a steady hand. The author chose the Radio Frequency Current values to occupy the vertical axis of the cross section paper so that each of the three divisions is divided into tenths. The R.F. Current values are plotted against, (1) the Grid Current readings, (2) the Plate Current readings, the latter two occupying the horizontal axis of their respective graphs. All the values should be arranged so that they are in tenths or fifths. (Example: See that the Grid Current Values on the Irf-Ig curve are arranged so that 10 and its multiples are on division lines of the cross section paper.) On the Grid Current-Plate Current curve, the Grid Current values occupy the vertical axis and the Plate Current values are found on the horizontal axis. When the values are arranged on the paper (one curve to the sheet, preferably), for example, the R.F. Grid Current curve is to be plotted: Start with the lowest value, which is 0 on both recordings, the next reading is 2.5 Irf, mark this position on the paper with a small dot, the next value is 5 Ig and 2.75 Irf similarly mark this position and continue to do this for all the values you obtain. When this has been completed, apply the French curve, or draw a line through the dots, so as to form a regular curve. This was done with the values obtained in the "test" on W6FFN's Transmitter with the resultant curves, shown here.

We now have our curves. What shall we do with them? What do they tell us? With no changes in the transmitter that was subject to the test the results obtained were those actually predicted, that the Irf-Ig curve would level off. We see from this, that in the last few values, only a very slight increase in R.F. output (L1) was obtained by a relatively large increase in Grid Excitation, (25%). I. e. the R.F. Current was 2.975 milliamperes at 30 milliamperes Grid Current, and, at 40 milliamperes Grid Current, the R.F. Current was 3 amperes; an increase of 0.025 amperes R.F. with an increase of 10 milliamperes Grid Current. On the other hand, at the lower portion of the curve, we find that an increase of .5 mil, over .5 mil increases the R.F. Current output to 2.5 from 1.5 amperes, an increase of 1 ampere R.F. with an increase of only ½ mil Grid Current, a relatively great increase in output resultant from a small increase in excitation. This tells us that in the lower portion of the curve, the tube can receive more excitation with a high degree of efficiency, while in the upper portion of the curve, the tube is being given just about all the excitation it can handle. Increasing the Grid excitation, at this part of the curve, will result in a very small R.F. increase and will do no good as we can readily see that farther on the curve, the R.F. Current is not increased by an increase in Grid excitation current, if anything, the R.F. output will drop off if the tube is given much more excitation current. The conclusion, in the case of W6FFN's transmitter, was that the tube was operating at a safe point relative to Grid excitation. Our R.F. Current output-Plate Current input curve, being a function of the Grid Current, corroborates the statement above, as it also comes to a level, while the Grid Current-Plate Current curve plainly shows that, at the upper portion of the curve, an increase in Grid Current will not cause the tube to draw many more milliamperes of current, indicating a loss of efficiency in the whole system if this is attempted, as the increase in Grid Current does not increase the R.F. output current appreciably, and the resultant increase in Plate Current only serves to overheat the tube, the loss in efficiency assuming the form of heat. However, if the R.F. Current output curve does not come to a level, but ends, pointing upward, then the tube can take more excitation. In this case, the excitation should be increased and then the test repeated and a new set of graphs drawn, which, if the excitation has been increased sufficiently, will take the form of those shown here. If not, more excitation is required and should be added until the curves do come a level. The proper excitation should be a value just off the level portion of the curve, i. e., reduce the excitation until it corresponds to that part of the curve which just approaches the level portion. (At the upper part of the curve, of course.)

The reader possibly questions the reading "3 amperes RF output from an '03-A type tube", which in this case was biased to class "C" and had plenty of excitation. The circuit "L1" is merely an indicator of maximum output of the final amplifier and does not, in any way, indicate the true output of that stage in watts or otherwise. It is safe to venture that if the curve, obtained from the R.F. Current output-Grid Current values, levels off, as did the curve on W6FFN's transmitter, the tube and the amplifier circuit are doing their utmost in power output.

THE foregoing data was accumulated when the final amplifier was operating at no load. In this particular instance, the Grid Current dropped a few mils when the load (Single wire fed Hertz) was applied. Therefore, in order to obtain a check on the operation of the final amplifier running at load; which, after all is the important objective, the procedure was repeated while the amplifier operated at that condition. The resultant curve (Irf-Ig) shown here verifies the conclusion reached in the first "run"—that the amplifier was running properly. The main curve (Irf-Ig) coming to a level at maximum reading on the RF meter, at maximum Grid Excitation, not at a lesser value, plainly tells us that the final stage continues to operate properly when loaded. As noted before, if this does not occur, then more excitation is required.

In applying this method to the transmitter of W6FFN, a factor entered into the procedure which affects the results slightly, however. Mr. Fisher's transmitter operates in the 3.9-4.0 mc. phone band and the final amplifier is modulated thoroughly by a W.E. 212-D in the conventional Heising Plate system. So, when the excitation to the last stage neared the zero point, the plate voltage on the 503-A increased approximately 100 volts which, in turn, affected the output of that tube positively. That, however, is believed to be of relatively small consequence in the accuracy of the results. The object of that statement is to warn the hams, who apply this test to their phone rigs, to watch their modulator tube (as it also receives an increase in plate voltage) which, if unnoticed, might be ruined.

Mr. Merle E. Monia (W6FDM), Mr. A. V. Roper (W6EQJ) and W6YBB, Pasadena Junior College, have applied this method to their respective final amplifiers with success.

W6FDM found his final stage to be operating properly, W6EQJ learned that the last stage in his transmitter was functioning at a point slightly below that required for proper output, while W6YBB, Russell N. Skeeters, discovered that the 210s push-pull, in the final, were considerably starved for excitation. The exciting stage uses a 247, which doesn't seem to do "the job", although it was running at "rating" at the time of the test.

In the plotting of the curve resulting from the R.F.-Plate current values, W6EQJ found that the curve apparently ended pointing vertically. Realizing that something was "amiss", the author enlarged the curve and found that, at the last two values, the curve leveled off, as it should. But the level portion was not of length great enough to justify a conclusion that the final amplifier was operating properly.

If the reader comes to a similar problem, should you perform this experiment, it might be well to enlarge the curves offering difficulty in interpretation. (Enlarging the curve is accomplished simply by allowing the values, for the portion involved, to occupy larger units of the curve paper.)

In the event that you, who read this article, apply this test to your respective transmitters, your results (all data) will be greatly appreciated by the author, who requests that you send it to his address.

The author wishes to take this opportunity to thank Mr. C. N. Fisher, W6FFN, for his cooperation in verifying the above practice, which was merely theoretical until the time it was applied to his transmitter.

Col. Foster's Comment

(Continued from page 4)

total for the serious contemplation of anyone who knows what such an army of citizens can say when it chooses to speak. An army of ONE MAN enlisted the cooperation of public-spirited senators and brought about the dissolution of an 8-billion-dollar trust and took from it its chief weapons that had been used for intimidating and plundering a great industry!

But Big Business dies hard. It may be adjudged to be organized and operating in defiance of the law, and it may be by law split up into its component parts, but still retain much of its influence in governmental affairs. The prime object of Big Business is not economy in operation but monopoly of all business in its line to exact from the public exhorbitant returns in money. A concomitant objective is to perfect its monopoly by subsidizing or otherwise exercising a control over departments of government. This influence does not die immediately with the legal death of the trust. Much of it lives on to harass the legitimate operations of all businesses that tend to lower the profits of that trust's component parts.

And so it is that the amateur radio stations must continue to battle for their right to serve the public. Just now the theatre of war encompasses the international telecommunications convention that was held last year in Madrid. Representatives of American communications corporations caused to be adopted at Madrid an absolute prohibition against the long-established practice of American amateurs of handling radiograms free of charge for people in foreign countries and their families in the United States. If the United States Senate should ratify the amateur restrictions of the Madrid convention this great and growing free service to our people would be completely wiped out.

It remains to be seen whether our Senate will permit this service to be destroyed. My own conviction is that the Senate will act for the people and not for the private interest of Big Business. Our Senate has just done the greatest single service for our people. It has dragged into public view some of the slimiest specimens of Big Business and disclosed how the public has been mercilessly robbed by men in high places. And these were only specimen exhibits. Big Business is full of such specimens. Many Big Businessmen have been kept out of jail by the efforts of their high-priced lawyers—these same fellows who now declare that Congress acted unlawfully when it enacted the measures under which the NRA is operating; many have gone to jail notwithstanding; many there are whose guilt will never be uncovered. But the signs are not lacking that this type of men are fast losing their grip on the functions of government and that the people themselves are having something to say about the use of their own air.

So, this is a great Christmas!

Band Pass Filters

THE growing tendency toward the use of triple and quadruple tuned intermediate frequency transformers is to be commended. The band pass filter allows us to obtain increased selectivity and at the same time to REDUCE side band cutting which eliminates the higher audio frequencies which are so essential to realism and fidelity of radio reproduction on both voice and music.

The 77 and 78 as Electron Coupled Oscillators

THE 77 does well as an Electron coupled oscillator because the external screen around the plate is connected to the internal screen. However, in the case of the 78 the external screen is tied to the cathode, which, in the Electron Coupled circuit, is above ground to RF, and therefore causes trouble.

40-Meter Crystal Oscillators

By W. W. SMITH, W6BCX

THE average amateur has come to look upon a 40-meter crystal as something that is all right in a circuit diagram, but not in a set. There are many reasons for this belief. In the first place, there seems to be on the market but one holder that has been specifically designed for use with 40-meter crystals. Manufacturers were quick to take advantage of the fact that a good 80 or 160 meter crystal is not at all "fussy" as to the holder, and have put more stress on appearance and price than on suitability for 40-meter operation. Consequently we have sundry fancy-looking holders that work very well—on 80 and 160—available at very reasonable prices. Many an amateur has made the mistake of presupposing that a 40-meter plate should work satisfactorily in a certain holder just because it "worked FB on 80".

Lack of operating data has been responsible for much misuse of 40-meter plates, and has discouraged many an amateur from even attempting to use one. It is safe to say that 90% of the 40-meter plates in use today are handicapped by improper operating conditions other than a poor holder.

And then, unfortunately, not all of the 40-meter plates sold today will deliver good output even when operated under ideal conditions. It is not enough for a 40-meter crystal to "oscillate"; it must be a **free** oscillator and stand a reasonable amount of loading without going out of oscillation. Such a crystal must necessarily be ground with a very high degree of precision. If you have a 40-meter plate, and, after all the suggestions and precautions given in this article are heeded, it refuses to settle down to the job of putting out stable watts of 40 meter RF, you had best put it away, along with the collection of defunct 210's. Nothing is more aggravating than a cranky 40-meter crystal that requires constant "babying".

First, we will take up the question of a suitable holder; a good holder is a prerequisite for good output. Very few of the manufactured holders have electrodes that have actually been lapped flat. And those that are correctly lapped usually have their bottom plate slightly warped by the tightening of the machine screws that hold the assembly together. The surfaces of the electrodes must be more accurately finished for 40-meter operation for the same reason that the allowable thickness tolerance is much less for a 40-meter crystal than for an 80. Most manufactured holders have a rather heavy top electrode, large enough to completely cover a one-inch crystal, and held against the crystal by spring pressure. A 40-meter crystal requires a very light top electrode with no additional spring pressure for maximum output. Most 40-meter plates are cut a bit under one-inch square to make them stronger mechanically, and because it is not necessary for the top electrode to completely cover the crystal. The top electrode can be cut down to ¾ inch square (or round) to reduce the weight on the crystal. The spring pressure is not necessary for stability unless the transmitter is subjected to severe vibration, and connection can effectively be made by soldering a small wire to the top electrode, thus eliminating the connecting spring and the pressure exerted by it upon the crystal. The faces of a 40-meter crystal are practically flat, and if the surfaces of the holder electrodes are as flat as they should be, the top electrode will not tend to "rock" on the crystal.

An excellent top plate can be made by taking a five-cent-piece that has been worn smooth and grinding down one side until it is just thick enough to hold a flat surface (about .03 in.). The finishing grinding can be done with fine abrasive on a piece of plate glass. The glass will wear down faster than the coin, but the nickle can be ground reasonably flat on the side of a wheel or on an oil stone and not much grinding on the glass is necessary.

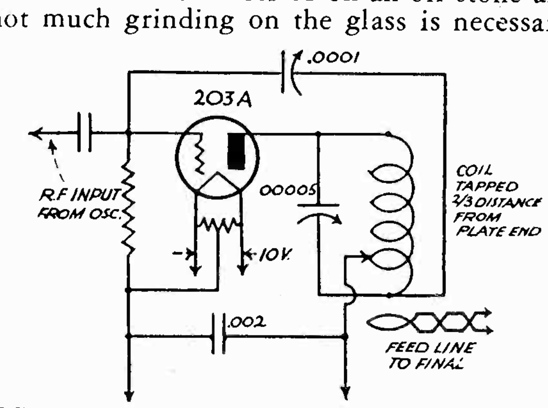


FIG. 1.—A single 03A is a fine frequency doubler at frequencies up to 14 MC. This circuit shows a regenerative doubler which will put out close to 100 watts on 20 meters when excited by a 40-meter crystal oscillator.

A single length of No. 36 or No. 38 wire should be fastened to the plate with a drop of solder. Cooling of the solder may warp the plate slightly, and it is therefore a good idea to touch it up on the glass again after making the connection. If heavier wire than No. 36 is used to connect to the electrode, the output will be reduced. Heavy wire tends to mechanically dampen the oscillations.

Before placing the crystal in the holder, the edges should be examined very carefully for nicks. A nick that is almost invisible to the naked eye will sometimes have an appreciable effect on the output of a 40-meter crystal. If the edges show that they have been chipped, the crystal should be returned to the manufacturer to have the edges refinished. If the edges are all free from nicks, the crystal can be washed carefully with soap and water and placed in the holder. Attention can then be given to other details of the oscillator.

Although a 40-meter crystal will perform in the new "triode-tetrode" oscillator circuit using a 59 tube, many amateurs seem to have difficulty in getting the bugs out of the circuit. Under certain conditions the crystal insists upon heating excessively, and 59's are likely to "go crazy" from grid-emission when fed over about 350 volts. When using a 40-meter crystal for harmonic operation, the best plan is to use the conventional 47 oscillator circuit and use over-biased, high-mu tubes with low "C" tanks for frequency multipliers.

The tank circuit of a crystal oscillator on any frequency should preferably be low "C", but on 40 meters it is **absolutely necessary** for respectable output. A good tank can be made by space-winding number 16 enameled on a two-inch form and using a .00005 mfd. midget for tuning. The coil should not be placed closer than several inches to any shielding, if it is used.

While either 25,000 or 50,000 ohms seem to work equally well for the screen dropping resistor on 80 meters, the higher value is preferable with a 40-meter crystal. The grid resistor should also be a bit higher for 40-meter operation—10,000 ohms being about the minimum for a 47. Wire-wound resistors will work without series RF chokes, if the distributed capacity is low and the number of turns of resistance wire is such that the resistor itself acts as an effective RF choke at the operating frequency. The small, manufactured chokes of the sectional-wound, grid-leak mounting type are very effective at 40 meters, and it is a good idea to use one in series with the grid resistor even if a carbon resistor is used.

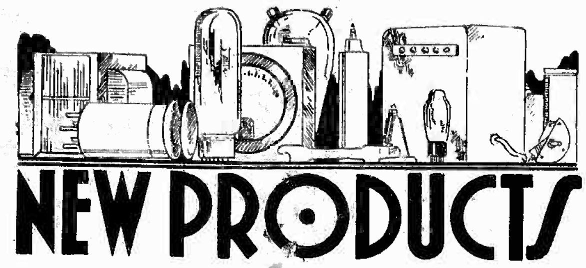
When using capacitive coupling to the next stage, it should be remembered that capacitive reactance changes with frequency, and a considerably smaller coupling condenser must be used to compensate for the increased effect of the grid-filament capacity of the tube in the next stage. If too large a capacity is used, the oscillator will be loaded too heavily for best operation. When feeding a 46, about .00001 mfd. is sufficient!

We will not attempt to give the maximum safe crystal current in RF mils, because very few amateurs have an accurate RF milliammeter. A crystal current that corresponds to 450 volts on a type 47 oscillator, **loaded** and tuned to slightly more than **minimum plate mils**, is a safe value for continuous operation and will not heat the crystal enough to cause noticeable drift. It is advisable, however, to use a lower value of plate voltage for the preliminary tuning. The frequency drift for a given change in temperature is twice as great as for an 80-meter crystal of the same cut, but as the drift is multiplied by two when doubling, the actual frequency shift at 40 meters will be the same for an 80 as for a 40-meter crystal.

When screen-grid tubes are available for buffers, a beautiful 40-meter rig can be made by using a 40-meter crystal and working "straight through" with push-pull throughout. If the tube following the oscillator is a triode working at the same frequency, extreme care must be taken to see that it is perfectly neutralized at all times in order to prevent

(Continued on page 34)

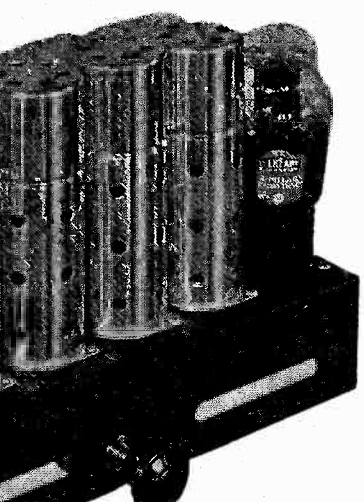
NEW I. F. AMPLIFIER
By McMURDO SILVER Opens Wide Field for Amateurs, Set Builders and Experimenters . .



T.R.F. Receivers
Can Be Converted Into Superheterodynes by the Addition of this New Amplifier . . . . .

The laborious and costly old-fashioned means of building superheterodynes gives way to a new simplified method of construction which has met with instant success.

NO LONGER is it necessary for the set builder, amateur, experimenter, engineer, service-man or manufacturer to be confronted with the problem of chassis-building and drilling, bothersome layout and design of superheterodyne construction, etc. The problem is made simple with the introduction of an assembled I.F. superheterodyne amplifier unit, announced by McMurdo Silver of Chicago.



"RADIO'S" Superheterodyne Unit as manufactured by McMurdo Silver of Chicago. Note compact placement of parts, permitting short, direct connections. The elongated slots on the front and sides of the chassis-base permits use of any desired number of controls.

This new I.F. Unit, pictured here, consists of three air-tuned intermediate transformers and a beat-frequency oscillator, on a common steel chassis, on which is also mounted a group of tube sockets and shield cans.

Previously, those who desired to build a superheterodyne receiver, or those who wanted to bring an old receiver up-to-date, were required to go into the open market and purchase separate transformers, oscillator coils, tube sockets, shields, etc. It was also necessary to buy a piece of sheet iron or aluminum, take it to a sheet-metal shop to have it formed into the desired size and shape, and last, but not least, another trip to an Electroplater who would give the chassis the finishing touches.

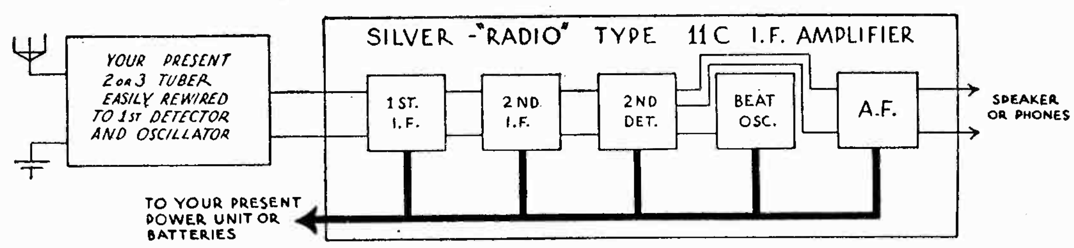
Too often it was found that the receiver, when completed, did not give the desired results. The parts were not spaced correctly, neither could the arrangement of parts be altered, nor circuit changes readily made. The many obstacles thrown in the path of the superheterodyne experimenter were the cause of much discouragement; prices for good air-tuned transformers, chassis and other essential parts, mounted to a substantial figure.

Thus the Engineering Laboratory Staff of "RADIO" undertook to design something revolutionary simple in super-heterodyne construction. The new Unit as manufactured by McMurdo Silver is the result. This versatile item lends itself to any type of superheterodyne construction, for it is the heart of the receiver. It saves the set builder many hours of labor, enables him to build a receiver to his likening, gives him all of the essential I.F. components on a common chassis, factory-built and designed, and all parts are correctly placed and spaced for best results.

If new tubes are to be tried, it is merely necessary to remove a few machine screws and insert a different type of tube socket. If a crystal filter is desired, the constructor merely adds this stage to the I.F. amplifier. If phone reception only is desired, the beat-frequency oscillator is disconnected from the circuit.

Any number of volume controls, gain controls, sensitivity controls or other adjusting devices can be secured to the chassis. The shafts of these controls extended through the elongated slots which are stamped into the front and sides of the chassis.

The Unit is designed so that all leads are of the shortest length. The air-tuned I.F. transformers are in square shield cans. The Unit can be housed in any kind of a cabinet, or made part of a relay-rack assembly.



Showing the "heart of the superheterodyne—the Intermediate Amplifier. Those who desire to bring an old-type t.r.f. receiver up to date need but add this new SILVER Unit, resulting in a modern superheterodyne with tuned-radio-frequency ahead of the detector. Air-Tuned I.F. transformers in the SILVER I.F. Unit make for utmost efficiency.

Each month in "RADIO", beginning in the January issue, complete constructional data and wiring diagrams will be shown for the many different purposes to which this Unit can be applied. There will be complete information on simple battery-operated supers, 6-volt types, A.C. supers of many descriptions, extremely advanced amateur type crystal-filter supers, rack-and-relay supers and receivers for special purposes, such as portables, shipboard and commercial designs, etc. Other editorial material will tell how to adapt this unit to the many types of T.R.F. receivers now in use, so that these receivers can be rebuilt into modern 1934 superheterodynes.

Some of the supers which will be described in "RADIO" are of more than ordinary interest, because they incorporate features not yet found in receivers of this type.

Tube Technique

By JAYENAY

The Carbon Screen On the 57 and 58

ON the inside of the glass envelope of most 57 and 58 type tubes will be found a thin layer of carbon. The purpose of this coating has long puzzled us all. The secret is out, at last. This screen prevents reflection of the heat radiated from the interior of the tube, back into said interior. I wonder why this process has not been used on the later types of tubes? At any rate, this carbon coating is credited with causing that bothersome blocking which has been observed when these tubes are used as amplifiers on 60 megacycles, truly unfortunate when we realize that these tubes are about the only satisfactory ones to use as amplifiers at ultra-high frequencies.

At Last—A Big Brother To the 46

THE National Radio Tube Co. of San Francisco has announced a zero-bias fifty-watter with many desirable features. This new tube, whose designation is the NCB, has a graphite plate and is rated at 100 watts dissipation. The tube is designed particularly for class B use (both at audio and radio frequencies), and operates without bias in somewhat the same manner as the 46 and 59 in the lower-powered field. However, there is one marked difference between this new development and th older types of zero-bias class B tubes. The NCB has the new "Dual-Unitary grid" which allows wide excursions into the positive region without intercepting excessive grid current. This feature becomes more evident when one realizes that only about 3.5 watts of excitation power is necessary to obtain an honest 200 watts of audio power from a push-pull pair of these tubes operating in class B.

This tube also does well as a class C amplifier. A small amount of grid-leak bias proves satisfactory to reach twice cut-off for phone work. No fear of fireworks need be felt by the operator who uses grid-leak bias alone because the loss of excitation merely brings the bias to zero, which, in itself, is very close to cut-off. A new type of press and stem eliminates failure at this point due to electrolysis, and the plate, grid and filament leads have wide separation.

Frequency Doubling Is Hard On Tube Filaments

MANY amateurs have complained that tubes used as frequency multipliers seem to have a short life when operated under conditions of plate voltage and current that are not damaging to the same type of tube when operated as a conventional RF amplifier. This condition is largely due to the fact that the usual form of plate doubler operates in extreme class C. When a tube operates in extreme class C the bias can equal from 2 to 5 or more times cut-off. This causes plate current to flow for only a very short portion of each cycle, and consequently the PEAK plate current can amount to as much as 200 times the observed plate current, read from the usual plate-current milliameter. If this high value of peak current exceeds the tube's rated filament emission, it will not take long for the filament to lose its ability to emit electrons. Therefore, it pays to operate doubler tubes at conservative values of OBSERVED plate current.

Graphite Plates In Transmitting Tubes

THIS type of plate is rightfully finding wide use in both amateur and commercial transmitters. While momentary overloads can cause the release of gas from this type of plate material, it has been found that this occluded gas is reabsorbed into the cooler portions of the plate when the overload has passed. The presence of carbon in a vacuum tube has long been recognized as a desirable way to keep a tube "hard." The carbon, if cool, has a tremendous faculty of absorbing undesired gas, which otherwise would cause ionization.

Complete Tube Data in Handy Form

TAKING into account the great multiplicity of tubes during the past year, the Hygrade Sylvania Corporation of Emporium, Pa., has just issued a bulletin containing all the tube data required by the engineer, service man and experimenter or amateur. The bulletin divides the many existing standard tubes into various groups, such as the 6.3 volt group for A.C. or D.C. operation, the 2.5 volt group for A.C. or D.C. operation, the 2.0 volt group for battery operation, special tubes including many of the former popular types which have now disappeared from current radio sets and amplifiers, and finally the rectifiers. The data includes type number, use, base, bulb size and design, cathode description, filament amperes, maximum plate voltage, maximum screen grid voltage, working plate voltage, negative grid voltage, screen voltage, plate current, plate resistance, mutual conductance, amplification factor, ohms for stated power output, and undistorted power output. The bulletin includes a bottom view of the bases of all standard tubes,. indicating the elements connecting with the various prongs, as well as top cap. There is also a diagram of the various glass bulbs together with dimensions, for the convenience of those designing or building compact assemblies and tube shields. The latest tubes are described at length. The bulletin will be sent to anyone on request.

I-TAPPA-KEE News

THE AMATEUR'S LEGION OF HONOR

This department is edited by the Hi-Kilowatt of the ITK Radio Fraternity, J. Richard Meloan (Jo) radio W6CGM-W6ZZGM-KERN, 1302 "M" Street, Bakersfield, California.

All communications concerning The I TAPPA KEE RADIO FRATERNITY, as well as inquiries from any amateur as to the Requirements for Membership, should be addressed to I TAPPA KEE HEADQUARTERS, either to the Secretary-Treasurer, Kenneth M. Isbell, W6AMR-W6BOQ, 5143 So. 6th Ave., Los Angeles, or to The Hi-Kilowatt, J. R. Meloan, W6CGM-W6ZZGM, 1302 "M" Street, Bakersfield, Calif.

FOR many years the Amateur Division of the I TAPPA KEE RADIO FRATERNITY has not, in any way, publicized its activities, inasmuch as its members have been quite satisfied with the small, but high quality ITK "happy family". This year the news of the successful operation of the fraternity has spread so rapidly by "grapevine radiotelegraph", and the resultant inquiries have caused a change of policy in ITK that we have decided to make the ITK brotherhood available to all amateurs who can meet ITK requirements for membership. This does not mean the letting-down ITK standards. We will continue to choose each man carefully, and he will be thoroughly investigated and properly pledged before being voted upon. Much of the success of ITK lies in this discrimination in the choosing of its members. It is not a free-for-all association, an I TAPPA KEE man represents the best in amateur radio. It is indeed the "cream of the crop" among amateur radio operators. That is why it is an honor to be invited to join ITK, to become a brother in this fraternity of regular fellows, who extend you real friendship and who are a credit to amateur radio as operators.

"RADIO" has been chosen by I TAPPA KEE as its world-wide mouthpiece for the dissemination of its news, achievements, activities, etc. The reasons for choosing "RADIO" is because of its fair and honorable attitude toward the amateur, its willingness to unselfishly help him, to contribute its efforts to his edification and general welfare, and to assist him in his march of progress. Secondly, "RADIO" best expresses the spirit of I TAPPA KEE. On the staff of "RADIO" our fraternity finds men of wide radio experience, all of them "born" radio operators with excellent both commercial and amateur radio operators' li- records of real achievement. Each of them hold commercial and amateur radio operators licenses, and each has an active amateur radio station in operation. "RADIO" reaches amateurs all over the world, especially the I TAPPA KEE kind of radio operator. "RADIO" will henceforth contain I Tappa Kee News, ITK station descriptions to which each ITK man will contribute. Secret ITK information will reach ITK men in bulletins as in the past. No change will be made in the policy of maintaining the ITK constitution, etc., strictly confidential to ITK members only. Information concerning the joining of I Tappa Kee and its membership requirements will be supplied to outsiders, who may be interested, by I Tappa Kee Headquarters.

ATTENTION, ALL ITK: Big XMAS QSO Party is scheduled for the holidays. Open to all ITK members. Dates: Xmas Morning to Midnight New Year's. All band operation. Call "CQ-ITK", and answer same call. Scoring will be as follows: 2 points for each ITK worked. 1 point for each ITK heard but not worked. 3 points for each 10 minute rag chew. 3 points for an exchange of any traffic both ways. 5 points for each three-way QSO. Multiply total score by the number of U. S. Radio Districts in which you worked ITK stations. Then multiply this total, by one of the following power factors:— if you use 30 watts input or less, multiply by 4. If you use 30 to 100 watts input, multiply by 2. If transmitter input is 100-300 watts input, multiply by 1.5. Any greater input by factor 1. If your input varies during the contest, figure your average power input to transmitter. 25 extra points goes to the man working an ITK at the greatest distance. To the winner of the entire contest, the fraternity man who makes the highest score, goes an Xmas present prize. Let's go! Here's hoping Santa Claus brings all you need for a fb station, so you can work at peak efficiency during this contest.

W2BPY, Bob Maloney, Perth Amboy, N. J., wants ITK skeds on 7mgc. Would like to work the California gang direct as he arrives home about midnight (E.S.T.) and that's a fb time to reach the coast in the wee' sma' hours. Bob started pounding brass when he was 13 years old and has achieved quite a few honors; among them are the ROWH, ORS, RM and Secretary of the Raritan Radio Club for the past three years. W2BPY will be active in organization of new ITK chapters on the East Coast.

W6DVD-WLVD, Oroville, Calif., one of the most enthusiastic members of ITK, recommends some fine ops for ITK candidacy . . . W6CKO-WLVK, Frank Ackerman of Colfax, Calif., handles about 600 messages of traffic per month . . . W6DJS has 211E in final stage . . . W6EDW big traffic man of San Pedro "Where Your Ship Comes In" uses 200 watts input on his CC rig . . . W6CGM-W6ZZGM Hi-Kilowatt undecided which call to keep under the new laws. Making a radio op of new wife in the hope that she can get one of them . . . W6ETM is CCC Radio op at Marysville, Calif., while W6BSV is chief op at the CCC station WUBB at Redding . . . W6AKW concerned with the fertility of Mabel, his pet bovine . . . W6AAN, age 39 (looks much younger), bank credit man, SCM of Los Angeles section, quite handsome . . . W6FAC and W6CGM argue over who has the best YF (lucky wimmen) . . . W6FAC "Wag" has new fb station with Super Het Receiver . . . W6DZN has been lumbering in the Mts. S'gud for your health Herb . . . W6AUJ Western Union Tel. op at Napa active on 7500 k.c. . . . W6EGS, one of youngest and best ITK ops, QSO him . . . W6BIJ, heard on WPDA police radio at Tulare, Calif. "Calling all cars, calling all cars—both of 'em" . . . W6DQA, Porterville, Calif., recently elected Alt. SNCS of AARS for Central Calif. . . . W6CVL is powerhouse operator at Northfork in California's high Sierras . . . W6AMR-W6BOQ, Secretary of ITK works at KFI-KECA and has several new transmitters on 7.5 mgc mostly . . . Captain Woolverton, Chief Signal Officer of the 9th Corps Area, U.S.A., W6PQ-WLV, is going on three months' vacation. Is active in the ITK . . . W6RJ, "Mac", the Captain's right hand man, one of the finest fellows we ever met and a typical ITK fraternity brother of whom we are proud.

ITK members remember to report to ITK headquarters the fifteenth of each month and include in your informal report . . . operating ideas, suggestions, news, etc., for use in this department in "RADIO". Private ITK information of confidential nature will reach you as usual in the ITK Bulletins and via ITK communication channels on the airways by ITK secret cipher code.

W8OQ, Shelby, Ohio, W9FI, Maywood, Ill., W9EGE at Connersville, Ind., are some of the original ITK charter members of the first ITK Amateur Division chapter organized in 1926 and are still active and going strong.

W6DYJ, formerly of San Pedro, now resident of Lomita, Calif., is a relatively new ITK brother and comes into the fold well-recommended. Ed is a real old-timer and first went on the air back in 1913 with a beautiful raw spark, which was induced to jump between two points, the object being to see how much noise could be made in the house. Those were the days of "audio frequency" when your signals were more often heard traveling the sound waves. Jamming the ether with a note some kilocycles wide was of no consequence. Who cared, anyway? W6DYJ's application to ITK was so modestly written that we had to turn loose the ITK Secret Service on Ed to find out what a swell op he really is.

We tell this one on W6EDW of San Pedro: One summer afternoon in Los Angeles, Lewis chased a car all over town believing it to be W6CGM-The Hi-Kilowatt, such belief being based entirely on the fact that a gorgeous yl was seated next to the driver of the mystery car. (Thus identifying W6CGM, so thot EDW). After a mad chase, Lewis crowded the pursued car to the curb (going to have some fun Hi.) when much to his humiliation the driver turned and called EDW some nasty names. It was not W6CGM. Was his countenance inflamed and did W6EDW betake himself hence most rapidly? Hi.

The WIMU Radio Association, comprising outstanding amateurs of the four states of Wyoming, Idaho, Montana and Utah, are interested in becoming an ITK Section for those states and invite ITK representatives to meet with them at their next annual meeting this summer.

I. T. K. Station W6ENH

I Tappa Kee radio station W6ENH is owned and operated by Cleetis Armistead ("Army"), at 256 Jefferson street, in Bakersfield, Calif. It has been on the air since 1928 when the signals of W6ENH first emanated from a single 210 in a low-C Hartley circuit. The usual ham experimenting and operating then followed, and in 1929 when High-C circuits became quite the thing this improvement was made; later another '10 was added as the owner became more prosperous (slightly before depression Hi.). The crash came, and W6ENH dropped to three '45's in parallel in a TNT circuit and discovered, as others have, that as much and perhaps more output than previously is secured; at least dx and traffic handling were not impaired. This is the transmitter shown in the foto.

At present a 50-watt Hartley is being used at W6ENH. This is the official transmitter of the local USNR Unit and was formerly used as W6KE. Much experimenting is being done with short-wave radio in the forest service. Schedules are being maintained with portables at forest camps, with W6ENH acting as key station. In addition to these tests considerable service has been rendered to individuals.

The Antenna is a 7 mgc. Zepp, voltage-fed, with 32-foot feeders and a flat top of 64 feet, pointing north and south it seems to put the best signal into New Zealand and Australia. No difficulty has been experienced in working the Orient, while contacts with South America have also been satisfactory. The receivers at W6ENH are three in number. The first . . . an REL 3-tuber, the second . . . an AC Pilot Super-Wasp and the third . . . a newly-acquired National FB7.

Personally, "Army" is a popular Bakersfield amateur and has been active in amateur activities. For the past four years he has been Secretary of Bakersfield Short Wave Amateur Radio Club. In the USNR unit he is an executive officer with a radioman 1st class rating, and has been particularly active in naval radio work for almost four years. During the Southern California earthquake he handled almost a thousand messages. "Army" holds both an Amateur First Class and a Radiotelephone First Class License. He is 29 years old, married and proud of a little junior op. W6ENH is heard on the air consistently, is known for its reliability and has a welcome sign over its door for all visiting hams.

A New Low Cost Commercial-Amateur Single Signal Super-Het

By McMURDO SILVER

AN amateur radio station is no better than its receiver, for there is no profit in pumping out a 10,000-mile signal if one has only a 1000-mile receiver. Likewise, the use of an efficient receiver means the ability to work low powered transmitters over greater distances, and if good receivers were generally employed, lower transmitting powers with lower costs would give even better results than are today had from high transmitter powers when working to inefficient receivers.

A year ago everything was wrong with amateur receivers. The typical RF stage, regenerative detector and an audio stage or two left everything to be desired—sensitivity, selectivity and signal to noise ratio. But in the last year the superheterodyne has gained popularity in its simpler forms, with great benefit.

Today, however, the shortcomings of these earlier experiments in amateur superhets are beginning to be realized. In looking over the popular amateur supers available today, four things are wrong.

Deficiencies of Amateur Super-Hets

1. The first mistake is the use of plug-in RF coils, subject to damage, dirty contact pins, worn socket contacts, and inconvenience and delay in shifting bands. The obvious remedy is the use of suitable permanent coils, selected by a well-designed switch protected from dust, dirt and grit.

2. Not one popular amateur superhet today uses a tuned RF stage preceding the first detector—an absolute necessity to eliminate image (repeat spot) interference from commercial services just outside the amateur bands. The answer is to use one—it's absolutely necessary, as owners of sets not so equipped know today to their sorrow.

3. Band spread tuning is a vital necessity, of sufficient spread to really make tuning over any amateur band easy. It is usually obtained by special plug-in band spread coils, an expensive solution in terms of doubled coil costs alone if coverage of anything else besides amateur bands is desired. The solution is to provide a vernier tuning adjustment available anywhere in the receiver frequency range, and adequately fine enough to really spread the amateur bands well out.

4. Last but not least, available supers are supplied less speaker, assuming that any old "cat and dog" speakers found in the surplus junk shops will have to do the job. The answer is to include a good matched speaker in the receiver design—maybe this is a too obvious solution?

Remedying These Defects

AFTER considering these only too obvious defects, and talking with many operating amateurs, the receiver described and illustrated herewith was designed. It eliminates all these defects, and so far as is known, all of their correlory deficiencies. Some success was apparently attained, as the first of these receivers to be built went to the U. S. Signal Corps for use on one of the heaviest of the Army Message Center's Traffic Circuits.

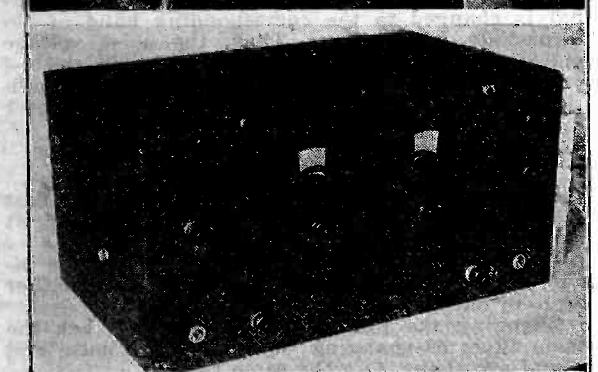
The receiver itself tunes from 1550 to 30,000 kilocycles, covering all five amateur bands that a super may be satisfactorily used on. This it does in three steps on one dial, using three separate sets of RF, first detector and oscillator coils and separate padding capacities picked up by a six gang, three-position switch identical in construction to those used in the Byrd Expedition voice communication receivers—as for that matter are the entire RF, first detector and oscillator circuits.

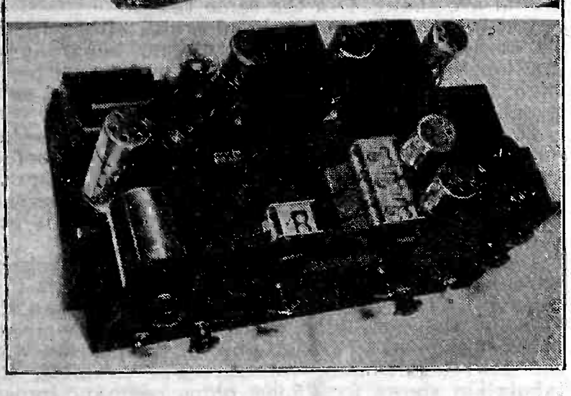
Band spread tuning at every point in this range is had by an oscillator vernier condenser on the left hand 6:1 automatic takeup gear drive vernier dial. This band spread is 200 degrees for the 160 and 80-meter bands—40 degrees for the 80-meter phone band alone, 100 degrees for the 20 and 40-meter bands, and nearly 100 degrees for the 10-meter band.

The circuit consists of a '58 tuned RF stage having separate antenna primaries for doublet antenna use, a 2A7 electron coupled oscillator and tuned first detector, two '58 air tuned 465 KC IF stages, '56 second or audio detector, '58 electron coupled audio beat oscillator, '59 three-watt output pentode and 5Z3 power supply rectifier. The set is entirely AC operated, absolutely humless on phones or speaker, and has its own special matched 8-in. Jensen dynamic speaker.

Its sensitivity is below 1.0 microvolts absolute—actually about ½ microvolt absolute, its selectivity without crystal 22 KC wide 10,000 times down, or absolute 10 KC as it is generally called. With crystal filter its selectivity is 50 cycles, not kilocycles.

(Continued on page 29)

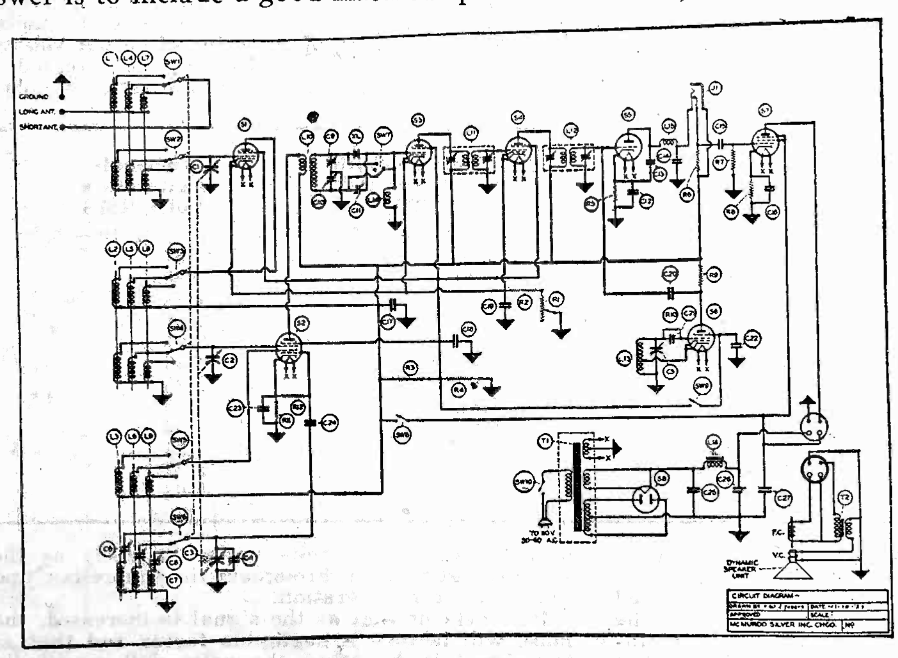




Upper Illustration
The McMurdo Silver MASTERPIECE II Receiver in operation at W6USA. The operator is Mr. Sitters, chief of the station. Standing behind him is McMurdo Silver. Four of these MASTERPIECE II Receivers serve as official all-wave broadcast-emergency communication receivers of the Byrd Expedition.

Center Illustration
The exterior view of the new McMurdo Silver 5B Amateur Single-Signal Super-Heterodyne.

Lower Illustration
Interior view of the McMurdo Silver 5B.



Circuit diagram of the McMurdo Silver 5B.

RADIO's Practical Data Sheets

DATA SHEET NO. 12

Influence of Circuit Constants on Receiver Output Noise

From an Engineering Bulletin Issued by R.C.A. Radiotron Co., Inc.

THE effect of circuit constants on the noise output of a radio receiver is discussed in this bulletin.

It is well known that extraneous noise in the output of a radio receiver may be caused in several different ways. A few of these are:

(1) Atmospheric static
(2) Power supply noise
(3) Man-made static
(4) Poor connections
(5) Defective or poor quality parts

There are, however, other noise sources which persistently remain after the above sources have been eliminated. These become evidnt as a steady hissing sound when the receiver sensitivity is high. When an attempt is made to eliminate these sources of noise, it is found that a certain minimum remains which approaches the value predicted theoretically as due to thermal agitation and "shot" effect.

Thermal-agitation noise is supposed to be due to the random movements of electrons within a conductor. It has no particular frequency, but consists of a series of pulses.

Shot-effect noise is produced by the emission of electrons. Electricity is not an infinitely fine grained fluid, but consists of discrete particles, that is, electrons. From the theory of emission it can be predicted that a certain noise current is present in the electron current. This noise current consists of a series of pulses similar to the thermal-agitation effect.

On a purely theoretical basis, relations have been derived for calculating both the thermal-agitation voltage and the shot-effect voltage. Measurements show agreement between calculated and measured values.

The theoretical relation for thermal agitation is:

$$\bar{e}^2 = 5.49 \times 10^{-23} \text{ TZ df}$$
$$\bar{e} = 7.4 \times 10^{-12} \text{ T}^{\frac{1}{2}} \text{ df}^{\frac{1}{2}} \text{ Z}^{\frac{1}{2}}$$

where, $\bar{e}^2$ = the mean square thermal-agitation voltage
T = the absolute temperature of the conductor = (273 + °C)
Z = the resistance of the conductor or the resonant impedance of a tuned circuit
df = the frequency band width factor

The theoretical relation for shot effect (without space charge) is:

$$\bar{E}^2 = 3.18 \times 10^{-19} \text{ I Z}^2 \text{ df}$$
$$\bar{E} = 5.63 \times 10^{-10} \text{ I}^{\frac{1}{2}} \text{ Z df}$$

where, $\bar{E}^2$ = the mean square shot voltage
I = the electron current
Z = the resonance impedance of the tuned circuit
df = the frequency band width factor

At normal filament voltage, a vacuum tube has sufficient space charge so that the shot voltage is reduced to about one-half of the value obtained without space charge.

From these formulae, assuming a temperature of 27°C, a band width factor of 10000 and a plate current of 4 milliamperes, the theoretical values for the thermal-agitation voltage and the shot voltage are as follows:

Load Impedance Z Ohms	Shot Voltage Without Space Charge Ē Volts RMS	Shot Voltage With Space Charge Ē/2 Volts RMS	Thermal-Agitation ē Volts RMS
1000	3.56×10^{-6}	2.19×10^{-6}	0.40×10^{-6}
2000	7.12	3.56	0.57
5000	17.8	8.90	0.90
10000	35.6	17.80	1.28
20000	71.2	35.6	1.81
30000	107.	53.6	2.21
40000	143.	71.6	2.55
50000	178.	89.0	2.85
75000	267.	133.6	3.50
100000	356.	178.0	4.04
150000	535.	268.	4.94
200000	713.	356.	5.71
500000	1780.	890.	9.03

DIAGRAMMATIC REPRESENTATION OF TYPICAL RADIO RECEIVER

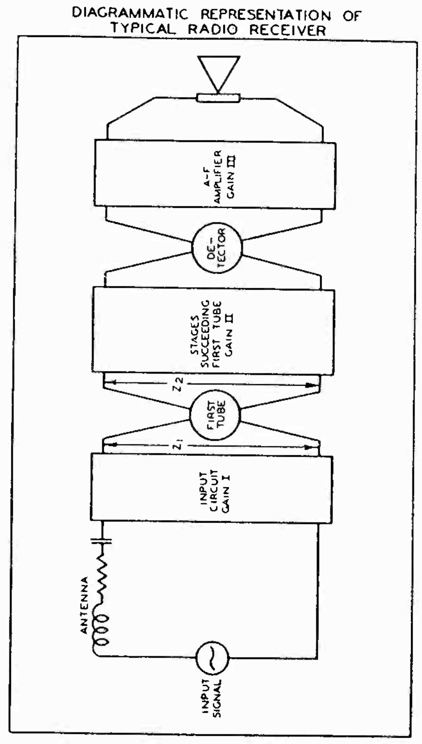


FIG. 1

RELATIVE NOISE OUTPUT & A-F OUTPUT VS. CARRIER INPUT VOLTS FOR TYPICAL RADIO RECEIVER

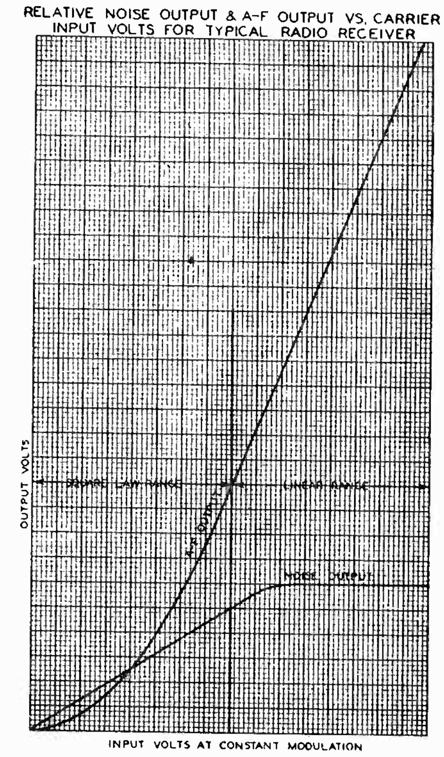


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FIG. 2

Fig. 1 shows a block diagram representing a receiver. Assume a standard signal applied to the receiver input. When the signal voltage is increased from zero, the a-f output volts increase first as the square of the input voltage, then linearly with input voltage. This is true for diodes as well as other types of detectors. The range of square-law increase will depend on the type of detector. For a diode operated with a large input signal, the square-law range may be entirely negligible. In more modern receivers there is sufficient a-f gain between the diode detector and the tube so that the output will be according to the square-law at the 50-milliwatt output level. In general, we may say then, that at the initial noise level, a detector will follow the square-law.

Frequently, a receiver has no noticeable noise until a carrier is tuned in. Fig. 2 shows how the noise-output voltage and the a-f output voltage increase as the carrier voltage is increased.

In the square-law range, the noise-output volts increase linearly while the a-f output increases according to the square-law. In the linear range the noise-output volts are constant, while the a-f output volts increase linearly.

The laws of increase of noise and a-f voltage are different. As the signal is increased, both carrier volts and sideband volts increase proportionately. The noise-input volts existing independent of signal appear as a constant sideband voltage. In both instances the output is proportional to the product of the carrier voltage and the sideband voltage.

As the detection becomes linear the output is no longer proportional to the product of the voltages, but is directly proportional to the smaller of the two voltages and is independent of the magnitude of the larger voltage. Since the carrier is the larger voltage, increasing it does not increase the noise-output voltage. The increase in a-f output voltage results because the sideband voltage is increased.

It is interesting to note that the ratio of noise-output volts to a-f volts varies inversely as the signal-input voltage throughout the square-law and linear range of operation.

It is evident that as the signal is increased, the noise will become a negligible factor and that as the signal is decreased the noise will eventually become greater than the a-f output. This latter condition may occur at an inaudible level.

The noise voltage usually originates either in the grid circuit or in the plate circuit of the first tube. Under conditions of very low gain in these circuits, the second tube may also contribute to the noise.

Since the noise is a series of pulses, it excites the associated circuits in the frequency range to which they respond. It is amplified by the succeeding stages provided they are in tune with the initial circuit either directly or through the medium of a frequency converter. For example, if the noise originates as a band of radio frequencies, it is changed by the converter just as any other signal is changed to the corresponding band of intermediate frequencies. Thus, the noise voltage appears at the detector input and also in the a-f output, although it may be inaudible until sufficient carrier voltage is supplied at the detector input.

Effect of Circuit Constants

Refer to Fig. 1 and suppose the input to the first tube is short-circuited so that only plate-circuit noise is amplified.

Then, by adjusting Gain II the noise-voltage input to the detector may be made any value either large or small.

Changing the plate-load impedance Z_2 has the same effect as changing Gain II. Both noise and signal are changed in the same ratio.

Cutting the frequency band width either in the i-f or a-f stages gives a satisfactory apparent reduction in noise, since the ear is most sensitive to high frequencies. Of course, the higher a-f components of the signal are reduced.

If the noise-volts input to the detector is low enough so that the detector becomes linear before the noise voltage reaches the audible level (approx. 0.1 volt across 4,000 ohms), no amount of increase in signal will produce audible noise. This is evident by referring to the curves of Fig. 2.

In the theoretical tabulation, the shot voltage appears large relative to the thermal-agitation voltage. From Fig. 1, it is evident that when the gain in the first tube is large, the plate-circuit noise voltage will be negligible in comparison with the grid-circuit noise voltage. For example, the tabulation shows for 75,000 ohms resonant impedance that the shot voltage is 133.6 microvolts and the thermal-agitation voltage, 3.5 microvolts. Assume the thermal-agitation voltage appears in the grid circuit and the shot voltage in the plate circuit. If the tube gain is 70, the plate-circuit noise is equivalent to less than 2 microvolts in the grid circuit. In this case, the 3.5 microvolts of thermal agitation in the input circuit will cause more of the noise in the output.

When Gain I is large, the signal is increased with respect to the noise at the first grid.

Choice of Tube and Operating Voltages

Theory shows that the shot voltage increases in proportion to the square root of the plate current of a tube.

(Continued on Data Sheet No. 13 on next page)

RADIO's Practical Data Sheets

Pentagrid Converter Tubes in Multi-Range Receivers

DATA SHEET NO. 13

THE pentagrid converted tubes 2A7, 6A7, and 1A6, frequently used as combination mixer (first detector) and oscillator in broadcast receivers, have application in short-wave or multi-range receivers.

This treatise is devoted to a discussion of the conditions under which the pentagrid converter may be used in multi-range receivers, of the proper circuit conditions for best operation, and of the specifications and constants for the inductances and capacitances suitable for various frequency bands.

The 2A7, 6A7, and 1A6 are suitable for operation in any frequency band in which they can be made to oscillate. All of the advantages which these tubes have for applications at broadcast frequencies are retained at the higher frequencies. The fundamental circuits for the higher frequencies are found to be almost identical with those used for the broadcast band. Also, operating voltages are the same as those recommended for broadcast fequencies.

In a multi-range receiver, it is generally desirable to use the same tuning condenser for each frequency band, a convenient capacity range being approximately 40 to 350 uuf.

In a multi-range receiver typical frequency bands are:

550 to 1500 kilocycles	4 to 10 megacycles
1.5 to 4 megacycles	10 to 25 megacycles

A low frequency band of 150 to 400 kilocycles (KC) is sometimes included.

An intermediate frequency of approximately 450 kilocycles is suitable for use with all of these bands. The 2A7 and 6A7 will operate satisfactorily in all of the bands to provide gain comparable with that obtained at broadcast frequencies. The 1A6 may be used in all except the 10 to 25 megacycles (mc) band. Although the 1A6 can be made to oscillate at frequencies higher than 25 mc, it is difficult to cover the 10 to 25 mc band. To cover this and higher frequency bands, the 1A6 can be used in combination with a triode in a circuit to be described.

The table below gives for the frequency ranges considered the approximate values of inductances for r-f and oscillator coils and of series condensers. The constants assumed are:

R-f tuning condenser .... 40 to 350 uuf
Intermediate frequency .... 450 kc.

The minimum capacity assumed will be somewhat higher for the high-frequency ranges, due to the close coupling between circuits necessary at high frequencies.

Frequency Band Megacycles	.15 to .40	.55 to 1.5	1.5 to 4.0	4 to 10	10 to 25	
R-f coil inductance (L_1)	3248	241.6	32.5	4.43	.709	uh
Oscillator grid coil inductance (L_2)	699	131.2	25.0	3.60	.648	uh
Tracking condenser (C_5)	120	385	1000	*	*	uuf
Additional minimum capacity required in oscillator circuit	22	9.5	4.3	11.3	4.2	uuf
Ratio of oscillator grid coil inductance to r-f inductance	.21	.54	.77	.81	.92	

* Not required for the 4 to 10 and 10 to 25 megacycle bands.

The design of the high-frequency oscillator coils requires care. The principal requirements are:

1. Low resistance in the grid coil.
2. High mutual inductance between grid and plate coils.
3. Low capacitance between grid and plate coils.
4. Low self-inductance in plate coil.

Since these requirements are to some extent contradictory, compromises are indicated. Other considerations such as restrictions on overall dimensions and wire size should be taken into account.

The details of coil design are illustrated in Fig. 1. Grid and plate coils are made short in comparison with their diameters to facilitate proper coupling. The plate coil is wound at the end of the grid coil rather than inside of it in order to keep their inter-capacitance at a low value. The inductance of the plate coil is about twice that of the grid coil for the 10 to 25 mc coil. Increasing plate turns beyond the number given will increase the amplitude of oscillation at the low-frequency end of the range, but will also limit the high-frequency end to a value considerably less than 25 mc.

All except the 10 to 25 mc coil may be used with the 1A6, although it may be desirable to increase the plate turns on the "4 to 10 mc" coil for use with this tube. All coils will operate with the 6A7 and 2A7 in the circuit of Fig. 2.

It is possible to use the 1A6 in the 10 to 25 megacycle band and the 2A7 and 6A7 at still higher frequencies by connecting a triode in parallel with the oscillator portion of the pentagrid converter, as shown in Fig. 3. This combination may be used in any variation of this circuit without change in connections or voltages. The function of an extra tube is to increase the voltage available for excitation of the oscillator circuit. This is necessary at high frequencies because of the very unfavorable L/C ratios and consequent low impedances obtained with tuned circuits operating at these frequencies. Combinations suitable for use in this circuit are:

Pentagrid Converter	Triode
2A7	56
6A7	37
1A6	30

When these converter-triode combinations are used, it is not necessary to disconnect the triode for low-frequency operation. However, with this combination, it will probably be found desirable to reduce the number of turns in the low-frequency oscillator plate coils in order to keep the voltage developed across the grid coils at the value best suited for operation of the converter.

Influence of Circuit Constants On Receiver Output Noise

(Continued from Data Sheet No. 12 on preceding page)

The variation of plate-circuit noise voltage with plate current is found to change in proportion to the square root of the plate current and to be almost independent of the plate, screen and grid voltage, and of whether or not the tube has oscillator-input voltage on it.

High gain in the first tube gives low output noise for any receiver sensitivity. For example, in a superheterodyne receiver, a first detector tube gives less gain for the same plate current than an amplifier tube. Hence, for a given sensitivity, a set which uses a first detector in the first tube position will have more noise than a similar set which uses an amplifier.

When gain is controlled in the first tube, the gain decreases faster than the square root of the plate current. That is, noise and gain are both decreased, but the gain is decreased more than the noise is decreased. It would be advantageous then, as regards noise, to secure this decrease in gain in the succeeding stages.

If the first tube can be operated at a fixed bias with small signal input, the lowest noise will be obtained by choosing a tube with high gain and low plate current, and by operating this tube at the highest value of plate current permissible. Operating with high plate current increases the gain more than it increases the noise. It is assumed that the plate resistance is not reduced enough to effect the results.

Similarly, if two or more tubes are put in parallel and the plate resistance remains high enough to be negligible, the gain will be increased n times, where n equals the number of tubes in parallel. The plate current is increased n times, also, and the noise is increased by the square root of n. The noise, for the same overall sensitivity, is thus reduced by a factor of one over the square root of n.

COIL DESIGN CHART FOR MULTI-RANGE RECEIVERS

COIL DATA

FREQUENCY BAND Megacycles		0.15 to 0.40	0.55 to 1.5		1.5 to 4.0	4.0 to 10	10 to 25
ASSEMBLY NO.		1	1	2	2	3	3
R-F COIL L_1	Turns	442	121	147	36.8	10.4	4.2
	Wire	#36 sse	#30 sse	#32 enam	#30 enam	#30 enam	#20 enam
OSC GRID COIL L_2	Turns	194	83	91	33.4	9.1	4.0 *
	Wire	#36 sse	#30 sse	#32 enam	#30 enam	#30 enam	#20 enam
OSC PLATE COIL L_3	Turns	90	45	30	12	12	6
	Wire	#36 sse	#30 sse	#32 enam	#30 enam	#36 enam	#36 enam

* This coil is not suitable for use with the 1A6 unless a type 30 tube is used in parallel.

COIL ASSEMBLIES

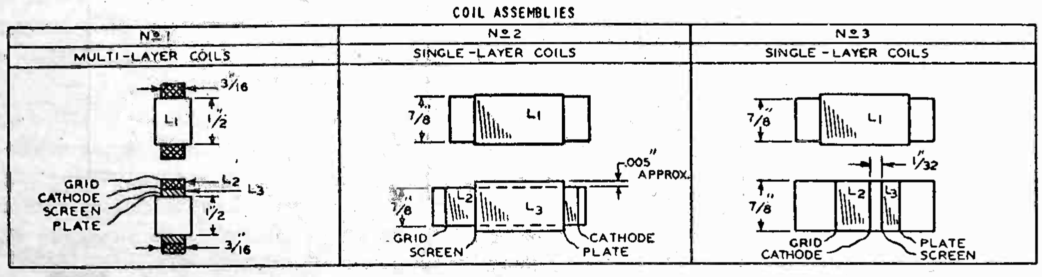


FIG. 1

TYPICAL PENTAGRID CONVERTER CIRCUITS FOR MULTI-RANGE RECEIVERS

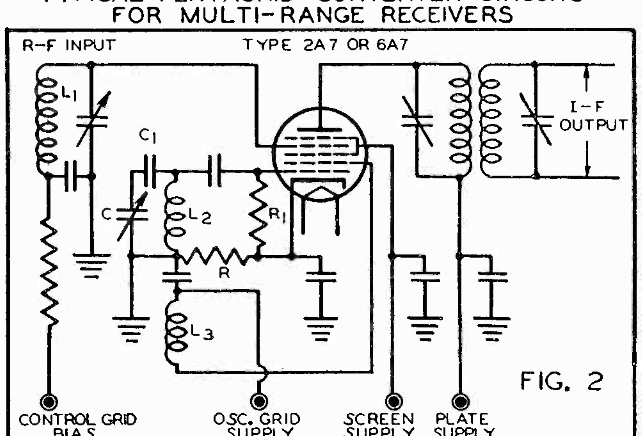


FIG. 2

C=OSC. TUNING CONDENSER
C1=TRACKING CONDENSER*
R=SELF-BIASING RESISTOR
R1=OSC. GRID RESISTOR
L1=R-F INPUT INDUCTANCE
L2=OSC. GRID INDUCTANCE } COUPLED
L3=OSC. PLATE INDUCTANCE
* NOT REQUIRED FOR THE 4 TO 10 AND 10 TO 25 MEGACYCLE BANDS

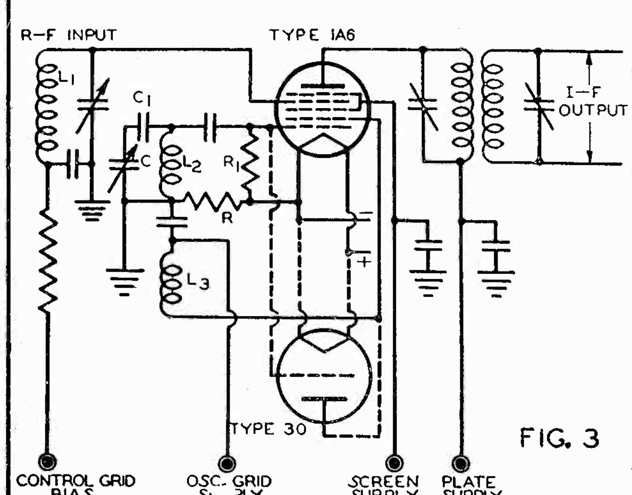


FIG. 3

NOTE: TYPE 30 IS TO BE USED WITH 1A6 FOR 10 TO 25 MEGACYCLE BAND, SEE TEXT

RADIO's Practical Data Sheets

DATA SHEET NO. 14

TUBE-BASE COIL DESIGN CHART

A Simplified Means For Rapid Calculation of Inductance, Capacity and Turns-per-Inch For Short-Wave Coils Wound on 1½ Inch Tube Bases or 1⅜ Inch Bakelite Tubing.

TUBE bases are used by a great number of amateurs for winding coils. The question of "how many turns and what size wire to use" is often asked. This chart is designed to answer these questions with a minimum of difficulty.

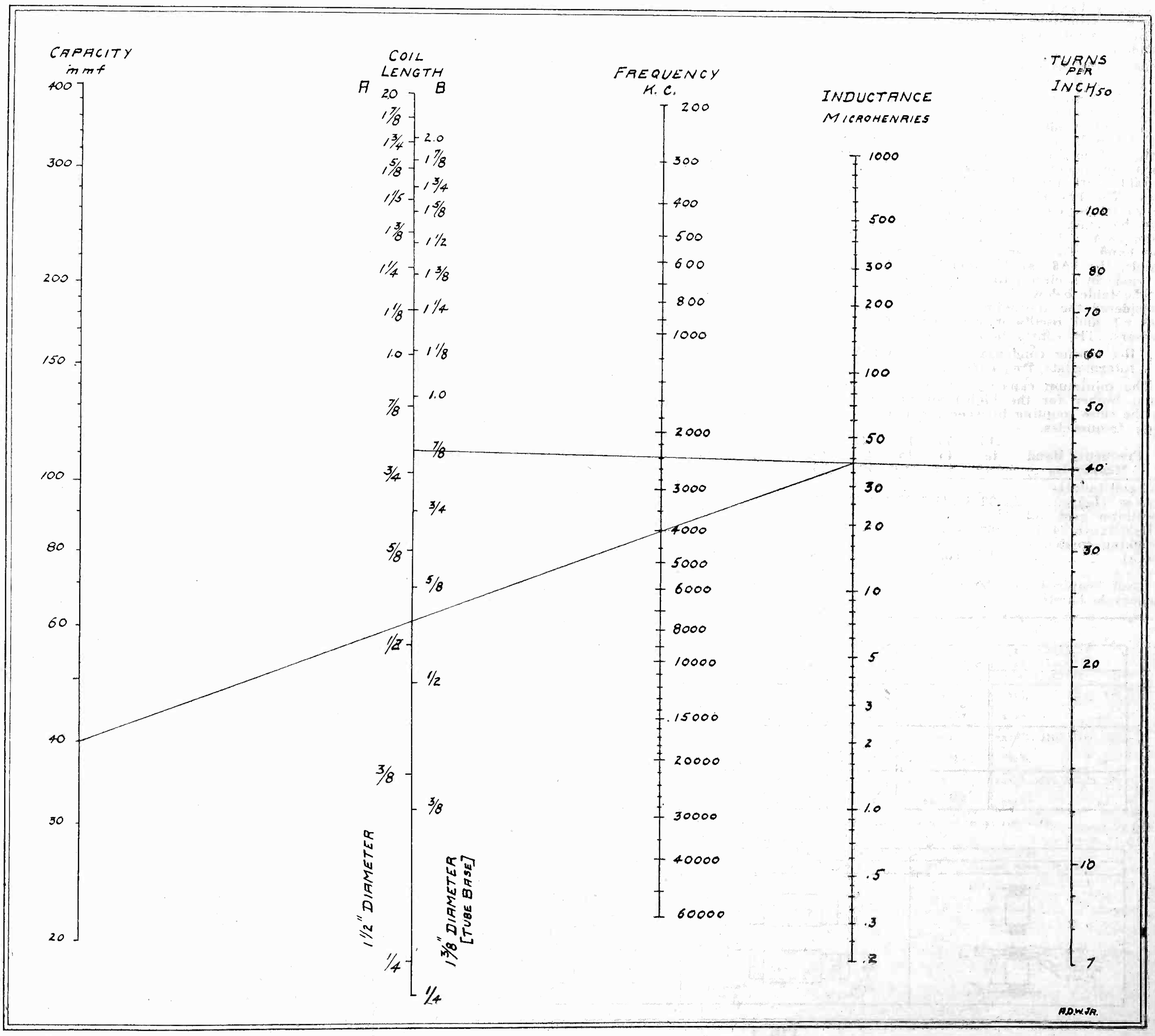
The chart is a combination of two. One solves the inductance of a coil wound on a tube base, and also for a tube of 1/16 inch bakelite mounted on the outside of a tube base. The other chart gives the frequency that the coil will tune to, using a known capacity. To find the inductance it is only necessary to know the turns per inch of the wire to be used, and the length available for winding. Or, if we have a coil already wound, we know the length, and consequently the turns per inch. Then, by using the chart, the inductance can be found. The capacity that will be used to tune a coil is generally known, so if we want to find the frequency to which the coil will tune, we use the second half of the chart. These operations are best illustrated by actual examples. The lines for these examples are drawn-in, and the examples are confined to one set of data, but the general operation of the chart is completely shown.

What is the inductance of a coil ⅞ inch long, wound with 35 turns of wire? This gives 40 turns per inch. Now line-up, with a straight edge, the 40 mark on the TURNS PER INCH scale with the ⅞ inch mark on the COIL LENGTH scale, and the chart shows about 38 microhenries as the inductance of the coil. It is desried to tune to the 80-meter phone band with this coil. How large a condenser is required? Line-up the 38 microhenry mark on the INDUCTANCE scale with 4000 on the FREQUENCY scale, and read 40 on the CAPACITY scale. Thus, 40 mmf. is required.

What are the dimensions of a coil to tune to 4000 KC with a tuning capacity of about 40 mmf. and using No. 26 DCC wire which winds about 40 turns per inch? Line up 4000 KC on the FREQUENCY scale with 40 mmf. on the CAPACITY scale, and read 38 microhenries as the required inductance. Now line up 38 on the INDUCTANCE scale with 40 turns on the TURNS PER INCH scale, and read ⅞ inch as the length of the coil. Therefore, the answer to the problem is to wind a coil ⅞ inch long.

Where the coil is to be wound on a tube mounted on the outside of a tube base, use the **"A" scale** on the COIL LENGTH scale. The procedure is exactly the same. The designer will be able to use the CAPACITY - INDUCTANCE - FREQUENCY scales to solve any problems involving these three factors. Coils of less than ¼ inch long have so small an inductance, and other factors such as the circuit constants will have so large an effect, that calculations will be far from accurate.

Designed, calculated and drawn by Lieut. (Retired) Alan D. Whittaker, Jr., W6SG and Portable W6DFK, Mill Valley, Calif.



Globe Girdlers

Conducted by CLAYTON F. BANE, W6WB

W5ATF—Buck McKinney, of Dallas, Texas

IT IS with a great deal of pleasure that I introduce one of the real big noises from down thar in 'ole Texas, W5ATF.

Old Buck McKinney first graced the air with his presence in 1921 under the call of 5TY. A quarter KW spark in the attic, and a receiver using the then-popular crystal detector, constituted Buck's first effort. W5ATF opened for business December 4, 1924, with a five watter in a three coil Meisner circuit, and from that moment things began to happen. A 210 with 50 watts input was good enough for a WAC in 1927. With the true old amateur spirit, this transmitter gave way to a higher power rig in the winter of the same year, a fifty watter doing the business this time. The first crystal rig was installed in November 1930, with an 860 with 250 watts input.

The transmitter in use at the present time uses a 47 crystal oscillator, a WE-261A as a power doubler-buffer, and a 204A in the final with 600 watts input and adequately filtered DC. This final uses an extremely low C tank circuit, as this has been found to be of decided benefit. Buck says the WE-261A, in the role of buffer-doubler works extremely well with 1000 volts on the plate.

Say . . . we see that W5ATF is another of the DX'ers who still uses the old stand-by receiver. Buck tells me that his receiver, which uses three 201A's, has so far, outclassed all of the receivers tried, from the standpoint of sensitivity and signal-to-noise ratio. Why argue, when we are told that well over a hundred countries have been heard on this receiver.

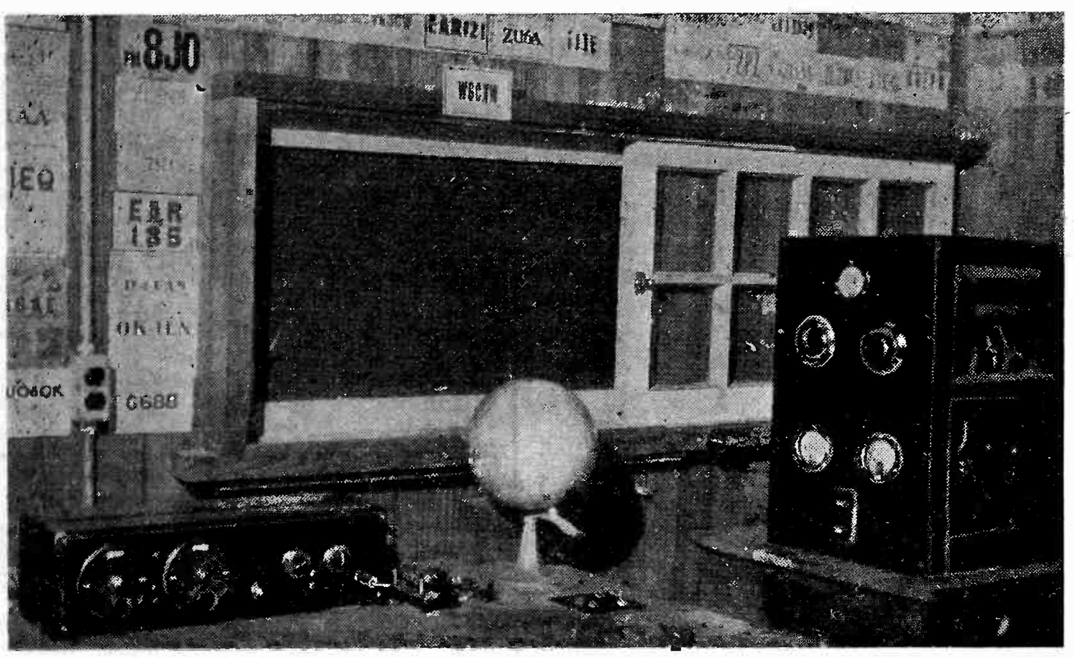
Another funny thing that seems to work extremely fine at W5ATF is the short antenna system in use. A 34 foot antenna, with the same length counterpoise does the work. This antenna is a mere 30 feet high at the high end, and is separated from another antenna by an angle of 45 degrees. The photos show the little auxiliary transmitter which is used on such occasions when "Big Joe" is being adjusted. This small transmitter is being rebuilt into a crystal-controlled rig, using a W.E. fifty watter in the final. This transmitter is intended principally for use on 14 MC, and uses a separate antenna with single wire feed.

We asked Buck to give us a list of the countries worked, but he said he felt that if he did, it would look too much like horn tooting Hi! Anyway, they total up to 96, which is a goodly number in any language! Africa is Buck's particular meat. A sked was kept with FM8IH from October 23, 1932, to March 1933, for a total number of 54 QSO's! Not bad at all! A nightly sked was also kept with old FOA50, (now ZS2B) for a period of about three months. This happened back in 1928 when the Africans were all on 36 meters and believe you me, keeping an African sked in those days was no mean feat. Most of the U. S. fellows were using self excited rigs and were not at all bashful about engaging in that deplorable practice of parking on your wave in vain hopes of sneaking your DX away. Real sporting, what?

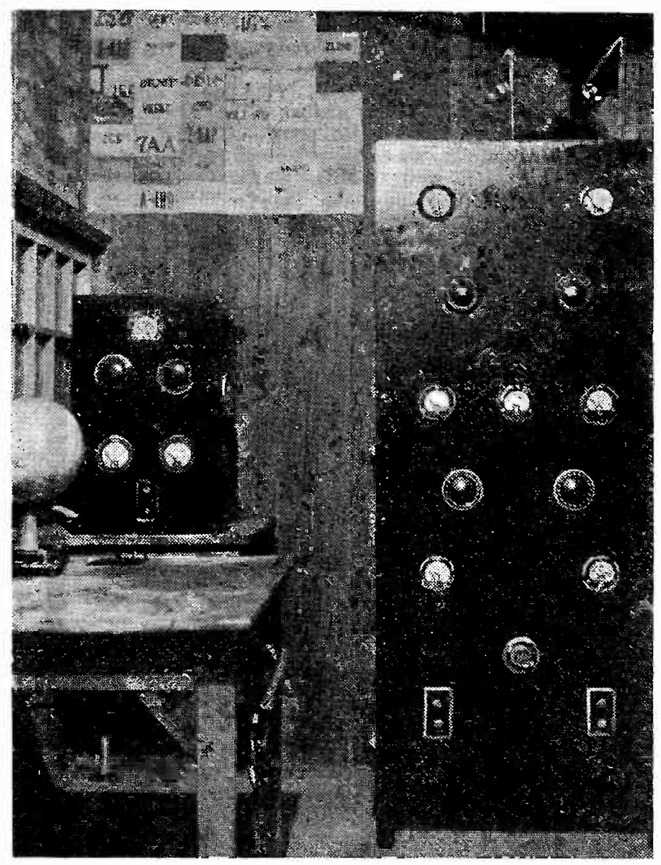
The station is mainly devoted to DX and rag chewing, and if a combination of the two can be had, so much the better. Everyone who has ever worked W5ATF realizes that the man behind the set knows how to whip that old bug into a frenzy. Incidentally, have you ever listened in on one of those famous nightly QSO's between W5ATF and W6-CXW? It would seem that a surprising number have. The main topic of conversation is generally of a DX nature, with CXW on the receiving end of all the latest dope on the DX that Buck is hearing. Now you can see why the gang listens in with such intense interest. The real funny thing about a sked of this sort is that you can hardly say a thing about anybody without risking that person hearing the whole story. Now take for instance what happened the other night. Buck and Henry were both kicking about the fact that ZS2A had been giving them the go-by the previous week. The comment was very fitting to the seriousness of the offense. After the sked, Buck heard ZS2A calling him, miles per hour. Buck answered, and discovered that 2A had listened in on the whole thing and he forewith proceeded to lay ATF out properly! Hi!

Other DX includes consistent skeds at times with stations in all continents. Total number of WAC's is 59 with 29 of these since January 1933! Winner of the DX contest for Northern Texas Section for this year and winner of the Spanish DX contest of 1933 for the same section. Best WAC was worked in two hours and thirty-five minutes.

In closing, Buck and I would like to propose a theory of Buck's for your consideration. He has done considerable work to determine whether or not the moon has any effect on radio propagation. After checking up on DX from various sections of the world, he has arrived at the conclusion that the Lunar Effects have a very definite bearing on DX. Briefly, he says that as the phases of the moon change, Europe and Africa are heard very consistently, fading out as the Asian and Australian stations come up to their peak. This is an extremely interesting theory, and if it could be worked out in advance, would undoubtedly save all of us many hours of searching for DX that is not coming through. Comment from other DX'ers is welcomed by the author.



Buck McKinney's 3-tube receiver, which uses 01-A tubes. W5ATF is one of those fortunate amateurs whose location makes possible the use of the simple receiver.



There are two transmitters at W5ATF. The little one shown here is the stand-by, the other is "Big Joe".

• • •

If you like this Globe Girdlers department and want a little chin-chat corner open to DX'ers, write us. This is your department.

Double or Nothing

(Continued from page 9)

impractical. The use of the electron-coupled circuit practically demands indirectly heated cathodes, but where is our power tube with an indirectly heated cathode? All this sounds dark, indeed, but there is an answer to our present-day doubler problem. The name we have coined for it sounds like Simon Legree's demands on his Darkies, but here it is . . . "Push-Push."

In the ordinary doubler circuit, the plate tank receives a kick on every other cycle. This demands an extremely efficient tank circuit to sustain oscillation. Now, if two tubes are used, their grids in push-pull and their plates in parallel, and the tubes biased to a point just below cutoff, the plate tank will receive a kick on every cycle of its swing. This obviously is a material gain over previous systems. There is absolutely nothing difficult about the operation of this circuit, and the wonder is why it is not more generally used. Perhaps those who have tried it have attempted to use shunt-feed in the grid circuit. With both chokes from grid to ground, it would be truly marvelous if some sort of oscillation did not result. The real nasty part about this is the fact that the chokes might not be exactly the same size, and consequently not resonant to the same frequencies. Can you imagine the horrible mess when those two tubes started oscillating independently, while also operating in the desired frequency? The circuit shown will completely eliminate this trouble. Tubes such as the 841, 210 or 46 will prove very satisfactory in this system and must suffice until the tube makers come out with a man-sized edition of the Wunderlich tube, in which case one tube would do the same work —and do it better. Incidentally, this circuit will work very well with one side of the filament on one of the tubes disconnected, working then as a single tube with the dead tube serving to maintain the balance. Fine chance to use one of your burned-out tubes, but be sure to use the pin with the long side of the filament on it. This same idea was used by one of the large manufacturers to neutralize a fifty watt, push-pull stage in one of their airplane transmitters. I am assured that it works beautifully.

When using this "Push-Push" circuit, remember that the plates of the tubes are in parallel and that every effort should be made to keep the leads short. Parasitic chokes might not be out of order.

It is well to remember that a push-pull circuit, when properly biased, makes a very good tripler. Most people ignore this fact and consider that if the second harmonic cancels in the output tank, the third must also. Give the tube the proper bias (around double cut-off), tune the tank to the third harmonic, and get a pleasant surprise.

The controversy now raging over the question of 7 MC crystal versus 3.5 MC crystal and doubler, should be mentioned here. In experiments conducted, it was found that a 7 MC crystal gave identical swing to the grid of the buffer as did a 3.5 MC crystal working into a fairly good doubler. Voltages on both crystals were the same, i.e., 320 volts. Considering the low price of a 7 MC crystal and the saving of an extra doubler stage, it would hardly seem economical to use the 3.5 MC crystal. It should be mentioned here that capacitive coupling from the higher frequency crystal to the buffer proved very unsatisfactory. It was necessary to tap back so far on the crystal tank in order to get the crystal to oscillate that the power supplied to the

(Continued on page 29)

Double or Nothing

(Continued from page 28)

doubler was inadequate. The use of a tuned tank in the buffer grid circuit, and link coupling from the crystal, solved this particular problem. It is safe to say that the use of inductive coupling from the crystal stage will increase the obtainable output at least 50%.

In conclusion, the writer wishes to impart the following advice: In all doubler plate and grid tanks, use the lowest amount of capacity, consistent with the ability to tune over the desired band width. Be certain that your doubler is working as one or the other types (Grid or Plate). Avoid harmonic content in the exciting source, unless you are doubling with the harmonic of the driving source (Electron-coupled xtal circuit). Use as high a plate voltage as the particular tube used will permit. Adjust your C Bias, not to ten times cut-off, but to the point where the gridmeter of the buffer shows the greatest reading. Use some form of neutralization or regeneration. Preferably use a more efficient doubling circuit, such as the suggested in this article ("Push-Push"). Last, and all-important, adjust the coupling loop from the doubler to the buffer with the utmost care. In a number of cases the maximum output has been obtained with the coupling loop on the doubler stage at almost right angles to the coil. Loose coupling is a virtual necessity when using high MU tubes, such as the 841, 865 or 47. It is also applicable to the coupling loop from the plate tank of a 7 MC crystal . . . and so—here's to more output from the doubler! Double or nothing!

• • •

New Silver Single Signal Receiver

(Continued from page 23)

Designed Especially for Crystal Filter

STILL another fault of most available amateur receivers utilizing a crystal filter is the fact that these sets were designed and laid out with no thought originally of including a quartz resonator for single signal CW code reception. The addition of such a crystal filter to an existing receiver is almost impossible if the full results possible are to be obtained in sensitivity and noise reduction.

The 5B receiver, though sold without crystal, is designed and built for the crystal filter, and even though sold without crystal, each and every set is built with the entire crystal circuit in it. Thus it requires merely the plugging in of a 465 KC crystal and realignment of four IF trimmers to the exact crystal frequency to provide the full measure of benefit in sensitivity, selectivity and noise reduction which can be had only from a super designed all the way through to utilize the crystal filter.

The Graphite Anode Tube

(Continued fom page 8)

the graphite mass acts as a getter, cleaning up gases. This getter action continues throughout the life of the tube, as contrasted with nickel or molybdenum which afford no getter action. The graphite anode tube remains "hard" throughout long service life.

Another important and unique feature of Sylvania transmitting tubes is the "Floating Element" principle. The advantages of the "Floating Element" are:

1. The insulation between the plate and the other elements is better.

2. Lower inter-element capacities which make for better efficiency on higher frequencies.

3. The elimination of corona discharges from the support in contact with the glass envelope.

4. A sturdier mechanical construction.

So much for the development and production of this new tube construction. But what does it mean to the radio amateur and to others engaged in radio communication?

In the first place, the graphite anode tube has better than 50% greater heat dissipation than the customary metal anode tube. This means that the tube elements run cooler, heat being transferred more rapidly and efficiently to the glass envelope, which in turn can radiate to the surrounding air. Because the grid runs much cooler, primary and secondary emission from the grid is reduced to negligible proportions, there is no bombardment of the filament by positive ions to hasten the wear and tear of that important element in tube life.

Greater heat dissipation means that a given tube at its rating will be under far less strain. The graphite anode does not heat to incandescence, as is the case with most metal anode tubes under normal service. If desired, the graphite anode tube can be made smaller, because of its greater heat dissipation.

Gassy tubes are quite unknown with the graphite anode construction. A minimum of supporting metal is necessary, thereby facilitating the gas clean-up at the time of bombardment. Also, the graphite mass serves as a getter, keeping the tube "hard" throughout life.

Despite a minimum of supporting metal, the graphite anode will not warp regardless of overload or operating temperature. Consequently, the graphite anode tube maintains its characteristics at all times, which is a most important consideration in these days of rigidly monitored frequencies, and even more so in the ultra-high-frequency range.

Lastly, the graphite anode tube under accelerated life tests indicates a much longer life, with uniformity of characteristics maintained.

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QSL CARDS. The kind that bring acknowledgments. Samples on request. Hinds & Edgarton, 19 So. Wells St., Chicago, Ill.

KRUSE'S RADIOPHONE GUIDE, 35c, postpaid. R. S. Kruse, North Guilford, Conn.

10 MFD, 450 working volt dry electrolytic filter condensers. Absolutely guaranteed to be finest money can buy. 75c each, or 4 for $2.75. '80 Rectifier Tubes, brand new, guaranteed, 40c each. 5Z3 Rectifier Tubes, guaranteed, 75c each. We prepay postage on orders of $1.00 or more. Ed Hoetzel, 260 Castro St., San Francisco, California.

BACK COPIES OF "RADIO". I have a few of each issue from June to October on hand, 25c each, postpaid. K. V. R. Lansingh, 1455 Glenville Drive, Los Angeles, California.

STATEMENT OF OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

"RADIO" published monthly at San Francisco, Calif., for October 1, 1933.
State of California,
County of San Francisco
ss.

Before me, a Notary Public in and for the State and County aforesaid, personally appeared H. W. Dickow, who, having been duly sworn according to law, deposes and says that he is the Business Manager of "RADIO" and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Sec. 411, Postal Laws and Regulations, to wit:

1. That the names and addresses of the Publisher, Editor, Managing Editor, and Business Managers are:

Publisher—Pacific Radio Publishing Co., Pacific Bldg., San Francisco, Calif.; Editor—A. Binneweg, Jr., Oakland, Calif.; Managing Editor—Clayton F. Bane, Pacific Bldg., San Francisco, Calif.; Business Manager—H. W. Dickow, Pacific Bldg., San Francisco, Calif.

2. That the owner is:

Pacific Radio Publishing Co., Pacific Bldg., San Francisco, Calif.; H. W. Dickow, Pacific Bldg., San Francisco, Calif.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are:

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest, direct or indirect, in the said stock, bonds, or other securities than as so stated by him.

H. W. DICKOW,
Business Manager.

Sworn to and subscribed before me this 7th day of October, 1933.

(Seal) JOHN L. MURPHY.
Notary Public in and for the City and County of San Francisco, State of California. My commission expires May 20, 1937.

SHORT WAVE STATION NOTES

BY NYDXI

(All times given are EST)

There remain to be mentioned, several more outstanding wave changes not already noted last month:

The station in Rabat, Morocco, broadcasts each Sunday, on two different wavelengths. From 7:30-9:00 a.m., they are heard on about 23.38 m. In the afternoon, until a few months ago, they employed a 32.26 m. wave and were heard very well in the Eastern U.S.A. However, they have moved up to 37.33 m. and are not received on this higher wave as well as on their former one, since they leave the air too early (at 5:00 p.m.). This station may be heard at times, on c.w. or commercial fone to Paris, under the call CNR.

SRI (one), a one KW station in Posnan, Poland, which was formerly operating on 31.3 m., is now on 31.6. The only chance that American fans have of hearing this station is on Tuesday from 2:00-4:00 p.m., and on Thursday, 2:00-3:30 p.m.

HKE, of Bogota, after gradually moving down toward the high-frequency end of the 7 mc. band, has settled down on about 41.3 m., though they announce it as 42.3; however, a letter from the station states that they are "controlled near 7250 KC", and that is where they are heard. Photos of this station's outfit are given herewith. HKE may be heard sending out talks between 6:15 and 7:00 p.m. on Monday, and talks, with some music, from 8:00-9:00 p.m. each Tuesday and Friday. The power is about 150 watts, and the quality excellent, though the programs are often marred by amateur c.w. QRM.

YV3BC of Caracas may be heard regularly, on 6134 KC, between 5:00 and 9:30 p.m. in the Eastern U.S.A. This station operates also on 31.56 m. between 9:30 and 10:00 p.m. daily, but the lower frequency is by far the best, when W8XK does not override them. The station director at YV3BC wrote that they planned to go on 6080 KC, but since a new station in Bolivia has opened up on, or close to that wave, YV3BC has, so far, remained on 6134 KC.

VE9HX of Halifax, N. S., is at present, on about 6095 KC. They are heard at irregular times, throughout the day, and in the evenings, as late as 10:00 p.m. Each fifteen minutes, chimes are sounded, and the stations CHNS and VE9HX are announced.

A letter from the owners of VE9JR of Winnipeg, Manitoba, Canada, give the schedule of this station as 9:30-10:00 a.m., 11:00-11:35 a.m., 2:00-2:15, 3:15-3:35, and 7:00-9:00 p.m. daily except Saturday and Sunday. On Saturday it is 9:30-10:00 and 11:00-11:30 a.m., 12:45-1:15, 7:00-8:30, and 9:00-10:30 p.m. The Sunday schedule is from 9:00-10:00 p.m. This station operates with 2 KW on 25.6 meters.

The British Broadcasting Corporation transmitters at Daventry, England, are at present operating on 31.5 under the call GSB; on 25.53, with the call GSD; 25.28, with the call GSE; and on 19.83 and 16.8, with the calls GSF and GSG, respectively. The latter may be heard during the morning hours, sending programs to the Australasian and Indian Zones, while GSB and GSD are to be heard on the African and Canadian Zone transmissions, at present, between 6:00 and 8:00 p.m. The Empire station, though one of the best, cannot compare with the German "senders", DJB, DJC, and DJD. These latter continue to lead the field of short-wave broadcasters, both in respect to quality and consistent volume.

YV2AM, of Maracaibo, Venezuela, is scheduled to transmit a musical program each Sunday, between the hours of 6:30 and 9:30 a.m., on a frequency which the operator gives as 14292 KC. YV2AM has been heard on this wave, as well as on 7146 KC, with R8-9 strength, but these Sunday morning programs do not seem to come through so well at this time.

The latest schedule given out by the Canadian Radio Commission, for their station VE9GW, operating on 6095 KC, states that the station is on the air on Tuesday, from 8:00 a.m. to 5:00 p.m.; Friday, 4:00 p.m.-12 midnight; Saturday, the same; and Sunday, 11:00 a.m.-9:00 p.m.

Among the various commercial fone stations to be heard at this time, IAC of Pisa, Italy, is one of the most consistent. Using about 15 KW, they are to be heard on 23.45, 35.8, or 45.1 meters, in communication with the Italian liners "Rex" and "Savoia", which may, in turn, be heard on the 4, 8, 12, and 17 mc. channels. These are believed to be the only Italian ships employing fone, as yet.

At the time of writing, GSB, GSD, GSE, DJB, DJD, DJC, EAQ, RV59, HJ3ABD, LSX, 12RO, and HC2RL (on 45.2 m., between 8:00 and 11:00 p.m. several evenings a week), are the best stations to be heard. Pontoise, HJ3ABF, HCJB, CP5, Prado, YV3BC on 48.9, HJ1ABB, HJ4ABB, HKE, XETE, and others may be listed among those that are "good bets".

In closing, let me urge that all fans who are really interested in S-W reception, acquaint themselves with the fine work that is being done by the International Short-Wave Club, of Klondyke, Ohio. Through this club one may become familiar with the activities of fans in remote parts of the world; besides, he has the opportunity of learning of special broadcasts especially for club members, from such stations as XETE, HJ1ABB, and others.

The proposed change of YV3BC, from 6134 to 6080 KC, did not take place; instead, the frequency of this station has been altered to approximately 6160 KC, where they may be logged with excellent volume, between 5 and 9 p.m. daily. Heretofore, they were but 6 KC from W8XK, and, at times the latter station "spilled over" YV3BC; this QRM is avoided, and volume seems to be noticeably improved by the change to the higher frequency. Until this time, one xmtter has been used on the short-waves, this being QSY'ed to 9510 KC, after the program on the lower frequency was completed; if plans given in a recent letter from the station owner, have been carried out, these frequencies will be used by two xmtters, operating simultaneously. The success obtained previously seemed to warrant the purchase of a new rig for use on SW.

Another strong South American signal is that of HC2RL, of Guayaquil, Ecuador, on about 45.2 meters. They have been heard as early as 6 p.m., but most operation is done between 8 and 10 p.m. Quality, both of program material, and of the station itself, is excellent. Frequent announcements are made in English, as well as Spanish, so that North American listeners may know just what is taking place. This station is said to operate on 70 m., in addition to the above-mentioned wave.

A new one appears on the list of SW broadcasters; it is HIZ, of Santo Domingo, Dominican Republic, which operates on about 47.5 m. from 4:40 to 5:40 p.m. daily. Occasionally these programs are extended, and HIZ has been logged in New York State as late as 8 p.m. The volume of this station is amazing, when one considers that their power is but 20 watts; however, quality is not of the best for, as the operator says: "The defect results from the current we have down here; voltage and cycle fluctuates very much and we have a hard job filtering the current." Since this station operates on long, as well as short waves, reports addressed simply to "Santo Domingo" should reach them all OK.

40-Meter Oscillators

(Continued from page 20)

RF from wandering back into the grid of the crystal tube and possibly fracturing the crystal. When working "straight through" it is necessary to either use a very small diameter coil for the oscillator or shield the whole stage to prevent inductive feedback.

For the benefit of the amateur who doubts the practicability of 40-meter crystal oscillators, let it be said that a properly designed 40-meter oscillator using a 47-tube will put out more than a 46-doubler with 400 volts on its plate. We can thus eliminate one stage, and the additional cost of the 40-meter crystal is justified by the saving in other parts.

A 203A makes a wonderful frequency doubler at frequencies up to 14 MC, and a single 03A in a regenerative doubler circuit will put out close to 100 watts on 20 meters when excited by a 40-meter crystal oscillator. This is more than enough to "kick the pants off" a pair of 852's in push-pull when inductively coupled to them. Thus we can have over 750 watts in the antenna on 14 MC with only three stages. The efficiency of the 03A stage could be increased by either increasing the excitation or lowering the input, but we can sacrifice a little efficiency for the sake of output, because an 03A will dissipate 80 or 90 watts without getting too warm. Thus, if the efficiency of the 03A stage is only 50 or 60 per cent, we can still get about 100 watts out of it without exceeding the dissipation rating of the tube. The circuit of the regenerative doubler is shown in Fig. 1. There has been much controversy as to whether the circuit is regenerative, degenerative, or neutralized, but in any event, the output is greatly increased over that of a straight doubler. The grid resistor should be between 20,000 and 50,000 ohms, and if over 1000 volts is used on the tube, some protection in the form of battery bias in addition to the resistor bias is advisable. The filament returns should be brought to a by-passed center tap if the transmitter is used for telephony. Inductive coupling to the next stage will allow more turns to be used in the tank of the 03A, and the efficiency will be increased. The tank coil should be very low "C" and be space wound.

By substituting an 800 for the 03A, the circuit will work nicely on 10 meters, but the output will be limited to about 25 watts because of the lesser allowable plate dissipation of the tube. With the 800, about 90 volts of battery bias should be used in addition to the grid-leak bias, for protection in the event that the tube should lose excitation.

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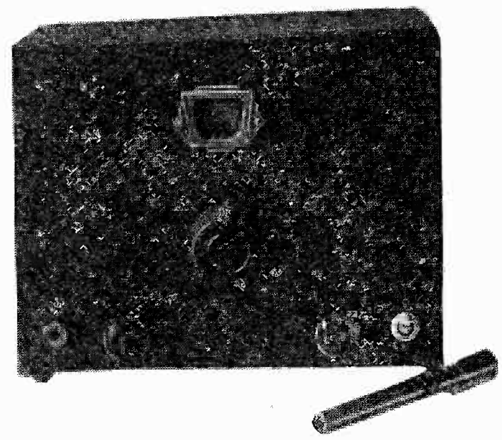

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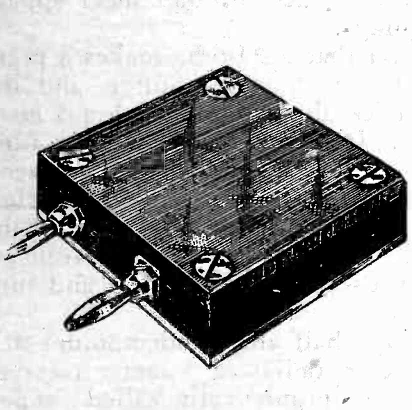

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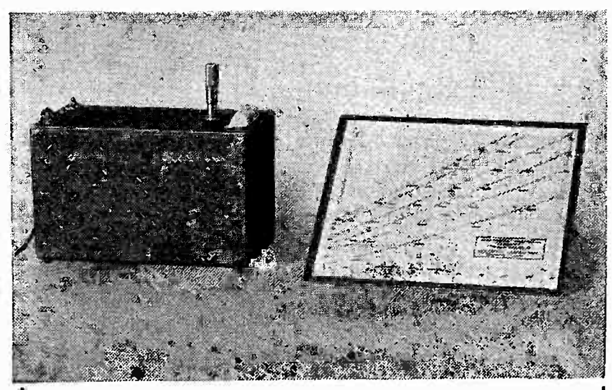

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TEN YEARS BEHIND

By ROBERT S. KRUSE

I AM increasingly being puzzled by the inconsistency which surrounds amateur transmission with more and more rules and regulations, especially if one wants to send words instead of dots and dashes—but at the same time recommends 5-meter transmitters of the vintage of 1924.

What possible reason is there for a modulated oscillator at 5 meters? The thing can't be modulated more than about 30% without severe distortion, yet in other bands it is regarded as a high crime to modulate less than 90%.

It cannot be that anyone actually thinks 5 meter RF amplifiers are impossible, though Frank Jones and others have many years ago described perfectly workable RF amplifiers that operate as far down as 1.5 meters, and even at ¾ meter.

One concludes that the difficulty is either in outright inertia or in an over-enthusiasm for miniature portable transmitters. Such things seem to me to be in the same class with the building of model locomotives, a very fascinating amusement, but not closely related to radio improvement. I will further admit that I don't see the extreme importance of making a transmitter so ultra-compact that it must backslide 10 years in performance—and then lugging a mule-load of batteries to operate it. After all, one has taken the weight off where it does the least good, and the most harm.

Regarding the "most harm" point. It is a regrettable fact, pointed out in recent times by experimental work of Messrs. Bacon and Millen, that a modulated oscillator, through its broadness, encourages the use of "tuneless" receivers. Such receivers, as commonly built, actually refuse to work well on a steady and correctly modulated signal.

Now it is true that gliders cannot carry more than a few ounces of radio equipment and may have to put up with something pretty rudimentary in consequence—but what proportion of radio amateurs use gliders?

In short, it seems to me that secondary and incidental uses of 5 meters have perverted the entire 5-meter game to its present state of wholesale interference through sheer apparatus shortcomings.

I assure you that a 24-tube makes a pretty decent low-power 5 meter buffer, and that there is no trick about modulating a 5 meter RF amplifier. It has all been done many times without circuit tricks. Of course, frequency stability requires more care than at 40 meters, but it really would be better if we used that care instead of covering up the drifting and wobbling by oscillator-modulation and tuneless receivers.

By the way—half the pandemonium at 5 meters is due to radiating 5 meter receivers of the type so optimistically called "super" regenerative. They are twenty times as bad as the oscillating detectors which cause periodical fireworks at 40 meters, yet nobody seems to be doing much about it. As far as I know the recent article in "RADIO" is the first word along this line.

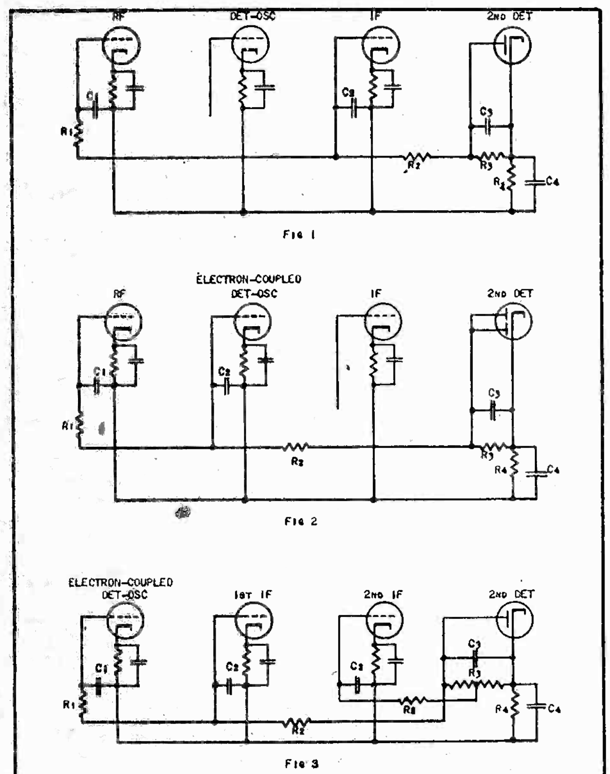
Personally, I favor some type of superheterodyne for 5 meter work, preferably with an autodyne first detector—of which more later.

While I said above that the 24 wasn't bad, it also isn't too good. It is low on size and high on losses. The 865 has a preposterous cost and too many defects. If we all live long enough we shall see an intermediate-size screen-grid buffer of low internal capacity, working at a plate voltage of about 700. That will be something. It will wash out most of the present buffers, even at wavelengths that need improvement less than does 5 meters.

Automatic Volume Control Circuits

THE function of the automatic volume control circuit is to properly regulate the bias applied to the control grids of the RF and IF tubes so that constant signal will be delivered to the input of the second detector.

In the first part of this discussion a superheterodyne receiver consisting of a TRF, 1st detector, IF amplifier and 2nd detector will be considered. The latter part is concerned with a circuit in which the RF stage is omitted and an extra stage of IF is introduced. The drawings have been simplified by indicating only the AVC circuits involved.



HYGRADE SYLVANIA CORPORATION

The RF stage has its input signal tuned to a given carrier, while the IF stage is always tuned to the same frequency. It is essential that coupling between various stages due to common grid returns be eliminated, since certain carrier frequencies are harmonics of the intermediate frequency.

Physical layout in the receiver has much to do with the amount of filtering required for a given design so that no hard and fast rules may be set up. Generally a filter system such as that shown in Fig. 1 is required. R_1 is usually at least 100,000 ohms, and is necessary to prevent coupling between the RF and IF stages. R_2 is usually 1 megohm, although higher values are occasionally required.

Whatever the values of resistors R_1 and R_2, it is necessary that the corresponding by-pass condensers C_1 and C_2 be of the proper value to insure that the time required to charge and discharge the condensers through the resistors be sufficiently short so that no time lag in the operation of automatic volume control is noticeable.

The proper return for the diode load resistor R_3 is very important. Unless special signal delay circuits are desired, the resistor R_3 should return directly to the cathode instead of to ground. If the latter circuit is used, the diodes are biased by an amount equal to the drop in the cathode resistor R_4, with the result that the low-signal sensitivity of the receiver is reduced very greatly. In older receivers, it was not customary to supply initial bias on the tubes being controlled. This is not the best practice because insufficient bias on the tubes may result in grid current flow. If this occurs, voltage drops in the isolating resistors will result. Under such conditions excessive plate currents, short tube life and coupling difficulties may be experienced. The use of a cathode resistor of proper value to supply the necessary bias, or the use of a tapped voltage supply, is to be recommended.

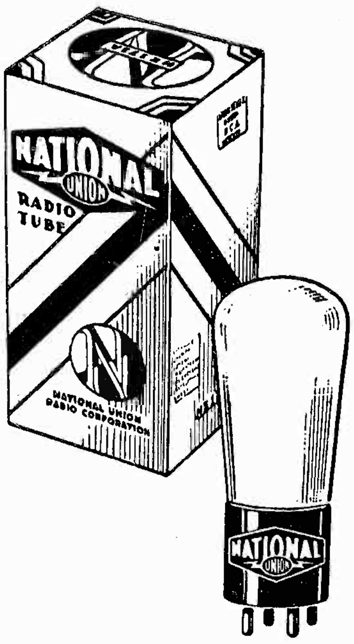
Since the introduction of the pentagrid converter, it has become possible to apply AVC voltage to the detector section of the tube (see Fig. 2). With most receivers it is not necessary to supply AVC voltage to three tubes. The IF tube no longer requires AVC bias providing the grid bias on that tube is adjusted so that with the strongest signals encountered the grid will not become positive.

Another circuit of interest incorporates a detector-oscillator followed by two stages of 456 KC IF amplification (Fig. 3). Prior to the advent of pentagrid converters it was impossible to apply a variable control-grid bias to the combined detector-oscillator for volume control purposes. This deficiency in control would permit strong local incoming signals to seriously affect the performance of the oscillator. The electron-coupled converters have removed this difficulty since it is possible to apply variable grid bias to the detector section of such tubes. When this type of circuit is employed satisfactorily performance may be obtained with AVC voltage applied to only one intermediate stage in addition to the detector section of the converter tube. (This arrangement would be similar to Fig. 3 except that no control voltage would be applied to the grid of the second IF tube). In case it is desirable to supply a portion of the AVC voltage to the second IF tube the additional filter and voltage-divider network are required.

Courtesy Hygrade-Sylvania

Some WE 211Es and 242As Should Be Avoided

WHEN buying second-hand tubes of these types one should be sure to test them in an amplifier before paying out his hard-earned dough. Often they will light and show normal space current in a tube tester, but still behave most erratically when used in an amplifier. The reason for this is usually due to the fact that certain Western Electric amplifiers use these tubes as the plate supply rectifiers, under which conditions the grid gets a thorough coating of the active oxide material normally confined to the filament. Thus, when the grid gets even the least bit warm it starts emitting on its own hook and the fireworks begin. This is PRIMARY and not secondary emission.



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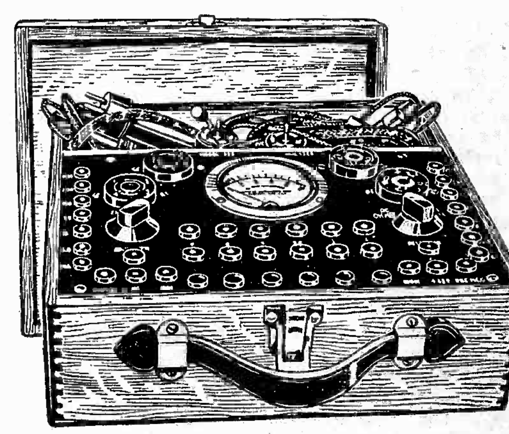

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The CROSLEY
DUAL FIVER
Lowboy

This cabinet is finished in choice figured Nyssa. Overlays of satinwood on sides of speaker grille. Overlays of rosewood at top and bottom of front panel. Edges of top and the base are finished in black. Employs the same type chassis and speaker as described in the Crosley Dual Fiver. Dimensions: 36⅝" high, 21" wide, 11⅜" deep.

$39.50 Complete with Tubes

The CROSLEY
DUAL SIXTY Lowboy

The beautiful veneers on the front panel are of V-matched pin stripe walnut veneer in center with stump walnut veneer stiles. Zebra wood overlays at top and bottom of grille opening. Pilasters are of satinwood. Top is walnut veneer. The 6-tube superheterodyne chassis and speaker are same as in the Crosley SIXTY and employing same type tubes. Dimensions: 38" high, 23" wide, 11" deep.

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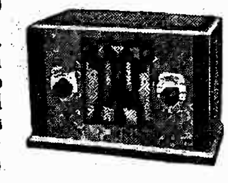
The Crosley **TRAVO DeLuxe**



This 4-tube superheterodyne operates on 110-volts D. C. or any cycle A. C. Has satinwood overlay front, with zebra wood overlays above and below the grille. The base is black and silver. Has pilot light, attached antenna, full floating moving coil electro-dynamic speaker. Requires no ground. The tubes are: One type 78, one type 6F7, one type 38, and one type 12Z3. Dimensions: 8" high, 10⅝" wide, 5" deep.

$19.95 Complete with Tubes

The CROSLEY
FORTY

The front of this cabinet is of pin stripe V-matched walnut veneer with a burl maple overlay above the grille and with decorative pilasters. This 4-tube superheterodyne has illuminated dial, combined volume control and on-off switch, full floating moving coil electro-dynamic speaker. Tubes are: one type 58, one type 6F7, one type 2A5, and one type 80. Dimensions: 12½" high, 10⅛" wide, 8" deep.

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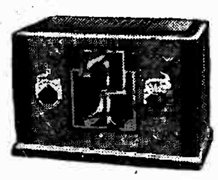
The CROSLEY
NEW FIVER

The front panel of this beautiful cabinet is of Prima Vera with decorative pilasters. There is a zebra wood overlay above the grille and a base of modernistic fluting. It is a 5-tube superheterodyne with a full floating moving coil electro-dynamic speaker. Has illuminated dial. Chassis completely stabilized. Employs the following tubes: Two type 58, one type 57, one type 2A5, and one type 80. Dimensions: 13⅝" high, 11¼" wide, 7¾" deep.

$23.50 Complete with Tubes

The Crosley
TRAVETTE MODERNE



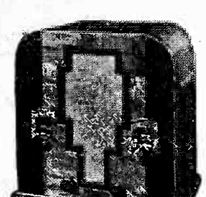
The grille of this cabinet is of chromium plated metal, with zebra wood overlay above and below. The front panel has a satinwood overlay. Has pilot light, attached antenna, full floating moving coil electro-dynamic speaker. Requires no ground. Operates on 110 volts D.C or any cycle AC. The superheterodyne circuit employs 5 tubes as follows: One type 6A7, one type 78, one type 6B7, one type 43 and one type 25Z5. Dimensions: 8" high, 10⅝" wide, 5" deep.

$26.00 Complete with Tubes

The CROSLEY
DUAL FIVER

The front of this cabinet is of V-matched Prima Vera, having decorative pilasters, zebra wood overlay above the grille and base of modernistic fluting. A 5-tube superheterodyne with dual range... completely stabilized. Has illuminated dial and full floating moving coil electro-dynamic speaker. The tubes are: Two type 58, one type 57, one type 2A5, and one type 80. Dimensions: 13⅝" high, 11¼" wide, 7¾" deep.

$26.00 Complete with Tubes



The CROSLEY
DUAL SIXTY

There are beautiful satinwood veneers on the front panel. The pilasters are finished with pin stripe walnut veneer. The grille is outlined with a back border. A 6-tube superheterodyne with dual range, automatic volume control, tone control, and full floating moving coil electro-dynamic speaker. Tubes are as follows: One type 2A7, two type 58, one type 56, one type 2A5, and one type 80. Dimensions: 13⅞" high, 13¾" wide, 8¼" deep.

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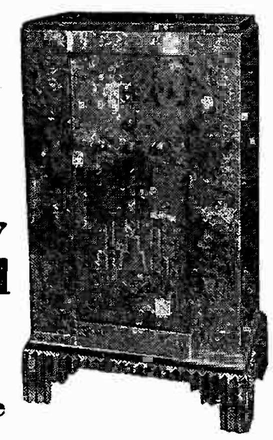
The Crosley
Dual 10
Moderne



The recessed front panel is of V-matched pin stripe walnut veneer above which is an overlay satinwood veneer. Pilasters of stump walnut. Top and end panels are of walnut veneer. Incorporates a superheterodyne 10-tube chassis with dual range, automatic volume control, push-pull output, continuous (stepless) tone and static control, full floating moving coil electro-dynamic speaker. Tubes are: Three type 58, four type 56, two type 2A5, and one type 80. Dimensions: 38¾" high, 23⅝" wide, 12½" deep.

$69.50 Complete with Tubes

The Crosley
Dual 12
Moderne

The front panel is of walnut veneer arched with Carpathian Elm. The rounded pilasters are of walnut veneer with stump walnut veneer caps. Has walnut veneer top and ends. A 12-tube superheterodyne employing dual range static control, automatic volume control, continuous (stepless) tone control, full floating moving coil electro-dynamic speaker. Tubes as follows: Three type 58, one type 2B7, five type 56, two type 2A5, one type 80. Dimensions: 38¼" high, 23" wide, 11¾" deep.

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