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REG. U. S. PAT. OFF.

ESTABLISHED 1917

SHORT-WAVE AND EXPERIMENTAL

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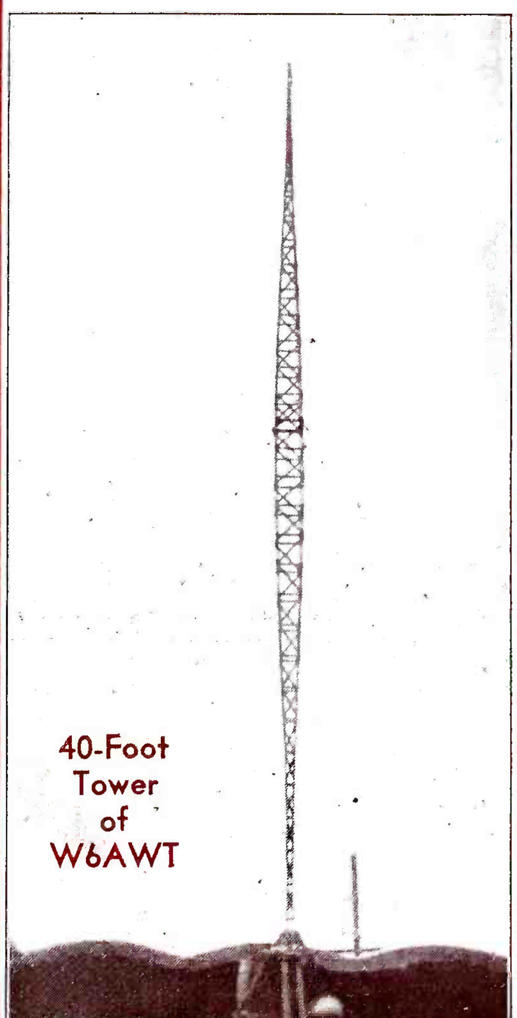

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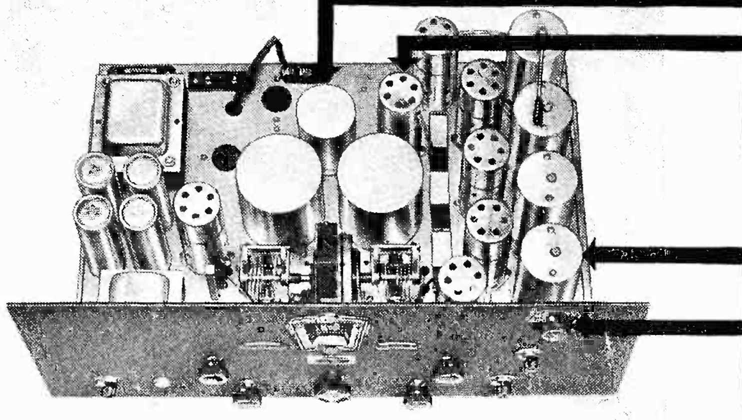

AUTOMATIC VOLUME CONTROL

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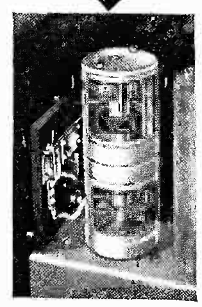

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(8 to 550 Meters)

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How to Prepare the Resolution

IN reply to those who have asked for a "form" of protest against the Madrid Treaty, the following suggestion is offered as a resolution to be passed by a radio club or other organization. It is modelled closely after that passed by the Pacific Division amateurs in their convention during September.

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So, obey that impulse. Have your radio club pass such a resolution and send it to your Senators, and other influential officials in time to prevent ratification of the obnoxious clause.

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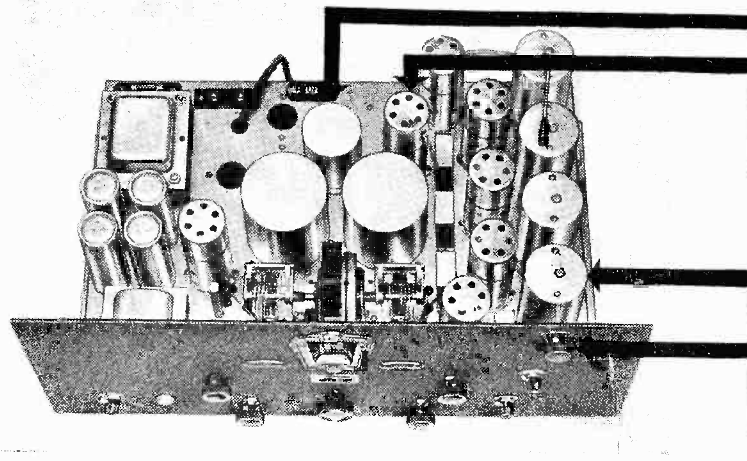

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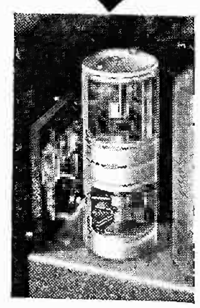

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COL. FOSTER'S COMMENT

K. B. Warner Wants Madrid Treaty Ratified As It Reads

NOW that Mr. K. B. Warner, Secretary-Manager of the ARRL, has elected to entertain the amateurs and the public with his side of the discussion with me about the Madrid amateur regulations, I feel I must do my part. Because the way is open I can happily talk all day, for there is no subject nearer to my heart than the amateur's right to serve the public with free message traffic; and there is nothing that so arouses me as seeing a man—either a commercial representative, a government employe or an amateur—trying to impede that service.

Mr. Warner represented the ARRL at the Madrid International Convention. When he returned he made a report to the amateurs. The most significant statement in it was, **"There is no change from a practical standpoint in our communications regulations."**

The men who represented certain American commercial radio corporations left the wording of the amateur provisions of the former convention more or less as it was, but they added this: **"It shall be absolutely forbidden to licensees of amateur stations to transmit international communications emanating from third parties. The above provision may be modified by special arrangements between the interested countries."** Mr. Warner has taken on the unhappy job of trying to prove that this addition, if ratified, would make no practical change in amateur traffic regulations.

THE present practice is, and always has been, that we United States amateurs handle third-party messages with any foreign country that does not object. This amateur service has grown to be of immense value to the public, especially the trans-Pacific service. We amateurs were providing this free service years before the Radio Corporation of America and Mackay had any trans-Pacific circuits in operation.

Let me assert again—and drive the statement home—that we are handling now, and have **always** handled, third-party messages with every country that does not object; and that our right to do so would be absolutely cut off if the Madrid amateur provisions were ratified by the United States Senate.

In the face of these facts, Mr. Warner feels that the flat prohibition in the Madrid addition to the 1927 regulations constitutes **"no change from a practical standpoint in our communications regulations."** The all-important question is . . . if this Madrid addition makes no change **why** was it added? This question Mr. Warner makes no attempt to answer. Instead he essays the impossible task of trying to prove that the 1927 regulations did prevent the international handling by amateurs of third-party messages. He struggles hard with the 1927 regulations and finally comes to a conclusion that appears to satisfy him, namely, that the 1927 regulations prohibited United States amateurs from handling "important" messages with licensed foreign amateurs, and that the only thing prohibited by Madrid that was not already prohibited was the international handling of unimportant messages with unlicensed amateurs—whatever that may mean.

● Not One Amateur Who Knows the Truth Wants It Ratified As It Reads.

THE Federal Radio Commissioners would perhaps be delighted if they were able to accept Mr. Warner's conclusion. But not even that body—with the 1927 regulations in front of them for the last five years—have been able to arrive at this conclusion.

It is easy to see why the FRC could not come to the Warner conclusion. Look over the findings of the 1927 convention. **"The exchange when permitted must be conducted in plain language and must be limited to messages bearing upon the experiments and to remarks of a private nature for which, by reason of their unimportance, recourse to the public telegraph service might not be warranted."** Did anyone ever see a more wobbly, weak and uncertain proclamation? A definite statement cannot be made by the use of indefinite terms, such as "private nature," "by reason of their unimportance" and "might not be warranted." A positive declaration cannot be made by the use of a whole string of negatives. Certainly, people who could make such an exhibition of jargon could never decide what is or is not "plain language," what is or is not "private," or what is or is not "important."

THIS 1927 regulation was devised by commercial people. The amateurs had no part in its formulation. Too bad; for I submit that all of my amateur acquaintances could have said in understandable language at least what they wished to say. I submit also that an amateur—to wit, Mr. Warner—is brave indeed to try to read into this jumble of negatives an intelligent interpretation. The FRC couldn't do it.

And that is precisely why the United States commercial representatives grabbed the opportunity provided by the next convention, Madrid, to tack onto this mess a **plain-language prohibition against amateur message handling between nations.** And that is why they arranged things so that no longer is, "unless one of the countries has given notice of its opposition," effective, and changed the whole complexion of the situation with, **"The above provision may be modified by special arrangements between the interested countries."**

SEE the difference? Under 1927 we properly handled messages—third-party or otherwise—with any foreign country until that country should file notice of its opposition, which no country ever did. While under Madrid we are **flatly prohibited from handling such traffic until a special arrangement shall have been made between the United States and all countries in question.** Which no country ever will do.

Now, Mr. Warner knew all this. He knew also that the amateurs wouldn't have a ghost of a chance of inducing our State Department even to attempt to make any "special arrangements." The commercial men, likewise, knew it when they added that joker. Mr. Warner knew that if the 1927 regulations did in fact stop our foreign traffic, the commercial people would have seen no need whatever for adding a **flat** prohibition to the 1927 regulations and then tacking on this joker. And yet, knowing all this, he did **not** disclose in his Madrid report the seriousness of the change, but, instead, reported, **"There is no change from a practical standpoint in our communications regulations."**

THE report was in narrative style, with casual and rather humorous treatment, which might have been satisfactory reading for youngsters. But it was not a report that would be completely understandable to serious-minded grown-ups who had the right to expect an **accurate and informative report** of the **final** outcome of the convention. It referred in anything but clear terms to attempts of the commercial representatives to put the ban on the whole of the traffic-handling activities of all amateurs, and then drew the conclusion just quoted. If Mr. Warner had left out all of his own side-remarks and given the actual wording of the provisions adopted (either in the original French or an accurate English translation), the amateurs could have drawn their own conclusions. Instead he summed up with his own, **"There is no change from a practical standpoint in our communications regulations."** Every man I have interviewed accepted that conclusion as the truth of the situation. And to this day every mother's son of us would have been dwelling in fancied security if "RADIO" had not unearthed and disclosed the facts.

JUST remember, the amateur body is not, even now—a year after the Madrid convention—officially in possession of the findings of that convention. The English translation has not yet been distributed from Washington. A few amateurs have obtained recently the French version of the amateur provisions only. The amateur representatives at Madrid had these provisions and could have, and should have, given us the final terminology instead of conclusions drawn by themselves.

The present situation with respect to this Madrid commercial treaty is this: **The commercial representatives who devised the new amateur regulations want them ratified as they read; Mr. Warner wants them ratified as they read; not ONE amateur who knows the truth wants them ratified as they read.**

This is by no means the end of the discussion. "RADIO'S" space this month does not permit the elucidation of many angles of the subject that have not yet seen the light of day. "RADIO'S" policy is to devote no space to discussions between individuals unless the subject is of vital importance to **all** amateurs. The invasion of the inalienable right of every amateur in the world is involved in this case.

—Claire Foster, W6HM

Farnsworth Cathode-Ray Television System

By ARTHUR H. HALLORAN

PART II

The Pick-up Tube

FIG. 1 is a diagram of a typical pick-up tube which may be used to illustrate the operating principles of a number of different tubes. It consists essentially of an evacuated glass chamber with a coated mirror or photosensitive surface, the cathode, at one end. At the other end of the tube is a slender target inclosing an electron-collector and perforated with a tiny aperture facing the cathode. The target is maintained at a positive potential of say 500 volts with reference to the photosensitive surface.

The entire tube is placed inside a framework consisting of three sets of coils. One coil is wound concentric with the tube so as to establish throughout its length a uniform magnetic field whose lines of force are parallel to the length of the tube when a continuous current is passed through the coil. The two coils of the second set are placed above and below the tube so as to establish a vertical magnetic field across the plane of the target. The two coils of the third set are placed on either side of the tube so as to establish an horizontal magnetic field across the plane of the target. The deflecting currents which are passed through these last two sets of coils have a wave form which resembles the teeth of a saw, sloping upwards at an acute angle and dropping downwards at a right angle to the base line.

During operation, an optical image of a scene of action is focused through a lens on the photosensitive surface, much as it might be focused on the ground glass of a camera. This optical image may be considered as an aggregate of microscopically small areas, each differing from the other merely in the intensity of its light. As a consequence, electrons are emitted from all parts of the photosensitive surface, the number of electrons from any particular spot being proportional to the strength of the light which strikes it. A great many electrons are emitted from a bright spot in the image and only a few electrons from a dim spot.

All of these electrons are attracted at a high velocity to the aperture in the target at the far end of the tube. If a fluroescent

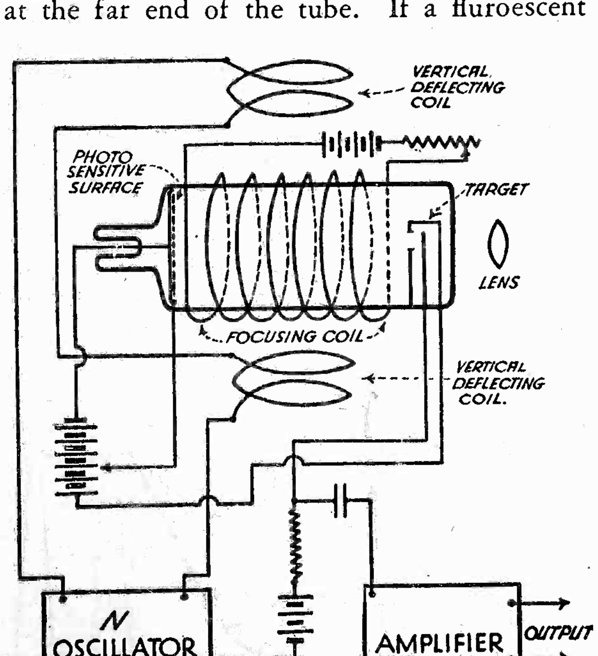
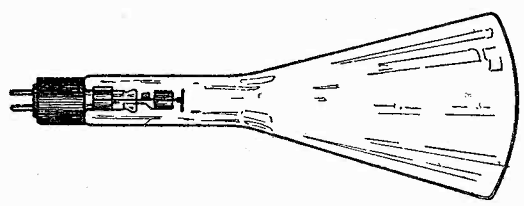


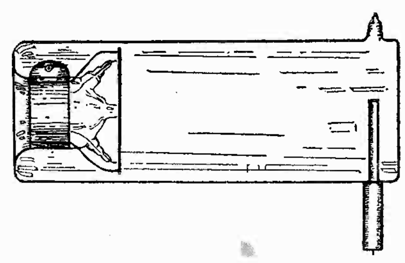
FIG. 1. Pick-up Tube with concentric focusing coil and vertical deflecting coils. (Horizontal deflecting coils not shown).

screen were placed in their path it would show an optical image of the scene of action. But there is no such screen in the tube. And, in its absence, there exists what may be called an electrical image in any vertical cross-section of the space between the photosensitive surface and the target. This invisible electrical image varies in intensity from point to point across its section in the same ratio as does the visible light intensity of the projected optical image.

In order that this electrical image be perfect, the electrons must follow parallel paths to the plane of the target. There is a natural tendency, however, for the electrons to diverge and form an imperfect image. This divergency is counteracted and corrected by the uniform magnetic field which is maintained by the external concentric coil throughout the length of the tube, as previously described. It "focuses" the electrons into a perfect image at the plane of the target. But only a single point of the image coincides with the tiny aperture in the target.



Farnsworth Receiving Tube



Farnsworth Transmitting Tube

When a saw-tooth current is passed through the vertical set of external coils, the entire electrical image is magnetically deflected up and down so that a narrow vertical line of electrons hit the target aperture. Due to the slope of the current wave, the downward deflection is relatively slow and the upward deflection almost instantaneous. If the image were made by visible light instead of by invisible cathode rays, the downward deflection could be seen as a vertical line, but the upward movement would be too fast to be seen. The actual electric current that hits the aperture during the downward deflection is measureable, while that produced during the upward deflection is not. So the effect on the target is that of a uni-directional current. If the deflecting current has a frequency of 20 cycles per second it will sweep the entire image downward past the aperture 20 times each second.

Likewise when another sawtooth current is passed through the horizontal set of external coils, the entire electric image is deflected horizontally across the target aperture as a narrow horizontal line of electrons. If this current has a frequency of 6,000 cycles per second, it will deflect the image past the aperture "slowly" in one direction and instantaneously in the other direction 6,000 times each second.

During the 1/20 second that the image is moving downward, it is simultaneously being swept horizontally past the aperture 300 times. The combined action is the same as if the aperture traversed or scanned the entire image in the same manner that the eye reads or scans a printed page. If the aperture be 1/300th the width of the image, the latter is subdivided into 300 x 300=90,000 elementary areas, each of which contains a certain number of electrons proportional to the intensity of the light in that part of the optical image to which it corresponds.

As the electrons sweep past the aperture they are attracted to the electron collector inside the target, beyond which is a resistor which causes a voltage drop. This is amplified through several stages of vacuum tubes and then modulates a radio carrier wave so as to produce the picture currents which are transmitted by radio to the receiver.

This, in brief, is the process whereby variations in the intensity of the light in an optical image are converted into corresponding variations in the intensity of an eectric current at the transmitter. The particular type of tube which has been described is better adapted for use with motion picture film than for direct pick-up at the scene of action. In such a case the downward motion is supplied by the movement of the film at the transmitter instead of by a scanning current. It is necessary, however, to supply a scanning current of proper frequency at the receiver. Direct pick-up requires a more sensitive tube. A number of other tubes have been devised for the purpose of picking up an optical image in a somewhat different manner. But the one described is thoroughly practical and serves to illustrate how and why a pick-up tube works.

The Receiving Tube

The reverse process of converting the received picture currents into a visible image is also accomplished with a cathode-ray tube, but of an entirely different form. It is quite similar to the standard type of oscillograph tube, excepting that it contains a grid which is placed between the filament, or electron source, and the plate, or fluorescent screen upon which the image appears. The received television signals are applied to this grid so as to control the intensity of the cathode ray in proportion to the amount of light from the scene which is being scanned at the transmitter.

This tube is also placed in a framework consisting of three sets of coils. Direct current in one coil concentric with the tube focuses the electrons from the filament to a small brilliant spot on the fluorescent screen. A second set of coils is supplied with a 6,000-cycle sawtooth current which sweeps the spot in a horizontal line across the screen. A third set of coils is supplied with a 20-cycle sawtooth current to establish a magnetic field which sweeps the spot downward across the screen.

The combined action of the two fields causes the spot of light to traverse the screen in 300 lines 20 times per second. As the intensity of the fluorescence is proportional to the intensity of the picture current, and as that, in turn, is proportional to the lighting at the corresponding area in the image at the transmitter, the scene of action is reproduced on the end of the tube.

(To be Continued)

Putting Power Into the Antenna
. . . . where it belongs

By CLAYTON F. BANE, W6WB

IN this day and age we hear so much talk about high efficiency that it would probably be a good idea if the loudest shouters for this self-same "high efficiency" would state exactly what they mean by the term. Now, in the first place, high efficiency and large power output are not necessarily synonomous. First, we must stipulate what we mean by efficiency. Do we mean the ratio of the total watts input to all stages (including filaments) to the watts actually in the antenna? If we did measure things by this rule, I'm very much afraid that most of us wouldn't do much bragging about the final percentage. No, some other means must be used.

The two things the amateur is interested in are the power in the antenna and the color of the plates of the tubes in the transmitter. Call this latter condition "Plate Dissipation." It is a fairly obvious fact that we are more interested in the antenna power than in the mere fact that our favorite "ten" is lighted up like a Christmas tree lamp. Surely, if it is possible to get this same output with the tube running glacier-like, we will have achieved something.

ENTER "EFFICIENCY"

Stop for a moment and ask yourself the reason why the plate runs hot. It takes energy to develop heat, doesn't it? The energy in this case is supplied from the plate supply source and the heat is simply wasted energy. Think of the watts being used to heat that plate; precious watts that should be expended in the antenna to create waves that would plop down in Africa with added zest! Granting for the moment that this loss is undesirable, let us see what its cause can be and attempt to clear it up. If we bias our amplifier with only a small value of bias (negative) so that the stage may approximate Class A in its operation, we will find that the steady plate current has reached a fairly high value with no increase (and a possible decrease) in output. This increased plate current will result in additional dissipation at the plate of the tube in the form of heat. If we analyze the curve of Fig. 1, we will find that the tube is now biased so that the voltage applied to the grid causes plate current to flow on both positive and negative halves of the cycle, and that the resultant plate current (RMS), as shown on the meter, is a fairly high value. Let us now increase the bias so that the operating point of the tube is as shown in Fig. 2; this point corresponding to Class B, or "Cutoff." We can see that the plate current now only flows on the positive halves of the cycle, and that the resultant plate current is lower than for the previous operating conditions. This lower plate current has caused the heating to disappear. Great! Let's carry the thing a step further. Bias now to the operating point of Fig. 3. This point being double "Cutoff" or, roughly speaking, Class C. The plate current now only flows during a fraction of the positive half of the cycle, and the plate dissipation has shown a tremendous downward jump. Efficiency, you are ours! Yes, we have efficiency all right, but where, oh where has our power output gone? We can now see the proof of the statement made earlier in this dissertation is that efficiency and power output were not necessarily synonomous.

The tank circuit in the final amplifier can be regarded as an oscillatory circuit. That is to say, if a potential is applied across the terminals of the coil-condenser, parallel resonant circuit, oscillations would be set up at the resonant frequency of the circuit. To explain this phenomena let us review some of our elementary theory. The potential we applied across the circuit charged the condenser, and when the charging source was removed the condenser discharged, causing a voltage to be set up across the inductance. This voltage in turn, set up a counter voltage in the inductance (counter EMF) charging the condense in the opposite direction. This charge and discharge process could go on indefinitely if it were not for the fact that the circuit has some resistance. Each time the current flows, some of it is dissipated in this resistance, causing the oscillations to become increasingly weaker; resulting finally in complete damping. If energy could be added in timed pushes to the oscillations just as they were about to die down, the oscillations could be sustained indefinitely. The amplitude of these would depend on the amplitude of the "Kicker," and the resistance of the coil and condenser. Referring back to our Class C amplifier, where we had lots of efficiency but small power output, and taking particular note of the plate current impulses, we can see that these impulses would be just the thing to furnish the timed "Kick" to our tank circuit. They are, but their amplitude is so small that it is rather obvious that the amplitude of the voltage in the tank circuit will be correspondingly small. We know these plate current impulses in the plate of the tube can be increased by decreasing the bias, but we have demonstrated that the use of this method will result in a lowered efficiency. If the grid swing is increased with the bias remaining constant, the amplitude of these impulses will naturally increase, resulting in the tank circuit receiving a greater "Kick" with attendant greater power available in the tank for the antenna load. See Fig. 4. The question now arises as to how far the grid voltage may drive the plate current upward by swinging far into the positive bias region. Two very important things happen when this is done. As soon as the grid excitation swings past the zero bias point, grid current will start to flow in the grid-filament circuit, this current becoming greater as the grid swings more positive. In the second place, an examination of the plate current-grid voltage characteristic curve will show that past a certain point, corresponding to a very high value of grid excitation voltage, the plate current will start falling off. This "falling off" is due to the fact that the filament in the tube has a certain limit of emission, beyond which it is unable to supply additional electrons to allow the plate current to increase. Working the tube over into the bend of the curve will result in the ultimate deterioration of the filament; a condition no good amateur likes to contemplate. There is, however, no reason why the tube cannot be worked right up to the limit of the filament emission, or to put it another way, up to the point where the output falls off even with increased grid excitation. I haven't mentioned the fact that when the tube is working at this point the grid current is bound to reach a high level, resulting in the grid requiring appreciable power from the driving source if the output wave is not to suffer a severe distortion in amplitude. If you are concerned with the value of grid current that should be used, a few suggestions as to proper adjustment may be in order. Obviously, it is impossible to predict or establish a value of grid current that will be applicable to all tubes since the characteristics of different tubes vary greatly, to say nothing of the widely different conditions under which they may operate. Let us take a given set of conditions to facilitate ease of explanation, and proceed to adjust our transmitter. First, let us say that our available excitation is ample, as for example it would be with an '03A driving a '52. Set the bias on the final amplifier to approximate "Class C" and observe the grid current. Suppose this happens to be around sixty-five mils. Couple a dummy load into the final with some

Fig.1

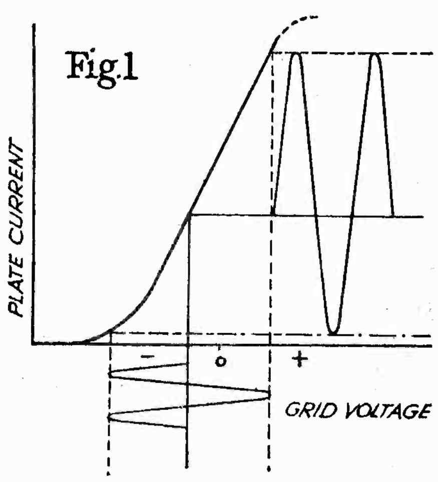


Fig.2

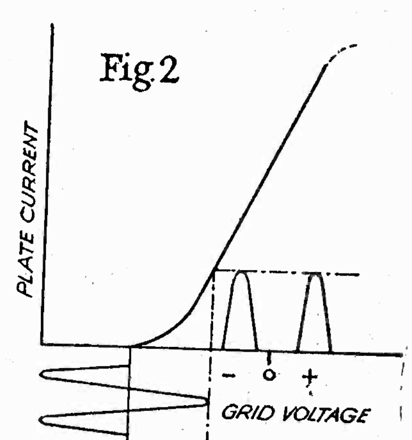


Fig.3

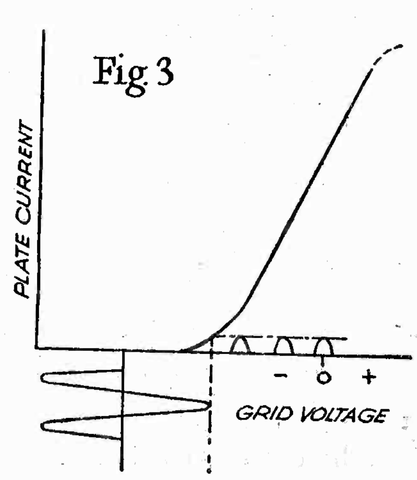
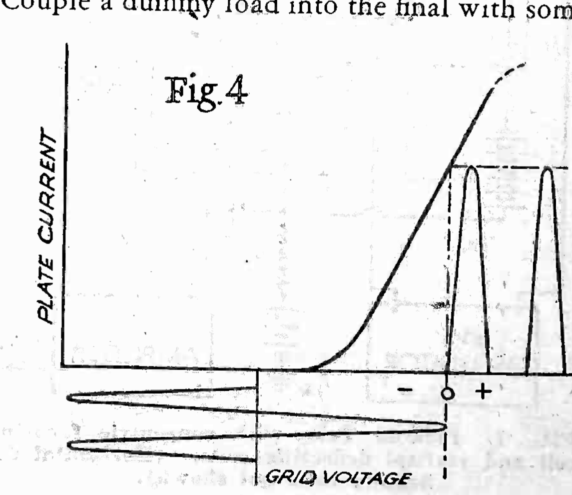


Fig.4



sort of an indicator, so that you may observe any increase or decrease in output. Suppose now, we increase the grid bias until the grid mils drop to fifty. It is fairly safe to predict that the output will not drop. But if you will take a reading from your plate milliameter, you will find that it shows a lower current than previously. Ha! the same output with less plate current, which is certainly desirable. Now, the point is simply this: Increase your C bias up to the point where your power output starts to show a decline, and let this value of bias be your normal one. The value of grid current now showing on the grid meter will be the value you will want to maintain. Another point to remember is that your DC plate current dropped with the increase in bias, but your power output didn't. Bring the plate current up to the value it formerly was, by coupling closer to the tank and your power output will be greater than it was before. This, assuming that your former value of plate current was within the allowable limits of plate dissipation, which it should have been. Having settled this point to our satisfaction, let's talk a little about the plate voltage, which has so far been neglected in our ramblings.

IT is highly desirable to obtain your high power input by using high plate voltage, rather than by the use of lower plate voltage and higher values of current. It can be shown that larger power output and higher efficiency result when the plate voltage is increased with a given value of plate current. This is so because the minimum plate voltage is about the same with a given plate current, regardless of the plate supply voltage. Increasing the plate supply voltage without changing the plate current will increase the power supplied to the tube almost in direct proportion to the voltage . . . . the plate loss changing but little; the net result of this being to supply a greater amount of power to the resonant circuit. However, the highest amount of plate voltage that can be safely used will, of course, depend upon the insulation of the particular tube in use. It is manifestly unwise to put 1500 volts on a ten, though any number of such tubes are working with 1000 volts on their plates and seem to stand the gaff. Let the insulation, plus some good judgment be your judge.

Having found out how to obtain the greatest amplitude of "Flick" impulses in the plate circuit of our tube, it now remains for us to check up on the recipient of this flick —our tank circuit.

Tank condensers being as they are, rather inflexible and practically all patterned along similar lines, there isn't much use in attempting a dissertation of their good or bad points. Nearly all standard transmitting condensers are designed to have a minimum of resistance and corona loss, so use what you have and let's hurry along to our old friend, the inductance. Yes, our poor old friend, the inductance! What a fertile source for controversy. Some say to build them long and narrow, others say short and fat. Some say to use tubing as big as water pipe, others say antenna wire is prime! Surely, you have been drawn into some discussion on high "Q" coils?

THE "Q" of an inductance can be defined as the ratio of the inductive reactance of the coil to its resistance. Stated another way, $\frac{wL}{R}$. It is immediately apparent that if the "Q" of the coil is to be high, the "R", which is usually considered as the effective resistance, and is caused mainly by "skin effect", must be kept to a low value. This resistance becomes greater with frequency, but as the reactance also increases with frequency, the value of "Q" will remain fairly constant over a rather wide range. The direct current resistance has very little bearing on the "Q", and as long as the tubing is not too small, need not be considered. Putting the above into practical form, let us say that there is no point in using half-inch tubing in a 40- or 20-meter inductance, even with power up to one kilowatt. The added skin effect will nullify the decreased DC resistance, and most certainly heating is not a serious factor in any well designed low C circuit. That half-inch pipe belongs back in the dark, dim days of High C and self excited rigs, where the circulating currents in the tank were enormous. Let's not get too enthusiastic in the opposite direction, however. Quarter-inch will be about the smallest permissible tubing that will efficiently do the job. Now to boldly leap into the controversy over the massive inductances popularized by my good friend, W6CUH. Oh, what insults have been heaped on the heads of some users of those big coils. One of my critics said: "That idea must have been originated by a fellow who owned declining copper stock!" Prof. Terman in his book, "Radio Engineering", says, "The best shape for a coil having a given inductance is neither a very long coil with a small diameter nor a short coil with a large diameter but rather one of intermediate proportions." It is generally conceded that six inches is just about the maximum diameter that one should use. Larger diameters usually defeat their own purpose by the necessary long leads to keep the field of the coil away from surrounding metallic objects. Tests have proven that a coil must be separated by at least its diameter, from metal in the set, so that it is hardly practical to make an inductance which is self-supporting, with leads any longer than about five inches. The writer uses an inductance five inches in diameter with sixteen turns of quarter-inch copper tubing; the turns spaced out so that the length of the coil is about nine inches. This is a compromise to permit the inductance to be separated from the tank condenser by its diameter. A coil whose length was equal to its diameter would probably have a somewhat higher "Q", but one can't carry the Purist Theory beyond the realms of practicability. So-ooo.

CONSIDER now the inductance and condenser as a unit, rather than separately. The question arises, "How far shall we go in this high-low C business?" There is absolutely no justification for the use of high C in any final stage of any crystal controlled amplifier. Its only purpose is to take a very poorly regulated oscillator and iron out the wave shape from the plate circuit of the tube into some semblance of a sine wave. This sine wave shape is desirable in any amplifier, as it denotes a freedom from harmonics, but the price is too great to pay. The large circulating tank currents that prevail in High C heat the inductance, and result in a large amount of power being wasted in the form of heat losses. There is no particular reason why the condenser used to tune the inductance should not be quite small. A maximum capacity of fifty-micro-mikes is about the largest that should be used. The fact that many amateurs use crystals at either end of the band rather makes the use of some such value necessary, in the interests of being able to cover a small frequency range with the condenser. The one disadvantage of such a low C circuit is the fact that the harmonics may, and probably will reach a high value when the amplifier is operated at real high efficiency. Those high amplitude "Flicks" we talked about are rich in harmonics and the tank output wave shape will undoubtedly show an appreciable amount of energy on the second and third harmonics. Push-pull will serve to greatly lessen the second harmonic, but is not a complete cure when the amplifier is running far below class C. This is so because the excitation has to swing from so deeply negative up to the positive region that it takes a fractional period of time to swing positive, back to zero, and then negative. The result of this is to create a very small time interval between the positive and negative plate current impulses (Push-Pull). This, of course, will change the phase relations of the second harmonics; they no longer being exactly out of phase and the cancellation is not complete, but leaves a small resultant. In single-ended amplifiers the second harmonic is apt to be quite strong, so it behooves the user to take care to see that his harmonic is not falling into the territory of Joe Commercial. Traps tuned to the harmonic and inserted in the feeder leads might be an easy way to eliminate this trouble. Ever try it? Now to get to the final step—impedance relations between the tube and the tank.

THE book tells us that the energy transfer will be maximum when the input and output impedances are equal. It might also be said that the current in both branches will equalize. This may be fine procedure for other type of electrical work, but is not what we want in our amplifier. Most of the medium power transmitting tubes have a fairly high plate impedance, so that in order to have the greater portion of the power in the plate tank we can see that the tank impedance should be considerably higher than the tube. Our tank being a parallel resonant circuit, its impedance at resonance is limited only by the resistance and this impedance may reach a very high value when the tank is uncoupled. Coupling a load to the tank couples a resistance into it, which will lower the impedance in proportion to the degree of coupling. Obviously, the higher the plate impedance of the tube the less the power than can be coupled into the load without lowering the tank impedance to a value that will approach the tube impedance. Cheer up! There is a low impedance tube in the labs at this moment that will solve this problem. Notwithstanding, the optimum value of coupling must be determined by the common sense method of watching the plate of the tube and the output meter. While on the subject of the plates of tubes, a word about the new carbon or graphite plate should be in order. Don't be deluded into thinking that you can run these tubes wild, just because the plate remains cold. The plates will stand the dissipation but the manufacturers didn't change the filaments. This, by way of saying that the filament emission is the limiting factor, rather than the color of the plate.

IN SUMMARY, let us briefly review the necessary requirements for high efficiency operation.

First of all, the most important point to remember is to adjust your C Bias to fit your excitation. Forget about the Class A-B-C designations. There is nothing sacred about these, and no reason why your amplifier must be held strictly to the definitions of these classes. Looking back, a good study of Figures 2, 3 and 4 will show the importance of adjusting the bias to fit your maximum available excitation. The comparison between Fig. 2 and 3 should convince the most skeptical. The excitation in both of these is the same; the bias only, being increased.

Remember, always, the fact that the limiting factors in the power output of your amplifier are the filament emission and the tube insulation. Use as high a plate voltage as the insulation will permit, and don't try to draw greater plate current than the filament can supply.

The L-C tank should consist of a well insulated, low resistance, low capacity condenser, and an inductance whose length is not much greater than its diameter. Spacing be-

(Continued on page 32)

A Frequency Meter-Monitor With Real Vernier Tuning Control

By F. H. SCHNELL, W9UZ*

NO MATTER whether you buy, build, beg or borrow a frequency meter-monitor, if you operate an amateur radio station, you ought to have one and have it in use constantly while you are operating. It isn't necessary to ask other amateurs how your note sounds or whether you are in the amateur band or not. You ought to make it your own business to know that first-hand—monitor your own signals and you will know how your note sounds; use your frequency meter and you won't have to ask others about your frequency.

Naturally, a frequency meter is of no value unless it has been calibrated accurately and even then it should be checked often enough to insure its calibration from day to day. Of course, one of the hardest jobs is to find a station from which a good calibration can be made without waiting for standard frequency transmissions. But here is a frequency meter that can be checked any minute of the day or

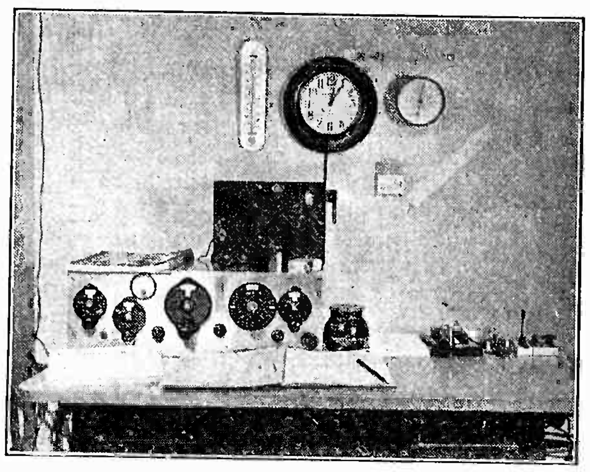


FIG. 1—Fred H. Schnell's Receiver and Monitor.

night as long as you can hear a broadcasting station on some frequency from 860 kilocycles to 1,020 kilocycles and assuming that the broadcasting station maintains a decent frequency.

The circuit is a Colpitts or so-called split filament, patterned after General Radio's Frequency meter. The inductance, L consists of 178 turns of No. 33 enamel wire wound to a length of 1-7/16" (no spacing between turns) on a bakelite tube 1" in diameter. The inductance is about 405 microhenrys. The tuning condenser, C is the General Radio Type 756-A, a two-section condenser having a minimum capacity of 140 micro-microfarads and a maximum of 225 micro-microfarads. The plates are cut for straight line frequency and the actual curve is practically a straight line. The coupling condenser, C1 consists of two copper pieces 1/4" square and spaced 1/4". It provides sufficient coupling to the binding post, A to which may be connected a short antenna for better pick-up. Ordinarily, no antenna is used. The monitor is mounted on top of the receiver where it is handy at all times, as shown in the photograph.

The main dial is 4" in diameter. In 180 degrees there are engraved 25 divisions. The vernier dial is 2" in diameter with 100 divisions for the complete 180 degrees. On the shaft of the tuning condenser, a worm gear is mounted. This is driven by the worm which is mounted on the shaft of the vernier control. One complete revolution (100 divisions) of the vernier moves the main dial one division.

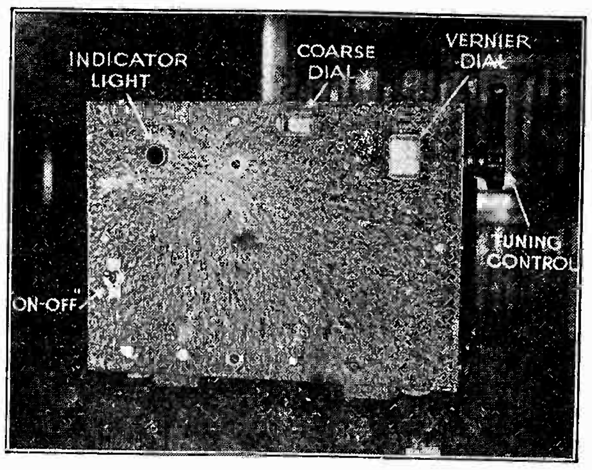
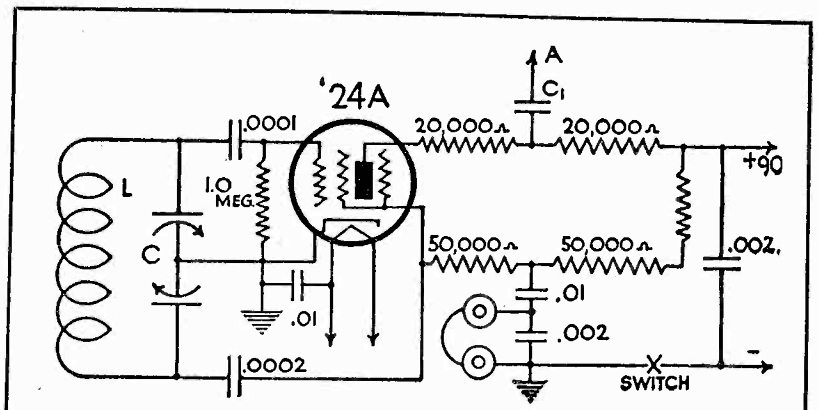


FIG. 2—Monitor Housing, Showing Controls.

The total number of divisions is 2,500 and each division is about 1/16" making it easily readable without a magnifying glass or hair-line vernier. The worm gear and gear-drive assembly is shown in figure 3.

The tuning condenser is mounted directly on the front panel which is 1/4" aluminum. The inductance is mounted on the tuning condenser. The rest of the parts, including the filament heating transformer are mounted on a small bakelite shelf which also is mounted directly on the front panel. The balance of the case is of 1/8" aluminum, measuring 9" across, 6½" high and 6" from front to back. The case is finished in black crackle. All resistors are the one-watt size.



Circuit Diagram of Fred Schnell's Monitor.

The frequency meter tunes in the fundamental of the broadcast band and covers a range from 860 to 1020 kilocycles. The even harmonics and the frequency range are as follows: 1720 to 2040 KC, 3440 to 4080 KC, 6880 to 8160 KC, 13,760 to 16,320 KC, 27,520 to 32,640 KC and 55,040 to 65,280 KC, covering all amateur bands without having to shift coils or fuss around with condensers.

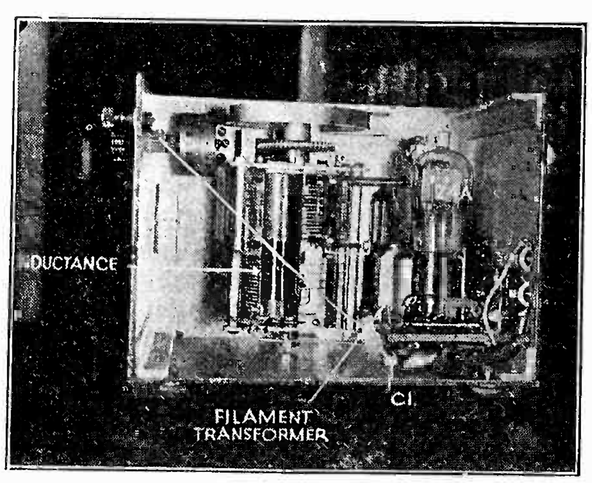


FIG. 4—Correct Placement of Parts is Essential.

Before calibrating, the frequency meter should be allowed to warm up for about 15 or 20 minutes. Then it is necessary to have a broadcast receiver which can be used to pick up stations on the fundamental frequencies. For example: Tune the broadcast receiver to 860 kilocycles and find a broadcasting station which is known to have good frequency stability. Then tune the frequency meter until it commences to cause the well-known "howl" in the broadcast receiver, tuning it finally to zero beat with the broadcast station. The monitor can be set to less than ½ cycle without any difficulty, but even if you come within one cycle, your calibration would be off only **8** cycles in the 7.0 MC band and **16** cycles in the 14.0 MC band. Next, locate a station on 870 kilocycles and calibrate with it and continue up to 1,020 kilocycles. Then plot the curve on a suitable piece of cross section paper—you have only one curve but it serves for all the frequency ranges mentioned above. On this particular frequency meter, the 7.0 MC band is covered in 450 divisions, making it 1½ divisions for each kilocycle. Each division can be estimated easily to a fifth, making it possible to read a frequency within 150 cycles direct.

Using it as a monitor, it is only necessary to connect the headphones as shown (they can be left in the circuit all the time) in the diagram. Start up your transmitter and tune the vernier until you hit your own signal and then tune it off zero beat to the audio note you prefer—that is if you have a good character signal.

Suppose some ham asks you to check his frequency. All you do is tune your receiver to zero beat with his signal and then tune the monitor to zero beat with the receiver. Pick off the dial reading and you have his frequency, knowing in which band he is operating, being sure you use the multiple for the harmonic of the frequency meter, that is, the 2nd, 4th, 8th, etc.

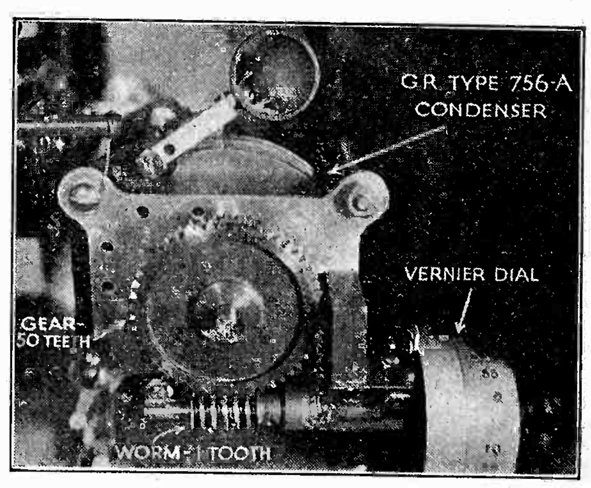


FIG. 3

NOTE: *Worm and gear can be purchased from Boston Gear Works, 935 Washington Blvd., Chicago, or any branch office can get them. The gear is G1037 and the worm is HLUH. The gear is 2-1/12" in diameter and has 50 teeth. The worm has one tooth.*

* 4915 N. Sawyer Ave., Chicago, Ill.

Simplified Frequency Monitoring & Control Apparatus

By LIEUTENANT E. C. DENSTAEDT*

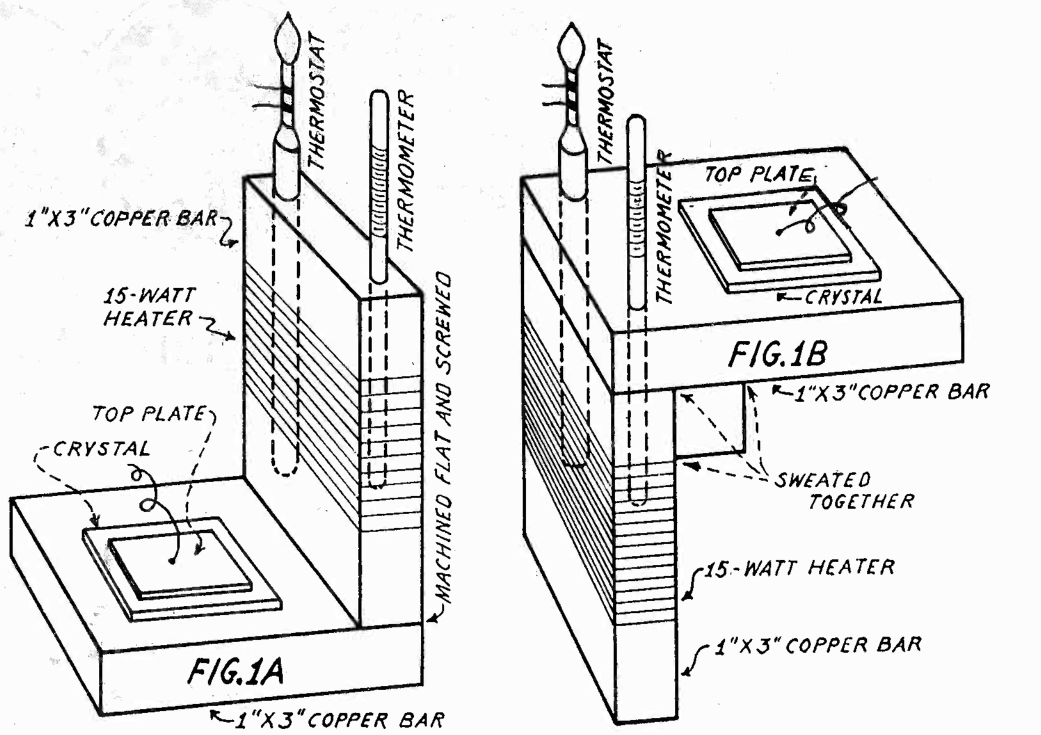


FIG. 1A FIG. 1B

At the present time there exists a number of radio services outside the broadcast band that have need for improved frequency control and monitoring apparatus, yet under present-day trends hardly feel able to install and maintain equipment such as in use in the broadcast field.

About one year ago it was felt at Detroit that some improvement in our frequency control apparatus was necessary. Since the main trouble was due to frequency drift as the transmitters came on the air, it was evident that the cure could be either:

1. Letting the oscillator run 24 hours a day.
2. Dropping the voltage upon the crystal stage until there was no longer any appreciable drift when the transmitter was turned on, and then building up the power with intermediate amplifiers.
3. Changing the crystal mounting and temperature control apparatus so as to minimize the effect of crystal heat.

The first method, since we have to monitor the transmitting of other police radio stations on the same frequency, required elaborate shielding and isolation of the crystal circuit. After a short trial this method, while of course possible, was given up as impractical.

The second method produced additional complications in the transmitters and since we were interested in improving the existing transmitters with as few changes as possible, we discarded this method. We also did not like to have too many intermediate stages in the transmitters.

We therefore decided to revamp the crystal holders and temperature control apparatus. It was apparent at the start that our trouble was caused by the crystal heating and raising the temperature of the whole crystal compartment to such a point that the crystal compartment was at a greater temperature than that for which the thermostat was set. Of course, should the transmitter be left on the air, the frequency would after 40 or 50 minutes gradually settle down to a new value which would be anywhere from 50 to 500 cycles away from the starting point, the drift depending upon the crystal, type of holder, voltage upon the crystal, type of heat box, etc., etc.

It was evident that the best chance for improvement lay in getting close contact btween the crystal and the thermostat and then using a sensitive thermostat to cut down the length and amplitude of the heat cycle. This, of course, eliminated all of the crystal control boxes in which an attenuating box is built between the crystal holder and the heat and thermostat.

The first trial unit was built as shown in Fig. 1. The thermostat was set in mercury in a hole drilled in the copper bar (the mercury providing good contact between bar and thermostat). The heating coil was wound directly around the vertical bar and the crystal sat upon the piece of bar forming the base of the "L." The heating coil dissipated about 15 watts on this first unit. The whole unit was placed in a balsa wood box.

A trial of this unit was disappointing. We found that the frequency would still drift 250 to 300 cycles (at 2414 kilocycles) after the transmitter came on the air. This, of course, was under extremely high crystal power outputs with parallel (Y) cut crystal. With a pair of thermometers we were able to find a temperature difference between the two pieces of copper forming the holder of .3 of a degree. In other words, the crystal was heating the base of the holder to a temperature .3 of a degree higher than that the thermostat was set for. Since we believed the trouble here was due to poor contact between the base and top bars of the holder even though they were machined surfaces, we built the unit shown at B in Fig. 1. In this unit the three pieces of bar forming the unit were sweated together and the unit turned over from its position in the first attempt. In this manner we obtained a better heat conduction between the crystal and the thermostat. This unit proved better than the first but was still not satisfactory since we again found a maximum frequency drift of about 200 cycles and again discovered a difference in temperature between opposite ends of the unit.

We went to a solid square 4-inch copper bar upon which we wound the heat coil and in which we drilled holes for thermostat and thermometer. The crystal sat upon the silvered top face of this bar as shown in A of Fig. 2. This bar proved fairly satisfactory but still left the problem of getting better control of the temperature on the top plate and of providing a good crystal mounting. The final bar is shown in B of Fig. 2 with an exploded view in Fig. 3.

It may seem that this type of unit would have a considerable temperature ripple. This, however, is not the case. By using a sensitive thermostat and properly adjusting the heat applied we have found it possible to cut the temperature variation due to thermostat action to less than 1/20 of a degree.

We have found that these units along with a proper oscillator circuit will hold the frequency of a police transmitter to well within 100 cycles which is several times better than required by law at present. These units are also practically unaffected by ordinary changes in ambient temperature and in conjunction with a reliable relay have been found to be practically trouble-free.

It also is not necessary to pack them away in an insulated chamber since they work very satisfactorily in the open as long as they are not placed where a draft can hit them or very large changes of ambient temperature take place.

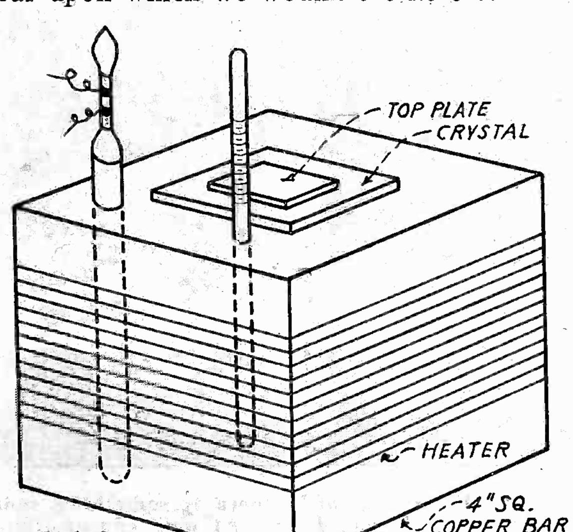


FIG. 2

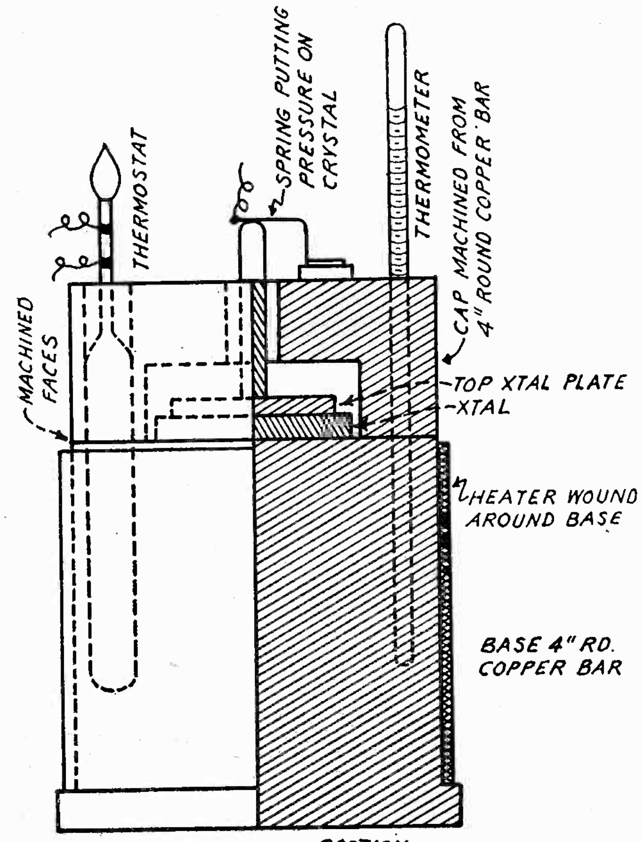


FIG. 3

* Radio stations WCK and WPDX of the police department, City of Detroit.

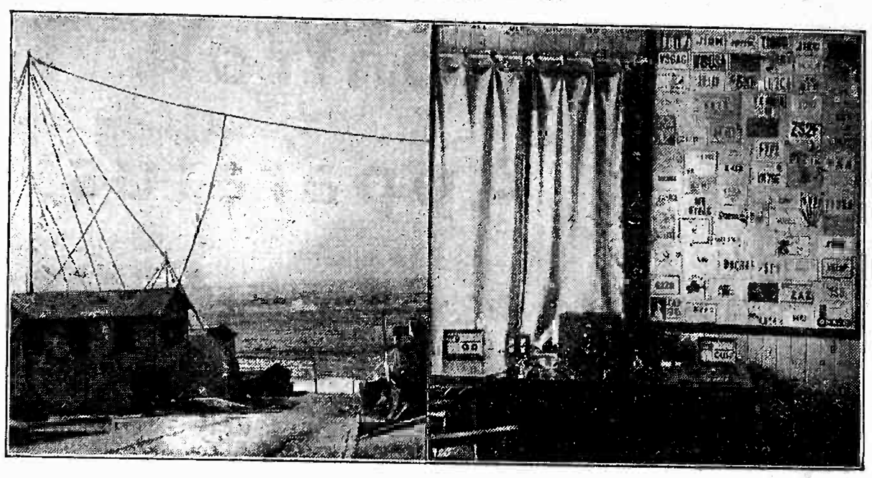
Globe Girdlers

Conducted by CLAYTON F. BANE, W6WB

W6QD-W6CUH, Manhattan Beach, California

THE Globe Girdler presents this month the combined station of Mr. Herbert Becker, W6QD, and Mr. Charles Perrine, Jr., W6CUH, located at Manhattan Beach, California—the beach of continuous radio waves and YL permanent waves. W6QD-W6CUH came into being July 1, 1933. Previous to that date, W6CUH was located in Hermosa Beach, having been on the air since 1927, while W6QD has been off and on the air since the spark days in 1920. Manhattan Beach is 15 miles southwest of Los Angeles, the station itself being about 100 yards from the Pacific ocean. The QRA is really not so bad, inasmuch as the station is the only one in town, the nearest ham being five miles away. (Page Mr. Ripley.)

The shack of QD-CUH is a two-story affair, built along the lines of Noah's Ark. The transmitter room is on the ground floor, while the operating room is on the second floor, where one can get a good view of the beach . . . and the YL's. The operating desk contains switches necessary for remote control of transmitter, also selector switch for several receiving antennas. The receiver is a hopped-up SW-3 with electron-coupled detector, RF and audio gain controls, and RF filtered AC power supply. A few of the DX cards shown in the photo are from countries worked, the bulk of the cards covering the walls of the transmitter room. The QD-CUH boys have a large photo album which contains photos of many DX stations throughout the world.



• What a QRA!

The station house and antenna of W6QD-W6CUH . . . On the brink of the Pacific Ocean. A North-South Hertz Antenna runs across the street and an East-West Hertz runs down hill toward the ocean.

The Transmitter

The remote-controlled transmitter is a six-stage crystal outfit, operating on 7 and 14 mc. It consists of a 47 crystal oscillator, 46 doubler to 7 mc., 210 first buffer, 242a second buffer, 852 third buffer, and a water-cooled 1652 as output amplifier. The 1652 operates as a straight amplifier on 7 mc. and as a power doubler to 14 mc.—a switch cuts in extra bias for this 14 mc. operation.

Being a good doubler is not the only advantage of this water-cooled tube, especially on Saturday nights . . . a two-minute CQ provides enough hot water for a shave, while a five-minute CQ will give a good bath. Each stage runs stone cold (no steam whistle yet needed on the final) and is absolutely foolproof—necessary requirement for remote control.

The R. F. part of the set is laid out on the top of the table 10 feet long, 2 feet wide and 4 feet high. All bypass condensers, filament transformers and R. F. chokes are mounted under the table top. Incidentally, it is very handy to work on any of apparatus under the table due to its height. The oscillator and doubler are in the small box at the end of the table; each of the other stages is spaced in proportion to its power. The photo gives a clear idea of the layout. Each stage has its own common ground point, each being separately connected to a main ground common to the whole transmitter—all this helping to decrease the inter-action between stages. The plate of the 242a is tapped down on the tank to load it further and increase the excitation to the 852. A modified form of the link coupling is used to excite the final. It has worked very well, since the 852 input is only 400 watts to fully excite the 1652 to 1000 watts input.

The power supplies are located some distance from the transmitter, power leads running under the floor. Two well-filtered 83s supply the 500 and 1000 volts. A mercury arc is used for the higher voltage which supplies the last two stages. Keying is done in the primary with consequent absence of BCL Qrm, except for trouble from sparking relays, which at last was eliminated with bypass condensers and R. F. chokes in the power lines.

Antenna

SEVERAL antennas are in use at W6QD-W6CUH, the result of continuous experiment. There are two single-wire-fed Hertz's, cut to 65 feet 6 inches by regular formula, but with feeder lengths kept non-resonant (about 83 feet). Feeder tapped on flat top 9 feet 2 inches from center. These antennas were cut to work on 7200kc. Results are checked by using them on both transmitter and receiver. One runs east and west and is best for AC, AU, J and VU. The other, north and south, is far better for ZL, VK, ZS. Both transmitting and receiving reports go up nearly two points on this antenna. Many Africans are audible only on the N-S antenna. Both antennas are about 60 feet high, slightly tilted. In general, antennas are first compared on the receiver when working in a certain direction, then the best one is used for the transmitter.

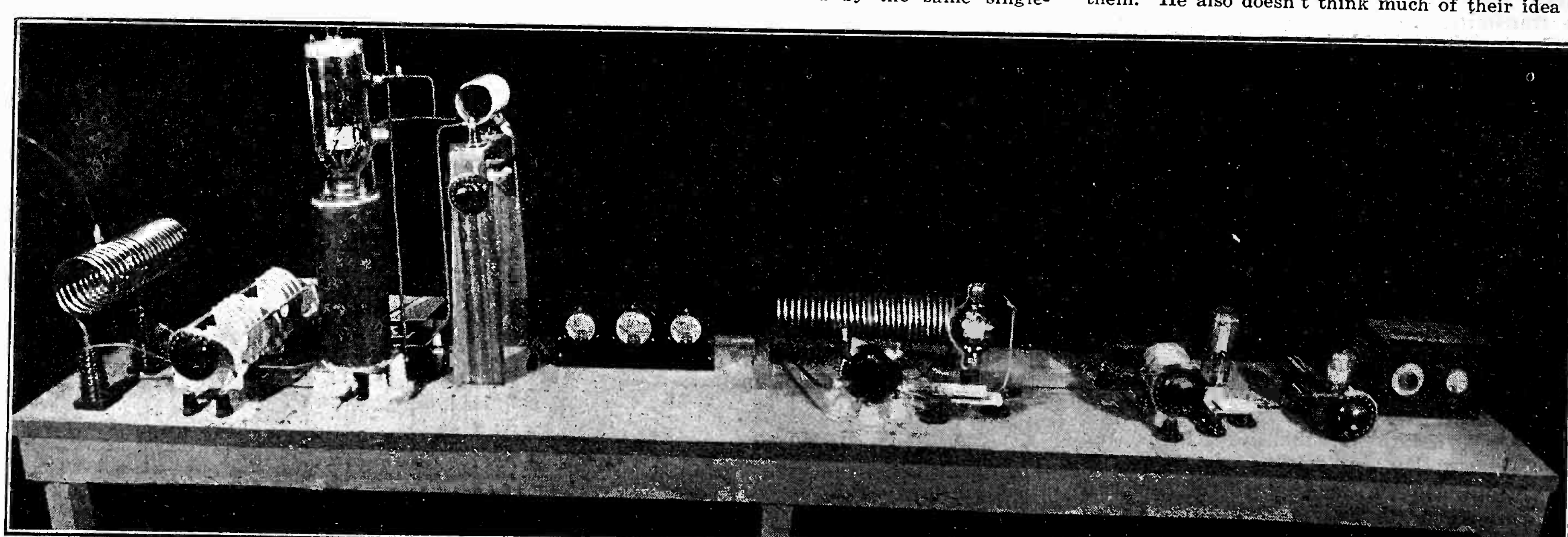
For 14 mc a simple beam antenna has been developed which gives a gain approximately equivalent to doubling the input to the transmitter. The beam consists of two horizontal half-wave 14 mc antennas, one set below and a quarter wave behind the other, so that transmission is directed 20 degrees above the horizontal. They are both fed by the same single-wire Hertz feeder connected as shown in the diagram. The values are not critical. At present this antenna is pointed at Europe and has given good results. On a test with PAOXF the beam was R7 while the N-S Hertz was R5. It is easy to see that the antenna system really means more for maximum results than increased input to the transmitter.

DX Ragchewing With Human Interest

DX is WAC, and 70 countries worked. Many one day WACs have been made, the shortest requiring only 9 1/2 hours. Since the station goal is DX, the new transmitter has done little else. Over 700 DX contacts have been logged since July 1, with an average report of a little over R8. It is interesting to note that actual R10 reports from Africa, Asia, Oceania and North America—also R9 in South America and R8 in Europe have been received. In Africa, reports averaged R7 for 91 QSOs with 25 stations.

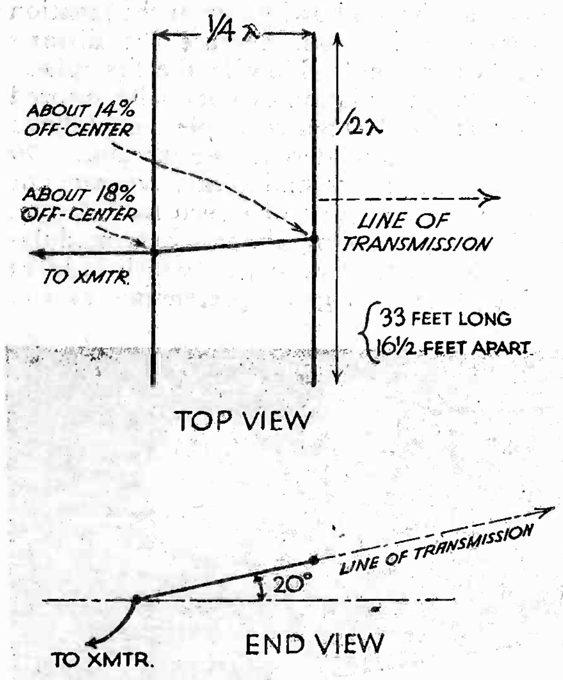
During one particularly good streak, R9 reports were received for 19 consecutive foreign QSOs with ZT, VK, ZL, K6, OM and J. The best report so far: QSA 10, R30 from J1EC!

THE above is only half the DX story because the personal side of real DX rag chewing has even more kick to it. The best one yet was the night VK4JU had his fone going . . . Charlie told him that Herb had just climed into bed behind the transmitter—4JU came back with his fone playing a phonograph record, and what should it be but "Good Night, Sweetheart." Herb's still wondering what JU thought he was. Another gem came from J1EG when things were a little to QRQ during a QSO . . . "Pse QRS, hr lid" . . . real frankness. And from J1EC enthusiastic remarks about his FB photo of "Japanese it." The cellar at KA1PS must be pretty good because he even thinks we in this country have "green monkeys" and "pink kangaroos" . . . at least he's always asking QD-CUH about them. He also doesn't think much of their idea of



Eight feet of power. The transmitter of W6QD-W6CUH. "Sell me some of it", said an amateur on a visit to the station. "How muchcha want?" asked Charlie and Herb. "Oh, about 4 feet worth of it"—so they built him one just like it, 4 feet long, stopping with the 852 stage. But, fellow amateurs, there is something radically wrong with this picture. Inadvertently, the artist omitted something from the transmitter. What did he leave out? Name it, and get a prize . . . the missing part goes to the first reader who tells us what has been left out of the picture.

sleeping under the transmitter . . . claims QD's snoring modulates the note and CUH's big feet kick the oscillator out, hi. Working ZL2CI one morning at 5:30 (1 a. m. his time) 2CI remarked that he just happened to turn on his receiver on getting home from the movies and heard W6QD in there—which was a bad break for him to make, because after five QSOs he hasn't yet explained what those 1 a. m. movies were. Another mystery is what keeps ZT2L in the jungle all week, yet lets him go on the air each week-end . . . and as for ZS2A, it's going to take an automatic tape sender to satisfy this QRQ hound. Incidentally, some real DX relaying was done by W6QD-W6CUH between ZS2A and ZL4AI, 4AO and 4BP in arranging skeds for a ZS-ZL QSO, the coveted DX goal of every ZL.



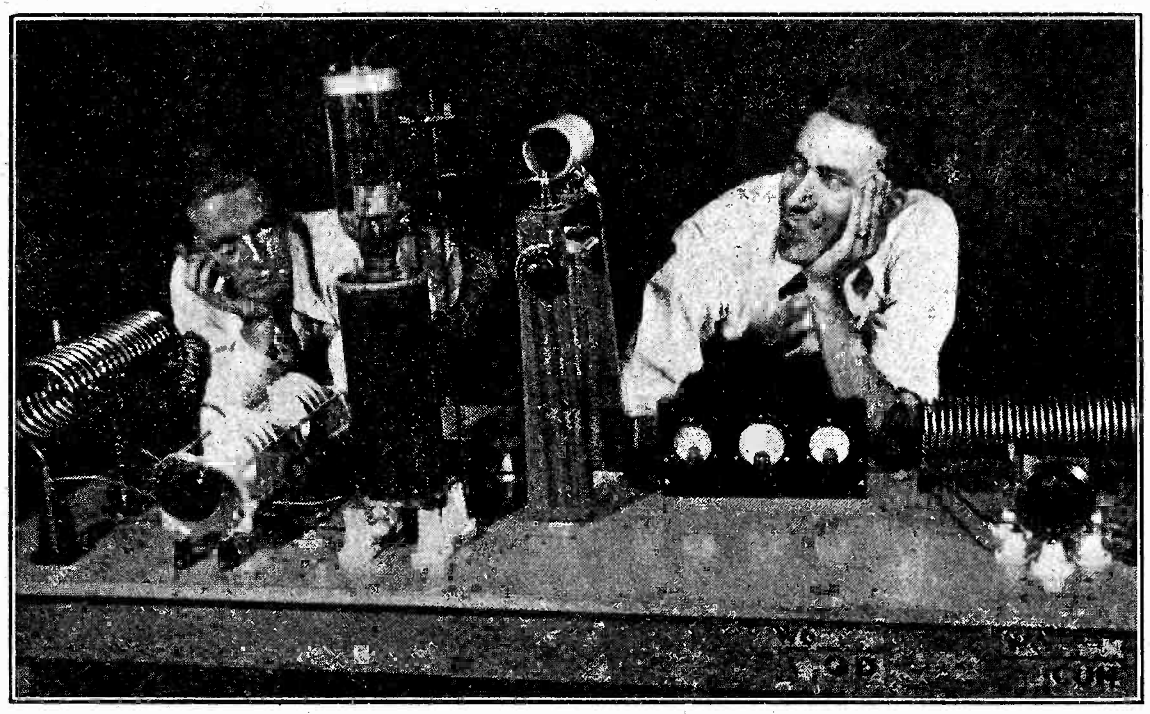
Directional Beam Transmitting Antenna for 14 MC as used by W6CUH-W6QD.

One of the biggest thrills came from hearing and working ZE1JH's 7 mc fone—and did he sound excited.

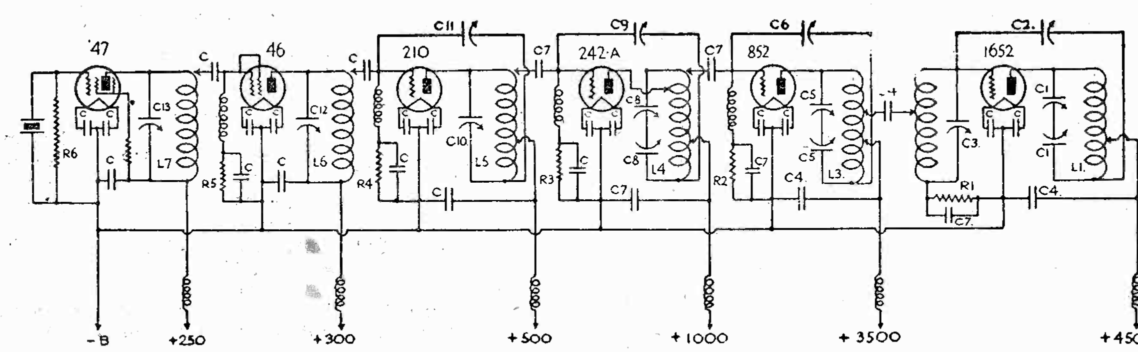
Charlie and Herb got the best laugh from a remark made B. B. (before beer) about the wine glass in J1DM's station photo . . . and when kidded about it over the air he replied that they too would soon have beer. A short time passed and beer came, also a letter from J1DM, quote, "I congratulate that you can drink openly now after the teetotalism was resolved in your state." J3CR also enlightened them with a new radio (?) formula: HAM plus YL equals—DX. These fellows, QD-CUH, get a wallop out of ZZE1JF, because every morning promptly at 6:30 PST he tosses out his first CQ, which enables them to set their timepieces for the day. When 1JF doesn't come through the day is lost.

W6QD-W6CUH are not alone in their opinions on DX QSOs as they are members of the South Bay Amateurs' Association, a small group of hams located along the south bay shores and whose ideas are those of fostering bigger and better DX rag-chews. All members have worked at least 40 countries, WAC, WBE—and are crystal-controlled.

This brings us to realize that, after all, there is a great deal of personality and human interest in DX-QSOs, which gives all of us a better chance to know our friends in other parts of the world, and thus promote international good-will.



"Umph", says Charlie Perrine, W6CUH (left), "What else can we do to make it work better?" "Aw, nertz", says Herb Becker, W6QD (right), "Let's leave it alone . . . We orter be workin' the man in the moon tonight and get another R-9 report."



COMPLETE CIRCUIT DIAGRAM OF TRANSMITTER OF W6CUH-W6QD

LEGEND:
C—.002; C1—.000017; C2—3 Aluminum Plates, 7" x 9", spaced ½".
C3—.0001 Cardwell; C4—.004 20,000 v. Dubilier.
C5—.000025 Split-Stator Cardwell.
C6—2 Aluminum Plates, 2" x 3", spaced 1.2".
C7—.002 Sangamo, 5000 volt.
C8—.00007 Split-Stator Cardwell.
C9—2 Aluminum Plates, 2" x 3", close spaced.
C10—.00025 Cardwell 3000-volt.
C11—.000025 Midget.
C12, C13—.0001 Midget.
R1—Three 5000 ohm, 150-watt Resistors in parallel for 7 MC, and in series on 14 MC.
R2—50,000 ohm, 100-watt Electrad.
R3—15 000 ohm, 25-watt.
R4—10,000 ohm, 25-watt.
R5—10,000 ohm, 3-watt.
R6—50,000 ohm, 3-watt.
Values for Inductances L1 to L7 can be secured, if desired, from "RADIO".

I-Tappa-Key Radio Fraternity—The Amateur's "Legion of Honor"

ORGANIZED in 1926, re-organized in 1932, the I Tappa Kee Radio fraternity was formed for the distinct purpose of filling the need in amateur radio for a real fraternity of selected men, a brotherhood of radio's best. This Legion of Honor is a society of regular fellows who are radio operators "par excellent," banded together for their mutual benefit to foster a spirit of closer comradeship; to provide a forum for discussion of common interest subjects; to carry on the noble traditions of the genuine "dyed-in-the-wool" radio operator; and for the dissemination of knowledge pertaining to the science of radio communication. An I Tappa Kee Fraternity man exemplifies the splendid courage and spirit of sacrifice characteristic of a true "Knight of the Key."

I Tappa Kee is the Amateur Division of Iota Tau Kappa (Greek letters signifying I Tappa Kee), whose headquarters is at the Oregon Institute of Technology at Portland, Ore. This parent chapter's membership is principally for Commercial Radio Operators, those who "go down to the sea in ships", ITK men cover the world, whether it is a lonely coast station in Alaska, or on one of the seven seas, you will find an ITK Frat man upholding the honor of his profession and meeting whatever emergency he may encounter in his line of duty. Likewise, the I Tappa Kee (hereinafter referring only to the Amateur Division) chooses its brothers carefully and for their individual merit.

ITK is a fraternity, not just another club or association, neither does it conflict or compete with any existing organization. In the true sense of the word it means just that, a **brotherhood** of men of similar mind and merit. An ITK brother is expected to extend to any other ITK brother, the warmth of genuine friendship, and to be a "friend in need" if occasion so demands. To insure this condition, personal qualifications are as essential to ITK membership as those technical in nature. An ITK man is the sort of a fellow you work on the air and say of him, "I surely enjoyed working that op; he's a real operator, and I bet he's a regular fellow", and then when you meet him in person, **he is**—he measures up!

Qualifications for candidacy to ITK are as follows:

(A) Candidate must have an active amateur radio station, actually handling traffic, and a First Class Amateur Radio Operator's license.

(B) Candidate must be pledged for membership by three ITK brothers in good standing, who know him to be of good reputation for high quality operation of his station, and conduct becoming a "Knight of the Key."

(C) Candidate must submit a record of his experience as a radio operator, and details of himself and his present amateur station. He must have held an active radio operator's license and actually operated an amateur radio station for at least 3 years.

(D) Candidate may then be voted upon and accepted into the brotherhood only by unanimous consent of the ITK members voting.

ITK being a true "Fraternity of the Air," holds periodic meetings on the air. In addition, local chapters hold meetings "in person". Degrees are conferred. Constitution is secret. Dues are $1.00 per year for which member receives all ITK benefits, including ITK Gold Membership Certificate, Bulletins, etc.

Operators who are not otherwise pledged but who desire to enter ITK, may secure information from ITK as to whether or not they know any ITK men who would pledge them. If not, the applicant will be investigated and if found thoroughly qualified, will be pledged for membership. In either case the candidate will be voted upon, and if found worthy will be honored with ITK brotherhood. ITK does not solicit members but is glad to welcome to its ranks every real "ham" who is as enthusiastic about ITK as its members are, and who meet ITK standards.

I TAPPA KEE RADIO FRATERNITY HEADQUARTER: Secretary-treasurer, Kenneth M. Isbell W6BOQ-W6AMR-KFI, 5143 So. 6th Ave., Los Angeles. The Hi-Kilowatt Joe Meloan W6CGM-W6ZZGM-KERN, 1302 M St., Bakersfield.

1934 Modulation Improvements

By ROBERT S. KRUSE, E.E.

● **EDITOR'S NOTE:**
This material is from "Kruse's Radiophone Guide."

EVERYONE has known for years that the ideal radiophone transmitter should be made of a high-fidelity audio system, operating on a beautifully linear r.f. stage which was excited by an r.f. system of extreme stability—but we have had a thunder of a time in building such a contrivance with the available tubes and apparatus, not to speak of the inadequate information available to the amateur.

Nineteen thirty-four seems to bring better radiophone days, and that's our story.

The Ever-Present Feedback Whipped

RECEIVER designers have long since thrown the neutralized triode overboard to get rid of r.f. feedbacks, and to produce better pre-stage amplifications. In transmission we keep dragging along with the triode largely from habit—though partly because the 865 is absurdly costly for use as a buffer, and its reputed successor seems very slow in appearing. But why wait? The most serious of all feedbacks is that which takes place in a modulated stage, and here we are in a position to do something about it right away, either by modulating a tetrode, in which we can prevent feedbacks, or else by modulating a triode under such conditions as to decrease the tendency toward feedbacks.

One can't simply plate-modulate a screen-grid tube 100 per cent as one does a triode, for on the downswings of the plate voltage it becomes a dynatron and oscillates uncontrollably, while on the upswings the fixed screen voltage cuts off the + peaks. It is therefore necessary to modulate the screen IN PROPORTION to the plate modulation, which can be done in a variety of ways, of which the circuit shown herewith is probably the simplest. The diagram is self-explanatory, except in a few points, which follow. The Modulating system may be of any sort suited to modulation of a '10 or a '52 respectively, transformer coupling being preferable as it permits the use of the same voltage all around. For other tetrodes than those tabulated R2 may be modified suitably—which means that it is adjusted so that when there is no modulation the screen voltage agrees with the maker's data. Don't try to measure it with a voltmeter—measure the d.c. current through R2, figure the IR drop through R2 and subtract it from the plate voltage. Suitable combinations are as follows:

20 Watt carrier. One 865 run as tabulated. Modulation by a 2A3 pair of A prime tubes through a transformer with a primary-to-secondary ratio of .65/1.

50 Watt carrier. Two 865 tubes at 500 volts, 140 Ma., screen +125 Modulator class A prime pair of '50 tubes running with 600 volts plate, 130 volts bias. Transformer ratio 2/1.

125 Watt carrier. 860 run as tabulated. Modulator, push-pull pair 845 tubes running in A prime, 1500 volts, 250 volts grid bias from small B-sub. Transformer ratio 1.1/1.

250 Watt carrier. 860 pair (push-pull or parallel) run as tabulated. Modulation by class B 203a pair running at 1000 volts, transformer ratio about .9/1, bias 45 volts.

A tremendously powerful weapon for determining if all is well is now within sight. This is the Cathode Ray tube whose use was described in the October issue of "RADIO" (page 8) by Mr. Ralph R, Batcher—who unfortunately (or modestly) forgot to mention that he has developed a cathode ray rig especially for the voice-transmitting amateur. It was demonstrated at Chicago's big amateur convention last summer. One can with one of these devices instantly spot r.f. or audio feedbacks, power supply diseases, over and under modulation. But until you get one, the modulated tetrode is a pretty good gadget to use in doing away "sight unseen" with the worst feedback a transmitter can have—feedback in the modulated stage. When that's done a good voice system has a chance to turn out a properly wrinkled carrier.

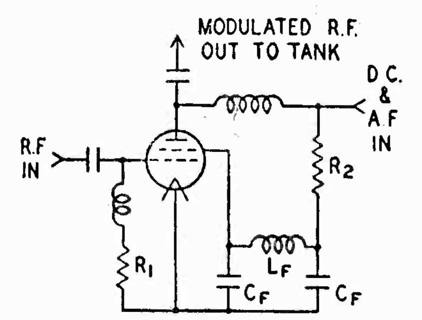


Fig. 1. A tetrode modulating circuit.

r.f. Tube	Plate Volts	Ma.	R1	R2	Screen Volts
850	500	60	10,000 or 75 volts	25,000	+125
860	2000	100	10,000 or 200 volts	100,000	+300

LF is any r.f. choke effective at working wave. CF, CF of mica and .0005 each (no more).

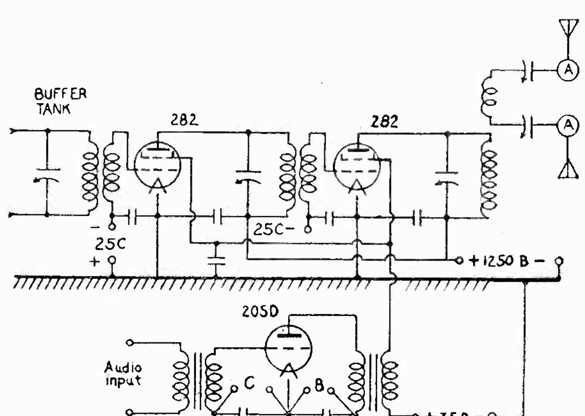


Fig. 2. A two stage scheme for high level screen modulation. While shown for Western Electric tubes it is equally applicable to other tetrodes.

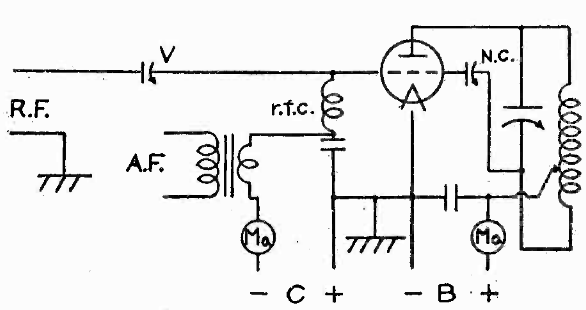


FIG. 4
The extremely simple circuit of a "modern grid modulator". It permits a receiving tube to modulate the LARGEST amateur radiophone. The adjustments are important but very simple. Briefly the A.F. input from a very small audio amplifier is adjusted by the usual gain control while the R.F. input is controlled either by V or in the buffer stage preceding for instance by adjustable bias just as receiving R.F. amplifiers are controlled. This setting is made but once. Monitoring is unnecessary and the absence of grid current gives long life to C batteries, or permits the use of a C sub. In line with 1934 practice a tetrode may be used and neutralization avoided.

1934 Screen Modulation

IF this screen-and-plate modulation seems too formidable to tackle, you may arrive at the same end—and gain an incidental advantage—by merely modulating the screen. I can always hear a howl go up at the mention of screen modulation, because "it distorts above 70 per cent." Now in the first place, 70 per cent modulation is not to be sneezed at, and many a "100 per cent" plate-modulated station can't show decent fidelity above 70 per cent. In the second place, we are not talking about that sort of screen modulation. Instead we are talking about screen modulation in two successive stages, which reduces the distortion at a given percentage, as you will be able to see. A high percentage is possible with perfectly acceptable speech—and it takes but 2 audio watts for a 25 watt carrier—or 8 watts for a 100 watt carrier. That is the incidental advantage. Thus a pair of 2A3 tubes with a proper output transformer can nicely modulate a pair of 860 stages. The circuit, on a small scale, is shown for Western Electric tubes. The 282 is an overgrown 865, the 205D is a fairly close relative of the 210. Furthermore—in all this work with screen-grid tubes one is to remember that they are very easily driven, and at most wave lengths one can use receiving tubes altogether for the crystal oscillator and the buffers. Don't overlook the '35 tube as a buffer either—until we get that long-awaited 865 replacement.

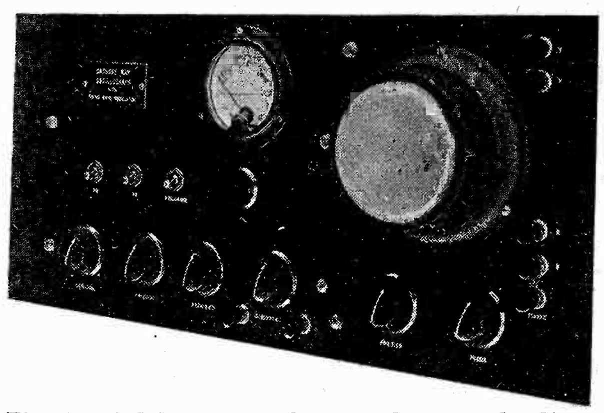


Fig. 3. A laboratory rule yesterday, a radiophone utility tomorrow. A modern simplified cathode ray oscilloscope.

"Modern Grid Modulation"

THIS heading was quoted because it is the wording above Boyd Phelps' very fine article in "Kruse's Radiophone Guide," wherein he explains the simplest sort of modulation that ever came to aid the troubled voice-transmitting amateur.

It is unfortunate that the telling of this story is a bit too lengthy for the present paper. Just now we wish mainly to suggest that, as Mr. Phelps says, "If you hear grid modulation condemned on grounds of fidelity or ECONOMY, find out if the speaker means ancient or modern grid modulation, which differ as night and day."

The principle of grid modulation is to save voice power by using the modulated r.f. tube as its own final audio amplifier——in other words one feeds the audio into its grid instead of its plate, thereby saving one large and costly audio stage. While it would appear that one loses heavily as to carrier level through being unable to swing the plate voltage to twice normal, this is incorrect to a degree, for one BEGINS with twice the usual plate voltage on the tube. This is safe since it is after all no more than one swings "up to" when plate-modulating 100 per cent. Thus 4000 volts on an 852 is quite o. k. Incidentally, one may as well make it a pair of 852 tubes since it is EXACTLY as easy to swing two of them. In either case a 210 audio tube is ample, and the r.f. input can be obtained from another 210. The same tubes will drive a pair of 851 tubes, or a water-cooled tube, giving a 1000 watt carrier in either case, with all the rest of the equipment made of receiving tubes. Several additional advantages appear. The bias battery of the modulated stage does not froth, steam and sputter, nor does its voltage wander around wildly in the manner of a bias battery on a late-modulated stage, A "c-sub" may be used if desired. In addition, the small r.f. drive required permits loose coupling to the preceding tank circuit, which greatly stabilizes the stage and makes neutralization (if any) uncritical, hence fidelity easier to reach.

Not to leave the subject without any specific data at all, we shall guess at the most-used hard-to-modulate stage and give the operating conditions for it. Assuming a pair of 852 output tubes in push-pull we would have: Plate volts, 4000, bias 500 from small C sub, carrier watts 250. Audio driver 210 with 350 plate volts, r.f. driver almost any tube with 600 plate volts, tapped down on its tank coil so as to give voltage step-up to the 852 grids, or 1000 volt tube without step-up. First set 852 bias at 330 volts and increase r.f. input until tubes together draw 125 Ma., then increase bias to 500 volts and raise audio level until grid current "kicks" appear on speech peaks.

The relatively high plate voltage may appear to be a great disadvantage, but the small plate currents make up for this by permitting use of quite modest transformers and filters. In a number of representative cases detailed cost figures show little choice between this and class B plate modulation, whereas the greater simplicity of the a.f. system is a distinct advantage.

Special Types of Modulation

WE hear much these days as to carrierless and single-sideband radiophones and other specialized voice signals. Their ultimate advantage in amateur voice work is still speculative. The most valuable thing in voice communication is certainly its casual and friendly nature, as compared with the somewhat formalized nature of telegraphy. It would be a great pity if we were to wander into any more complex type of transmission which might demand prearranged schedules for any considerable ease of tuning in the signal.

Again, the object of such a change would be to decrease interference, whereas the greatest care will be necessary to prevent INCREASED interference through the nefarious by-products of special modulations, which are hard to trace to their owners because frequently unintelligible. This is not an off-hand guess; the art of sideband-suppression and carrier-suppression, as well as the special types of multiple modulation, are all old—though we shall surely in the next few months hear of alleged developments in this regard, with more or less the over-statement which has accompanied recent 5-meter work—and with the same cheerful disregard of work done a good many years ago.

The specialized voice signal IS coming, of course, one has but to listen any evening to hear a number of stations using it in assorted forms—all due to the Bell Laboratories or Hammond Laboratories originally, though before this is printed you shall surely see articles in which neither outfit receives much credit. While on this subject of giving credit; the Phelps grid-modulation scheme presented for amateur use is apparently much like that used in recent Western Electric police transmitters, although the work appears to have been done entirely independently as so often happens in this art.

Power Supplies

POWER supplies appear to have little to do with modulation. This is exactly why they so often have a great deal to do with it—all bad. "Long hours may be spent in trying to improve transmitter behavior—without realizing that the performance may be handicapped by improper power supply." The quotation is from Dr. F. S. Dellenbaugh, Jr. Note that he says "improper" not "bad." A power supply that supplied perfectly fine "pure d.c." to a pair of 852 tubes working c.w. might very easily be completely awful when the same two tubes were modulated. Both filtering and regulation enter. If the filtering is bad one can HEAR and SEE that something is wrong with the carrier and the rectifiers, but if the regulation is bad and one lacks a cathode ray tube, it is harder to tell. One had best avoid trouble by starting with a correct filter design. While in no way wishing to be so presumptious as to compress Dr. Dellenbaughs 6 pages of "Radiophone Guide" design information and examples into a paragraph, I shall undertake to suggest what is usually wrong with the picture. Briefly, then, the first choke should be so large that its inductance, when multiplied by 500 is larger than the load resistance. Thus if the filter feeds 100 ma. (= .1 amp) into its load at 1000 volts we evidently have a load resistance of 1000/.1=10,000 ohms of load resistance. A 20 henry choke will JUST answer, since 20X500=10,000. Filtering, rectifier life, and condenser life, are all helped by this rule, as is the heating of the plate-supply transformer. The first filter condenser must be large enough so that when it is multiplied by the inductance of the first choke the product is at least 7 (or 10 if you have 50 cycle supply). Thus for example we seem to need at least 1/3 (or 1/2 at 50 cycles) mfd., but 1 or 2 is better by far. The second choke and condenser must be at least as large, and can be a good bit larger to advantage.

This is NOT design information, it is merely a bit of test information by which to judge whether your filter needs some re-design, in which case you are referred to the complete article for the actual cures. Regardless of any figures, if your carrier bears a hum or "mush," it might be well to suspect the first filter choke of having been rated by an optimist. Don't be too hard on him, though, we need optimists in this voice game until we hatch some new kilocycles or split the old ones.

20-Meter Antenna R. F. Feeders

By FRANK C. JONES, Ultra-Short-Wave Editor

RECENTLY Jack Holmes, W6BUY, wanted to check some r.f. feeders for use on his half wave antenna designed for 20 meter operation. As a result, W6PB, W6WP and the writer, spent an afternoon at W6BUY changing feeder systems and checking the radiation by means of a small field strength measuring device. The results were, of course, subject to the particular surroundings at W6BUY, but since his location is like a large number of other stations the results may be of general interest.

The antenna was a half wave affair about 33 feet long, practically horizontal, and suspended between a couple of poles about 15 or 16 feet high. These poles were on top of a Spanish type stucco house, so the antenna was about a half-wave above ground. The r.f. feeders consisted of the familiar "zepp" type, single wire, "matched impedance" feeders and twisted No. 14 wire feeders. The transmitter consisted of the usual crystal oscillator, doublers and a final amplifier using a pair of so-called 50 watters running at about 200 watts input, as nearly as could be maintained by output circuit and coupling variation. The output plate tank circuit consisted of 12 turns, 2 inches diameter ,of copper tubing, and both direct and inductive coupling were utilized to the r.f. feeders. The latter were about 40 feet long and ran out through a basement window up along about 15 or 16 feet of stucco wall; then up to the antenna. The spaced two wire feeders used low r.f. loss spacers about six inches long and the feeders were kept fairly close to the stucco wall, about 7 or 8 inches clearance.

The field strength measuring device was quite simple, and while not very sensitive, served the purpose. It consisted of an antenna and a tuned circuit using a current-squared galvanometer. The antenna part had to be kept at least 15 feet from the feeders, particularly the single wire feeder which seemed to have considerable radiation.

With this set-up, the galvanometer read 60 divisions for optimum adjustments with the matched impedance feeders connected 1½ turns each side of center of the plate tank circuit. Three turns was found to be the best value of the total of 12 turns for this 600 ohm r.f. line. The feeders fanned out to a Y connection on the antenna in accordance with the usual amateur practice of about 1/7 of the total length for each side of the antenna center. The maximum galvanometer reading obtainable with inductive coupling was 40, which only represented two-thirds as much actual power in the antenna for the same amplifier input. Probably greater care in adjustments of coupling, and impedance matching across a portion of the coupled circuit when tuning out its reactance would have made this reading more nearly approach the higher value of 60. Conductive coupling with a pair of plate voltage isolating condensers in series with the feeders gave 55 divisions.

Using the same two feeder wires as a "zepp" feeder, gave a maximum deflection of 40 divisions. The feeders were inductively coupled with a pair of series tuning condensers for tuning it as a ¾ wave system. This again only represented two-thirds as much antenna power for the same amplifier input. With this scheme the feeders have standing waves on them with points of maximum and minimum voltage with attendant high losses due mostly to the nearby stucco wall which had a metal wire screen interior.

The single wire feeder attached 1/7 off center with conductive coupling, gave a galvanometer deflection of 26 divisions when the feeder was tapped up the tank circuit coil at a point which gave the same amplifier plate current as before. The ground acts as the other feeder in this scheme and there is some radiation from the single wire. Again, the stucco building seemed to have a great effect on feeder losses as well as the possibility of a very high ground resistance entering into the problem. At any rate, the horizontally polarized wave only had half as much power as the two wire 600 ohm line to the antenna gave, and less than ¾ as much as was obtained when using the zeppelin feeders.

Finally a twisted-pair feeder was made, using No. 14 rubber covered wire such as used in house wiring. This was connected to the antenna by simply cutting the latter at the

(Continued on page 32)

•Do You Want to Be Hung Hi?

By LOUIS R. HUBER

• Chinese history relates the sad case of Hung Hi, whose lands were overrun by bandits. In desperation he appealed to the high priest, Kay Wa.

"O wisest one", he wailed, "ruffians have taken my land. When I go to reap they chase me. I have only a small garden to call my own."

• Kay Wa, the high priest, whose sleek jowls were fattened off the flocks of Hung Hi and other peasants, stroked his beard and frowned.

• "Fool!" he said. "Fool, to offend those who oppose thee! Go back to your land, look over what is left and see if it is not sufficient."

In a few days Hung Hi returned.

• "O wisest one", he answered, "it is so. I have plowed under the temple garden and the orchard. My children must stay in the house, but now we shall have enough rice."

• Years passed, and Hung Hi's family increased twofold. Again he sought Kay Wa.

• "O wisest one", he pleaded, "my family is twice as large. We are starving. There is plenty of land all around me but I am not permitted to use it. What shall I do?"

• Kay Wa remained silent for a long moment, and then looked into the eyes of Hung Hi.

• "The trouble with you," he scowled, "is that you and your children work too hard. If you will stop going into the village to hear the gossip, you wouldn't feel so hungry."

• The high priest permitted a smile of deepest benevolence to cover his visage, and as he smiled he said, "Now, for the great love you bear Kay Wa, go home and sit all day with your children in your house. Do not stir except to water your rice shoots every morning."

• Hung Hi murmured obedience and left. Months passed by until one day a visitor came to the house of Hung Hi.

"I am Wa For, your neighbor from the next kingdom", the visitor said, "and I come to tell you how we have rid our fields of the bandits."

• Hung Hi opened his sunken eyes and looked languorously at Wa For. He opened his mouth to speak, but his dry tongue only clacked against the roof of his mouth.

He was partly paralyzed, and deaf. A short time later, he died. His spindly sons buried him beside the door-step.

• Until 1924 amateur radio was given the use of all frequencies above 1500 kc. Then some rough but large slices around 1750, 3500, 7000 and 14000 kc. were cut off for amateur radio and the rest given to commercial and government services.

• In 1927 the Washington Conference was held and commercial services grabbed off all they could get.

Amateur radio was driven into the unconscionably small bands now reserved for it.

• In answer to all objections about the theft of amateur frequency territory by the commercial services, the amateurs were told that they didn't deserve any more than they got, that what they had was enough anyhow.

• Since 1927 the number of amateurs has doubled, and yet they are still restricted to the same narrow bands. Another international conference has refused to widen amateur territory, although wide portions of the radio spectrum around the amateur bands are practically unoccupied.

• This manifestly unjust situation has resulted in the formation of two groups of amateurs: those who follow the high priest who lost their territory; and those who believe a vigorous campaign to arouse public justice, leaving no opportunity slip that might regain lost rights, is the only way in which amateur radio can be perpetuated.

• The first group, the do-nothings, have for encouragement the spectacle of their lost frequencies—nothing more. The second group, the "radicals", have all kinds of successful "lost causes" to cheer them on—not the least of which is the defeat of the Radio Combine by one lone man, Oswald F. Schuette, who so effectively martialed public opinion that the "patent pool" which monopolized the radio industry was dissolved by law.

• At no time before this in the history of this country has "the public interest" commanded such quick attention by Congress. What Schuette and the small manufacturers have done for patent rights, WE can do for frequency rights.

The Bad News! New "Q" Signals

QSK? . . . .

NO, Sparks, I'm not a-asking you if you want me to shut up. Not at all, old timer—for the new Q Signals are out, and QSK? means "Shall I continue the transmission of all my traffic? I can use break-in operation."

Just another of the little surprises the playboys of the International Conferences have in store for us poor stiffs every five years. Who it is that makes up these new Q Signals is not generally known.

About five years ago, QRV was a perfectly docile little abbreviation meaning "Are you ready?". And then the Washington conference came along and some Sadistic rascals with a bent for changing things all around the way your big sister does when she comes home—they were given the Q Signals and told to "Go ahead boys, swap 'em around, make 'em sound new!"

They did. They changed QRV?, for example, to mean "Shall I send a series of V's?" And now, just for example, these 1933 playboys come along and decide that it's just plain nertz to use QRV? for that purpose. So they have changed it around to the old stall of five years ago—"Are you ready?"

Well, we're ready! You bet we're ready! Ready to murder these rapscallions who go around to international conferences changing O Signals on us so often we don't known whether we're being insulted or not when somebody tells us "QSX 600". We might think they were getting fresh and telling us our wavelength was off 600 meters. But just about the time we got sarcastic and said, "Oh, yeah?" they could tell us, "Hey, you big bum—I'm listening for you on 600 meters."

And that's not all. When Happy New Year rolls around again, don't get out your wavemeter when somebody says QRH? Because he'll only be asking you "Does my frequency vary?" And when anybody says QSV?, don't jump to the hasty conclusion that he's asking if you want him to change his wave. He'll only be asking you if you want him to send a series of V's.

Now, there are a lot of us who like to postpone some of our work now and then. When that happens we say "QSK 45 min, pse". But just try that after Happy New Year. There's not a single -Q sig in the bunch that will work that way, now—unless you want to ues QRX. It doesn't fit, but maybe it will do, if we grit our teeth.

And the playboys didn't like those new QA Signals ay-tall! No, sir! They kicked 'em right out and put in some new ones that start out with OU. These new QU ones aren't bad signals, though. But look out for a change about five years from now.

It doesn't pay to have a memory any more.

The bad news: . . . .

To Your Right

Q SIGNALS To Go Into Effect January 1, 1934—From Madrid Treaty

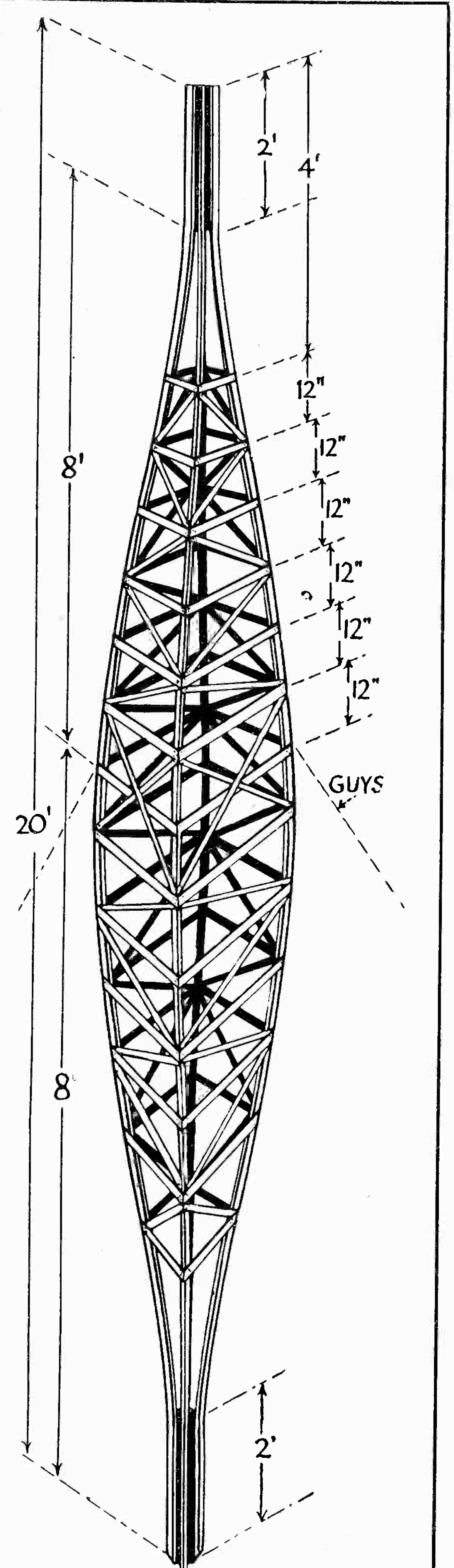
Abbreviation	Question	Answer
QRA	What is the name of your station?	The name of my station is......
QRB	What is your approximate distance from my station?	The approximate distance between our stations is......
QRC	By what private company (or Government administration) are the accounts for charges of your station liquidated?	The accounts for charges of my station are liquidated by the private company...... (or by the ......government administration).
QRD	Where are you going and where do you come from?	I am going to......and I am coming from......
QRG	Will you indicate to me my exact frequency (or wavelength) in kc. (or m.)?	Your exact frequency in kc. (or wavelength in m.) is......
QRH	Does my frequency (or wavelength) vary?	Your frequency (or wavelength) varies.
QRI	Is my note steady?	Your note varies.
QRJ	Are you receiving me badly? Are my signals weak?	I can not receive you. Your signals are too weak.
QRK	Are you receiving me well? Are my signals good?	I receive you well. Your signals are good.
QRL	Are you busy?	I am busy (or I am busy with......). Please do not interfere.
QRM	Are you being interfered with?	I am being interfered with.
QRN	Are you bothered by static?	I am bothered by static.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRQ	Shall I send faster?	Send faster.
QRS	Shall I send slower?	Send slower.
QRT	Shall I stop sending?	Stop sending.
QRU	Have you something for me?	I have nothing for you.
QRV	Are you ready?	I am ready.
QRW	Shall I tell......you are calling him on ......kc. (or m.)	Please tell......I am calling him on......kc. (or m.)
QRX	Shall I wait? When will you call me again?	Wait. (or Wait until I have finished communicating with......) I shall call you at......o'clock (or soon).
QRY	Which is my turn?	Your turn is number......(or after every other call).
QRZ	Who is calling me?	You are called by......
QSA	What is the strength of my signals (1 to 5)?	The strength of your signals is......(1 to 5).
QSB	Does the strength of my signals vary?	The strength of your signals varies.
QSD	Is my keying accurate? Are my signals distinct?	Your keying is inaccurate. Your signals are bad.
QSG	Shall I transmit......telegrams (or one telegram) at once?	Transmit......telegrams (or one telegram) at once.
QSJ	What is the charge per word for......, including your interior telegraph charge?	The charge per word for......is......francs, including my interior telegraph charge.
QSK	Shall I continue the transmission of all my traffic? I can use break-in operation	Continue the transmission of all your traffic. I shall break you if necessary.
QSL	Can you give me acknowledgment of receipt?	I give you acknowledgment of receipt.
QSM	Shall I repeat the last telegram I sent to you?	Repeat the last telegram you sent to me.
QSO	Can you communicate with......directly (or through......)?	I can communicate with......directly (or through......).
QSP	Will you relay to......free of charge?	I will relay to......free of charge.
QSR	Has the distress call from......been attended to?	The distress call received from......has been attended to by......
QSU	Shall I transmit (or reply) on......kc. (or......m.) and/or with waves of type A1, A2, A3, or B?	Transmit (or Reply) on......kc. (or......m.) and/or with waves of type A1, A2, A3 or B.
QSV	Shall I transmit a series of VVV......?	Transmit a series of VVV......
QSW	Do you wish to transmit on......kc (or......m.) and/or with waves of type A1, A2, A3 or B?	I am going to transmit (or I shall transmit) on......kc. (or ......m.) and/or with waves of type A1, A2, A3 or B.
QSX	Do you wish to hear......(call signal) on......kc. (or......m.)?	I hear......(call signal) on......kc. (or......m.)
QSY	Shall I change to transmission on......kc. (or......m.) without changing the type of wave? or Shall I change to transmission on another wave?	Change to transmission on......kc. (or......m.) without changing the type of wave. or Change to transmission on another wave.
QSZ	Shall I send word or group twice?	Send each word or group twice.
QTA	Shall I cancel telegram number......as if it had not been sent?	Cancel telegram number......as if it had not been sent
QTB	Do you agree with my word count?	I do not agree with your word count; I herewith repeat the first letter of each word and the first figure of each number.
QTC	How many telegrams have you sent?	I have ......telegrams for you (or for......
QTE	What is my true bearing relative you? or What is my true bearing relative to......(call signals)? or What is the true bearing of......(call signal) to......?	Your true bearing relative to me is......degrees. or Your true bearing relative to......(call signal) is......degrees at......o'clock. or The true bearing of......(call signal) relative to......(call signal) is......degrees at......o'clock.
QTF	Will you give me the position of my station based on bearings taken by radiocompass stations you control?	The position of your station as based on radiocompass stations that I control is......latitude......longitude.
QTG	Will you transmit your call signal for fifty seconds, ending with a dash of ten seconds, on......kc. (or......m.) so that I can take your radiocompass bearing?	I am going to transmit my call signal for forty seconds, ending with a dash of ten seconds, on......kc. (or......m.) so that you can take my radiocompass bearing.
QTH	What is your position in latitude and longitude (or according to any other indication)?	My position is......latitude, ...longitude (or according to any other indication).
QTI	What is your true course?	My true course is......degrees.
QTJ	What is your speed?	My speed is......knots (or......kilometres) per hour.
QTM	Send radio signals and submarine sound signals so that I can determine my bearing and my distance.	I am sending radio signals and submarine signals so that you can determine your bearing and your distance.

(Continued on page 17)

UP SHE GOES!

A 40-Foot Antenna Mast . . . Supported By Four Guy Wires . . . Costs Less than $4 To Construct Can Be Erected By One Person

Here's How W6AWT Did It



A 20-Foot Tower, suitable for average purposes. It weighs less than 20 pounds and can be made self-supporting by weighting it down with sacks of sand laid on the base brackets. The constructional details for a 40-foot tower are proportionately identical.

"WHAT a political pull that man must have to permit him to put that steel skyscraper on his roof and another in his backyard, only a few feet from my house. They must have cost him at least $700."

"Land sakes, Mrs. Sullivan, I'm afraid to look at the things. They make me dizzy."

"But you should have been home, Mrs. Murphy, when he put up those big towers. He did it almost by himself, and when he had 'em 'most the way up, along came another feller and helped him tie some wires to the fence. In an hour they finished the job."

So the wind blew, and the bull flew, but these are true statements of fact, overheard by Mrs. B. Molinari, better-half of the W6AWT power house that is ready for the air with a couple of 204-A's in the final, and modulated for 80-meter phone communication with a rack-and-panel amplifier and modulator that will be described in a later issue.

Molinari is another of the real old-timers who comes back on the air after pawning everything but the kitchen sink to buy parts needed for a modern amateur station. His neighbors don't like the looks of his almost self-supporting antenna towers, but to the amateur they are a treat for sore eyes. Small wonder the neighbors gossip over the fence about those big "steel" towers. But the laugh is on them. "There ain't no steel in them thar towers." They are made of wood, cost but a few dollars each, and can be erected by a man and a half. Furthermore, any enterprising amateur can build one or more of these commercial-looking contrivances by purchasing a few lengths of lumber and resorting to the diagrams in this article that show how to build a duplicate of the towers that now adorn the W6AWT abode.

These towers look like a million, but cost practically nothing. Given a coat of steel-grey paint they will fool the smartest of the back-fence conventioneers; you can't tell them from genuine steel towers. Not until the neighbor's boy digs his teeth into the base of the tower will the secret of the forest come out.

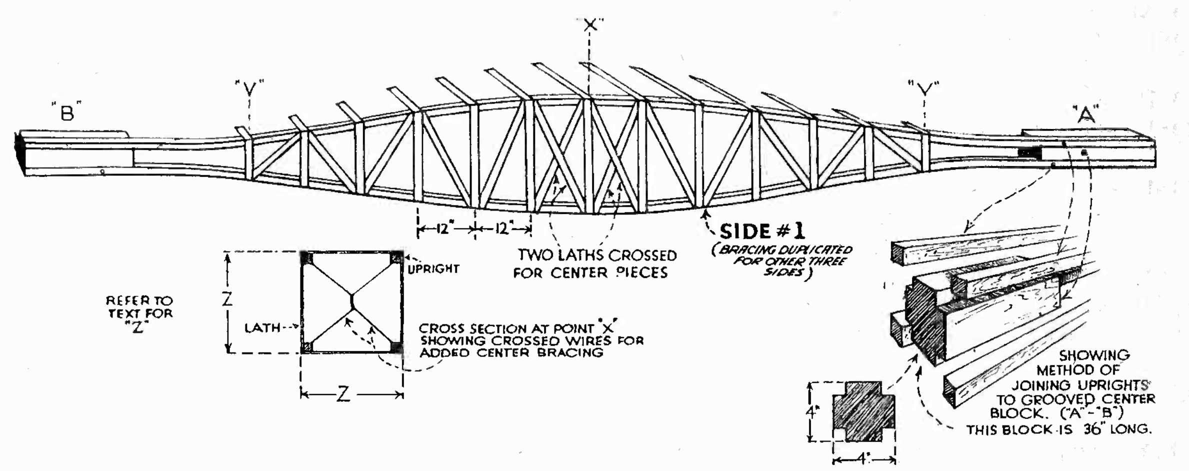
Molinari saw a photograph of the big new WCAU towers in a magazine; 700 feet into the air they rise. Four guy wires support the tower. "Well," said he, "if they build 'em that high in Philadelphia and use 4 guy wires, I can build 'em 40 feet high and use no guys at all." Four sticks of spruce, each 40 feet long and ¾-inch square, a handful of laths, a bag of lath nails, hammer, saw and a couple of sacks of sand, plus a can of grey paint, and you are ready to build the neatest looking, practical amateur tower that will stand up against any of them. Also, it will be standing when others have fallen to the ground.

The cost of materials for building a 40-foot tower is about $4.00. Do some quick figuring and you get the answer . . . ten cents a foot. A 40-foot tower weighs only 35 pounds. Two people can erect it with ease. A 20-foot tower weighs less than 20 pounds, and one man can put it up.

No guys are needed to support the 20 footer. It rests on an "X" base, made of wood; two sacks filled with sand and laid on the "X" base keep the tower from going for a walk. It's ideal for the roof of your house. You can rest it close to the edge and it won't fall off.

If a 40-foot tower is built it should be supported with a set of four guy wires, these guys being fastened at the center of the tower. Molinari has a 40-foot tower on the roof of his house and a 60-footer in his backyard. The 60-foot tower uses a dozen guys, but only because it had to be erected in a space less than 25 feet square. The tower on the roof of the house is 40 feet high and only four center guys are used to support it. A 20-foot tower can be rested on the roof, or nailed to the side of the house, and no guys are needed to support it.

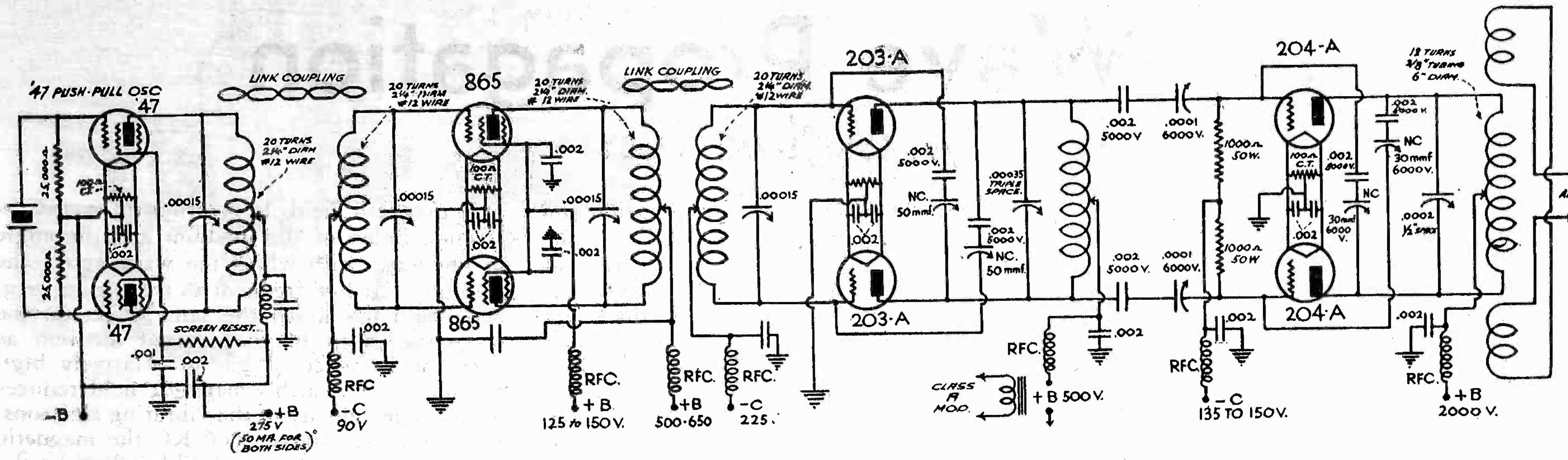
The illustrations show all constructional details. W6AWT used spruce for building



Constructional Details for Building the Tower: If the tower is to be more than 20 feet high, it is advisable to brace it in the center with a "cross-wire-center-brace" as shown at "Z" in the illustration above. The bracing wires are twisted tightly together where they cross each other in the center. As is seen from the illustration, the tower has four sides; two sides are first constructed and the lattice-work bracing is then nailed in place to complete the remaining sides. Towers 20, 40 or 60 feet high are constructed along similar lines, the only difference being in the thickness of the long pieces that determine the height. 40-foot towers should be made from ¾" or 1" square lumber for the main "runners", but the lattice-work bracing can still be made with ordinary pieces of lath.

The center of the 20-foot tower ("X") is only 7" square; 14" square for 40 feet; 18" to 21" for 60 feet. The end-pieces "A" and "B" are sawed in "cross-shaped" fashion, as shown, from a piece of 4 x 4. These pieces are from 2 to 4 feet long, depending upon the height of the tower.

A coat of grey paint preserves the lumber and gives the completed tower a steel-like appearance. A crow-foot base is used for resting the tower on the roof. Supports are then nailed to the tower and two sacks of sand are laid on the base supports. W6AWT's 40-foot tower, as shown on the front cover of this issue, rests 4 feet from the front edge of the roof of his home.

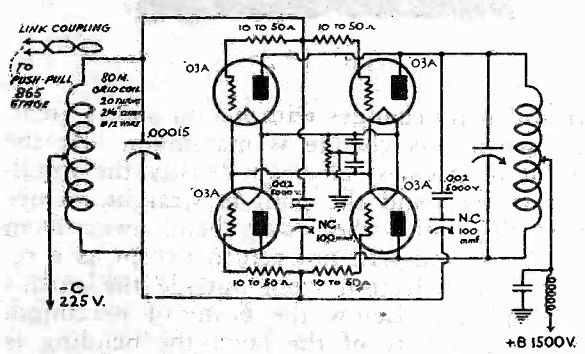


Complete Circuit Diagram, Showing All Constants, of W6AWT's "Push-Pull-Throughout" 1 K.W. Transmitter for 80 Meters, C.W. and Phone.

his towers. Other kinds of wood will give almost equal satisfaction but spruce was used because it is light in weight and also because it will not split when the bracing laths are nailed to the four corner pieces. Then, too, nails do not easily work loose when driven into spruce.

W6AWT finds it good policy to break-up the guy wires with insulators spaced ten feet apart. Too few amateurs realize that long guy wires, with few insulators or none at all, have a natural wavelength of their own, and will absorb a lot of energy from the transmitting antenna, re-radiate harmonics and make the operator wonder why his signals are not reaching out. Play safe. Insulators are cheap. Use a lot of them in the guy wires.

To construct one or more of these fine looking towers the constructor is advised to first lay the four side pieces on the ground. These



Four 203-A's in parallel-push-pull, 1 K.W. input, with 1500 volts on the plates. Circuit used by W6AWT before he installed the 204-A's.

pieces can be as small as ½ inch square if only a 20-foot tower is to be built. They can be an inch square for a 60-foot tower. ¾ inch for the 40-footer. However, the size of these corner pieces can be such as to satisfy the taste of the builder.

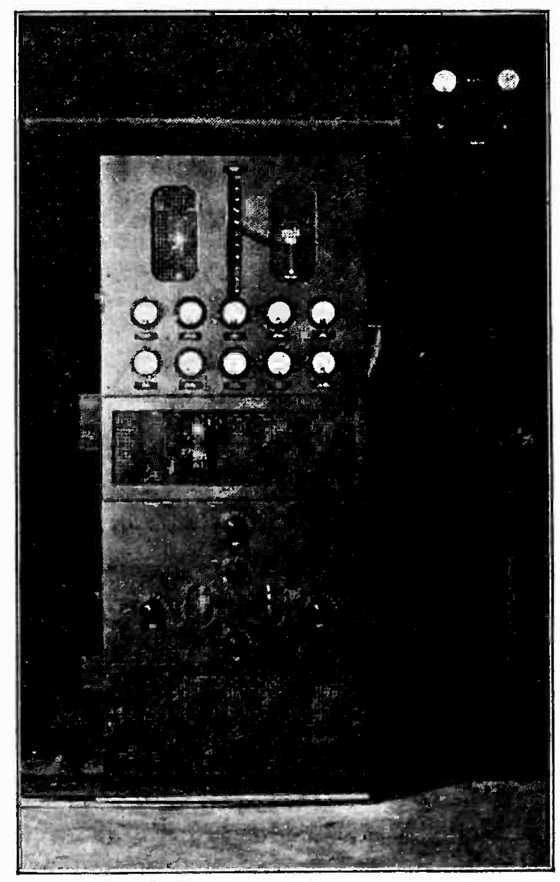
The four corner pieces can be ripped from long strips of ½ inch or 1 inch lumber, or a sawmill will cut them to size. If it is impossible for you to secure strips of lumber of the desired length for the height of the tower you desire to build, shorter lengths can be used and nailed together.

The lath braces are cut from ordinary surfaced or unsurfaced lathing, about 1 inch wide and ¼ inch thick. Half-inch lath nails are used to secure these braces to the four corner pieces. The laths should be given a coat of paint before they are cut. Likewise, the four corner pieces should also be painted before actual construction gets under way.

Step by step, the drawings here show how to construct the tower. The 20-foot tower is described. Construction of a 40, 60 or 80-foot tower is identical, but the long pieces for the 60 and 80-footer should be about an inch square, the two or more sections secured together as shown in one of the drawings.

The extreme light weight of these towers, their fine appearance, simplicity of construction and utmost ease of installation will appeal to many amateurs who want to go up in the world.

The towers at W6AWT have withstood heavy wind pressure in a location only a mile or two from where the Pacific Ocean gets its start. December "RADIO" will bring you a complete description of W6AWT's amplifier, modulator and rectifier system.



W6AWT'S Transmitter . . . using a veneered-wood rack, painted dark green. Another similar rack houses the power supply.

New "Q" Signals (Continued from page 11)

QTO—Are you leaving the dock (or the port)?........	I am going to leave the dock (or the port).
QTP—Are you going to enter the dock (or the port)?........	I am going to enter the dock (or the port).
QTQ—Can you communicate with my station by means of the International Signal Code?........	I am going to communicate with your station by means of the International Signal Code.
QTR—What is the correct time?........	The correct time is........
QTU—What are the working hours of your station?........	The working hours of my station are from .... to ....
QUA—Have you any news of........(call signal of mobile station?........	The news of........(call signal of mobile station) is........
QUB—Can you give me, in this order, information concerning: visibility, height of clouds, and ground wind for........(place of observation)?........	Following are the weather details requested:........
QUC—What is the last message received by you from........(call signal of mobile station)?........	The last message received by me from........(call signal of mobile station) is ....
QUD—Have you received the urgency signal made by........(call signal of mobile station)?........	I have received the urgency signal made by........(call signal of mobile station) at .... (o'clock).
QUF—Have you received the distress signal made by........(call signal of mobile station)?........	I have received the distress signal made by........at........o'clock.
QUG—Are you going to be forced to alight at sea (or on land)?........	I am going to be forced to alight at sea (or on land) at........(place).
QUH—Will you give me the barometric pressure at sea level?........	The barometric pressure at sea level is .... (units).
QUJ—Will you give me the true head to follow, with no wind, for directing me to come to you?........	The true head to follow, with no wind, for directing you to come to me, is from .... degrees at .... o'clock.

The signal series of QA, QB, QC, QD, QF and QG are reserved for special aeronautical codes.

Sky-Wave Propagation

By A. L. MUNZIG, W6BY

WITH the approach of minimum solar activity and its resulting effect on the ionized region in the upper atmosphere, it will probably prove of interest to the readers of "RADIO" if an explanation of sky wave propagation is given. Since the transmission to distant points at high-frequencies is dependent on the ability of the ionized region to refract the radio wave, the beginning of this eleven-year cycle solar activity disturbance will have a decided effect upon its refractive index. The writer will endeavor to explain the generally accepted theories on the existence of this ionized region and the path a radio wave follows in passing through it.

Kennelly-Heaviside Layer

As a result of ultra-violet radiation from the sun, there exists an ionized region in the upper atmosphere at an elevation of approximately 16 miles. (See Fig. 1). Studies of the propagation characteristics of radio waves by Kennelly and Heaviside have proven beyond any possible doubt that this ionized region exists. Scientists are not certain whether the electron density increases gradually to a single maximum or whether there is a minor maximum near the lower boundary. However, it is the contention of the writer that the latter is the case due to observation of the action of radio waves propagated at high angles in experiments conducted over a period of four years. (See Fig. 2).

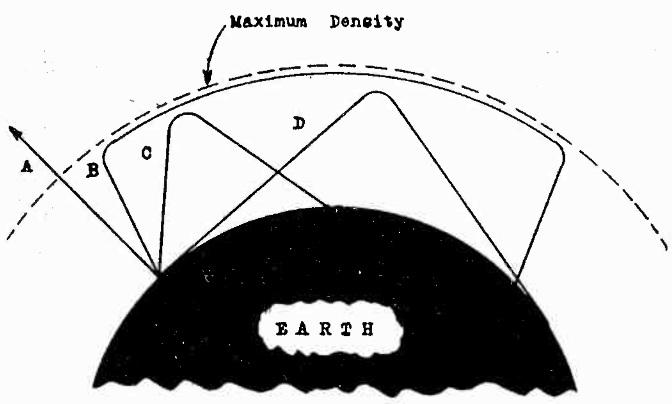


FIG. 1

FIG. 1—Diagram showing ray paths as refracted from the Kennelly-Heaviside layer.

FIG. 2—Diagram showing possible ray paths of deep penetrating rays and grazing rays. Also illustrating hypothetical locations of a heavy maximum and a minor maximum density of the ionized region above the earth.

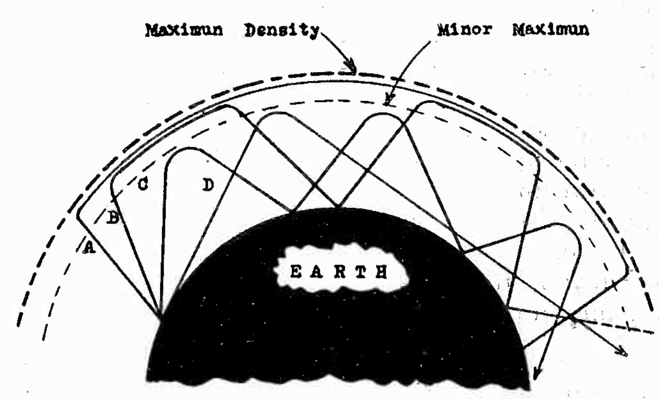


FIG. 2

Refraction

The transmission of high-frequency signals depends upon the ability of the ionized region above the earth, known as the Kennelly-Heaviside layer, to refract the sky wave back to earth at the receiving point. As a result the strength of the signal received from a distant point depends upon:

1. Frequency transmitted.
2. Height of Heaviside layer.
3. Density of Heaviside layer.
4. Angle of incidence.

Referring to Fig. 1, most of the important features involved in the refraction of high-frequency sky waves can be understood. The diagram assumes a single ionized layer and illustrates hypothetical ray paths for sky waves of different frequencies leaving the transmitting antenna at different vertical angles. Waves of a very high frequency and extremely high vertical angles are radiated almost directly upward from the antenna and are not refracted sufficiently to be bent earthward and so travel directly through the ionized region into the space beyond. (See "A", Fig. 1). At "B" is shown a ray of somewhat lower vertical angle than "A" that is bent parallel with the earth's surface just before reaching the region of maximum ionization of the Kennelly-Heaviside layer. This ray has penetrated very deeply into the ionized region and travels a considerable distance parallel to the earth's surface because of the low rate of change of ionization with height. However, it is ultimately bent downward into the lower part of the layer where the ionization gradient is greater and then is directed earthward. This path is evidently that taken by 28 MC signals and lower frequencies propagated at high vertical angles. A ray marked "C", Fig. 1, leaving the transmitting antenna at a still lower vertical angle, does not reach the region where the density of ionization changes slowly with height and so returns to the earth moderately closer to the transmitter. Ray "D" is propagated at an extremely low angle with the result that the wave is refracted back to earth at a much greater distance. In the region between the transmitter and the point at which the wave is refracted to earth, there is a silent zone in which no signals are received. Of course if one is located within the range of the rapidly attenuated ground wave, then the ground wave will be received. The distance from the transmitting antenna to the point at which the first refracted sky wave returns to the earth is called the "skip distance", because the sky waves skip over it. At high-frequencies the "skip distance" is correspondingly increased because the refracting power of the ionized region is less, resulting in the critical angle of elevation at which the radiated rays first return to earth being less. The "skip distance" depends upon the critical vertical angle at which the sky wave is first refracted to earth and is very nearly proportional to the height of the Kennelly-Heaviside layer. Therefore, the "skip distance" increases as the frequency is increased, as the **electron density in the ionized region** becomes less and as the **height of the layer is increased.**

Path of Wave in Ionized Region

The effect which an ionized region has on the path of a sky wave from the transmitting antenna is relatively complicated. The energy which each individual electron in this region abstracts from the passing wave is reradiated in a new phase and a new plane of polarization, with the result that this reradiated energy is in part re-absorbed by other electrons causing a further change in the phase and plane of polarization. This results in a refraction or bending of the radio wave away from the region of high electronic density toward regions of lower density. Hence, the exact path followed by the wave is determined by the extent to which the refractive index of the upper atmosphere departs from unity as a result of the ionized layer.

Refractive Index

The path followed by a radio wave in traveling through an ionized region in the absence of a magnetic field, is determined by the refractive **index of the medium** and the **angle of incidence** with which the wave enters the medium. At low frequencies the earth's magnetic field has much the same effect on the refractive index of the ionized medium as does the presence of gas of relatively high pressure. The earth's magnetic field reduces the average velocity of the vibrating electrons. At frequencies above 6000 KC the magnetic field of the earth has negligible effect on the refractive index. The curvature of the path of the sky wave as it enters the ionized medium, results from the fact that each part of the wave front travels with a velocity equal to the phase velocity in that part of the medium. The edge of the wave front where the electron density is greatest and phase velocity greatest, **advances faster** than the rest of the front, thus causing the wave to follow a curved path in which the bending is away from the region of maximum density. The curvature depends upon the **rate** at which the **electron density changes with height** and is greatest when this change is maximum. At the point of greatest electron density the gradient is zero and the path is straight. Once past this point the waves bend away from the earth and will not return except as a result of a reflection from outside the earth's atmosphere. Below the point of maximum electron density of the layer the bending is always earthward.

Attenuation

There are a number of factors governing the attenuation of the sky wave in the Kennelly-Heaviside layer. **As the frequency of the wave is increased the attenuation tends to become less because the average velocity of the vibrating electrons is reduced.** Because of the low refracting power of the upper ionized region at high frequencies, these waves penetrate deeply into the layer and consequently travel considerable distances in the region. (See ray "B", Fig. 1. See ray "A" and "B", Fig. 2). The attenuation is also affected by the **angle of incidence** of the wave, since the length of the ray path within the Kennelly-Heaviside layer and the average density encountered by the wave both vary with the angle of incidence. Further losses also depend upon the **height of the layer,** because at high elevations the gas pressure is low, making **collisions between vibrating electrons and gas molecules less frequent.** So we see that it is of great importance that the attenuation of the sky wave in the upper ionized region be low. Referring to ray "C", Fig. 2, it will be noted that when the sky waves strike the earth they are reflected upward since the earth is a relatively good conductor. However, irregularities in the surface of the earth, such as mountains and valleys, cause a large fraction

(Continued on page 31)

By JAYENAY

Majestic Tubes

NOTE that several Majestic tubes differ from the standard RCA designation and often have an extra pin in the base, which connects to the spray shield. In general, the spray shield improves the shielding between control grid and plate but at the cost of increased shunt capacity from grid and plate to ground. In other words, at frequencies in the broadcast band and below, the Majestic tubes probably allow a little more gain to be realized than the usual types; however, at the higher frequencies, shunt capacities take their toll of efficiency, due to the higher C tanks which are generally undesirable. However, the difference between these tubes and the unshielded tubes is very slight and is probably too small for the ear to detect.

The RCA 800

THE RCA 800 does exceptionally well down on ¾ of a meter as a BK or Kozanowski electron orbit oscillator. In these oscillators the grid is positive and the plate is negative. The output is limited only by the grid current which can be drawn without melting the grid. Look into this ¾-meter band; it is great stuff for low power, as there is very little loss in signal up to ordinary optical distances. In other words, it can get through with one watt in your antenna where five meters would require ten watts due to the attenuation of the five-meter signal.

The 76 by Sylvania

THE 56 triode has long been popular as an audio frequency voltage amplifier due to its amplification factor of 13.8. But because its six-volt counterpart (the 37) has an amplification factor of only 9.2, many builders of sound equipment for DC use have wired the heaters of 56's in series rather than sacrifice gain by using the lower mu 37 which has a six-volt heater. In view of this fact, the 76 was brought out by Sylvania. The 76 is electrically and mechanically identical to the 56, except for the six-volt heater in place of the two-and-a-half-volt heater.

Tube Noise

NOW that crystal filters have come into common use in singe signal supers, we find that static and radio-frequency noise has been removed as a limit to usable sensitivity. The present limitation is set noise, and a good part of this is tube noise. As long as we make sure that all the resistors are running cool and that all joints are properly soldered, we can be pretty certain that most of the remaining set noise comes from the tubes. Irregular emission of electrons from the cathode causes corresponding irregularities in the plate current which modulates all incoming signals with a masking hiss. This shot-effect can be minimized if we keep the cathode emission high enough to maintain a high space charge around the cathode. This space charge acts as a reservoir of electrons and smooths out the minute variations in the electron flow to the plate.

It occurred to your columnist that a pentagrid tube might make an exceptionally quiet tube when used as a radio frequency amplifier. Grid number one (next to the cathode) was made about six volts positive in order to accelerate the emission from the cathode. Grid number two was made six volts negative in order to slow down the electron flow and therefore establish a dam, behind which the electrons would pile up. The purpose of this dam was to store up a supply and thus smooth out the normal variations which cause so much tube noise. However, the lack of instruments with which to measure the noise prevents my making any authoritative statement as to the success of the experiment. Nevertheless, I would like to offer the idea to anyone equipped to make an accurate quantitative study of my theory.

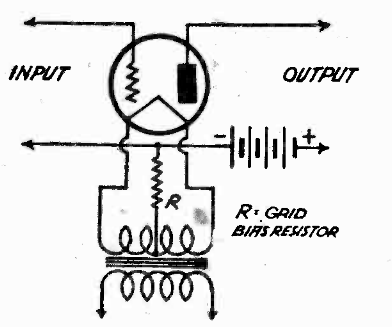
Majestic G-6C7

THIS is a duo-diode-triode second detector tube, somewhat like the 55 and 75, but having an amplification factor intermediate between them. It is said to have more gain than the 55 but does not overload as easily as does the 75. It has a 6.3-volt heater and a seven-pin base and cap. At the present time it has no counterpart in the RCA line.

Calculating Grid Bias Resistors

All radio tube manufacturers now give the proper operating voltages of their tubes; among these is the grid biasing voltage at which the tube performs best. This grid bias or voltage may be obtained from a separate C-battery, from a tap on the voltage divider supplying the plate voltage, or from the voltage drop across a resistor in the cathode circuit. This last method is called "self-biasing" since the cathode current of the tube itself is used to produce the bias voltage. Since the self-biasing method deals with resistors we will discuss it here.

A voltage drop is produced by passing the cathode current through a resistor connected between the cathode and the negative B-supply. Since the voltage drop along the resistor is increasingly negative with respect to the cathode, the necessary grid bias voltage can be obtained by connecting the grid return to the negative side of the resistance unit.



Circuit used to determine Grid Bias

The value of the self-biasing resistor can be calculated by the formula:

$$\text{Resistance in Ohms} = \frac{\text{Grid bias x 1000}}{\text{Plate current mils.}}$$

Thus for a '45 tube which has a plate current of 34 mills and for which a grid bias of 50 volts is needed.

$$R = \frac{\text{50 Volts x 1000}}{34}$$

$$= 1{,}470 \text{ ohms}$$

Wattage of resistor equals E x I or .034 x 50, or 1.7 watts.

For calculating the resistor needed for two tubes in push-pull, use the combined plate currents. For screen grid and pentode tubes use the sum of the screen and plate currents as the plate current in the equation.

—"Ohmite News".

The Western Electric 212D

THIS is the standard 250-watter in the Western Electric line and has long been used by hams for both RF and audio circuits. However, very few people know the limitations of this tube. Due to the oxide coated filament it is not a very "Hard" tube, consequently it will not stand high voltages. It does its best work at 1500 volts, though many hams use it at 1750 volts, and W6AWT has bounced his pair on the floor so often that they are "hard" enough to stand around 2100 volts on the plates. However, we mortals will do well to observe the 1500-volt limitation. There is a widespread belief that this tube has a very high audio output but the comparatively high amplification factor only allows us to obtain 35 watts of audio power at 1500 volts (Class A). It should be noted that there are 4 different types of 212D's and if two or more tubes are to operate in parallel or push-pull they should be of the same type. The types are designated Nos. I, II, III and IV. These numerals will be found on the glass just above the base. Type No. 1 has the highest plate resistance and type No. IV has the lowest plate resistance. Type No. 1 has been found most desirable for Class B audio use and Type No. IV best for Class A audio. For Class C use at radio frequencies, all the types are about equally desirable. The plate dissipation must be limited to 200 watts for long life. With 1500 volts on the plates it is possible to obtain 350 watts of audio power with a pair of WE212D's in Class B (push-pull).

Improved Volume Control For 57, 58, 6C6, 6D6

The somewhat unusual volume control circuit shown in Fig. 2 does three things at one time. As the resistance between cathode and ground is increased the control grid becomes more negative, as does the suppressor grid. At the same time the screen voltage is reduced. This tremendously extends the region of volume control without any tendency towards detection or cross modulation. This feature is true only of the 58 and 6D6. In the case of the 57 and 6C6 it is possible to maintain optimum detection characteristics with a fairly wide control over sensitivity or regeneration. The variation in suppressor voltage can be used to effect a change in the selectivity of the plate circuit because this suppressor bias materially affects the tube's plate resistance. This is the basis of some of the "automatic tone controls" featured in the new broadcast receivers. By increasing the selectivity of the intermediate amplifier of a superheterodyne it is possible to cut the side bands to such an extent that the higher audio frequencies are attenuated. When a signal fades down and the AVC circuit brings up the sensitivity, it usually brings up the noise level too, therefore at such times the noise is minimized if the band passed by the IF amplifier is cut down.

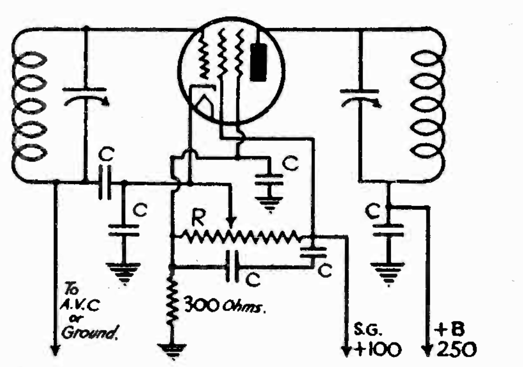


FIG. 2

R—25,000 ohms tapered—must be able to carry 25 M.A.

C—By-pass—Size depends on frequency.

The Western Electric 242A and the RCA 211

IT should be noted that the 242A and 211 are practically identical in every respect. However, they are just different enough so that they should not be used in parallel or push-pull circuits with each other. However, one can be replaced by the other without circuit change. These are the standard, general purpose 100-watters and have an amplification factor of 12, which allows their use in Class A, B and C circuits.

The Heintz & Kaufmann HK255 500 Watter

SINCE the Pacific Division Convention I have had many inquiries about the standard Gammatron made by Heintz & Kaufman, Ltd. This is the tube with the Gamma plate instead of the usual grid. This plate controls the plate current by reason of its electrostatic field but does NOT attract electrons away from the plate by being driven from zero bias into the positive region, as many believe. A negative bias applied to the Gamma plate tends to reduce the plate current just as it does with conventional grid structures. The tube can dissipate 500 watts from the plate and has an amplification factor of about 4. The plate resistance is only 600 ohms so the tube has a tremendously high mutual conductance. At 2000 volts on the plate it is no trick at all to obtain 600 watts of audio power from a pair of these tubes operating in Class A Prime. These tubes are not available to amateurs at the present time but may be some day, if all goes well.

HAM HINTS By JAYENAY

The IV High Vacuum Half Wave Rectifier As a Phone Monitor

THIS tube has a 6.3 volt .3 amp. heater and will stand 50 milliamperes of space current at 250 volts RMS. It is used primarily in AC-DC receivers of the midget type but is useful as a bias rectifier for various types of Class B amplifiers. When used as a bias rectifier its AC supply must have good regulation and series resistors should be avoided. The new General Radio "VARIAC" auto-transformer provides an excellent means of varying the voltage supplied to the rectifier because its regulation is especially good.

The IV also is very desirable as a monitoring rectifier in a phone transmitter as shown in the illustration. It also can be used in a vacuum tube voltmeter or modulometer to determine percentage of modulation.

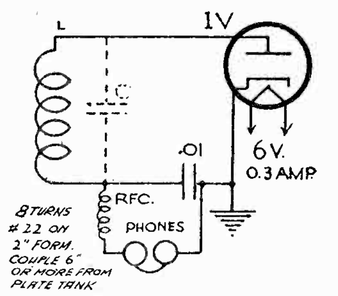


FIG. 1

This phone monitor can be used up to 50 feet from the transmitter if a condenser is shunted across L and the number of turns chosen so that the circuit resonates at the transmitted frequency. However, with the tuning condenser tuned to resonance, close coupling should be avoided, or fireworks may occur in the phones or the rectifier tube.

Resistor Or Condenser Control of Regeneration, Which?

MUCH has been said regarding the relative merits of screen voltage potentiometer versus tickler throttle condenser as a means of controlling a regenerative detector. Let me maintain my neutrality by outlining some of the advantages and disadvantages of each. The screen potentiometer varies the DC voltage applied to the screen grid of the detector, and thereby varies the ability of the tube to amplify. Because the regeneration depends on the amplification, this affords a sensitive and smooth control. However, it is essential that there be just exactly the right amount of feedback coupling into the detector grid, otherwise the sensitivity is greatly reduced. This critical feature makes it very difficult to wind coils, without a great deal of "cut and try" on the number of tickler turns to use, in order that the threshold of oscillation will occur at a screen voltage which gives highly sensitive detection.

By using a "throttle condenser" from tickler to ground, we can fix the screen-grid voltage for most sensitive detection and then vary the regeneration by adjusting the amount of external feedback. The number of tickler turns on the plug-in coil is not critical, because the variable throttle capacity rectifies any errors one might make. However, this form of regeneration control has two interrelated disadvantages. The regeneration control has a serious detuning effect on the grid circuit, and the amount of feedback varies widely over even a narrow tuning band. This means that we have two interlocking controls, both of which must be constantly adjusted as we tune across a band of frequencies.

If you are prepared to go to all the work of rebuilding, trying and then rebuilding your coils again, probably the most satisfactory arrangement is to use screen potentiometer control with screen-grid feedback by means of a cathode tap on the grid coil, in the conventional electron-coupled oscillator circuit. If the tap is properly located, it is possible to tune across the three- or four-hundred KC without touching the regeneration control to maintain the detector at that highly sensitive point just beyond the threshold of oscillation. However, changing tubes may necessitate a change in the cathode tap.

Exciting the 46 and 47

Almost all of the pentodes and zero bias class B tubes can be over-excited with RF when used in a transmitter. This over-excitation causes the output to drop off and causes a tremendous overload on the cathode emission. If you use any of these tubes as buffers or doublers try reducing the excitation to increase the efficiency. The grid current should never exceed one-third of the plate current, and usually should be less than one-fourth of the plate current. Don't forget that every mill of grid current reduces the amount of cathode emission available for the plate circuit, so use as little excitation as is necessary to give the required output. Excess excitation also causes the grid to become red hot under which condition it will start emitting, due to the particles of cathode material which have been deposited on it. This is NOT secondary emission but PRIMARY emission. This action on the part of the grid is one cause of the parasitics which occasionally causes a transmitter to emit a good signal about every 2 KC all the way across the band. This might be considered desirable for truly effective CQing, but is frowned upon in the best circles.

Finding the Missing "Lows" In the Audio Channel

Fidelity tests on representative speech amplifiers used in Ham phones show a distressing lack of the low voice frequencies which are so essential to "naturalness" and pleasing quality. Very few speech amplifiers show any response at all below 250 cycles, even with ribbon mikes and high quality transformers. Where then, are the lows being lost? There are two principal holes through which the lows are escaping. The first one is easy to remedy; it is due to DC saturation. The DC plate current tends to saturate the cores of the audio transformers and thus the impedance to the low frequencies practically disappear, allowing the lows to short-circuit to ground. This condition can be remedied by either using shunt feed to the plates of the audio tubes through some form of audio choke, see Fig. 2) or better still, use push-pull throughout the audio amplifier. If the shunt feed method is used, high quality audio chokes are essential. Old audio transformers with the primaries and secondaries in series can be used for this purpose. The other hole through which the lows escape is the cathode bias resistor and its associated by-pass condenser. To be really effective this by-pass condenser should be around 75 micro-farads, and more if possible. The lower the bias, the more by-pass is necessary to keep the low frequencies up where they belong. Thus, with screen-grid tubes and pentodes, the problem becomes even worse than with triodes, such as the 27, 37 or 56. Fig. 2 shows an excellent method of avoiding large capacities at this point when working out of a transformer. Fig. 3 shows a method applicable to resistance coupled circuits, but this requires a special tapped choke in the filter system, and a separate choke for each stage in the amplifier. Note that the DC resistance of the choke from the tap to ground equals the resistance of the recommended cathode bias resistor which it replaces. This second system utilizes regeneration to bring up the lows, and is especially applicable to a pentode output stage in a receiver. However, note that push-pull throughout will also cure this trouble because audio frequencies do not appear across the bias resistor in push-pull circuits and need no by-passing.

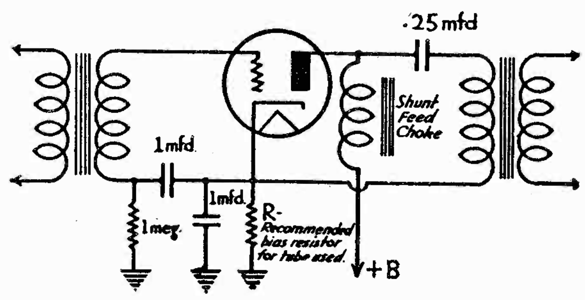


FIG. 2

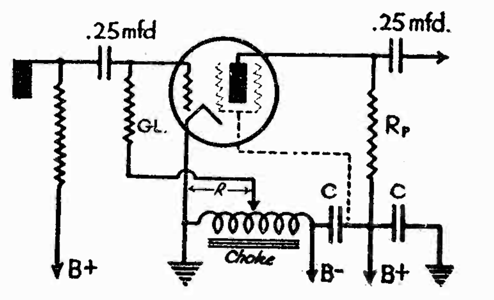


FIG. 3

R—DC resistance recommended for whatever tube is used.
C—Usual filter condensers, 8 mfd.
Rp—Load resistance. Can be transformer primary.
Choke—Usual filter choke, about 30 H.

Selectivity

THE peaked audio amplifier as a means of obtaining receiver selectivity died out because the hams wanted to vary the frequency of the beat note. Now that the single-snooper is here, we are forced to set our BFO at a fixed frequency away from the intermediate frequency. Why not go back to peaked audio for CW signals? It would certainly cut down set noise as well as providing some real selectivity and gain.

The 24A As a Dynatron Oscillator

It should be noted that the newer 24A's refuse to oscillate in the usual dynatron circuit because steps have been taken to minimize the secondary emission which is essential to dynatron action. Those still using this circuit in a fremeter should remember to get the older type of 24 for this purpose. I might mention that some of the lesser known tube manufacturers have assured me that their 24's still function perfectly in this type of circuit!

Mercury Vapor Rectifiers and the Climate

Few realize the effect of heat and cold on their rectifiers. For those that live in a hot country it is essential to reduce the inverse peak ratings of their 866's, or whatever they have, about 25 per cent. Note that adequate ventilation is also a necessity for long life. In cold weather allow plenty of time for the tubes to warm up. Too little heat is as bad as too much heat.

CCC and RAC

SEVERAL stations of the Civilian Conservation Corps are located on 3495 KC, which is just above the amateur 80 meter band. While most of these stations are crystal controlled, their notes leave much to be desired. Their mush covers from 50 to 200 KC inside the 80 meter band and effectively prevents nearby and often distant hams from working except at the high frequency end of the band. The operators contacted have shown little desire to co-operate with us and give the impression that because they are Army stations they can do about as they please. This delusion will be rapidly dispelled if the matter is brought to the attention of the proper Army authorities. Log this interference and send us copies of your log. We will see that the right people hear about it.

10-Meter Phone

IT SHOULD be repeated that the new 10-meter phone band (from 28,000 to 28,500 KC) is open to all amateurs and not just those with the special phone endorsement. Who will be the first to make WAC on phone with the aid of this band? Please design your rig for MOPA ultimately because I already foresee the terrible QRM that we will have to fight when 30 or 50 modulated oscillators start slopping over. You might start with a push-pull unity coupled oscillator and then later you can inductively couple a neutralized amplifier to the oscillator. Some dope is coming on just such a low powered transmitter, so keep this point in mind. By the way, the well known Simpson circuit does well on 10. It is nothing but a conventional push-pull neutralized amplifier with an excess of neutralizing capacity over the amount necessary to neutralize. It is First Cousin to the unity coupled oscillator, but uses capacitive feedback instead of inductive. The feedback is adjustable, which helps to obtain a good note and quiet carrier.

Percentage Modulation

EVERY phone ham should memorize this . . . "Take the ratio of one-half of the difference between the minimum and maximum amplitudes of the modulated wave and the average amplitude of the wave, and express this ratio in percentage. This gives the **percentage of modulation.**" Some hams claim more than 100% modulation, but it shuld be remembered that 105% modulation is not even intelligible, let alone good in quality. For 100% modulation the audio power output of the modulators must equal 60% of the DC input to the class C stage.

Marconi Bends the Ultra-Short Waves Over the Horizon

MR. GUGLIELMO MARCONI, the original ham, has recently succeeded in bending 18 CM waves over the horizon. He claims two-way communication over a two hundred mile circuit. He is very reticent about how he does it but has intimated that the angle of radiation is of the utmost importance. Your columnist obtained a photo of one of his beam antennas, and by extensive use of a protractor and countless rulers arrived at 18 degrees as the magic angle. For those who want to use crystal control you are advised to get a 3333 KC crystal and about 10 doublers, because 18 CM equals 1666 MEGACYCLES. Seriously, though, a 27 can be made to oscillate clear down to 15 CM in a Kozanowski electron orbit oscillator, and the dimensions of a beam antenna are small enough to make it portable.

Class B Output Transformers

Almost without exception, good class B transformers are BIG transformers. The requirements for class B service are so stringent that it is almost impossible to make a small and compact output transformer without making a material sacrifice in quality. There must be enough core material and air gap (or its equivalent) so that the DC plate current cannot saturate the core. It should be noted that in the class B push-pull circuit there exists a large DC unbalance between the two halves of the plate winding. In ordinary class A push-pull circuits the DC plate current is balanced so that there is no tendency for saturation to occur. Another source of core saturation in most class B output transformers for Ham transmitter use, lies in the fact that the DC plate current to the modulated stage must usually be carried by the secondary winding. Therefore, in order to obtain good low frequency response it is necessary to have plenty of iron and copper which is always associated with weight. The insulation of a class B output transformer also differs materially from class A practice. The transformer windings must be insulated to stand at least 10 times the plate voltage, and if the load is removed from the secondary the voltage surge across the open secondary can reach a peak of 50 times the plate voltage. It is entirely possible to break down 50,000 volt insulation with a pair of 203A's with 1,000 volts on the plate, working into an unloaded class B output transformer. Class B transformers for broadcast use often provide a spark gap across the secondary to minimize the fireworks when and if something should happen to the load. Therefore, avoid the smaller sized class B transformers if you want to have a good quality phone.

5 and 10 Meter Self Excited Oscillators

Push-pull oscillators minimize the drift in frequency caused by heating of the tube elements and also simplify the problem of RF chokes. The "UNITY-COUPLED" circuit deserves wide use because of its inherent stability and also due to the fact that it lends itself to compact portable use. Use high C for stability, and note that a variable grid leak, such as a Clarostat or a Resistograd, helps us to find the point of maximum output and stability easily and quickly. Note that the low-mu tubes seem more stable as self-excited oscillators than the high-mu tubes.

Parasitic Oscillation In Class B Modulators

The harsh quality evident in many class B modulated phones is often due to parasitic oscillation of the modulators. This oscillation is not continuous, but starts on the voice peaks and thus ruins the quality. The best remedy for this condition is to use .004 MF from plate to plate, or from grid to grid, or both. This will bypass the higher audio frequencies slightly, but the effect is imperceptable. Do not use series resistors in the grid leads because the grid circuit MUST be kept at as low resistance as possible to reduce harmonic distortion. Sometimes 25,000 ohms SHUNTED from grid to grid will prevent this unwanted oscillation, and will also improve quality by stabilizing the load on the driver stage.

Crystal Holders For SS Supers

It has been found essential that the crystal in a single-signal super be perfectly free to resonate and not be damped in any way. An air-gap holder is much more desirable than the more common types that exert pressure on the crystal through a spring pressing on the top plate. The ideal way to mount the crystal seems to be vertically, so that the crystal rests on its side, as even its own weight causes a noticeable damping effect.

Copper-clad Steel

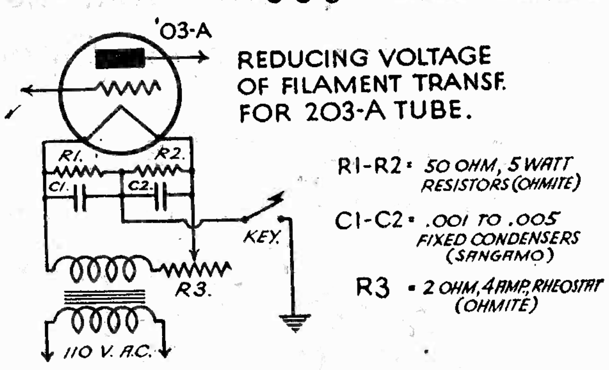
As Mr. Ralph Heintz has pointed out on several occasions, copper-clad steel wire has just as low a radio frequency resistance as ordinary copper wire, but shows less change in length with ordinary variations in temperature. This variation is often appreciable, and materially affects a self-excited oscillator directly coupled to the antenna. Another disadvantage of pure copper wire is that a sixty-six foot antenna becomes a seventy-foot antenna after only a few months, due to stretching of the copper. Last, but by no means least, copper-clad steel wire is cheaper than copper. This wire is also FB for tank coils because it stays put, regardless of tension and temperature. While we are on this subject, look into the advantages of silver-plated INVAR for the frequency determining circuit of an electron-coupled oscillator, or any type of self-excited oscillator.

Single Wire Feed To the Full Wave Antenna

Now that full wave antennas are becoming popular again, I might point out that the single wire feeder can be attached at any one of four points. The way to find these four points is to consider the antenna as two half waves placed end to end. The feeder is then attached 14 per cent (approx.) of a half wave away from either of the two current nodes. On the full wave antenna the points are 18 per cent and 32 per cent of the total length, measured from either end. The two wire type of non-resonant transmission line can be used by feeding either half of the antenna in the usual manner. Don't forget to match the impedance of the line at the transmitter.

New Filter Idea!

One of my two readers wrote and suggested that a chopper wheel be placed between the rectifier tubes and the filter to modulate the DC coming from the rectifiers. He claims that the resulting high frequency hash is easier to filter than the regular 120-cycle output of the rectifiers. HI!



Many so-called 10-volt filament transformers actually deliver as much as 12 volts. Tubes should be operated at their rated filament voltage. The above diagram shows how the filament voltage can be satisfactorily regulated. Another method is by use of the new General Radio VARIAC. The VARIAC regulates the 110-volt AC line voltage before it reaches the input transformer. The device is a variable auto-transformer whose voltage regulation remains constant, even when the output is varied between 0-130 volts.

Watch Those Notes

REMEMBER that nothing but pure DC is legal now. Too many hams are waiting for the other fellow to clean up his note before buying an additional filter for himself. That is a very short-sighted course to follow and will ultimately mean trouble. The FRC has spent a lot of money on equipment for the sole purpose of monitoring our bands, and more facilities are to be available soon. Unless steps are taken immediately to clean up your note certain grief will result. This new FRC regulation is no joke and WILL be enforced. So get that filter NOW.

Older Tube Types Improved

RCA and the other tube manufacturers have, for some time, been engaged in refining and improving the older types of receiving tubes. Notable progress has been made toward quiet, hum-free operation, as well as improved stability. Mechanically the tubes have been made stronger and will stand much rougher handling than their ancestors. Due to the tremendous influx of new tube types in the last year many people have lost sight of the fact that the older types, as they are now made, include many of the worthwhile features of the newer types.

Grid Modulation

BEFORE you get all excited about the possibilities of grid modulation for a ham transmitter, remember that the plate dissipation of the tubes used in the modulated amplifier must equal at least eight times the unmodulated carrier, for 100% modulation. This means that a pair of grid modulated 852's would give us a 25-WATT carrier . . . a lonely 210 or a pair of 46's, plate modulated, will do that well. Western Electric uses two 500-watt tubes in push-pull to get a hundred watt carrier, so save grid modulation until we are using single-sideband transmitters, when percentage modulation will be meaningless. With grid modulation the modulated RF stage operates as a class A amplifier. (Perhaps 20% eff.).

Exciting Radio Frequency Power Amplifiers

AN interesting question came up at a technical meeting of the Pacific Division Convention, recently held in San Jose. It was asked whether a high mu tube, such as the 203A, is easier to excite than its low mu equivalent, the 211 or 845. In answer it was stated that the high mu tube is just as hard to excite to a given output as the low mu tube, due to the fact that the high mu tube requires more grid current, though less exciting voltage. In other words, while one type may require more voltage, it also draws less grid current and an equal number of watts are drawn from the driver tube in either case. Quite a bit of argument has arisen and your columnist will welcome letters on each side of this question. How about it? Write and tell me your views on this subject. A year's subscription for the best letter, so hurry up!

Plate Voltage and Efficiency

ANOTHER question which has caused quite a bit of controversy is whether or not the efficiency of any given tube increases as the plate voltage is increased. In another form the question might be worded this way—Given a limitation of 500 watts input, and one 852, would more output be obtained if the 852 were operated at 5000 volts on the plate drawing 100 milliamperes than if it were operated at 2500 volts and 200 milliamperes? We assume that nothing arcs over and that the plate tanks are identical. What do you think about it? There seems to be a lot of authority on each side of this question so why not drop me a line and tell YOUR side of the story?

I'll give a year's subscription for the best letter on this question.

RCA Announces Price of "800"

TELEGRAPHIC advice from RCA informs us, as we go to press, that the newly-announced RCA-800 high-frequency transmitter tube will sell for $10.00, list. RCA jobbers will probably have the new tubes in stock by the time this issue of "RADIO" reaches you.

Diversity Transmission and Reception

DURING the time when communication between any two points can be established on either of two amateur bands, try diversity transmission and reception. Key two transmitters simultaneously and put one on 40 and the other on either 80 or 20 meters, depending on which frequency gets through. Have the operator at the other end combine the outputs from two receivers tuned to your two frequencies, and there you have it. It usually happens that the fading characteristics of two frequencies, one of which is approximately twice the other, differ so that when the signal fades out on one frequency it is probably very readable on the other. Of course, this would increase the present overabundance of QRM on 40 meters, but might be worth trying sometime when QRM is light and fading bad. Of course you must first have the two transmitters and the man at the other end must have two receivers. I first noted this effect on KA1HR whose 20 meter harmonic is often quite readable in California when his 40 meter fundamental is coming through.

Primary Keying

KEEP the L low and the C high in your filter, if you are using primary keying. But still the C must not be too high, because too much filter adds tails to the dots, due to the energy stored in the filter. In these days of pure DC on the plates it is hard to get pure DC without tails, so try blocked—grid keying if you have trouble getting clear keying with enough filter to make the plate supply pure DC.

Why Push-Pull Audio Amplifiers?

ALL audio amplifiers produce more or less distortion. The perfect audio amplifier is still a dream. However, certain types of distortion can be neutralized by the use of push-pull circuits. This is most evident in amplifiers operated in class B or class A prime. The even harmonics of the frequencies being amplified are neutralized, and thereby reduced. Push-pull has other advantages. In transformer coupled circuits the DC plate current tends to saturate the core of the audio transformer which reduces the response of the amplifier at the lower audio frequencies and can also cause harmonic distortion. Push-pull avoids this saturating effect because the DC is balanced between the two tubes in the circuit. Thus it should be noted that a good push-pull transformer can be ruined by removing one of the tubes with the plate voltage turned on. Certain types of cores remain permanently affected once they have been subjected to this unbalanced saturation. The problem involved in properly by-passing the cathode bias resistor is eliminated in the push-pull connection and this prevents what often amounts to a tremendous loss in the low audio frequencies. Most high gain audio amplifiers have a tendency toward regeneration, which has a very harmful effect on quality, even if the point of oscillation is not reached. Feedback tends to make an amplifier peak at some one frequency to the exclusion of all others, so we must remove all tendency to regenerate from our high quality amplifier. Push-pull aids us in this respect, because all bias and plate voltages are applied to the circuit at points of minimum audio frequency voltage. This reduces interaction between stages and keeps stray feedback out of the power supply leads. This relieves us from the necessity of using isolation chokes and large by-pass capacities which are usually more expensive than the extra tubes necessary for push-pull. It is interesting to note that most of the newer Western Electric high-quality broadcast amplifiers are push-pull throughout.

More Mu

TALKING about mu, recalls a bit of "back-fence philosophy." Said one alley-cat to the other: "Just between you and I, Tom, how many mews make a multi-mu?"

Ramblings

A Little o' This—and a Little o' That . . . Taken from the Editor's Mail Bag. Readers are invited to contribute to this Open Forum.

The Famous Squirrel Club

By DON C. WALLACE

IN Long Beach, California, exists the famous "Squirrel" Club, noted for the things which it does not possess.

The rules are as follows:

1. It has no rules.
2. It has no officers.
3. It has no treasurer.
4. It has no meeting place.
5. It has no regular meetings.
6. There are no requirements for membership (but try and get in).
7. Every member seems to have a 1 KW. transmitter. (This is not a requirement but seems to be more or less accidental).
8. Coffee at 10 p. m.
9. It has no constitution or by-laws.
10. No committee.
11. It has no probationary period for membership, although most of the members are on probation.
12. No uniforms, badges, signs, nor insignias.
13. No charters.
14. Password: "It's alive."

You can see from the above that this is a strange and weird organization of radio hams. It has been in existence for many years and numbers among its members, associated members and probationary members the following:

W6DEP Larry Lynde, 261 Orizaba St., Long Beach (commercial photographer).

W6EWK, Dr. L. J. Trowbridge, 133 Pomona (dentist).

W6RO Dwight B. Williams, 1127 Raymond Ave. (banker).

W6MK Foster G. Strong, 2017 Florida St. (radio installation engineer).

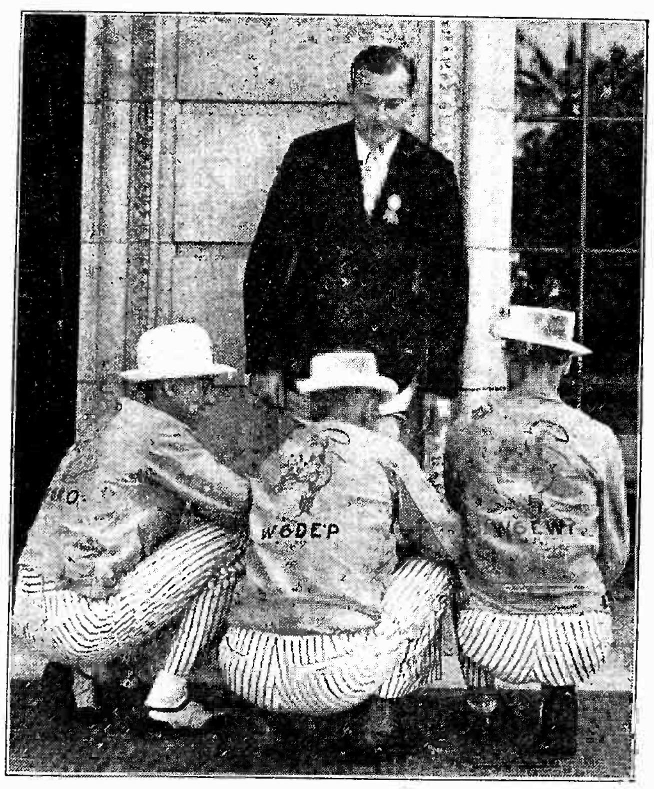
W6FYF Joseph W. Huff, 255 St. Joseph Ave. (aviator).

W6CZZ George Weller, 912 Loma Vista Drive (garage owner).

6EZN A. Leon Drake, 1122 Walnut (barber).

W6AM Don C. Wallace, 4214 Country Club Drive (manufacturers' agent).

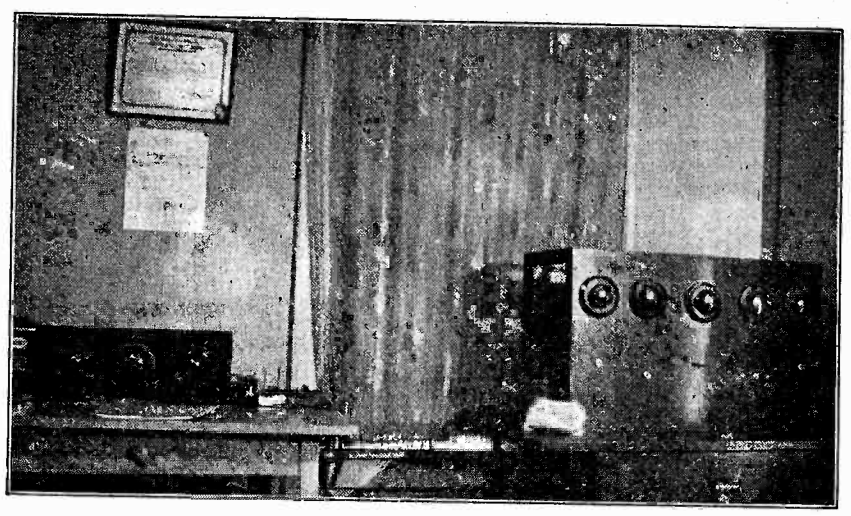
Ornery Electron-coupled member—Lt. J. B. Dow, U. S. S. "Utah".



Meet them face-to-face. Some of the Squirrel Club members. Standing—Don C. Wallace, W6AM. Stooping, left to right—W6RO, W6DEP, W6EWK. You can identify them by the Squirrel and 852 Tube insignias on their backs. When the Squirrel Club goes visiting, the members carry a live squirrel around with 'em.

YL's, YF's, OW's

Activities of the She-Hams . . . Introducing W6EK . . . Flora L. Card, of Pomona, Calif.



80-Watt Transmitter of W6EK.

W6EK

Here's the Dope...

Crystal control—'47 xtal osc., '46 buffer, WE211D final, 80 watts input. Station works on either 40 or 80 meters—at present on 80 meters with freq. 3540 KC.

Antenna—132 volt. feed Hertz.

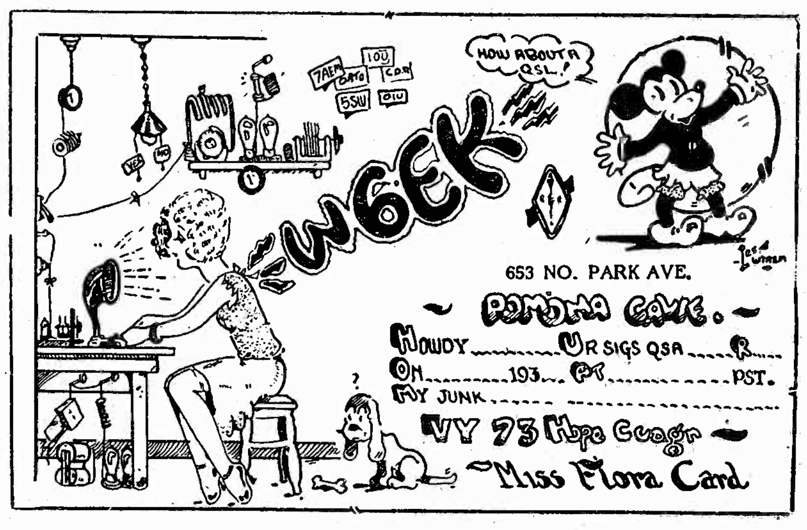
Receiver—2-201a's.

Both bug and straight key are used.

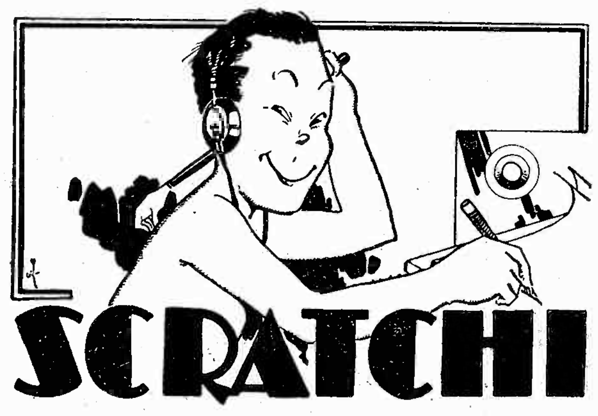
W6EK originally came on the air in August, 1931, with 71a's in parallel—later graduating to 45's in push-pull, and finally to the present state of crystal control in May, 1933.

Operator

18 yrs. old, ham since Aug. '31. Made Brasspounder's League twice, ORS. Would much rather handle traffic than rag chew. Handled quite a few messages during the earthquake.



Here's What You Get When You Ask W6EK for a QSL Card.



Osockme, Japan,
September 10, 1933.

Honorable Editor "RADIO":

Extreme difficulty arise when Scratchi resort to use of transmitter which become all excited by itself. forthwith honorable oscillating crystal rig-up already ceased operation because of poor gippie crystal which Scratchi first buy. Instruction book say tube must not have red color on plate. I find impossible to remove color from my tube. So Scratchi put on pair of rose colored glasses and tube color look all right again. All-excited-by-itself transmitter blow up tube, so Scratchi send tube back to manufacturer with long letter of lies to tell how trouble come about.

Two day later come another crystal from Scratchi which he buy from huge independent male-order house. Scratchi make selection from very large catalog which show picture of Empire Shake Building from New York. Must be very firm institution, think Scratchi, with such massive structure for radio mail store to occupy. Alas, Scratchi being deceived again, for in same mail come letter from my cousin which live in New York and say to me that big male-order house not in Empire Stake Building at all, but occupy only small Chic Sale institution down in basement in Cortlandt alley.

Look out for such merchandise which come from there, say my cousin. Scratchi have great confidence in hewman nature. New oscillating crystal come packed in nice box on which is picture of seagull with one foot on sparg-gap and other foot on old-fashion radio dial wheel.

Under picture of bird is letters N.R.A. Scratchi try for nine day and all night make new crystal show oscillation, with success further than remote. Wife come in shack and ask to see box in which come crystal. She look at bird on box and see N.R.A. letters. "Scratchi", she say, "you buy wrong kind of crystal again. N.R.A. . . . that mean No Resonance Anywhere".

Quick thoughts come to Scratchi. Recall cautious wording of insulting engineers for make stubborn crystal oscillate. Put crystal in oven, say advisor, so Scratchi proceed with process and put crystal in kitchen stove, where also go all other garbage which also go up in smoke. Hoping you do the same, I am,

Your esteemed reader,

SCRATCHI.

RADIO'S Practical Data Sheets

SYLVANIA 865 GRAPHITE-PLATE TUBE

DATA SHEET NO. 7

R.F. Amplifier and Frequency Multiplier

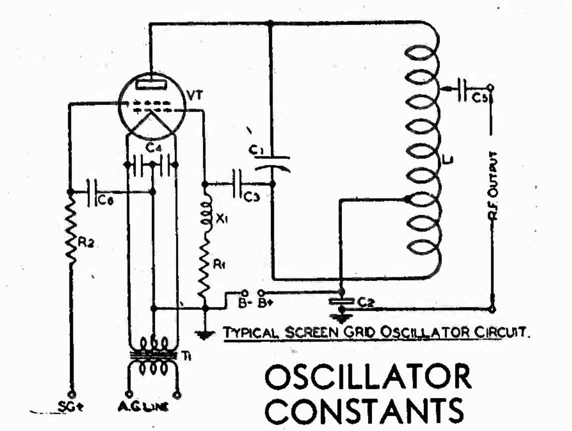
THE Sylvania Type 865 is a screen grid tube designed for use as a radio-frequency amplifier or frequency multiplier. It is also useful as a radio-frequency oscillator. Because of its low interelectrode capacity it is especially valuable for use at frequencies not exceeding 20 megacycles. The complete shielding built into the tube eliminates the necessity for external neutralization to prevent self-oscillation and feedback. The 865 employs the specially processed graphite anode incorporated in all Sylvania air-cooled transmitting tubes and rectifiers.

General Characteristics

Number of Elements	4
Filament Voltage	7.5
Filament Current (Amperes)	2.0
Filament Type	Thoriated Tungsten
Average Characteristics at:	
Ep = 500, Eg = 0, Esg = 125, Ef = 7.5	
Plate Current	.021 Amp.
Amplification Factor	150
Plate Resistance	200,000 Ohms
Mutual Conductance	750
Approx. Interelectrode Capacity:	
Grid to Plate	.05 Uufd.
Grid to Filament	10 Uufd.
Plate to Filament and Screen	7.5 Uufd.
Max. Overall Dimensions:	
Length	6 1/4 inches
Diameter	2 3/16 inches
Type of Cooling	Air

Class C—OSC. and R. F. Power Amp.

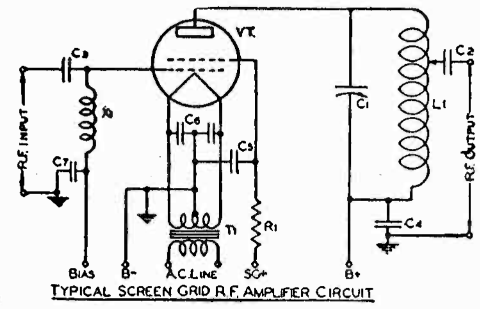
Max. D. C. Plate Volts (Mod)	500 V.		
Max. D. C. Plate Volts (Unmod.)	750 V.		
Max. D. C. Plate Current	.060 A.		
Max. Plate Dissipation	15 W.		
Max. Screen Dissipation	3 W.		
Max. D. C. Grid Current	.015 A.		
Max. R. F. Grid Current	5 A.		
Typical Operation:			
Filament (A. C.)	7.5	7.5	7.5 V.
Plate	375	500	750 V.
Screen (Approx.)	125	125	125 V.
Grid (Approx.)	—75	—75	—75 V.
D. C. Plate Current (Unmod.)	.050	.050	.038 A.
Power Output	8.5	12.5	16 W.



OSCILLATOR CONSTANTS

C1—.00035 Variable.
C2—.002 Fixed.
C3—.00025 (Variable if crystal control is used).
C4—.002 Fixed.
C5—.0001 Variable.
C6—.002 Fixed.
R1—10,000 ohms, 25 watts.
R2—25,000 ohms, 10 watts.
X1—RF Choke.
L1—Tank Coil.
T1—Filament Transformer.

NOTE: SCREEN GRID of tube connects to "B plus" high voltage (but is shown as "SG-PLUS" in drawing. If crystal is used, C3 should be a .00025 Variable Condenser and crystal should be connected between C3 and X1. This circuit is not desirable for crystal control because the Pentode tubes, such as the 47, 59 or 2A5 give better results. However, the 865 is an ideal doubler or amplifier.



AMPLIFIER CONSTANTS

L1—Tank Coil. X1—RF Choke.
T1—Filament Transformer.
C1—.0002 Variable.
C2—.00025 Fixed.
C3—.00025 Fixed.
C4, C5, C6, C7, .002 Fixed.
R1—25,000 ohms.

NOTE: SG-Plus goes to B-Plus. A grid-leak of approximately 25,000 ohms can be connected from the point marked "Bias" to ground.

Class B—R. F. Power Amp.

Max. D. C. Plate Volts	750 V.	
Max. D. C. Plate Current (Unmod.)	.050 A.	
Max. Plate Dissipation	15 W.	
Max. Screen Dissipation	3 W.	
Max. R. F. Grid Current	5 A.	
Typical Operation:		
Filament (A. C.)	7.5	7.5 V.
Plate	500	750 V.
Screen (Approx.)	125	125 V.
Grid (Approx.)	—30	—30 V.
D. C. Plate Current (Unmod.)	.030	.022 A.
Peak Power Output	12	18 W.
Carrier Output (100% Mod)	3	4.5 W.

New Sylvania Graphite-Plate 210 and 830 Tubes

THE Sylvania Type 210 is a general purpose, air-cooled triode especially designed for service in radio transmitters and similar equipment. Electrical losses are kept at a minimum by means of advanced methods of construction and the use of a low-loss ceramic base. High efficiency is obtained by the incorporation into the tube structure of the specially processed Sylvania graphite anode.* A "floating anode" type of construction, with its apparent advantages in improved insulation and reduced capacity, is a unique feature of this tube. This is accomplished **by insulating the supporting structure electrically from the active elements.**

General Characteristics

Number of Elements	3
Filament Voltage	7.5 V.
Filament Current	1.25 A.
Filament Type	Thoriated Tungsten
Average Characteristics at:	
Ep = 425, Eg = —39, Ef = 7.5	
Plate Current	.018 A.
Amplification Factor	8
Plate Resistance	5450 Ohms
Mutual Conductance	1550 uMhos
Approx. Interelectrode Capacities:	
Grid to Plate	7 uufd.
Grid to Filament	4 uufd.
Plate to Filament	2.2 uufd.
Max. Overall Dimensions:	
Length	5⅝ Inches
Diameter	2 Inches
Type of Cooling	Air

Class "A" Operation

Max. Operating Plate Voltage	600
Max. Plate Dissipation	15 Watts
Typical Operation at:	
Ep = 600, Eg = —58, Ef = 7.5	
D.C. Plate Current	.018 Amp.
Peak Grid Swing	55 Volts
Load Resistance	10,000 Ohms
Power Output	3 Watts

Class "B" Operation

Max Operating Plate Voltage	600
Max. D.C. Plate Current (Unmod.)	.070 Amp.
Max. Plate Dissipation	20 Watts
Max. R.F. Grid Current	5 Amp.
Max. D.C. Grid Current	.015 Amp.
Typical Operation at:	
Ep = 600, Eg = —80, Ef = 7.5	
D.C. Plate Current (Unmod.)	.066 Amp.
Peak Power Output	12 Watts
Carrier Output (Mod. Factor 1)	3 Watts

Class "C" Operation

Max. Operating Plate Voltage	
Modulated D.C.	450
Unmodulated D.C.	600
A.C. (R.M.S.)	600
Max. D.C. Plate Current	.070 Amp.
Max. Plate Dissipation	20 Watts
Max. R.F. Grid Current	5 Amp.
Max. D.C. Grid Current	.015 Amp.
Typical Operation at:	
Ep = 600, Eg = —125, Ef = 7.5	
D.C. Plate Current	.066 Amp.
Peak Power Output	15 Watts

The New Sylvania 830

GENERAL CHARACTERISTICS

Filament Voltage	10
Filament Current	2.15 Amp.
Max. Overall Length	5⅞ Inches
Max. Diameter	2 1/16 Inches
Bulb	T16—26X
Base	Med. 4-pin Isolantite

CLASS "A" SERVICE

Max. Operating Plate Voltage	450 V.
Max. Plate Dissipation	17 Watts

OPERATING CONDITIONS

Plate Voltage	250	350	450
Grid Voltage	—15	—26	—38
Load Resistance	9300	8800	8000
Amplification Factor	8.0	8.0	8.0
Plate Resistance	4600	4250	4000
Mutual Conductance	1750	1900	2000
Plate Current	15.0	17.5	20.0
Undistorted Power Output, Watts	.35	1.1	2.0

CLASS "B" R.F. SERVICE

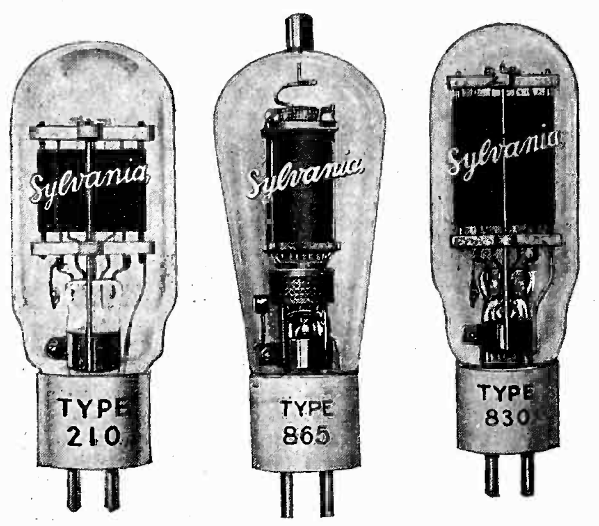
Max. Operating Plate Voltage	750 V.
Max. D.C. Plate Current	60 Ma.
Max. R.F. Grid Current	60 Amp
Typical Operation at:	
Ep = 600, Eg = —70, (Mod. Factor 1.0)	

CLASS "C" SERVICE

Max. Operating Plate Voltage (Mod.)	750 V.
Max. D.C. Plate Current	110 Ma.
Max. D.C. Grid Current	18 Ma.
Max. R.F. Grid Current	6 Amp.
Typical Operation at:	
Ep = 750, Eg = —180	
Power Output	55 Watts

DIRECT INTERELECTRODE CAPACITANCES

Grid to Plate	9.9 uuFd.
Grid to Filament	4.9 uuFd.
Plate to Filament	2.2 uuFd.



* A graphite anode is now used in all Sylvania intermediate and high power air-cooled transmitting tubes. The graphite anode adds the following major advantages over tubes employing the ordinary type of metallic plate:

1. High plate dissipation without overheating. This is a direct result of the high thermal emissivity of graphite.

2. Lower operating temperature at the anode. This results in a lower operating temperature of the other electrodes, preventing primary and secondary emission from the grid.

3. Uniformity of characteristics. The physical properties of graphite permit exact processing. Graphite does not warp under high temperatures and the mechanical dimensions of the anode remain constant. Proper relation between the tube elements retained in this manner preserve the normal electrical characteristics of the tube. One-piece construction of the anode eliminates high contact resistance found in other methods of construction.

4. Long life. Comparative freedom from gas is another important result of the use of the graphite anode and the high vacuum obtainable results in longer tube life.

A process developed in the Sylvania laboratories produces **a one-piece** anode of **pure graphite,** with all amorphous carbon and other impurities removed. This treatment insures freedom from harmful carbon deposits on filament, insulators and presses.

DATA SHEET NO. 8

DELTA Class "B" AUDIO AMPLIFIERS

20 To 200 Watts Output

CLASS "B" Audio Amplification was introduced to the radio amateur and experimenter in November 1931.

The results obtained from its use and consequently the opinions of its users seem to have varied over wide limits.

Delta laboratory tests and field observation for the past year of a local police transmitter equipped with a Delta 200 watt Class "B" amplifier prove definitely that this method of amplification is excellent for obtaining large amounts of audio power for amateur, experimental and most commercial applications.

Such amplifiers are economical and more efficient than Class "A", developing a much higher output for a given plate dissipation and emission rating.

It is the purpose of this Data Sheet to provide accurate information based on actual experience which, if carefully followed, will insure the best results from this type of equipment.

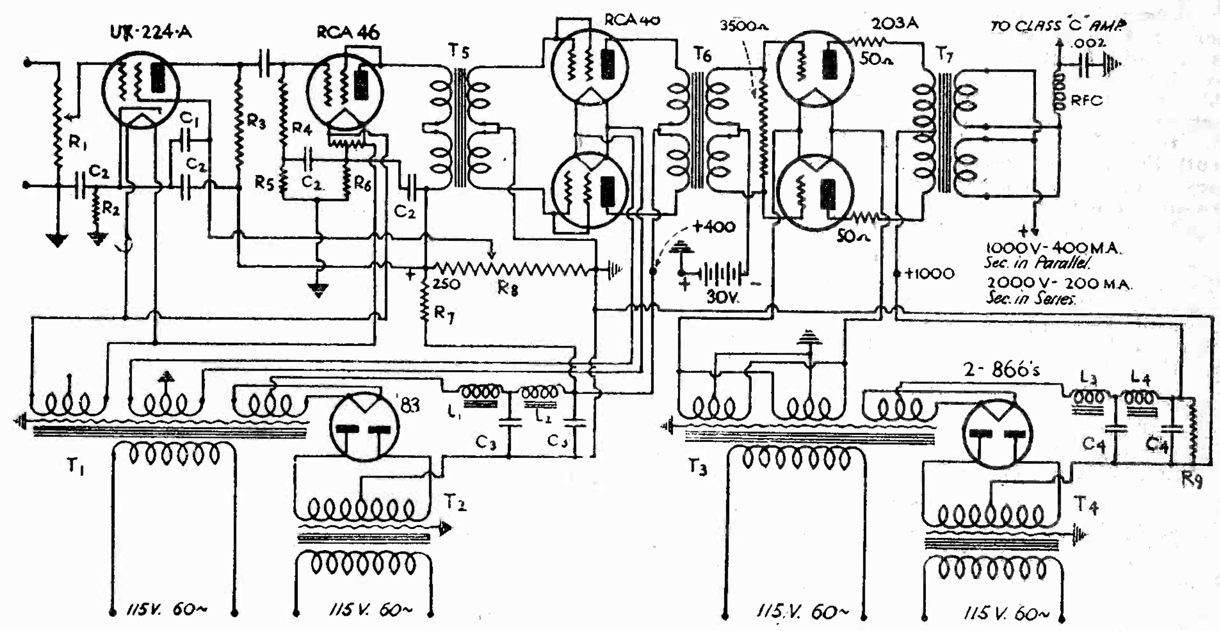


FIG. 1—CLASS B MODULATOR AND POWER SUPPLY. OUTPUT 200 WATTS

T1—AD-18
T2—AD-20
T3—AD-12
T4—AD-22
T5—AD-72
T6—AD-70
R1—500,000 Vol. Control
R2— 750 2 Watt R3—250,000 2 Watt

T7—AD-71
L1—AD-30
L2—AD-40
L3—AD-32
L4—AD-42

R4—500,000 Grid Leak R7— 3,650 5 Watt
R5—100,000 1 Watt R8— 15,000 10 Watt
R6— 1,500 5 Watt R9— 40,000 50 Watt
C1—0.5 mfd. C2—2.0 mfd.
300 v. By-Pass each for C1 and C2
C3—AD-51 (4 mfd. 1250 v.)
C4—AD-50 (2 mfd. 1250 v.)

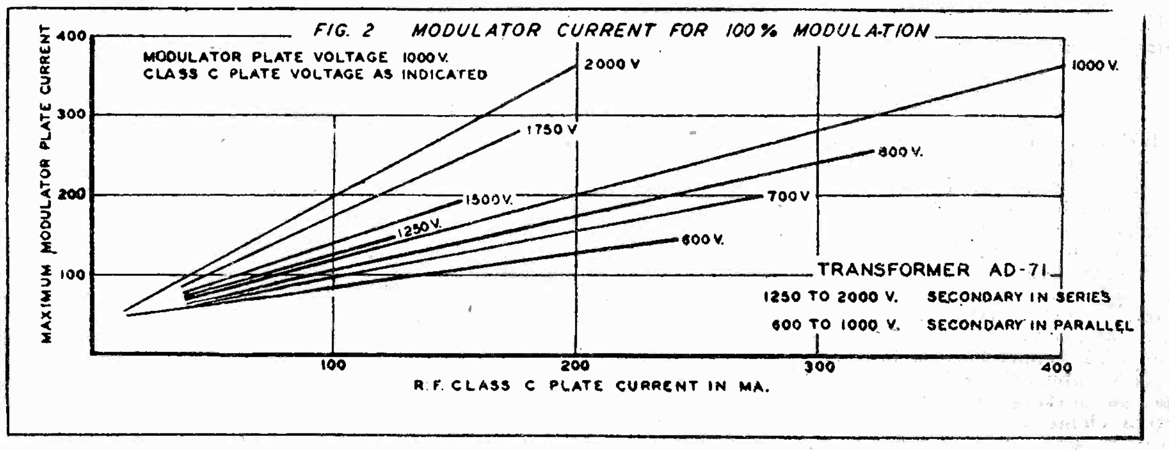


FIG. 2 MODULATOR CURRENT FOR 100% MODULATION

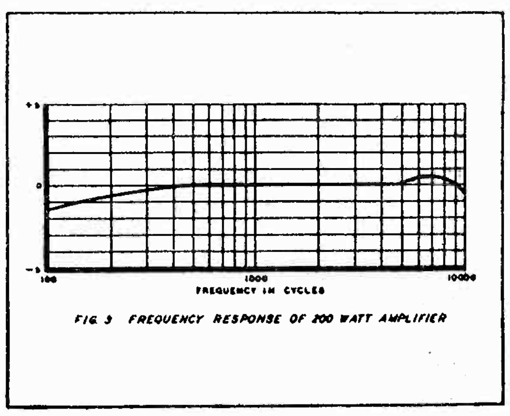


FIG. 3 FREQUENCY RESPONSE OF 200 WATT AMPLIFIER

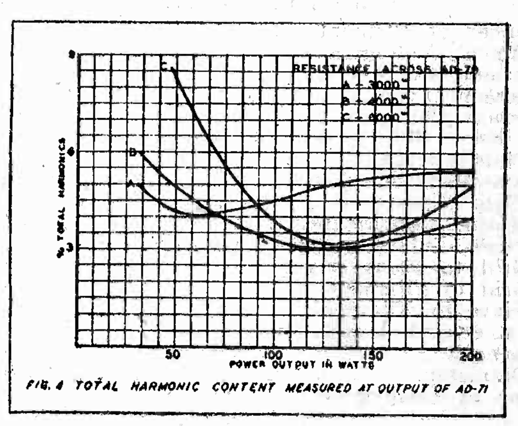


FIG. 4 TOTAL HARMONIC CONTENT MEASURED AT OUTPUT OF AD-71

Power Supply—

Starting with "Power Supply" at the beginning of a Data Sheet on radio and audio subjects may seem strange. Such matters are usually dismissed with a few brief words as an afterthought.

This prominence of Power Supply is warranted by engineering facts even though this company specializes in such equipment and may be wrongly suspected of ulterior motives.

WITHOUT PROPER POWER SUPPLY THE OTHER INFORMATION IN THIS DATA SHEET IS OF LITTLE OR NO VALUE.

In radio telephony where a tube is operated as a Class "A" Audio Modulator or amplifier, the DC current supplied to the plate of the tube is constant regardless of the AC voltage impressed on the grid of the tube provided the tube is not overloaded. For this reason any power supply, no matter how poor the regulation, which will deliver the required voltage and current may be used with fairly good results. The terminal condenser must always be sufficiently large to carry the load during ½ cycle at the lowest desired frequency. (This is usually 100 cycles per second in amateur phone work and 30 cycles per second in broadcast work.)

When a pair of tubes is used as a Class "B" Audio Modulator or amplifier the DC plate current varies directly with the applied AC grid voltage. Thus, if no signal is impressed on the grids of a Class "B" amplifier the DC plate current will be very low (about 40 m.a. for a pair of 203-A tubes) whereas a strong signal will cause the DC plate current to rise to as much as 375 m.a. Therefore, if one speaks into a microphone connected to such an amplifier the DC plate current will vary with the intensity of sound, jumping up and down as each word is spoken. Obviously, if the power supply does not have good regulation, the DC plate voltage will drop as the current goes up, and thus the output power will not be in proportion to the signal input and distortion will result. It will also be impossible to obtain the expected power output from the tubes due to the loss of plate voltage.

The regulation of a power supply depends upon transformer regulation, proper filter design and the resistance of various parts of the circuit. Care must be used to keep this resistance low if satisfactory results are to be obtained. Resistance units cannot be used to reduce the voltage of the supply from a high value to that required for the amplifier. This applies to resistance in series with the primary as well as any other part of the circuit.* Therefore, the power supply should be designed to supply the correct voltage for the Class "B" plates. Connection to the plate tap of the output transformer must be made directly to the + terminal of the power supply and cannot be obtained from a drop wire as for Class "A" amplifiers. A satisfactory power supply should have regulation not exceeding 10% over the working load range. This means that if the plate voltage is 1100 volts with no signal applied to the grids, it should not fall below 1000 volts when the signal is strong enough to deliver maximum output from the Class "B" tubes.

In order to satisfy the above requirements it is essential that the power supply components conform with these specifications.

1. **Rectifier Tubes**—Must have low internal voltage drop such as mercury vapor type.
2. **Plate Transformer**—Must have good regulation and deliver rated output.
3. **Filter Circuit**—Must be choke input type with adequate inductance in 1st choke. Correctly rated swinging choke provides required circuit control with least material. All filter chokes must have low resistance.
4. **Ripple**—Must be low to prevent modulation of speech by carrier ripple. Ripple of ¼% or less is satisfactory.

* Note: A voltage adjusting transformer such as AD-80 or 81 may be used to regulate the output voltage since this does not impair regulation.

Tubes—

Selection of Tubes for Class "B" Use

Tube characteristics of a Class "A" amplifier tube have little bearing upon its use as a Class "B" audio amplifier, particularly the optimum load impedance and maximum power output characteristics. Tubes delivering the highest output as Class "A" amplifiers are invariably unsuited to Class "B" audio use.

Tubes having a high amplification factor, low grid bias and high plate dissipation are in general the most satisfactory for Class "B" audio use. The type 03-A tube meets these conditions excellently where audio power of approximately 200 watts or less is required. For this reason the type AD-70 and 71 transformers were designed for use with this type of tube.

The types 211 and WE 242 tube may be used but the maximum output will be less and greater distortion will result.

Selection of Driver Tube for Class "B" Tubes

To obtain maximum output from tubes operating as Class "B" amplifiers, the grids must be excited to a high positive voltage. This causes a relatively high grid current over a part of each cycle. Thus the preceding "Driver" must operate into a circuit of varying impedance.

In order to reduce distortion from this cause the "Driver" should be capable of delivering much more power than that required to fully excite the grids of the Class "B" tubes. The coupling trans-

(Continued on Data Sheet No. 9 on facing page)

DATA SHEET NO. 9

Delta Class "B" Audio Amplifiers (Continued)

former should have a step down ratio as high as possible and still deliver sufficient voltage to excite the Class "B" tubes to full output.

Two type 250 tubes in push-pull undoubtedly are most suited as driver tubes but due to their high cost many prefer to use type 46 Class "B" tubes as shown in the diagram. For amateur phone use these tubes are entirely satisfactory and are recommended for this purpose. The type AD-70 transformer may be used equally well with either type of driver. Type '45 tubes may also be used with this transformer where high output is not required.

Circuit Diagram—

The circuit diagrams Figs. 1, 6, 7 and 8 may be followed in assembling either the Delta 20 watt or 200 watt Class "B" Amplifier. To make the 20 watt unit substitute transformer AD-73 or AD-74 in place of AD-70 at T6 and disregard the balance of the circuit.

The microphone and its coupling transformer are not shown but it should be kept in mind that the quality finally obtained can be no better than that of the input.

Acme-Delta Coupling Transformer AD-90 provides in one unit, by means of primary taps, proper coupling at this point for either S.B. or D.B. microphones and phono-pick up.

Assembly Instructions—

The construction of a Class "B" Audio Modulator or Amplifier is somewhat different than the usual (Class A) amplifier, and certain precautions are necessary if successful operation is to be expected.

In constructing the amplifier, care should be taken to separate the input and output as much as possible to avoid feed back. The cores and cases of all the component parts should be carefully grounded. This includes the parts used in the power supply and shields between transformer windings. This will greatly reduce AC hum and insure stable operation.

If the driver stage for the modulator is a Class "B" amplifier, as shown in the diagram, a separate power supply having good regulation must be used for this stage as the voltage for the plates of Class "B" tubes cannot be reduced by resistance. (This spoils the voltage regulation as discussed under power supply and would result in distortion and lack of power.) The power for the plates of the preceding Class "A" stages of the voice amplifier may be supplied from this power supply by the use of drop wires if desired.

A volume control should always be provided and should be connected somewhere between the microphone and 1st audio stage the exact position depending upon the type used. The complete amplifier should be shielded from the R.F. part of the transmitter or should be installed some distance from it to prevent R.F. feed back from this source. All grid and plate leads should be as short and as direct as possible. Care should be exercised to make connections secure. An open grid circuit in the 1st audio stage, will cause the grid to pick up sufficient AC voltage to damage both tubes and transformer.

Operation of Class "B" Audio Modulators—

In operating a Class "B" Modulator there are several points to be remembered.

First, the power supply must have good regulation.

Second, tubes must be properly matched and have adequate filament emission (old tubes seldom work satisfactorily).

Third, the use of adequate R.F. filter in the lead to the Class "C" amplifier is important to protect the output transformer and tubes from high voltage surges.

Fourth, the amplifier must never be operated with load disconnected from the secondary of the output transformer.

Fifth, the plate current of Class "B" tubes should never exceed the value necessary for 100% modulation of the Class "C" amplifier if transformer or tube breakdown is to be avoided. (See chart for proper current.)

Sixth, maximum plate dissipation of the tubes should never be exceeded.

Seventh, it must be remembered that this type of equipment will deliver very high power and much damage may be done to tubes and equipment if the amplifier is not properly operated.

The load into which a Class "B" modulator works is determined by the plate current and voltage of the Class "C" amplifier which it modulates, thus if the Class "C" amplifier draws 400 m.a. at 1000 volts the load resistance is 1000/0.4=2500 ohms.

The plate load of the Class "B" tubes is equal to the load impedance times the square of the turns ratio of the output transformer. Thus it is seen that as the load impedance is changed the impedance into which the Class "B" tubes works is also changed. Therefore, there can be but one correct Class "C" adjustment for **maximum power output** from the Class "B" tubes, the proper plate load per tube for this condition being 1250 ohms. However, the plate load impedance may be increased for lower output as long as the normal plate loss of the Class "B" tubes is not exceeded. It is possible, therefore, to modulate a Class "C" amplifier working at less than 400 m.a. without changing the output transformer, provided the plate voltage is 1000 V. or less. The Chart, Fig. 2, shows the maximum DC in the common plate lead to the Class "B" tubes, which must be reached to modulate various Class "C" loads 100%.

The load impedance (Class "C" amplifier plate supply) may be varied by changing the grid excitation of the Class "C" stage to obtain any desired value. If the values in the chart are adhered to, 100% modulation of any plate power up to 400 watts and up to 2000 volts may be obtained without exceeding the allowable percentage of distortion and without changing the output transformer, thus this type of modulator is ideal from the amateur's point of view.

20-WATT MODULATOR DIAGRAMS

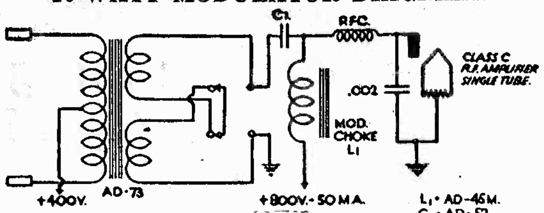


FIG. 6

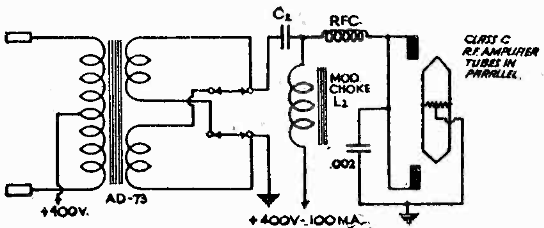


FIG. 7

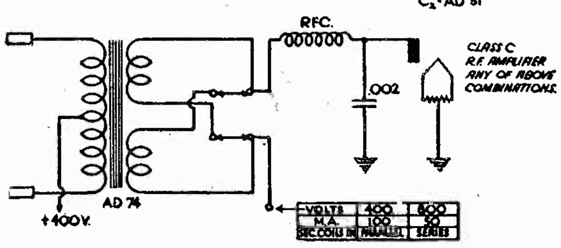


FIG. 8

Operation of 20 Watt Class "B" Modulator

The circuit for this amplifier is the same as the 200 watt modulator up to the plates of the 46 Class "B" tubes. The primary of AD-73 or AD-74 is connected in place of AD-70 in the 200 watt diagram. The secondary coils should be connected in parallel and a 4000 ohm resistor should be connected to the output terminals so that the unit may be tested out, in the same manner as described in the first part of the instructions for operating the 200 watt modulator.

After the modulator has been made to work properly the secondary may be connected to the Class "C" R.F. amplifier as shown in the diagrams.

If a single 210 or similar tube is used it may be operated at 800 volts and 50 m.a. and connected as shown in Fig. 6.

If the Class "C" amplifier is a pair of 46's or 210's in parallel, the tubes should be operated at 400 volts and 100 m.a. and the transformer secondary windings should be connected in parallel, the connections then being as shown in Fig. 7.

If AD-74 is used in place of AD-73, the DC plate current for the Class "C" R.F. amplifier can be passed through the secondary as shown in Fig. 8 eliminating the condensers and chokes shown in Figures 6 and 7.

The secondary jumpers should be connected as shown in Figures 6 or 7 for the particular Class "C" combination used.

When properly connected, the Class "C" amplifier will be modulated 100% when a milliameter in the B+ lead to the modulator tubes reads 110 m.a. on peaks.

If the Class "C" amplifier is operated at 400 volts a single power supply of suitable size may be used for both the Class "B" modulator and Class "C" R.F. amplifier tubes if desired.

Operation of 200 Watt Unit Shown in Diagram

In the case of the 200 watt unit it is recommended that the stages preceding the final Class "B" modulator tubes be tried out. This may be done by connecting a resistance of approximately 1600 ohms across the grid terminal of the AD-70 transformer. A loud speaker or head phones may then be connected across a small part of this resistance. The amplifier may now be operated without putting the 203-A tubes in place. After this part of the amplifier has been made to operate satisfactorily the 1600 ohm resistor may be disconnected and the 203-A tubes put in place. Before putting plate voltage on these tubes, measure the voltage between filament and grid of each tube to make sure the proper negative bias is being supplied to the grids. The plate voltage may now be applied and the plate current to each tube should be measured. This current should be 20 to 30 m.a. per tube and may be adjusted by varying the grid bias. Separate C-terminals are provided on the secondary of the AD-70 transformer so that each tube may be adjusted separately if desired. This will not be necessary, however, if the tubes are matched and is to be avoided if possible.

Before operating the amplifier be sure a load is connected to the secondary of the modulation transformer (AD-71). For test purposes a resistance of 2500 ohms, 200 watts should be used and the secondary coils of the AD-71 transformer should be connected in parallel, by placing the links so they cover the white lines engraved between terminals on the panel. Ten 50 watt 115 volt **carbon** lamps connected in series may be used for a load. **Tungsten** lamps are **not satisfactory** for this purpose. A loud speaker may be connected across one of the lamps and should then operate at about normal volume when the amplifier is working at full load.

A 500 m.a. DC milliameter should be connected between the C.T. of the 203-A filament winding and negative end of the 1000 volt power supply. This meter will act as a volume level indicator and give a good check on the performance of the amplifier since the current indicated by this meter gives a fairly accurate measurement of the power-output.

Having completed the test of the amplifier it may now be connected to the Class "C" R.F. stage. If this stage operates at 1000 volts or less, have the secondary links on the AD-71 transformer in the parallel position. If more than 1000 volts connect secondary coils in series by placing the links so they cover the red line. More than 2000 volts should not be applied to the Class "C" stage when using this transformer.

In order to obtain proper impedance matching the load impedance (Class "C" plate voltage divided by the plate current) must not be less than 2500 ohms at 1000 volts or less, and must not be less than 10,000 ohms at 2000 volts or less. That is if the Class "C" stage is operated at 800 volts, the AD-71 secondary should be connected in parallel and the plate current must not exceed 800/2500=.320 amps (320 m.a.)

In operating the amplifier always keep the volume control turned down low enough to prevent over modulation. Over modulation is most readily indicated by a milliammeter in the plate circuit of the Class "C" amplifier. This meter should be perfectly steady when the microphone is used unless over modulation takes place. This will cause the meter to vary a small amount.

The meter in the plate circuit of the Class "B" tubes will dance up and down as the microphone is used. This is a normal condition and as previously mentioned indicates the amount of power supplied to the load.

The Class "B" modulator should never be operated unless the Class "C" stage is drawing current or unless a suitable resistor is connected across the secondary of the output transformer as described above for test purposes.

Performance Data—

Characteristic Curves

The curve in Fig. 3 shows the overall frequency response of 200 watt Class "B" amplifier from input to Class "A" 46 to Class "C" amplifier load, using transformers AD-72, AD-70 and AD-71.

The curve in Fig. 4 shows total harmonic distortion at the output of transformer AD-71.

The curve in Fig. 2 is intended to show the maximum modulator current for 100% modulation of various Class "C" combinations when coupled to the Class "B" modulator by transformer AD-71.

As an example, suppose a Class "C" amplifier is operating at 800 volts and 250 m.a. The AD-71 secondary coils should be connected in parallel and the point of intersection on the 800 volt line shows that the modulator current for 100% modulation will be 200 m.a. Suppose the Class "C" amplifier operates at 2000 volts and 200 m.a. Then the AD-71 secondary is connected in series and the point of intersection on the 2000 volt line shows the maximum modulator current to be 360 m.a. This is the maximum power which can be handled by the modulator.

This set of curves is only intended as a guide to proper operation, but any great deviation from them will indicate that some trouble exists.

New SHORT WAVE Patents

By HERBERT E. METCALF *

No. 1,918,238 issued July 18, 1933 to Fred P. Andrews, U. S. Army, Seattle, Wash., for Radio Receiving System.

This patent relates to the remote control of two short-wave receivers by placing a condenser plate from each receiver closely adjacent, and then moving a common plate over them, the common plate being attached to a remotely controlled meter mechanism.

* * * *

No. 1,918,262 issued July 18, 1933 to Fred N. Goldsmith of New York, N. Y., and assigned to R.C.A. for an Ultra Short-Wave Repeating System.

An interesting system of "Chaining" short-wave stations by utilizing directive antennas on repeater stations placed between the main transmitter and receiver, with local broadcasting stations connected to one or more of the repeater stations, the local broadcast station using a non-directional antenna.

* * * *

No. 1,918,291 issued July 18, 1933 to Fritz Schröeter, Berlin, Germany, and assigned to Telefunsen, for an arrangement for broadcasting on waves of one meter and one decimeter.

Another "Chained" short-wave system in which parabolic mirrors are used for directing the ultra short-waves. Repeater stations are used with the receiving directive antenna pointed at the preceding transmitter, and a plurality of transmitting directional antennas directed away from the main transmitter.

* * * *

No. 1,920,156 issued July 25, 1933 to Walter Hahnemann, Berlin-Marinfelde, Germany, and assigned to C. Lorenz Aktiengesellshaft, Berlin-Templehof, Germany, for an antenna for short and ultra short-waves.

A good description is given by the following claim:

1. An antenna arrangement for directive reception of short and ultra short-waves, comprising in combination an antenna loop having a side length not greater than one-tenth the length of the wave to be received and an antenna lead having an effective vertical length not less than one-half the length of the wave to be received.

No. 1,921,187 issued August 8, 1933 to Hans Erich Hollman of Berlin-Charlottenburg, Germany, and assigned to A. T. & T., for an Ultra Short-Wave System.

This patent discloses a relatively simple and apparently worth while receiving circuit, as described by the following claim:

1. In a receiving circuit for modulated ultra short-wave signals, comprising a first vacuum tube for receiving said signals, said tube having a cathode, anode and grid electrode, means for operating said tube with a positive grid and a free anode-electrode to produce ultra-high frequency, oscillations, a second regular amplifying tube operated with a normally unbiased control electrode and means for directly applying modulated potential variations on the anode of said first tube to the control electrode of the second tube.

* * * *

No. 1,921,448 issued August 8, 1933 to Raoul Baronowsky, Berlin, Germany, and assigned to Telefunsen, for an oscillation circuit for Short-Wave Generators. The claim describes the invention:

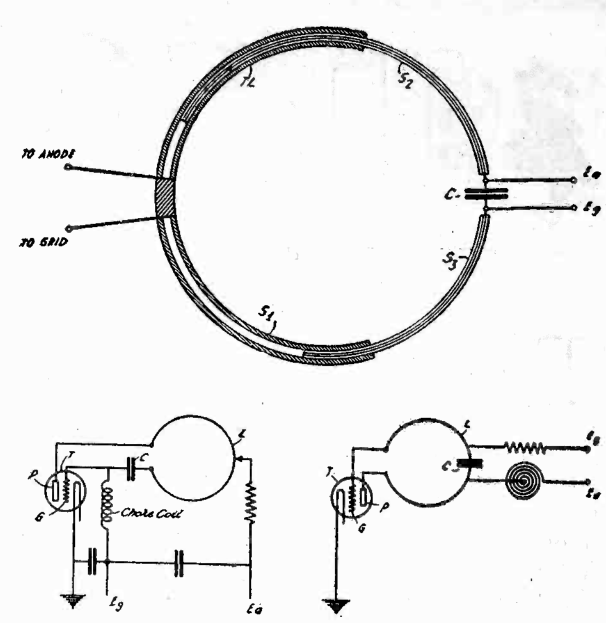


FIG. 1 Patent No. 1,921,448

1. In an oscillation circuit, a telescopic loop inductance in the form of a circle comprising two sections, one movable with respect to the other, a capacity element connected in substantially the middle of one of said sections and movable therewith, a vacuum tube having its grid and plate elements connected to said other section, and individual connections from both sides of said capacity element to sources of potential.

NOTE—These abstracts are necessarily short and incomplete. If interested in full information, complete printed copies of patents are furnished by the U. S. Patent Office at 10 cents each. Address the Commissioner of Patents, Washington, D. C.

* Patent Attorney, San Francisco, Calif.

The Commercial Brasspounder

By WAYNE P. PASCHAL

WORD comes that at a hearing of the Broadcast Industry Codes, held in Washington, D.C., September 27th, the American Radio Telegraphists Association, Inc., presented the following modification to apply to the code submitted by the National Association of Broadcasters.

The Technicians of any broadcasting station shall be defined as being persons employed in a managerial or executive position not required to work on regular program watches. Operators are persons in any broadcasting station employed at the transmitter or control boards, such as speech amplifiers and monitors, working on regular program schedules. Maximum hours to be thirty-six in one week for technicians and operators. Minimum salaries shall be, Technician, $225.00 per month; Chief Operator, $200.00 per month; Second Operator, $185.00 per month; Third Operator, $175.00 per month; and all Subsequent Operators $150.00 per month.

No oral hearing was allowed for presentation of evidence or suggestion and all were made in writing. Mr. E. H. Reitzke of the Capitol Radio Engineering Institute of Washington, D.C., submitted evidence of education of radio operators. The evidence defined operators in the broadcast industry as being an average of twenty-eight years of age and having not less than four years of high school education.

The American Steamship Owner's Association submitted a code September 25th calling for hours of work as defined in the Navigation Laws of the United States (two operators—12 hours) with a minimum salary of $75.00 per month for Chief Operator. No suggested salaries for other operators were included, and no news concerning any adjustment for other operators is forthcoming.

We are in receipt of a letter from an operator who is sufficiently foresighted to realize the advantage of united action and doing something to better the conditions now existing. He set forth some interesting reasons for increasing the wages of radio operators generally, and we quote the following, an excerpt from his letter:

To justify a request for a reasonable living wage for the radio operator the following reasons are listed:

A Radio Operator is required to know the laws, principles, and theory of radio and electricity, to have a practical knowledge of the equipment he is required to operate, to know the laws of his government relating to radio communication, to be able to correctly read and write the English language, and in particular to have an excellent knowledge of spelling, to know minor accounting, to know the basic principles of navigation on sea or in the air, to know the basic principles of meteorology, to have a concise knowledge of business and stenographic procedure, to have a good worging knowledge of geography, and to be kind, courteous, tactful and able, for he is in many cases the link between his employer and the public.

It is mandatory that he possess a license allowing him to follow his chosen profession. It is necessary that he renew his privilege every three years, either by proof of continued activity in his profession or by re-examination, making necessary the continued study of the developments in electricity and radio.

To procure his license and to carry on his means of earning a living he must take an oath to preserve the secrecy of all his communications, making him liable to prosecution should he reveal to persons unauthorized the contents of his communications.

He is continually risking his life and health in his work, for he must make adjustments on apparatus utilizing voltages dangerous to life, and on shipboard he is the next to the last person to leave the ship in case of distress or sinking. He must stand by his post in any emergency, though it may mean his death, for he is the sole contact with rescue, and this tradition has never been violated.

He is a public servant, contributing to the pleasure, welfare, security, interest, and convenience of society, for without broadcasting stations, ship radio, and other forms of radio communication, life would indeed be dreary.

What is your opinion of a city that is financially able to build and maintain a police radio station, but yet whose treasury is too small to permit transporting a relief operator from a city fifty miles away, during the time the regular operator is renewing his license? Instead, the city employs an amateur operator without a radio telephone license to operate the station. "The King can do no wrong"—and the Police cannot break the law, perhaps!

One of our radio communication companies in a large Coast city recently found it necessary to import radio operating talent from outside the immediate territory when there happened to be a number of capable ops on the local Community Chest rolls. The op was recently on a famous expedition, and sent innumerable words of press through the Company's stations.

The operators of the fishing fleet off the West Coast of Mexico might use the following form of message transmission. It is the generally accepted form on the Pacific, and makes for accurate recording of necessary data relative to the message handling.

NR 1 CK 26 DH OPR
M S RAJO FLD 7.00PM OCT 27TH
Miss Winnie Winkle
326 West Fourteenth St. Los Angeles (Calif.)
Trip excellent fishing fine will arrive Tuesday send regards to family will all my love and kisses BOB

The sending of commas, semi-colons, periods, and other forms of punctuation in transmitting the text are wholly unnecessary and only confuse the checking. Observe a standard form and become **operators.**

Next month we will give you the Atlantic Coast method of sending messages.

Overheard on the intermediate ship frequencies:

"R R R OK OK OK OM OM TKS TKS 73 73 FB FB GN GN SK" (Communication over 25 miles—and no QRM!)

"The Codes are darned good things; hope we have more—I think that Haddock and his gang are a bunch of chair warmers—what's this country coming to—The OM's a bum—QRX, here's a note to the Purser"

"SA, OM where in heck did you get the equip—nize stuff yr putting out—you outta be proud o' tt job—just gotta ¼ kw spk hr—the recvr is the bunk—CUL in port when we QTP, solong"

"CK CQ CQ de — — — QSO KPE KEK KFS KOK QRU? QSP" (a certain Union Oil Company tanker repeated this every ten mins for a half-hour one afternoon)

"QRT QRT QRT QRX QRX QRX 10 MINS LIGHTSHIP WX NW"

"JBID JBID JBID de —— —— —— do you know we keep a log?"

We haev the above calls on our log, but we dont' think the fellows ought to be reported, so will keep mum, but look out fellows, rag chewing isn't operating!

A great number of requests have come to the Manager of Radio KUP for a schedule card. Inasmuch as schedules are handy things, and we have a hard time getting them sometimes, we are quoting here the schedules of KUP. Schedules of other stations will be printed if you will send them in.

RADIO STATION KUP
San Francisco Examiner Radio

Time	Frequency	Type of Transmission
0300 GCT	6440 KC.	World-wide press CQ 20-25 wpm.
0400 GCT	6440 KC.	Major, Marine Weather, NPG repeat 0330 GCT
0530 GCT—	6440 KC.	NERK-NQO special press features 30-45 wpm. May be copied by ships.
0900 GCT	6440KC.	World-wide press CQ 20-25 wpm. (late edition of S. F. Examiner) with stock at 1000-1015 GCT.

Some wonderful stories have come our way, but we think one of the best is the one that was told in the static room the other day while the boys were "whooping it up." It is about one of our purser-ops who is sailing to the land of Wahini and Oke.

It seems that "Major" Dave Bain of WMCS took a vacation in San Francisco this year, and while contemplating upon the worries of the world, suddenly decided to drown his sorrows. Accordingly, Major hied himself to the well-known hangout of the marine fraternity where they purchase their grog, and proceeded to hoist a few for the good of posterity.

Two glasses were enough. Dave thought he would like a little something to remember his favorite land, so down to the mainstem he hikes.

Into a restaurant he waltzes, for he was floating on air, and with a serious look on his countenance, asks, "Pardon, do you happen to have some "Two-finger Poi?"

Ye tavern keeper gives him a look, very very sad, and replies, "I'm sorry, fella, but we don't keep the stuff. You might try across the street."

Across the street goes Major, to the doorway of "Ye Musty Inn", and again asks for his beloved Poi.

This time things din't go over so big, for ye restauranteur smelled a rat. (We should say a gin fizz, but let it pass). So he sez, "Naw, whatcha think we are anyhow? Gwan home where ye belong, and keep outta mischief."

Dave leaves hurried like, and with a now fast becoming wistful expression on his face, sets foot in the direction of the next sign announcing a "Place of Good Eats."

Here he repeats his query, and the result was the same, for this cook knew his oats. He sez, "Lissen, buddy, I know whatcha mean, fer I've been there, too, but I sold the last just a few minutes ago."

But, to make a long story short, Dave went to twenty-six places in San Francisco before he suddenly tumbled—"Two-finger Poi" is a Hawaiian dish, and, unfortunately, does not come up to the social standards of San Francisco.

We are really sorry, Dave, it sounds so queer, but we guess it is "Oke"!

SOME PERSONAL MENTIONS

Oren F. Porter, late of the **Matson Line, has** opened up a "Racqueteer Shop" in SF, but deals in tennis goods and service, not liquid.

Larry Shannon is coasting on the Ruth Alexander as second. How come, Larry?

P. S. Barnard is again warming the bench in the static room of Radiomarine in SF after a relief trip to the hospital for an appendix amputation. Did I hear a remark about the "Radio Cynic"?

Jimmy Foran, late of WKDS, spent the summer in British Columbia fishing. It seems Jimmy became very jealous when a certain op told him, via short wave, that his girl in SF had gone to the show with another guy. We also remember hearing the transmission of a couple of messages addressed "HONEY Foran." What's the matter, Jimmy, can't you take it?

What Ho! Fay Stoddard has quit the sea and is sign painting again. This is the 'teenth time, isn't it, Fay?

"Tiny" Nelson of the new luxury liner KIEK is

(Continued on page 32)

NEW BOOKS
AND REVIEWS of CATALOGS

Electron, Tubes and Their Application, Prof. John H. Morecroft. Published by John Wiley & Sons, New York, N. Y.

A text and reference book of the highest order, setting forth the details of the operation and theory of vacuum tubes. A work which should be on the bookshelf of everyone interested in vacuum tubes and their applications. There is no atempt made to sidestep explanations or expositions, and hence mathematics are used where necessary. This need not deter those who are inclined non-mathematically, as there is plenty of "meat" for anyone, even if the mathematical explanations are passed over.

Continue Sky-Wave Propagation By A. L. Munzig Here

(Continued from page 18)

of the energy in the incident wave to be scattered and hence lost as far as transmission to distant points is concerned. While this scattering is particularly great in rough country, it is, nevertheless, appreciable even when the reflecting surface is the sea. The fraction of the energy lost in an earth reflection depends to a considerable extent upon the angle of incidence of the downward ray and becomes greater as the angle of incidence is reduced, until, with grazing waves, there is almost complete extinction. Most of the attenuation of the sky wave takes place while the wave is passing through the lower edge of the ionized layer and during the reflections at the surface of the earth. Between the earth's surface and the lower boundary of the ionized region, the attenuation is negligible.

Electron Action

To more clearly understand the effect which an ionized region has on a passing radio wave, let us first consider the action of a single ion or electron when under the influence of a passing radio wave. Consider the case of an electron in a vacuum with no magnetic field present other than the weak magnetic field of the wave. The wave's electrostatic field exerts forces on the electron which vary sinusoidally with time and cause the electron to vibrate sinusoidally along a path parallel with the flux lines of the wave. The amplitude and average velocity are greater the lower the frequency and the velocity lags 90 degrees behind the electric field of the radio waves because the moving electron offers an inertia reactance to the forces acting upon it. Since a moving charge is an electrical current, the vibrating electron acts as a small antenna which abstracts energy from the radio waves and then re-radiates this energy in a different phase. The resulting effect is exactly as though the vibrating charge were a parasitic antenna tuned to offer an inductive or inertia reactance to the wave frequency and alters the direction in which the resultant energy flows. The magnitude of this effect varies with the amplitude and average velocity of the electron vibration and therefore becomes increasingly great as the frequency of the wave is lowered. Ions in the path of a radio wave act in much the same way as electrons, but because of their heavier mass ions move enormously slower than electrons under the same force and so in comparison have negligible effect.

Atmospheric Pressure

In the discussion that has been given of the effect which an electron has on a passing wave, it has been assumed that the electron was in a vacuum. Actually, however, there is always a certain amount of gas present in the atmosphere even at high elevations. From time to time a vibrating electron will collide with a gas molecule. In the result of such a collision, the kinetic energy which the electron has acquired from the radio wave, is partly transferred to the gas molecule and partly radiated in the form of a distorted radio wave which contributes nothing to the transmission. Hence, the result is therefore an absorption of energy from the passing wave. The magnitude of the energy thus absorbed depends upon the gas pressure, or in other words, upon the possibility of a vibrating electron colliding with a gas molecule. Also, upon the velocity which the electron acquires in its vibration, resulting in the energy lost per collision. Hence, the absorption of energy from a radio wave traveling through an ionized region is less for a wave of high-frequency than for a wave of low-frequency and in the case of low-frequency waves is reduced by the presence of a magnetic field.

Continue Commercial Brasspounders Here

(From page 25)

contemplating walking the plank of matrimony just prior to the cruise around the Pacific. Whatta honeymoon!

Oney Johnson of WKER is studying photography wirth a vengeance and is coming along in fine shape. How are the models, Oney?

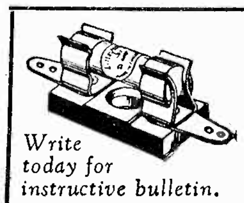
Roy Campbell, late of the "Marollo" is ZFA and on his way to Seattle. Too bad, Roy, and hope you make out okay.

Al Lucey of Globe Wireless has taken over the Orient Service with the painting of his name on the Super's Chair.

A. C. Fallon is still going "round-and-round" on a Dollar. How do you do it?

Since when did Ed Caveny of Radiomarine SF MRI go back to sea? We will swear we saw him sail in on one of the new luxury liners, and he was on the boat deck. What's it all about, Ed? More pilot boating, we bet!

Where is Oscar Antrim, Oliver Treadway, Gene Gylfe, Vernon Bourg, Allen Wheelock, Herb Fish, Kenneth Wilcox, George Johnson, the Estep twins, and the host of others having given up radio? Let's hear from the gang for a change. Write in, OM's, and let's have something about your favorite "Radio Star."



20-Meter Antenna R.F. Feeders

(Continued from page 13)

center and connecting each half to one feeder. The center impedance of a half wave antenna, a half wave off ground, is about 73 ohms and the line figures near this value since the capacity per unit section is high because of a rubber dielectric. Since it is a low impedance line, the dielectric losses should be quite low.

This line gave a galvanometer reading of only 30 divisions when the feeders were tapped up so that the amplifier drew normal plate current. This was better than the single wire feeder, but not as good as it should have been; so some further experiments were made. It was found that by adjusting the feeder taps, a galvanometer reading of 42 divisions could be obtained, but this was so close to the center of the output coil that the amplifier drew only 125 ma., instead of the 150 ma. that had been used in all previous readings.

This was only ⅞ of a turn each side of center on the 12 turn coil. Apparently, the efficiency was nearly as high as with the spaced two wire impedance matched feeder but no way could be found to efficiently couple it to the amplifier output. The usual amateur scheme of running the feeder taps out until normal plate current was drawn did not apply in this case as the antenna power output was actually less when this was done.

Inductive coupling was tried, using these twisted feeders, and the maximum reading obtained was 28 divisions with the amplifier drawing 130 ma., or 20 less than normal. The antenna coil was tuned and feeders connected across various portions of the pick-up coil. The maximum readings were obtained with the feeders connected across the whole coil and the condenser was simply used to tune out the reactance to some extent. Apparently, this type of feeder is quite efficient, but not very practical on the higher amateur frequency bands. Five-meter results checked this but the writer has hopes of better success on the 40 and 80 meter bands. It has excellent antinoise characteristics for receiving. The same antenna can be used for both transmitting and receiving by using a small D.P.D.T. knife switch.

The matched impedance type spaced feeders proved best but have one disadvantage in that they will work effectively on even harmonics such as phone operation on 20 and 10 and 5 meters. The writer has often wished that more nearby amateurs used this form of antenna when listening to their harmonics on higher frequency bands. The astonishing difference in output power between this system and the more usual "zepp" feeders was likely due to use of an additional tuned circuit for coupling (low Q on 20 meters) and the absorption losses in the stucco walls. An amateur desiring to use the "zepp" feeders must bear in mind the need of spacing them with very low loss materials and keeping them several feet from nearby walls. The spaced impedance matched feeders have the advantage of not being critical in length or spacing insulator losses, and can be adjusted for efficient operation by the usual adjustment of coupling until normal tube plate current is obtained. The losses from nearby walls are also less, by far, than with "zepp" feeders.

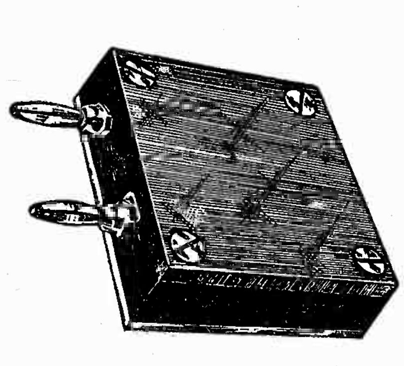
Putting Power Into the Antenna

(Continued from page 7)

tween turns should be at least equal to the diameter of the tubing, and preferably slightly greater, for highest "Q". Keep the inductance away from the metal of the tuning condenser by at least the coil diameter.

A word about the new grounded-grid system will probably be in order. An analysis of this system by the author failed to show any advantage, except that no neutralizing is required. In fact, when used in this circuit, the final amplifier requires a small additional amount of excitation over that required in the conventional neutralized amplifier. A further point is that the tubes now on the market, such as the '52, are not well suited to work as grounded grid; there being considerable trouble on the higher frequencies from feedback.

It is the careful attention to the various little points outlined in this article that determine whether the amplifier is to put into the antenna tank a goodly amount of the power supplied to the plate, or waste this power in heat or other losses. The only kind of "Efficiency" that really matters is "Conversion Efficiency."



Vacuum Tube Keying Methods

By J. NORRIS HAWKINS

KEYING by means of a vacuum tube has long been recognized as one of the best means to eliminate key clicks. In the common tube-keying circuits the keying tube acts as a relay in series with the B minus lead from the power supply. For example, the plate resistance of a type 45 tube is something less than 2000 ohms at zero grid bias. However, if we raise the bias to cut-off, the plate impedance becomes infinitely high. In Figure 1 we see the keying tube located in the center-tap lead of an amplifier stage. When the key is up, the battery biases the keying tube to cut-off, which practically opens the DC return from the amplifier filament to ground. This cuts off the plate voltage just as effectively as if we had used a conventional relay or key in this center-tap lead. Then, when we short-circuit the negative bias to the keying tube with the key, it passes current and thus completes the circuit from filament to ground. The 100,000 ohm resistor in series with the bias battery cuts down the current through the key . . . which otherwise would use up the bias battery in short order.

The circuit shown in Figure 2 is an improvement in that it eliminates the 45 to 90 volts of battery necessary in the circuit of Figure 1. A small battery is shown, but it should be noted that it is for the purpose of applying a small POSITIVE bias to the keying tube's grid when the key is down. This battery is only necessary when an especially large amount of current must be passed by the keying tube. Ordinarily it can be omitted.

The circuit shown in Figure 3 is, I believe, entirely new, and has not been published before. It represents a combination of automatic bias, blocked grid keying and center-tap tube keying! It is one of the most efficient tube keying circuits possible, in that the plate resistance of the keying tube is reduced to an exceptionally low value, due to the fact that the grid is tied to the plate when the key is down.

It should be noted that the keyed tube and the keying tube must always have separate filament supplies. The keying tube must be capable of passing the total amplifier plate current. Of course, if one keying tube will not pass sufficient current, additional tubes may be connected in parallel. The low-mu, low plate impedance tubes such as the 2A3,45,50 and WE211E, make the best tubes for keying service. The 45 and the WE211E also have the advantage of being cheap. Often we can use tubes for keying which have been discarded for ordinary purposes, due to slight loss of emission, etc.

The 1-mfd. condenser shunted across the key contacts removes the last trace of a click, which otherwise might prove bothersome in the operator's own receiver.

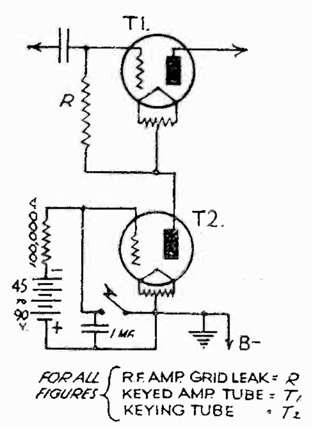


FIG. 1

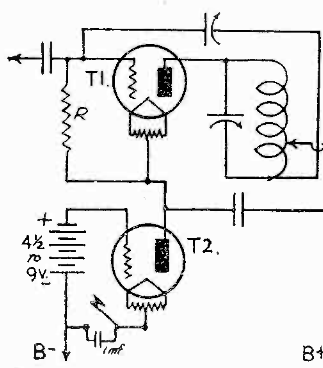


FIG. 2

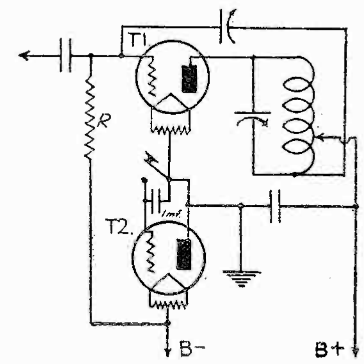


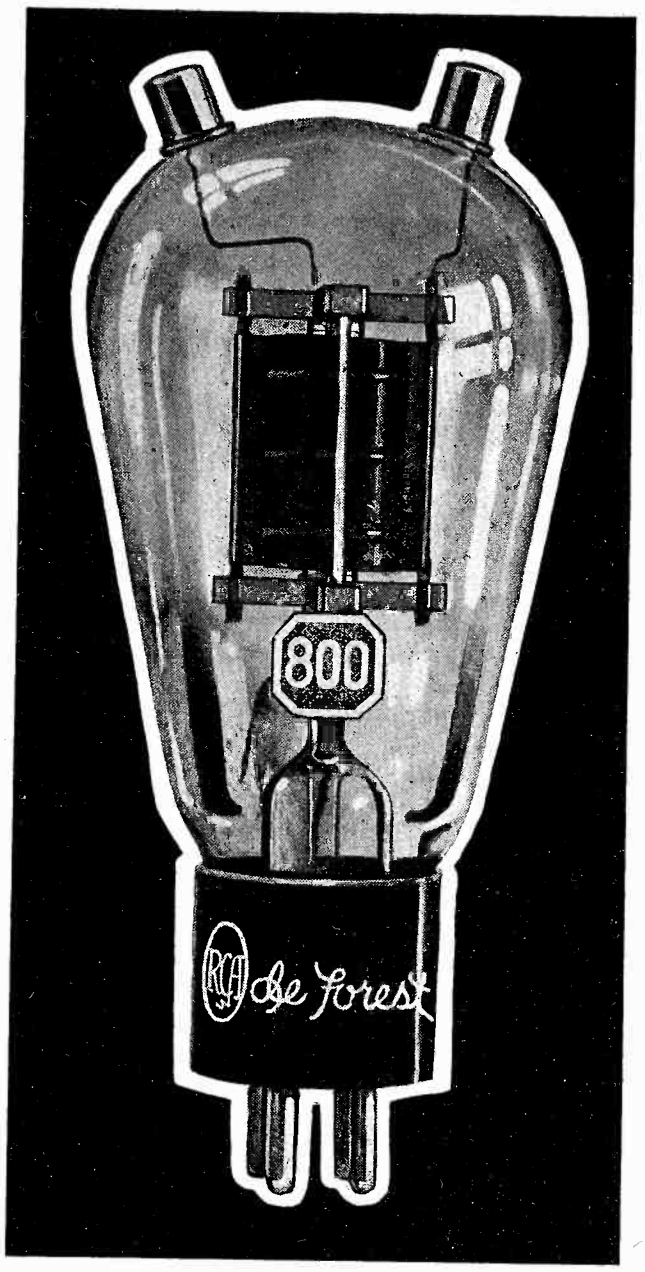
FIG. 3

KEYING TUBES TO USE WITH VARIOUS AMPLIFIERS

Plate Current	25 MA.	50 MA.	75 MA.	100 MA.	150 MA.	200 MA.
Tube or Tubes to Use Note: When more than one keying tube is used, these tubes are connected in parallel.	One '45 or One 71-A	Two 45's Or One 50 Or One 211E	Three 45's Or Two 2A3's	Four 45's Or Three 2A3's Or Two 50's Or Two 211E	Four 2A3's Or Three 50's Or Three 211E Or Two 845's	Four 50's Or Four 211E Or Three 845's

What Is Harmonic Distortion?

HARMONIC, or amplitude distortion is that distortion which affects the TIMBRE of voice or music. It makes voice sound fuzzy, or harsh, and can make the comparatively pure notes of a clarinet or violin sound like a pipe organ. It is usually caused by a non-linear response somewhere in the audio channel and is often a sign that a tube is overloading. Improper bias and the improper matching of impedances are two other common sources of this type of distortion. Once this distortion is present in an audio amplifier it is impossible to later remove it by equalization or by other methods. It has been determined that 2% harmonic distortion can hardly be noticed, but above about 8% the quality will not be tolerated by a trained listener. With 15% distortion, listening becomes almost painful even to an untrained ear. This ability of a vacuum tube amplifier to generate frequencies not present in the input is used to good advantage in frequency doublers. It should also be noted that a detector or demodulator is a form of harmonic amplifier.



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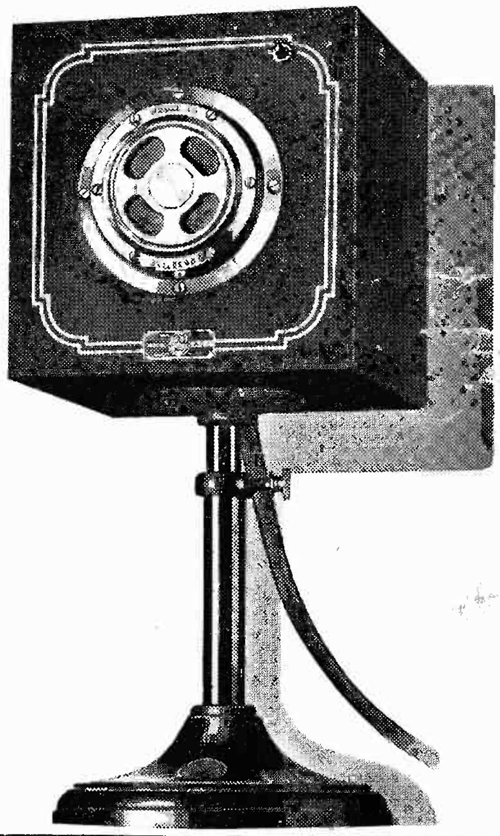

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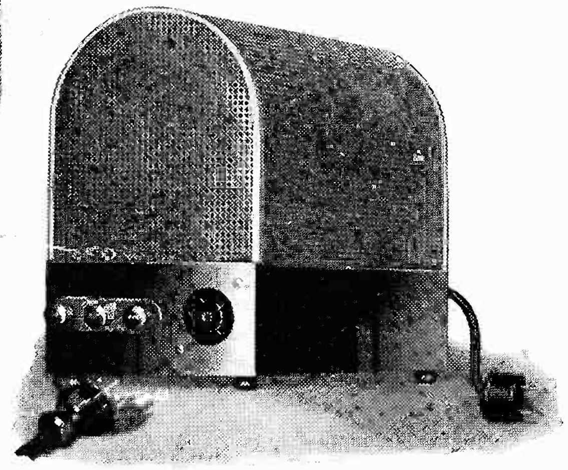

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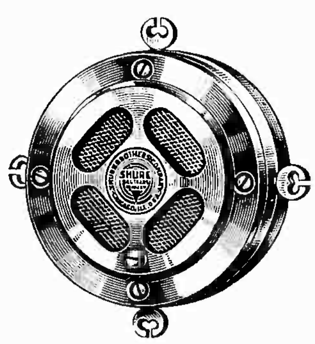
Model 41A. Code: RUPAR. Condenser Microphone Power Supply, complete with plug for microphone cable, A.C. cord and plug and one type '80 rectifier tube. List Price **$40**



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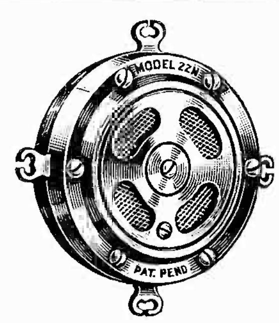

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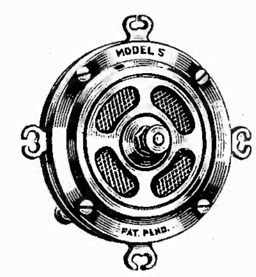

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