QST

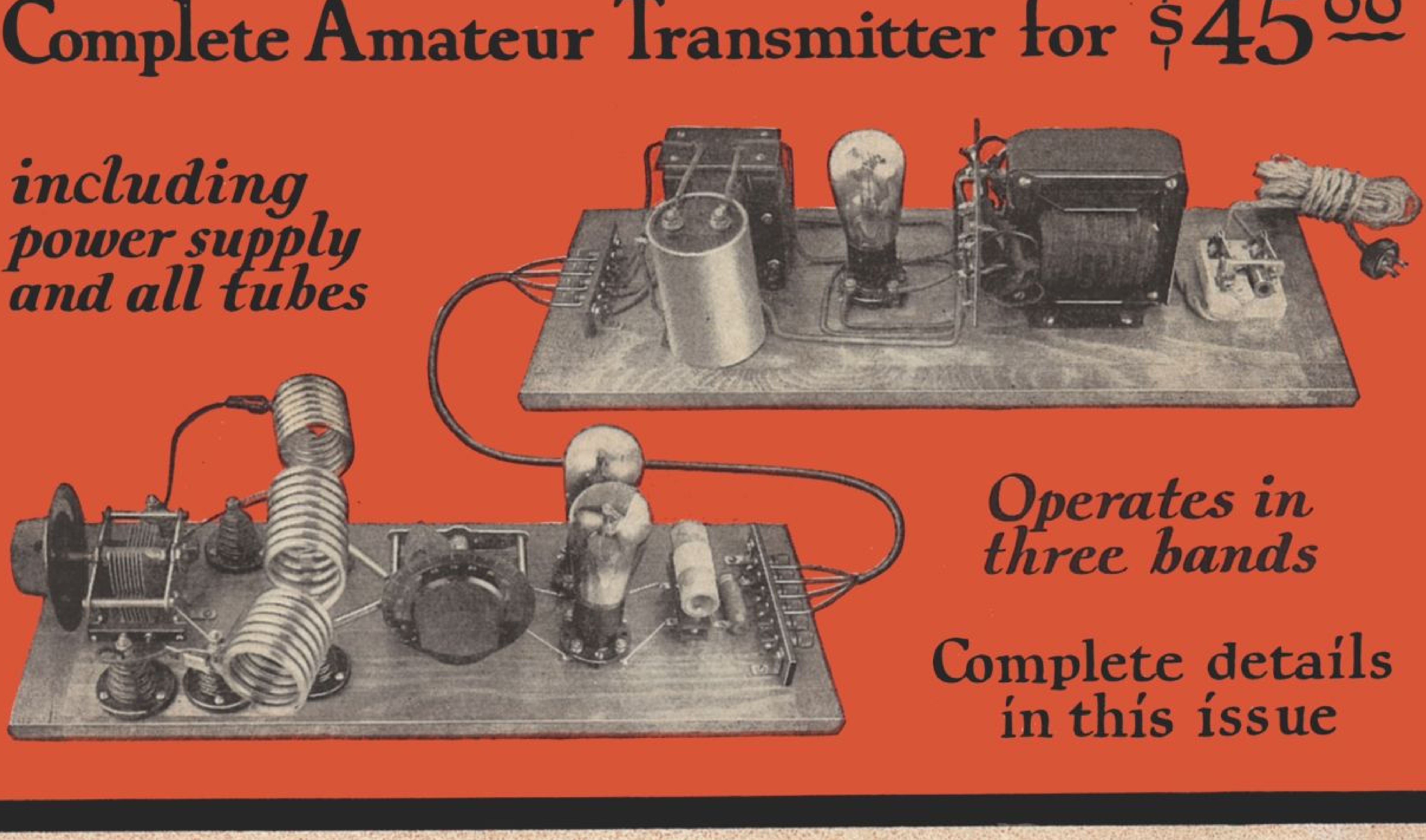
DEVOTED ENTIRELY TO

AMATEUR RADIO

PUBLISHED SINCE 1915 BY THE AMERICAN RADIO RELAY LEAGUE INC.

Complete Amateur Transmitter for $45.00

including power supply and all tubes



Operates in three bands

Complete details in this issue

NOVEMBER, 1930

25c

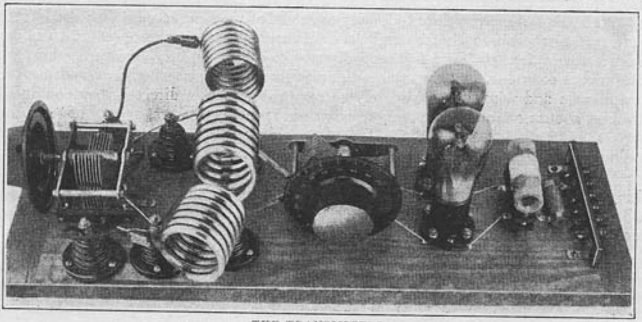
A Complete Push-Pull C.W. Transmitter at Low Cost

By George Grammer, *Assistant Technical Editor*

IT'S an easy job to build up a low-power transmitter of the conventional pattern using a Type '10 tube as an oscillator with a pair of Type '81 rectifiers working from a 550-volt transformer. It's likewise easy to put together an oscillator using a small receiving tube and a few "B" batteries or a "B" eliminator for plate supply. The first outfit will cost around $80.00 (list prices) complete with tubes and the necessary accessories, even without allowing anything for the two or three meters which ought to be included in an amateur transmitter — but it will "get out" and get plenty of DX with any kind of intelligent handling. The second one is satisfyingly cheap — but the power output is so low that the station is practically out of the running if competition from other stations is bad.

The tendency toward a sort of standardization among broadcast receiver manufacturers, remote though such a movement would seem to be from amateur radio, has resulted in a lowering of prices on the tubes most commonly used, notably the Type '45 and the Type '80, and concurrently a fairly low level of prices on power supply equipment designed to be used with those tubes. The immediate effect of this, so far as the amateur is concerned, is to help bring together the two extremes cited in the first paragraph. It is not yet possible to build a transmitter using a Type '10 tube for the same price as the "B" battery outfit, but it *is* possible to build a transmitter with as much power output as the '10 will give, the cost of which will be about half-way between the two.

This transmitter, illustrated in the photographs, is built almost entirely of receiving equipment which is readily obtainable; and the cost of all the necessary parts, including the key, is approximately $45. A milliammeter to read plate current, the use of which is strongly recommended, will add seven or eight dollars more to the cost. In these examples, of course, the prices given are list, not those which are quoted by bargain houses. It is certainly true that by judicious buying it is easily possible to reduce the cost of the set to $35 or less.

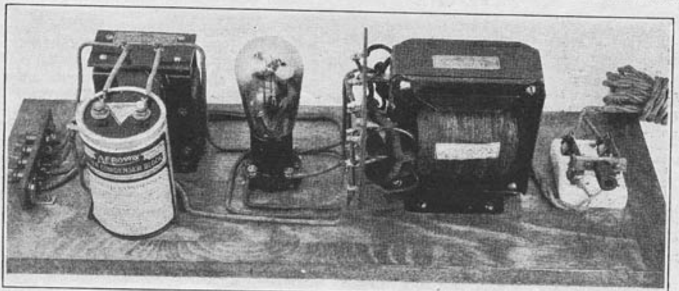


THE TRANSMITTER

The circuit is the push-pull tuned-plate tuned-grid, with a fixed resonant grid coil. The oscillator tubes are Type '45's. The arrangement of the parts is explained in the text.

And the set is not a toy or another flea-power outfit — it is intended for practical communication, and will do anything the typical Type '10 outfit sketched at the opening of this story will do — and perhaps do it better. It will put just about the same amount of power into an antenna that the '10 outfit will — and with better frequency stability. The push-pull circuit takes care of the latter.

When the Type '45 tube was first introduced it was labelled "not intended to be used as an oscillator," and most amateurs, remembering bitter experiences with the Type '50, were inclined to believe it. Whatever the intentions may have been, however, the fact is that the '45 is a very good oscillator, exhibiting none of the characteristics which made the '50 infamous. Having made this statement, we suppose that by the time this *QST* is out a week we'll have at least seven letters telling us we're all wet, because the writers personally tried out the tubes with only a thousand volts on the plate and they (the tubes, of course) blew up. If that happens all we can do is write back, "So they ought." It is a fact, however, that a number of the tubes have stood up for continuous runs with 400 volts and more on the plates without showing any signs of an early demise or losing their ability to oscillate. Strange to say, the '45 at 400 volts and less gives more output than the '10 with the same plate voltage. This was found to be invariably true in a number of test set-ups in the laboratory. But don't get the idea on that account that the '45 is a better tube than the '10 — it won't stand the voltage that the '10 will by any means. The point we wish to bring out is this — *two* '45's in a push-pull transmitter with about 350 volts d.c. on the plate will give as much output with as good frequency stability, as *one* Type '10 with 600 volts d.c. on the plate (the usual voltage from a 550-volt transformer with a good filter and normal load on the tube). And the cost is a whole lot less. The latter point is the important one. Aside from that, the r.f. portion of this transmitter can be used with a pair of Type '10 tubes as well as with '45's, with quite an increase in output if the '10's are run with the normal power supply used with those tubes.



THE POWER SUPPLY

Utilizing a Type '80 rectifier, a broadcast power-pack transformer and choke, and a double-section electrolytic condenser.

BUILDING THE TRANSMITTER

Getting down to constructional details, the circuit will be recognized to be essentially that of the 150-watt transmitter in June, *QST*, with a few simplifications. A fixed-tune grid coil is incorporated in the transmitter in place of the usual tuned circuit, and the antenna tuning system has been changed to eliminate one condenser. All circuit elements which could possibly be dispensed with have been eliminated from the set.

The baseboards for both the transmitter and power supply are both the same size, each being half of an 18 x 26 breadboard. They are sandpapered smooth and given three coats of Duco clear lacquer, with a little smoothing treatment with fine sandpaper between each coat. Rubber "bumpers" are used as feet, one at each corner of the baseboard.

Most of the transmitter parts are mounted on top of the baseboard. From left to right are the antenna tuning condenser, a pair of standoff insulators to which the antenna or feeder connections are made, another pair of standoff insulators which support the antenna coupling coils, and a third pair of insulators supporting the plate coils of the transmitter. Next in line is the tank tuning condenser, the tubes and their sockets, the grid coil and mounting, the grid leak, and finally, the binding post strips for connections. The photo of the under side of the transmitter baseboard shows the radio-frequency choke coil in the positive high-voltage lead, the filament center-tapped resistor, the filament by-pass condensers, and the wiring to the connection strip.

The layout shown is about the most logical for a push-pull transmitter, and allows connections to be symmetrical. In fact, the transmitter is laid out in exactly the same way as the schematic diagram in Fig. 1, except, of course, that the connections have been brought out to the end of the board instead of one side of it, as the schematic diagram would indicate. The wiring underneath the baseboard has been kept as near to the center of the board as possible to keep it away from strong r.f. fields. The center-tapped resistor across the filaments is connected at the mid-points of the wires joining the filament connections on the tube sockets. A home-made strap of thin brass holds the wires, which are No. 14 rubber covered, in place. The r.f. choke coil in the

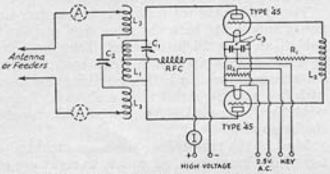


FIG. 1. — THE TRANSMITTER CIRCUIT

Showing series antenna tuning.
C_1 — 500 μμfd.
C_2 — 350 or 500 μμfd.
C_3 — 250 μμfd.
R_1 — 50,000 ohms.
R_2 — 20-ohm center-tapped resistor.
RFC — Two-inch winding of No. 36 d.s.c. on half-inch form.
L_1 — 3500 kc. — 12 turns of ¼-inch copper tubing 2⅜" inside diameter.
7000 kc. — 8 turns of ¼-inch copper tubing 1⅝" inside diameter.
14,000 kc. — 4 turns of ¼-inch copper tubing 1⅝" inside diameter.
L_2 — 3500 kc. — 72 turns No. 32 s.s.c. on 1" form.
7000 kc. — 40 turns No. 28 d.c.c. on 1" form.
14,000 kc. — 16 turns No. 28 d.c.c. on 1" form.
L_3 — 7 turns of ¼" copper tubing 1⅝" inside diameter.
I — 0-150 d.c. milliammeter or 6-volt flashlight bulb.
A — 0–1 thermocouple ammeters — these are not entirely necessary but are helpful in tuning.

plate lead is connected to a brass bolt which comes through the baseboard, and should be installed as near the plate coil as possible, but at right-angles to it.

The grid coils are wound on rigid insulating forms 1" in outside diameter, and no spacing is used between turns. These coils, together with the plate coils accompanying them, are shown in another photograph. The coils are mounted on General Radio Type 274-BP plug assemblies, and the socket is a Type 274-BJ three-jack assembly. These assemblies are very convenient, although a dollar or so can be saved by using G.R. jacks and plugs and mounting them on bits of hard rubber or bakelite in a similar fashion. In winding the coils it should be remembered that a change in the wire size, or even a change in the type of insulation on the same size of wire, will make necessary a different number of turns. If the diameter of the wire, including insulation, is smaller than that given, less turns will be needed, and vice-versa. The correct number of turns is easily found if a plate milliammeter is available, and the adjustment will be described later. Be sure that the same number of turns is used on each side of the center tap. When the coil is completed it should be "doped" to prevent loosening of the turns and to keep out moisture.

Connections between the grid coil socket and the grid posts on the tube sockets, and also between the tuning condenser and the plate posts on the tube sockets, are made with ordinary bus wire, since these wires do not have to carry heavy currents. The connections between the tuning condenser and the insulators which support the plate coil, however, must be made of the same size of copper tubing used for the plate coil, because these connections are part of the tank circuit and heavy currents flow in them. In placing the tuning condenser and the insulators be sure that both of the copper-tubing connectors are the same length from the connections on the condenser to the insulators, to make certain that the tank circuit is symmetrical.

The insulators which hold the plate coil are spaced 4½ inches between centers. The coils are wound to fit on the insulators, and the spacing between turns can be judged by an inspection of the photograph. The 3500-kc. coil is wound on a piece of pipe with an outside diameter of 2⅜ inches, while all the other coils are wound on pipe 1⅝ inches in outside diameter. Each of the plate coils must have an even number of turns so that the clip for the center tap can be placed on the under side of the coil. A brass machine screw is run through the baseboard midway between the insulators holding the plate coil, and a nickel-plated battery clip is connected to the screw by a short length of flexible wire. When the coil is fastened to the insulator the clip is placed on the center turn.

The antenna coils are wound on 1⅝-inch pipe, one end of the coil being brought out so that the axis of the coil will line up with the axis of the plate coil when fastened in place. Be sure to wind both antenna coils in the same direction. If wound in opposite directions the fields will "buck," and the antenna will not take power from the transmitter. The antenna coils shown have seven turns each, but the exact number to use will depend on the type of antenna system employed. These coils will be satisfactory with a Zeppelin antenna on all bands if the feeders are between 45 and 50 feet long.

The coils will keep a pleasing bright finish if they are carefully cleaned and lacquered. Before winding each coil, the necessary length of tubing should be thoroughly scoured with steel wool. After the coil is finished and the spacing between turns adjusted correctly, it should again be touched up with steel wool and then scrubbed with a rag soaked in alcohol to remove grease. When dry, Duco lacquer, preferably thinned out considerably with the thinner which comes for that purpose, should be painted on with a small brush, making certain that the entire surface is covered, and then allowed to dry thoroughly before the coil is put in service. If the coils are not lacquered they will oxidize in a day or two. This is particularly true of the plate coils, which get appreciably warm in operation, and if not lacquered will turn a muddy brown color in a very short time.

In building the transmitter be certain to use exactly the same values for the circuit elements as are specified in Fig. 1. They are the ones which were found to be best after a considerable period of experimentation.

THE POWER SUPPLY

There is nothing unusual about the power-supply unit, except that the output voltage is somewhat lower than that commonly employed in low-power transmitters. The high-voltage winding of the power transformer furnishes 350 volts each side of the center tap, which is rectified by the Type '80 tube, and then fed into the filter. The latter is a brute-force arrangement, using a double-section dry electrolytic condenser and a 30-henry choke. Each of the condenser sections is rated at 8 μfd. and will stand 500 volts peak. The peak voltage of the transformer output is safely within this rating. An actual test of the power supply unit showed that the no-load voltage delivered by the rectifier and filter was between 450 and 500, dropping to about 350 volts under a load current of 100 milliamperes, the normal current taken by the transmitter when delivering power to the antenna.

The power transformer is of the type often used in broadcast receivers, and in addition to the high-voltage winding has a 5-volt winding for the filament of the Type '80 rectifier and two 2.5-volt windings, one of which is used to light the filaments of the Type '45 tubes in the transmitter, the other being left idle.

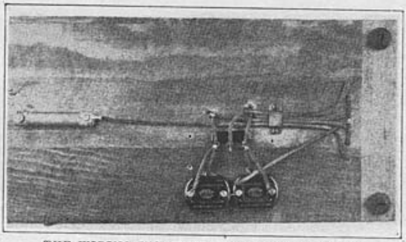
All of the wiring is above the baseboard in the power supply. No. 14 rubber-covered wire is used for connections, the insulation effectively preventing short-circuits. A double-pole single-throw switch for tuning the line voltage on and off, and a cord and plug for making connections to the house current complete the outfit.

When using electrolytic filter condensers be sure to connect them in the circuit with the polarities correct. The outside can is usually the negative connection, the positives being the binding posts on top. Instructions usually accompany the condenser.

With this power supply it is easily possible to get a pure d.c. note on all bands if the transmitter is well built and properly adjusted. If the d.c. note is not forthcoming look to the transmitter itself and not the power supply — this same trouble was encountered in working out the details of this outfit and it can be overcome with a little patience.

GETTING INTO OPERATION

There is nothing more hopeless than trying to adjust a transmitter without the means of knowing just what effect each change made has on the frequency, note and output. Two things at the very least are necessary — a monitor and some sort of indicator for telling when the antenna is taking load. The monitor should be used in conjunction with a frequency meter, or at least should be calibrated so that it is possible to tell with certainty whether the transmitter is in the band or not. Radio-frequency ammeters in the feeder leads are useful for determining when the antenna is tuned correctly, but the plate milliammeter is the handiest all-around meter to have, because with it the input power can be estimated and it can be used to indicate resonance with the antenna. By its use it is also possible to tell whether the tubes in the set are being overloaded or not. A 6-volt flashlight bulb or dial-light may be substituted for the milliammeter and will serve as a resonance indicator, although the actual plate current cannot be read in this case.



THE WIRING UNDERNEATH THE BASEBOARD

The plate choke, filament center-tap resistor and filament by-pass condensers are shown in this photograph. Note that the condensers and resistor are connected to the midpoints of the wires joining the filament connections on the tube sockets.

Suppose now that the monitor is ready for use and that a milliammeter or bulb is connected in the positive high-voltage lead to the transmitter. The transmitter is to work on the 3500-kc. band for this illustration. The proper coils are in place and all connections are tight.

First make sure that the antenna or feeders are disconnected and that the antenna coupling coils are moved as far from the plate coil as possible. Set the plate tuning condenser at maximum and close the key. The milliammeter reading should be somewhere between 25 and 45 milliamperes. Slowly turn the plate condenser, watching the milliammeter at the same time, and see if the plate current decreases to a minimum at some reading and then begins to rise again. This dip should occur at very near full capacity on the condenser, and if it is very far down the scale a few turns should be added to each side of the grid coil. This is, in fact, the way to adjust the grid coil in a circuit of this sort. The number of turns on the grid coil should be such that the minimum point on the plate current reading (with the antenna not coupled to the oscillator) occurs at a frequency slightly lower than the low-frequency end of the band on which that coil is supposed to work. Without some means of checking frequency it is apparent that an intelligent adjustment of the coil cannot be made.

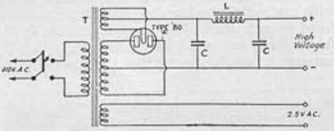


FIG. 2. — THE POWER-SUPPLY UNIT

T — Power transformer. Should have high-voltage winding giving at least 350 and not more than 400 volts each side of center tap, a 5-volt center-tapped winding for the filament of the Type '80 rectifier, and a 2.5-volt winding to supply the filaments of the transmitting tubes.

L — 10-to 30-henry choke with 100-milliampere or greater current-carrying capacity.

C — 8-μfd. filter condensers. The one shown in the photograph is an electrolytic condenser consisting of two 8-μfd. sections.

If the transmitter does not oscillate the plate current reading will be quite high — 150 to 200 milliamperes. Reasons for non-oscillation might be: grid coil turns not adjusted correctly; center tap on grid coil or plate coil not on electrical center; bad tubes, or low filament voltage. Ordinarily, however, if the circuit specifications are followed exactly there will be no trouble in getting the transmitter to oscillate.

Now set the tuning condenser at the point which gives the lowest plate current reading and check the frequency and the quality of the signal. The note should be pure d.c. and very steady, and the frequency should be very near 3500 kc. Next choose the frequency on which the transmitter is to be operated (this will naturally be the resonance frequency of the Hertz antenna, if such is used) and tune the transmitter to that frequency.

Now set the antenna coupling coils so that the distance between each of them and the plate coil is about an inch to an inch and a half. Both coils should be exactly the same distance from the plate coil. If the Zeppelin type of antenna is used and the feeders are between 45 and 50 feet long the parallel tuning connection shown in Fig. 3 should be used. The feeders should be clipped on the two insulators to which the antenna tuning condenser is connected, and a jumper should be connected between the two insulators to which the flexible leads which connect to the antenna coils are fastened. Now turn the antenna tuning condenser until the milliammeter or bulb shows the maximum plate current is flowing. The frequency and character of the note should next be checked with the monitor, and if the former has changed appreciably a readjustment of the plate condenser to bring it back to the proper place should be made. This will also necessitate retuning the antenna condenser. If the note shows signs of ripple the antenna condenser should be tuned a little off resonance until the note clears up again, or the antenna coils may be moved a little farther away from the plate coil. The correct adjustment will be that at which the antenna takes the most load with the note remaining steady and pure — the character of the note is more important than the current put into the antenna, because high antenna current is useless unless the signal is clean and steady.

The method of adjustment on the 7000- and 14,000-kc. bands is similar, except that series antenna tuning, as shown in Fig. 1, is used with the 45-foot feeders assumed. Other feeder lengths or differing antenna types will require different handling, and as the number of combinations is rather large it is impossible to cover all of them. The *Handbook* shows methods of tuning with practically all types of antennas in common use among amateurs, and should be consulted for further information if the builder is not familiar with antenna tuning systems. The proper setting of the plate tuning condenser will be at approximately 75% of full capacity on 7000 kc. and 60% on 14,000 kc.

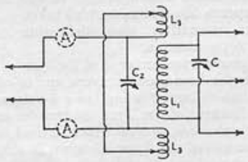


FIG. 3. — CONNECTIONS FOR PARALLEL ANTENNA TUNING

The feeders are connected directly across the antenna condenser and the clip connections on the coupling coils tied together. The remainder of the circuit diagram is the same as Fig. 1. The antenna ammeters are again optional.

The output obtainable will vary somewhat with the frequency, as is the case with all vacuum-tube oscillators, but tests with a dummy antenna have shown that it can be expected to at least equal that obtainable from a typical single Type '10 with similar values and circuit conditions on corresponding frequencies. The stability seems to be better than the '10 will give, probably because of the use of the push-pull circuit.

The r.f. ammeters indicated in Figs. 1 and 3 will be found useful for tuning purposes, although not altogether necessary. The antenna current values are really meaningless, and if the meters are used the transmitter and antenna tuning should be adjusted so that the current through both is the same, regardless of the actual value of that current. A scale of 0–1 ampere will be sufficient for a set of this power.

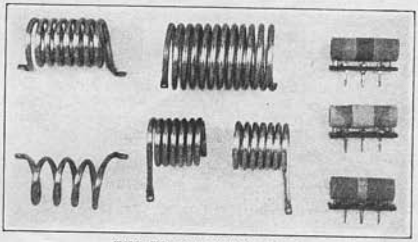
SOME TROUBLES

One of the worst problems encountered in building the set was that of eliminating unwanted r.f. in the power supply. R.f. wandering back into the power transformer and filter always makes itself known by roughening up the note — the blame for which is usually placed on the filter. The d.c. returns to the grid and plate in this circuit are fed in at a point of minimum r.f. voltage so that no chokes would seem to be required. This is true so far as the fundamental frequency is concerned, but unfortunately, as pointed out in the September "Uncle Jimmy" story, the second harmonic flows in these leads with much gusto unless something is done to prevent it. This happened with this transmitter and led to some rather curious results.

In an experimental "haywire" layout first built up for the purpose of testing out the '45's, a generator was used to supply plate voltage so the voltage could be readily adjusted, and the filament winding on a "B" supply furnished the filament power. The set was reduced to the bare essentials — no chokes or by-pass condensers were in it at all — and consisted of a plate coil, plate tuning condenser, two tubes, an untuned grid coil and a grid leak. A dummy antenna was used for a load. No trouble was experienced in getting a very good d.c. note on 14,000 kc. with this rig, even though no attempt was made to filter out the commutator ripple of the generator.

Next the outfit shown in the photographs was built up, but without any chokes or by-pass condensers in the transmitter itself. The 2.5-volt winding on the power transformer had no center tap, and since no center-tapped resistor was handy at the time, the filament supply used with the experimental set — which *was* center-tapped — was used temporarily. The power-supply unit shown furnished the plate power, however. This set performed in exactly the same way as the first one, which naturally was expected. In the meantime the center-tapped resistor arrived from downtown and was installed in the set — and then our troubles commenced. Using the 2.5-volt winding on the power transformer, the set simply would not give a d.c. note on any of the three bands — yet as soon as a separate filament supply was used the note became d.c. again.

Checking on the monitor showed that a strong second harmonic was present, and the inference was that this harmonic was getting back to the power transformer through the filament wiring and thus into the plate-supply system. With a separate filament transformer it was probably "washed out" in the line before it could get back to the plate supply. 500-$\mu\mu$fd. by-pass condensers were then tried across the filament, and on 3500 kc. the note immediately changed to pure d.c. On 14,000 kc., however, the note was much worse with the by-pass condensers than without them. This didn't look so good, so the next thing tried was a small choke in the positive lead, leaving off the by-pass condensers. The note immediately changed to d.c. on 14,000 kc., which was highly encouraging, but back on 3500 kc. there was still a noticeable ripple, although less than without the choke. A larger choke (the one shown in the photograph) was next tried with some improvement on 3500-kc. and no change in the d.c. on 14,000 kc. No larger chokes were available, so the filament by-pass condensers were tried again, this time with the choke in the circuit, and the note was again pure d.c. on 3500 kc. But again there was some ripple on 14,000 kc.



THE TRANSMITTER COILS

The two copper-tubing coils on the left are the 7000-kc. and 14,000-kc. plate coils. The large coil in the center is the 3500-kc. plate coil, and the two below it are the antenna coupling coils. The grid coils for the three bands are at the right.

Finally 250-$\mu\mu$fd. condensers were substituted for the 500-$\mu\mu$fd. size which we had been using, and this capacity proved to be large enough, in conjunction with the choke, to give the desired d.c. note on 3500 kc., and still small enough not to upset things on 14,000 kc. On 7000 kc. this combination functioned equally well. With a good-enough choke the by-pass condensers could probably be eliminated on all bands — and if a separate filament transformer is used for the oscillator filaments neither choke nor condensers are necessary. Certainly there are more things than the filter alone to be considered in getting that elusive d.c. note on high frequencies.

INCREASING POWER

The fact that Type '10 tubes can be used in the set has been mentioned previously. The power output can be considerably increased by using a pair of '10's with about 600 volts on the plate, although there is no advantage in using these tubes with the power supply illustrated — rather the opposite. It may be found desirable to change the size of the grid coils slightly to get the best results with Type '10 tubes, and the method of adjustment already described should be followed. No changes in the other values are necessary, except that a 10,000-ohm leak would allow slightly greater output. The high-resistance leak specified for the '45's is necessary because greater bias is required for efficient operation, the amplification factor of the '45 being less than half that of the '10.

The set is an excellent one for the beginner just as it is, giving as it does a reasonable amount of power output with excellent frequency stability. If higher power is desired later, the money invested is not wasted, because this outfit forms an ideal master-oscillator to feed a pair of amplifier tubes. The output is more than ample to swing a pair of Type '10 tubes with 750 volts on the plates as a neutralized amplifier, and although we have not had an opportunity to try it with larger tubes, should be capable of feeding a pair of '03-A's or '52's to give normal output. Use of the outfit as a master oscillator is highly recommended, because the effect of a swinging antenna on the frequency is eliminated, and since a separate power supply for the oscillator is available the regulation under load conditions is good. In addition, the separately-excited amplifiers will give more output and can be adjusted for greater efficiency than when the same tubes are used as oscillators.

Central Division Convention
(Ohio State)

THE convention this year was held at the Dayton Biltmore Hotel in Dayton, Ohio. Officially the dates were the 30th and 31st of August; however, on the 29th several of the early comers got together in true ham fashion and held a private party the evening of the 29th and friendships were made and renewed before the actual convention. Saturday, delegates arrived from all Ohio and surrounding states and before lunch there were 150 registrations, which gave promise to be a well attended affair.

K. B. Warner and C. C. Rodimon of A.R.R.L. Headquarters appeared on the scene early and trips to the famous Wright Airport were made by some of the delegates while others preferred to visit the Van Horne tube factory or the General Motors Radio Corp.

After lunch the convention was officially opened when Mr. "Art." John, president of the Dayton Amateur Radio Assn., sponsors of this year's convention, welcomed the delegation and was followed in turn by Mayor MacDonald. Director D. J. Angus then gave the fellows a "handshake" and introduced Secretary-Editor Warner and C. C. Rodimon, W1SZ. Short talks were then given by George Morton on "Condenser Microphones"; W. T. Walter, of Jewell Elect. Inst. Co., about "Electrical Measuring Instruments and Their Application to Amateur Radio"; E. C. Estey, of Aluminum Co. of America, told about some of the high spots in the Toronto I. R. E. Convention and also of the "Application of Aluminum to Amateur Radio"; C. H. Vincent, W8RD, spoke on "Aircraft Radio Communication" and H. F. Breckel gave a Naval Reserve talk.

After dinner the gang assembled and listened to talks by F. R. Finehout, E. Springer, J. R. Martin and F. H. Schnell. Schnell of Radio and Television Inst., Chicago, did not have a chance to finish his talk, so it was finished with illustrated slides after the banquet on the following evening. After adjournment Saturday evening, informal chats were held here and there around the hotel until listeners, gradually overcome by the strenuous day, were forced to retire.

Sunday morning a good attendance was noted at the Traffic Meeting. This meeting was presided over by Director Angus and several points that were heretofore hazy were cleared up to the satisfaction of all those present. After this spirited meeting those present assembled out doors and had a group photo taken.

During the afternoon most of the fellows took the trip out to Mason, Ohio, to give WLW-WSAI the once over. The 'phone men were in their element at this Mecca.

All assembled back at the hotel for the great event of the convention — the banquet. The final registration was 201 and when all were seated at the banquet tables there were about 250 present. After a delicious dinner, entertainment and the general hilarity had settled down Director Angus acted as toastmaster and all hands entered in and gave a hand to the Program Committee and D.A.R.A. for one mighty fine convention. Mr. Warner talked on amateur matters and regulations. This was followed by talks from C. C. Rodimon and H. F. Breckel. Mr. Schnell then finished his talk on a superheterodyne receiver. After the prize drawing of some seventy prizes and the 'phone and c.w. men had a general open meeting the curtain was lowered on one more of these amateur conventions which are getting to be more and more cosmopolitan. Mr. L. E. Furrow, W8IX, and his helpers on various committees are to be congratulated on the enjoyable meetings and get-togethers.

— C. C. R.